EFFECT OF INTEGRATED NUTRIENT AND WEED MANAGEMENT ON GROWTH AND YIELD OF SOYBEAN (*Glycine max* L. Merrill)

Thesis
submitted to

NAGALAND UNIVERSITY

in partial fulfillment of requirements for the Degree

of

Doctor of Philosophy

in

AGRONOMY

by

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2022

DECLARATION

I, **Meshenji Apon**, hereby declare that the subject matter of this thesis is the record of work done by me, that the contents of this thesis did not form the basis of the award of any previous degree to me or to the best of my knowledge to anybody else, and that the thesis had not been submitted by me for any research degree in any other university/institute.

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CERTIFICATE – I

This is to certify that the thesis entitled **"Effect of integrated nutrient and weed management on growth and yield of soybean (*Glycine max* L. Merrill)"** to Nagaland University in partial fulfillment of the requirements for the award of degree of Doctor of Philosophy in Agronomy is the record of research work carried out by Ms. **Meshenji Apon** Registration No. **830/2019** under my personal supervision and guidance.

The result of the investigation reported in the thesis have not been submitted for any other degree or diploma. The assistance of all kinds received by the student has been duly acknowledged.

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This is to certify that the thesis entitled **"Effect of integrated nutrient and weed management on growth and yield of soybean *(Glycine max* L. Merrill)"** submitted by Ms. **Meshenji Apon**, Admission No. 212/16 Registration No. 830/2019 to the NAGALAND UNIVERSITY in partial fulfillment of the requirements for the award of degree of Doctor of Philosophy in **Agronomy** has been examined by the Advisory Board and External examiner on ……………….............

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LIST OF ABBREVIATIONS

a.i.	Active ingredient
ANOVA	Analysis of variance
AOAC	Association of Official Agricultural Chemists
Av.	Average
@	At the rate of
B:C	Benefit Cost Ratio
C.D.	Critical difference
Cfu	Colony forming unit
CGR	Crop Growth Rate
cm	Centimetre
DAA	Days after application
DAC & FW	Department of Agriculture, Cooperation and Farmers Welfare
DAS	Days After Sowing
°C	Degree celsius
DF	Degree of Freedom
E	East
E.C.	Emulsifiable concentrate
et al.	And others
etc.	Et cetera
FAO	Food and Agriculture Organisation
fb	Followed by
Fig.	Figure
FYM	Farmyard Manure
>	Greater than
g	Gram
ha^{-1}	Per hectare
Hrs	Hours
HW	Hand weeding
i.e.	Id est (in other words)
kg	Kilogram
l	Litre

LAI	Leaf Area Index
<	Less than
Max.	Maximum
Min.	Minimum
m^2	Square metre
ml	Millilitre
mm	Millimetre
M.S.S.	Mean Sum of Square
^0N	Degree North
no.	Number
NPKS	Nitrogen, Phosphorus, Potassium and Sulphur
NS	Non-Significant
OC	Organic carbon
pH	Negative log of H ion activity
$^{-1}$	Per
%	Percentage
PSB	Phosphate Solubilising Bacteria
PoE	Post-emergence
PE	Pre-emergence
q	Quintal
RGR	Relative Growth Rate
₹	Rupees
S	Significant
SPD	Split Plot Design
SEm±	Standard error of mean
S.S	Sum of Square
t	Tonnes
viz.	Namely
W	West

ABSTRACT

A field experiment on "Effect of integrated nutrient and weed management on growth and yield of soybean (*Glycine max* L. Merrill)" was conducted during the *Kharif* seasons of 2017 and 2018 at the experimental farm of School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema campus. The experiment was laid out in split-plot design with three replications. The main plot consisted of three nutrient management treatments, *viz.* N_1-100% RDF (NPKS-20-60-40-20), N_2-75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB), and N_3-50% RDF + 50% organic through *Rhizobium* + Phosphate solubilising bacteria (PSB) and sub-plot consisted of five weed management treatments *viz.* W_1-Weedy check, W_2-Weed free (Hand weeding at 15, 30 and 45 DAS), W_3-Mechanical weeding at 20 and 40 DAS, W_4-Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS and W_5-Propaquizafop @ 0.075 kg ha^{-1} *a.i.* PoE *fb* Hand weeding at 45 DAS in the sub-plots. The weed flora present in the field were *Cynodon dactylon* L., *Digitaria sanguinalis* L., *Eleusine indica* L., *Bulbostylis barbata* (Rottb.) C.B.Clarke, *Cyperus iria* L., *Cyperus kyllingia* L., *Cyperus rotundus* L., *Ageratum conyzoides* L., *Amaranthus viridis* Hook. F., *Borreria latifolia* (Aubl.) K. Schum., *Cleome rutidosperma* DC., *Mimosa pudica* L. and *Mollugo pentaphylla* L. The average data revealed that N_2 treatment resulted in the maximum growth parameters *viz.* plant height (47.39 cm), number of primary branches plant^{-1} (4.07), dry matter accumulation plant^{-1} (25.04 g plant^{-1}), CGR (7.22 g m^{-2} day^{-1}). It also recorded the highest number of pods plant^{-1} (53.97), pod weight plant^{-1} (18.04 g), grain yield (1.63 t ha^{-1}), and stover yield (2.27 t ha^{-1}) and protein content (38.10%). N_2 treatment was found to be statistically at par with N_3 treatment in terms of plant height, plant dry matter accumulation plant^{-1}, number of root nodules plant^{-1} at 30 and 60 DAS, nodules fresh and dry weight at 30 DAS, number of pods plant^{-1} and stover yield. The different nutrient management practices did not significantly influenced the LAI, RGR, number of seeds pod^{-1}, 100-seed weight, harvest index, days to 50% flowering, days to maturity and oil content. N_3 treatment recorded significantly lower weed density, weed biomass and higher weed control efficiency compared to the other two nutrient treatments. Whereas, maximum weed density and weed biomass was observed in N_2 treatment. No significant variation was found in soil pH after harvest among different management treatments. N_2 treatment recorded significantly the lowest bulk density (1.33 g/cc) and the highest water holding capacity (41.28%), soil organic carbon (1.38%), soil available N, P and K (360.07 kg ha^{-1}, 17.37 kg ha^{-1} and 182.83 kg ha^{-1}, respectively) and soil microbial population. N_2 recorded the maximum NPKS uptake in grain and stover. The highest cost of cultivation and gross returns was recorded in N_2 treatment; however, N_3 treatment resulted in highest net returns (₹ 62682.04 ha^{-1}) and B:C ratio (1.63). With respect to weed management treatments, W_2 recorded higher growth, yield and quality of soybean, soil available NPKS over the rest of the weed treatments. This was followed by W_5 treatment. All of the weed treatments recorded lower weed density and weed biomass over the weedy check significantly. W_2 recorded the lowest weed density and weed biomass and higher weed control efficiency. The weed management treatments did not significantly influence the soil physical properties and microbial population. W_2 treatment recorded the highest soil available NPKS, highest cost of cultivation, gross returns (₹ 136684.26 ha^{-1}) and net returns (₹ 88156.69 ha^{-1}). The highest B:C ratio (1.82) was recorded in W_5 treatment. Interaction of N_2W_2 gave higher grain yield (2.27 t ha^{-1}). N_2W_1 recorded maximum cost of cultivation, gross returns and net returns. However, maximum B:C ratio (2.19) was obtained from N_3W_5.

Keywords: Weed, Nutrient, Soybean, *Rhizobium*, Pendimethalin, Propaquizafop, Yield.

CHAPTER I

INTRODUCTION

INTRODUCTION

Soybean (*Glycine max* (L.) Merrill) is a key oilseed crop with global adaptation, accounting for more than half of global oilseed output. Soybean seed has a unique chemical makeup that comprises several nutraceutical components such as isoflavones, tocopherol, lecithin, and 20% oil and 40% protein, making it one of the most valuable agronomic crops in the world. Owing to its amino acids composition, the protein of soybean is called a complete protein. It can be cultivated as an oilseed crop as well as a pulse crop (Thakare *et al*., 2006). It is known as the "golden bean" and has been dubbed the "wonder crop" of the twenty-first century.

Soybean cultivation has a lot of potential because of its high nutritional quality, high yield, short duration (90-110 days), ability to withstand long dry spells, and the fact that it is a leguminous crop that helps improve soil fertility because it fixes atmospheric nitrogen through root nodules and leaves that are absorbed into the soil at maturity and thereby enhances productivity. As a result, it is known as "Soil Gold" (Saste, 2011). Soybean is a major rainy-season crop in India. Its cultivation has been quickly expanding, and it now ranks first in area and production among the oilseed crops in India. It is produced on 11.20 million hectares and produces 13.2 million tonnes per year. However, despite its great yielding potential (4.5 t ha^{-1}) and making remarkable progress in terms of both coverage and total production, India's soybean productivity (1.18 t ha^{-1}) is significantly lower than the global average of 2.91 t ha^{-1} (FAO, 2016-17).

Soybean is a promising crop in the North Eastern Region of India. In Nagaland, soybean is grown under a total area of 24,980 ha, with a total yield of 31,400 tons and a productivity of 1.26 t ha^{-1} (Anon., 2016-17a). Soybean is used mainly as a fermented product and a pulse crop in Nagaland. Despite its widespread use in a variety of foods, large-scale cultivation and commercial production have received less attention in Nagaland (Mere and Singh, 2015). Because of local cultivars, lack of nutrients, and insufficient fertilization, soybean production in Nagaland is limited, and yields are low (Bhattacharjee *et al*., 2013). Compared to the national average, fertilizer application and consumption in Nagaland is still low. Nagaland consumed 34.71 kg ha^{-1} of NPK, while the national average was 128.34 kg ha^{-1} of NPK (Anon., 2016-17b). Intense weed competition is another significant stumbling block to increase soybean productivity (Nainwal *et al*., 2010). Farmers' plots have been found to have low soybean yields due to crop-weed competition and inadequate soil quality (Sodangi *et al*., 2011). However, by using integrated nutrient and weed management approaches, there is a lot of room to expand its cultivation.

Being an oilseed and pulse crop, soybean is nutrient intensive and therefore, proper nutrient management is one of the most important factors in achieving optimum yield. Chemical fertilizers are the most common source of nutrients and meet the crop's nutrient requirements and increase yield; however, rising production costs, heavy reliance on non-renewable resources, decreased microbial diversity, deficiency in several soil micronutrients, reduced soil productivity and fertility, and increased water contamination, chemical residues in food grains, and population health risks due to their continued usage are all reasons to consider substituting the nutrient requirements of crops with different inputs (Kumar, 2008). Organic manure not only provides nutrients and organic matter, but it also increases the size, biodiversity, and activity of the microbial population in the soil, influences structure, and promotes the turnover of nutrients, among other changes to the soil's physical, chemical, and biological parameters (Albiach *et al*., 2000). However, using organic manures alone is insufficient to provide long-term production sustainability. One technique for maintaining soil fertility for long-term soybean production is to utilize fertilizers judiciously in combination with organic resources. It has been demonstrated that using organic manures in conjunction with fertilizers meets the micronutrient requirements of soybean (Joshi *et al*., 2000).

In order to produce a higher protein meal, soybean requires more nitrogen. Soybean can meet their nitrogen requirement mostly by N_2 fixation from the atmosphere through symbiosis with *Rhizobium* fixation, which may fix up to 200 kg N ha^{-1} per year (Graham and Vanace, 2003). Legumes require a lot of P for growth and nitrogen fixation, and it has been shown to increase leaf area, biomass, yield, nodule number, nodule mass, and other traits in a variety of legumes. It is known that phosphorus deficit can prevent legumes from nodulating, while P fertilizer can help to compensate. However, a considerable amount of P provided as fertilizer reaches the immobile pools as a result of precipitation reactions with highly reactive Aluminum (Al^{3+}) and Iron (Fe^{3+}) in acidic soils (Gyaneshwar *et al.*, 2002). PSB (Phosphate Solubilizing Bacteria) is a key part of P availability because it converts soil P into forms by the secretion of different organic acids that plants can use (Devi *et al*., 2013). Biofertilizers have helped reduce production costs, aiding in increased farm productivity depending upon their activity of mobilizing different nutrients while also avoiding environmental hazards (Galal *et al*., 2001). Therefore, it is becoming increasingly clear that adopting integrated nutrient management, which combines synthetic fertilizers, organic manures, and biofertilizers, is required to maintain soil health and fertility (Ellafi *et al*., 2011). In soybean, the integration of different sources of nutrients has also been demonstrated to increase productivity and monetary rewards (Bhattacharyya *et al*., 2008).

Soybean crop suffers greatly from weed stress because it is a rainy-season crop. In the early part of the growing season, soybean crop is not a strong competitors, so weeds outgrow it. The first 20 to 45 days following sowing is the most critical period for weed competition, and weeds must be kept under control during this time for achieving optimum yield (Bali *et al*., 2016). The percentage of soybean production lost due to weed infestation varies from 37 to

84 percent, depending on the type of weed, the soil, the season, and the severity of the weed infestation (Kachroo *et al*., 2003; Mujalde *et al*., 2018). So, successful weed control is the most significant aspect of obtaining high soybean production in addition to proper nutrient and soil management.

Weed depletes the applied plant nutrients at a faster rate than crop plants and its infestation removes 21.4 kg N and 3.4 kg P ha^{-1} in soybean (Pandya *et al*., 2005). To control weeds in soybean, manual weeding and hoeing are commonly used. Hand weeding is a traditional and effective method of weed control, but labour shortages during peak season, and continuous rains during the crucial weeding period make weed management in soybean a difficult task, while the mechanical method generally result in root injury (Lal *et al*., 2016). So, manual and mechanical weeding may not be effective and cost-effective since it raises cultivation costs and depletes the resource base (Kumar *et al*., 2018a). As a result, farmers are becoming increasingly interested in using herbicides to manage weeds in order to reduce cultivation costs due to labour shortages and expensive costs.

Several herbicides for soybean can be used as pre-plant incorporated, pre-emergence and post-emergence to effectively control annual grass and broad-leaved weeds in soybeans under these conditions (Singh *et al*., 2014; Rana and Rana, 2016). Due to the limited time available for sowing soybean during the *Kharif* season, farmers typically prefer post-emergence herbicides to pre-emergence herbicides for weed management (Sandil *et al*., 2015). Pre-emergence herbicides have been found to be successful in suppressing weeds during the early stages of the crop, but they have not been found to be useful in preventing weed emergence later in the crop. Post-emergence herbicides are gaining popularity as a solution to this problem since they allow farmers to apply it between 10 and 30 days after sowing (Raj *et al*., 2020). However, herbicides applied alone are unable to completely eliminate weeds due to their selective killing. Most farmers are unable to use them owing to their high expenses. Herbicide use may increase weed resistance and negatively affect the crop and environment. As a result, alternative weed control approaches are required. Supplementing their use with manual weeding or hoeing can make them more effective, save money on herbicides, and benefit the crop by ensuring optimum aeration and moisture conservation (Deore *et al.*, 2009). So, the integrated weed management system is a desirable approach to reduce herbicide dosage in effectively managing weeds to sustain and enhance soybean production.

Therefore, taking into account the above points relating to nutrient and weed management in soybean, it was felt necessary to conduct the experiment entitled "Effect of integrated nutrient and weed management on growth and yield of soybean (*Glycine max* L. Merrill)" with the following objectives:

1. To study the effect of integrated nutrient and weed management on growth, yield and quality of soybean.
2. To study the effect of integrated nutrient and weed management on weed flora.
3. To study the effect of integrated nutrient and weed management on soil and microbiological properties.
4. To find the economics of the treatments.

CHAPTER II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

In this chapter, an attempt has been made to review the study undertaken by many workers in different parts of India and the world on various aspects of nutrient and weed management in soybean under the following headings:

1. Weed flora of soybean ecosystem
2. Effect of chemical fertilizers on crop and weed
3. Effect of chemical fertilizers on soil and microbiological properties
4. Effect of integrated nutrient management on crop and weed
5. Effect of integrated nutrient management on soil and microbiological properties
6. Effect of hand weeding on crop and weed
7. Effect of hand weeding on soil and microbiological properties
8. Effect of herbicides on crop and weed
9. Effect of herbicides on soil and microbiological properties
10. Effect of integrated weed management on soybean and weed
11. Effect of integrated weed management on soil and microbiological properties
12. Effect of integrated nutrient and weed management on crop and weed
13. Effect of integrated nutrient and weed management on soil and microbiological properties

2.1 Weed flora of soybean ecosystem

Singh and Kumar (2008) conducted a field experiment during *Kharif* seasons of 2003 and 2004 and reported that the field in soybean crop was infested mainly with monocot weeds (*Cynodon dactylon*, *Cyperus rotundus*, *Echinochloa crusgalli* and *E. colona*) and dicot weeds (*Celosia argentea*, *Digera arvensis*, *Commmelina benghalensis* and *Amaranthus viridis*). The nar-

-row leaved weeds dominated (60%) than the broad-leaved weeds (40%) in terms of density but the dry weight of dicots was more than the monocots.

Vyas and Kushwah (2008) noted about 23 weed species, consisting of both monocots and dicot severely infested the experimental field in weedy check plots at Sehore (Madhya Pradesh). Among monocot weeds, *Cyperus rotundus, Digitaria sanguinalis, Echinocloa colonum. Commelina benghalenis, Cynotis axillaries and Dinebra arabica* were dominant whereas *Caesulia axillaries, Acalypha indica, Anotis mothulani, Digera arvensis, Xanthium strumarium, Phyllanthus maderaspteris, Corchorus* sp. and *Euphorbia sp.* were dominant among dicot weeds.

Dhaker *et al*. (2010) found *Echinochloa colona, Cynodon dactylon, Cyperus rotundus* among monocot weeds and *Trianathema portulacastrum, Commelina benghalensis, Amaranthus spinosus, Digera arvensis and Parthenium hysterophorus* among dicot weeds in the experimental field during *Kharif* -2009 at Instructional Farm, Rajasthan College of Agriculture, Udaipur. Overall the experiment was dominated by monocot weeds.

Chander *et al.* (2013) reported that the experimental field conducted at *Kharif* 2009-10 and 2010-11 at Palampur was infested with *Commelina benghalensis* (43.36 and 57.87% during 2009 and 2010, respectively), *Echinochloa colona* (18.04 and 15.02%), *Aeschynomene indica* (3.78 and 2.73%), *Ageratum conyzoides* (3.68 and 4.91%), *Panicum dichotomiflorum* (11.53 and 5.12%), *Digitaria sanguinalis* (4.25 and 3.69%), *Eleusine indica* (3.54 and 3.48%) and *Cyperus* sp. (9.21 and 5.12%). *Commelina benghalensis* was found to be the most dominant weed in soybean.

Sangeetha *et al.* (2013) conducted a field experiment during *Kharif* seasons of 2009 at Agricultural Research Station, Bhavanisagar, Tamil Nadu and observed that *Dactyloctenium aegypticum, Acrachne racemosa* and *Bracharia reptans*, were the dominant grass weeds. *Cyperus rotundus* was the only sedge present and the predominant broad-leaved weeds were *Boerhavia diffusa, Digera arvensis, Parthenium hysterophorus* and *Trichodesma indicum.*

Singh *et al.* (2013) concluded from an experiment conducted at JNKVV, Jabalpur during *Kharif* 2008 that among the monocot weeds *Echinochloa colona, Dinebra retroflexa* and *Cyperus iria* were the most dominant weed. Whereas, dicot weeds like *Eclipta alba* and *Alternanthera philoxeroides* (19.2 and 20.2%) were observed to be less dominant in soybean ecosystem.

Panda *et al.* (2015) revealed that grassy weeds were predominant (76.25%) compared with broadleaved weeds (23.75%) in the experimental field conducted at the Product Testing Unit, JNKVV, Jabalpur during *Kharif* season 2013 and 2014. However, *Echinochloa colona* (33.90%) and *Dinebra retroflexa* (23.90%) were predominant in soybean. Other weeds such as *Cyperus rotundus, Cynodon dactylon, Alternanthera philoxeroides, Eclipta alba and Mollugo pentaphylla* were also present.

Parmar *et al.* (2016) conducted a field investigation during *Kharif* season of 2014 at the Research Farm, College of Agriculture, Tikamgarh, Madhya Pradesh and reported that there was prevalence of dicot weeds in the experimental field (relative density of 66.1%) as compared to monocot weeds (relative density of 33.9%). In the dicot weeds, the intensity of *Phyllanthus niruri* was the highest (23.7%) followed by *Digera arvensis* (15.8%) and *Trianthema monogyna* (10.8%) whereas *Echinochloa colona* (15.3%) and *Cyperus rotundus* (11.1%) were seen as dominant monocot weeds in the field.

Parmar *et al*. (2017) concluded that the major eight weed species contributing about 90% of the total weed flora in the experimental plots were *Cyperus rotundus, Echinochloa colonum, Commelina benghalensis, Digera arvensis, Phyllanthus niruri, Trianthema monogyna, Corchorus olitorius,* and *Leucas aspera.*

Sharma *et al.* (2016a) reported from the field experiment carried out at Rajasthan College of Agriculture, MPUAT, Udaipur during *Kharif* 2014 that the field was heavily infested with mixed flora of broad–leaved, sedge and grassy weeds, *viz. Trianthema portulacastrum, Commelina benghalensis, Parthenium hysterophorus, Amaranthus viridis, Digera arvensis, Cynodon dactylon, Echinochloa colona* and *Cyperus rotundus*.

Virk *et al.* (2018) conducted a field experiment at Punjab Agricultural university, Ludhiana during *Kharif* and reported that the major weed flora comprised of *Cyperus rotundus, Arachne racemosa, Commelina benghalensis, Digitaria ciliaris* and *Eleucine aegyptiacum*.

Jadhav and Kashid (2019) carried out an experiment at Agricultural Research Station, Karad Maharashtra and reported that the dominant weeds in the experimental field during the three years were *Cynodon dactylon, Cyperus rotundus, Celosia argentea, Portulaca oleracea, Eclipta alba, Echinochloa colona, Alternenthra* spp.*, Euphorbia* spp. *etc*.

2.2 Effect of chemical fertilizers on crop and weed

Sharma *et al*. (2002) showed that applying 60 P_20_5 kg ha^{-1} significantly improved plant height, branches plant^{-1}, nodules plant^{-1}, nodule weight plant^{-1}, dry matter accumulation plant^{-1} and seed yield over 30 P_20_5 kg ha^{-1}.

Farhad *et al.* (2010) conducted a field experiment at the Sher-e-Bangla Agricultural University Farm, Dhaka during the period from December 2008 to April 2009 to study the role of potassium and sulphur on the growth, yield and oil content of soybean (*Glycine max* var. BARI Soybean-5). Results revealed that the application of potassium at 40 kg ha^{-1} produced the highest plant height, seed yield, 1000-seed weight and straw yield. And the application of sulphur at 20 kg ha^{-1} produced the highest plant height, seed yield, 1000-seed weight and straw yield. The combined application of potassium at 40 kg ha^{-1} and sulphur at

20 kg ha^{-1} resulted in the highest seed yield, plant height, 1000-seed weight, straw yield, protein and oil content of soybean.

Mahmoodi *et al*. (2013) conducted an experiment at Mahmoud Abad Agricultural Research Center of Mazandaran Province, Iran, in 2011. The results indicated that the increase in the application of phosphorous fertilizer caused a significant increase in the plant height, number of pod plant^{-1}, number of seed pod^{-1}, seed yield and oil concentration of the seed of soybean. Maximum yield and seed oil concentration (5158.27 kg ha^{-1} and 17.48% respectively) were registered under 90 kg P ha^{-1}. Meanwhile, the application of the 40 kg S ha^{-1} had the maximum seed yield and oil concentration by producing 4653.81 kg ha^{-1} and 16.97%, respectively.

Rachna and Badiyala (2014) revealed that 100% RDF resulted in significantly highest seed yield (1.59 t ha^{-1}) and straw yield (3.25 t ha^{-1}) of soybean as compared to 50% RDF and the control. In addition, 100% RDF also recorded significantly highest oil content (19.7%), oil yield (310.3 kg ha^{-1}) and NPK uptake.

Thenua *et al.* (2014) conducted a field experiment during *Kharif* seasons of 2009 and 2010 at Agronomical Research Farm of Amar Singh College Lakhaoti, Bulandshahr (CCS University, Meerut) and showed that the highest yield of soybean was recorded under 40 kg S ha^{-1}, it was closely followed by 30 kg S ha^{-1} and application of Zinc at 30 kg ha^{-1} recorded higher yield as compared to its lower levels.

Walia *et al*. (2014) revealed that the lowest count of weeds m^{-2} and dry matter accumulation by weeds were found in treatment where 100% RDF (NPK) was added to rice and wheat crops. Whereas, the highest weed count was recorded in treatments where no fertilizer or organic manures as well as sub-optimum doses of fertilizers were added which was significantly higher than all other treatments.

Chakma *et al.* (2015) revealed in a field experiment carried out at the Field Research Site of Bangabandhu Sheikh MujiburRahman Agricultural University (BSMRAU), Gazipur in 2013 that the number of pods, seeds pod^{-1}, 100-seed weight and seed yield of soybean were high with RDF (27.6, 36.96, 59.76, 18.72, 1.05 kg NPKSB ha^{-1}).

Verma *et al*. (2015) conducted a field experiment at research farm, IGKV, Raipur during *Zaid* and *Kharif* season of 2012 on Vertisols, and showed that the application of 100% (RDF) was found to be significantly superior over other treatments in producing higher number pods per plant, seeds per pod, higher test weight, higher seed and stover yields.

Tambe *et al.* (2019) conducted an experiment at IFS, MPKV, Rahuri and revealed that the total nitrogen uptake (210 kg ha^{-1}), total phosphorous uptake (35 kg ha^{-1}), total potassium uptake (90 kg ha^{-1}) of soybean was recorded significantly highest with the application of 100% recommended NPK dose though fertilizers which was at par with 50% N through FYM + 50% RDF.

2.3 Effect of chemical fertilizers on soil and microbiological properties

Meena *et al.* (2013) revealed from a field experiment, conducted in *Rabi* season 2009-10 at Agricultural Research Farm, BHU, Varanasi, on alluvial soils that the total bacterial counts ranged from 42×10^5 cfu g^{-1} to 67×10^6 cfu g^{-1}, while the fungal density varied from 35×10^5 cfu g^{-1} to 70×10^5 cfu g^{-1} and actinomycetes range 43×10^5 cfu g^{-1} to 62×10^5 cfu g$^{-1.}$ The highest microbial population was recorded during wheat's flowering stage with 100% NPK+300 kg well grow soil ha^{-1}, while the lowest counts were recorded after harvest with 100% RDF.

Bonde and Gawade (2017) reported that the organic carbon, available N, P, K, S and Zn increased with increasing levels of fertilizers whereas pH and EC decreased.

Deekshitha *et al*. (2017) conducted a field experiment during *Kharif*, 2013 at Agricultural college farm, Bapatla on *Bt* cotton and revealed that application of higher doses of fertilizers in combination with sulphur significantly influenced the microbial properties. Treatments which received 125 and 150% RDF + S @30 kg ha^{-1} were at par and higher in microbial activity over the 100% RDF treatment.

Patel *et al.* (2018) reported that the availability of N, P, K, S, soil microbial biomass carbon (SMBC) and soil microbial biomass nitrogen (SMBN) were increased significantly with the integrated application of fertilizers and FYM over control and other fertilizer treatments (*i.e.* 50% NPK, 100% NPK, 150% NPK, 100% NP, 100% N, 100% NPKS) under soybean-wheat cropping sequence.

Raut *et al.* (2018) reported that the mean N, P and K content, total N, P and K uptake in soybean crop and available N, P and K were maximum with the application of 125% RDF followed by 100% RDF.

Suman *et al.* (2018) found that increasing the application of sulphur and phosphorus, singly as well as in combination, significantly increased the grain yield and contents of N, P and K of soybean over control. Available P in soil increased with increasing levels of phosphorus. Similarly, available S in the soil increased with increasing levels of sulphur.

Aziz *et al.* (2019) reported that soil physical properties were enhanced by application of recommended inorganic fertilizers except for bulk density.

Ravi *et al*. (2019) conducted an experiment during *Kharif* of 2014 and 2015 at Krishi Vigyana Kendra (KVK), Bidar, University of Agricultural Sciences, Raichur, Karnataka, India to assess the sulphur and boron nutrition on chemical properties of soil after harvest of soybean under rainfed situation of Northern Karnataka. Results indicated that among different rate of sulphur and boron application along with recommended dose of fertilizer was significantly not differed with respect to pH and organic carbon content in soil after harvest of soybean. Application of recommended dose of fertilizer + 12 kg $ZnSO_4$ ha^{-1} + 30 kg Sulphur ha^{-1} +1.0 kg Boron ha^{-1} recorded significantly (p=0.05) higher available nitrogen (283.5 kg ha^{-1}), phosphorus (30.5 kg ha^{-1}), potassium (407.5 kg ha^{-1}), sulphur (22.82 kg ha^{-1}) and boron (0.44 ppm) in soil after harvest of soybean and was at par with the application of recommended dose of fertilizer + 12 kg $ZnSO_4$ ha^{-1}+30 kg Sulphur ha^{-1} + 1.5 kg Boron ha^{-1} (21.5 q ha^{-1}) compared to other treatments.

Dwivedi *et al*. (2020) conducted a field experiment under All India Co-ordinate Research Project on "Long term Fertilizer Experiment" during *Kharif* season 2014-15 with soybean-wheat cropping system at the D3 block of the Norman E. Borlaug Crop Research Centre, G.B. Pant University of Agriculture and Technology, Pantnagar. The result indicated that the treatments of combined application of chemical fertilizers with and without FYM have significant effect on organic carbon content, available nitrogen, phosphorus and potassium content in surface soil of soybean under soybean-wheat cropping system.

Lokya *et al*. (2021) reported from a field experiment on soybean conducted on farmer's field at Kanehri, Tq. Barshitakli, Dist. Akola during *Kharif* 2015-16 that the soil chemical properties *viz*. pH, EC and organic carbon were significantly improved with the application of 30:75:90 kg NPK ha^{-1} followed by 30:75:60 kg NPK ha^{-1}. The available N, P and K were improved significantly with the application of 90 kg K_2O ha^{-1} along with recommended dose of N and K in soybean crop.

2.4 Effect of integrated nutrient management on crop and weed

Wasule *et al.* (2007) reported that applying full fertilizer dose + *Rhizobium* + PSB gave the highest 1000 seed weight (109.92 gm). Whereas half fertilizer dose + *Rhizobium* + PSB gave highest yield (10.67 q ha^{-1}), which was equivalent to yield recorded with full fertilizer dose + *Rhizobium* + PSB (10.66 q ha^{-1}) and *Rhizobium* + PSB (10.63 q ha^{-1}).

Dhage and Kachhave (2008) revealed that the highest grain yield was recorded due to the inoculation of *Rhizobium* + PSB with 100% RDF. The highest grain yield of 15.46 q ha^{-1} was recorded in 100% RDF + *Rhizobium* + PSB significantly superior over all the treatments. The highest N (6.23%), P (2.68%) and K (2.29%) contents in seed was obtained in 100% RDF+ *Rhizobium* + PSB treatment. Dual inoculation of *Rhizobium* + PSB also improved the quality of soybean in presence as well as absence of chemical fertilizer. The residual fertility in soil was also more due to 100% RDF + *Rhizobium* + PSB treatment.

Aziz *et al.* (2011) studied the effect of integrated nutrient management for soybean under temperate conditions at KVK, Srinagar and revealed that the application of 75% recommended inorganic fertilizers with 10 t ha^{-1} FYM and dual inoculation of *Rhizobium* and PSB showed significantly superior seed quality over control.

Koushal and Singh (2011) reported that the maximum plant height of 16.89 cm, 65.78 cm, and 73.37 cm at 30, 60 and 90 DAS, the highest number of pods per plant (80.40) and the highest test weight (17.02 g) was recorded in the treatment where 50% recommended N applied through urea + 50% N through FYM + PSB and the lowest of these were found in the control treatment.

Reddy *et al*. (2011) conducted an experiment at Regional Agricultural Research Station, Lam, Guntur, ANGRAU and reported that 50% RDF + seed treatment with *Rhizobium* at 200 g kg^{-1} seed recorded significantly more number of branches, pods, higher seed yield and net returns.

Ahsan *et al*. (2012) conducted an experiment at Bangladesh Agricultural University to study the integrated use of phosphate solubilizing bacteria (PSB), *Bradyrhizobium* and P on nodulation and sustainable soybean production and reported that integrated nutrient management with the application of 60% of the recommended dose of phosphorus, PSB and *Bradyrhizobium* has significantly increased plant height, number of nodule plant^{-1}, nodule dry weight plant^{-1}, pod plant^{-1} and seeds pod^{-1} in soybean.

Leela *et al*. (2012) reported that 50% recommended N applied through urea + 50% N through FYM + PSB recorded significantly higher number of pod plant^{-1}, test weight, seed yield, oil content and oil yield in soybean. The uptake of nutrients (N, P, K, Ca, Mg, S, Cu, Zn, Fe and Mn) was positive and significantly correlated with the seed yield.

Waghmare *et al*. (2012) conducted an experiment at the Research Farm, Department of Agronomy, Latur, to study the effect of integrated nutrient management in soybean on its yield attributes, seed yield and quality attributes. Application of 75% NPK with FYM and *Rhizobium* and PSB has significantly increased pod yield plant^{-1}, seed yield plant^{-1}, 100 seed weight, seed yield, protein and oil yield in soybean over all other treatments. Maximum seed yield, straw yield and biological yield were observed at 75% RDF applied with FYM at 5 t ha^{-1} over control.

Billore and Srivatava (2015) conducted field experiments at different locations across four agro-climatic regions of India for three years (2009-11) under All India Coordinated Research Project on Soybean. The results showed that integration of inorganic fertilizers with FYM increased the seed yield over control by 10.9, 7.5, 5.5 and 9.8 per cent in North Plain, North Eastern, Central and Southern zones, respectively. The integration of nutrient carriers led to a reduction in chemical fertilizer components between 10 and 20 per cent.

Borah *et al*. (2015) conducted a field experiment on nutrient management practices in direct sown rainfed upland rice during the *Kharif* seasons of 2007 and 2008 in the demonstration farm of Krishi Vigyan Kendra, Tirap district, Deomali, Arunachal Pradesh and showed that application of 75% RDN through FYM + 25 % RDF recorded higher weed infestation than other treatments during both the years. Whereas, INM with 50% RDN through FYM + 50% RDF considerably reduced weed infestation, which was comparable to other nutrient management practices except a higher level of FYM application.

Jaga and Satish (2015) reported that the integrated use of 75% RDF with PSB and *Rhizobium* recorded significantly higher nodules plant^{-1}, nodules weight, plant height, pods plant^{-1}, seeds pod^{-1}, seed yield, leaf area index and harvest index.

Vyas and Kushwah (2015) conducted a field experiment during *Kharif* 2009, 2010 and 2011 under All India Coordinated Research Project on soybean at RAK College of Agriculture, Sehore, to assess the optimum nutrient level for soybean varieties in Vertisols of Vindhyan plateau of Madhya Pradesh. Results showed that the growth and yield attributes, seed and straw yield, total uptake and balance of nitrogen, phosphorus and potassium in soil were significantly higher with the application of 125% RDF (20:60:20:20:: N: P_2O_5: K_2O: S kg ha^{-1}) with FYM at 5 t ha^{-1} than other fertilizer schedules except for 100% RDF with FYM at 5 t ha^{-1}.

Bonde and Gawande (2017) conducted a field experiment at Amravati (Maharashtra) during the *Kharif* season of 2010 and 2011, and it was observed that the application of 75% NP + 4 t FYM ha^{-1} + 25 kg S ha^{-1} produced the highest seed (29.59 q ha^{-1}) and straw (4.49 q ha^{-1}) yield which were 50.2 and 50.8% more than that of control. The uptake of N, P, K and S by soybean seeds and straw was the highest at 75% NP + 4t FYM + 25 kg S ha^{-1} and the lowest in control.

Geetha *et al*. (2017) conducted a field experiment during the *Kharif* season of 2013-14 at main Agriculture Research Station (MARS), Dharwad, Karnataka. Application of 80 kg P_2O_5 ha^{-1} cured with FYM + PSB + VAM recorded significantly higher grain yield of 30.80 q ha^{-1} and straw yield of 45.40 q ha^{-1}. It also resulted in the highest net returns of ₹ 63995 ha^{-1} and benefit cost ratio of 3.30.

Verma *et al.* (2017) conducted a field experiment at Udaipur (Rajasthan) to assess the effect of integrated nutrient management on the growth, quality and yield of soybean during the *Kharif* seasons of 2014 and 2015. The results revealed that the application of 75 % NPK + 25 % N through vermicompost + *Rhizobium* + PSB recorded the highest values of plant height (58.2 cm), dry matter accumulation (27.3 g), number of total and effective nodules (34.5 and 18.6) and yield attributes *viz.*, number of pods plant^{-1} (52.0), number of seeds pod^{-1} (3.7), seed yield plant^{-1} (14.8 g), test weight (113.7 g). Furthermore, this treatment also gave significantly higher values of the seed yield (2.3 t ha^{-1}), haulm yield (2.7 t ha^{-1}) and biological yield (5.1 t ha^{-1}), oil content (20.1 %), oil yield (476.2 kg ha^{-1}), protein content (41.5 %), protein yield (976.8 kg ha^{-1}), net returns (₹71882 ha^{-1}**)** and B: C ratio (2.90) than rest of the treatments.

Dipak *et al*. (2018) conducted a field experiment on soybean *Cv*. MAUS-71 at the Department of Soil Science and Agricultural Chemistry, College of agriculture, Latur during *Kharif* season of 2008-2009, and reported that under rainfed conditions for achieving higher grain and straw yield, soybean crop should be fertilized with 50% RDF + 10 t FYM ha^{-1} + 45 kg S ha^{-1} + biofertilizer which is more beneficial and reduces 50% dose of fertilizer over treatment 100% RDF + 10 t FYM + 45 kg S ha^{-1} + Biofertilizer.

Jalalzai *et al*. (2018) conducted field research during the spring season in 2017 in Paktia province, Afghanistan and the results showed that application of recommended NPK + FYM + PSB + *Rhizobium* recorded significantly higher plant height (40 cm at 60 DAS and 51.47 cm at harvest), number of branches (6.57 at 60 DAS and 8.40 at harvest), number of root nodules (34 at 60 DAS and 58.43 at harvest), number of pods per plant (66.03), number of seeds per pod

(2.57), 100 seeds weight (20.33 g), seed yield per plant (20.13 g), seed yield (2490 kg ha^{-1}) and straw yield (4109 kg ha^{-1}). The same treatment recorded a non-significantly higher harvest index (38.20) and significantly higher gross return (1929 US$ ha^{-1}), net return (1067 US$ ha^{-1}) and net benefit cost ratio (1.36).

Solanki *et al.* (2018a) investigated the impact of integrated application of inorganic fertilizer (NPK) and farmyard manure (FYM) on soybean and found that the integrated fertilizer application significantly ($P<0.05$) enhanced the nodulation rate, total chlorophyll, grain yield and grain nutrient uptake over control.

Chaudhari *et al.* (2019) studied the effect of INM on growth, yield a quality of soybean at the College of Agriculture, Badnapur and observed the significantly highest plant height (51.70 cm) in treatment 100% NPKS + biofertilizer + FYM at harvesting stage over the control. The higher number of pods $plant^{-1}$ (71.05) were recorded with an application of 100% NPKS + biofertilizer + FYM. Maximum nodules $plant^{-1}$ (30.40) were observed in the plot that received 100% NPKS + biofertilizer + FYM. Application of 100% NPKS + Biofertilizer + FYM recorded highest seed yield $plant^{-1}$ (15.91 g $plant^{-1}$ and 1815 kg ha^{-1}) and protein content (31.34 %).

2.5 Effect of integrated nutrient management on soil and microbiological properties

Bandyopadhyay *et al.* (2010) reported that conjunctive use of recommended dose of fertilizer and farmyard manure (NPK+FYM) resulted in significant ($P < 0.05$) decrease of bulk density (9.3%) and soil organic carbon content (45.2%) compared to control.

Dhok (2011) reported that the population of soil bacteria, fungi and actinomycetes was favoured under the integrated management modules in soybean-wheat and soybean-gram cropping system. The value of N, P, and K status of soil was found significantly superior with 50% RDF + FYM at 5 t ha^{-1} over organic or inorganic modules.

Wanjari *et al*. (2013) revealed that applying the recommended dose of NPK along with FYM or lime (in Alfisols) has further improved the richness of soil microbial fauna in terms of their count, enzymatic activity and active pools of nutrients.

Shirale *et al*. (2014) revealed that the improvement of soil properties concerning pH, EC, OC, available NPKS and Zn was prominent with the application of 100% NPK+FYM at 10 Mg ha^{-1}.

Geetha *et al.* (2018) revealed that the available N, P, K and S and micronutrients of soil after soybean harvest improved significantly due to the integration of inorganic fertilizers with organic manures.

Aziz *et al.* (2019) reported that applying the recommended dose of inorganic fertilizers and 10 t ha^{-1} FYM improved the soil physical properties. Dual inoculation with *Rhizobium* + PSB has shown significantly superior results in improved soil physical properties over no-inoculation.

Yadav *et al*. (2019) reported that soil organic carbon, available N and available P were significantly increased with the conjoint application of organic manure and inorganic fertilizer in comparison to application of fertilizer alone.

Bairwa *et al.* (2021) reported on the project on long-term fertilizer experiment with soybean-wheat cropping sequence since 1972 at the Research Farm of Department of Soil Science and Agricultural Chemistry, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur that there was a significant increase in soil organic carbon, total N and available N recorded with 100% NPK+FYM. The bacteria, fungi and actinomycetes population counts in soil were 39.1×10^{7}, 42.7×10^{4} and 39.1×10^{5} cfu g^{-1} soil, respectively with the application of 100%

NPK+FYM over control (11.7×10^7, 18.5×10^4 and 13.6×10^5 cfu g^{-1} soil, respectively).

2.6 Effect of hand weeding on crop and weed

Singh and Kumar (2008) conducted a field experiment during the *Kharif* seasons of 2003 and 2004 in soybean crops in south-eastern Rajasthan and showed that the lowest weed density and biomass were recorded with two hand weedings at 30 and 45 DAS.

Wadafale *et al*. (2011) reported that the treatment of two hoeings and two hand weedings at 20 DAS and 35 DAS was at par with the application of imazethapyr @ 75 g a.i. ha^{-1} at 15 DAS + 1 hoeing and 1 hand weeding at 35 DAS and chlorimuron ethyl @ 10 g a.i. ha^{-1} at 15 DAS + 1 hoeing and 1 hand weeding at 35 DAS in soybean crop. These treatments were more effective in controlling weeds throughout the crop growth period and improving growth characters *viz*., plant height, number of leaves $plant^{-1}$, leaf area index, number of branches $plant^{-1}$ and plant dry matter (g) significantly over the rest of the treatments under study.

Jadhav and Gadade (2012) carried out the field experiment at weed science research center, MKV, Parbhani during 2011 and 2012 in soybean and showed that the grain yield and straw yield were highest with 2 hand weeding and hoeing treatments. Two hand weedings at 20 and 40 DAS significantly reduced the weed density and dry weed weight at 30 DAS and 60 DAS respectively over weedy check, and was at par with imazethapyr + imazamox 30 g ha^{-1} and imazethapyr 0.1 kg ha^{-1} as PoE at 20 DAS.

Singh *et al*. (2013) showed that two hand weedings checked the weed growth and recorded significantly higher seed yield (1.87 t ha^{-1}) of soybean over the rest of the treatments, but net monetary return (₹15,594 ha^{-1}) was lower than the application of quizalofop-p-ethyl 37.5 g ha^{-1} + chlorimuron 24 g ha^{-1}.

Bali *et al.* (2016) revealed that the lowest weed density and weed dry matter in soybean crop was recorded in twice hand weeding at 15 and 35 DAS.

Devi *et al*. (2016) revealed plant height, the number of pods plant^{-1} and seed yield of soybean was highest in twice hand weeding at 20 and 40 DAS.

Parmar *et al.* (2016) revealed that the seed yield of soybean was significantly higher under two hand weeding at 20 and 40 DAS. Conversely, uncontrolled weeds in weedy check resulted yield loss of 52.25% in soybean.

Patel *et al*. (2016) carried out a field experiment on the silty clay soil at Mahatma Phule Krishi Vidyapith, Rahuri (Maharastra) during *Kharif* 2013-2014. One hoeing at 15 DAS + two hand weeding at 25 and 45 DAS was found to be the best treatment for growth attributing and yield attributing characters of soybean. The weed dry matter and intensity were lowest in one hoeing at 15 DAS + two hand weeding at 25 and 45 DAS.

Parmar *et al*. (2017) revealed that hand weeding twice was most effective and recorded minimum weed intensity among all the treatments in soybean crop. The highest weed control efficiency was recorded under hand weeding twice at 20 and 40 DAS (96.27%). Seed yield (922.22 kg ha^{-1}) was also found to be significantly higher under two hand weeding at 20 and 40 DAS.

Paudel *et al*. (2017) reported that two hand weedings at 20 and 40 DAS with the highest weed control efficiency (84.29 %) recorded the lowest weed population and weed dry matter accumulation with the highest growth and yield attributes, seed and stalk yield of soybean.

Rajkumari *et al*. (2017) reported from a field experiment conducted at Rajasthan College of Agriculture, Udaipur, during *Kharif* 2007 and 2008 that hand weeding twice gave significantly the highest plant height, RGR, CGR, seed yield, stover yield and the highest chlorophyll content in soybean.

Raj *et al.* (2020) reported that hand weeding twice at 25 and 45 DAS was found the most effective in controlling weeds in soybean and recorded the lowest weed count, weed dry matter, and highest weed control efficiency.

2.7 Effect of hand weeding on soil and microbiological properties

Panneerselvam *et al.* (2000) revealed that the P uptake of soybean at 40, 60 DAS and at harvest was increased considerably by hand weeding twice in soybean crop. Hand weeding twice also favourably increased the availability of P in soil.

Pachauri *et al*. (2012) observed that cultural operation enhanced the microbial population in the soil as compared to the control (weedy check) or weedicide application in soybean crops.

Deshmukh *et al*. (2013) revealed that organic carbon content (8.0 g kg^{-1}), soil porosity (48%) and cation exchange capacity (63.66 cmol (p+) kg^{-1}) was significantly higher in the plots treated with 3 hoeings and 3 hand weedings as compared to all other herbicide treatments applied as a pre and post-emergence. An almost similar trend was observed in the available N (184.90 kg ha^{-1}), available P (11.70 kg ha^{-1}) and available K (666.20 kg ha^{-1}). The practice of 3 hoeing and 3 hand weedings showed the highest efficiency in weed control of cotton crop and thus reflected in higher yields.

Toppo *et al.* (2019) conducted a field experiment during the *Kharif* season of 2010 at Research cum Instructional farm, IGKV, Raipur (C. G.) and revealed that hand weeding twice at 20 and 40 DAS was equally effective with wheel hoeing to the productivity of soybean. Furthermore, the rhizobial population was comparable in hand weeding and wheel hoeing at 50 DAS.

2.8 Effect of herbicides on crop and weed

Panneerselvam and Lourduraj (2000) conducted a field experiment from 1994 to 1996 on different weed management practices in soybean and revealed that at early stages, weed control efficiency (WCE) was higher with alachlor 1.0 kg ha^{-1} followed by pendimethalin 0.75 kg ha^{-1}. However, in the later stages, hand weeding twice registered the highest WCE due to effective control of weeds in all the seasons.

Pradhan *et al.* (2010) revealed that the post-emergence application of lactofen 120 g ha^{-1} + propaquizafop 60 g ha^{-1} was found to have higher weed control efficiency with higher grain yield of soybean. All the recorded weed flora were found to reduce dry matter accumulation by combined herbicides rather than alone application.

Sangeetha *et al.* (2012) showed that early post-emergence application of imazethapyr in soybean reduced broad-leaved weeds and grass density and dry weight compared with pre-emergence application of pendimethalin and oxyfluorfen.

Jha and Soni (2013) conducted a field experiment at Jabalpur and showed that the maximum weed control efficiency (80.0%) was observed with the application of pendimethalin (0.75 kg ha^{-1}) *fb* imazethapyr (0.75 g ha^{-1}).

Panda *et al.* (2015) conducted a field experiment at the Product Testing Unit, JNKVV, Jabalpur, during the *Kharif* seasons of 2013 and 2014 to adjudge the efficacy of propaquizafop and imazethapyr mixture against weeds in soybean. It was shown that post-emergence application of propaquizafop (75 g ha^{-1}) alone curbed only grassy weeds. However, its efficacy was improved when combined with imazethapyr, being higher under propaquizafop + imazethapyr mixture applied at 53 + 80 g ha^{-1} or higher rate (56 + 85 g ha^{-1}). Yield attributing characters and yield were superior under propaquizafop + imazethapyr mixture applied at 56 + 85 g ha^{-1} followed by 53 + 80 g ha$^{-1,}$ which were comparable to hand weeding twice at 20 and 40 DAS.

Sandil *et al.* (2015) conducted an experiment in soybean crop on the agricultural farm at Jawaharlal Nehru Krishi Vishwa Vidyalaya at Jabalpur in 2011-12 and revealed that among the propaquizafop treatments, the activity of propaquizafop at the lowest dose (62.5 g ha^{-1}) and highest dose (75 g ha^{-1}) as post emergence was not well marked against most of the weeds (broad-leaved) but imazethapyr applied at 50, 75, 100 g ha^{-1} controlled broadleaved and grassy leaved weeds. Among herbicidal treatments, the combined application of propaquizafop + imazethapyr as post-emergence 75 + 100 g ha^{-1} was most effective in reducing most weed flora.

Devi *et al*. (2016) revealed that the weed index was found to be the highest with weedy check (42.10%) followed by the pre-emergence application of pendimethalin (19.09%) in soybean.

Lal *et al.* (2017) conducted a field experiment during the *Kharif* seasons of 2013 and 2014 at Livestock Farm, JNKVV, Jabalpur (M.P.). Post-emergence application of propaquizafop + imazethapyr mixture at 53 + 74 and 56 + 78 g ha^{-1} at 30 days after application in soybean crop effectively curbed the density and dry weight of grasses, sedges and broad-leaved weeds and attained superior values of weed indices, yield attributing traits, seed and haulm yields comparable to hand weeding twice (20 and 40 DAS) in soybean. It was also found to be superior over application of mixture at lower rates (47 + 66 and 50 + 70 g ha^{-1}), sole application of propaquizafop (75 g ha^{-1}) and imazethapyr (100 g ha^{-1}) which attained the low values of weed indices due to poor weed control.

Kumar *et al.* (2018b) revealed that application of propaquizafop 50 g + imazethapyr 100 g ha^{-1} followed by a post-emergence tank-mix combination of quizalofop-ethyl 60g + chlorimuron-ethyl 4 g ha^{-1} at 20 DAS gave higher weed control efficiency, crop resistance index and lowest weed index over other treatments in soybean. Net returns due to weed control were highest in post-emergence tank-mix combination of propaquizafop 50g + imazethapyr 100 g ha^{-1}.

2.9 Effect of herbicides on soil and microbiological properties

Herbicides have been used successfully in India to control weeds in agricultural systems. Herbicide field doses are usually safe for soil microbes, although their response to herbicide application cannot be expected in all situations. This is because the herbicide-microbe interaction is influenced by a variety of soil and climatic parameters such as temperature, soil moisture, acidity and the herbicide's molecular arrangement (Patil *et al*., 2020). One of the likely causes of productivity decline has been identified as a shift in soil microbiota. So, herbicide use in agriculture may disrupt and change the ecological balance in the soil. Herbicides can modify soil microbial populations' qualitative and quantitative composition and enzyme activity (Saeki and Toyota, 2004). According to Sandor (2006), herbicides reduced the quantity of total viable bacteria and microscopic fungi.

Sarkar and Majumdar (2013) revealed that the application of pre and post-emergence herbicides in jute affected the total bacteria, actinomycetes and fungi population in soil initially, but the microbial population improved gradually and reached to normal level by harvest.

Bera and Ghosh (2014) reported that though, herbicide treatments resulted in decreases in microbial counts initially but with the degradation of applied herbicides within considerable time, the population even exceeded later than the initial count. In general, the soil microflora population (*viz.* total bacteria, actinomycetes and fungi) and soil physico-chemical properties (*viz*. bulk density, water holding capacity, moisture content, soil pH, organic matter content, electrical conductivity, total nitrogen, available phosphorus and available potassium contents), herbicidal treatments did not show any long run adverse effect on the field soil of the experimental field of potato and was safe in comparison to untreated control.

Younesabadi *et al.* (2014) concluded from two years of studies during the rainy seasons of 2010 and 2011 at Indian Agricultural Research Institute, New Delhi, that irrespective of weed species pendimethalin 0.5 kg ha^{-1} + imazethapyr 0.075 kg ha^{-1} having better weed control, less impact on soil micro-flora and microbial activity, resulted in a higher yield of soybean comparable with weed-free check.

Thakare *et al.* (2020) showed that the effect of herbicides after spraying significantly influenced the population of soil microorganisms, *viz*. bacteria, fungi and actinomycetes compared to their population before herbicide application in onion crop. But at harvest time of the crop, the microbial population with all the treatments attained a slight higher level.

2.10 Effect of integrated weed management on crop and weed

Sankaranaranyan *et al*. (2002) revealed that among the different treatments hand weeding twice at 15 and 30 DAS, and pendimethalin 0.75 kg ha^{-1} with one hand weeding at 30 DAS were effective in the control of weeds. These treatments also reduced weed dry matter production, with increased growth characters, yield attributes and yield of soybean. The highest yield and net return were observed in pendimethalin 0.75 kg ha^{-1} with hand weeding 30 DAS (1436 kg ha^{-1}), followed by hand weeding twice on 15 and 30 DAS (1415 kg ha^{-1}).

Singh (2005) reported that application of pendimethalin at 1 kg ha^{-1} integrated with hand weeding 30 DAS recorded the highest grain yield in soybean.

Sharma *et al.* (2016a) revealed from a one-year field experiment at Udaipur during *Kharif* of 2014 that pre-emergence application of pendimethalin

750 g ha^{-1} + hand weeding at 30 DAS recorded the maximum seed yield (1.38 t ha^{-1}) of soybean along with the highest economic returns in terms of net returns (₹ 27244 ha^{-1}) and B: C ratio (2.32). The highest total N and P uptake (143.8 kg ha^{-1} and 15.6 kg ha^{-1}, respectively) by the crop was recorded under weed free treatment, which was closely followed by pendimethalin 750 g ha^{-1} + hand weeding at 30 DAS and two hand weeding treatment at 15 and 30 DAS.

Sharma *et al*. (2016b) conducted a field experiment at the research farm of Rajasthan College of Agriculture, Udaipur, during *Kharif* of 2014. Pre-emergence application of pendimethalin 0.75 kg ha^{-1} + hand weeding at 30 DAS in soybean crop resulted in a broad spectrum of weed control besides giving a higher grain yield.

Borana *et al.* (2017) revealed that the maximum uptake of total nitrogen (143.78 kg ha^{-1}) and phosphorus (15.63 kg ha^{-1}) by the soybean crop was significantly more in weed free check closely followed by pre-emergence application of pendimethalin 0.75 kg ha^{-1} + hand weeding 30 DAS.

Sepat *et al*. (2017) reported that application of pendimethalin at 0.75 kg ha^{-1} along with one hand weeding at 30 DAS recorded the lowest total weed density and biomass.

Patil *et al.* (2018) carried out a field experiment during *Kharif* 2009-2010 at the instructional farm, Junagadh Agricultural University, Junagadh, to evaluate the suitable integrated weed management (IWM) practices for soybean. Results indicated that the integration of herbicides like pendimethalin at 0.750 kg ha^{-1} pre-emergence + 1HW (handweeding) and IC (interculturing) at 20 DAS recorded a significant reduction of weed dry matter and higher weed control efficiency resulting in higher yield.

Virk *et al.* (2018) conducted a field experiment at Punjab Agricultural University, Ludhiana and showed that pendimethalin 0.45 kg ha^{-1} as pre-emergence + hand weeding at 40 DAS recorded a significantly higher seed yield of soybean than other treatments. However, it was at par with two hand weedings. Application of pendimethalin 0.45 kg ha^{-1} (PE) + HW at 40 DAS also gave the highest net returns (₹ 49496 ha^{-1}), followed by two hand weedings.

2.11 Effect of integrated weed management on soil and microbiological properties

Sharma *et al*. (2015) reported that the highest available N, P and K in the soil after harvesting of groundnut crop was recorded under oxadiargyl at 90 g ha^{-1} as PoE at 20 DAS + hand-weeding and interculturing at 40 DAS, which remained statistically at par with the application of pendimethalin 38.7% CS @ 0.75 kg ha^{-1} as PPI + hand-weeding and interculturing at 40 DAS, and oxyfluorfen @ 0.24 kg ha^{-1} as PE + hand-weeding and interculturing at 40 DAS.

Rathore *et al*. (2016) reported that there was no influence of weed management practices (unweeded, chemical, IWM) on microbial activities (fungi, bacteria and actinomycetes) in a rice-based cropping system.

2.12 Effect of integrated nutrient and weed management on crop and weed

Pratap *et al*. (2006) reported from an experiment conducted at Kota during the rainy season of 2002 and 2003 that two hand weedings at 30 and 45 DAS, alachlor applied as pre-emergence @ 2 kg ha^{-1} + hand weeding (HW) at 30 DAS, and tank mixture of chlorimuron ethyl + fenoxaprop-p-ethyl (9+70 and 6+ 50 g ha^{-1}) as post-emergence reduced the weed density and dry matter at 50 and 70 DAS. These treatments also recorded significantly higher pod $plant^{-1,}$ 1000-seed weight, seed yield and net return of soybean crop. The maximum NPK uptake by the crop was recorded under alachlor 2 kg ha^{-1} + HW at 30 DAS, two hand weedings and chlorimuron ethyl + fenoxaprop-p-ethyl (9+70 and 6+ 50 g ha^{-1}). The fertility levels did not influence the weed density, but a decrease in fertilizer application to 75% of RDF reduced the dry matter of weeds. The yield and net returns decreased on reducing the rate of fertilizer application. And by applying 125% RDF, nutrient uptake by crop increased significantly.

Dhaker *et al*. (2010) revealed that hand weeding twice at 20 and 40 DAS was significantly superior in reducing the density and weed dry matter at all the stages of observations in soybean and recorded the highest total weed control efficiency (80.39%). Maximum net returns and B: C ratio were obtained with imazethapyr 100 g ha^{-1} + one hand weeding at 40 DAS (₹ 15601 ha^{-1} and 1.93, respectively) followed by two hand weedings 20 and 40 DAS (₹ 15566 $ha^{-1}$and 1.84, respectively). The application of different levels of sulphur significantly increased weed dry matter at 50 DAS and at harvest compared to no sulphur application. The highest total weed dry matter at 50 DAS and at harvest was recorded due to 40 kg S ha^{-1} which was found at par with 20 kg sulphur application.

Rao (2018) conducted an experiment under field conditions at Agricultural College farm, Rajendranagar. Hyderabad, Telangana State during 2014–2015 and 2015–2016, to assess the effect of bio-fertilizers and Integrated Weed Management (IWM) practices on yield of soybean. Different treatments did not influence days to 50% flowering. At harvest, the number of pods $plant^{-1}$ (33, 32), number of seeds pod^{-1} (3.0, 3.1), test weight (g) (12.5, 12.8), seed yield (17.21, 17.35 q ha^{-1}), haulm yield (25.18, 25.34 q ha^{-1}) were recorded significantly highest in hand weeding at 25 and 45 DAS in two years respectively which was on par with pendimethalin @ 1.0 kg *a.i* ha^{-1} as pre-emergence + hand weeding at 25 DAS. The yield of grain and haulms were not altered by the application of bio-fertilizers or their interaction with weed management treatments.

Sikka *et al*. (2018) revealed that the application of FYM with NP or NPK improved the yield of soybean over NP or NPK alone treatment. Integrated use of FYM with NPK increased the yield of soybean by 10.8 per cent over NPK alone. Pre-emergence application of pendimethalin at 1.5 l ha^{-1} + one hand weeding at 40 DAS and two hand-weeding at 20 and 40 DAS were equally effective for weed control and in influencing the soybean yield.

Raj *et al.* (2019) carried out a field investigation to study the effect of nutrient and weed management practices on the growth and yield of soybean in the alluvial soil of Bihar during the *Kharif* season in 2016. Application of 50% RDF along with 2.5 t FYM ha^{-1} and vermicompost 1.25 t ha^{-1} recorded significantly higher plant height (54.60 cm), dry weight $plant^{-1}$ (18.60 g), number of leaves $plant^{-1}$ (35.70), leaf area index at 60 DAS (5.36), number of root nodules $plant^{-1}$ at 30 DAS (20.46) and 60 DAS (61.31), number of pods $plant^{-1}$ (23.50), number of grain pod^{-1} (2.52), grain yield (16.94 q ha^{-1}) and straw yield (28.64 q ha^{-1}) over rest of the treatments but was statistically at par with 50% RDF + 5 t FYM ha^{-1}. On the other hand, in weed management practices, hand weeding twice at 25 and 45 DAS recorded significantly higher plant height (55.47), dry weight plant (18.40 g), number of leaves $plant^{-1}$ (35.10), leaf area index at 60 DAS (5.22), number of root nodules $plant^{-1}$ at 30 DAS (20.14) and 60 DAS (60.30), number of pods $plant^{-1}$ (22.52), number of seeds pod^{-1} (2.42), 100-grain weight (9.50 g), grain yield (16.71 q ha^{-1}) and straw yield (28.11 q ha^{-1}) over control but was at par with pendimethalin 1.0 kg ha^{-1} (pre-emergence) + one hand weeding at 40 DAS and pendimethalin 1.0 kg ha^{-1} (pre-emergence) + imazethapyr 55g ha^{-1} (post-emergence) at 25 DAS.

2.13 Effect of integrated nutrient and weed management on soil and microbiological properties

Bharat *et al*. (2019) conducted an experiment under field conditions at Agricultural College farm, Rajendranagar. Hyderabad, Telangana State during 2014-2015 and 2015-2016, to assess the effect of bio-fertilizers and Integrated Weed Management (IWM) practices on soil physico-chemical properties and nutrient availability at harvest of soybean. Results revealed that weed management treatments and bio-fertilizers had no significant influence on soil physico-chemical properties and nutrient availability in either of the two years. The interactions were also not significant.

Lokose *et al*. (2019) conducted a field experiment during 2015-16 and 2016-17 on loamy sand soil to assess the impact of two commonly used herbicides (pendimethalin and oxyfluorfen) and nutrient management on soil microbial populations in maize + cowpea intercropping system. The results revealed that the herbicide treatments significantly inhibited the development of microbial populations in the soil at the initial stage after the application of herbicide. However, no inhibition was observed after 30 days of application (DAA) up to 60 DAA. Among the herbicides, oxyfluorfen reduced the soil microbial population significantly compared to pendimethalin at the initial crop growth stage. A higher value of microbial population was observed under the combined application of recommended NPK+ FYM and lime compared to the mere application of recommended NPK.

CHAPTER III

MATERIALS AND METHODS

MATERIALS AND METHODS

The field experiment entitled **"Effect of integrated nutrient and weed management on growth and yield of soybean (*Glycine max* L. Merrill)"** was conducted at the experimental farm of School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema campus during the *Kharif* season of 2017 and 2018. Details of the experimental materials used and the research methodology adopted during the course of experimentation has been discussed in this chapter.

3.1. GENERAL INFORMATION

3.1.1 SITE OF THE EXPERIMENT

The experimental field is situated at geographical location of 25°45′43″ N latitude and 95°53′04″E longitude at an altitude of 310 m above the mean sea level (MSL).

3.1.2 CLIMATIC AND WEATHER CONDITIONS

The experimental farm lies in humid sub-tropical region with an average rainfall ranging from 2000-2500 mm annually. The maximum rain was received during May to October month. The mean temperature varied from 21°C to 32°C during summer and rarely went below 8°C in winter due to high atmospheric humidity.

The detailed meteorological data recorded during the investigation period is presented in Table 3.1 and graphically shown in Fig 3.1. The highest maximum temperature was recorded in the month of August in 2017 and 2018 *i.e.,* 32.1°C and 36.80°C, respectively and the minimum temperature was in October month for both the years. The monthly mean maximum and minimum relative humidity varied from 93.2 to 95.2% and 71.7 to 76.0%, respectively during July to October, 2017. Likewise, monthly mean maximum relative humidity and mini-

Table 3.1: Meteorological data during the period of experimentation (July-October, 2017 and July- October, 2018)

Month	Temperature (ºC)				Relative Humidity (%)				Sunshine hours		Rainfall (mm)	
	Maximum		Minimum		Maximum		Minimum					
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
July	31.3	35.8	24.4	23.8	93.7	91.6	76.0	71.7	3.1	3.1	112.7	43.4
August	32.1	36.8	24.7	23.7	93.2	94.2	71.7	71.4	4.0	3.8	109.2	72.2
September	31.6	35.3	24.5	22.7	95.2	93.6	74.0	66.7	4.2	5.3	60.1	30.4
October	30.9	33.9	22.4	17.7	95.0	95.7	74.2	66.7	5.5	6.0	24.9	14.6

Source: ICAR Research Complex for NEH Region, Jharnapani, Nagaland

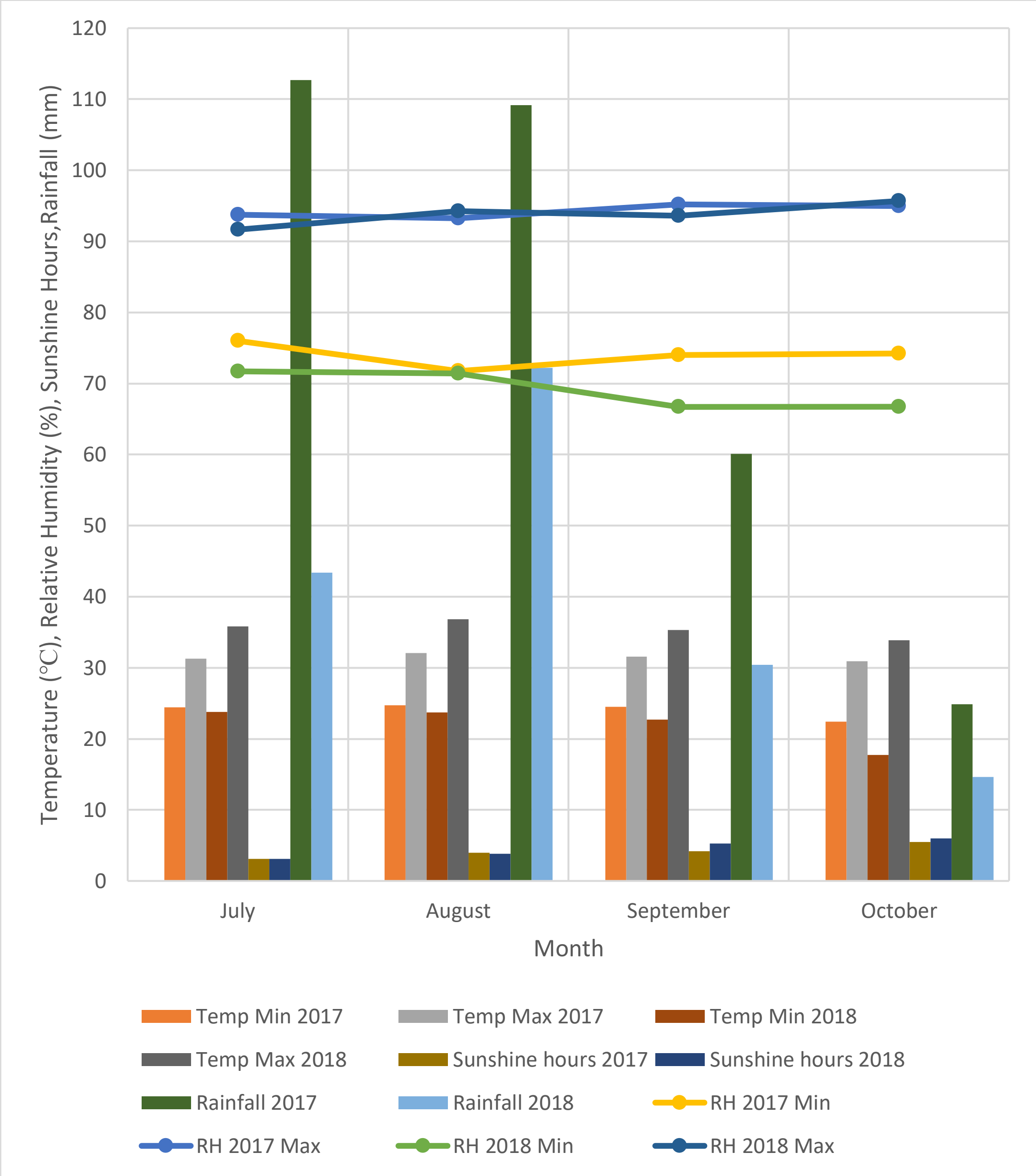


Fig 3.1: Meteorological data during the period of experimental period.

mum relative humidity from July to October 2018, ranged from 91.6 to 95.7% and 66.7 to 71.7%, respectively. The maximum relative humidity in 2017 was recorded in September month and for 2018 in October month. Whereas, in 2017 the minimum relative humidity was recorded in August month and for 2018, it was recorded in September and October. The maximum sunshine hours were received in October month for both years. During 2017, the total rainfall received was 306.9 mm with the highest rainfall recorded in July (112.7 mm). During 2018, the total rainfall was 160.6 mm with the highest rainfall (72.2 mm) recorded in August month.

3.1.3 DETAILS OF THE EXPERIMENTAL SOIL CONDITION

The experimental soil was well drained and sandy loam in texture. The soil sample were collected with *khurpi* from 0-20 cm depth. The soil samples collected were mined, sieved and analyzed by the methods of physical and chemical analysis. Table 3.2 shows the initial physico-chemical properties of the experimental soil.

Table 3.2: Initial physico-chemical properties of the experimental soil

Particulars	Content	Method employed
Soil depth (0-20 cm)		
Bulk density (g/cc)	1.39	Core method (Baruah and Barthakur, 1997)
Water holding capacity (%)	37.92	Keen-Raczkowski box method (Piper, 1966)
Soil pH	4.63 (Strongly acidic)	Digital pH meter (single electrode method)
Organic carbon (%)	1.07 (High)	Walkey and Black rapid titration (Piper, 1966)
Available N (kg ha^{-1})	328.65 (Medium)	Alkaline Potassium Permanganate method (Subbiah and Asija, 1956)

Available P (kg ha^{-1})	13.44 (Medium)	Bray's No. 1 method (Bray's No. 1 method (Bray and Kurtz, 1945)
Available K (kg ha^{-1})	165.87 (Medium)	Neutral Normal Ammonium Acetate Method (Hanway and Heidal, 1952)
Available S (kg ha^{-1})	12.14	Turbidimetric method (Chesnin and Yien, 1951)

3.1.4. PREVIOUS CROPPING HISTORY OF THE SITE

The following table (Table 3.3) shows previous cropping history of the experimental site-

Table 3.3: Previous cropping history of the site

Sl. No.	**Year**	**Season**	
		Kharif	***Rabi***
1.	2014	Soybean + Sesamum	Fallow
2.	2015	Rice	Fallow
3.	2016	Rice	Fallow

3.2 DETAILS OF EXPERIMENTAL TECHNIQUES

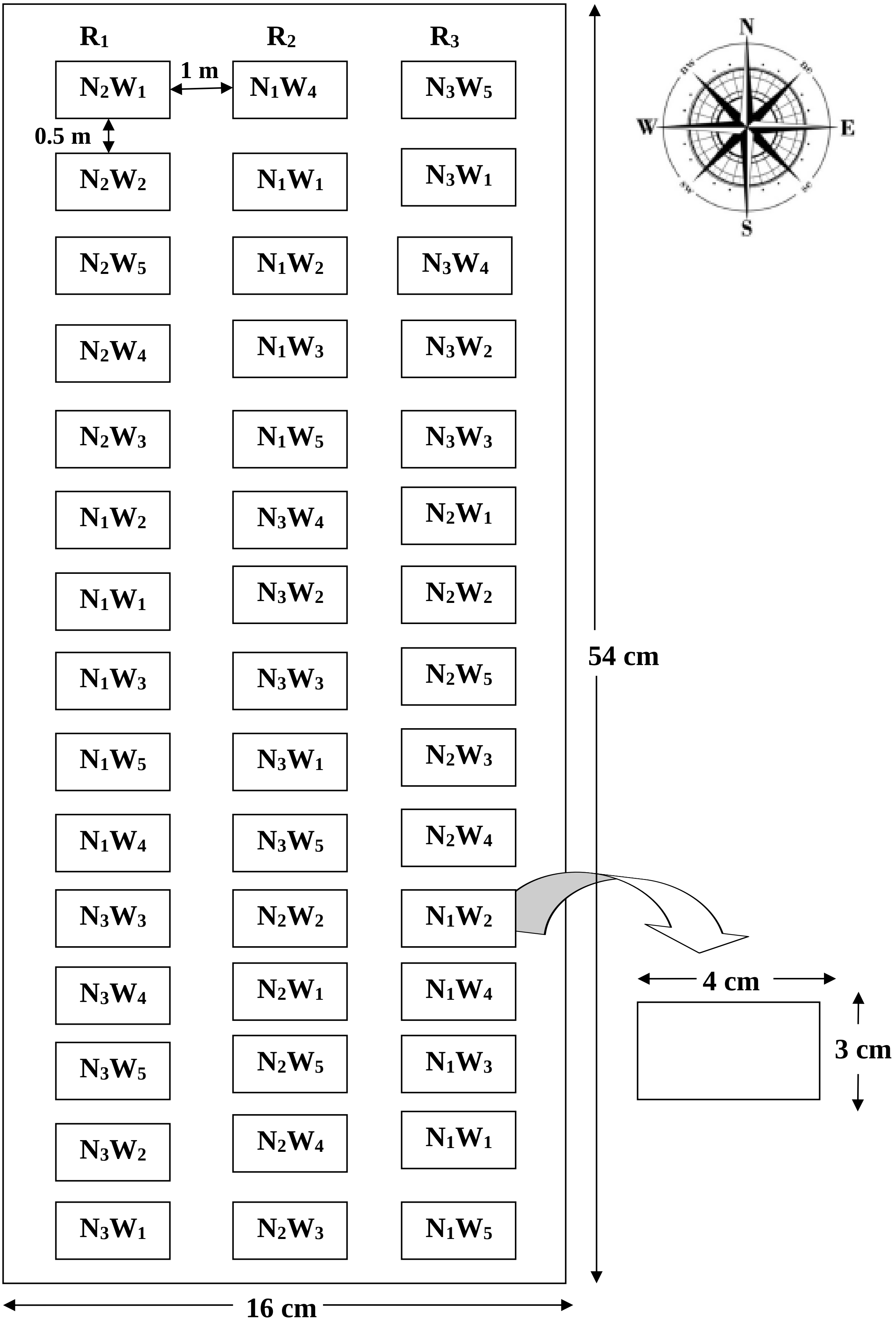
3.2.1 Design and experimental layout

The experimental design used was Split Plot Design (SPD) consisting of three nutrient management treatments in the main plot and five weed management treatments in the sub-plot and were replicated thrice. The layout of the experiment for both years has been presented in Fig 3.2.

3.2.2 Details of the experiment

The experimental details are given below:

Crop	: Soybean (*Glycine max* L. Merrill)
Variety	: JS 97-52
Design of the experiment	: Split Plot Design (SPD)
Number of replications	: 3



3.2: Layout of the experimental field in Split Plot Design

Number of treatments in main plot: 3

Number of treatments in sub-plot : 5

Number of treatment combinations: 15

Total number of plots	: 45
Spacing	: 40 cm × 10 cm
Gross plot size	: 4 m × 3 m
Net plot size	: 3.2 m × 2.10 m
Distance between each replication	: 1 m
Distance between each plot	: 0.5 m
Length of experimental plot	: 54 m
Width of experimental plot	: 16 m
Gross area of experimental field	: 864 m^2

3.2.3 Treatment details

3.2.3.1 Main plot

The three nutrient management treatments allotted in the main-plots are described below-

1) N_1: 100 % RDF (NPKS)
2) N_2: 75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB)
3) N_3: 50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB)

NOTE:

*RDF (NPKS)-20-60-40-20 kg ha^{-1}

***Rhizobium* @ 20 g kg^{-1} seed, Phosphate solubilising bacteria (PSB) @ 20 g kg^{-1} seed

3.2.3.2 Sub-plot

Five weed management treatments allotted in the sub-plots are described below-

1) W_1: Weedy check

2) W_2: Weed free (Hand weeding at 15, 30 and 45 DAS)

3) W_3: Mechanical weeding at 20 and 40 DAS

4) W_4: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS

5) W_5: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS

NOTE:

PE: Pre-emergence (at 2 DAS); PoE: Post-emergence (at 15 DAS)

3.2.3.3 Treatment combinations

There were altogether fifteen (15) treatment combinations as mentioned below-

Treatment combinations	Symbol
100 % RDF + Weedy check	N_1W_1
100 % RDF + Weed free (Hand weeding at 15, 30 and 45 DAS)	N_1W_2
100 % RDF + Mechanical weeding at 20 and 40 DAS	N_1W_3
100 % RDF + Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS	N_1W_4
100 % RDF + Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS	N_1W_5
75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB) + Weedy check	N_2W_1
75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB) + Weed free (Hand weeding at 15, 30 and 45 DAS)	N_2W_2
75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB) + Mechanical weeding at 20 and 40 DAS	N_2W_3
75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB) + Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS	N_2W_4
75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB) + Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS	N_2W_5

50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB) + Weedy check	N_3W
50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB) + Weed free (Hand weeding at 15, 30 and 45 DAS)	N_3W_2
50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB) + Mechanical weeding at 20 and 40 DAS	N_3W_3
50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB) + Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS	N_3W_4
50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB) + Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS	N_3W_5

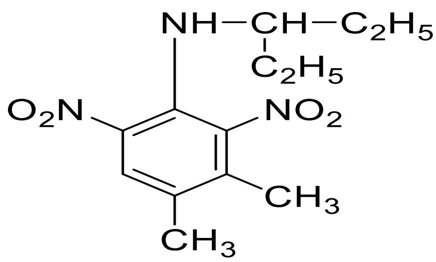
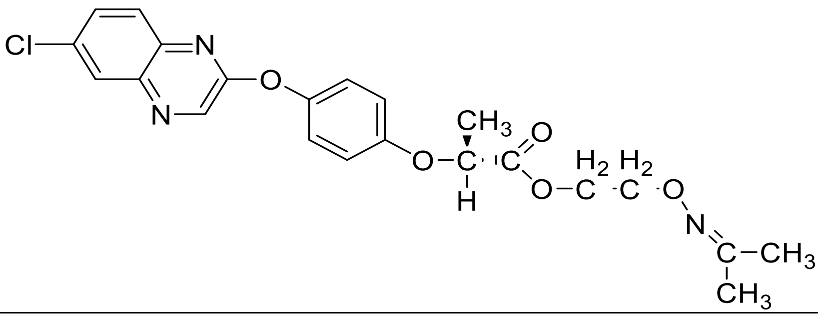
3.2.4 Details of the chemical herbicides used in the experiment

The chemical information of the herbicides used in the experiment has been given in Table 3.4.

Pendimethalin (Dhanutop) controls both narrow and broad leaf weeds. It is applied as pre-emergence herbicide. It is selective herbicide used before emergence of weeds and crops. The mode of action of pendimethalin is to inhibit the plant cell division and cell elongation. It does so by blocking filamentous division in the cells of the roots and targets the important microtubules that form the cell wall, spindle filaments and chromosomal separations thereby, preventing the roots and shoots of the target weed from growing. With the weed unable to develop further, it eventually dies.

Propaquizafop (Agil) is a systematic herbicide which is quickly absorbed by the leaves and translocated from the foliage to the growing points of the leaves and roots of the sprayed weeds. It is selective to all major broadleaf crops during all their stages of development. It is used as post emergence control of a wide range of annual and perennial grasses. This herbicide kills grass weeds because it binds to a target site protein in the weed called acetyl-CoA carboxylase (ACCase) and blocks it from functioning.

Table 3.4: Details of the chemical herbicides used in the experiment

Name of the herbicide	Chemical formula and Chemical structure	Chemical group	Trade name
Pendimethalin	N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine 	Dinitroaniline	Dhanutop
Propaquizafop	(R)-2-((propan-2-ylideneamino)oxy)ethyl 2-(4-((6-chloroquinoxalin-2-yl)oxy)phenoyxy)propanoate 	Aryloxyphenoxypropionates	Agil

3.2.5 Details of the experimental crop

Soybean (*Glycine max*. L Merrill) belongs to the family leguminoseae**.**

JS 97-52 Variety: JS 97-52 is a wide adaptable, high yielding and multiple resistant variety. It matures in 99 to 102 days (medium duration). Its yield potential is 2.0 to 2.2 t ha^{-1}. It is suitable for heavy and low rain condition. It is tolerant to yellow mosaic disease and other diseases such as root rot, bacterial pustules, charcoal rot, Cercospora leaf spot and target leaf spot. It is also resistant against insect pests on the basis of tolerance shown against stem-fly, girdle beetle and defoliators. It possesses excellent germinability, field emergence and longevity during storage.

3.2.6 Calendar of agronomic management operations

The dates of operations from initial field preparation to final crop harvest are presented in the table below (Table 3.5)

Table 3.5: Calendar of agronomic management practices

Sl. No.	Operations	Year-2017	Year-2018
		Date	
1	**Land preparation**		
	Ploughing	16.06.2017	08.06.2018
	Harrowing + Planking	19.06.2017	28.07.2018
2	Layout	28.06.2017	04.07.2018
3	Manure application	28.06.2017	04.07.2018
4	Fertilizer application (NPKS)	06.07.2017	10.07.2018
5	Seed sowing	06.07.2017	10.07.2018
6	**Herbicide application**		
	Pendimethalin	08.07.2017	12.07.2018
	Propaquizafop	21.07.2017	25.07.2018
7	**Hand weeding**		
	at 15 DAS	21.07.2017	25.07.2018
	at 30 DAS	05.08.2017	09.08.2018
	at 45 DAS	20.082017	24.08.2018
8	**Mechanical weeding**		
	at 20 DAS	26.07.2017	30.07.2018
	at 40 DAS	15.08.2017	19.08.2018
9	Harvesting	24.10.2017	31.10.2018
10	Threshing	28.10.2017	03.11.2018

3.2.7 Agronomic management

The details of various agronomic practices carried out during the research are presented below.

3.2.7.1 Field preparation

A rectangular plot having uniform fertility and even topography was selected for conducting the field trials. The field was initially ploughed by tractor drawn disc plough. Following this, two harrowings by using disc harrow. Then, the remaining stubbles and weeds were removed and planking was carried out.

3.2.7.2 Design and layout

After planking, with the help of measuring tape, pegs and ropes, the field plots were laid out in the field as per the statistical design (Split plot design). There were three main plots and five sub plots. There were 45 plots in total with each plot having gross plot size of 4m × 3m. The layout of the experiment is presented in Fig 3.2.

3.2.7.3 Manure and Fertilizer application

Well decomposed farmyard manure (FYM) were applied accordingly to the treatments during the plot preparation and mixed thoroughly. Likewise, the full dose of fertilizers (DAP and MOP) were calculated and applied accordingly to the treatment requirements before sowing.

3.2.7.4 Seed rate, seed treatment and method of sowing

The seeds were treated initially with bavistin at 2 g kg^{-1} of seed followed by seed treatment with *Rhizobium* (20 g kg^{-1} seed) and Phosphate solubilising bacteria (20 g kg^{-1} seed) as per the treatment requirements. Then it was sown in lines with seed rate of 60 kg ha^{-1}. A spacing of 40 cm from row to row and 10 cm between plant to plant were maintained**.**

3.2.7.5 Herbicide application

Pendimethalin 30% EC @ 1 kg ha^{-1} (PRE) and Propaquizafop 10% EC @ 0.075 kg ha^{-1} (PoE) were sprayed as aqueous solution on the plots as per the required treatment requirement using 500 litres of water per hectare. The herbicides were sprayed with the help of knapsack sprayer with flat fan nozzle on the designated days (Pendimethalin and Propaquizafop at 2 DAS and 15 DAS, respectively.

3.2.7.6 Weeding

Hand weeding and mechanical weeding were done accordingly to the treatment requirements. Mechanical weeding was done with the help of wheel hoe.

3.2.7.7 Plant protection measures

Routine monitoring of pest and diseases for the experimental crop was performed. Malathion dust (10%) was applied as soil application @ 25 kg ha^{-1} to prevent ants. Blister beetle infestation was observed during the flowering time. It was controlled manually by hand picking.

3.2.7.8 Harvesting and threshing

The crop was harvested plot wise when more than 80 percent of the pods turned dark brownish in colour and were brittle on slight pressure with fingers and all the leaves turned yellow. The crop was harvested with the help of sickle by cutting the stalks on the ground level. Then the crop were sun dried for 3-4 days and threshing was done manually. The weight of the grain were recorded for each plot after cleaning by winnowing. And the stover for each individual plots were also weighed separately.

3.3 FORMULAE ADOPTED FOR CALCULATION OF DIFFERENT CHEMICALS REQUIRED IN THE EXPERIMENT

3.3.1 Herbicide application

The amount of herbicides required by the experiment was calculated by using the following formula:

$$Q=\frac{\mathrm{R\ x\ A}}{\mathrm{C}} \times 100$$

Where, Q= quantity of herbicides required in kg or litre ha^{-1}

R = Recommended rate in kg *a.i.* ha^{-1}

C = % *a.i.* in herbicide formulation

3.3.2 Fertilizer application

The amount of fertilizers required was calculated by using the following formula:

Amount of fertilizer required (kg)

$$= \frac{\text{Recommended rate (kg ha}^{-1}\text{)} \times \text{Area to be fertilized} \times 100}{\text{\% element in fertilizer}}$$

3.3.3 Insecticide application

The amount of insecticides required was calculated by using the following formula:

$$\text{Amount of insecticide} = \frac{\text{(Rate desired (kg a.i.ha}^{-1}\text{)} \times 100}{\text{Concentration of insecticide (\%)}}$$

3.4 METHOD OF RECORDING DIFFERENT OBSERVATIONS ON SOYBEAN CROP

Five plants were randomly selected from each plot and were tagged for taking observations on plant growth parameters. Periodic plant sampling was done in both the years for monitoring plant growth attributes.

3.4.1 GROWTH ATTRIBUTES

3.4.1.1 Plant height (cm)

In each plot, five plants were randomly selected and tagged avoiding the border row. Plant height was recorded from ground level to the apical portion of the main shoot. The mean plant height in cm was calculated as average of five plants. Plant height was recorded at 30, 60 DAS and at harvest.

3.4.1.2 Number of primary branches plant^{-1}

The number of primary branches plant^{-1} were counted on the main stem from the five tagged plants from each plot at 30, 60 DAS and at harvest.

3.4.1.3 Plant dry matter accumulation (g plant^{-1})

Destructive plant samples were taken at 30, 60 DAS and at harvest. Five plant samples were taken randomly from each plot avoiding the border rows. Then they were kept in hot air oven and dried at 80-90°C till it attained a constant dry weight and their weight were recorded.

3.4.1.4 Leaf area index (LAI)

Leaf area index (LAI) is the ratio between the area of the surface of green leaves and ground area cover. It was determined by indirect method. Ten leaves were selected from the plant samples. The middle portions of the leaves were punched with a puncher with a radius of 1 cm. The area of ten punched leaves was calculated by multiplying the area of puncher with the number of leaves. Then the samples of each treatment were dried in a hot air oven at 60°C till a constant weight was obtained and their weight was recorded separately. The dry weight of these punched leaves was used to determine the leaf area indices. LAI was worked out with the concept proposed by Watson (1947). Leaf area index (LAI) was recorded at 30 and 60 DAS by using the following formula:

$$\text{LAI} = \frac{\text{Total leaf area}}{\text{Ground area}}$$

3.4.1.5 Number of root nodules plant^{-1}

The number of root nodules were counted from five plants and their average was taken as number of root nodules plant^{-1} at 30 and 60 DAS.

3.4.1.6 Nodules fresh and dry weight plant^{-1} (g)

From the above collected root nodules of five plants at 30 DAS, their fresh and dry weight (g) was weighed and their average was taken. Likewise, the same procedure was done at 60 DAS.

3.4.1.7 Crop growth rate (CGR) (g m^{-2} day^{-1})

Crop growth rate (CGR) (g m^{-2} day^{-1}) at (30-60 DAS) was calculated by using the dry matter accumulation (g) of plant from each plot at 30 DAS and 60 DAS with the following formula (Watson, 1956):

$$\text{CGR} = \frac{W_2 - W_1}{(t_2 - t_1)S}$$

Where, W_1 and W_2 are the dry weights of plants at t_1 and t_2, respectively. S is the land area (m^2) over which dry matter was recorded.

3.4.1.8 Relative growth rate (RGR) (g g^{-1} day^{-1})

The Relative growth rate (RGR) (g g^{-1} day^{-1}) at (30-60 DAS) was also calculated using the data of dry matter accumulation (g) of plant from each plot at 30 DAS and 60 DAS with the following formula (Blackman, 1919):

$$\text{RGR} = \frac{\text{In}W_2 - \text{In}W_1}{(t_2 - t_1)}$$

Where, W_1 and W_2 are the dry matter produced by a gram (g) of existing dry matter in the day at a time t_1 and t_2, respectively.

3.4.2 YIELD AND YIELD ATTRIBUTES

3.4.2.1 Number of pods plant^{-1}

Total number of pods from five tagged plants were counted and average was worked out as the mean number of pod plant^{-1}.

3.4.2.2 Pod weight plant^{-1} (g)

The weight of pods from five tagged plants were taken and average was worked out as the mean number of pod plant^{-1}.

3.4.2.3 Number of seeds pod^{-1}

Number of seeds pod^{-1} of five tagged plants were counted and average was recorded as the number of seeds pod^{-1}.

3.4.2.4 100-seed weight (g)

Hundred seeds were counted randomly from the tagged plants from each plot separately after threshing and cleaning. Then, it was properly sun dried and their respective weight was taken.

3.4.2.5 Grain yield (t ha^{-1})

The obtained seed from each plot after threshing and cleaning were thoroughly sun dried and then weighed to determine in terms of t ha^{-1}. The grain yield (in terms of kg) obtained from each plot was recorded and later converted into t ha^{-1} using the formula:

$$\text{Grain yield (kg ha}^{-1}) = \frac{\text{Weight of the grain per plot}}{\text{size of the plot}} \times 10000$$

$$\text{Grain yield (t ha}^{-1}) = \frac{\text{Grain yield (kg ha}^{-1})}{1000}$$

3.4.2.6 Stover yield (t ha^{-1})

The stover collected from each plot after harvesting and threshing were allowed to dry in the sun for some days and their weight was taken to determine the stover yield in terms of t ha^{-1}. The stover yield (in terms of kg) obtained from each plot was recorded and later converted into t ha^{-1} using the formula:

$$\text{Stover yield (kg ha}^{-1}) = \frac{\text{Weight of the stover per plot}}{\text{size of the plot}} \times 10000$$

$$\text{Stover yield (t ha}^{-1}\text{)} = \frac{\text{Stover yield (kg ha}^{-1}\text{)}}{1000}$$

3.4.2.7 Harvest Index (%)

Harvest Index is the ratio of economic yield to biological yield. It is calculated by dividing the economic yield (grain yield) by the biological yield (grain yield and stover yield), multiplied by 100.

$$\text{Harvest Index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

$$\text{Harvest Index (\%)} = \frac{\text{Grain yield}}{\text{Grain yield} + \text{Stover yield}} \times 100$$

3.4.3 PHENOLOGICAL OBSERVATION

3.4.3.1 Days to 50% flowering

It is the number of days in which 50% of the plants flower. The days to 50% flowering for each plot were worked out from the date of sowing to date of 50% flowering.

3.4.3.2 Days to maturity

It is the number of days in which plants obtained maturity. The days to maturity for each plot were worked out from the date of sowing to date of maturity.

3.4.4 SEED QUALITY ATTRIBUTES

3.4.4.1 Oil content (%)

The oil content (%) in seed was determined by adopting Soxhlet ether extraction method as per method described by (AOAC, 1960). The oil content (%) was determined by taking seed samples of 5 g from each plot. The seeds were crushed in a mortar and transferred in a thimble. A solvent was added for oil extraction. The petroleum ether (boiling point 60-80°C) was used as a solvent. The extract was then transferred to weight flask and kept in hot air oven at 80°C for half an hour or till the last traces of solvent and moisture was removed. The weight of the oil was recorded after a constant weight was obtained. From the weight of the oil, the oil content of the seed was calculated using the following formula:

$$\text{Oil content (\%)} = \frac{W_2 - W_1}{W} \times 100$$

Where, W_1= weight of the empty flask (g)

W_2= weight of the empty flask + weight of oil (g)

W= weight of sample (g)

3.4.4.2 Protein content (%)

The protein content in seed was estimated by the formula:

Protein content (%) = 6.25 × N% in seed

3.5 BIOMETRICAL OBSERVATION ON WEEDS (SPECIES WISE)

The different weed species found in the experimental plots were identified and observed at 15, 30, 45 and 60 DAS.

3.5.1 Weed density

The population of different weed species observed in the experimental plots were recorded at 15, 30, 45 and 60 DAS. A quadrate with a dimension of 0.5 m × 0.5 m (0.25 m^2) was placed randomly at two places in each plot and the weeds from that area were removed. Each weeds was counted and converted into number per square metre.

3.5.2 Weed biomass

The individual weeds collected from each plot were kept in sample paper bag and labelled properly. It was then sun dried and transferred to hot air oven at 60℃ to get constant weights. Then, the dry weight of each weed species labelled was recorded.

3.5.3 Weed Control Efficiency (WCE)

Weed control efficiency is expressed as the percentage of control of weeds over untreated control. It denotes the efficiency of the applied herbicide for comparison purpose. Weed control efficiency of different treatments was computed on the basis of weed biomass by using the following formula:

$$\text{Weed Control Efficiency (\%)} = \frac{W_C - W_T}{W_C} \times 100$$

Where, W_C = Weed dry weight in control (unweeded) plot

W_T = Weed dry weight in treated plot for which WCE is to be worked out.

3.6 SOIL ANALYSIS

Soil samples were collected randomly from the plough layer depth (0-20 cm) with the help of *khurpi* before sowing and after harvesting crop from each plot. The collected soil samples were mixed thoroughly and dried, crushed and sieved through 2 mm sieve. The samples were then subjected to physical and chemical analysis following standard procedures.

3.6.1 Bulk Density (g/cc)

The bulk density of soil was determined by core method as described by Baruah and Barthakur (1997).

3.6.2 Water Holding Capacity (%)

The soil samples were kept in Keen Raczkowski boxes with uniform tapping and saturated overnight. After saturation the samples are weighed and kept in the oven for 48 hours at an equilibrium temperature of 105℃. The samples were then cooled and weighed. The water holding capacity was calculated by the weight difference (Piper, 1966).

3.6.3 pH (soil reaction)

Soil pH was determined in soil:water (1:2) ratio by digital pH meter (Jackson, 1967)

3.6.4 Organic carbon (%)

Organic carbon was determined by Walkey and Black rapid titration method as outlined by Piper (1966) and the result was expressed in terms of percentage.

3.6.5 Available nitrogen (kg ha^{-1})

The procedure involves distillation of soil alkaline potassium permanganate solution determining the ammonia liberated. This serves as an index of the available (mineralization) N status of the soil and was proposed as soil test for N by Subbiah and Asija (1956).

3.6.6 Available phosphorous (kg ha^{-1})

Available phosphorus was extracted with 0.03 N NH_4F in 0.025 N HCl and the phosphorus content was estimated colorimetrically using ascorbic acid method. The procedure is primarily meant for soils which is moderate to strongly acidic with pH around 5.5 or less (Bray and Kurtz, 1945). The phosphorus content of the soil extract was determined by calorimetric method of estimation.

3.6.7 Available potassium (kg ha^{-1})

Available potassium was extracted from 5 g of soil by shaking with 25 ml of neutral ammonium acetate (pH 7) solution for half an hour and the extract was filtered immediately through a dry filter (Whatman No. 1) and then potassium concentration in the extract was determined by Flame photometer (Hanway and Heidal, 1952).

3.6.8 Available sulphur (kg ha^{-1})

The available sulphur was determined by turbidimetric method using 1:5 soil and extractant 0.15% $CaCl_2$ solution and the intensity of turbidity formed was measured using UV spectrophotometer at a wave length of 440 nm (Chesnin and Yien, 1951).

3.7 SOIL MICROBIOLOGICAL ANALYSIS

Soil samples were collected before sowing and at harvest. The samples collected from each plot were properly tagged and carried out from the field to the laboratory for microbiological analysis. The enumeration of the microbial count was done on appropriate media following serial dilution technique and pour plate method (Pramer and Schmidt, 1965). Seven tubes containing 9 ml of sterile water was taken. One of the test tube containing 10 ml of sterile distilled water was taken and 1 g of soil was added to it and thoroughly mixed. Then the 1 ml of microbial suspension was added to another test tubes containing 9 ml sterile distilled water and thoroughly mixed. The same step was repeated serially for other test tubes. In this way the microbial suspension was diluted 10 folds. Finally, 100 μl (*i.e*. 0.1 ml) of diluted suspension was poured into the surface of nutrient agar plate and spread by "L" shaped spreader. The bacteria can thus be isolated and counted by Cfu *i.e.* Colony forming unit. The same procedure was carried out for fungi and actinomycetes.

3.7.1 Soil bacteria (Cfu g^{-1})

Nutrient Agar medium (NAM) of the following composition was prepared for counting for bacteria.

Chemicals/ Ingredients	Grams litre^{-1} of water
Beef extract	3 g
Peptone	5 g
Sodium Chloride (NaCl)	5 g
Agar	15 g
Distilled water	1 L

The ingredients except agar-agar were weighed carefully and dispensed in approximately 100-200 ml of distilled water. The agar-agar was dissolved separately by heating of water bath till the solution became transparent. Then both were dispensed in the measuring cylinder and finally raised the volume up to 1 litre. The pH was adjusted to 7.1 using pH meter/ paper. Then it was dispensed into suitable vessel with cotton plug and sterilized at 121℃ for 15 minutes.

3.7.2 Soil fungi (Cfu g^{-1})

Potato dextrose agar medium (PDA) of the following composition was prepared for counting fungi.

Chemicals/ Ingredients	grams litre^{-1} of water
potatoes	250 g
Dextrose ($C_6H_{12}0_6$)	250 g
Agar	20 g
Distilled water	1 L

After preparing the media it was sterilized by autoclaving at 15 lbs pressure (121℃) for 15 minutes and then mixed well before dispensing.

3.7.3 Soil actinomycetes (Cfu g^{-1})

Kenknight media of the following composition was prepared for counting actinomycetes.

Chemical/ ingredients	grams litre^{-1} of water
Dextrose ($C_6H_{12}0_6$)	1.0 g
Potassium dihydrogen orthophosphate (K_2HPO_4)	0.1 g
Sodium nitrate ($NaNO_3$)	0.1 g
Potassium chloride (KCl)	0.1 g
Magnesium sulphate ($MgSO_4.7H_2O$)	0.1 g
Agar	15 g
Distilled water	1 L

pH of the medium was adjusted at 7.4 ± 0.2 at 25℃. 16.4 grams of the ingredients was suspended in 1000 ml distilled water. It was heated to boil such as to dissolve the medium completely. Then it was sterilized at 15 lbs pressure (121℃) for 15 minutes. It was mixed well and poured onto sterile petri-plates.

3.8 CHEMICAL ANALYSIS OF PLANT MATERIALS

3.8.1 NPKS content (%) in grain and stover

After threshing, the grain and stover samples were collected separately from each plot. The samples were ground to powder and subjected to chemical analysis for N, P, K and S content.

Nutrient	Method
Nitrogen	Modified Kjeldhal method as described by (Black, 1965)
Phosphorus	Vanado-molybdate-phosphoric acid method (Jackson, 1973)
Potassium	Flame photometer (Chapman and Pratt, 1961)
Sulphur	Turbidimetric method (Chesnin and Yien, 1951)

3.8.2 NPKS uptake (kg ha^{-1}) in grain and stover

Nutrient uptake is the amount of nutrient taken up by the crop. The percentage of nutrient was multiplied with grain or stover yield to obtain uptake by grain and straw. The uptake of nutrient was computed as follows:

$$\text{Nutrient uptake in grain (kg ha}^{-1}\text{)} = \frac{\text{Percent nutrient content in grain} \times \text{grain yield (kg ha}^{-1}\text{)}}{100}$$

$$\text{Nutrient uptake in stover (kg ha}^{-1}\text{)} = \frac{\text{Percent nutrient content in stover} \times \text{stover yield (kg ha}^{-1}\text{)}}{100}$$

3.9 ECONOMICS

Economics of different treatments was worked out as per existing market prices.

3.9.1 Cost of cultivation (₹ ha^{-1})

The cost of cultivation was calculated as per item wise cost incurred in each treatment.

3.9.2 Gross return (₹ ha^{-1})

Gross return for each treatment was calculated by multiplying the values of economic produce with the prevailing support prices of output.

3.9.3 Net return (₹ ha^{-1})

Net returns for each treatment was estimated by subtracting the total cost of cultivation from the gross return.

Net return= Gross return-total cost of cultivation

3.9.4 Benefit Cost Ratio

Benefit Cost Ratio (B: C Ratio) was calculated by using the following formula:

$$\text{B: C Ratio} = \frac{\text{Net return}}{\text{Cost of cultivation}}$$

3.10 STATISTICAL DATA ANALYSIS

All the data collected were subjected to statistical analysis by using Analysis of Variance as described by Gomez and Gomez (1984). The average data of two years were also analysed inorder to establish the trend of treatments applied following Gomez and Gomez (1984). The significance of different sources of variation was tested by Fisher's and Snedecor's F-test at probability level of 0.05. For the determination of critical difference at 5% level of significance, the statistical tables formulated by Fisher and Yates (1979) tables were consulted. The Standard Error mean (SEm±) and the value of C.D. at 5% level of significance were computed to compare the difference between means.

Concerning weed management treatments, the weed count was expressed as number per square metre and the data were subjected to square root transformation ($\sqrt{x + 0.5}$) to normalise their distribution (Panse and Sukhatme, 1978).

Plot preparation

at 15 DAS

at 30 DAS

PLATE 1 (a): General view of the experimental field at different stages

at 45 DAS

at 60 DAS

at maturity

PLATE 1 (b): General view of the experimental field at different stages

CHAPTER IV

RESULTS AND DIS CUSSION

RESULTS AND DISCUSSION

The results obtained during the period of the present experiment entitled **"Effect of integrated nutrient and weed management on growth and yield of soybean (*Glycine max* L. Merrill)"** are presented in this chapter. The data of two years (2017 and 2018) field experiment, as well as their average data were statistically analysed, presented and discussed in this chapter with the help of tables and figures; available literature and pieces of evidence wherever necessary under the following headings:

4.1 GROWTH ATTRIBUTES

4.1.1 Plant height (cm)

The data on plant height of soybean were recorded during the *Kharif* season of 2017 and 2018. The data of these two years and the average data of these two years on plant height at 30 DAS, 60 DAS and at harvest are presented in Table 4.1 and 4.2.

4.1.1.1 Effect of nutrient management treatments on plant height

At 30 DAS, the data on both the years and the average of two years showed no significant variation in the plant height among the nutrient management treatments.

At 60 DAS, the highest plant height (46.08 cm) in 2017 was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) which was statistically at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). N_1 (100% RDF) recorded the lowest plant height (37.40 cm). The 2018 data showed no significant effect on plant height. The average data of two years showed a similar trend as observed in 2017, where the highest plant height (46.12 cm) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) which was statistically at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) and N_1 (100% RDF) recorded the lowest plant height (37.86 cm).

At harvest, a similar trend of plant height was observed as recorded at 60 DAS. The highest plant height (47.67 cm and 47.39 cm) in 2017 and the average data of two years were recorded with the treatment N_2 (75% RDF + 25% organic through FYM + PSB) which was statistically at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). N_1 (100% RDF) recorded the lowest plant height. The data of 2018 showed no significant effect on plant height at harvest.

The influence of integrated nutrient management was evident with the height of the plant. The higher plant height in treatments receiving 75% RDF + 25% organic through FYM + PSB may be because of the availability of more nutrients to soybean crops due to slow nutrient release from farmyard manure apart from the nutrients supplied through fertilizers. Raj *et al*. (2019) also found similar findings. Mohod *et al*. (2010) reported that the addition of FYM accelerated various metabolic processes and resulted in increased vegetative growth. In addition, PSB may have aided in the release of P from native as well as the fixation of added phosphate by excretion of organic acid and enzymes, some of which may have come from chelates with cations such as Ca^{++} and Fe^{++}, resulting in effective phosphate solubilisation and rendering more available phosphorus for the plants. Hence, this resulting in increased nutrient content and increased plant height (Singh and Pareek, 2003). Singh and Rai (2005) and Alam *et al*. (2009) also observed that the integrated use of chemical fertilizers and biofertilizers increased plant height significantly in soybean.

4.1.1.2 Effect of weed management treatments on plant height

The weed management treatments had a significant effect on the plant height of soybean in both the years of experimentation and their average data compared to weedy check.

In the first year at 30 DAS, W_2 (hand weeding at 15, 30 and 45 DAS) recorded the highest plant height which was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) followed by W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). The second year and the average data of two years recorded significantly highest plant height (34.33 cm and 33.14 cm, respectively) in W_2 (hand weeding at 15, 30 and 45 DAS) followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) which was at par with W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). The lowest plant height was recorded in W_1 in all the years. The removal of weeds at 15 DAS in W_2 treatment may be the possible reason for higher plant height due to more resources available to the crop. Application of propaquizafop at 20 DAS has caused a significant reduction in weed species which also may be the reason for better plant height at 30 DAS.

At 60 DAS, the 2017 data revealed that W_2 (hand weeding at 15, 30 and 45 DAS) recorded the highest plant height (51.78 cm), subsequently followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) at 47.58 cm and 40.44 cm, respectively. The 2018 data showed that W_2 (hand weeding at 15, 30 and 45 DAS) recorded the highest plant height (50.56 cm), subsequently followed W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) which was at par with W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). The average data of two years showed a similar pattern as the first year results. Highest plant height at 60 DAS in W_2 treatment may be due to lesser crop and weed competition as hand weeding was carried out at 45 DAS. Treatments W_5 and W_4 also recorded better plant height was along with chemical treatment, hand weeding was performed at 45 DAS and 30 DAS, respectively, which resulted in lesser competition for resources between crop and weeds.

At harvest, the first year data revealed that W_2 (hand weeding at 15, 30 and 45 DAS) recorded the highest plant height (53.18 cm), followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) at 48.53 cm and 41.48 cm, respectively. The second year data revealed that W_2 (hand weeding at 15, 30 and 45 DAS) recorded the highest plant height and (51.63 cm) was statistically at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). The average data of two years revealed that W_2 (hand weeding at 15, 30 and 45 DAS) recorded the highest plant height (52.41 cm) and was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS).

The control of weeds in W_2 treatment due to weeding in timely interval has resulted in highest plant height while weedy check recorded the lowest plant height. The decrease in plant height of crop might be due to crop weed competition as the weeds were not controlled leading to inhibition of cell division or cell enlargement (Akter *et al*., 2013). Integration of herbicide and hand weeding also resulted in better control of weeds which was reflected in plant height. It conforms to the findings of Devi *et al*. (2016).

4.1.1.3 Interaction effect of treatments on plant height

The interaction effect of nutrient management and weed management on plant height (Table 4.2) did not significantly affect plant height at all growth stages except in the first year (2017) at 60 DAS.

The highest plant height (56.07 cm) at 60 DAS in 2017 was recorded significantly in interaction of N_2 and W_5 treatment (N_2×W_5) which was at par with interaction of N_2×W_2 (55.33 cm) and N_2×W_2 (51.67 cm). The lowest plant height was recorded in N_1×W_1 (28.00 cm). The better plant height might be due

Table 4.1: Effect of nutrient and weed management treatments on plant height (cm) of soybean at 30 DAS, 60 DAS and at harvest

Treatments	Plant height (cm)								
	30 DAS			60 DAS			at harvest		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
Nutrient management (N)									
N_1	26.68	27.40	27.04	37.40	38.32	37.86	38.60	39.45	39.02
N_2	30.43	30.40	30.41	46.08	46.17	46.12	47.67	47.11	47.39
N_3	28.89	28.67	28.78	41.13	42.52	41.83	42.03	44.02	43.02
SEm±	**1.27**	**1.08**	**0.73**	**1.33**	**1.76**	**1.34**	**1.49**	**1.65**	**1.20**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**5.23**	**NS**	**5.28**	**5.87**	**NS**	**4.73**
Weed Management (W)									
W_1	23.44	22.67	23.06	31.27	30.57	30.92	32.49	31.77	32.13
W_2	31.96	34.33	33.14	51.78	50.56	51.17	53.18	51.63	52.41
W_3	28.60	27.33	27.97	36.62	38.31	37.47	38.13	39.56	38.84
W_4	28.93	29.78	29.36	40.44	44.40	42.42	41.48	45.89	43.68
W_5	30.40	30.00	30.20	47.58	47.84	47.71	48.53	48.79	48.66
SEm±	**0.82**	**0.97**	**0.66**	**0.94**	**1.06**	**0.79**	**1.02**	**1.68**	**1.02**
CD (*p*=0.05)	**2.39**	**2.83**	**1.93**	**2.73**	**3.09**	**2.31**	**2.98**	**4.91**	**2.97**

N_1: 100 % RDF (NPKS), N_2: 75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB), N_3: 50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB), W_1: Weedy check, W_2: Weed free (Hand weeding at 15, 30 and 45 DAS), W_3: Mechanical weeding at 20 and 40 DAS, W_4: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS, W_5: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS

Table 4.2: Interaction effect of nutrient and weed management treatments on plant height (cm) at 30 DAS, 60 DAS and at harvest

Treatments	Plant height (cm)								
	30 DAS			60 DAS			at harvest		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
N_1W_1	22.67	20.67	21.67	28.00	26.33	27.17	28.53	27.50	28.02
N_1W_2	30.60	33.67	32.13	48.33	43.67	46.00	49.12	45.67	47.39
N_1W_3	25.73	26.00	25.87	31.67	36.33	34.00	33.33	37.33	35.33
N_1W_4	25.53	28.67	27.10	39.00	41.33	40.17	39.99	42.40	41.20
N_1W_5	28.87	28.00	28.43	40.00	43.93	41.97	42.00	44.33	43.17
N_2W_1	24.93	25.33	25.13	33.27	33.57	33.42	35.67	34.30	34.98
N_2W_2	33.60	35.33	34.47	55.33	57.33	56.33	57.17	57.67	57.42
N_2W_3	30.73	28.33	29.53	42.20	41.87	42.03	43.57	43.67	43.62
N_2W_4	31.20	30.67	30.93	43.53	46.80	45.17	45.43	47.60	46.52
N_2W_5	31.67	32.33	32.00	56.07	51.27	53.67	56.50	52.33	54.42
N_3W_1	22.73	22.00	22.37	32.53	31.80	32.17	33.27	33.50	33.38
N_3W_2	31.67	34.00	32.83	51.67	50.67	51.17	53.27	51.57	52.42
N_3W_3	29.33	27.67	28.50	36.00	36.73	36.37	37.50	37.67	37.58
N_3W_4	30.07	30.00	30.03	38.80	45.07	41.93	39.00	47.67	43.33
N_3W_5	30.67	29.67	30.17	46.67	48.33	47.50	47.10	49.70	48.40
SEm± (N×W)	**1.42**	**1.68**	**1.15**	**1.620**	**1.83**	**1.37**	**1.77**	**2.92**	**1.76**
SEm± (W×N)	**1.56**	**1.51**	**1.03**	**1.680**	**2.10**	**1.60**	**1.87**	**2.48**	**1.64**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**4.73**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**5.97**	**NS**	**NS**	**NS**	**NS**	**NS**

to effective interaction between the nutrient and weed management treatments, which could have increased the availability of better nutrition from farmyard manure and biofertilizers and chemical fertilizers and efficient control of weeds under the respective treatments.

4.1.2 Number of primary branches plant^{-1}

The data on the number of primary branches plant^{-1} at 30, 60 DAS and harvest were recorded and presented in Table 4.3 and 4.4.

4.1.2.1 Effect of nutrient management treatments on number of primary branches plant^{-1}

At 30 DAS, the study found no significant effect on the number of primary branches plant^{-1} in both the years and average data.

At 60 DAS, the first year data showed no significant variation among the treatments. However, the second year data revealed significant variations among the treatments where N_2 (75% RDF + 25% organic through FYM + PSB) recorded the highest number of primary branches plant^{-1} (4.13) which was statistically at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). While the lowest number of primary branches plant^{-1} (3.36) was recorded in N_1 (100% RDF). The average data of two years also showed no significant variations among the treatments.

At harvest, the first year and average data of two years showed significant variation among the treatments where N_2 (75% RDF + 25% organic through FYM + PSB) recorded the highest number of primary branches plant^{-1} (4.20 and 4.07 in 2017 and average data of two years, respectively). The lowest number of primary branches plant^{-1} (3.63 and 3.50 in 2017 and average data of two years, respectively) was recorded in N_1 (100% RDF). The second year data did not reveal any significant variation among the treatments.

Higher availability of nutrients due to the combined application of organic and inorganic nutrients in N_2 treatment (75% RDF + 25% organic through FYM + PSB) may be the possible reason for the increase in the number of primary branches plant^{-1} due to presence of more growth promoting factors (Dipak *et al*., 2018). Lynrah and Nongmaithem (2017) also reported that increased number of branches in soybean when the crop was dually inoculated with *Rhizobium* and PSB.

4.1.2.2 Effect of weed management treatments on number of primary branches plant^{-1}

The weed management significantly affected the number of primary branches plant^{-1} in both years and their average data compared to the weedy check in all the recorded growth stages.

At 30 DAS, the first year data revealed that the highest number of primary branches plant^{-1} (2.29) was recorded in W_2 (hand weeding at 15, 30 and 45 DAS), which was statistically at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS). It was followed by W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). The 2018 and average data of two years showed similar results where W_2 (hand weeding at 15, 30 and 45 DAS) recorded significantly highest number of primary branches plant^{-1} (2.20 and 2.24, respectively), subsequently followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). Weedy check recorded the lowest number of primary branches plant^{-1} in both years and average data of two years.

At 60 DAS, 2017 data revealed that the highest number of primary branches plant^{-1} (4.89) was recorded in W_2 (hand weeding at 15, 30 and 45 DAS), subsequently followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand

Table 4.3: Effect of nutrient and weed management treatments on number of primary branches plant^{-1} of soybean at 30 DAS, 60 DAS and at harvest

Treatments	Number of primary branches plant^{-1}								
	30 DAS			60 DAS			at harvest		
	2017	2018	Average	2017	2018	Average	2017	2018	Average
Nutrient management (N)									
N_1	1.84	1.60	1.72	3.48	3.36	3.42	3.63	3.37	3.50
N_2	2.11	1.85	1.98	4.40	4.13	4.27	4.20	3.93	4.07
N_3	1.91	1.71	1.81	3.93	3.67	3.80	3.75	3.47	3.61
SEm±	**0.08**	**0.10**	**0.06**	**0.23**	**0.13**	**0.17**	**0.08**	**0.16**	**0.06**
CD (p=0.05)	**NS**	**NS**	**NS**	**NS**	**0.52**	**NS**	**0.30**	**NS**	**0.23**
Weed Management (W)									
W_1	1.58	1.13	1.36	3.07	2.91	2.99	2.56	2.44	2.50
W_2	2.29	2.20	2.24	4.89	4.49	4.69	4.84	4.36	4.60
W_3	1.71	1.53	1.62	3.58	3.33	3.46	3.56	3.33	3.44
W_4	2.02	1.76	1.89	3.82	3.82	3.82	4.02	3.73	3.88
W_5	2.16	1.98	2.07	4.33	4.04	4.19	4.31	4.09	4.20
SEm±	**0.06**	**0.06**	**0.05**	**0.15**	**0.13**	**0.10**	**0.15**	**0.12**	**0.09**
CD (p=0.05)	**0.17**	**0.17**	**0.14**	**0.44**	**0.39**	**0.29**	**0.43**	**0.35**	**0.26**

N_1: 100 % RDF (NPKS), N_2: 75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB), N_3: 50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB), W_1: Weedy check, W_2: Weed free (Hand weeding at 15, 30 and 45 DAS), W_3: Mechanical weeding at 20 and 40 DAS, W_4: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS, W_5: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS

Table 4.4: Interaction effect of nutrient and weed management treatments on number of primary branches plant^{-1} at 30 DAS, 60 DAS and at harvest

Treatments	Number of primary branches plant^{-1}								
	30 DAS			60 DAS			at harvest		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
N_1W_1	1.47	1.07	1.27	2.67	2.60	2.63	2.13	2.27	2.20
N_1W_2	2.13	2.07	2.10	4.27	4.13	4.20	4.67	4.27	4.47
N_1W_3	1.60	1.40	1.50	3.00	3.07	3.03	3.40	3.00	3.20
N_1W_4	1.93	1.67	1.80	3.47	3.33	3.40	3.87	3.33	3.60
N_1W_5	2.07	1.80	1.93	4.00	3.67	3.83	4.07	4.00	4.03
N_2W_1	1.73	1.20	1.47	3.67	3.33	3.50	3.20	2.67	2.93
N_2W_2	2.47	2.40	2.43	5.60	4.93	5.27	5.07	4.60	4.83
N_2W_3	1.93	1.73	1.83	4.07	3.67	3.87	3.73	3.87	3.80
N_2W_4	2.07	1.87	1.97	4.07	4.27	4.17	4.33	4.27	4.30
N_2W_5	2.33	2.07	2.20	4.60	4.47	4.53	4.67	4.27	4.47
N_3W_1	1.53	1.13	1.33	2.87	2.80	2.83	2.33	2.40	2.37
N_3W_2	2.27	2.13	2.20	4.80	4.40	4.60	4.80	4.20	4.50
N_3W_3	1.60	1.47	1.53	3.67	3.27	3.47	3.53	3.13	3.33
N_3W_4	2.07	1.73	1.90	3.93	3.87	3.90	3.87	3.60	3.73
N_3W_5	2.07	2.07	2.07	4.40	4.00	4.20	4.20	4.00	4.10
SEm± (N×W)	**0.10**	**0.10**	**0.08**	**0.26**	**0.23**	**0.17**	**0.25**	**0.21**	**0.16**
SEm± (W×N)	**0.10**	**0.12**	**0.08**	**0.28**	**0.20**	**0.21**	**0.18**	**0.21**	**0.11**
CD (p=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (p=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

weeding at 45 DAS). The 2018 data revealed W_2 (hand weeding at 15, 30 and 45 DAS) recorded the highest number of primary branches plant^{-1} (4.49), subsequently followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) which was at par with W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). The average data showed similar results as in 2017. Weedy check recorded the lowest number of primary branches plant^{-1} (3.07, 2.91 and 2.99) in both years and average data of two years.

At harvest, the average data of two years revealed that W_2 (hand weeding at 15, 30 and 45 DAS) recorded significantly the highest number of primary branches plant^{-1} (4.60) followed subsequently by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). Weedy check recorded the lowest number of primary branches plant^{-1} (2.50).

Effective control of weeds through weed control measures led to better development of crops which is reflected in the enhanced branching of the soybean crop. It conforms to the findings of Samudre *et al.* (2019). In addition, Kushwah and Vyas (2005) reported an increased number of branches due to integrated chemical and hand weeding methods. Conversely, greater weed competition in weed check resulted in fewer branches per plant (Peer *et al.*, 2013).

4.1.2.3 Interaction effect of treatments on number of primary branches plant^{-1}

The interaction effect of nutrient and weed treatments did not significantly affect the number of primary branches plant^{-1} in both years and average data of two years (Table 4.4).

4.1.3 Plant dry matter accumulation (g plant^{-1})

The data on plant dry matter accumulation (g plant^{-1}) recorded at 30, 60 DAS and at harvest are presented in Table 4.5 and 4.6.

4.1.3.1 Effect of nutrient management treatments on plant dry matter accumulation (g plant^{-1})

At 30 DAS, there was no significant effect on plant dry matter accumulation due to different nutrient treatments in both years and average data of two years. However, at 60 DAS, the second year and average data of two years revealed that N_2 (75% RDF + 25% organic through FYM + PSB) recorded maximum plant dry matter accumulation (10.19 g plant^{-1} and 10 g plant^{-1}) and was statistically at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). Minimum plant dry matter accumulation (7.30 g plant^{-1} and 7.91 g plant^{-1}) was recorded in N_1 (100% RDF). Similarly, the two years data and average data of two years recorded at harvest revealed that N_2 (75% RDF + 25% organic through FYM + PSB) recorded maximum plant dry matter accumulation (25.92 g plant^{-1}, 24.15 g plant^{-1} and 25.04 g plant^{-1} in 2017, 2018 and average data of two years, respectively) and was statistically at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). Minimum plant dry matter accumulation (22.88 g plant^{-1}, 17.40 g plant^{-1} and 20.14 g plant^{-1} in 2017, 2018 and average data of two years, respectively) was recorded in N_1 (100% RDF).

Increased plant dry matter production indicated the better utilisation of nutrients accompanied by a better solar energy harvest. Here, the slow release of nutrients associated with FYM might have resulted in a higher concentration of nutrients in plant cells resulting in higher dry-matter accumulation. Furthermore, in association with soil microorganisms, organic manures help synthesise certain phytohormones and vitamins that promote the growth and development of crops (Raj *et al*., 2019). Moreover, the application of biofertilizers resulted in improved nodulation and supplied a higher amount of nitrogen for growth and yield attributes, which in turn helped to realise higher growth parameters and dry matter of soybean (Thenua *et al*., 2010).

4.1.3.2 Effect of weed management treatments on plant dry matter accumulation (g plant^{-1})

The weed management treatments had a significant effect on plant dry matter accumulation in all the recorded growth stages.

The two years data and average data of two years on plant dry matter accumulation at 30 DAS revealed that W_2 (Hand weeding at 15, 30 and 45 DAS) recorded the maximum plant dry matter accumulation (1.45, 1.41 and 1.43 g plant^{-1} in 2017, 2018 and average data of two years, respectively) and was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). This was followed by W_3 (Mechanical weeding at 20 and 40 DAS). Minimum plant dry matter accumulation was recorded in weedy check.

At 60 DAS, the first year data showed that W_2 (hand weeding at 15, 30 and 45 DAS) recorded the maximum plant dry matter accumulation (11.74 g plant^{-1}) and was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS). This was subsequently followed by W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). In the second year data, W_2 (Hand weeding at 15, 30 and 45 DAS) recorded the maximum plant dry matter accumulation (13.23 g plant^{-1}) followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS), W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) and W_3 (Mechanical weeding at 20 and 40 DAS). Minimum plant dry matter accumulation (3.73 g plant^{-1}) was recorded in weedy check. Average data of two years showed result having same trend as second year (2018).

At harvest, average data of two years revealed that significantly maximum plant dry matter accumulation (30.91 g plant^{-1}) was recorded in W_2 (hand weed-

Table 4.5: Effect of nutrient and weed management treatments on plant dry matter accumulation (g plant^{-1}) of soybean at 30 DAS, 60 DAS and at harvest

Treatments	Dry matter accumulation (g plant^{-1})								
	30 DAS			60 DAS			at harvest		
	2017	2018	Average	2017	2018	Average	2017	2018	Average
Nutrient management (N)									
N_1	1.27	1.06	1.17	8.53	7.30	7.91	22.88	17.40	20.14
N_2	1.37	1.30	1.33	9.82	10.19	10.00	25.92	24.15	25.04
N_3	1.31	1.26	1.28	8.94	9.40	9.17	24.22	22.68	23.45
SEm±	**0.04**	**0.06**	**0.05**	**0.34**	**0.42**	**0.32**	**0.52**	**1.08**	**0.58**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**NS**	**1.65**	**1.25**	**2.04**	**4.23**	**2.28**
Weed Management (W)									
W_1	1.08	0.96	1.02	4.80	3.73	4.27	12.58	9.02	10.80
W_2	1.45	1.41	1.43	11.74	13.23	12.49	31.82	29.99	30.91
W_3	1.23	1.03	1.13	7.24	6.43	6.84	19.46	15.86	17.66
W_4	1.39	1.24	1.32	10.41	10.14	10.28	27.44	25.25	26.35
W_5	1.43	1.39	1.41	11.29	11.27	11.28	30.40	26.93	28.66
SEm±	**0.03**	**0.07**	**0.04**	**0.34**	**0.32**	**0.22**	**0.71**	**0.91**	**0.66**
CD (*p*=0.05)	**0.10**	**0.21**	**0.13**	**0.98**	**0.94**	**0.63**	**2.07**	**2.67**	**1.92**

N_1: 100 % RDF (NPKS), N_2: 75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB), N_3: 50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB), W_1: Weedy check, W_2: Weed free (Hand weeding at 15, 30 and 45 DAS), W_3: Mechanical weeding at 20 and 40 DAS, W_4: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS, W_5: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS

Table 4.6: Interaction effect of nutrient and weed management treatments on plant dry matter accumulation (g plant^{-1}) at 30 DAS, 60 DAS and at harvest

Treatments	Dry matter accumulation (g plant^{-1})								
	30 DAS			60 DAS			at harvest		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
N_1W_1	1.05	0.89	0.97	4.23	2.32	3.28	10.92	6.30	8.61
N_1W_2	1.39	1.17	1.28	11.05	10.63	10.84	29.65	23.43	26.54
N_1W_3	1.17	0.81	0.99	6.63	4.70	5.66	18.77	11.66	15.22
N_1W_4	1.37	1.19	1.28	10.02	8.93	9.48	26.17	22.36	24.26
N_1W_5	1.39	1.22	1.30	10.71	9.92	10.32	28.88	23.27	26.08
N_2W_1	1.12	0.97	1.05	5.66	4.83	5.25	14.22	10.41	12.31
N_2W_2	1.53	1.47	1.50	12.68	14.45	13.56	33.36	34.16	33.76
N_2W_3	1.30	1.26	1.28	7.88	7.99	7.94	20.63	18.48	19.55
N_2W_4	1.41	1.22	1.32	11.00	10.47	10.74	28.97	26.31	27.64
N_2W_5	1.50	1.57	1.53	11.89	13.18	12.54	32.45	31.40	31.93
N_3W_1	1.08	1.00	1.04	4.50	4.05	4.27	12.61	10.35	11.48
N_3W_2	1.42	1.58	1.50	11.50	14.61	13.06	32.44	32.39	32.42
N_3W_3	1.23	1.01	1.12	7.22	6.60	6.91	18.97	17.44	18.21
N_3W_4	1.40	1.31	1.35	10.21	11.03	10.62	27.19	27.09	27.14
N_3W_5	1.41	1.39	1.40	11.28	10.70	10.99	29.88	26.11	27.99
SEm± (N×W)	**0.06**	**0.13**	**0.08**	**0.58**	**0.56**	**0.37**	**1.23**	**1.58**	**1.14**
SEm± (W×N)	**0.05**	**0.10**	**0.07**	**0.50**	**0.55**	**0.40**	**0.94**	**1.47**	**0.92**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

-ing at 15, 30 and 45 DAS) which was followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 45 DAS). The minimum plant dry matter accumulation (10.80 g $plant^{-1}$) was recorded in weedy check.

The dry matter increased with the advancement of crop growth. The plant dry matter accumulation wasminimum under weedy check. The crops under weedy check faced weed competition and observed lowest plant height with lowest branches which ultimately reflected in its dry matter accumulation as the plants cannot take up more nutrients for its assimilation. The increase in plant dry matter accumulation in weed control treatments might be due to better control of weed flora. The reduction in the population and dry weight of weeds under these treatments created a favourable micro-environment for the growth and development of soybean and thus increased the dry matter accumulation of soybean. It conforms to the findings of Kumar *et al.* (2018a) and Samudre *et al*. (2019).

4.1.3.3 Interaction effect of treatments on plant dry matter accumulation (g $plant^{-1}$)

The interaction of different nutrient and weed management treatments did not show any significant effect on plant dry matter accumulation in both the years and average data of two years (Table 4.6).

4.1.4 Leaf area index (LAI)

The data on Leaf area index (LAI) at 30 and 60 DAS is presented in Table 4.7 and 4.8.

4.1.4.1Effect of nutrient management treatments on leaf area index

The data at 30 DAS revealed no significant variation in the LAI among the nutrient treatments in all the years of study. The LAI data of the second year at 60 DAS, revealed significant variation among the nutrient treatments. The maximum LAI (1.93) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) which was statistically at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). The minimum LAI (1.64) was recorded in N_1 (100% RDF).

4.1.4.2Effect of weed management treatments on leaf area index

The data for both years and average data of two years at 30 and 60 DAS revealed significant variation in LAI among the different weed management treatments.

In 2017, the LAI (0.77) at 30 DAS, was found significantly highest in W_2 (Hand weeding at 15, 30 and 45 DAS). This was followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). The least LAI (0.45) was found significantly in W_1 (Weedy check). The data of 2018 at 30 DAS revealed that the highest LAI (0.56) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) which was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS). This was followed subsequently by W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) and W_3 (Mechanical weeding at 20 and 40 DAS). The least LAI (0.41) was found significantly in W_1 (Weedy check). The average data of two years revealed similar trend as that of the first year.

At 60 DAS, the average data of two years revealed that the highest LAI (2.67) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) which was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS). This was followed subsequently by W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1}

Table 4.7: Effect of nutrient and weed management treatments on Leaf Area Index (LAI) of soybean at 30 DAS and 60 DAS

Treatments	LAI					
	30 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average
Nutrient management (N)						
N_1	0.59	0.47	0.53	1.95	1.64	1.79
N_2	0.63	0.52	0.57	2.21	1.93	2.07
N_3	0.60	0.48	0.54	2.12	1.88	2.00
SEm±	**0.01**	**0.03**	**0.01**	**0.09**	**0.05**	**0.07**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**NS**	**0.21**	**NS**
Weed Management (W)						
W_1	0.45	0.41	0.43	1.10	0.80	0.95
W_2	0.77	0.56	0.66	2.75	2.59	2.67
W_3	0.55	0.44	0.50	1.47	1.39	1.43
W_4	0.59	0.49	0.54	2.44	2.05	2.25
W_5	0.66	0.53	0.59	2.71	2.25	2.48
SEm±	**0.01**	**0.02**	**0.01**	**0.14**	**0.09**	**0.10**
CD (*p*=0.05)	**0.03**	**0.05**	**0.03**	**0.40**	**0.27**	**0.28**

N_1: 100 % RDF (NPKS), N_2: 75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB), N_3: 50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB), W_1: Weedy check, W_2: Weed free (Hand weeding at 15, 30 and 45 DAS), W_3: Mechanical weeding at 20 and 40 DAS, W_4: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS, W_5: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS.

Table 4.8: Interaction effect of nutrient and weed management treatments on Leaf Area Index (LAI) at 30 DAS and 60 DAS.

Treatments	LAI					
	30 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average
N_1W_1	0.42	0.38	0.40	0.94	0.70	0.82
N_1W_2	0.75	0.58	0.67	2.66	2.46	2.56
N_1W_3	0.54	0.39	0.47	1.38	1.21	1.29
N_1W_4	0.57	0.48	0.53	2.23	1.78	2.00
N_1W_5	0.66	0.50	0.58	2.53	2.04	2.28
N_2W_1	0.49	0.41	0.45	1.28	0.80	1.04
N_2W_2	0.80	0.60	0.70	2.73	2.88	2.81
N_2W_3	0.57	0.48	0.52	1.45	1.45	1.45
N_2W_4	0.59	0.53	0.56	2.74	2.06	2.40
N_2W_5	0.68	0.57	0.63	2.87	2.45	2.66
N_3W_1	0.45	0.45	0.45	1.09	0.89	0.99
N_3W_2	0.75	0.50	0.63	2.87	2.42	2.64
N_3W_3	0.54	0.46	0.50	1.57	1.52	1.54
N_3W_4	0.59	0.48	0.53	2.37	2.31	2.34
N_3W_5	0.66	0.50	0.58	2.72	2.28	2.50
SEm± (N×W)	**0.02**	**0.03**	**0.02**	**0.24**	**0.16**	**0.17**
SEm± (W×N)	**0.02**	**0.04**	**0.02**	**0.18**	**0.12**	**0.13**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

PE *fb* hand weeding at 30 DAS) and W_3 (Mechanical weeding at 20 and 40 DAS). The least LAI (0.95) was found significantly in W_1 (Weedy check).

In general, the assimilation area over the ground area was minimum during the early crop growth period, which increased after that under all the treatments. Effective control of weeds may be the reason for higher LAI in weed control treatments. With better control of weeds under hand weeding the plants seemed to utilise more growth resources which resulted in better plant growth with increase in crop canopy. This factor might have attributed to higher LAI of the crop. Similarly integration of herbicide and hand weeding also recorded better LAI. It conforms to the findings of Sharma *et al*. (2016b). Weedy check plot gave lowest LAI on account of higher weed competition, which did not compensate the leaf area index (Parmar *et al*., 2016)

4.1.4.3 Interaction effect of treatments on leaf area index

The interaction of different nutrient and weed management treatments did not show any significant effect on leaf area index in both the years and average data of two years (Table 4.8).

4.1.5 Number of root nodules plant^{-1}

The data on the number of root nodules plant^{-1} at 30 and 60 DAS are presented in Table 4.9 and 4.10.

4.1.5.1Effect of nutrient management treatments on the number of root nodules plant^{-1}

At 30 DAS and 60 DAS, a perusal of the data for both years and average data of two years revealed a significant variation in the number of root nodules plant^{-1} among the different nutrient management treatments.

At 30 DAS, average data of two years of maximum number of root nodules plant^{-1} (17.33) was recorded in N_3 (50% RDF + 50% organic through *Rhizobium*

+ PSB) which was statistically at par with N_2 (75% RDF + 25% organic through FYM + PSB). The minimum number of root nodules plant^{-1} (13.91) was significantly observed in N_1 (100% RDF). Both the years (2017 and 2018) also recorded the same trend.

At 60 DAS, the data for 2017 revealed maximum number of root nodules plant^{-1} (38.02) in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) which was statistically at par with N_2 (75% RDF + 25% organic through FYM + PSB). The minimum number of root nodules plant^{-1} (27.32) was significantly observed in N_1 (100% RDF). The data for 2018 showed that N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) recorded significantly higher number of root nodules plant^{-1} (35.48), subsequently followed by N_2 (75% RDF + 25% organic through FYM + PSB) which was at par with N_1 (100% RDF). The average data of two years revealed a similar trend as that of the first year.

The highest number of root nodules per plant in N_3 treatment might be due to the synergistic effect of *Rhizobium* and PSB for biological nitrogen as against their individual application. It also might be due to PSB which produces organic acids and solubilize insoluble form of phosphorus in the rhizosphere and make it available to the growing plants, which promotes root development in plants. Similar results have been reported by Tagore *et al*. (2013). The higher number of root nodules per plant in N_2 treatment can also be due to favourable effects of FYM in improving soil fertility through positive effects of physical, chemical and biological soil properties. The addition of organic manure with inorganic nutrients creates favourable soil conditions for nodulation and nitrogen fixation resulting in a beneficial effect on vegetative growth, increased metabolic activity, and root growth (Singh *et al*., 2010 and Mere *et al*., 2013). Similarly, Aziz *et al*. (2018) also observed that the integration of inorganic fertilizers and application of FYM and inoculation with *Rhizobium* and PSB showed a significant effect on the number of root nodules. Alam *et al*. (2015) reported that inoculated plants had a significantly higher number of root nodules than uninoculated plants.

4.1.5.2 Effect of weed management treatments on the number of root nodules plant^{-1}

The data for both years and average data of two years revealed significant variation in the number of root nodules plant^{-1} among the different weed management treatments.

In 2017, the number of root nodules plant^{-1} (18.22) at 30 DAS, was found highest in W_2 (Hand weeding at 15, 30 and 45 DAS) and statistically at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). On the other hand, the least number of root nodules plant^{-1} (10.72) was found significantly in W_1 (Weedy check). The data of 2018 revealed that the highest number of root nodules plant^{-1} (20.03) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) and was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS). This was followed subsequently by W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) and W_3 (Mechanical weeding at 20 and 40 DAS). The least number of root nodules plant^{-1} (12.19) was found significant in W_1 (Weedy check). The average data of two years followed similar trend with 2017 data.

At 60 DAS, the two years data and average data of two years revealed that the highest number of root nodules plant^{-1} (52.78, 49.27 and 51.02 in 2017, 2018 and average data of two years, respectively) was significantly recorded in W_2 (Hand weeding at 15, 30 and 45 DAS). This was followed subsequently by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS), W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) and W_3 (Mechanical weeding at 20 and 40 DAS). The least number of root nodules plant^{-1} (17.50, 19.16 and 18.33 in 2017 and average data of two years, respectively)

Table 4.9: Effect of nutrient and weed management treatments on number of root nodules plant^{-1} of soybean at 30 DAS and 60 DAS

Treatments	Number of root nodules plant^{-1}					
	30 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average
Nutrient management (N)						
N_1	13.17	14.66	13.91	27.32	28.64	27.98
N_2	15.57	17.28	16.42	31.21	30.91	31.06
N_3	16.37	18.29	17.33	38.02	35.48	36.75
SEm±	**0.63**	**0.68**	**0.63**	**1.99**	**1.11**	**1.46**
CD (*p*=0.05)	**2.47**	**2.67**	**2.46**	**7.83**	**4.34**	**5.75**
Weed Management (W)						
W_1	10.72	12.19	11.46	17.50	19.16	18.33
W_2	18.2P2	20.03	19.13	52.78	49.27	51.02
W_3	12.33	14.07	13.20	23.11	22.44	22.78
W_4	16.44	17.53	16.99	29.70	30.89	30.30
W_5	17.44	19.90	18.67	37.84	36.63	37.24
SEm±	**0.67**	**0.76**	**0.67**	**2.22**	**1.26**	**1.44**
CD (*p*=0.05)	**1.95**	**2.21**	**1.96**	**6.49**	**3.67**	**4.21**

N_1: 100 % RDF (NPKS), N_2: 75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB), N_3: 50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB), W_1: Weedy check, W_2: Weed free (Hand weeding at 15, 30 and 45 DAS), W_3: Mechanical weeding at 20 and 40 DAS, W_4: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS, W_5: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS

Table 4.10: Interaction effect of nutrient and weed management treatments on number of root nodules plant^{-1} at 30 DAS and 60 DAS

Treatments	Number of root nodules plant^{-1}					
	30 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average
N_1W_1	8.17	9.72	8.95	14.50	17.20	15.85
N_1W_2	17.33	17.93	17.63	44.83	43.83	44.33
N_1W_3	10.83	13.35	12.09	21.00	21.17	21.08
N_1W_4	14.50	15.21	14.86	22.78	29.00	25.89
N_1W_5	15.00	17.07	16.03	33.50	32.00	32.75
N_2W_1	11.33	12.87	12.10	18.50	18.50	18.50
N_2W_2	18.50	20.87	19.68	57.17	50.67	53.92
N_2W_3	12.67	13.86	13.26	21.33	24.83	23.08
N_2W_4	16.83	18.03	17.43	27.50	28.00	27.75
N_2W_5	18.50	20.75	19.63	31.56	32.57	32.06
N_3W_1	12.67	13.98	13.33	19.50	21.77	20.63
N_3W_2	18.83	21.29	20.06	56.33	53.30	54.82
N_3W_3	13.50	15.00	14.25	27.00	21.33	24.17
N_3W_4	18.00	19.33	18.67	38.83	35.67	37.25
N_3W_5	18.83	21.87	20.35	48.46	45.33	46.90
SEm± (N×W)	**1.16**	**1.31**	**1.05**	**3.85**	**2.18**	**2.50**
SEm± (W×N)	**0.96**	**1.07**	**0.91**	**3.15**	**1.77**	**2.15**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**6.35**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**5.85**	**NS**

was found significant in W_1 (Weedy check).

The physical alteration of soil involved in hand weeding might have created favourable soil condition (better aeration) for the growth of rhizobia which therefore has resulted more nodulation on treatments comprising hand weeding. This conforms with the findings of Virk *et al.* (2018). The herbicide treatment also did not affect the number of nodules. The lack of inhibitory effect of herbicide on nodulation could be due to its rapid inactivation in soil or its quick translocation, along with photosynthate, to a distant metabolic sink (Zaid *et al.*, 2014).

4.1.5.3 Interaction effect of treatments on the number of root nodules plant^{-1}

The interaction effect of treatments on the number of root nodules plant^{-1} was non-significant at 30 DAS for both years and average data of two years (Table 4.10). Similarly, the interaction effect of treatments on the number of root nodules plant^{-1} at 60 DAS was also non-significant for the first year and average data of two years.

However, the second year data at 60 DAS revealed significant variation among the different treatment interactions.

Among the interactions, $N_3 \times W_2$ recorded the highest number of nodules plant^{-1} (53.30) which was statistically at par with $N_2 \times W_2$ (50.67). The favourable soil condition due to hand weeding at 15, 30 and 45 DAS along with supply of both organic and inorganic nutrients might have helped to cause more nodulation in plants at 60 DAS. These results indicated that integrated nutrient management under a comparatively weed-free environment could significantly influence the root nodules of soybean.

4.1.6 Nodules fresh and dry weight plant^{-1} (g)

The data on nodules fresh and dry weight plant^{-1} at 30 DAS and 60 DAS is presented on Table 4.11 and 4.12.

4.1.6.1 Effect of nutrient management treatments on nodules fresh and dry weight plant^{-1}

An inquisition on the data of two years and average data of two years at 30 DAS on nodules fresh weight plant^{-1} revealed a significant variation among the nutrient treatments. The average data of two years showed that the highest nodules fresh weight plant^{-1} (0.33 g) was recorded in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) which was statistically at par with N_2 (75% RDF + 25% organic through FYM + PSB). The minimum nodules fresh weight plant^{-1} (0.27 g) was significantly observed in N_1 (100% RDF).

At 60 DAS, the data of two years on nodules fresh weight plant^{-1} revealed a similar trend in variation as observed in 30 DAS. The average data of two years recorded significantly highest nodules fresh weight plant^{-1} (1.17 g) in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). The lowest nodules fresh weight plant^{-1} (0.89 g) was recorded in N_1 (100% RDF).

Futhermore, an inquisition on the data of two years and average data of two years at 30 DAS on nodules dry weight plant^{-1} revealed that there was also a significant variation among the nutrient treatments. It revealed the same pattern observed in nodules fresh weight plant^{-1} at 30 DAS where the highest nodules dry weight plant^{-1} (0.082 g) was recorded in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) which was statistically at par with N_2 (75% RDF + 25% organic through FYM + PSB). The minimum nodules dry weight plant^{-1} (0.065 g) was significantly observed in N_1 (100% RDF).

At 60 DAS, the average data of two years recorded significantly highest nodules dry weight plant^{-1} (0.37 g) in N_3 (50% RDF + 50% organic through

Rhizobium + PSB). And N_1 (100% RDF) recorded the lowest nodules dry weight plant^{-1} (0.28 g).

The higher nodule fresh and dry weight under N_3 and N_2 treatments might be due to more number of nodules plant^{-1}. Alam *et al*. (2015) reported that inoculated plants had a significantly higher fresh and dry weight of root nodules than uninoculated plants.

4.1.6.2 Effect of weed management treatments on nodules fresh and dry weight plant^{-1}

For both years and average data of two years, the data revealed significant variation in nodules fresh weight and dry weight plant^{-1} among the different weed management treatments at 30 DAS and 60 DAS.

At 30 DAS, the average data of two years recorded maximum nodules fresh weight plant^{-1} (0.36 g) in W_2 (Hand weeding at 15, 30 and 45 DAS) and W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) treatments and it was found to be at par W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). The least weight (0.22 g) was found in W_1 (Weedy check), which was at par with W_3 (Mechanical weeding at 20 and 40 DAS).

At 60 DAS, the two years data and average data of two years revealed a similar trend where significant maximum nodules fresh weight plant^{-1} (1.58 g, 1.63 g and 1.60 g in 2017, 2018 and average data of two years, respectively) was found highest in W_2 (Hand weeding at 15, 30 and 45 DAS). This was followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS),

With regard to dry weight of nodules, both the years recorded similar trend of observation. The average data of two years of nodules dry weight plant^{-1} at 30 DAS revealed the highest (0.090 g) in W_2 (Hand weeding at 15, 30 and 45 DAS) which was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weed-

Table 4.11: Effect of nutrient and weed management treatments on nodules fresh and dry weight plant^{-1} (g) at 30 DAS and 60 DAS

Treatments	Nodules fresh weight plant^{-1} (g)						Nodules dry weight plant^{-1} (g)					
	30 DAS			60 DAS			30 DAS			60 DAS		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
Nutrient management (N)												
N_1	0.25	0.28	0.27	0.83	0.95	0.89	0.062	0.069	0.065	0.25	0.31	0.28
N_2	0.30	0.33	0.31	0.96	1.02	0.99	0.074	0.083	0.079	0.28	0.34	0.31
N_3	0.32	0.35	0.33	1.15	1.19	1.17	0.078	0.086	0.082	0.35	0.39	0.37
SEm±	**0.01**	**0.01**	**0.01**	**0.06**	**0.04**	**0.05**	**0.003**	**0.003**	**0.003**	**0.02**	**0.01**	**0.01**
CD (p=0.05)	**0.04**	**0.05**	**0.04**	**0.23**	**0.17**	**0.19**	**0.012**	**0.011**	**0.011**	**0.07**	**0.05**	**0.05**
Weed management (W)												
W_1	0.21	0.23	0.22	0.56	0.63	0.60	0.050	0.057	0.054	0.16	0.21	0.18
W_2	0.35	0.38	0.36	1.58	1.63	1.60	0.086	0.050	0.090	0.48	0.53	0.50
W_3	0.24	0.28	0.26	0.73	0.78	0.75	0.058	0.069	0.063	0.22	0.25	0.24
W_4	0.31	0.33	0.32	0.89	1.02	0.96	0.078	0.082	0.080	0.27	0.34	0.30
W_5	0.33	0.38	0.36	1.14	1.21	1.17	0.084	0.094	0.089	0.34	0.41	0.37
SEm±	**0.01**	**0.01**	**0.01**	**0.06**	**0.04**	**0.04**	**0.003**	**0.003**	**0.003**	**0.02**	**0.01**	**0.01**
CD (p=0.05	**0.04**	**0.04**	**0.04**	**0.19**	**0.11**	**0.12**	**0.008**	**0.010**	**0.009**	**0.06**	**0.04**	**0.04**

Table 4.12: Interaction effect of nutrient and weed management treatments on nodules fresh and dry weight plant^{-1} (g) at 30 DAS and 60 DAS

Treatments	Nodules fresh weight plant^{-1} (g)						Nodules dry weight plant^{-1} (g)					
	30 DAS			60 DAS			30 DAS			60 DAS		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
N_1W_1	0.16	0.18	0.17	0.50	0.57	0.53	0.038	0.046	0.042	0.13	0.19	0.16
N_1W_2	0.33	0.32	0.33	1.35	1.45	1.40	0.081	0.080	0.081	0.40	0.45	0.42
N_1W_3	0.21	0.25	0.23	0.63	0.75	0.69	0.051	0.063	0.057	0.21	0.23	0.22
N_1W_4	0.28	0.29	0.28	0.68	0.96	0.82	0.068	0.072	0.070	0.20	0.32	0.26
N_1W_5	0.29	0.34	0.31	1.01	1.06	1.03	0.071	0.084	0.077	0.30	0.37	0.34
N_2W_1	0.22	0.24	0.23	0.56	0.61	0.58	0.053	0.060	0.057	0.17	0.20	0.18
N_2W_2	0.35	0.39	0.37	1.72	1.67	1.69	0.087	0.098	0.092	0.51	0.55	0.53
N_2W_3	0.24	0.27	0.25	0.74	0.82	0.78	0.060	0.072	0.066	0.19	0.27	0.23
N_2W_4	0.32	0.34	0.33	0.83	0.92	0.87	0.083	0.085	0.084	0.25	0.31	0.28
N_2W_5	0.35	0.40	0.37	0.95	1.07	1.01	0.090	0.098	0.094	0.28	0.35	0.32
N_3W_1	0.24	0.27	0.25	0.62	0.72	0.67	0.060	0.066	0.063	0.18	0.24	0.21
N_3W_2	0.36	0.42	0.39	1.69	1.76	1.72	0.089	0.103	0.096	0.51	0.58	0.54
N_3W_3	0.28	0.31	0.30	0.81	0.78	0.79	0.063	0.071	0.067	0.27	0.25	0.26
N_3W_4	0.34	0.37	0.35	1.17	1.18	1.17	0.085	0.091	0.088	0.35	0.40	0.37
N_3W_5	0.36	0.40	0.38	1.45	1.50	1.47	0.092	0.100	0.096	0.44	0.49	0.47
SEm± (N×W)	**0.02**	**0.02**	**0.02**	**0.11**	**0.07**	**0.07**	**0.005**	**0.006**	**0.005**	**0.04**	**0.02**	**0.02**
SEm± (W×N)	**0.02**	**0.02**	**0.02**	**0.09**	**0.06**	**0.07**	**0.004**	**0.005**	**0.004**	**0.03**	**0.02**	**0.02**
CD (p=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**0.20**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.07**	**NS**
CD (p=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**0.21**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.06**	**NS**

-ing at 45 DAS), followed by W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). The least (0.054 g) was found in W_1 (Weedy check).

At 60 DAS, the two years and average data of two years revealed similar results where significantly highest nodules dry weight plant^{-1} (0.48 g, 0.53 g and 0.50 g, in 2017 and average data of two years, respectively) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS). This was followed subsequently by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). The least nodules dry weight plant^{-1} (0.16 g, 0.21 g and 0.18 g in 2017, 2018 and average data of two years, respectively) was found significantly in W_1 (Weedy check).

Aggarwal *et al.* (2014) and Virk *et al.* (2018) also observed higher nodule dry and fresh weight due to effective control of weeds under weed control treatments.

4.1.6.3 Interaction effect of treatments on nodules fresh and dry weight plant^{-1}

The data on interaction effect of treatments on nodules fresh and dry weight plant^{-1} at 30 DAS and 60 DAS are presented in Table 4.12.

The interaction effect of treatments on nodules fresh and dry weight plant^{-1} was non-significant at 30 DAS for both years and average data of two years.

At 60 DAS, except for 2018, there was non-significant effect for the interaction of treatments. The nodule fresh and dry weight was recorded maximum in $N_3 \times W_2$ interaction and was at par with $N_2 \times W_2$. The higher number of nodules plant^{-1} obtained at 60 DAS in the interactions of $N_3 \times W_2$ and $N_2 \times W_2$ might be the reason for obtaining higher nodule fresh and dry weight plant^{-1}. These results indicated that integrated nutrient management under a comparatively weed-free environment could significantly influenced the nodules weight of soybean crop.

4.1.7 Crop growth rate (CGR) (g m^{-2} day^{-1})

The data on Crop Growth Rate (g m^{-2} day^{-1}) at (30-60 DAS) is presented in Table 4.13 and 4.14.

4.1.7.1 Effect of nutrient management treatments on crop growth rate

A perusal of the data presented in Table 4.13 showed no variation in the first year for CGR at (30-60 DAS). However, there was significant variation in the second year and average data of two years for among the nutrient management treatments where the maximum CGR (7.41 g m^{-2} day^{-1} and 7.22 g m^{-2} day^{-1}, respectively) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) which was statistically at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). The minimum CGR (5.20 g m^{-2} day^{-1} and 5.62 g m^{-2} day^{-1} in 2017, 2018 and average data of two years, respectively) was significantly observed in N_1 (100% RDF).

The higher CGR was recorded in integrated use of both organic and inorganic nutrients. The continuous availability of nutrients in this treatments might have resulted in more accumulation of crop biomass per unit area per unit time that have reflected in higher CGR. Verma *et al*. (2006) and Rasool *et al*. (2015) reported similar findings.

4.1.7.2 Effect of weed management treatments on crop growth rate

For both the years and average data of two years, the data revealed significant variation in CGR among the different weed management treatments at (30-60 DAS). In 2017, the CGR (8.58 g m^{-2} day^{-1}) was found maximum in W_2 (Hand weeding at 15, 30 and 45 DAS). It was found to be at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and followed by W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) and W_3 (Mechanical weeding at 20 and 40 DAS). The minimum CGR (3.10 g m^{-2} day^{-1}) was found significantly in W_1 (Weedy check). Whereas, 2018 and average data of two years revealed that the maximum CGR (9.85 g m^{-2} day^{-1} and 9.22 g m^{-2} day^{-1}, respectively) was significantly recorded in W_2 (Hand weeding at 15, 30 and 45 DAS). This was subsequently followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS), W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) and W_3 (Mechanical weeding at 20 and 40 DAS).

The control of weeds through hand weeding might have resulted in more nutrients to be utilised by crops which helped in assimilation of more plant biomass resulting in higher CGR. This corroborates with the findings of Rajkumari *et al*. (2017). Similarly, control of weeds through herbicide and hand weeding have helped the plant to recorded more growth rate (Borana *et al*., 2017).

4.1.7.3 Interaction effect of treatments on crop growth rate

The data on CGR revealed no significant variation in the different interaction treatments (Table 4.14).

4.1.8 Relative growth rate (RGR) (g g^{-1} day^{-1})

The data on Relative Growth Rate (g g^{-1} day^{-1}) at (30-60 DAS) is presented in Table 4.13 and 4.14.

4.1.8.1 Effect of nutrient management treatments on relative growth rate

An inquisition on two years' data and average data of two years on RGR at (30-60 DAS) revealed no significant variation among the nutrient treatments.

4.1.8.2 Effect of weed management treatments on relative growth rate

The two years data and average data of two years, revealed significant variation in RGR among the different weed management treatments at (30-60 DAS) where a common trend was found. The maximum RGR (0.070 g g^{-1} day^{-1}, 0.075 g g^{-1} day^{-1} and 0.072 g g^{-1} day^{-1} in 2017, 2018 and average data of two

Table 4.13: Effect of nutrient and weed management treatments on crop growth rate (CGR) (g m^{-2} day^{-1}) and relative growth rate (RGR) (g g^{-1} day^{-1}) of soybean at (30-60 DAS)

Treatments	Crop Growth Rate (g m^{-2} day^{-1}) (30 -60 DAS)			Relative Growth Rate (g g^{-1} day^{-1}) (30-60 DAS)		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)						
N_1	6.05	5.20	5.62	0.061	0.060	0.061
N_2	7.04	7.41	7.22	0.064	0.067	0.066
N_3	6.36	6.78	6.57	0.062	0.064	0.063
SEm±	**0.28**	**0.32**	**0.24**	**0.001**	**0.001**	**0.001**
CD (*p*=0.05)	**NS**	**1.26**	**0.95**	**NS**	**NS**	**NS**
Weed Management (W)						
W_1	3.10	2.32	2.71	0.049	0.045	0.047
W_2	8.58	9.85	9.22	0.070	0.075	0.072
W_3	5.01	4.50	4.76	0.059	0.061	0.060
W_4	7.51	7.42	7.47	0.067	0.070	0.069
W_5	8.22	8.23	8.22	0.069	0.070	0.069
SEm±	**0.28**	**0.25**	**0.17**	**0.001**	**0.002**	**0.001**
CD (*p*=0.05)	**0.80**	**0.74**	**0.49**	**0.004**	**0.006**	**0.003**

Table 4.14: Interaction effect of nutrient and weed management treatments on crop growth rate (CGR) (g m^{-2} day^{-1}) and relative growth rate (RGR) (g g^{-1} day^{-1}) of soybean at (30-60 DAS).

Treatments	Crop Growth Rate (g m^{-2} day^{-1}) (30-60 DAS)			Relative Growth Rate (g g^{-1} day^{-1}) (30-60 DAS)		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**
N_1W_1	2.65	1.19	1.92	0.046	0.032	0.039
N_1W_2	8.05	7.88	7.96	0.069	0.074	0.071
N_1W_3	4.55	3.24	3.89	0.058	0.059	0.058
N_1W_4	7.21	6.45	6.83	0.066	0.068	0.067
N_1W_5	7.77	7.25	7.51	0.068	0.070	0.069
N_2W_1	3.78	3.22	3.50	0.054	0.056	0.055
N_2W_2	9.29	10.81	10.05	0.071	0.076	0.074
N_2W_3	5.49	5.61	5.55	0.060	0.062	0.061
N_2W_4	7.99	7.71	7.85	0.069	0.071	0.070
N_2W_5	8.66	9.68	9.17	0.069	0.071	0.070
N_3W_1	2.85	2.54	2.69	0.048	0.046	0.047
N_3W_2	8.40	10.86	9.63	0.069	0.074	0.072
N_3W_3	4.99	4.66	4.83	0.059	0.063	0.061
N_3W_4	7.34	8.10	7.72	0.066	0.071	0.069
N_3W_5	8.22	7.76	7.99	0.069	0.068	0.069
SEm± (N×W)	**0.48**	**0.44**	**0.29**	**0.002**	**0.003**	**0.002**
SEm± (W×N)	**0.41**	**0.42**	**0.30**	**0.002**	**0.003**	**0.002**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**0.005**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**0.006**

years, respectively) was found in W_2 (Hand weeding at 15, 30 and 45 DAS) which was found to be at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). The minimum RGR (0.049 g g^{-1} day^{-1}, 0.045 g g^{-1} day^{-1} and 0.047 g g^{-1} day^{-1} in 2017, 2018 and average data of two years, respectively) was recorded in W_1 (Weedy check).

The results indicated that weed infestation has a significant impact on soybean growth in weed check. Whereas, better RGR were recorded in W_2 (Hand weeding at 15, 30 and 45 DAS), W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). This could be due to successful weed control and low weed biomass which allowed plants receiving treatments to have a higher photosynthetic rate. Olayinka and Etejere (2015), Rajkumari *et al*. (2017) and Mahaveer *et al.* (2020) reported similar findings.

4.1.8.3 Interaction effect of treatments on relative growth rate

An inquisition on two years' data on RGR at (30-60 DAS) revealed no significant variation among the treatments interactions (Table 4.14).

4.2 YIELD AND YIELD ATTRIBUTES

The two years' data and their average data of two years of number of pods plant^{-1}, pod weight plant^{-1} (g), number of seed pod^{-1} and 100-seed weight (g) are presented in Table 4.15 and 4.16. The two years' data and their average data of grain yield (t ha^{-1}), stover yield (t ha^{-1}) and harvest (%) are presented in Table 4.17 and 4.18

4.2.1 Number of pods plant^{-1}

4.2.1.1 Effect of nutrient management treatments on number of pods plant^{-1}

The data presented in Table 4.15 on the number of pods plant^{-1} in both years and average data of two years revealed significant variation among the nutrient management treatments. The maximum number of pods plant^{-1} in 2017, 2018 and average data of two years (55.72, 52.22 and 53.97, respectively) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) which was statistically at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). The minimum number of pods plant^{-1} (45.64, 44.63 and 45.13 in 2017, 2018 and average data of two years, respectively) was significantly observed in N_1 (100% RDF).

The better growth of crop under N_2 and N_3 is possible reason for higher number of pod formation in the same treatment. Chaudhari *et al*. (2019) reported that the increase in pod bearing capacity of crop could possibly due to improved N and P fertilisation efficiency in the presence of FYM. Alam *et al.* (2009) reported that integrated application of chemical fertilizers with biofertilizers gave the highest number of pods plant^{-1}. Similar findings have been reported by Kanase *et al*. (2006), Suryawanshi *et al.* (2006) and Koushal and Singh (2011).

4.2.1.2 Effect of weed management treatments on number of pods plant^{-1}

Significant results were recorded on number of pods plant^{-1} in both years and average data of two years. In 2017 and 2018, the maximum number of pods plant^{-1} (62.84 and 61.89, respectively) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) and found to be at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS). The minimum number of pods plant^{-1} (28.02) was found significantly in W_1 (Weedy check). The average data of two years also revealed a similar trend.

Among all the weed management treatments, the minimum number of pods per plant was recorded in weedy check, which was increased significantly when weed control measures were adopted. This is in conformity with the results reported by Kumar *et al.* (2018c). Severe weed competition in the weedy check might have reduced the number of pods plant^{-1}. Hand weeding done thrice and herbicides integrated with hand weeding were at par. It indicated a more pronounced effect of their integrated use because the initial achievement of limiting weed growth by the herbicides is maintained and hand weeding eliminated the fresh flush of weeds that may regenerate due to loss of persistence of the applied herbicides. Similar findings were reported by Malik *et al*. (2006) and Peer *et al*. (2013).

4.2.1.3 Interaction effect of treatments on number of pods plant^{-1}

There was no significant effect on the number of pods plant^{-1} due to the interaction of nutrient and weed management treatments in all the years of experimentation and average data of two years (Table 4.16).

4.2.2 Pod weight plant^{-1} (g)

4.2.2.1 Effect of nutrient management treatments on pod weight plant^{-1} (g)

The data presented in Table 4.15 on pod weight plant^{-1} (g) in both years and average data of two years revealed a significant variation among the nutrient treatments. In 2017 and 2018 experiments, the maximum pod weight plant^{-1} (18.55 g and 17.54 g, respectively) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) which was statistically at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). The minimum pod weight plant^{-1} (16.12 g and 15.11 g in 2017 and 2018, respectively) was significantly observed in N_1 (100% RDF). The average data of two years revealed significantly maximum pod weight plant^{-1} (18.04 g) in N_2 (75% RDF + 25% organic through FYM + PSB) and the least pod weight plant^{-1} (15.62 g) was recorded significantly in N_1 (100% RDF).

The combined influence of chemical fertilizers, farmyard manure and biofertilizers may be responsible for the increase in this yield attribute in N_2 treatment. Furthermore, the higher pod weight may be attributed to higher number of pods plant^{-1} accompanied by possibility of more nutrient assimilation by the crop. Acccording to Chaudhari *et al*. (2019), the increased rate of photosynthetic and symbiotic activity caused by the use of FYM in combination with chemical fertilizers stimulated better vegetative and reproductive growth of crop, resulting in higher pod weight. Similarly, Koushal and Singh (2011) found that applying 50% recommended N applied through urea + 50% through FYM+ PSB resulted in maximum pod weight plant^{-1}. Bonde and Gawade (2017) also reported similar findings.

4.2.2.2 Effect of weed management treatments on pod weight plant^{-1} (g)

Significant results were recorded on pod weight plant^{-1} in both years of experimentation and average data of two years. In 2017, the maximum pod weight plant^{-1} (24.18 g) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS). It was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS). The minimum pod weight plant^{-1} (8.54) was found significantly in W_1 (Weedy check). In 2018 and average data of two years, the maximum pod weight plant^{-1} (23.91 g and 24.05 g, respectively), was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) which was subsequently followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS).

The higher value of this yield attribute might be due to low competition stress of crop with weed plants due to better control of weed in different stages of crop (Patel *et al*., 2016). Kaur *et al*. (2015), Chouhan (2017) and Jadon *et al.* (2019) also reported similar results where the improvement in yield attributes turned out when weeds were controlled on early growth stages, particularly during critical growth period either manually or chemically, which curtailed competition and established congenial micro-environment for better establishment and growth of the crop.

4.2.2.3 Interaction effect of treatments on pod weight plant^{-1} (g)

There was no significant effect on pod weight plant^{-1} due to the interaction of nutrient and weed management treatments in all the years of experimentation and average data of two years (Table 4.16).

4.2.3 Number of seeds pod^{-1}

4.2.3.1 Effect of nutrient management treatments on number of seeds pod^{-1}

An inquisition on two years' data and average data of two years on the number of seeds pod^{-1} revealed no significant variation among the nutrient treatments.

4.2.3.2 Effect of weed management treatments on number of seeds pod^{-1}

Significant results were recorded on the number of seeds pod^{-1} in both years of experimentation and average data of two years. In 2017 and 2018, the maximum number of seeds pod^{-1} (3.02 and 2.73, respectively) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) which was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). The minimum number of seeds pod^{-1} was found significantly in W_1 (Weedy check). However, the average data of two years revealed maximum number of seeds pod^{-1} (2.88) recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) which was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS) only.

Excellent growth and development of soybean plants under three hand weeding might have resulted in superior yield attributes under weed control treatment. Similar findings were reported by Sandil *et al*. (2015) and Shete *et al*. (2008). Un-checked growth of weeds in weedy check caused lowest number of seeds pod^{-1} (Peer *et al*., 2013). Another report by Rao (2018) observed that such reduction in number of seeds pod^{-1} could be probably due to less number of

Table 4.15: Effect of nutrient and weed management treatments on yield attributes of soybean

Treatments	Number of pods plant^{-1}			Pod weight plant^{-1}(g)			Number of seeds pod^{-1}			100-seed weight (g)		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
Nutrient management (N)												
N_1	45.64	44.63	45.13	16.12	15.11	15.62	2.59	2.45	2.52	9.12	8.66	8.89
N_2	55.72	52.22	53.97	18.55	17.54	18.04	2.87	2.56	2.71	9.67	9.17	9.42
N_3	50.08	49.03	49.55	17.21	16.50	16.85	2.72	2.49	2.61	9.38	9.13	9.26
SEm±	**1.74**	**1.20**	**1.19**	**0.41**	**0.44**	**0.30**	**0.07**	**0.11**	**0.06**	**0.24**	**0.24**	**0.21**
CD (*p*=0.05)	**6.82**	**4.71**	**4.67**	**1.60**	**1.74**	**1.18**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	28.02	24.98	26.50	8.54	7.16	7.85	2.29	2.11	2.20	8.22	7.69	7.95
W_2	62.84	61.89	62.37	24.18	23.91	24.05	3.02	2.73	2.88	10.38	9.84	10.11
W_3	43.62	39.51	41.57	11.28	10.70	10.99	2.67	2.38	2.52	8.72	8.33	8.53
W_4	57.47	56.73	57.10	20.18	18.78	19.48	2.78	2.60	2.69	9.68	9.26	9.47
W_5	60.44	60.01	60.23	22.27	21.36	21.82	2.87	2.69	2.78	9.96	9.82	9.89
SEm±	**1.40**	**1.75**	**1.18**	**0.71**	**0.75**	**0.37**	**0.10**	**0.07**	**0.06**	**0.23**	**0.22**	**0.19**
CD (*p*=0.05)	**4.09**	**5.10**	**3.46**	**2.08**	**2.18**	**1.09**	**0.29**	**0.20**	**0.18**	**0.66**	**0.64**	**0.55**

Table 4.16: Interaction effect of nutrient and weed management treatments on yield attributes of soybean

Treatments	Number of pods plant^{-1}			Pod weight plant^{-1}(g)			Number of seeds pod^{-1}			100-seed weight (g)		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
N_1W_1	27.80	21.13	24.47	7.60	6.49	7.05	2.00	2.07	2.03	8.19	7.27	7.73
N_1W_2	55.40	56.53	55.97	22.16	21.74	21.95	2.80	2.73	2.77	10.02	9.60	9.81
N_1W_3	39.67	36.87	38.27	10.56	10.27	10.42	2.67	2.27	2.47	8.32	8.53	8.43
N_1W_4	52.00	54.00	53.00	19.07	16.88	17.98	2.73	2.53	2.63	9.21	8.30	8.75
N_1W_5	53.33	54.60	53.97	21.19	20.18	20.69	2.73	2.67	2.70	9.86	9.60	9.73
N_2W_1	30.00	25.73	27.87	9.55	7.47	8.51	2.53	2.13	2.33	8.27	7.60	7.93
N_2W_2	71.33	67.47	69.40	26.34	25.29	25.82	3.20	2.80	3.00	10.70	10.20	10.45
N_2W_3	45.20	41.53	43.37	12.40	11.26	11.83	2.67	2.33	2.50	8.96	7.93	8.45
N_2W_4	62.40	59.53	60.97	20.96	20.11	20.53	2.93	2.73	2.83	10.30	10.13	10.22
N_2W_5	69.67	66.83	68.25	23.51	23.54	23.53	3.00	2.80	2.90	10.14	10.00	10.07
N_3W_1	26.27	28.07	27.17	8.48	7.53	8.01	2.33	2.13	2.23	8.20	8.20	8.20
N_3W_2	61.80	61.67	61.73	24.05	24.70	24.38	3.07	2.67	2.87	10.42	9.73	10.08
N_3W_3	46.00	40.13	43.07	10.89	10.57	10.73	2.67	2.53	2.60	8.88	8.53	8.71
N_3W_4	58.00	56.67	57.33	20.51	19.33	19.92	2.67	2.53	2.60	9.53	9.33	9.43
N_3W_5	58.33	58.60	58.47	22.11	20.36	21.24	2.87	2.60	2.73	9.89	9.87	9.88
SEm± (N×W)	**2.43**	**3.03**	**2.05**	**1.24**	**1.30**	**0.65**	**0.17**	**0.12**	**0.11**	**0.39**	**0.38**	**0.33**
SEm± (W×N)	**2.32**	**2.26**	**1.76**	**0.88**	**0.93**	**0.51**	**0.13**	**0.13**	**0.09**	**0.35**	**0.34**	**0.30**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

flowers and impaired fertility in the overcrowded crop by the diverse vegetation of weed flora.

4.2.3.3 Interaction effect of treatments on number of seeds pod^{-1}

There was no significant effect on the number of seeds pod^{-1} due to the interaction of nutrient and weed management treatments in all the years of experimentation and average data of two years (Table 4.16).

4.2.4 100-seed weight (g)

4.2.4.1 Effect of nutrient management treatments on 100-seed weight (g)

An inquisition on two years' data and average data of two years on 100-seed weight (g) revealed no significant variation among the nutrient treatments. Being a varietal character, it is less sensitive to management levels. Similar results were reported by Bijarnia *et al*. (2017) and Raj *et al.* (2019).

4.2.4.2 Effect of weed management treatments on 100-seed weight (g)

Significant results were recorded on 100-seed weight in both years of experimentation and average data of two years. In 2017 and 2018, the maximum 100-seed weight (10.38 g and 9.84 g, respectively) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) which was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS). And, the minimum 100-seed weight (8.22 g and 7.69 g) was found significantly in W_1 (Weedy check). The average data of two years revealed a maximum 100-seed weight (10.11 g) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) which was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) only.

All the weed management treatments significantly increased 100-seed weight over the weedy check. The weeds removed from inter and intra row spaces provided suitable aeration owing to manipulation of the soil surface and thus more availability of nutrients, light, space and water. Therefore, relatively greater values of yield attributes were attained. These results also conform to Kumar *et al*. (2018c). Vyas and Jain (2003) and Peer *et al*. (2013) also reported improved 100-seed weight which was facilitated by reduced weed competition due to effective weed control measures. Parmar *et al.* (2016) also reported similar findings where hand weeding at 20 and 40 DAS in soybean crop gave highest test weight due to reduced weed stress. Severe weed competition due to unchecked weed growth consequently led to a reduction in 100-seed weight.

4.2.4.3 Interaction effect of treatments on 100-seed weight (g)

There was no significant effect on 100-seed weight (g) due to the interaction of nutrient and weed management treatments in all the years of experimentation and average data of two years (Table 4.16).

4.2.5 Grain yield (t ha^{-1})

4.2.5.1 Effect of nutrient management treatments on grain yield (t ha^{-1})

The data presented in Table 4.17 and depicted in Fig 4.1 on grain yield in both years and average data of two years revealed a significant variation among the nutrient treatments. In 2017 and 2018 experiments, the maximum grain yield (1.70 t ha^{-1} and 1.56 t ha$^{-1,}$ respectively) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) which was statistically at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). The average data of two years revealed significantly maximum grain yield (1.63 t ha^{-1}) in N_2 (75% RDF + 25% organic through FYM + PSB).

The minimum grain yield (1.40 t ha^{-1}, 1.37 t ha^{-1} and 1.39 t ha^{-1} in 2017, 2018 and average data of two years, respectively) was significantly observed in N_1 (100% RDF) as compared to integration of inorganic fertilizers with biological and organic manures. It might be due to the quick exhaustion of nutrients, especially nitrogen, to the crop at the later stages of crop growth when the root nodules degenerate and the nitrogen supply falls short of crop requirements during the pod development phase of the crop. Similar results were reported in soybean (Raj *et al.*, 2019).

The application of 75% RDF along with FYM and PSB in N_2 treatment recorded highest grain yield of soybean. This treatment recorded highest yield attributes which was reflected in grain yield. Similar findings were reported by Maheshbabu *et al*. (2008), Bonde and Gawade (2017) and Raj *et al*. (2019). This might be attributed to more availability of macronutrients from the fertilizers along with integration of FYM and PSB. The rapid mineralization of N from inorganic fertilizers and steady supply of N from FYM, might have met the N requirement of crop at critical stages. FYM acts as nutrients reservoir and upon decomposition produces organic acids, thereby absorbed ions are released slowly during the growth period leading to improvement in different yield components thereby resulting in higher grain yield. Further more, Chen *et al*. (2006) and Devi *et al*. (2013) reported that PSB enhances the phosphorus availability to plants by mineralizing organic P in the soil and by solubilizing precipitated phosphate resulting in higher grain yield. Phosphorus has important effects on photosynthesis, nitrogen fixation, root development, flowering, seed formation, fruiting and improvement of crop quality (Brady, 2002). Mere *et al*. (2013) found an increase in seed yield due to integrated nutrient management of inorganic fertilizers and farmyard manure application with inoculation of biofertilizers.

The grain yield of N_3 treatment (50% RDF with *Rhizobium* and PSB) was found to be at par with the best treatment *i.e*., N_2 treatment. This may be due to more availability of macro nutrients from the fertilizers along with that augmented through biofertilizers. *Rhizobium* enhances the growth and yield of soybean as it is known to promote growth promoting substances like IAA, Gibberellins and Cytokinins, *etc*. The increased biological nitrogen fixation and solubilisation of more amount of P by PSB and improved soil condition favourable for availability of nutrients to crop throughout the growth period might have increased the grain yield. Dhage and Kachhave (2008) and Lynrah and Nongmaithem (2017) also recorded the highest yield with co-inoculation of *Rhizobium* + PSB with RDF.

The grain yields were lower in all the treatments during 2018 than the previous year (2017) because of low rainfall coupled with long dry spells. Similar results was reported by Vyas and Kushwah (2008).

4.2.5.2 Effect of weed management treatments on grain yield (t ha^{-1})

Significant results were recorded on grain yield in both years of experiment and average data of two years. In 2017, significantly highest grain yield (2.12 t ha^{-1}) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) which was followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS). Significantly lowest grain yield (0.69 t ha^{-1}) was found in W_1 (Weedy check). In 2018, the highest grain yield (2.01 t ha^{-1}) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) and at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS). The average data of two years also revealed a similar trend as revealed in the 2017 experiment.

These results also confirm to findings of Parmar *et al*. (2017) and Kumar *et al*. (2018c). Yield of grain was least under weedy check for the reason that severe competition stress occurs and consequently, crop showed poor growth parameters and yield attributes. On the contrary, hand weeding at 15, 30 and 45 DAS, Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS produced more grain yield than weedy check. The enhancement in the grain yield under these effective weed control measures might be because of the fact that when weeds were removed during critical crop-weed competition period (40-45 DAS) they helped in better utilisation of resources *viz*., nutrients, moisture, solar light, *etc*. This consequently led to the production of more vigorous and healthy plants having more pod bearing capacity, more seed per pod and 100-seed weight. The cumulative effect of all these resulted in higher grain yields, making it amply clear that these weed control measures exerted a profound influence in curtailing the weed population and thereby reducing the weed biomass at important crop growth stages. The results corroborate the findings of Pandya *et al.* (2005) and Peer *et al*. (2013).

4.2.5.3 Interaction effect of treatments on grain yield (t ha^{-1})

The data presented in Table 4.18 and depicted in Fig 4.3 revealed a significant interaction effect on grain yield due to the treatments in all the years of experimentation and average data of two years. It was observed that interaction of $N_2 \times W_2$ gave the highest grain yield in both the years which was closely followed by $N_2 \times W_5$ interaction. These results indicated that integrated nutrient management under a comparatively weed free environment can significantly influence the soybean yield components and grain yield. Kalaiyarasan *et al*. (2019) reported similar findings in sunflower crop.

4.2.6 Stover yield (t ha^{-1})

4.2.6.1 Effect of nutrient management treatments on stover yield (t ha^{-1})

The data of stover yield (Table 4.17) for both years of experiments and average data of two years recorded the highest stover yield in N_2 (75% RDF + 25% organic through FYM + PSB) which was statistically at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). The lowest stover yield was significantly observed in N_1 (100% RDF).

The total dry matter accumulation and other plant morphological parameters of growth, *i.e*., plant height as well as the number of branches is possibly the reason for the increased stover yield in integrated nutrient management treatment. These findings confirm with Tripathi *et al*. (2010). In another study, Chaturvedi *et al*. (2010) reported an increase in the stover yield which might be due to beneficial effect of farmyard manure in combination with chemical fertilizers which could be due to its synergistic role of farmyard manure in increasing the nutrient availability and sustaining it over a period of time as compared to chemical application alone.

4.2.6.2 Effect of weed management treatments on stover yield (t ha^{-1})

Significant results were recorded on stover yield in both years of experiment and average data of two years. In 2017, the highest stover yield (2.73 t ha^{-1}) was recorded significantly in W_2 (Hand weeding at 15, 30 and 45 DAS). It was followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS), which was statistically at par with each other. And the lowest stover yield (1.39 t ha^{-1}) was found significantly in W_1 (Weedy check). In 2018, the highest stover yield (2.53 t ha^{-1}) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) and found at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS). The lowest stover yield (1.28 t ha^{-1}) was found significantly in W_1 (Weedy check). The average data of two years also revealed a similar trend of variations as recorded in the 2017 experiment.

The yield of stover was least under weedy check for the reason that severe competition stress occurs and as a result, crop showed poor growth parameters. Similar to grain yield, an increase in stover yield may be due to the beneficial effect of weed free environment (Raj *et al.*, 2019).

4.2.6.3 Interaction effect of treatments on stover yield (t ha^{-1})

In the first year (2017) of the experiment, a significant effect on stover yield due to the interaction of nutrient and weed management treatments was revealed (Table 4.18). There was no significant effect on stover yield in the second year (2018) and average data of two years.

In 2017, interaction of $N_2 \times W_2$ recorded significantly highest stover yield (3.03 t ha^{-1}) followed $N_3 \times W_2$ interaction. The increase in stover yield might be due to effective interaction between the nutrient management and weed manage-

Table 4.17: Effect of nutrient and weed management treatments on yield attributes of soybean

Treatments	Grain yield (t ha^{-1})			Stover yield (t ha^{-1})			Harvest index (%)		
	2017	**2018**	**Av.**	**2017**	**2018**	**Av.**	**2017**	**2018**	**Av.**
Nutrient management (N)									
N_1	1.40	1.37	1.39	2.07	1.97	2.02	39.20	39.87	39.53
N_2	1.70	1.56	1.63	2.35	2.19	2.27	40.50	40.26	40.38
N_3	1.53	1.49	1.51	2.23	2.11	2.17	39.57	40.13	39.87
SEm±	**0.05**	**0.03**	**0.02**	**0.04**	**0.04**	**0.03**	**0.30**	**0.23**	**0.18**
CD (*p*=0.05)	**0.19**	**0.10**	**0.08**	**0.14**	**0.14**	**0.11**	**NS**	**NS**	**NS**
Weed Management (W)									
W_1	0.69	0.63	0.66	1.39	1.28	1.34	33.07	33.05	33.05
W_2	2.12	2.01	2.07	2.73	2.53	2.63	43.68	44.35	44.03
W_3	1.09	1.08	1.09	1.98	1.87	1.93	35.49	36.68	36.09
W_4	1.83	1.73	1.78	2.43	2.34	2.39	42.92	42.35	42.65
W_5	1.98	1.91	1.94	2.55	2.42	2.49	43.63	44.02	43.82
SEm±	**0.04**	**0.04**	**0.03**	**0.05**	**0.05**	**0.04**	**0.47**	**0.51**	**0.29**
CD (*p*=0.05)	**0.12**	**0.11**	**0.08**	**0.15**	**0.14**	**0.10**	**1.38**	**1.50**	**0.85**

N_1: 100 % RDF (NPKS), N_2: 75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB), N_3: 50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB), W_1: Weedy check, W_2: Weed free (Hand weeding at 15, 30 and 45 DAS), W_3: Mechanical weeding at 20 and 40 DAS, W_4: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS, W_5: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS

Table 4.18: Interaction effect of nutrient and weed management treatments on yield attributes of soybean

Treatments	Grain yield (t ha^{-1})			Stover yield (t ha^{-1})			Harvest index (%)		
	2017	**2018**	**Av.**	**2017**	**2018**	**Av.**	**2017**	**2018**	**Av.**
N_1W_1	0.62	0.59	0.60	1.37	1.15	1.26	31.16	33.61	32.31
N_1W_2	1.82	1.98	1.90	2.36	2.43	2.40	43.51	44.90	44.23
N_1W_3	1.07	1.05	1.06	1.97	1.77	1.87	35.26	37.20	36.20
N_1W_4	1.70	1.47	1.59	2.32	2.22	2.27	42.29	39.90	41.14
N_1W_5	1.80	1.78	1.79	2.31	2.29	2.30	43.78	43.77	43.78
N_2W_1	0.72	0.66	0.69	1.42	1.31	1.36	33.72	33.67	33.68
N_2W_2	2.45	2.10	2.27	3.07	2.63	2.85	44.39	44.35	44.35
N_2W_3	1.11	1.06	1.08	1.94	1.93	1.93	36.17	35.46	35.85
N_2W_4	1.99	1.88	1.93	2.56	2.51	2.53	43.73	42.88	43.30
N_2W_5	2.23	2.09	2.16	2.77	2.55	2.66	44.51	44.95	44.73
N_3W_1	0.73	0.65	0.69	1.39	1.38	1.38	34.33	31.88	33.16
N_3W_2	2.09	1.96	2.03	2.75	2.52	2.63	43.15	43.80	43.50
N_3W_3	1.09	1.15	1.12	2.03	1.92	1.98	35.04	37.37	36.22
N_3W_4	1.80	1.83	1.82	2.42	2.30	2.36	42.75	44.28	43.51
N_3W_5	1.91	1.87	1.89	2.58	2.43	2.50	42.59	43.34	42.96
SEm± (N×W)	**0.07**	**0.07**	**0.05**	**0.09**	**0.08**	**0.06**	**0.82**	**0.89**	**0.50**
SEm± (W×N)	**0.06**	**0.05**	**0.04**	**0.07**	**0.06**	**0.05**	**0.60**	**0.61**	**0.37**
CD (*p*=0.05) (W at same level of N)	**0.20**	**0.19**	**0.14**	**0.25**	**NS**	**NS**	**NS**	**2.59**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**0.22**	**0.15**	**0.12**	**0.21**	**NS**	**NS**	**NS**	**1.86**	**NS**

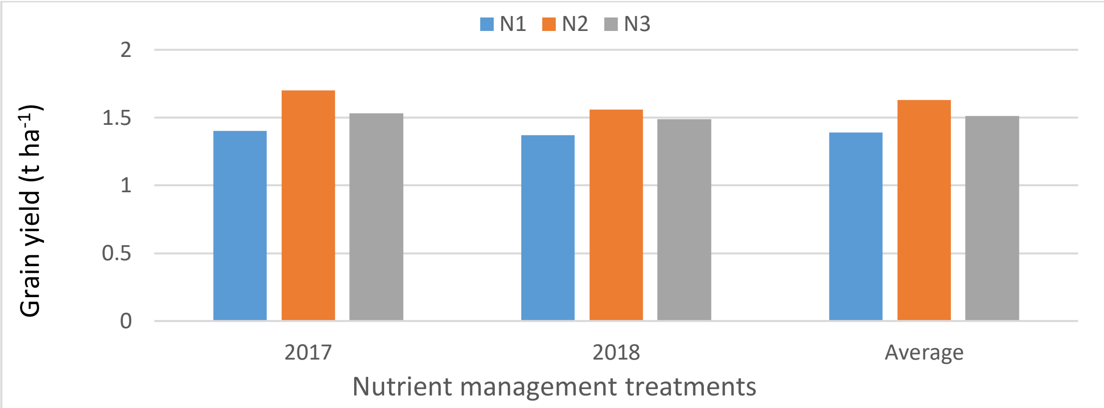


Fig 4.1 Effect of nutrient management treatments on grain yield (t ha^{-1})

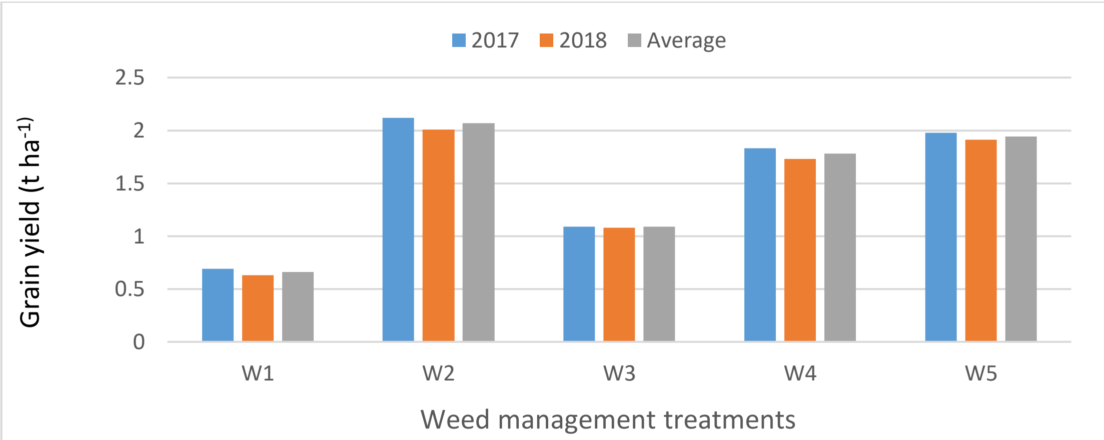


Fig 4.2 Effect of weed management treatments on grain yield (t ha^{-1})

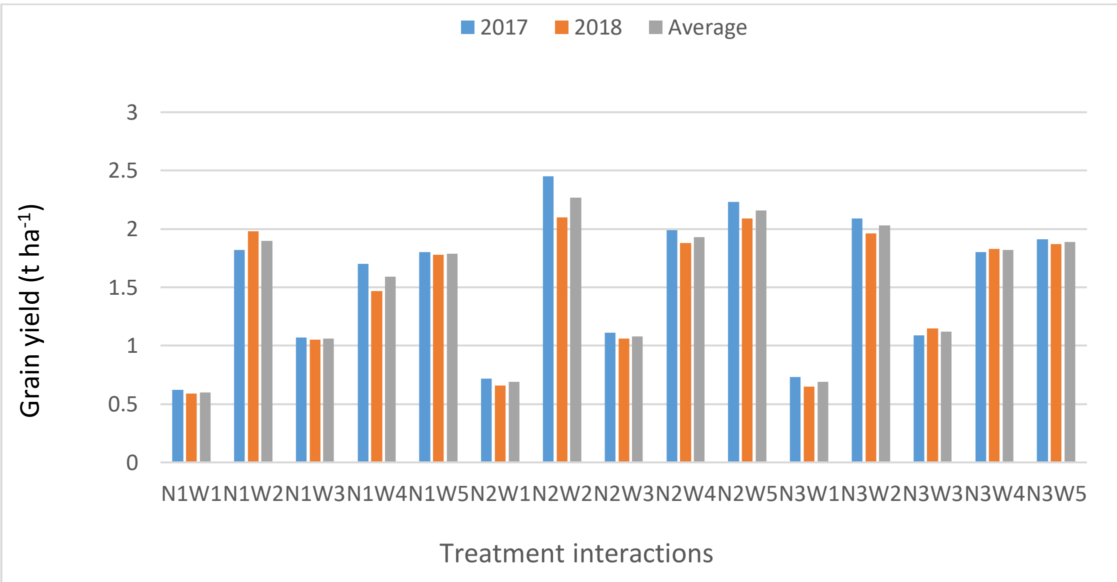


Fig 4.3 Interaction effect of treatments on grain yield (t ha^{-1})

-ment, which could have increased the availability of better nutrition along with efficient control of weeds by the respective treatments. A similar trend was reported by Kalaiyarasan *et al*. (2019).

4.2.7 Harvest Index (%)

4.2.7.1 Effect of nutrient management treatments on harvest index (%)

An inquisition on two years' data and average data of two years on harvest index revealed no significant variation among the nutrient treatments.

4.2.7.2 Effect of weed management treatments on harvest index (%)

The harvest index recorded significant results in both years of experiment and average data of two years. In 2017, the highest harvest index (43.68 %) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) which was statistically at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS. In 2018 and average data of two years, the highest harvest index (44.35 % and 44.03 %, respectively) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) which was found at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS).

The weed free (three hand weedings) and chemical herbicide integrated with one hand weeding plots recorded higher harvest index than weedy check which is probably due to better availability of water and nutrient resulting in enhanced sink capacity and higher grain productivity. This was in conformity with the findings of Raj *et al*. (2019).

4.2.7.3 Interaction effect of treatments on harvest index (%)

There was no significant effect on harvest index due to the interaction of nutrient and weed management treatments in the first year of experiment and average data of two years. However, in the second year (2018), a significant effect on harvest index was revealed due to the interaction of nutrient and weed management treatments. The interaction of $N_2 \times W_5$ recorded the highest harvest index (44.95%) while the lowest was observed in $N_3 \times W_1$ interaction (33.61%). Under respective treatments, the higher harvest index could be attributed to balance nutrient supply and effective weed control.

4.3 PHENOLOGICAL OBSERVATIONS

The data on days to 50% flowering and days to maturity of soybean crop as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.19 and 4.20.

4.3.1 Days to 50% flowering

4.3.1.1 Effect of nutrient management treatments on days to 50% flowering

An inquisition on two years' data and average data of two years on days to 50% flowering revealed no significant variation among the nutrient treatments.

4.3.1.2 Effect of weed management treatments on days to 50% flowering

The data for both years revealed non-significant variation in days to 50% flowering among the different weed management treatments. However, the average data of two years revealed a significant variation on days to 50% flowering among the different weed management treatments. The minimum days to 50% flowering (48.33) was found in W_2 (Hand weeding at 15, 30 and 45 DAS) which was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS). While the maximum days to 50% flowering (52.83) was found in W_1 (Weedy check).

Early flowering in weed free plots could be attributed to less weed competition for nutrients leading to early growth and development. This is supported by the findings of Lamptey *et al*. (2015) where weed free plots recorded the lowest number of days to 50% flowering. The delay of 50% flower-

Table 4.19: Effect of nutrient and weed management treatments on phenological observations of soybean

Treatments	Days to 50% flowering			Days to maturity		
	2017	2018	Average	2017	2018	Average
Nutrient management (N)						
N_1	48.93	50.67	49.80	100.07	100.60	100.33
N_2	49.53	52.73	51.13	100.40	103.07	101.73
N_3	50.47	53.93	52.20	101.67	104.27	102.97
SEm±	**1.81**	**1.48**	**1.14**	**1.72**	**1.80**	**1.22**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed Management (W)						
W_1	52.00	53.67	52.83	103.56	105.67	104.61
W_2	47.11	49.56	48.33	98.78	98.11	98.44
W_3	51.22	54.11	52.67	102.56	104.56	103.56
W_4	49.44	53.56	51.50	99.44	103.56	101.50
W_5	48.44	51.33	49.89	99.22	101.33	100.28
SEm±	**1.20**	**1.62**	**1.06**	**1.01**	**1.76**	**1.00**
CD (*p*=0.05)	**NS**	**NS**	**3.09**	**2.96**	**5.13**	**2.91**

N_1: 100 % RDF (NPKS), N_2: 75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB), N_3: 50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB), W_1: Weedy check, W_2: Weed free (Hand weeding at 15, 30 and 45 DAS), W_3: Mechanical weeding at 20 and 40 DAS, W_4: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS, W_5: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS.

Table 4.20: Interaction effect of nutrient and weed management treatments on phenological observation of soybean

Treatments	Days to 50% flowering			Days to maturity		
	2017	2018	Average	2017	2018	Average
N_1W_1	50.67	53.67	52.17	103.33	102.33	102.83
N_1W_2	45.67	47.33	46.50	98.33	97.00	97.67
N_1W_3	51.67	53.00	52.33	101.67	103.33	102.50
N_1W_4	49.33	52.33	50.83	98.67	101.67	100.17
N_1W_5	47.33	47.00	47.17	98.33	98.67	98.50
N_2W_1	51.00	54.67	52.83	102.67	107.33	105.00
N_2W_2	47.67	50.33	49.00	99.00	98.67	98.83
N_2W_3	51.00	51.67	51.33	101.33	104.00	102.67
N_2W_4	49.33	53.67	51.50	99.67	102.67	101.17
N_2W_5	48.67	53.33	51.00	99.33	102.67	101.00
N_3W_1	54.33	52.67	53.50	104.67	107.33	106.00
N_3W_2	48.00	51.00	49.50	99.00	98.67	98.83
N_3W_3	51.00	57.67	54.33	104.67	106.33	105.50
N_3W_4	49.67	54.67	52.17	100.00	106.33	103.17
N_3W_5	49.33	53.67	51.50	100.00	102.67	101.33
SEm± (N×W)	**2.08**	**2.80**	**1.84**	**1.76**	**3.04**	**1.73**
SEm± (W×N)	**2.24**	**2.31**	**1.63**	**2.05**	**2.63**	**1.64**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

-ing in weedy plot might be due to high weed density due to weed interference on the growth and development of soybean. Similar findings were reported by Odeleye *et al*. (2007).

4.3.1.3 Interaction effect of treatments on days to 50% flowering

There was no significant effect on days to maturity due to nutrient and weed management treatments' interaction in both years of experiment and average data of two years.

4.3.2 DAYS TO MATURITY

4.3.2.1 Effect of nutrient management of treatments on days to maturity

An inquisition on two years' data and average data of two years on days to maturity revealed no significant variation among the nutrient treatments.

4.3.2.2 Effect of weed management of treatments on days to maturity

The data for both years and average data of two years revealed significant variation in days to maturity among the different weed management treatments. In average data of two years, the minimum days to maturity (98.41) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) which was found at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS). While the maximum days to maturity (104.61) was found in W_1 (Weedy check).The early maturity in W_2, W_5 and W_4 could be attributed to effective weed control because weed competes with crops for resources like sunlight and nutrients. Similar results were reported by Misbabullah *et al*. (2019). In weedy check, weeds may have shaded crop plants, reducing sunlight interception and prolonging vegetative growth, resulting in a delay in flowering days and eventually maturity. Similar findings were reported by Merga and Alemu (2019) in chickpea crop.

4.3.2.3 Interaction effect of treatments on days to maturity

There was no significant effect on days to maturity due to nutrient and weed management treatments' interaction in both years of experiment and average data of two years.

4.4 SEED QUALITY ATTRIBUTES

The data for both years and average data of two years on oil content (%) and protein content (%) are presented in Table 4.21 and 4.22, respectively.

4.4.1 Oil content (%)

4.4.1.1 Effect of nutrient management treatments on oil content (%)

The study found no significant effect on oil content (%) due to nutrient management treatments in both the years and average data of two years.

4.4.1.2 Effect of weed management treatments on oil content (%)

Significant results were recorded on oil content in both years of experiment and average data of two years. In 2017 and 2018, the highest oil content (19.56% and 19.21%, respectively) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) which was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS). The lowest oil content (17.30 % and 17.31% in 2017 and 2018, respectively) was found significantly in W_1 (Weedy check). The average data of two years revealed that the highest oil content (19.38%) was found in W_2 (Hand weeding at 15, 30 and 45 DAS) and at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS).

Weedy check exhibited inferior values of oil content in soybean seeds as compared to other weed management treatments. The enhancement in the oil content under these effective weed management treatments may be attributed to better nutrition of soybean which play a vital role in improving oil value of soybean. Similar results were reported by Mohamed (2004), El-Metwally and Shalby (2007) and Peer *et al*. (2013)

4.4.1.3 Interaction effect of treatments on oil content (%)

The study found was no significant effect on oil content (%) due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years.

4.4.2 Protein content (%)

4.4.2.1 Effect of nutrient management treatments on protein content (%)

The data of both years of experiments and average data of two years showed significant effect due to different nutrient management treatments. The two years data and average data of two years revealed similar trend where the highest protein content (38.17%, 38.03% and 38.10% in 2017, 2018 and average data of two years, respectively) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) which was statistically at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). The lowest protein content (37.22%, 37.08% and 37.15% in 2017, 2018 and average data of two years, respectively) was significantly observed in N_1 (100% RDF).

Similar findings were reported by Alam *et al*. (2009) and Bonde and Gawade *et al*. (2017). The application of farmyard manure enhances microbial activity of ammonifiers, nitrifiers and phosphate solubilising bacteria. As a result, the availability of organic carbon increases, which increases root growth and nodulation, resulting in increased nitrogen and protein content. In addition, inoculation enhances nitrogen fixation and an adequate supply of plant phosphorus, thereby enhancing the plant protein synthesis and its higher concentration in seed. Dhage and Kachhave (2008) recorded that quality parameters improved by dual inoculation of Rhizobium + PSB with or without chemical fertilizers.

4.4.2.2 Effect of weed management treatments on protein content (%)

The data for both years and average data of two years revealed significant variation on protein content among the different weed management treatments. The two years data and their average data revealed similar trend where the maximum protein content (39.19%, 38.76% and 38.97% in 2017, 2018 and average data of two years, respectively) was found in W_2 (Hand weeding at 15, 30 and 45 DAS) which was statistically at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS). The minimum protein content (34.55%, 34.65% and 34.60% in 2017, 2018 and average data of two years, respectively) was found significantly in W_1 (Weedy check).

The better protein content in soybean crop as a result of weed control measures could be attributed to better nitrogen content under these treatments favoured by effective elimination of weeds. The presence of weeds throughout the growing season in weedy check plots was instrumental in reducing the protein content. The results corroborates with the findings of El-Metwally and Shalby (2007) and Peer *et al*. (2013).

4.4.2.3 Interaction effect of treatments on protein content (%)

The study found no significant effect on protein content (%) due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years.

Table 4.21: Effect of nutrient and weed management treatments on seed quality attributes of soybean

Treatments	Oil content (%)			Protein content (%)		
	2017	2018	Average	2017	2018	Average
Nutrient management (N)						
N_1	18.53	18.48	18.50	37.22	37.08	37.15
N_2	18.76	18.63	18.70	38.17	38.03	38.10
N_3	18.72	18.51	18.61	38.03	37.69	37.86
SEm±	**0.07**	**0.05**	**0.05**	**0.19**	**0.17**	**0.17**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**0.75**	**0.65**	**0.68**
Weed Management (W)						
W_1	17.30	17.31	17.31	34.55	34.65	34.60
W_2	19.56	19.21	19.38	39.19	38.76	38.97
W_3	18.26	18.15	18.20	37.69	37.43	37.56
W_4	19.07	18.91	18.99	38.74	38.54	38.64
W_5	19.16	19.12	19.14	38.85	38.62	38.73
SEm±	**0.22**	**0.14**	**0.13**	**0.35**	**0.32**	**0.29**
CD (*p*=0.05)	**0.64**	**0.40**	**0.38**	**1.03**	**0.94**	**0.85**

N_1: 100 % RDF (NPKS), N_2: 75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB), N_3: 50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB), W_1: Weedy check, W_2: Weed free (Hand weeding at 15, 30 and 45 DAS), W_3: Mechanical weeding at 20 and 40 DAS, W_4: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS, W_5: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS.

Table 4.22: Interaction effect of nutrient and weed management treatments on seed quality attributes of soybean

Treatments	Oil content (%)			Protein content (%)		
	2017	2018	Average	2017	2018	Average
N_1W_1	17.33	17.33	17.33	33.77	33.44	33.60
N_1W_2	19.30	19.12	19.21	38.69	38.33	38.51
N_1W_3	18.23	18.04	18.14	37.17	37.17	37.17
N_1W_4	18.92	18.88	18.90	38.15	38.21	38.18
N_1W_5	18.87	19.02	18.94	38.33	38.27	38.30
N_2W_1	17.18	17.38	17.28	34.83	35.48	35.16
N_2W_2	19.80	19.30	19.55	39.27	39.08	39.18
N_2W_3	18.31	18.30	18.31	38.23	37.79	38.01
N_2W_4	19.18	18.90	19.04	38.83	39.10	38.97
N_2W_5	19.33	19.27	19.30	39.67	38.67	39.17
N_3W_1	17.39	17.22	17.31	35.04	35.04	35.04
N_3W_2	19.57	19.22	19.39	39.60	38.85	39.23
N_3W_3	18.23	18.10	18.17	37.69	37.33	37.51
N_3W_4	19.10	18.96	19.03	39.25	38.31	38.78
N_3W_5	19.28	19.07	19.17	38.54	38.92	38.73
SEm± (N×W)	**0.42**	**0.24**	**0.27**	**0.61**	**0.56**	**0.51**
SEm± (W×N)	**0.27**	**0.16**	**0.17**	**0.43**	**0.39**	**0.36**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

N_1W_1

N_1W_2

N_1W_3

N_1W_4

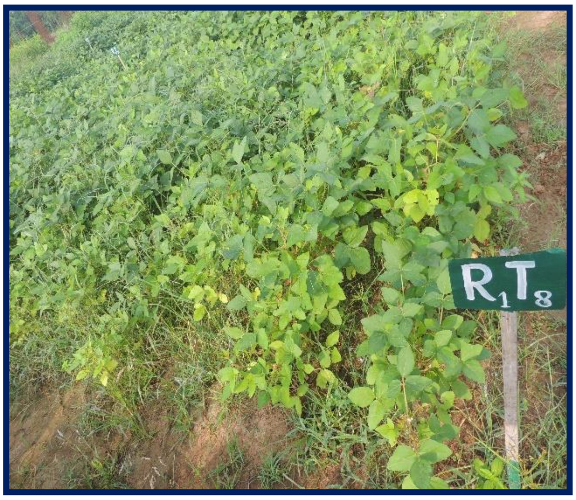
N_1W_5

N_1: 100 % RDF
W_1: Weedy check
W_2: Weed free (Hand weeding at 15, 30 and 45 DAS)
W_3: Mechanical weeding at 20 and 40 DAS
W_4: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS
W_5: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS

PLATE 2(a): EXPERIMENTAL PLOTS AT 60 DAS.

N_2W_1

N_2W_2



N_2W_3

N_2W_4

N_2W_5

N_2: 75% RDF + 25% organic through FYM + PSB
W_1: Weedy check
W_2: Weed free (Hand weeding at 15, 30 and 45 DAS)
W_3: Mechanical weeding at 20 and 40 DAS
W_4: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS
W_5: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS

PLATE 2(b): EXPERIMENTAL PLOTS AT 60 DAS.

N_3W_1

N_3W_2

N_3W_3

N_3W_4

N_3W_5

N_3: 50% RDF + 50 % organic through *Rhizobium* + PSB
W_1: Weedy check
W_2: Weed free (Hand weeding at 15, 30 and 45 DAS)
W_3: Mechanical weeding at 20 and 40 DAS
W_4: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS
W_5: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS

PLATE 2(c): EXPERIMENTAL PLOTS AT 60 DAS.

N_1W_1

N_2W_1

N_3W_1

N_1W_2

N_2W_2

N_3W_2

N_1W_3

N_2W_3

N_3W_3

N_1W_4

N_2W_4

N_3W_4

N_1W_5

N_2W_5

N_3W_5

N_1: 100 % RDF; **N_2**: 75% RDF + 25% organic through FYM + PSB**;** **N_3**: 50% RDF + 50 % organic through *Rhizobium* + PSB**;** **W_1**: Weedy check; **W_2**: Weed free (Hand weeding at 15, 30 and 45 DAS); **W_3**: Mechanical weeding at 20 and 40 DAS; **W_4**: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS; **W_5**: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS

PLATE 3: ROOT NODULES AT 60 DAS.

Flowering stage

Pod formation stage

Maturity stage

Pods

Seeds

PLATE 4: Soybean variety JS 97-52 (N_2W_2 treatment)

4.5 OBSERVATION ON WEEDS (species wise)

4.5.1 WEED FLORA PRESENT IN THE EXPERIMENTAL FIELD

There were a total of 13 major weed flora observed in experimental plots during both the years of experiment (2017 and 2018). The details of the weed flora is presented in Appendix-A. The grasses included *Cynodon dactylon* L., *Digitaria sanguinalis* L. and *Eleusine indica* L.; sedges included *Bulbostylis barbata* (Rottb.) C.B.Clarke, *Cyperus iria* L., *Cyperus kyllingia* L. and *Cyperus rotundus* L. Broad leaf weeds included- *Ageratum conyzoides* L., *Amaranthus viridis* Hook. F., *Borreria latifolia* (Aubl.) K. Schum., *Cleome rutidosperma* DC., *Mimosa pudica* L. and *Mollugo pentaphylla* L. Similar weed species were reported in soybean field by Upadhyay *et al*. (2012), Panda *et al*. (2015) and Sangeetha *et al*. (2013).

The details of the relative density of weed flora in weedy check plot at 15, 30, 45 and 60 DAS is presented in Appendix-B. The relative density at 60 DAS in the weedy plots in 2017 and 2018, respectively were *Cynodon dactylon* L. (12.61%, 12.53%), *Digitaria sanguinalis* L. (20.35%, 20.03%), *Eleusine indica* L. (11.52, 11.44%), *Bulbostylis barbata (Rottb.)* C.B.Clarke (3.27%, 2.28%), *Cyperus iria* L. (12.85%, 11.10%), *Cyperus kyllingia* L. (3.73%, 2.29%), *Cyperus rotundus* L. (4.21%, 4.71%), *Ageratum conyzoides* L. (3.72%, 2.57%), *Amaranthus viridis* Hook. F. (4.52%, 3.94%), *Borreria latifolia* (Aubl.) K. Schum. (13.40%, 15.58%), *Cleome rutidosperma* DC. (2.68%, 2.29%), *Mimosa pudica* L. (2.90%, 4.71%), *Mollugo pentaphylla* L. (4.24%, 6.57%).

The major proportion of the weed flora comprised of grasses at all stages of growth. Similar findings were reported by Thirumalaikumar *et al*. (2017). At all stages of observations, *Digitaria sanguinalis* was the most dominant weed recorded among the weed flora as well as among grasses. *Cyperus iria* was most dominant among sedges, and *Borreria latifolia* was most dominant among broad leaf weeds.

***Cynodon dactylon* L.**

***Digitaria sanguinalis* L.**

***Eleusine indica* L.**

PLATE 5(a): Grasses found in the experimental field

Bulbostylis barbata **(Rottb.) C.B.**

Cyperus iria **L.**

Cyperus kyllingia **L.**

Cyperus rotundus **L.**

PLATE 5(b): Sedges found in the experimental field

Ageratum conyzoides **L.**

Amaranthus viridis **Hook. F.**

Borreria latifolia (Aubl.) K. Schum

Cleome rutidosperma **DC.**

Mimosa pudica **L.**

Mollugo pentaphylla **L.**

PLATE 5(c): Broad leaf weeds found in the experimental field

4.5.2 WEED DENSITY (no. m^{-2}) AT 15, 30, 45 AND 60 DAS

4.5.2.1 Weed density (no. m^{-2}) of *Cynodon dactylon* L.

The data on weed density (no. m^{-2}) of *Cynodon dactylon* at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.23 and 4.24.

4.5.2.1.1 Effect of nutrient management on weed density (no. m^{-2}) of *Cynodon dactylon* L.

An inquisition on two years' data and their average data on weed density of *Cynodon dactylon* revealed no significant variation among the nutrient treatments at various stages of observations.

4.5.2.1.2 Effect of weed management on weed density (no. m^{-2}) of *Cynodon dactylon* L.

The data for both years and average data of two years revealed no significant variation on weed density (no. m^{-2}) of *Cynodon dactylon* at 15 DAS among the different weed management treatments. However, at 30, 45 and 60 DAS, it was found to have significant variation among the different weed management treatments where highest weed density was significantly recorded in W_1 (Weedy check).

Results on average data of two years at 30 DAS revealed that the lowest weed density (6.61) was found at W_2 (Hand weeding at 15, 30 and 45 DAS) which was statistically at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS). At 45 and 60 DAS, the average data of two years revealed that the lowest weed density was found significantly at W_2 which was followed by W_5.

Table 4.23: Effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Cynodon dactylon* L. at 15, 30, 45 DAS and 60 DAS.

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	3.68 (13.40)	3.29 (10.07)	3.49 (11.93)	4.23 (19.33)	4.02 (17.80)	4.13 (18.57)	3.78 (15.80)	3.61 (15.00)	3.70 (15.40)	3.80 (16.13)	3.40 (13.73)	3.60 (14.93)
N_2	3.73 (13.60)	3.45 (11.47)	3.59 (12.53)	4.31 (20.13)	4.00 (17.20)	4.16 (18.67)	3.81 (16.27)	3.58 (14.20)	3.69 (15.23)	3.81 (16.27)	3.50 (14.47)	3.65 (15.37)
N_3	3.47 (11.73)	3.16 (9.73)	3.32 (10.73)	4.04 (17.73)	3.54 (14.27)	3.79 (16.00)	3.60 (14.73)	3.20 (11.93)	3.40 (13.33)	3.77 (16.00)	3.27 (13.13)	3.52 (14.57)
SEm±	**0.20**	**0.07**	**0.08**	**0.06**	**0.24**	**0.08**	**0.17**	**0.11**	**0.14**	**0.10**	**0.09**	**0.06**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	3.79 (14.33)	3.43 (11.33)	3.61 (12.83)	5.81 (33.56)	5.56 (30.78)	5.69 (32.17)	6.45 (41.11)	6.19 (37.89)	6.32 (39.50)	6.49 (41.67)	6.31 (39.44)	6.40 (40.56)
W_2	3.47 (11.67)	3.24 (10.11)	3.36 (10.89)	2.81 (7.44)	2.50 (5.78)	2.66 (6.61)	2.54 (6.00)	1.98 (3.44)	2.26 (4.72)	2.09 (3.89)	1.74 (2.56)	1.92 (3.22)
W_3	3.64 (13.00)	3.40 (11.22)	3.52 (12.11)	3.62 (12.78)	3.22 (11.00)	3.42 (11.89)	3.45 (12.00)	2.97 (8.89)	3.21 (10.44)	3.62 (12.89)	3.49 (12.00)	3.55 (12.44)
W_4	3.73 (14.22)	3.19 (9.78)	3.51 (12.00)	5.78 (33.11)	5.22 (27.00)	5.50 (30.06)	2.65 (6.56)	3.10 (9.11)	2.87 (7.83)	3.62 (12.78)	3.36 (10.89)	3.49 (11.83)
W_5	3.47 (11.33)	3.25 (10.33)	3.33 (10.83)	2.97 (8.44)	2.77 (7.56)	2.87 (8.00)	3.57 (12.33)	3.08 (9.22)	3.32 (10.78)	3.14 (9.44)	2.04 (4.00)	2.59 (6.72)
SEm±	**0.16**	**0.15**	**0.10**	**0.14**	**0.23**	**0.13**	**0.13**	**0.13**	**0.11**	**0.14**	**0.16**	**0.12**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**0.42**	**0.67**	**0.38**	**0.39**	**0.37**	**0.31**	**0.42**	**0.47**	**0.34**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.24: Interaction effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Cynodon dactylon* L. at 15 , 30, 45 and 60 DAS.

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average	2017	2018	Average	2017	2018	Average
N_1W_1	3.65 (14.00)	3.49 (11.67)	3.57 (12.83)	5.92 (34.67)	5.79 (33.67)	5.86 (34.17)	6.47 (41.33)	6.46 (41.33)	6.46 (41.33)	6.52 (42.00)	6.28 (39.00)	6.40 (40.50)
N_1W_2	3.67 (13.00)	2.96 (8.33)	3.32 (10.67)	3.02 (8.67)	2.54 (6.00)	2.78 (7.33)	2.61 (6.33)	1.95 (3.33)	2.28 (4.83)	2.12 (4.00)	1.77 (2.67)	1.95 (3.33)
N_1W_3	3.80 (14.33)	3.57 (12.33)	3.69 (13.33)	3.61 (12.67)	3.69 (13.33)	3.65 (13.00)	3.57 (12.33)	3.36 (11.00)	3.47 (11.67)	3.67 (13.33)	3.46 (12.00)	3.57 (12.67)
N_1W_4	3.83 (14.33)	3.13 (9.33)	3.48 (11.83)	5.74 (32.67)	5.28 (28.00)	3.65 (30.33)	2.73 (7.00)	3.13 (9.33)	2.93 (8.17)	3.53 (12.00)	3.29 (10.33)	3.41 (11.17)
N_1W_5	3.44 (11.33)	3.32 (10.67)	3.38 (11.00)	2.90 (8.00)	2.77 (8.00)	5.51 (8.00)	3.53 (12.00)	3.14 (10.00)	3.33 (11.00)	3.13 (9.33)	2.21 (4.67)	2.67 (7.00)
N_2W_1	4.04 (16.00)	3.47 (11.67)	3.76 (13.83)	6.03 (36.00)	5.49 (29.67)	5.76 (32.83)	6.62 (43.33)	6.14 (37.33)	6.38 (40.33)	6.51 (42.00)	6.43 (41.00)	6.47 (41.50)
N_2W_2	3.43 (11.33)	3.29 (10.33)	3.36 (10.83)	2.80 (7.33)	2.61 (6.33)	2.71 (6.83)	2.54 (6.00)	2.04 (3.67)	2.29 (4.83)	2.11 (4.00)	1.77 (2.67)	1.94 (3.33)
N_2W_3	3.78 (14.00)	3.67 (13.00)	3.73 (13.50)	3.88 (14.67)	3.64 (13.33)	3.76 (14.00)	3.66 (13.00)	3.44 (11.33)	3.55 (12.17)	3.69 (13.33)	3.59 (12.67)	3.64 (13.00)
N_2W_4	3.94 (15.00)	3.38 (11.00)	3.66 (13.00)	5.85 (34.00)	5.40 (28.67)	5.63 (31.33)	2.61 (6.33)	3.19 (9.67)	2.90 (8.00)	3.58 (12.33)	3.43 (11.33)	3.50 (11.83)
N_2W_5	3.48 (11.67)	3.44 (11.33)	3.46 (11.50)	3.00 (8.67)	2.88 (8.00)	2.94 (8.33)	3.61 (12.67)	3.07 (9.00)	3.34 (10.83)	3.16 (9.67)	2.26 (4.67)	2.71 (7.17)
N_3W_1	3.67 (13.00)	3.34 (10.67)	3.51 (11.83)	5.48 (30.00)	5.41 (29.00)	5.44 (29.50)	6.26 (38.67)	5.95 (35.00)	6.11 (36.83)	6.44 (41.00)	6.23 (38.33)	6.33 (39.67)
N_3W_2	3.32 (10.67)	3.46 (11.67)	3.39 (11.17)	2.61 (6.33)	2.35 (5.00)	2.48 (5.67)	2.48 (5.67)	1.95 (3.33)	2.22 (4.50)	2.04 (3.67)	1.68 (2.33)	1.86 (3.00)
N_3W_3	3.33 (10.67)	2.96 (8.33)	3.14 (9.50)	3.36 (11.00)	2.33 (6.33)	2.85 (8.67)	3.12 (10.67)	2.12 (4.33)	2.62 (7.50)	3.49 (12.00)	3.41 (11.33)	3.45 (11.67)
N_3W_4	3.72 (13.33)	3.04 (9.00)	3.38 (10.17)	5.75 (32.67)	4.97 (24.33)	5.36 (28.50)	2.61 (6.33)	2.96 (8.33)	2.79 (7.33)	3.76 (14.00)	3.38 (11.00)	3.57 (12.50)
N_3W_5	3.33 (11.00)	2.99 (9.00)	3.16 (10.00)	3.00 (8.67)	2.65 (6.67)	2.83 (7.67)	3.56 (12.33)	3.01 (8.67)	3.29 (10.50)	3.12 (9.33)	1.65 (2.67)	2.39 (6.00)
SEm± (N×W)	**0.28**	**0.25**	**0.17**	**0.25**	**0.40**	**0.23**	**0.23**	**0.22**	**0.18**	**0.25**	**0.28**	**0.20**
SEm± (W×N)	**0.26**	**0.17**	**0.13**	**0.24**	**0.35**	**0.16**	**0.23**	**0.18**	**0.18**	**0.18**	**0.20**	**0.14**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

W_2 treatment significantly reduced the population of *Cynodon dactylon* effectively due to three hand weeding. The results at 15 DAS indicated that the pre-emergence application of Pendimethalin (in W_4 treatment) did not curb the concerned weeds in discussion. The results at 30 DAS indicated that the application of Propaquizafop could reduce the density of *Cynodon dactylon*. Panda *et al*. (2015) reported similar findings where post-emergence application of Propaquizafop (75 g ha^{-1}) alone gave effective control of *Cynodon dactylon*.

At 45 and 60 DAS, it could be seen that when hand weeding is integrated with herbicide application, the density of this weed is reduced.

4.5.2.1.3 Interaction effect on weed density (no. m^{-2}) of *Cynodon dactylon* L.

The study found no significant effect on weed density of *Cynodon dactylon* due to the interaction of nutrient and weed management treatments in both years of experiment and their average data in all the stages of observation.

4.5.2.2 Weed density (no. m^{-2}) of *Digitaria sanguinalis* L.

The data on weed density (no. m^{-2}) of *Digitaria sanguinalis* at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and their average data is presented in Table 4.25 and 4.26.

4.5.2.2.1 Effect of nutrient management on weed density (no. m^{-2}) of *Digitaria sanguinalis* L.

An inquisition on two years' data and their average data on weed of *Digitaria sanguinalis* revealed no significant variation among the nutrient treatments at various stages of observations.

Table 4.25: Effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Digitaria sanguinalis* L. at 15, 30, 45 and 60 DAS.

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	5.69 (32.27)	4.10 (16.67)	4.90 (24.47)	5.65 (34.07)	4.62 (23.67)	5.14 (28.87)	4.38 (25.33)	3.70 (18.73)	4.04 (22.13)	3.55 (19.73)	3.17 (16.20)	3.36 (17.97)
N_2	5.73 (33.13)	4.14 (16.87)	4.93 (25.00)	5.90 (37.00)	4.72 (24.53)	5.31 (30.77)	4.44 (26.67)	3.68 (18.80)	4.06 (22.73)	3.76 (21.33)	3.25 (17.07)	3.50 (19.20)
N_3	5.20 (27.07)	3.89 (14.93)	4.55 (21.00)	5.56 (33.07)	4.51 (22.53)	5.03 (27.80)	4.25 (23.87)	3.57 (17.67)	3.91 (20.77)	3.50 (18.93)	3.13 (15.93)	3.32 (17.43)
SEm±	**0.37**	**0.16**	**0.19**	**0.16**	**0.18**	**0.13**	**0.07**	**0.22**	**0.09**	**0.08**	**0.10**	**0.04**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	5.44 (31.11)	4.23 (17.67)	4.84 (24.39)	7.34 (53.56)	6.42 (41.00)	6.88 (47.28)	8.22 (67.11)	7.77 (59.89)	7.99 (63.50)	8.23 (67.33)	7.97 (63.00)	8.10 (65.17)
W_2	5.47 (29.67)	3.96 (15.56)	4.72 (22.61)	2.91 (8.00)	2.33 (5.00)	2.62 (6.50)	1.79 (2.78)	1.71 (2.44)	1.75 (2.61)	1.16 (1.00)	1.03 (0.67)	1.10 (0.83)
W_3	5.66 (31.78)	4.17 (17.11)	4.91 (24.44)	5.60 (31.00)	4.14 (16.89)	4.87 (23.94)	4.92 (23.89)	3.38 (11.56)	4.15 (17.72)	5.11 (26.11)	3.66 (13.33)	4.38 (19.72)
W_4	5.65 (26.78)	4.06 (16.33)	4.86 (24.06)	7.13 (50.33)	6.31 (39.56)	6.72 (44.94)	1.19 (1.00)	1.38 (1.44)	1.29 (1.22)	2.13 (4.11)	2.08 (4.00)	2.10 (4.06)
W_5	5.49 (29.78)	3.79 (14.11)	4.64 (21.94)	5.54 (30.67)	3.87 (15.44)	4.70 (23.06)	5.66 (32.00)	4.03 (16.67)	4.84 (24.33)	1.38 (1.44)	1.17 (1.00)	1.28 (1.22)
SEm±	**0.23**	**0.20**	**0.15**	**0.13**	**0.24**	**0.13**	**0.17**	**0.23**	**0.16**	**0.17**	**0.17**	**0.12**
CD(*p*=0.05)	**NS**	**NS**	**NS**	**0.38**	**0.70**	**0.39**	**0.49**	**0.68**	**0.46**	**0.49**	**0.51**	**0.34**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.26: Interaction effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Digitaria sanguinalis* L. at 15, 30, 45 and 60 DAS.

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
N_1W_1	5.70 (33.00)	4.49 (20.33)	5.09 (26.50)	7.24 (52.00)	6.46 (41.33)	6.85 (46.67)	8.24 (67.33)	7.78 (60.00)	8.01 (63.67)	8.32 (68.67)	7.90 (62.00)	8.11 (65.33)
N_1W_2	5.69 (32.00)	4.08 (16.33)	4.89 (24.17)	2.85 (7.67)	2.20 (4.33)	2.52 (6.00)	1.86 (3.00)	1.68 (2.33)	1.77 (2.67)	1.17 (1.00)	1.05 (0.67)	1.11 (0.83)
N_1W_3	5.64 (31.33)	4.22 (17.33)	4.93 (24.33)	5.51 (30.00)	4.07 (16.33)	4.79 (23.17)	4.87 (23.33)	3.44 (12.00)	4.15 (17.67)	4.89 (24.00)	3.63 (13.33)	4.26 (18.67)
N_1W_4	5.87 (34.33)	3.97 (16.00)	4.92 (25.17)	7.06 (49.33)	6.33 (39.67)	6.69 (44.50)	1.17 (1.00)	1.46 (1.67)	1.32 (1.33)	2.04 (3.67)	2.08 (4.00)	2.06 (3.83)
N_1W_5	5.57 (30.67)	3.74 (13.67)	4.66 (22.17)	5.61 (31.33)	4.03 (16.67)	4.82 (24.00)	5.76 (33.00)	4.16 (17.67)	4.96 (25.33)	1.34 (1.33)	1.17 (1.00)	1.26 (1.17)
N_2W_1	5.70 (35.33)	4.20 (17.33)	4.95 (26.33)	7.69 (58.67)	6.51 (42.33)	7.10 (50.50)	8.51 (72.00)	7.95 (62.67)	8.23 (67.33)	8.49 (70.00)	8.09 (65.00)	8.24 (67.50)
N_2W_2	5.60 (31.00)	3.95 (15.67)	4.77 (23.33)	3.13 (9.33)	2.61 (6.33)	2.87 (7.83)	1.76 (2.67)	1.76 (2.67)	1.76 (2.67)	1.27 (1.33)	1.00 (0.67)	1.13 (1.00)
N_2W_3	5.97 (35.33)	4.33 (18.33)	5.15 (26.83)	5.69 (32.00)	4.20 (17.33)	4.95 (24.67)	4.99 (24.67)	3.33 (11.33)	4.16 (18.00)	5.40 (29.00)	3.77 (14.00)	4.58 (21.50)
N_2W_4	5.67 (31.67)	4.14 (16.67)	4.90 (24.17)	7.31 (53.00)	6.50 (42.00)	6.90 (47.50)	1.17 (1.00)	1.46 (1.67)	1.32 (1.33)	2.26 (4.67)	2.21 (4.67)	2.24 (4.67)
N_2W_5	5.72 (32.33)	4.06 (16.33)	4.89 (24.33)	5.66 (32.00)	3.79 (14.67)	4.72 (23.33)	5.75 (33.00)	3.92 (15.67)	4.83 (24.33)	1.46 (1.67)	1.17 (1.00)	1.32 (1.33)
N_3W_1	4.93 (25.00)	4.02 (15.67)	4.47 (20.33)	7.11 (50.00)	6.30 (39.33)	6.70 (44.67)	7.90 (62.00)	7.58 (57.00)	7.74 (59.50)	7.99 (63.33)	7.90 (62.00)	7.95(62.67)
N_3W_2	5.13 (26.00)	3.85 (14.67)	4.49 (20.33)	2.73 (7.00)	2.20 (4.33)	2.47 (5.67)	1.76 (2.67)	1.68 (2.33)	1.72 (2.50)	1.05 (0.67)	1.05 (0.67)	1.05 (0.67)
N_3W_3	5.36 (28.67)	3.96 (15.67)	4.66 (22.17)	5.61 (31.00)	4.14 (17.00)	4.88 (24.00)	4.91 (23.67)	3.36 (11.33)	4.14 (17.50)	5.03 (25.33)	3.59 (12.67)	4.31 (19.00)
N_3W_4	5.42 (29.33)	4.06 (16.33)	4.74 (22.83)	7.01 (48.67)	6.11 (37.00)	6.56 (42.83)	1.22 (1.00)	1.22 (1.00)	1.22 (1.00)	2.08 (4.00)	1.94 (3.33)	2.01 (3.67)
N_3W_5	5.17 (26.33)	3.57 (12.33)	4.37 (19.33)	5.33 (28.67)	3.80 (15.00)	4.57(21.83)	5.46 (30.00)	4.01 (16.67)	4.73 (23.33)	1.34 (1.33)	1.17 (1.00)	1.26 (1.17)
SEm± (N×W)	**0.40**	**0.35**	**0.26**	**0.22**	**0.41**	**0.23**	**0.29**	**0.40**	**0.27**	**0.29**	**0.30**	**0.20**
SEm± (W×N)	**0.45**	**0.27**	**0.25**	**0.21**	**0.32**	**0.20**	**0.20**	**0.33**	**0.20**	**0.20**	**0.21**	**0.13**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

4.5.2.2.2 Effect of weed management on weed density (no. m^{-2}) of *Digitaria sanguinalis* L.

Significant results were recorded on weed density of *Digitaria sanguinalis* at all stages of observations except at 15 DAS in both the years and their average data.

At 30 DAS, the average data of two years results recorded significantly lowest weed density (6.50) of *Digitaria sanguinalis* in W_2 (Hand weeding at 15, 30 and 45 DAS) treatment which was followed by W_5 and W_4 treatments. This indicated that hand weeding at 15 DAS in W_2 treatment, application of Propaquizafop in W_5 treatment and mechanical weeding at 20 DAS in W_3 treatment were effective in reducing density of *Digitaria sanguinalis.*

At 45 DAS, the average data of two years revealed that the lowest weed density (1.22) was found at W_4 which was statistically at par with W_2 treatment. This indicated that hand weeding at 30 DAS in both of these treatments helped in reducing density of *Digitaria sanguinalis.*

At 60 DAS, the average data of two years revealed that the lowest weed density (0.83) was found significantly at W_2 followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS) treatment. The highest weed density was recorded in W_1 (Weedy check) at all stages. The results showed that W_2 treatment effectively controlled *Digitaria sanguinalis.* Integration of Propaquizafop with hand weeding could also reduce the density of *Digitaria sanguinalis*.

4.5.2.2.3 Interaction effect on weed density (no. m^{-2}) of *Digitaria sanguinalis* L.

The study found no significant effect on weed density of *Digitaria sanguinalis* due to the interaction of nutrient and weed management treatments in both years of experiment and their average data in all the stages of observation.

4.5.2.3 Weed density (no. m^{-2}) of *Eleusine indica* L.

The data on weed density of *Eleusine indica* L. at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and their average data is presented in Table 4.27 and 4.28.

4.5.2.3.1 Effect of nutrient management on weed density (no. m^{-2}) of *Eleusine indica* L.

The effect of nutrient management on weed density of *Eleusine indica* did not show any significant effect at all stages of observation.

4.5.2.3.2 Effect of weed management on weed density (no. m^{-2}) of *Eleusine indica* L.

Significant results were observed on weed density of *Eleusine indica* at all stages of observations except at 15 DAS in both the years and their average data.

The average data of two years results at 30, 45 and 60 DAS recorded significantly highest weed density (26.89, 35.06 and 37.17, respectively) of *Eleusine indica* in weedy check.

At 30 DAS, the average data of two years results recorded the lowest weed density (5.83) of *Eleusine indica* in W_2 (Hand weeding at 15, 30 and 45 DAS) treatment which was followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS) treatment. This indicated that hand weeding at 15 DAS in W_2 treatment and application of Propaquizafop in W_5 treatment were effective in reducing density of *Eleusine indica.*

At 45 DAS, the average data of two years revealed that the lowest weed density (2.00) was found at W_2 which was statistically at par with W_4 (Pendimethalin @

Table 4.27: Effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Eleusine indica* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
Nutrient management (N)												
N_1	3.60 (12.60)	2.99 (9.07)	3.30 (10.83)	4.18 (18.53)	3.78 (15.13)	3.98 (16.83)	3.35 (13.40)	3.06 (11.53)	3.21 (12.47)	3.00 (11.73)	2.54 (9.67)	2.77 (10.70)
N_2	3.85 (14.60)	3.29 (10.87)	3.57 (12.73)	4.27 (19.40)	3.79 (15.07)	4.03 (17.23)	3.21 (12.60)	3.19 (12.93)	3.19 (12.77)	3.09 (12.67)	2.76 (11.67)	2.93 (12.17)
N_3	3.22 (10.33)	2.93 (8.53)	3.07 (9.43)	4.03 (17.13)	3.39 (12.20)	3.71 (14.67)	3.00 (11.00)	2.96 (10.27)	2.96 (10.63)	2.66 (9.30)	2.41 (8.67)	2.53 (9.23)
SEm±	**0.20**	**0.21**	**0.15**	**0.22**	**0.13**	**0.17**	**0.15**	**0.07**	**0.07**	**0.09**	**0.12**	**0.08**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	3.69 (13.56)	3.44 (11.78)	3.35 (12.67)	5.58 (30.78)	4.82 (23.00)	5.20 (26.89)	5.98 (35.33)	5.93 (34.78)	5.95 (35.06)	6.22 (38.22)	6.04 (36.11)	6.13 (37.17)
W_2	3.27 (10.67)	3.15 (9.78)	3.21 (10.22)	2.64 6.56)	2.35 (5.11)	2.50 (5.83)	1.67 (2.33)	1.40 (1.67)	1.53 (2.00)	1.28 (1.22)	0.88 (0.33)	1.08 (0.78)
W_3	3.79 (14.22)	3.13 (10.22)	3.46 (12.22)	3.71 (13.67)	3.11 (9.78)	3.41 (11.72)	2.75 (7.44)	2.84 (8.00)	2.80 (7.72)	3.11 (9.44)	3.03 (9.33)	3.07 (9.39)
W_4	3.52 (12.00)	2.53 (6.00)	3.02 (9.00)	5.31 (28.11)	4.74 (22.33)	5.02 (25.22)	1.90 (3.22)	1.78 (2.78)	1.84 (3.00)	2.52 (6.44)	2.08 (4.00)	2.30 (5.22)
W_5	3.51 (12.11)	3.10 (9.67)	3.31 (10.89)	3.55 (12.67)	3.25 (10.44)	3.40 (11.56)	3.63 (13.33)	3.28 (10.67)	3.45 (12.00)	1.45 (1.67)	0.82 (0.22)	1.14 (0.94)
SEm±	**0.18**	**0.25**	**0.15**	**0.20**	**0.22**	**0.13**	**0.20**	**0.20**	**0.17**	**0.16**	**0.17**	**0.12**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**0.59**	**0.65**	**0.39**	**0.58**	**0.59**	**0.48**	**0.47**	**0.50**	**0.36**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.28: Interaction effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Eleusine indica* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
N_1W_1	3.63 (13.00)	3.18 (10.00)	3.40 (11.50)	.52 (30.00)	5.05 (25.00)	5.28 (27.50)	6.12 (37.00)	5.82 (33.33)	5.97 (35.17)	6.23 (38.33)	5.90 (34.33)	6.06 (36.33)
N_1W_2	3.43 (11.33)	3.43 (11.33)	3.43 (11.33)	2.54 (6.00)	2.34 (5.00)	2.44 (5.50)	1.86 (3.00)	1.47 (2.00)	1.66 (2.50)	1.34 (1.33)	0.88 (0.33)	1.11 (0.83)
N_1W_3	3.80 (14.00)	3.03 (10.67)	3.42 (12.33)	.56 (12.67)	3.23 (10.00)	3.40 (11.33)	2.83 (7.67)	2.83 (8.00)	2.83 (7.83)	3.11 (9.33)	2.96 (9.33)	3.03 (9.33)
N_1W_4	3.70 (13.33)	2.67 (6.67)	3.19 (10.00)	.45 (29.33)	4.98 (24.33)	5.22 (26.83)	2.02 (3.67)	1.86 (3.00)	1.94 (3.33)	2.86 (8.00)	2.08 (4.00)	2.47 (6.00)
N_1W_5	3.43 (11.33)	2.65 (6.67)	3.04 (9.00)	.84 (14.67)	3.32 (11.33)	3.58 (13.00)	3.94 (15.67)	3.32 (11.33)	3.63 (13.50)	1.46 (1.67)	0.88 (0.33)	1.17 (1.00)
N_2W_1	4.19 (17.33)	3.68 (13.67)	3.93 (15.50)	.78 (33.00)	5.07 (25.33)	5.42 (29.17)	6.03 (36.00)	6.44 (41.00)	6.24 (38.50)	6.49 (41.67)	6.54 (42.33)	6.52 (42.00)
N_2W_2	3.71 (13.33)	3.14 (10.00)	3.43 (11.67)	2.85 (7.67)	2.61 (6.33)	2.73 (7.00)	1.56 (2.00)	1.29 (1.33)	1.42 (1.67)	1.27 (1.33)	0.88 (0.33)	1.07 (0.83)
N_2W_3	3.97 (15.67)	3.61 (12.67)	3.79 (14.17)	.85 (14.67)	3.19 (10.33)	3.52 (12.50)	3.04 (9.00)	2.95 (8.67)	2.99 (8.83)	3.36 (11.00)	3.28 (10.67)	3.32 (10.83)
N_2W_4	3.43 (11.33)	2.53 (6.00)	2.98 (8.67)	.39 (29.67)	4.87 (23.33)	5.13 (26.50)	1.84 (3.00)	1.81 (3.00)	1.82 (3.00)	2.78 (7.33)	2.21 (4.67)	2.49 (6.00)
N_2W_5	3.97 (15.33)	3.51 (12.00)	3.74 (13.67)	.46 (12.00)	3.21 (10.00)	3.34 (11.00)	3.57 (13.00)	3.32 (10.67)	3.45 (11.83)	1.56 (2.00)	0.88 (0.33)	1.22 (1.17)
N_3W_1	3.24 (10.33)	3.47 (11.67)	3.35 (11.00)	.46 (29.33)	4.34 (18.67)	4.90 (24.00)	5.79 (33.00)	5.52 (30.00)	5.65 (31.50)	5.93 (34.67)	5.67 (31.67)	5.80 (33.17)
N_3W_2	2.68 (7.33)	2.88 (8.00)	2.78 (7.67)	2.53 (6.00)	2.11 (4.00)	2.32 (5.00)	1.58 (2.00)	1.44 (1.67)	1.51 (1.83)	1.22 (1.00)	0.88 (0.33)	1.05 (0.67)
N_3W_3	3.60 (13.00)	2.76 (7.33)	3.18 (10.17)	.72 (13.67)	2.92 (9.00)	3.32 (11.33)	2.39 (5.67)	2.76 (7.33)	2.57 (6.50)	2.86 (8.00)	2.86 (8.00)	2.86 (8.00)
N_3W_4	3.42 (11.33)	2.39 (5.33)	2.90 (8.33)	.07 (25.33)	4.38 (19.33)	4.73 (22.33)	1.86 (3.00)	1.68 (2.33)	1.77 (2.67)	1.94 (4.00)	1.94 (3.33)	1.94 (3.67)
N_3W_5	3.14 (9.67)	3.14 (10.33)	3.14 (10.00)	.36 (11.33)	3.21 (10.00)	3.29 (10.67)	3.36 (11.33)	3.21 (10.00)	3.29 (10.67)	1.34 (1.33)	0.71 (0.00)	1.03 (0.67)
SEm± (N×W)	**0.32**	**0.43**	**0.25**	**0.35**	**0.39**	**0.23**	**0.35**	**0.35**	**0.29**	**0.28**	**0.30**	**0.21**
SEm± (W×N)	**0.28**	**0.34**	**0.20**	**0.31**	**0.28**	**0.23**	**0.26**	**0.23**	**0.20**	**0.20**	**0.22**	**0.16**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS) treatment. This indicated that hand weeding at 30 DAS in both of these treatments helped in reducing density of *Eleusine indica.*

At 60 DAS, the average data of two years revealed that the lowest weed density (0.78) was found significantly at W_2 which statistically at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS). The results indicated that W_2 treatment effectively controlled this weed due to three hand weeding at 15, 30 and 45 DAS. The removal of weeds at regular intervals have resulted in good control of weeds. Integration of hand weeding with chemicals has also resulted in reduction of weeds. The removal of weeds through hand weeding at 45 DAS in W_5 treatment has resulted in maximum control of weeds.

4.5.2.3.3 Interaction effect on weed density (no. m^{-2}) of *Eleusine indica* L.

The study found no significant effect on weed density of *Eleusine indica* due to the interaction of nutrient and weed management treatments in both years of experiment and their average data in all the stages of observation.

4.5.2.4 Weed density (no. m^{-2}) of *Bulbostylis barbata* (Rottb.) C.B.Clarke

The data on weed density of *Bulbostylis barbata* at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and their average data is presented in Table 4.29 and 4.30.

4.5.2.4.1 Effect of nutrient management on weed density (no. m^{-2}) of *Bulbostylis barbata* (Rottb.) C.B.Clarke.

An inquisition on two years' data and their average data on weed density of *Bulbostylis barbata* revealed no significant variation among the nutrient treatments at various stages of observations except at 45 and 60 DAS.

Table 4.29: Effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Bulbostylis barbata* (Rottb.) C.B. Clarke. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average	2017	2018	Average	2017	2018	Average
Nutrient management (N)												
N_1	2.03 (3.73)	1.80 (2.80)	1.92 (3.27)	2.05 (4.33)	2.03 (4.20)	2.04 (4.27)	1.61 (3.27)	1.64 (2.93)	1.63 (3.10)	1.42 (2.53)	1.37 (2.13)	1.39 (2.33)
N_2	2.10 (3.93)	1.83 (3.00)	1.96 (3.47)	2.17 (4.80)	2.14 (4.73)	2.15 (4.77)	1.71 (3.80)	1.76 (3.67)	1.73 (3.73)	1.48 (3.00)	1.44 (2.47)	1.46 (2.73)
N_3	1.91 (3.20)	1.81 (2.87)	1.86 (3.03)	2.00 (4.00)	2.00 (4.07)	2.00 (4.03)	1.51 (2.80)	1.58 (2.67)	1.54 (2.73)	1.31 (2.13)	1.32 (1.87)	1.31 (2.00)
SEm±	**0.12**	**0.05**	**0.08**	**0.08**	**0.10**	**0.05**	**0.08**	**0.09**	**0.05**	**0.03**	**0.04**	**0.02**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.20**	**0.10**	**NS**	**0.07**
Weed management (W)												
W_1	2.04 (3.78)	1.63 (2.22)	1.83 (3.00)	2.64 (6.56)	2.61 (6.33)	2.63 (6.44)	3.21 (9.89)	2.73 (7.00)	2.97 (8.44)	3.36 (10.89)	2.77 (7.22)	3.07 (9.06)
W_2	2.00 (3.56)	1.86 (3.00)	1.93 (3.28)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_3	2.01 (3.56)	2.02 (3.67)	2.02 (3.61)	1.94 (3.33)	2.01 (3.67)	1.98 (3.50)	0.90 (0.44)	1.61 (2.44)	1.26 (1.44)	1.52 (1.89)	1.99 (3.56)	1.75 (2.72)
W_4	2.10 (4.00)	1.86 (3.00)	0.71 (3.50)	2.57 (6.22)	2.49 (6.00)	2.53 (6.11)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_5	1.92 (3.22)	1.70 (2.56)	1.81 (2.89)	2.50 (5.78)	2.47 (5.67)	2.49 (5.72)	2.51 (6.11)	2.53 (6.00)	2.53 (6.06)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm±	**0.07**	**0.10**	**0.06**	**0.08**	**0.12**	**0.08**	**0.10**	**0.12**	**0.07**	**0.06**	**0.06**	**0.03**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**0.23**	**0.36**	**0.24**	**0.30**	**0.34**	**0.20**	**0.16**	**0.16**	**0.10**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.30: Interaction effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Bulbostylis barbata* (Rottb.) C.B.Clarke. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average	2017	2018	Average	2017	2018	Average
N_1W_1	2.15 (4.33)	1.46 (1.67)	1.80 (3.00)	2.73 (7.00)	2.61 (6.33)	2.67 (6.67)	3.19 (9.67)	2.73 (7.00)	2.96 (8.33)	3.29 (10.33)	2.80 (7.33)	3.04 (8.83)
N_1W_2	2.11 (4.00)	1.87 (3.00)	1.99 (3.50)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_3	2.04 (3.67)	1.76 (2.67)	1.90 (3.17)	1.86 (3.00)	2.02 (3.67)	1.94 (3.33)	1.00 (0.67)	1.58 (2.00)	1.29 (1.33)	1.68 (2.33)	1.94 (3.33)	1.81 (2.83)
N_1W_4	2.08 (4.00)	1.95 (3.33)	2.02 (3.00)	2.57 (6.33)	2.41 (5.67)	2.49 (6.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_5	1.77 (2.67)	1.95 (3.33)	1.86 (3.00)	2.41 (5.33)	2.41 (5.33)	2.41 (5.33)	2.47 (6.00)	2.48 (5.67)	2.47 (5.83)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_1	2.11 (4.00)	1.77 (2.67)	1.94 (3.33)	2.79 (7.33)	2.80 (7.33)	2.80 (7.33)	3.48 (11.67)	2.97 (8.33)	3.22 (10.00)	3.67 (13.00)	2.97 (8.33)	3.32 (10.67)
N_2W_2	2.11 (4.00)	1.86 (3.00)	1.99 (3.50)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_3	2.11 (4.00)	2.27 (4.67)	2.19 (4.33)	2.11 (4.00)	2.00 (3.67)	2.06 (3.83)	1.00 (0.67)	1.61 (2.67)	1.31 (1.67)	1.58 (2.00)	2.10 (4.00)	1.84 (3.00)
N_2W_4	2.03 (3.67)	1.77 (3.00)	1.90 (3.17)	2.67 (6.67)	2.67 (6.67)	2.67 (6.67)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_5	2.11 (4.00)	1.47 (2.00)	1.79 (3.00)	2.55 (6.00)	2.54 (6.00)	2.54 (6.00)	2.67 (6.67)	2.78 (7.33)	2.73 (7.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_1	1.87 (3.00)	1.64 (2.33)	1.76 (2.67)	2.41 (5.33)	2.41 (5.33)	2.41 (5.33)	2.96 (8.33)	2.48 (5.67)	2.72 (7.00)	3.13 (9.33)	2.54 (6.00)	2.84 (7.67)
N_3W_2	1.77 (2.67)	1.86 (3.00)	1.82 (2.83)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_3	1.87 (3.00)	2.04 (3.67)	1.95 (3.33)	1.86 (3.00)	2.02 (3.67)	1.94 (3.33)	0.71 (0.00)	1.65 (2.67)	1.18 (1.33)	1.29 (1.33)	1.94 (3.33)	1.62 (2.33)
N_3W_4	2.18 (4.33)	1.86 (3.00)	2.02 (3.67)	2.48 (5.67)	2.40 (5.67)	2.44 (5.67)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_5	1.87 (3.00)	1.68 (2.33)	1.77 (2.67)	2.54 (6.00)	2.48 (5.67)	2.51 (5.83)	2.47 (5.67)	2.34 (5.00)	2.40 (5.33)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm± (N×W)	**0.13**	**0.18**	**0.11**	**0.14**	**0.21**	**0.14**	**0.18**	**0.20**	**0.12**	**0.10**	**0.10**	**0.06**
SEm± (W×N)	**0.14**	**0.12**	**0.10**	**0.12**	**0.17**	**0.10**	**0.14**	**0.15**	**0.09**	**0.07**	**0.07**	**0.04**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.17**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.13**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x+0.5}$ transformation.

The average data of two years at 45 DAS revealed that the highest weed density of *Bulbostylis barbata* was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment. The lowest density of this weed was recorded in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) which was at par with N_1 (100% RDF).

The average data of two years at 60 DAS revealed that the lowest and the highest weed density of *Bulbostylis barbata* was recorded in N_3 and N_2 treatments, respectively.

4.5.2.4.2 Effect of weed management on weed density (no. m^{-2}) of *Bulbostylis barbata* (Rottb.) C.B.Clarke

Significant results were observed on weed density of *Bulbostylis barbata* at all stages of observations except at 15 DAS in both the years and average data of two years. Significantly highest weed density was recorded in W_1 (Weedy check) at 30, 45 and 60 DAS.

The average data of two years at 30 DAS revealed that W_2 (Hand weeding at 15, 30 and 45 DAS) treatment completely controlled the density of *Bulbostylis barbata* in W_2. At 45 DAS, the average data of two years revealed that the weed density of this weed was totally controlled in W_2 and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS) treatments. At 60 DAS, the average data of two years revealed that the weed density of this weed was totally controlled in W_2, W_4 and W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS) treatments. The highest weed density was observed in W_1.

The results indicated that W_2 (Hand weeding at 15, 30 and 45 DAS) treatment controlled *Bulbostylis barbata* till the final stage of observation. The application of Pendimethalin and Propaquizafop in W_4 and W_5 treatments, respectively had no effect on the density of this weed as seen in Table 4.29. However, the integration of one hand weeding with herbicides in W_4 at 30 DAS and W_5 at 45 DAS could help to control the density of *Bulbostylis barbata*.

4.5.2.4.3 Interaction effect on weed density (no. m^{-2}) of *Bulbostylis barbata* (Rottb.) C.B.Clarke

The study found no significant effect on weed density of *Bulbostylis barbata* due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observation except at 60 DAS where highest weed density of *Bulbostylis barbata* (10.67 in average data of two years) was recorded in $N_2 \times W_1$ interaction. Treatments which involved only hand weeding or integration of herbicides and hand weeding resulted in control of this weed at 60 DAS.

4.5.2.5 Weed density (no. m^{-2}) of *Cyperus iria* L.

The data on weed density (no. m^{-2}) of *Cyperus iria* L. at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.31 and 4.32.

4.5.2.5.1 Effect of nutrient management on weed density (no. m^{-2}) of *Cyperus iria* L.

An inquisition on two years' data and average data of two years on weed density of *Cyperus iria* revealed no significant variation among the nutrient treatments at various stages of observations except at 30 DAS.

At 30 DAS in the first year, significantly lowest weed density (20.53) of *Cyperus iria* was found in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). And the highest weed density (25.40) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment which was at par with N_1 (100% RDF).

Table 4.31: Effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Cyperus iria* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	3.83 (14.40)	3.50 (12.40)	3.66 (13.40)	4.74 (24.00)	4.34 (20.00)	4.54 (22.00)	3.71 (19.00)	3.58 (17.07)	3.64 (18.03)	2.77 (12.20)	2.73 (10.93)	2.75 (11.57)
N_2	4.34 (18.53)	3.77 (13.87)	4.05 (16.20)	4.92 (25.40)	4.42 (20.93)	4.67 (23.17)	3.75 (19.60)	3.59 (17.53)	3.67 (18.57)	2.87 (12.73)	2.78 (11.53)	2.83 (12.13)
N_3	3.35 (11.00)	3.24 (10.47)	3.30 (10.73)	4.37 (20.53)	4.09 (17.87)	4.23 (19.20)	3.38 (15.87)	3.40 (15.53)	3.39 (15.70)	2.64 (10.33)	2.58 (10.00)	2.61 (10.17)
SEm±	**0.21**	**0.11**	**0.15**	**0.10**	**0.15**	**0.11**	**0.10**	**0.10**	**0.09**	**0.09**	**0.17**	**0.08**
CD (p=0.05)	**NS**	**NS**	**NS**	**0.40**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	3.92 (15.33)	3.62 (12.78)	3.77 (14.06)	5.76 (32.89)	5.38 (28.44)	5.57 (30.67)	6.44 (41.11)	5.90 (34.44)	6.17 (37.78)	6.56 (42.67)	5.95 (35.00)	6.26 (38.83)
W_2	3.80 (14.22)	3.51 (12.00)	3.65 (13.11)	2.49 (5.78)	2.29 (4.78)	2.39 (5.28)	0.71 (0.00)	0.94 (0.44)	0.82 (0.22)	0.71 (0.00)	0.76 (0.11)	0.74 (0.06)
W_3	3.93 (15.33)	3.36 (11.56)	3.64 (13.44)	3.82 (14.33)	3.35 (11.33)	3.58 (12.83)	3.33 (10.89)	3.84 (14.67)	3.59 (12.78)	3.48 (12.00)	3.96 (15.78)	3.72 (13.89)
W_4	3.81 (14.22)	3.43 (12.33)	3.62 (13.28)	5.63 (31.33)	5.32 (27.89)	5.47 (29.61)	1.48 (1.89)	1.13 (0.89)	1.31 (1.39)	1.84 (3.00)	1.65 (2.22)	1.74 (2.61)
W_5	3.74 (14.11)	3.59 (12.56)	3.67 (13.33)	5.69 (32.22)	5.09 (25.56)	5.39 (28.89)	6.10 (36.89)	5.80 (33.11)	5.95 (35.00)	1.22 (1.11)	1.17 (1.00)	1.20 (1.06)
SEm±	**0.16**	**0.28**	**0.15**	**0.15**	**0.16**	**0.11**	**0.14**	**0.15**	**0.13**	**0.15**	**0.15**	**0.09**
CD (p=0.05)	**NS**	**NS**	**NS**	**0.44**	**0.47**	**0.32**	**0.41**	**0.44**	**0.36**	**0.43**	**0.44**	**0.26**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.32: Interaction effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Cyperus iria* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
N_1W_1	3.95 (15.33)	3.58 (12.67)	3.77 (14.00)	5.84 (33.67)	5.46 (29.33)	5.65 (31.50)	6.64 (43.67)	6.08 (36.67)	6.36 (40.17)	6.77 (45.33)	5.98 (35.33)	6.37 (40.33)
N_1W_2	3.70 (13.33)	3.67 (13.00)	3.69 (13.17)	2.34 (5.00)	2.35 (5.00)	2.34 (5.00)	0.71 (0.00)	1.05 (0.67)	0.88 (0.33)	0.71 (0.00)	0.88 (0.33)	0.79 (0.17)
N_1W_3	3.86 (14.67)	3.17 (11.00)	3.52 (12.83)	3.97 (15.33)	3.41 (11.33)	3.69 (13.33)	3.41 (11.33)	3.83 (14.33)	3.62 (12.83)	3.49 (12.00)	3.94 (15.67)	3.71 (13.83)
N_1W_4	3.88 (14.67)	3.45 (12.67)	3.66 (13.67)	5.78 (33.00)	5.30 (27.67)	5.54 (30.33)	1.58 (2.00)	1.17 (1.00)	1.38 (1.50)	1.84 (3.00)	1.68 (2.33)	1.76 (2.67)
N_1W_5	3.73 (14.00)	3.62 (12.67)	3.68 (13.33)	5.75 (33.00)	5.18 (26.67)	5.47 (29.83)	6.19 (38.00)	5.76 (32.67)	5.98 (35.33)	1.05 (0.67)	1.17 (1.00)	1.11 (0.83)
N_2W_1	4.54 (20.00)	3.75 (13.67)	4.14 (17.00)	6.18 (37.67)	5.58 (30.67)	5.88 (34.17)	6.67 (44.00)	6.09 (36.67)	6.38 (40.33)	6.74 (45.00)	6.15 (37.33)	6.44 (41.17)
N_2W_2	4.41 (19.00)	3.66 (13.00)	4.04 (16.00)	2.79 (7.33)	2.34 (5.00)	2.56 (6.17)	0.71 (0.00)	0.88 (0.33)	0.79 (0.17)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_3	4.56 (20.33)	3.72 (13.33)	4.14 (16.83)	4.21 (17.33)	3.45 (12.00)	3.83 (14.67)	3.67 (13.33)	3.93 (15.67)	3.80 (14.50)	3.71 (14.00)	4.09 (16.67)	3.90 (15.33)
N_2W_4	3.79 (14.33)	3.79 (14.33)	3.79 (14.33)	5.86 (34.00)	5.64 (31.33)	5.75 (32.67)	1.48 (2.00)	1.17 (1.00)	1.33 (1.50)	1.93 (3.33)	1.68 (2.33)	1.81 (2.83)
N_2W_5	4.37 (18.67)	3.93 (15.00)	4.15 (16.83)	5.57 (30.67)	5.11 (25.67)	5.34 (28.17)	6.24 (38.67)	5.87 (34.00)	6.05 (36.33)	1.27 (1.33)	1.29 (1.33)	1.28 (1.33)
N_3W_1	3.26 (10.33)	3.53 (12.00)	3.40 (11.17)	5.27 (27.33)	5.08 (25.33)	5.18 (26.33)	6.01 (35.67)	5.52 (30.00)	5.77 (32.83)	6.18 (37.67)	5.73 (32.33)	5.95 (35.00)
N_3W_2	3.29 (10.33)	3.18 (10.00)	3.23 (10.17)	2.35 (5.00)	2.20 (4.33)	2.27 (4.67)	0.71 (0.00)	0.88 (0.33)	0.79 (0.17)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_3	3.36 (11.00)	3.20 (10.33)	3.28 (10.67)	3.27 (10.33)	3.19 (10.67)	3.23 (10.50)	2.90 (8.00)	3.77 (14.00)	3.33 (11.00)	3.23 (10.00)	3.84 (15.00)	3.54 (12.50)
N_3W_4	3.75 (13.67)	3.04 (10.00)	3.39 (11.83)	5.23 (27.00)	5.01 (24.67)	5.12 (25.83)	1.39 (1.67)	1.05 (0.67)	1.22 (1.17)	1.76 (2.67)	1.58 (2.00)	1.67 (2.33)
N_3W_5	3.12 (9.67)	3.23 (10.00)	3.18 (9.83)	5.74 (33.00)	4.98 (24.33)	5.36 (28.67)	5.87 (34.00)	5.76 (32.67)	5.81 (33.33)	1.34 (1.33)	1.05 (0.67)	1.20 (1.00)
SEm± (N×W)	**0.28**	**0.48**	**0.27**	**0.26**	**0.28**	**0.19**	**0.25**	**0.26**	**0.22**	**0.26**	**0.26**	**0.15**
SEm± (W×N)	**0.27**	**0.32**	**0.22**	**0.20**	**0.24**	**0.16**	**0.19**	**0.20**	**0.16**	**0.19**	**0.24**	**0.13**
CD (*p*=0.05) (W a same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N a same or differen level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

4.5.2.5.2 Effect of weed management on weed density (no. m^{-2}) of *Cyperus iria* L.

Significant results were observed on weed density of *Cyperus iria* at all stages of observations except at 15 DAS in both the years and average data of two years.

At 30 DAS, the average data of two years recorded significantly lowest weed density of *Cyperus iria* in W_2 (Hand weeding at 15, 30 and 45 DAS) treatment followed by W_3 (Mechanical weeding at 20 and 40 DAS). At 45 DAS, the average data of two years recorded significantly lowest weed density of *Cyperus iria* in W_2 treatment followed by W_4. At 60 DAS, the average data of two years results recorded significantly lowest weed density of *Cyperus iria* in W_2 treatment followed by W_5 and W_4 treatments. Highest weed density was recorded in W_1 (Weedy check) at all stages of observations.

W_2 (Hand weeding at 15, 30 and 45 DAS) treatment controlled *Cyperus iria* till the final stage of observations. It can be observed from Table 4.31 that use of mechanical weed control could not give good result in reduction of *Cyperus iria*. The application of herbicides also did not give significant reduction in weed density of this weed species. However, when one hand weeding is given at 30 and 45 DAS at W_4 and W_5, respectively, there has been reduction in density of *Cyperus iria*.

4.5.2.5.3 Interaction effect on weed density (no. m^{-2}) of *Cyperus iria* L.

The study found no significant effect on weed density of *Cyperus iria* due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observation.

4.5.2.6 Weed density (no. m^{-2}) of *Cyperus kyllingia* L.

The data on weed density of *Cyperus kyllingia* L. at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.33 and 4.34.

4.5.2.6.1 Effect of nutrient management on weed density (no. m^{-2}) of *Cyperus kyllingia* L.

An inquisition on two years' data and average data of two years on weed density of *Cyperus kyllingia* revealed no significant variation among the nutrient treatments at various stages of observations except at 45 DAS.

The average data of two years at 45 DAS revealed that significantly lowest weed density (3.70) of *Cyperus kyllingia* was found in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). The highest weed density (4.80) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment which was at par with N_1 (100% RDF).

4.5.2.6.2 Effect of weed management on weed density (no. m^{-2}) of *Cyperus kyllingia* L.

Significant results were observed on weed density of *Cyperus kyllingia* at all stages of observations in both the years of experiment and average data of two years.

The highest weed density was recorded in W_1 (Weedy check) at all stages of observations. At 15 DAS, the lowest density of this weed was found in W_4 treatment. The average data of two years results revealed that the lowest weed density at 30 DAS was found at W_2 (Hand weeding at 15, 30 and 45 DAS). It is seen from the Table 4.33 that application of Propaquizafop at 15 DAS, had no effect of this weed. In the case of Pendimethalin also, it was found that from 30 DAS, there has been increase in the density of this weed. However, in both W_4 and W_5 treatment with the integration of hand weeding at 30 and 45 DAS, the

Table 4.33: Effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Cyperus kyllingia* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	1.52 (1.87)	1.27 (1.20)	1.40 (1.53)	1.99 (4.00)	1.62 (2.53)	1.80 (3.27)	2.02 (4.87)	1.82 (3.67)	1.92 (4.27)	1.63 (3.53)	1.42 (2.27)	1.52 (2.90)
N_2	1.47 (1.73)	1.414 (1.67)	1.44 (1.70)	2.11 (4.40)	1.73 (2.93)	1.92 (3.67)	2.14 (5.60)	1.88 (4.00)	2.01 (4.80)	1.74 (4.20)	1.30 (2.00)	1.52 (3.10)
N_3	1.44 (1.67)	1.17 (1.00)	1.30 (1.33)	1.84 (3.33)	1.50 (2.20)	1.67 (2.77)	1.94 (4.40)	1.69 (3.00)	1.81 (3.70)	1.62 (3.53)	1.25 (1.60)	1.44 (2.57)
SEm±	**0.10**	**0.10**	**0.07**	**0.10**	**0.09**	**0.09**	**0.03**	**0.03**	**0.03**	**0.03**	**0.07**	**0.04**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.11**	**0.11**	**0.10**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	1.66 (2.33)	1.60 (2.11)	1.63 (2.22)	2.65 (6.56)	2.20 (4.33)	2.42 (5.44)	3.46 (11.56)	2.77 (7.22)	3.12 (9.39)	3.57 (12.33)	2.77 (7.22)	3.17 (9.78)
W_2	1.37 (1.44)	1.29 (1.33)	1.33 (1.39)	0.98 (0.56)	0.71 (0.00)	0.84 (0.28)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_3	1.61 (2.11)	1.46 (1.67)	1.54 (1.89)	1.50 (2.00)	1.22 (1.22)	1.36 (1.61)	2.43 (5.44)	2.38 (5.22)	2.41 (5.33)	2.62 (6.44)	1.66 (2.44)	2.14 (4.44)
W_4	1.40 (1.56)	0.92 (0.44)	1.16 (1.00)	2.50 (5.78)	2.16 (4.22)	2.33 (5.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_5	1.34 (1.33)	1.15 (0.89)	1.25 (1.11)	2.26 (4.67)	1.81 (3.00)	2.04 (3.83)	2.87 (7.78)	2.41 (5.33)	2.64 (6.56)	0.71 (0.00)	0.76 (0.11)	0.74 (0.06)
SEm±	**0.08**	**0.09**	**0.06**	**0.11**	**0.13**	**0.08**	**0.04**	**0.03**	**0.03**	**0.05**	**0.08**	**0.05**
CD (*p*=0.05)	**0.22**	**0.26**	**0.18**	**0.32**	**0.37**	**0.24**	**0.13**	**0.09**	**0.08**	**0.15**	**0.23**	**0.14**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.34: Interaction effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Cyperus kyllingia* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS		45 DAS				60 DAS		
	2017	2018	Average	2017	2018	Average	2017	2018	Average	2017	2018	Average
N_1W_1	1.66 (2.33)	1.46 (1.67)	1.56 (2.00)	2.74 (7.00)	2.20 (4.33)	2.47 (5.67)	3.38 (11.00)	2.86 (7.67)	3.12 (11.00)	3.43 (11.33)	2.86 (7.67)	3.14 (9.50)
N_1W_2	1.58 (2.00)	1.34 (1.33)	1.46 (1.67)	0.88 (0.33)	0.71 (0.00)	0.79 (0.17)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_3	1.58 (2.00)	1.34 (1.33)	1.46 (1.67)	1.57 (2.33)	1.27 (1.33)	1.42 (1.83)	2.41 (5.33)	1.58 (5.33)	2.41 (5.33)	2.61 (6.33)	1.93 (3.33)	2.27 (4.83)
N_1W_4	1.58 (2.00)	1.22 (0.67)	1.29 (1.33)	2.54 (6.00)	2.18 (4.33)	2.36 (5.17)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_5	1.22 (1.00)	1.22 (1.00)	1.22 (1.00)	2.20 (4.33)	1.76 (2.67)	1.98 (3.50)	2.91 (8.00)	2.41 (5.33)	2.66 (6.67)	0.71 (0.00)	0.88 (0.33)	0.79 (0.17)
N_2W_1	1.68 (2.33)	1.87 (3.00)	1.77 (2.67)	2.80 (7.33)	2.27 (4.67)	2.53 (6.00)	3.67 (13.00)	2.91 (8.00)	3.29 (13.00)	3.76 (13.67)	2.91 (8.00)	3.34 (10.83)
N_2W_2	1.22 (1.00)	1.47 (2.00)	1.35 (1.50)	1.17 (1.00)	0.71 (0.00)	0.94 (0.50)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_3	1.58 (2.00)	1.58 (2.00)	1.58 (2.00)	1.56 (2.00)	1.29 (1.33)	1.42 (1.67)	2.68 (6.67)	2.61 (6.33)	2.64 (6.67)	2.80 (7.33)	1.47 (2.00)	2.13 (4.67)
N_2W_4	1.27 (1.33)	0.88 (0.33)	1.07 (0.83)	2.55 (6.00)	2.18 (4.33)	2.37 (5.17)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_5	1.58 (2.00)	1.22 (1.00)	1.40 (1.50)	2.48 (5.67)	2.19 (4.33)	2.33 (5.00)	2.97 (8.33)	2.48 (5.67)	2.72 (7.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_1	1.66 (2.33)	1.46 (1.67)	1.56 (2.00)	2.41 (5.33)	2.12 (4.00)	2.27 (4.67)	3.34 (10.67)	2.54 (6.00)	2.94 (10.67)	3.53 (12.00)	2.54 (6.00)	3.04 (9.00)
N_3W_2	1.29 (1.33)	1.05 (0.67)	1.17 (1.00)	0.88 (0.33)	0.71 (0.00)	0.79 (0.17)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_3	1.68 (2.33)	1.46 (1.67)	1.57 (2.00)	1.39 (1.67)	1.10 (1.00)	1.24 (1.33)	2.20 (4.33)	2.12 (4.00)	2.16 (4.33)	2.47 (5.67)	1.58 (2.00)	2.03 (3.83)
N_3W_4	1.34 (1.33)	0.88 (0.33)	1.11 (0.83)	2.41 (5.33)	2.11 (4.00)	2.26 (4.67)	0.71 (7.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_5	1.22 (1.00)	1.00 (0.67)	1.11 (0.83)	2.12 (4.00)	1.48 (2.00)	1.80 (3.00)	2.74 (1.00)	2.33 (5.00)	2.54 (6.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm± (N×W)	**0.13**	**0.15**	**0.10**	**0.19**	**0.22**	**0.14**	**0.08**	**0.06**	**0.05**	**0.09**	**0.14**	**0.08**
SEm± (W×N)	**0.13**	**0.14**	**0.10**	**0.15**	**0.17**	**0.13**	**0.06**	**0.05**	**0.04**	**0.06**	**0.11**	**0.07**
CD (*p*=0.05) (W at san level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.16**	**0.14**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.15**	**0.13**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

density of the weed was controlled. Hence, at 60 DAS, the average data of two years revealed that the weed density was effectively controlled in W_2, W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS) treatments and W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) treatment.

4.5.2.6.3 Interaction effect on weed density (no. m^{-2}) of *Cyperus kyllingia* L.

The study found no significant effect on weed density of *Cyperus kyllingia* due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observation except at 45 DAS.

At 45 DAS, the average data of two years revealed that significantly highest weed density (13.00) of *Cyperus kyllingia* was recorded in $N_2 \times W_1$ interaction.

4.5.2.7 Weed density (no. m^{-2}) of *Cyperus rotundus* L.

The data on weed density (no. m^{-2}) of *Cyperus rotundus* L. at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.35 and 4.36.

4.5.2.7.1 Effect of nutrient management on weed density (no. m^{-2}) of *Cyperus rotundus* L.

An inquisition on two years' data and average data of two years on weed density of *Cyperus rotundus* revealed no significant variation among the nutrient treatments at 15 DAS.

The average data of two years at 30 DAS revealed that significantly lowest weed density (4.67) of *Cyperus rotundus* was recorded in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). And the highest weed density (5.73) was

Table 4.35: Effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Cyperus rotundus* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	1.94 (3.32)	1.75 (2.60)	1.84 (2.97)	2.36 (5.93)	2.13 (4.67)	2.25 (5.30)	2.11 (5.73)	2.36 (6.53)	2.24 (6.13)	1.69 (3.73)	1.85 (4.40)	1.77 (4.07)
N_2	1.78 (2.80)	1.88 (3.13)	1.83 (2.97)	2.52 (6.60)	2.19 (4.87)	2.36 (5.73)	2.19 (6.40)	2.41 (7.13)	2.30 (6.77)	1.84 (4.40)	1.97 (5.20)	1.90 (4.80)
N_3	1.80 (2.80)	1.62 (2.27)	1.71 (2.53)	2.27 (5.33)	1.97 (4.00)	2.12 (4.67)	2.03 (5.20)	2.26 (6.00)	2.14 (5.60)	1.58 (3.27)	1.74 (3.73)	1.66 (3.50)
SEm±	**0.07**	**0.09**	**0.06**	**0.06**	**0.08**	**0.04**	**0.09**	**0.11**	**0.06**	**0.04**	**0.11**	**0.06**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**0.16**	**0.35**	**NS**	**NS**	**0.17**	**NS**	**NS**
Weed management (W)												
W_1	2.06 (3.78)	2.06 (3.78)	2.06 (3.78)	3.07 (9.00)	2.81 (7.44)	2.94 (8.22)	3.54 (12.11)	3.91 (14.89)	3.72 (13.50)	3.80 (14.00)	3.91 (14.89)	3.86 (14.44)
W_2	1.64 (2.33)	1.57 (2.00)	1.60 (2.17)	0.98 (0.56)	0.99 (0.56)	0.99 (0.56)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_3	1.95 (3.33)	1.76 (2.67)	1.85 (3.00)	1.87 (3.1)	1.50 (2.00)	1.69 (2.56)	0.90 (0.44)	2.00 (3.67)	1.45 (2.06)	1.29 (1.33)	2.26 (5.00)	1.78 (3.17)
W_4	2.01 (3.56)	1.83 (3.00)	1.92 (3.28)	3.05 (8.89)	2.70 (6.89)	2.88 (7.89)	1.60 (2.22)	1.50 (1.89)	1.55 (2.06)	2.01 (3.67)	1.66 (2.33)	1.83 (3.00)
W_5	1.53 (1.89)	1.53 (1.89)	1.53 (1.89)	2.95 (8.22)	2.48 (5.67)	2.72 (6.94)	3.82 (14.11)	3.58 (12.33)	3.70 (13.22)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm±	**0.07**	**0.08**	**0.05**	**0.10**	**0.12**	**0.08**	**0.10**	**0.10**	**0.06**	**0.10**	**0.11**	**0.07**
CD (*p*=0.05)	**0.19**	**0.23**	**0.14**	**0.29**	**0.34**	**0.23**	**0.30**	**0.28**	**0.18**	**0.29**	**0.33**	**0.22**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.36: Interaction effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Cyperus rotundus* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average	2017	2018	Average	2017	2018	Average
N_1W_1	2.20 (4.33)	1.95 (3.33)	2.08 (3.83)	3.07 (9.00)	2.80 (7.33)	2.93 (8.17)	3.58 (12.33)	3.94 (15.00)	3.76 (13.67)	3.81 (14.00)	3.94 (15.00)	3.87 (14.50)
N_1W_2	1.86 (3.00)	1.58 (2.00)	1.72 (2.50)	0.88 (0.33)	1.05 (0.67)	0.97 (0.50)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_3	2.04 (3.67)	1.68 (2.33)	1.86 (3.00)	1.82 (3.00)	1.54 (2.33)	1.68 (2.67)	1.00 (0.67)	2.09 (4.00)	1.54 (2.33)	1.29 (1.33)	2.12 (4.33)	1.71 (2.83)
N_1W_4	2.04 (3.67)	1.93 (3.33)	1.99 (3.50)	3.08 (9.00)	2.80 (7.33)	2.94 (8.17)	1.46 (1.67)	1.58 (2.00)	1.52 (1.83)	1.94 (3.33)	1.77 (2.67)	1.86 (3.00)
N_1W_5	1.56 (2.00)	1.58 (2.00)	1.57 (2.00)	2.97 (8.33)	2.48 (5.67)	2.73 (7.00)	3.81 (14.00)	3.49 (11.67)	3.65 (12.83)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_1	2.04 (3.67)	2.27 (4.67)	2.15 (4.17)	3.29 (10.33)	3.03 (8.67)	3.16 (9.50)	3.85 (14.33)	4.18 (17.00)	4.01 (15.67)	4.02 (15.67)	4.18 (17.00)	4.10 (16.33)
N_2W_2	1.29 (1.33)	1.68 (2.33)	1.48 (1.83)	1.17 (1.00)	1.05 (0.67)	1.11 (0.83)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_3	2.04 (3.67)	2.04 (3.67)	2.04 (3.67)	2.02 (3.67)	1.68 (2.33)	1.85 (3.00)	0.71 (0.00)	2.02 (3.67)	1.36 (1.83)	1.58 (2.00)	2.58 (6.67)	2.08 (4.33)
N_2W_4	1.95 (3.33)	1.74 (2.67)	1.85 (3.00)	3.17 (9.67)	2.64 (6.67)	2.90 (8.17)	1.76 (2.67)	1.47 (2.00)	1.62 (2.33)	2.18 (4.33)	1.66 (2.33)	1.92 (3.33)
N_2W_5	1.58 (2.00)	1.68 (2.33)	1.63 (2.17)	2.97 (8.33)	2.54 (6.00)	2.76 (7.17)	3.93 (15.00)	3.66 (13.00)	3.80 (14.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_1	1.95 (3.33)	1.95 (3.33)	1.95 (3.33)	2.85 (7.67)	2.61 (6.33)	2.73 (7.00)	3.18 (9.67)	3.63 (12.67)	3.40 (11.17)	3.58 (12.33)	3.63 (12.67)	3.60 (12.50)
N_3W_2	1.76 (2.67)	1.44 (1.67)	1.60 (2.17)	0.88 (0.33)	0.88 (0.33)	0.88 (0.33)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_3	1.77 (2.67)	1.56 (2.00)	1.67 (2.33)	1.77 (2.67)	1.29 (1.33)	1.53 (2.00)	1.00 (0.67)	1.90 (3.33)	1.45 (2.00)	3.58 (0.67)	2.08 (4.00)	1.54 (2.33)
N_3W_4	2.04 (3.67)	1.82 (3.00)	1.93 (3.33)	2.92 (8.00)	2.66 (6.67)	2.79 (7.33)	1.57 (2.33)	1.46 (1.67)	1.51 (2.00)	1.00 (3.33)	1.56 (2.00)	1.73 (2.67)
N_3W_5	1.46 (1.67)	1.34 (1.33)	1.40 (1.50)	2.92 (8.00)	2.41 (5.33)	2.66 (6.67)	3.71 (13.00)	3.58 (12.33)	3.65 (12.83)	1.90 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm± (N×W)	**0.12**	**0.14**	**0.08**	**0.17**	**0.20**	**0.14**	**0.18**	**0.17**	**0.11**	**0.17**	**0.20**	**0.13**
SEm± (W×N)	**0.10**	**0.13**	**0.08**	**0.12**	**0.15**	**0.10**	**0.14**	**0.15**	**0.09**	**0.12**	**0.17**	**0.10**
CD (*p*=0.05) (W same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N same or differe level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment which was at par with N_1 (100% RDF).

At 45 DAS, the 2017 data revealed that the lowest weed density (5.20) of *Cyperus rotundus* was found in N_3 and the highest weed density was recorded in N_2 treatment.

At 60 DAS, the 2017 data revealed that similar trend as that of average data of two years at 30 DAS.

4.5.2.7.2 Effect of weed management on weed density (no. m^{-2}) of *Cyperus rotundus* L.

Significant results were observed on weed density of *Cyperus rotundus* at all stages of observations in both the years of experiment and average data of two years.

The highest weed density was recorded in W_1 (Weedy check) at all stages of observations. The average data of two years results revealed that the lowest weed density at 30 DAS was found at W_2 (Hand weeding at 15, 30 and 45 DAS) followed by W_3 (Mechanical weeding at 20 and 40 DAS). This might be due to removal of weeds at 15 DAS for W_2. The mechanical weeding at 20 DAS also might have exerted some effect on the density of *Cyperus rotundus*.

At 45 DAS, the average data of two years revealed that the weed density was effectively controlled in W_2. Weed density was found lower in W_4 which might be due to hand weeding at 30 DAS.

At 60 DAS, the average data of two years revealed that the weed density was totally controlled in W_2 and W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) treatment. W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS) treatments also recorded significantly reduced weed density of this weed over weedy check.

4.5.2.7.3 Interaction effect on weed density (no. m^{-2}) of *Cyperus rotundus* L.

The study found no significant effect on weed density of *Cyperus rotundus* due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observations.

4.5.2.8 Weed density (no. m^{-2}) of *Ageratum conyzoides* L.

The data on weed density (no. m^{-2}) of *Ageratum conyzoides* L. at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.37 and 4.38.

4.5.2.8.1 Effect of nutrient management on weed density (no. m^{-2}) of *Ageratum conyzoides* L.

An inquisition on two years' data and average data of two years on weed density of *Ageratum conyzoides* revealed no significant variation among the nutrient treatments at all stages of observations except at 15 DAS.

At 15 DAS, the first year data (2017) revealed that significantly highest weed density (6.00) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment. And the lowest weed density (4.80) was recorded in (50% RDF + 50% organic through *Rhizobium* + PSB) treatment which was at par with N_1 (100% RDF).

4.5.2.8.2 Effect of weed management on weed density (no. m^{-2}) of *Ageratum conyzoides* L.

Significant results were observed on weed density of *Ageratum conyzoides* at all stages of observations in both the years of experiment and average data of two years. The highest weed density was significantly recorded in W_1 (Weedy check) at all stages of observations except at 15 DAS.

Table 4.37: Effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Ageratum conyzoides* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	2.26 (4.80)	1.80 (3.00)	2.03 (3.90)	2.30 (5.27)	1.97 (3.73)	2.13 (4.50)	1.94 (4.33)	1.85 (3.67)	1.90 (4.00)	1.89 (3.93)	1.94 (3.67)	1.91 (3.80)
N_2	2.52 (6.00)	2.00 (3.73)	2.26 (4.87)	2.46 (6.07)	2.12 (4.53)	2.29 (5.3)	2.06 (5.20)	2.08 (4.40)	2.07 (4.80)	1.98 (4.40)	2.08 (4.27)	2.03 (4.33)
N_3	2.27 (4.80)	1.83 (3.20)	2.05 (4.00)	2.29 (5.07)	1.89 (3.47)	2.09 (4.27)	1.85 (4.00)	1.94 (3.67)	1.89 (3.83)	1.74 (3.33)	1.86 (3.33)	1.80 (3.33)
SEm±	**0.05**	**0.14**	**0.07**	**0.13**	**0.08**	**0.08**	**0.11**	**0.07**	**0.06**	**0.12**	**0.08**	**0.09**
CD(*p*=0.05)	**0.21**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	2.64 (6.56)	2.11 (4.00)	2.37 (5.28)	3.15 (9.44)	2.75 (7.11)	2.95 (8.28)	3.48 (11.67)	2.85 (7.67)	3.17 (9.67)	3.58 (12.33)	2.93 (8.11)	3.25 (10.22)
W_2	2.39 (5.33)	1.94 (3.56)	2.17 (4.44)	0.71 (0.00)	1.47 (1.89)	1.53 (2.06)	1.60 (2.22)	1.40 (1.67)	1.50 (1.94)	1.09 (0.78)	1.16 (1.00)	1.13 (0.89)
W_3	2.48 (5.67)	2.20 (4.44)	2.34 (5.06)	1.82 (5.00)	2.07 (3.89)	2.19 (4.44)	1.10 (0.89)	1.65 (2.22)	1.37 (1.56)	1.91 (3.22)	1.93 (3.33)	1.92 (3.28)
W_4	1.85 (3.00)	1.19 (1.00)	1.52 (2.00)	0.71 (3.00)	1.30 (1.33)	1.58 (2.17)	0.71 (0.00)	1.15 (0.89)	0.93 (0.44)	1.37 (1.44)	2.10 (4.00)	1.73 (2.72)
W_5	2.40 (5.44)	1.95 (3.56)	2.18 (4.50)	2.46 (7.67)	2.38 (5.33)	2.61 (6.50)	2.86 (7.78)	2.74 (7.11)	2.80 (7.44)	1.40 (1.67)	1.67 (2.33)	1.54 (2.00)
SEm±	**0.11**	**0.13**	**0.10**	**0.13**	**0.15**	**0.18**	**0.11**	**0.11**	**0.07**	**0.11**	**0.10**	**0.07**
CD(*p*=0.05)	**0.33**	**0.39**	**0.28**	**0.37**	**0.45**	**0.14**	**0.33**	**0.31**	**0.20**	**0.33**	**0.30**	**0.21**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.38: Interaction effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Ageratum conyzoides* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
N_1W_1	2.45 (5.67)	2.09 (4.00)	2.27 (4.83)	2.96 (8.33)	2.68 (6.67)	2.82 (7.50)	3.33 (10.67)	2.92 (8.00)	3.12 (9.33)	3.48 (11.67)	2.97 (8.33)	3.23 (10.00)
N_1W_2	2.26 (4.67)	1.77 (2.67)	2.01 (3.67)	1.47 (2.00)	1.39 (1.67)	1.43 (1.83)	1.57 (2.33)	1.00 (0.67)	1.28 (1.50)	1.17 (1.00)	1.05 (0.00)	1.11 (0.83)
N_1W_3	2.41 (5.33)	2.09 (4.00)	2.25 (4.67)	2.40 (5.33)	2.04 (3.67)	2.22 (4.50)	1.29 (1.33)	1.58 (2.00)	1.44 (1.67)	2.12 (4.00)	1.94 (3.33)	2.03 (3.67)
N_1W_4	1.86 (3.00)	1.05 (0.67)	1.45 (1.83)	1.84 (3.00)	1.34 (1.33)	1.59 (2.17)	0.71 (0.00)	1.05 (0.67)	0.88 (0.33)	1.29 (1.33)	2.04 (3.67)	1.66 (2.50)
N_1W_5	2.35 (5.33)	2.02 (3.67)	2.18 (4.50)	2.81 (7.67)	2.41 (5.33)	2.61 (6.50)	2.80 (7.33)	2.71 (7.00)	2.75 (7.17)	1.39 (1.67)	1.68 (2.33)	1.53 (2.00)
N_2W_1	2.80 (7.33)	2.11 (4.00)	2.46 (5.67)	3.34 (10.67)	2.86 (7.67)	3.10 (9.17)	3.67 (13.00)	2.97 (8.33)	3.32 (10.67)	3.81 (14.00)	3.03 (8.67)	3.42 (11.33)
N_2W_2	2.68 (6.67)	2.27 (4.67)	2.47 (5.67)	1.74 (2.67)	1.57 (2.33)	1.65 (2.50)	1.68 (2.33)	1.66 (2.33)	1.67 (2.33)	1.22 (1.00)	1.27 (1.33)	1.25 (1.17)
N_2W_3	2.61 (6.33)	2.41 (5.33)	2.51 (5.83)	2.29 (5.00)	2.23 (4.67)	2.26 (4.83)	1.00 (0.67)	1.77 (2.67)	1.39 (1.67)	1.93 (3.33)	2.08 (4.00)	2.01 (3.67)
N_2W_4	1.93 (3.33)	1.46 (1.67)	1.70 (2.50)	1.86 (3.00)	1.29 (1.33)	1.57 (2.17)	0.71 (0.00)	1.17 (1.00)	0.94 (0.50)	1.46 (1.67)	2.26 (4.67)	1.86 (3.17)
N_2W_5	2.59 (6.33)	1.72 (3.00)	2.16 (4.67)	3.08 (9.00)	2.65 (6.67)	2.87 (7.83)	3.23 (10.00)	2.84 (7.67)	3.04 (8.83)	1.47 (2.00)	1.76 (2.67)	1.62 (2.33)
N_3W_1	2.68 (6.67)	2.11 (4.00)	2.39 (5.33)	3.13 (9.33)	2.71 (7.00)	2.92 (8.17)	3.44 (11.33)	2.68 (6.67)	3.06 (9.00)	3.44 (11.33)	2.80 (7.33)	3.12 (9.33)
N_3W_2	2.24 (4.67)	1.77 (3.33)	2.01 (4.00)	1.58 (2.00)	1.46 (1.67)	1.52 (1.83)	1.56 (2.00)	1.56 (2.00)	1.56 (2.00)	0.88 (0.33)	1.17 (1.00)	1.03 (0.67)
N_3W_3	2.41 (5.33)	2.08 (4.00)	2.25 (4.67)	2.26 (4.67)	1.93 (3.33)	2.09 (4.00)	1.00 (0.67)	1.58 (2.00)	1.29 (1.33)	1.68 (2.33)	1.77 (2.67)	1.73 (2.50)
N_3W_4	1.77 (2.67)	1.05 (0.67)	1.41 (1.67)	1.86 (3.00)	1.27 (1.33)	1.56 (2.17)	0.71 (0.00)	1.22 (1.00)	0.97 (0.50)	1.34 (1.33)	2.00 (3.67)	1.67 (2.50)
N_3W_5	2.26 (4.67)	2.12 (4.00)	2.19 (4.33)	2.61 (6.33)	2.08 (4.00)	2.35 (5.17)	2.54 (6.00)	2.65 (6.67)	2.60 (6.33)	1.34 (1.33)	1.58 (2.00)	1.46 (1.67)
SEm± (N×W)	**0.20**	**0.23**	**0.17**	**0.22**	**0.27**	**0.18**	**0.20**	**0.19**	**0.12**	**0.20**	**0.18**	**0.13**
SEm± (W×N)	**0.14**	**0.20**	**0.12**	**0.19**	**0.19**	**0.14**	**0.17**	**0.14**	**0.09**	**0.17**	**0.14**	**0.12**
CD (*p*=0.05) (W a same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N a same or differen level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

At 15 DAS, the average data of two years recorded significantly lowest weed density of *Ageratum conyzoides* in W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatment over all the other weed management treatments.

At 30 DAS, the average data of two years revealed that W_2 treatment reduced the weed density of *Ageratum conyzoides* due to hand weeding at 15 DAS and showed lowest weed density followed by W_4. It is seen from the Table 4.37 that application of Propaquizafop in W_5 treatment did not significantly reduce the weed density of *Ageratum conyzoides.* This corresponded with the findings of Kumar *et al*. (2018a).

At 45 DAS, lowest weed density of *Ageratum conyzoides* was recorded in W_4 followed by W_3 treatment. The hand weeding carried out at 30 DAS in W_4 treatment might have resulted in lowest weed density. The reduction of *Ageratum conyzoides* in W_3 treatment might be due to effect of mechanical weeding carried out at 40 DAS.

At 60 DAS, the average data of two years revealed significantly lowest weed density was at W_2 treatment which was followed by W_5 and W_4 treatments. Treatments involving sole hand weeding or integration of herbicides with hand weeding were able to control *Ageratum conyzoides.*

4.5.2.8.3 Interaction effect on weed density (no. m^{-2}) of *Ageratum conyzoides* L.

The study showed no significant effect on weed density of *Ageratum conyzoides* due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observations.

4.5.2.9 Weed density (no. m^{-2}) of *Amaranthus viridis* Hook. F.

The data on weed density (no. m^{-2}) of *Amaranthus viridis* at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.39 and 4.40.

4.5.2.9.1 Effect of nutrient management on weed density (no. m^{-2}) of *Amaranthus viridis* Hook. F.

An inquisition on two years' data and average data of two years on weed of *Amaranthus viridis* revealed no significant variation among the nutrient treatments at all stages of observations except at 15 DAS.

At 15 DAS, the average data of two years revealed significantly lowest weed density (3.73) of *Amaranthus viridis* in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). N_1 (100% RDF) recorded the highest weed density (4.43) which was at par with N_2 (75% RDF + 25% organic through FYM + PSB) treatment.

4.5.2.9.2 Effect of weed management on weed density (no. m^{-2}) of *Amaranthus viridis* Hook. F.

Significant results were observed on weed density of *Amaranthus viridis* at all stages of observations in both the years of experiment and average data of two years.

At 15 DAS, the average data of two years recorded significantly lowest weed density of *Amaranthus viridis* in W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatment over all the other weed management treatments.Application of Pendimethalin might have helped in controlling the growth of *Amaranthus viridis.* Similar findings were reported by Kalpana and Velayutham (2004).

Table 4.39: Effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Amaranthus viridis* Hook. F. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	2.15 (4.40)	2.15 (4.47)	2.15 (4.43)	2.32 (5.53)	2.17 (5.07)	2.24 (5.30)	2.15 (6.00)	1.86 (4.20)	2.01 (5.10)	1.66 (3.93)	1.55 (3.27)	1.60 (3.60)
N_2	2.27 (4.87)	2.22 (4.67)	2.25 (4.37)	2.40 (6.13)	2.21 (5.13)	2.30 (5.63)	2.27 (7.07)	1.92 (4.60)	2.10 (5.83)	1.66 (4.07)	1.53 (3.47)	1.60 (3.77)
N_3	1.95 (3.53)	2.05 (3.93)	2.00 (3.73)	2.12 (4.80)	2.04 (4.40)	2.08 (4.60)	2.04 (5.40)	1.72 (3.53)	1.88 (4.47)	1.54 (3.27)	1.50 (2.87)	1.52 (3.07)
SEm±	**0.15**	**0.12**	**0.04**	**0.06**	**0.10**	**0.07**	**0.06**	**0.10**	**0.07**	**0.05**	**0.09**	**0.03**
CD (*p*=0.05)	**NS**	**NS**	**0.14**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	2.45 (5.78)	2.51 (5.89)	2.48 (5.83)	3.23 (10.00)	3.05 (8.89)	3.14 (9.44)	3.93 (15.11)	3.30 (10.44)	3.62 (12.78)	3.92 (15.00)	3.59 (12.44)	3.76 (13.72)
W_2	2.28 (4.78)	2.32 (4.89)	2.30 (4.83)	0.98 (0.56)	0.76 (0.11)	0.87 (0.33)	0.71 (0.00)	0.76 (0.11)	0.74 (0.06)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_3	2.32 (5.00)	2.41 (5.33)	2.37 (5.17)	2.14 (4.22)	2.37 (5.22)	2.26 (4.72)	1.76 (2.67)	1.45 (1.78)	1.60 (2.22)	2.05 (3.78)	1.92 (3.56)	1.99 (3.67)
W_4	1.44 (1.78)	1.31 (1.44)	1.38 (1.61)	1.86 (3.00)	1.63 (2.33)	1.75 (2.67)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_5	2.11 (4.00)	2.16 (4.22)	2.14 (4.11)	3.18 (9.67)	2.87 (7.78)	3.03 (8.72)	3.67 (13.00)	2.95 (8.22)	3.31 (10.61)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm±	**0.13**	**0.10**	**0.07**	**0.08**	**0.11**	**0.07**	**0.07**	**0.08**	**0.06**	**0.06**	**0.11**	**0.06**
CD (*p*=0.05)	**0.37**	**0.30**	**0.21**	**0.24**	**0.31**	**0.21**	**0.20**	**0.24**	**0.16**	**0.18**	**0.33**	**0.17**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.40: Interaction effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Amaranthus viridis* Hook. F. at 15 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average	2017	2018	Average	2017	2018	Average
N_1W_1	2.28 (5.00)	2.69 (7.00)	2.49 (6.00)	3.13 (9.33)	3.11 (9.33)	3.12 (9.33)	3.83 (14.33)	3.34 (10.67)	3.58 (12.50)	3.92 (15.00)	3.67 (13.00)	3.80 (14.00)
N_1W_2	2.48 (5.67)	2.35 (5.00)	2.41 (5.33)	1.05 (0.67)	0.71 (0.00)	0.88 (0.33)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_3	2.48 (5.67)	2.41 (5.33)	2.45 (5.50)	2.41 (5.33)	2.34 (5.00)	2.37 (5.17)	1.94 (3.33)	1.58 (2.00)	1.76 (2.67)	2.26 (4.67)	1.94 (3.33)	2.10 (4.00)
N_1W_4	1.39 (1.67)	1.17 (1.00)	1.28 (1.33)	1.86 (3.00)	1.66 (2.33)	1.76 (2.67)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_5	2.11 (4.00)	2.12 (4.00)	2.12 (4.00)	3.13 (9.33)	3.03 (8.67)	3.08 (9.00)	3.58 (12.33)	2.97 (8.33)	3.27 (10.33)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_1	2.68 (6.67)	2.48 (5.67)	2.58 (6.17)	3.58 (12.33)	3.19 (9.67)	3.38 (11.00)	4.26 (17.67)	3.48 (11.67)	3.87 (14.67)	4.14 (16.67)	3.81 (14.00)	3.97 (15.33)
N_2W_2	2.41 (5.33)	2.41 (5.33)	2.41 (5.33)	1.17 (1.00)	0.88 (0.33)	1.03 (0.67)	0.71 (0.00)	0.88 (0.33)	0.79 (0.17)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_3	2.45 (5.67)	2.48 (5.67)	2.46 (5.67)	1.94 (3.33)	2.38 (5.33)	2.16 (4.33)	1.76 (2.67)	1.47 (2.00)	1.62 (2.33)	2.03 (3.67)	1.73 (3.33)	1.88 (3.50)
N_2W_4	1.56 (2.00)	1.48 (2.00)	1.52 (2.00)	1.95 (3.33)	1.76 (2.67)	1.86 (3.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_5	2.27 (4.67)	2.27 (4.67)	2.27 (4.67)	3.34 (10.67)	2.85 (7.67)	3.09 (9.17)	3.94 (15.00)	3.08 (9.00)	3.51 (12.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_1	2.40 (5.67)	2.35 (5.00)	2.37 (5.33)	2.96 (8.33)	2.86 (7.67)	2.91 (8.00)	3.70 (13.33)	3.08 (9.00)	3.39 (11.17)	3.70 (13.33)	3.29 (10.33)	3.49 (11.83)
N_3W_2	1.95 (3.33)	2.20 (4.33)	2.08 (3.83)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_3	2.04 (3.67)	2.35 (5.00)	2.19 (4.33)	2.08 (4.00)	2.40 (5.33)	2.24 (4.67)	1.58 (2.00)	1.29 (1.33)	1.44 (1.67)	1.86 (3.00)	2.08 (4.00)	1.97 (3.50)
N_3W_4	1.95 (1.67)	1.29 (1.33)	1.34 (1.50)	1.77 (2.67)	1.48 (2.00)	1.63 (2.33)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_5	1.95 (3.33)	2.08 (4.00)	2.02 (3.67)	3.08 (9.00)	2.73 (7.00)	2.91 (8.00)	3.49 (11.67)	2.80 (7.33)	3.14 (9.50)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm± (N×W)	**0.22**	**0.18**	**0.13**	**0.14**	**0.18**	**0.12**	**0.12**	**0.14**	**0.10**	**0.10**	**0.20**	**0.10**
SEm± (W×N)	**0.20**	**0.16**	**0.09**	**0.11**	**0.15**	**0.10**	**0.10**	**0.13**	**0.09**	**0.08**	**0.16**	**0.07**
CD (*p*=0.05) (W a same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N a same or differer level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

At 30 DAS, the average data of two years revealed significantly lowest weed density at W_2 (Hand weeding at 15, 30 and 45 DAS) followed by W_4 treatment. At this stage, application of Propaquizafop in W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) treatment did not show control of this weed.

At 45 DAS, W_4 treatment resulted in control of *Amaranthus viridis* which was controlled at par with W_2. The mechanical weeding treatment at 40 DAS resulted in better control of this weed than W_5.

At 60 DAS, treatments involving hand weeding (W_2, W_4, W_5) treatments were found to completely control density of *Amaranthus viridis.*

4.5.2.9.3 Interaction effect on weed density (no. m^{-2}) of *Amaranthus viridis* Hook. F.

The study found no significant effect on weed density of *Amaranthus viridis* due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observations.

4.5.2.10 Weed density (no. m^{-2}) of *Borreria latifolia* (Aubl.) K. Schum.

The data on weed density (no. m^{-2}) of *Borreria latifolia* (Aubl.) K. Schum. at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.41 and 4.42.

Table 4.41: Effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Borreria latifolia* (Aubl.) K. Schum. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	2.82 (8.13)	3.89 (15.87)	3.36 (12.00)	3.77 (6.53)	4.33 (20.40)	4.05 (18.47)	4.45 (22.80)	4.35 (22.27)	4.40 (22.53)	3.67 (16.53)	3.56 (15.20)	3.62 (15.87)
N_2	3.13 (9.73)	3.97 (16.33)	3.55 (13.03)	4.05 (19.00)	4.64 (23.33)	4.35 (21.17)	4.58 (24.73)	4.52 (23.93)	4.55 (24.33)	3.83 (17.93)	3.72 (16.80)	3.78 (17.37)
N_3	2.66 (7.13)	3.51 (12.93)	3.08 (10.03)	3.57 (15.13)	4.17 (19.13)	3.87 (17.13)	4.36 (22.07)	4.33 (21.67)	4.35 (21.30)	3.46 (15.20)	3.45 (14.53)	3.46 (14.87)
SEm±	**0.17**	**0.24**	**0.16**	**0.04**	**0.05**	**0.03**	**0.18**	**0.12**	**0.12**	**0.11**	**0.08**	**0.05**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**0.15**	**0.20**	**0.10**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.19**
Weed management (W)												
W_1	3.23 (10.11)	4.20 (17.67)	3.71 (13.89)	5.94 (34.89)	6.11 (37.00)	6.03 (35.94)	6.65 (43.89)	6.89 (47.11)	6.77 (45.50)	6.69 (44.44)	7.04 (49.11)	6.87 (46.78)
W_2	3.25 (10.11)	4.28 (18.22)	3.76 (14.17)	2.36 (5.11)	3.18 (9.67)	2.77 (7.39)	2.25 (4.56)	2.76 (7.11)	2.50 (5.83)	1.83 (2.89)	2.30 (4.89)	2.06 (3.89)
W_3	3.19 (9.78)	4.18 (17.56)	3.68 (13.67)	2.95 (8.56)	4.12 (17.00)	3.54 (12.78)	4.59 (21.33)	2.98 (8.89)	3.78 (15.11)	4.74 (22.67)	3.11 (9.67)	3.93 (16.17)
W_4	1.51 (2.00)	1.96 (3.56)	1.75 (2.78)	2.13 (4.11)	2.59 (6.22)	2.36 (5.17)	2.43 (5.44)	2.80 (7.33)	2.62 (6.39)	3.23 (10.00)	2.81 (7.44)	3.02 (8.72)
W_5	3.18 (9.67)	4.31 (18.22)	3.74 (13.94)	5.62 (31.78)	5.90 (34.89)	5.76 (33.33)	6.41 (40.78)	6.55 (42.67)	6.48 (40.78)	1.77 (2.78)	2.63 (6.44)	2.20 (4.61)
SEm±	**0.11**	**0.21**	**0.09**	**0.20**	**0.21**	**0.16**	**0.19**	**0.16**	**0.12**	**0.18**	**0.15**	**0.11**
CD (*p*=0.05)	**0.32**	**0.62**	**0.26**	**0.60**	**0.61**	**0.45**	**0.54**	**0.46**	**0.35**	**0.52**	**0.43**	**0.32**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.42: Interaction effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Borreria latifolia* (Aubl.) K. Schum. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
N_1W_1	3.20 (10.00)	4.44 (19.33)	3.82 (14.67)	5.86 (34.00)	6.03 (36.00)	5.94 (35.00)	6.60 (43.33	6.87 (46.67)	6.74 (45.00)	6.65 (44.00)	6.99 (48.33)	6.82 (46.17)
N_1W_2	3.23 (10.00)	4.21 (18.00)	3.72 (14.00)	2.34 (5.00)	3.19 (9.67)	2.76 (7.33)	2.27 (4.67	2.73 (7.00)	2.50 (5.83)	1.86 (3.00)	2.34 (5.00)	2.10 (4.00)
N_1W_3	3.12 (9.33)	4.49 (20.00)	3.81 (14.67)	2.87 (8.00)	4.02 (16.00)	3.45 (12.00)	4.59 (21.00	2.85 (8.67)	3.72 (14.83)	4.73 (22.67)	3.02 (8.67)	3.88 (15.67)
N_1W_4	1.39 (1.67)	1.93 (3.33)	1.66 (2.50)	2.18 (4.33)	2.61 (6.33)	2.39 (5.33)	2.48 (5.67	2.80 (7.33)	2.64 (6.50)	3.23 (10.00)	2.85 (7.67)	3.04 (8.83)
N_1W_5	3.18 (9.67)	4.37 (18.67)	3.78 (14.17)	5.63 (31.33)	5.78 (34.00)	5.70 (32.67)	6.31 (39.33	6.48 (41.67)	6.40 (40.50)	1.87 (3.00)	2.61 (6.33)	2.24 (4.67)
N_2W_1	3.42 (11.33)	4.40 (19.33)	3.91 (15.33)	6.15 (37.33)	6.31 (39.33)	6.23 (38.33)	6.96 (48.00	7.17 (51.00)	7.07 (49.50)	6.96 (48.00)	7.29 (52.67)	7.13 (50.33)
N_2W_2	3.39 (11.00)	4.55 (20.33)	3.97 (15.67)	2.55 (6.00)	3.34 (10.67)	2.94 (8.33)	2.27 (4.67	2.80 (7.33)	2.53 (6.00)	1.95 (3.33)	2.54 (6.00)	2.25 (4.67)
N_2W_3	3.53 (12.00)	4.17 (17.33)	3.85 (14.67)	3.23 (10.33)	4.60 (21.00)	3.92 (15.67)	4.66 (22.67	3.06 (9.33)	3.86 (16.00)	4.90 (24.00)	3.19 (10.67)	4.04 (17.33)
N_2W_4	1.86 (3.00)	2.16 (4.33)	2.01 (3.67)	2.26 (4.67)	2.73 (7.00)	2.50 (5.83)	2.48 (5.67	2.86 (7.67)	2.67 (6.67)	3.38 (5.00)	2.85 (7.67)	3.11 (9.33)
N_2W_5	3.44 (11.33)	4.56 (20.33)	4.00 (15.83)	6.08 (36.67)	6.23 (38.67)	6.16 (37.67)	6.55 (42.67	6.69 (44.33)	6.62 (43.50)	1.95 (3.33)	2.74 (7.00)	2.35 (5.17)
N_3W_1	3.06 (9.00)	3.74 (14.33)	3.40 (11.67)	5.81 (33.33)	6.00 (35.67)	5.90 (34.50)	6.39 (40.33	6.64 (43.67)	6.51 (42.00)	6.46 (41.33)	6.84 (46.33)	6.65 (43.83)
N_3W_2	3.12 (9.33)	4.08 (16.33)	3.60 (12.83)	2.20 (4.33)	3.02 (8.67)	2.61 (6.50)	2.20 (4.33	2.73 (7.00)	2.47 (5.67)	1.68 (2.33)	2.02 (3.67)	1.85 (3.00)
N_3W_3	2.91 (8.00)	3.87 (15.33)	3.39 (11.67)	2.76 (7.33)	3.74 (14.00)	3.25 (10.67)	4.51 (20.33	3.02 (8.67)	3.77 (14.50)	4.60 (21.33)	3.13 (9.67)	3.87 (15.50)
N_3W_4	1.29 (1.33)	1.86 (3.00)	1.57 (2.17)	1.94 (3.33)	2.41 (5.33)	2.18 (4.33)	2.35 (5.00	2.74 (7.00)	2.54 (6.00)	3.08 (9.00)	2.74 (7.00)	2.91 (8.00)
N_3W_5	2.91 (8.00)	4.01 (15.67)	3.46 (11.83)	5.15 (27.33)	5.69 (32.00)	5.42 (29.67)	6.38 (40.33	6.49 (42.00)	6.44 (38.33)	1.48 (2.00)	2.54 (6.00)	2.01 (4.00)
SEm± (N×W)	**0.19**	**0.37**	**0.16**	**0.35**	**0.36**	**0.27**	**0.32**	**0.27**	**0.21**	**0.31**	**0.26**	**0.19**
SEm± (W×N)	**0.21**	**0.34**	**0.19**	**0.23**	**0.23**	**0.17**	**0.27**	**0.21**	**0.18**	**0.22**	**0.18**	**0.13**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

4.5.2.10.1 Effect of nutrient management on weed density (no. m^{-2}) of *Borreria latifolia* (Aubl.) K. Schum.

An inquisition on two years' data and average data of two years on weed density of *Borreria latifolia* revealed no significant variation among the nutrient treatments at all stages of observations except at 30 and 60 DAS.

At 30 and 60 DAS, the average data of two years revealed that significantly lowest weed density (17.13 and 14.87, respectively) of *Borreria latifolia* was found in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). And the highest weed density was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment and was at par with N_1 (100% RDF).

4.5.2.10.2 Effect of weed management on weed density (no. m^{-2}) of *Borreria latifolia* (Aubl.) K. Schum.

Significant results were observed on weed density of *Borreria latifolia* at all stages of observations in both the years of experiment and average data of two years.

At 15 DAS, the average data of two years recorded significantly lowest weed density of *Borreria latifolia* in W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatment over all the other weed treatments. This result showed that Pendimethalin helped in controlling this weed.

At 30 DAS, W_4 recorded the lowest density and was at par with W_2 treatment. The application of Propaquizafop at 15 DAS did not seem to control this weed as shown in the Table 4.41. At 45 DAS, the lowest density of *Borreria latifolia* was recorded in W_2 which was at par with W_4. At 60 DAS, W_2 continued to record the lowest weed density followed by W_5. The hand weeding alone at 45 DAS in W_5 treatment might have reduced the density of this weed. At 60 DAS, the manual weeding done in W_3 could not prove better than W_4 and W_5.

4.5.2.10.3 Interaction effect on weed density (no. m^{-2}) of *Borreria latifolia* (Aubl.) K. Schum.

The study found no significant effect on weed density of *Borreria latifolia* due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observations.

4.5.2.11 Weed density (no. m^{-2}) of *Cleome rutidosperma* DC.

The data on weed density (no. m^{-2}) of *Cleome rutidosperma* at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.43 and 4.44.

4.5.2.11.1 Effect of nutrient management on weed density (no. m^{-2}) of *Cleome rutidosperma* DC.

The two years' data and average data of two years on weed of *Cleome rutidosperma* revealed no significant variation among the nutrient treatments at all stages of observations except at 30 and 45 DAS.

At 30 DAS, the average data of two years recorded the highest weed density (2.97) of *Cleome rutidosperma* in N_2 (75% RDF + 25% organic through FYM + PSB) treatment. The lowest density was recorded in N_1 (100% RDF) which was at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB).

At 60 DAS, the average data of two years revealed that significantly lowest weed density (2.63) was found in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). And the highest weed density was recorded in N_2 and was at par with N_1.

Table 4.43: Effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Cleome rutidosperma* DC. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average	2017	2018	Average	2017	2018	Average
Nutrient management (N)												
N_1	1.41 (1.60)	1.33 (1.40)	1.32 (1.50)	1.63 (2.40)	1.55 (2.20)	1.59 (2.30)	1.62 (3.20)	1.57 (2.73)	1.60 (2.97)	1.37 (2.13)	1.35 (1.80)	1.31 (1.97)
N_2	1.62 (2.27)	1.22 (1.13)	1.37 (1.70)	1.81 (3.13)	1.71 (2.80)	1.76 (2.97)	1.74 (3.93)	1.60 (2.87)	1.67 (3.40)	1.48 (2.80)	1.54 (2.13)	1.42 (2.47)
N_3	1.40 (1.60)	1.27 (1.27)	1.30 (1.43)	1.66 (2.60)	1.56 (2.13)	1.61 (2.37)	1.61 (3.13)	1.42 (2.13)	1.51 (2.63)	1.37 (2.20)	1.42 (1.87)	1.33 (2.03)
SEm±	**0.09**	**0.12**	**0.10**	**0.04**	**0.05**	**0.03**	**0.05**	**0.08**	**0.04**	**0.03**	**0.07**	**0.07**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**0.13**	**NS**	**NS**	**0.14**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	1.80 (2.78)	1.66 (2.33)	1.73 (2.56)	2.36 (5.11)	2.24 (4.56)	2.30 (4.83)	3.05 (8.89)	2.45 (5.56)	2.75 (7.22)	3.05 (8.89)	2.78 (7.22)	2.92 (8.06)
W_2	1.52 (1.89)	1.27 (1.22)	1.39 (1.56)	1.34 (1.33)	1.25 (1.11)	1.29 (1.22)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_3	1.74 (2.56)	1.42 (1.56)	1.58 (2.06)	1.05 (0.67)	1.37 (1.56)	1.21 (1.11)	1.00 (0.67)	1.22 (1.22)	1.11 (0.94)	1.86 (3.00)	1.61 (2.44)	1.74 (2.72)
W_4	0.99 (0.56)	0.88 (0.33)	0.71 (0.44)	1.55 (2.00)	1.17 (1.00)	1.36 (1.50)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_5	1.34 (1.33)	1.13 (0.89)	1.24 (1.11)	2.20 (4.44)	2.01 (3.67)	2.10 (4.06)	2.83 (7.56)	2.57 (6.11)	2.70 (6.83)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm±	**0.06**	**0.08**	**0.04**	**0.10**	**0.12**	**0.08**	**0.08**	**0.09**	**0.05**	**0.04**	**0.10**	**0.06**
CD (*p*=0.05)	**0.18**	**0.24**	**0.13**	**0.30**	**0.36**	**0.22**	**0.24**	**0.25**	**0.14**	**0.13**	**0.28**	**0.17**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.44: Interaction effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Cleome rutidosperma* DC. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
N_1W_1	1.76 (2.67)	1.77 (2.67)	1.77 (2.67)	2.26 (4.67)	2.27 (4.67)	2.27 (4.67)	2.85 (7.67)	2.61 (6.33)	2.73 (7.00)	2.85 (7.67)	2.86 (7.67)	2.85 (7.67)
N_1W_2	1.34 (1.33)	1.05 (0.67)	1.20 (1.00)	1.34 (1.33)	1.34 (1.33)	1.34 (1.33)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_3	1.68 (2.33)	1.46 (1.67)	1.57 (2.00)	1.05 (0.67)	1.39 (1.67)	1.22 (1.17)	1.00 (0.67)	1.29 (1.33)	1.14 (1.00)	1.87 (3.00)	1.29 (1.33)	1.58 (2.17)
N_1W_4	1.05 (0.67)	0.88 (0.33)	0.97 (0.50)	1.56 (2.00)	1.00 (0.67)	1.28 (1.33)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_5	1.22 (1.00)	1.46 (1.67)	1.34 (1.33)	1.94 (3.33)	1.77 (2.67)	1.86 (3.00)	2.86 (7.67)	2.55 (6.00)	2.70 (6.83)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_1	1.86 (3.00)	1.56 (2.00)	1.71 (2.50)	2.55 (6.00)	2.41 (5.33)	2.48 (5.67)	3.34 (10.67)	2.54 (6.00)	2.94 (8.33)	3.34 (10.67)	2.80 (7.33)	3.07 (9.00)
N_2W_2	1.87 (3.00)	1.46 (1.67)	1.67 (2.33)	1.46 (1.67)	1.34 (1.33)	1.40 (1.50)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_3	1.87 (3.00)	1.34 (2.00)	1.61 (2.17)	1.05 (0.67)	1.44 (1.67)	1.25 (1.17)	1.00 (0.67)	1.39 (1.67)	1.19 (1.17)	1.94 (3.33)	1.90 (3.33)	1.92 (3.33)
N_2W_4	1.05 (0.67)	0.88 (0.33)	0.97 (0.50)	1.64 (2.33)	1.05 (0.67)	1.35 (5.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_5	1.46 (1.67)	0.88 (0.33)	1.17 (1.00)	2.33 (5.00)	2.30 (5.00)	2.31 (5.00)	2.97 (8.33)	2.68 (6.67)	2.82 (7.50)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_1	1.77 (1.67)	1.66 (2.33)	1.71 (2.50)	2.27 (4.67)	2.04 (3.67)	2.15 (4.17)	2.97 (8.33)	2.20 (4.33)	2.58 (6.33)	2.97 (8.33)	2.68 (6.67)	2.82 (7.50)
N_3W_2	1.34 (2.67)	1.29 (1.33)	1.32 (1.33)	1.22 (1.00)	1.05 (3.67)	1.14 (0.83)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_3	1.68 (1.33)	1.46 (1.67)	1.57 (2.00)	1.22 (0.67)	1.29 (0.67)	1.17 (1.00)	1.00 (0.67)	1.00 (0.67)	1.00 (0.67)	1.76 (2.67)	1.65 (2.67)	1.71 (2.67)
N_3W_4	1.05 (0.33)	0.88 (0.33)	0.88 (0.33)	1.05 (1.67)	1.46 (1.33)	1.45 (1.67)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_5	1.34 (1.33)	1.05 (0.67)	1.20 (1.00)	1.44 (5.00)	1.95 (1.67)	2.14 (4.17)	2.68 (6.67)	2.48 (5.67)	2.58 (6.67)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm± (N×W)	**0.10**	**0.14**	**0.08**	**0.18**	**0.21**	**0.13**	**0.15**	**0.15**	**0.08**	**0.08**	**0.17**	**0.10**
SEm± (W×N)	**0.11**	**0.15**	**0.11**	**0.12**	**0.15**	**0.09**	**0.10**	**0.12**	**0.06**	**0.06**	**0.13**	**0.08**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**0.22**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**0.40**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x+0.5}$ transformation.

4.5.2.11.2 Effect of weed management on weed density (no. m^{-2}) of *Cleome rutidosperma* DC.

Significant results were observed on weed density of *Cleome rutidosperma* at all stages of observations in both the years of experiment and average data of two years.

At 15 DAS, the average data of two years recorded significantly lowest weed density of *Cleome rutidosperma* in W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatment which showed that Pendimethalin was able to reduce population of *Cleome rutidosperma*.

At 30 DAS, W_2 recorded the lowest density (1.29) which might be due to hand weeding carried out at 15 DAS. This was then followed W_4 where pendimethalin as pre-emergence application has exerted its effect. The increase in the weed density from 15 DAS to 30 DAS in W_5 treatment might be because of Propaquizafop at 15 DAS had no effect on the control of weeds.

At 45 DAS, it can be seen from Table 4.43 that hand weeding carried out at 30 DAS on W_2 and W_4 has resulted in no more appearance of *Cleome rutidosperma.*

At 60 DAS, all the weed control treatments were found capable to reduce weed density of *Cleome rutidosperma* as compared to weedy check. W_2 (Hand weeding at 15, 30 and 45 DAS), W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) and W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) treatments completely check the growth of *Cleome rutidosperma.*

4.5.2.11.3 Interaction effect on weed density (no. m^{-2}) of *Cleome rutidosperma* DC.

The study found no significant effect on weed density of *Cleome rutidosperma* due to the interaction of nutrient and weed management

Table 4.45: Effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Mimosa pudica* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	2.12 (4.07)	2.29 (5.33)	2.21 (4.70)	2.11 (4.53)	2.52 (6.47)	2.32 (5.50)	2.04 (4.67)	2.38 (6.80)	2.21 (5.73)	1.71 (3.40)	2.00 (5.13)	1.85 (4.27)
N_2	2.20 (4.47)	2.50 (6.13)	2.35 (5.30)	2.16 (4.73)	2.67 (7.20)	2.42 (5.97)	2.10 (4.87)	2.46 (7.27)	2.28 (6.07)	1.73 (3.47)	2.04 (5.67)	1.89 (4.57)
N_3	2.00 (3.60)	2.17 (4.73)	2.08 (4.17)	1.94 (3.87)	2.36 (5.60)	2.15 (4.73)	1.80 (3.40)	2.24 (5.93)	2.02 (4.67)	1.51 (2.47)	1.88 (4.47)	1.69 (3.47)
SEm±	**0.13**	**0.22**	**0.12**	**0.11**	**0.11**	**0.10**	**0.05**	**0.11**	**0.06**	**0.06**	**0.08**	**0.05**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.19**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	2.28 (4.78)	2.63 (6.89)	2.46 (5.83)	2.82 (7.44)	3.43 (11.33)	3.12 (9.39)	3.16 (9.56)	3.91 (14.89)	3.53 (12.22)	3.18 (9.67)	3.91 (14.89)	3.54 (12.28)
W_2	2.09 (3.89)	2.57 (6.33)	2.33 (5.11)	0.86 (0.33)	1.91 (3.22)	1.39 (1.78)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_3	2.25 (4.67)	2.70 (7.00)	2.47 (5.83)	2.09 (4.00)	2.53 (6.22)	2.31 (5.11)	1.58 (2.11)	2.73 (7.22)	2.15 (4.67)	1.76 (2.78)	2.90 (8.33)	2.33 (5.56)
W_4	1.71 (2.56)	1.34 (1.44)	1.53 (2.00)	1.83 (3.00)	1.60 (2.11)	1.71 (2.56)	1.61 (2.11)	1.19 (1.00)	1.40 (1.56)	1.89 (3.11)	1.65 (2.22)	1.77 (2.67)
W_5	2.19 (4.33)	2.36 (5.33)	2.28 (4.83)	2.75 (7.11)	3.11 (9.22)	2.93 (8.17)	2.87 (7.78)	3.27 (10.22)	3.07 (9.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm±	**0.08**	**0.17**	**0.10**	**0.11**	**0.12**	**0.08**	**0.07**	**0.12**	**0.07**	**0.08**	**0.13**	**0.08**
CD (*p*=0.05)	**0.23**	**0.49**	**0.29**	**0.32**	**0.34**	**0.24**	**0.21**	**0.35**	**0.20**	**0.24**	**0.38**	**0.22**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.46: Interaction effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Mimosa pudica* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
N_1W_1	2.24 (4.67)	2.58 (6.67)	2.41 (5.67)	2.86 (7.67)	3.44 (11.33)	3.15 (9.50)	3.34 (10.67)	3.93 (15.00)	3.64 (12.83)	3.34 (10.67)	3.93 (15.00)	3.64 (12.83)
N_1W_2	2.04 (3.67)	2.51 (6.00)	2.27 (4.83)	0.88 (0.33)	1.86 (3.00)	1.37 (1.67)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_3	2.27 (4.67)	2.62 (6.67)	2.44 (5.67)	2.12 (4.00)	2.50 (6.00)	2.31 (5.00)	1.68 (2.33)	2.71 (7.00)	2.19 (4.67)	1.93 (3.33)	2.96 (8.33)	2.44 (5.83)
N_1W_4	1.86 (3.00)	1.17 (1.00)	1.51 (2.00)	1.90 (3.33)	1.56 (2.00)	1.73 (2.67)	1.46 (1.67)	1.17 (1.00)	1.32 (1.33)	1.86 (3.00)	1.68 (2.33)	1.77 (2.67)
N_1W_5	2.20 (4.33)	2.59 (6.33)	2.39 (5.33)	2.80 (7.33)	3.24 (10.00)	3.02 (8.67)	3.03 (8.67)	3.39 (11.00)	3.21 (9.83)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_1	2.34 (5.00)	2.73 (7.67)	2.54 (6.33)	2.92 (8.00)	3.63 (12.67)	3.27 (10.33)	3.34 (10.67)	4.14 (16.67)	3.74 (13.67)	3.34 (10.67)	4.14 (16.67)	3.74 (13.67)
N_2W_2	2.18 (4.33)	2.85 (7.67)	2.51 (6.00)	1.00 (0.67)	2.11 (4.00)	1.56 (2.33)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_3	2.48 (5.67)	2.77 (7.33)	2.63 (6.50)	2.22 (4.67)	2.67 (7.00)	2.44 (5.83)	1.76 (2.67)	2.90 (8.00)	2.33 (5.33)	1.86 (3.00)	2.97 (9.33)	2.42 (6.17)
N_2W_4	1.64 (2.33)	1.68 (2.33)	1.66 (2.33)	1.94 (3.33)	1.77 (2.67)	1.86 (3.00)	1.68 (2.33)	1.22 (1.00)	1.45 (1.67)	2.04 (3.67)	1.68 (2.33)	1.86 (3.00)
N_2W_5	2.34 (5.00)	2.47 (5.67)	2.40 (5.33)	2.72 (7.00)	3.17 (9.67)	2.95 (8.33)	3.02 (8.67)	3.33 (10.67)	3.18 (9.67)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_1	2.27 (4.67)	2.59 (6.33)	2.43 (5.50)	2.68 (6.67)	3.24 (10.00)	2.96 (8.33)	2.79 (7.33)	3.66 (13.00)	3.23 (10.17)	2.86 (7.67)	3.66 (13.00)	3.26 (10.33)
N_3W_2	2.04 (3.67)	2.35 (5.33)	2.19 (4.50)	0.71 (0.00)	1.77 (2.67)	1.24 (1.33)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_3	2.00 (3.67)	2.70 (7.00)	2.35 (5.33)	1.94 (3.33)	2.41 (5.67)	2.18 (4.50)	1.29 (1.33)	2.58 (6.67)	1.93 (4.00)	1.48 (2.00)	2.76 (7.33)	2.12 (4.67)
N_3W_4	1.64 (2.33)	1.17 (1.00)	1.41 (1.67)	1.64 (2.33)	1.46 (1.67)	1.55 (2.00)	1.68 (2.33)	1.17 (1.00)	1.42 (1.67)	1.77 (2.67)	1.58 (2.00)	1.68 (2.33)
N_3W_5	2.04 (3.67)	2.03 (4.00)	2.03 (3.83)	2.72 (7.00)	2.91 (8.00)	2.82 (7.50)	2.55 (6.00)	3.07 (9.00)	2.81 (7.50)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm± (N×W)	**0.14**	**0.29**	**0.17**	**0.19**	**0.20**	**0.14**	**0.12**	**0.21**	**0.12**	**0.15**	**0.23**	**0.13**
SEm± (W×N)	**0.16**	**0.29**	**0.16**	**0.16**	**0.17**	**0.14**	**0.09**	**0.17**	**0.10**	**0.11**	**0.17**	**0.10**
CD (*p*=0.05) (W a same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.30**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N a same or differen level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.29**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

treatments in both years of experiment and average data of two years in all the stages of observation except at 15 DAS. At 15 DAS, the average data of two years results recorded highest weed density (2.67) of *Cleome rutidosperma* in $N_1 \times W_1$ interactions.

4.5.2.12 Weed density (no. m^{-2}) of *Mimosa pudica* L.

The data on weed density (no. m^{-2}) of *Mimosa pudica* L. at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.45 and 4.46

4.5.2.12.1 Effect of nutrient management on weed density (no. m^{-2}) of *Mimosa pudica* L.

The two years' data and average data of two years on weed of *Mimosa pudica* revealed no significant variation among the nutrient treatments at all stages of observations except at 45 DAS.

At 45 DAS, the first year data recorded significantly lowest weed density (3.40) of *Mimosa pudica* in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). And the highest weed density was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) which was at par with N_1 (100% RDF) treatment.

4.5.2.12.2 Effect of weed management on weed density (no. m^{-2}) of *Mimosa pudica* L.

Significant results were observed on weed density of *Mimosa pudica* at all stages of observations in both the years of experiment and average data of two years.

At 15 DAS, it can be seen from Table 4.45 that application of Pendimethalin as pre-emergence in W_4 treatment could result in reduction of this weed which recorded the lowest value.

At 30 DAS, the average data of two years showed significantly lowest weed density of *Mimosa pudica* in W_2 treatment (Hand weeding at 15, 30 and 45 DAS) followed by W_4. Application of Propaquizafop at 15 DAS did not cause reduction in density of this weed as there was increase in density from 15 to 30 DAS.

At 45 DAS, W_2 recorded control of *Mimosa pudica* (Table 4.45). In W_4, there was emergence of this weed after hand weeding at 30 DAS which could be seen from the table. W_3 proved to be better than W_5 as it recorded lesser weed density at this date of observation.

At 60 DAS, W_2 and W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) treatments showed control of this weed followed by W_4 treatment. The highest weed density was recorded in W_1 (Weedy check) at all stages of observations.

4.5.2.12.3 Interaction effect on weed density (no. m^{-2}) of *Mimosa pudica* L.

The study found no significant effect on weed density of *Mimosa pudica* L. due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observations except at 30 DAS.

At 30 DAS, the average data of two years results revealed significantly highest weed density of *Mimosa pudica* was recorded in $N_1 \times W_1$ and $N_2 \times W_1$ interactions.

4.5.2.13 Weed density (no. m^{-2}) of *Mollugo pentaphylla* L.

The data on weed density (no. m^{-2}) of *Mollugo pentaphylla* L. at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.47 and 4.48.

Table 4.47: Effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Mollugo pentaphylla* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Av.**	**2017**	**2018**	**Av.**	**2017**	**2018**	**Av.**	**2017**	**2018**	**Av.**
Nutrient management (N)												
N_1	2.13 (4.47)	3.24 (10.44)	2.69 (7.43)	2.32 (6.13)	3.18 (10.67)	2.75 (8.40)	2.01 (5.47)	2.52 (8.67)	2.27 (7.07)	1.55 (3.47)	1.86 (5.40)	1.71 (4.43)
N_2	2.24 (5.00)	3.70 (13.60)	2.97 (9.30)	2.46 (6.67)	3.39 (12.80)	2.97 (9.73)	2.08 (6.00)	2.63 (9.60)	2.35 (7.80)	1.57 (3.73)	1.95 (6.07)	1.76 (4.90)
N_3	1.94 (3.53)	3.24 (10.47)	2.59 (7.00)	2.20 (5.07)	2.97 (9.27)	2.58 (7.17)	1.94 (4.87)	2.38 (7.73)	2.16 (6.30)	1.47 (2.87)	1.81 (5.00)	1.64 (3.93)
SEm±	**0.15**	**0.14**	**0.12**	**0.05**	**0.09**	**0.04**	**0.08**	**0.07**	**0.06**	**0.05**	**0.05**	**0.03**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**0.19**	**0.34**	**0.14**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	2.46 (5.67)	3.59 (12.67)	3.02 (9.17)	3.48 (11.78)	4.12 (16.56)	3.80 (14.17)	3.74 (13.56)	4.60 (20.67)	4.17 (17.11)	3.81 (14.11)	4.61 (20.78)	4.21 (17.44)
W_2	2.28 (4.89)	3.66 (13.11)	2.97 (9.00)	1.25 (1.11)	1.63 (2.22)	1.44 (1.67)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_3	2.39 (5.44)	3.74 (13.67)	3.07 (9.56)	2.18 (4.33)	3.70 (13.33)	2.94 (8.83)	1.35 (1.56)	2.29 (5.00)	1.82 (3.28)	1.72 (2.67)	2.65 (6.67)	2.19 (4.67)
W_4	1.13 (0.89)	2.33 (5.11)	1.73 (3.00)	1.32 (1.44)	2.53 (6.11)	1.93 (3.78)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_5	2.26 (4.78)	3.64 (12.89)	2.95 (8.83)	3.40 (11.11)	4.08 (16.33)	3.74 (13.72)	3.55 (12.11)	4.26 (17.67)	3.90 (14.89)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm±	**0.13**	**0.10**	**0.07**	**0.12**	**0.11**	**0.09**	**0.09**	**0.10**	**0.08**	**0.08**	**0.07**	**0.06**
CD (*p*=0.05)	**0.39**	**0.29**	**0.22**	**0.35**	**0.32**	**0.26**	**0.25**	**0.28**	**0.22**	**0.25**	**0.21**	**0.17**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.48: Interaction effect of nutrient and weed management treatments on weed density (no. m^{-2}) of *Mollugo pentaphylla* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average	2017	2018	Average	2017	2018	Average
N_1W_1	2.53 (6.00)	3.51 (12.33)	3.02 (9.17)	3.61 (12.67)	4.06 (16.00)	3.84 (14.33)	3.80 (14.00)	4.56 (20.33)	4.18 (17.17)	3.89 (14.67)	4.56 (20.33)	4.23 (17.50)
N_1W_2	2.28 (5.00)	3.57 (12.33)	2.93 (8.67)	1.05 (0.67)	1.66 (2.33)	1.35 (1.50)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_3	2.38 (5.33)	3.48 (11.67)	2.93 (8.50)	2.18 (4.33)	3.84 (14.33)	3.01 (9.33)	1.29 (1.33)	2.39 (5.33)	1.84 (3.33)	1.76 (2.67)	2.64 (6.67)	2.20 (4.67)
N_1W_4	1.17 (1.00)	2.27 (4.67)	1.72 (2.83)	1.29 (1.33)	2.39 (5.33)	1.84 (3.33)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_5	2.28 (5.00)	3.38 (11.00)	2.83 (8.00)	3.49 (11.67)	3.97 (15.33)	3.73 (13.50)	3.53 (12.00)	4.26 (17.67)	3.90 (14.83)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_1	2.59 (6.33)	3.80 (14.00)	3.20 (10.17)	3.80 (14.00)	4.38 (18.67)	4.09 (16.33)	3.98 (15.33)	4.85 (23.00)	4.41 (19.17)	4.06 (16.00)	4.85 (23.00)	4.45 (19.50)
N_2W_2	2.43 (5.67)	3.97 (15.67)	3.20 (10.67)	1.34 (1.33)	1.68 (2.33)	1.51 (1.83)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_3	2.64 (6.67)	4.06 (16.00)	3.35 (11.33)	2.26 (4.67)	3.94 (15.00)	3.10 (9.83)	1.29 (1.33)	2.46 (6.00)	1.87 (3.67)	1.65 (2.67)	2.79 (7.33)	2.22 (5.00)
N_2W_4	1.17 (1.00)	2.65 (6.67)	1.91 (3.83)	1.39 (1.67)	3.02 (8.67)	2.21 (5.17)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_5	2.38 (5.33)	4.02 (15.67)	3.20 (10.50)	3.48 (11.67)	4.42 (19.33)	3.95 (15.50)	3.72 (13.33)	4.41 (19.00)	4.07 (16.17)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_1	2.26 (4.67)	3.46 (11.67)	2.86 (8.17)	3.02 (8.67)	3.94 (15.00)	3.48 (11.83)	3.44 (11.33)	4.38 (18.67)	3.91 (15.00)	3.49 (11.67)	4.41 (19.00)	3.95 (15.33)
N_3W_2	2.12 (4.00)	3.44 (11.33)	2.78 (7.67)	1.34 (1.33)	1.56 (2.00)	1.45 (1.67)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_3	2.16 (4.33)	3.69 (13.33)	2.93 (8.83)	2.08 (4.00)	3.32 (10.67)	2.70 (7.33)	1.47 (2.00)	2.02 (3.67)	1.74 (2.83)	1.76 (2.67)	2.53 (6.00)	2.14 (4.33)
N_3W_4	1.05 (0.67)	2.08 (4.00)	1.57 (2.33)	1.29 (1.33)	2.18 (4.33)	1.74 (2.83)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_5	2.12 (4.00)	3.53 (12.00)	2.83 (8.00)	3.24 (10.00)	3.84 (14.33)	3.54 (12.17)	3.39 (11.00)	4.10 (16.33)	3.75 (13.67)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm± (N×W)	**0.23**	**0.17**	**0.13**	**0.21**	**0.19**	**0.15**	**0.15**	**0.17**	**0.13**	**0.15**	**0.12**	**0.10**
SEm± (W×N)	**0.21**	**0.18**	**0.15**	**0.14**	**0.15**	**0.10**	**0.12**	**0.13**	**0.10**	**0.10**	**0.09**	**0.07**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x+0.5}$ transformation.

4.5.2.13.1 Effect of nutrient management on weed density (no. m^{-2}) of *Mollugo pentaphylla* L.

The two years' data and average data of two years on weed of *Mollugo pentaphylla* revealed no significant variation among the nutrient treatments at all stages of observations except at 30 DAS.

At 30 DAS, the average data of two years recorded significantly lowest weed density (7.17) of *Mollugo pentaphylla* in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). And the highest weed density was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment.

4.5.2.13.2 Effect of weed management on weed density (no. m^{-2}) of *Mollugo pentaphylla* L.

Significant results were observed on weed density of *Mollugo pentaphylla* at all stages of observations in both the years of experiment and average data of two years.

At 15 DAS, the average data of two years results recorded significantly lowest weed density of *Mollugo pentaphylla* in W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatment.

At 30 DAS, W_2 recorded the lowest weed density followed by W_4. However, post emergence application of Propaquizafop did not result in weed reduction. Panda *et al*. (2015) also reported similar result where post-emergence application of Propaquizafop (75 g ha^{-1}) failed to control *Mollugo pentaphylla.*

At 45 DAS, the average data of two years showed lowest weed density of *Mollugo pentaphylla* in W_2 and W_4 treatment.

At 60 DAS, the average data of two years revealed that W_2, W_4 and W_5 treatments effectively controlled density of *Mollugo pentaphylla*. This might be

Table 4.49: Effect of nutrient and weed management treatments on weed density (no. m^{-2}) of grasses at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	7.65 (58.27)	6.02 (36.20)	6.84 (47.23)	8.19 (71.93)	7.18 (56.60)	7.68 (64.27)	6.71 (54.53)	6.01 (45.27)	6.36 (50.00)	6.03 (47.60)	5.30 (39.60)	5.66 (43.60)
N_2	7.84 (61.33)	6.27 (39.20)	7.05 (50.27)	8.44 (76.53)	7.21 (56.80)	7.83 (66.67)	6.69 (55.53)	6.03 (45.93)	6.36 (50.73)	6.20 (50.27)	5.50 (43.20)	5.85 (46.73)
N_3	7.02 (49.13)	5.79 (33.20)	6.41 (41.17)	7.94 (67.93)	6.66 (49.00)	7.30 (58.47)	6.35 (49.60)	5.61 (39.87)	5.98 (44.73)	5.84 (44.73)	5.05 (37.73)	5.45 (41.23)
SEm±	**0.22**	**0.21**	**0.12**	**0.26**	**0.24**	**0.16**	**0.17**	**0.15**	**0.07**	**0.09**	**0.12**	**0.03**
CD (*p*=0.05)	**NS**	**NS**	**0.48**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.28**	**NS**	**NS**	**0.12**
Weed management (W)												
W_1	7.65 (59.00)	6.39 (40.78)	7.02 (49.89)	10.87 (117.89)	9.74 (94.78)	10.31 (106.33)	12.00 (143.56)	11.53 (132.56)	11.76 (138.06)	12.15 (147.22)	11.79 (138.56)	11.95 (142.89)
W_2	7.22 (52.00)	5.97 (35.44)	6.60 (43.72)	4.74 (22.00)	4.04 (15.89)	4.39 (18.94)	3.40 (11.11)	2.83 (7.56)	3.12 (9.33)	2.54 (6.11)	2.00 (3.56)	2.27 (4.83)
W_3	7.70 (59.00)	6.21 (38.56)	6.95 (48.78)	7.58 (57.44)	6.10 (37.67)	6.84 (47.56)	6.58 (43.33)	5.31 (28.44)	5.95 (35.89)	6.96 (48.44)	5.91 (34.67)	6.44 (41.56)
W_4	7.63 (58.0)	5.69 (32.11)	6.66 (45.06)	10.57 (111.56)	9.43 (88.89)	10.00 (100.22)	3.35 (10.78)	3.71 (13.33)	3.53 (12.06)	4.86 (23.33)	4.40 (18.89)	4.63 (21.22)
W_5	7.32 (53.22)	5.87 (34.11)	6.59 (43.67)	7.18 (51.78)	5.79 (33.44)	6.48 (42.61)	7.58 (56.67)	6.04 (36.56)	6.81 (47.11)	3.60 (12.56)	2.32 (5.22)	2.96 (8.89)
SEm±	**0.18**	**0.19**	**0.13**	**0.18**	**0.26**	**0.15**	**0.21**	**0.21**	**0.16**	**0.17**	**0.13**	**0.10**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**0.54**	**0.74**	**0.44**	**0.60**	**0.60**	**0.47**	**0.50**	**0.39**	**0.30**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.50: Interaction effect of nutrient and weed management treatments on weed density (no. m^{-2}) of grasses at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Pooled**	**2017**	**2018**	**Pooled**	**2017**	**2018**	**Pooled**	**2017**	**2018**	**Pooled**
N_1W_1	7.76 (60.00)	6.46 (41.67)	7.11 (50.83)	10.82 (116.67)	10.00 (100.00)	10.41 (108.33)	12.09 (145.67)	11.62 (134.67)	11.86 (140.17)	12.23 (149.00)	11.65 (135.33)	11.94 (142.17)
N_1W_2	7.54 (56.33)	6.03 (36.00)	6.78 (46.17)	4.78 (22.33)	3.98 (15.33)	4.38 (18.83)	3.58 (12.33)	2.85 (7.67)	3.22 (10.00)	2.61 (6.33)	2.04 (3.67)	2.32 (5.00)
N_1W_3	7.75 (59.67)	6.33 (40.33)	7.04 (50.00)	7.44 (55.33)	6.32 (39.67)	6.88 (47.50)	6.61 (43.33)	5.50 (31.00)	6.06 (37.17)	6.83 (46.67)	5.91 (34.67)	6.37 (40.67)
N_1W_4	7.89 (62.00)	5.67 (32.00)	6.78 (47.00)	10.56 (111.33)	9.59 (92.00)	10.08 (101.67)	3.48 (11.67)	3.80 (14.00)	3.64 (12.83)	4.89 (23.67)	4.34 (18.33)	4.61 (21.00)
N_1W_5	7.33 (53.33)	5.61 (31.00)	6.47 (42.17)	7.34 (54.00)	6.01 (36.00)	6.68 (45.00)	7.78 (60.67)	6.26 (39.00)	7.02 (49.83)	3.58 (12.33)	2.54 (6.00)	3.06 (9.17)
N_2W_1	8.24 (68.67)	6.52 (42.67)	7.38 (55.67)	11.32 (127.67)	9.88 (97.33)	10.60 (112.50)	12.32 (151.33)	11.89 (141.00)	12.11 (146.17)	12.41 (153.67)	12.20 (148.33)	12.30 (151.00)
N_2W_2	7.49 (55.67)	6.00 (36.00)	6.75 (45.83)	4.98 (24.33)	4.41 (19.00)	4.70 (21.67)	3.34 (10.67)	2.85 (7.67)	3.09 (9.17)	2.60 (6.67)	2.02 (3.67)	2.31 (5.17)
N_2W_3	8.09 (65.00)	6.67 (44.00)	7.38 (54.50)	7.84 (61.33)	6.36 (41.00)	7.10 (51.17)	6.83 (46.67)	5.61 (31.33)	6.22 (39.00)	7.32 (53.33)	6.14 (37.33)	6.73 (45.33)
N_2W_4	7.64 (58.00)	5.84 (33.67)	6.74 (45.83)	10.81 (116.67)	9.71 (94.00)	10.2 (105.33)	3.29 (10.33)	3.85 (14.33)	3.57 (12.33)	4.98 (24.33)	4.60 (20.67)	4.79 (22.50)
N_2W_5	7.73 (59.33)	6.33 (39.67)	7.03 (49.50)	7.26 (52.67)	5.70 (32.67)	6.48 (42.67)	7.65 (58.67)	5.93 (35.33)	6.79 (47.00)	3.71 (13.333)	2.54 (6.00)	3.13 (9.67)
N_3W_1	6.96 (48.33)	6.20 (38.00)	6.58 (43.17)	10.47 (109.33)	9.35 (87.00)	9.91 (98.17)	11.58 (133.67)	11.07(122.00)	11.32 (127.83)	11.81 (139.00)	11.51 (132.00)	11.66 (135.50)
N_3W_2	6.65 (44.00)	5.89 (34.33)	6.27 (39.17)	4.45 (19.33)	3.72 (13.33)	4.08 (16.33)	3.29 (10.33)	2.78 (7.33)	3.04 (8.83)	2.41 (5.33)	1.95 (3.33)	2.18 (4.33)
N_3W_3	7.25 (52.33)	5.64 (31.33)	6.45 (41.83)	7.47 (55.67)	5.61 (32.33)	6.54 (44.00)	6.29 (40.00)	4.82 (23.00)	5.55 (31.50)	6.74 (45.33)	5.68 (32.00)	6.21 (38.67)
N_3W_4	7.36 (54.00)	5.57 (30.67)	6.47 (42.33)	10.35 (106.67)	9.00 (80.67)	9.67 (93.67)	3.28 (10.33)	3.48 (11.67)	3.38 (11.00)	4.72 (22.00)	4.26 (17.67)	4.49 (19.83)
N_3W_5	6.89 (47.00)	5.66 (31.67)	6.27 (39.33)	6.94 (48.67)	5.65 (31.67)	6.29 (40.17)	7.29 (53.67)	5.92 (35.33)	6.61 (44.50)	3.52 (12.00)	1.87 (3.67)	2.70 (7.83)
SEm± (N×W)	**0.31**	**0.33**	**0.23**	**0.32**	**0.44**	**0.26**	**0.36**	**0.30**	**0.28**	**0.29**	**0.23**	**0.18**
SEm± (W×N)	**0.29**	**0.29**	**0.19**	**0.32**	**0.37**	**0.23**	**0.28**	**0.27**	**0.19**	**0.21**	**0.19**	**0.12**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

due to effect of hand weeding at various intervals. The highest weed density was recorded in W_1 (Weedy check) at all stages of observations.

4.5.2.13.3 Interaction effect on weed density (no. m^{-2}) of *Mollugo pentaphylla* L.

The study found no significant effect on weed density of *Mollugo pentaphylla* due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observations.

4.5.2.14 Weed density (no. m^{-2}) of grasses

The data on weed density (no. m^{-2}) of grasses at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.49 and 4.50.

4.5.2.14.1 Effect of nutrient management on weed density (no. m^{-2}) of grasses.

The two years' data and average data of two years on weed of grasses revealed no significant variation among the nutrient treatments at all stages of observations except at 15 and 60 DAS.

At 15 DAS, the average data of two years significantly recorded lowest weed density (41.17) of grasses in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). And the highest weed density of grasses (50.27) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment which was at par with N_1 (100% RDF).

At 60 DAS, the average data of two years significantly recorded lowest weed density (40.97, respectively) of grasses in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). N_2 (75% RDF + 25% organic through FYM + PSB) recorded the highest weed density of grasses (46.73).

The probability of constant availability of nutrients in N_2 treatment may be one of the reasons for higher weed occurrence. The immediate supply of nutrients through chemical fertilizers aided in immediate flush of weeds.

4.5.2.14.2 Effect of weed management on weed density (no. m^{-2}) of grasses.

Significant results were observed on weed density of grasses at all stages of observations in both the years of experiment and average data of two years except at 15 DAS.

At 30 DAS, W_2 recorded the lowest density of grasses which hand weeding at 15 DAS might have contributed to it. It can be observed that at this stage, reduction in weed density in W_5 treatment compared to 15 DAS suggested that application of Propaquizafop at 15 DAS might have some effect on the grass density at this stage. Sandil *et al.* (2015) reported that the application of Propaquizafop as post emergence reduced the weed density of monocot weeds over weedy check.

At 45 DAS also, W_2 continued to exhibit the lowest density followed by W_4 treatment where hand weeding at 30 DAS might have contributed to its reduction. It has been found that there has been increase in grasses density in W_5 treatment compared to 30 DAS. This might be due to reduction in its effect with increase in duration after its application. Ramprakash *et al*. (2016) reported that half-life of propaquizafop at the recommended dose (62.5 g ha^{-1}) was 17.67 days and residues reached below detectable limit (BDL) beyond 30 DAA.

At 60 DAS, it has been found that in those treatment where hand weeding at 45 DAS has been involved, there was reduction in grass density. The lowest density was found in W_2 followed by W_5.

4.5.2.14.3 Interaction effect on weed density (no. m^{-2}) of grasses.

The study found no significant effect on weed density of grasses due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observations.

4.5.2.15 Weed density (no. m^{-2}) of sedges.

The data on weed density (no. m^{-2}) of sedges at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.51 and 4.52.

4.5.2.15.1 Effect of nutrient management on weed density (no. m^{-2}) of sedges.

The two years' data and average data of two years on weed density of sedges revealed significant variation among the nutrient treatments at all stages of observations except at 60 DAS.

At 15, 30 and 45 DAS, the average data of two years recorded significantly lowest weed density (17.63, 30.67 and 27.73, respectively) of sedges in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). And the highest weed density of sedges was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment which was at par with N_1 (100% RDF).

4.5.2.15.2 Effect of weed management on weed density (no. m^{-2}) of sedges.

Significant results were observed on weed density of grasses at all stages of observations in both the years of experiment and average data of two years except at 15 DAS.

Observation of sedges at 30 DAS showed lowest density in W_2 treatment which is due to hand weeding operation at 15 DAS. This was then followed by W_3 treatment where mechanical weeding was done at 20 DAS. However, the

Table 4.51: Effect of nutrient and weed management treatments on weed density (no. m^{-2}) of sedges at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average	2017	2018	Average	2017	2018	Average
Nutrient management (N)												
N_1	4.85 (23.33)	4.36 (19.00)	4.60 (21.17)	5.90 (38.27)	5.37 (31.40)	5.63 (34.83)	4.79 (32.87)	4.73 (30.20)	4.76 (31.53)	3.61 (22.00)	3.56 (19.73)	3.59 (20.87)
N_2	5.23 (27.00)	4.69 (21.67)	4.96 (24.33)	6.20 (41.20)	5.53 (33.47)	5.86 (37.23)	4.99 (35.40)	4.83 (32.33)	4.91 (33.87)	3.85 (24.33)	3.62 (21.20)	3.73 (22.77)
N_3	4.35 (18.67)	4.10 (16.60)	4.23 (17.63)	5.50 (33.20)	5.07 (28.13)	5.28 (30.67)	4.42 (28.27)	4.47 (27.20)	4.45 (27.73)	3.45 (19.27)	3.27 (17.20)	3.36 (18.23)
SEm±	**0.17**	**0.12**	**0.13**	**0.08**	**0.16**	**0.09**	**0.13**	**0.08**	**0.09**	**0.09**	**0.17**	**0.08**
CD (*p*=0.05)	**NS**	**NS**	**0.53**	**0.31**	**NS**	**0.34**	**NS**	**NS**	**0.34**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	5.08 (25.22)	4.60 (20.89)	4.82 (23.06)	7.43 (55.00)	6.85 (46.56)	7.14 (50.78)	8.66 (74.67)	7.99 (63.56)	8.32 (69.11)	8.95 (79.89)	8.04 (64.33)	8.50 (72.11)
W_2	4.68 (21.56)	4.31 (18.33)	4.49 (19.94)	2.69 (6.89)	2.41 (5.33)	2.55 (6.11)	0.71 (0.00)	0.94 (0.44)	0.82 (0.22)	0.71 (0.00)	0.76 (0.11)	0.74 (0.06)
W_3	4.95 (24.33)	4.42 (19.56)	4.68 (21.94)	4.79 (22.78)	4.28 (18.22)	4.53 (20.50)	4.17 (17.22)	5.11 (26.00)	4.64 (21.61)	4.66 (21.67)	5.16 (26.78)	4.91 (24.22)
W_4	4.87 (23.33)	4.31 (18.78)	4.59 (21.06)	7.25 (52.22)	6.73 (45.00)	6.99 (48.61)	2.06 (4.11)	1.77 (2.78)	1.92 (3.44)	2.64 (6.67)	2.24 (4.56)	2.44 (5.61)
W_5	4.54 (20.56)	4.27 (17.89)	4.40 (19.22)	7.15 (50.89)	6.35 (39.89)	6.75 (45.39)	8.08 (64.89)	7.57 (56.78)	7.82 (60.83)	1.22 (1.11)	1.21 (1.11)	1.22 (1.11)
SEm±	**0.14**	**0.23**	**0.13**	**0.15**	**0.13**	**0.10**	**0.15**	**0.14**	**0.11**	**0.16**	**0.15**	**0.10**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**0.44**	**0.39**	**0.29**	**0.44**	**0.41**	**0.32**	**0.47**	**0.43**	**0.30**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.52: Interaction effect of nutrient and weed management treatments on weed density (no. m^{-2}) of sedges at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS				45 DAS		60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
N_1W_1	5.15 (26.33)	4.42 (19.33)	4.79 (22.83)	7.56 (56.67)	6.92 (47.33)	7.24 (52.00)	8.78 (76.67)	8.17 (66.33)	8.48 (71.50)	9.03 (81.00)	8.11 (65.33)	8.57 (73.17)
N_1W_2	4.77 (22.33)	4.45 (19.33)	4.61 (20.83)	2.47 (5.67)	2.48 (5.67)	2.48 (5.67)	0.71 (0.00)	1.05 (0.67)	0.88 (0.33)	0.71 (0.00)	0.88 (0.33)	0.79 (0.17)
N_1W_3	4.93 (24.00)	4.10 (17.33)	4.52 (20.67)	4.89 (23.67)	4.34 (18.67)	4.62 (21.17)	4.27 (18.00)	5.10 (25.67)	4.69 (21.83)	4.70 (22.00)	4.94 (26.67)	4.94 (24.33)
N_1W_4	4.97 (24.33)	4.40 (20.00)	4.69 (22.17)	7.40 (54.33)	6.74 (45.00)	7.07 (49.67)	2.04 (3.67)	1.86 (3.00)	1.95 (3.33)	2.58 (6.33)	2.34 (5.00)	2.46 (5.67)
N_1W_5	4.43 (19.67)	4.41 (19.00)	4.42 (19.33)	7.16 (51.00)	6.38 (40.33)	6.77 (45.67)	8.15 (66.00)	7.47 (55.33)	7.81 (60.67)	1.05 (0.67)	1.29 (1.33)	1.17 (1.00)
N_2W_1	5.54 (30.33)	4.94 (24.00)	5.24 (27.17)	7.95 (62.67)	7.20 (51.33)	7.57 (57.00)	9.13 (83.00)	8.40 (70.00)	8.76 (76.50)	9.36 (87.33)	8.44 (70.67)	8.90 (79.00)
N_2W_2	5.08 (25.33)	4.55 (20.33)	4.83 (22.83)	3.13 (9.33)	2.47 (5.67)	2.80 (7.50)	0.71 (0.00)	0.88 (0.33)	0.79 (0.17)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_3	5.52 (30.00)	4.92 (23.67)	5.22 (26.83)	5.24 (27.00)	4.44 (19.33)	4.84 (23.17)	4.58 (20.67)	5.30 (28.33)	4.94 (24.50)	5.05 (25.33)	5.40 (29.33)	5.23 (27.33)
N_2W_4	4.80 (22.67)	4.49 (20.00)	4.65 (21.33)	7.52 (56.33)	7.03 (49.00)	7.28 (52.67)	2.22 (1.00)	1.79 (3.00)	2.00 (3.83)	2.84 (7.67)	2.26 (4.67)	2.55 (6.17)
N_2W_5	5.21 (26.67)	4.55 (20.33)	4.88 (23.50)	7.15 (50.67)	6.52 (42.00)	6.83 (46.33)	8.31 (68.67)	7.78 (60.00)	8.04 (64.33)	1.27 (1.33)	1.29 (1.33)	0.71 (1.33)
N_3W_1	4.39 (19.00)	4.45 (19.33)	4.42 (19.17)	6.79 (45.67)	6.44 (41.00)	6.62 (43.33)	8.05 (64.33)	7.40 (54.33)	7.73 (59.33)	8.47 (71.33)	7.58 (57.00)	8.03 (64.17)
N_3W_2	4.18 (17.00)	3.93 (15.33)	4.05 (16.17)	2.48 (5.67)	2.27 (4.67)	2.37 (5.17)	0.71 (0.00)	0.88 (0.33)	0.79 (0.17)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_3	4.40 (19.00)	4.24 (17.67)	4.32 (18.33)	4.25 (17.67)	4.06 (16.67)	4.15 (17.17)	3.66 (13.00)	4.92 (24.00)	4.29 (18.50)	4.23 (17.67)	4.90 (24.33)	4.57 (21.00)
N_3W_4	4.83 (23.00)	4.04 (16.33)	4.44 (19.67)	6.81 (46.00)	6.43 (41.00)	6.62 (43.50)	1.93 (4.00)	1.68 (2.33)	1.80 (3.17)	2.50 (6.00)	2.11 (4.00)	2.31 (5.00)
N_3W_5	3.95 (15.33)	3.85 (14.33)	3.90 (14.83)	7.15 (51.00)	6.15 (37.33)	6.65 (44.17)	7.77 (60.00)	7.45 (55.00)	7.61 (57.50)	1.34 (1.33)	1.05 (0.67)	1.20 (1.00)
SEm± (N×W)	**0.24**	**0.40**	**0.22**	**0.26**	**0.23**	**0.17**	**0.26**	**0.24**	**0.19**	**0.28**	**0.26**	**0.18**
SEm± (W×N)	**0.23**	**0.28**	**0.19**	**0.18**	**0.22**	**0.14**	**0.21**	**0.17**	**0.15**	**0.20**	**0.24**	**0.14**
CD (*p*=0.05) (W a same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N a same or differen level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

application of herbicides in W_4 and W_5 treatment did not seem to reduce the density of sedge. Chandrika *et al*. (2009) reported that Pendimethalin was not effective against sedges, however adding one hand weeding at 40 DAS may have effectively reduced the weed density as well as the dry weight.

However, data at 45 DAS, continued to exhibit lowest density in W_2 followed by W_4 which might be due to hand weeding at 30 DAS. At 60 DAS, it was observed that W_2, due to its regular weeding, exhibited the least sedge weed density. This was followed by W_5 where integration of hand weeding at 45 DAS could help to reduce density of sedges. At this stage, density in W_3 is found to be increased.

4.5.2.15.3 Interaction effect on weed density (no. m^{-2}) of sedges.

The study found no significant effect on weed density of sedges due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observations.

4.5.2.16 Weed density (no. m^{-2}) of broad leaf weeds.

The data on weed density (no. m^{-2}) of broad leaf weeds at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.53 and 4.54.

4.5.2.16.1 Effect of nutrient management on weed density (no. m^{-2}) of broad leaf weeds.

At 15 DAS, the first year (2017) data on weed density of broad leaf weeds revealed significant variation among the nutrient treatments where lowest weed density was significantly recorded in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) and the highest weed density was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment. The second year (2018) and average data of two years at 15 DAS on weed density of broad leaf weeds showed no significant variation among the nutrient treatments.

Table 4.53: Effect of nutrient and weed management treatments on weed density (no. m^{-2}) of broad leaved weeds at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	5.19 (27.47)	6.22 (40.47)	5.70 (33.97)	5.97 (40.40)	6.67 (48.53)	6.32 (44.47)	6.08 (46.47)	6.21 (48.33)	6.15 (47.40)	4.94 (33.40)	5.11 (34.47)	5.03 (33.93)
N_2	5.63 (32.33)	6.66 (45.60)	6.15 (38.97)	6.37 (45.73)	7.18 (55.80)	6.78 (50.77)	6.37 (51.80)	6.51 (52.67)	6.44 (52.23)	5.16 (36.40)	5.42 (38.40)	5.29 (37.40)
N_3	4.67 (24.20)	5.92 (36.53)	5.40 (30.37)	5.65 (36.53)	6.34 (44.00)	6.00 (40.27)	5.86 (42.87)	6.02 (44.67)	5.94 (43.77)	4.58 (29.33)	4.93 (32.07)	4.76 (30.70)
SEm±	**0.10**	**0.22**	**0.15**	**0.09**	**0.07**	**0.07**	**0.09**	**0.13**	**0.07**	**0.13**	**0.04**	**0.07**
CD(*p*=0.05)	**0.37**	**NS**	**NS**	**0.37**	**0.28**	**0.27**	**0.35**	**NS**	**0.28**	**NS**	**0.17**	**0.27**
Weed management (W)												
W_1	6.00 (35.67)	7.04 (49.44)	6.52 (42.56)	8.88 (78.67)	9.26 (85.44)	9.07 (82.06)	10.14 (102.67)	10.33 (106.33)	10.23 (104.50)	10.23 (104.44)	10.63 (112.56)	10.43 (108.50)
W_2	5.58 (30.89)	6.88 (47.33)	6.23 (39.11)	3.32 (10.67)	4.32 (18.22)	3.82 (14.44)	2.69 (6.78)	3.06 (8.89)	2.87 (7.83)	2.02 (3.67)	2.51 (5.89)	2.26 (4.78)
W_3	5.78 (33.11)	7.05 (49.56)	6.42 (41.33)	5.19 (26.78)	6.89 (47.22)	6.04 (37.00)	5.40 (29.22)	5.12 (26.33)	5.26 (27.78)	6.16 (38.11)	5.85 (34.00)	6.00 (36.06)
W_4	3.34 (10.78)	3.61 (12.89)	3.48 (11.83)	4.11 (16.56)	4.41 (19.11)	4.26 (17.83)	2.83 (7.56)	3.11 (9.22)	2.97 (8.39)	3.87 (14.56)	3.75 (13.67)	3.81 (14.11)
W_5	5.46 (29.56)	6.74 (45.11)	6.10 (37.33)	8.48 (71.78)	8.78 (77.22)	8.63 (74.50)	9.45 (89.00)	9.61 (92.00)	9.53 (90.50)	2.19 (4.44)	3.04 (8.78)	2.62 (6.61)
SEm±	**0.12**	**0.15**	**0.10**	**0.17**	**0.17**	**0.13**	**0.15**	**0.16**	**0.12**	**0.17**	**0.13**	**0.10**
CD(*p*=0.05)	**0.36**	**0.44**	**0.28**	**0.49**	**0.49**	**0.38**	**0.45**	**0.46**	**0.34**	**0.51**	**0.37**	**0.28**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x+0.5}$ transformation.

Table 4.54: Interaction effect of nutrient and weed management treatments on weed density (no. m^{-2}) of broad leaved weeds at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
N_1W_1	5.85 (34.00)	7.23 (52.00)	6.54 (43.00)	8.77 (76.67)	9.19 (84.00)	8.98 (80.33)	10.06 (100.67)	10.37 (107.00)	10.21 (103.83)	10.20 (103.67)	10.64 (112.67)	10.42 (108.17)
N_1W_2	5.53 (30.33)	6.67 (44.67)	6.10 (37.50)	3.21 (10.00)	4.30 (18.00)	3.75 (14.00)	2.72 (7.00)	2.86 (7.67)	2.79 (7.33)	2.08 (4.00)	2.48 (5.67)	2.28 (4.83)
N_1W_3	5.75 (32.67)	7.05 (49.33)	6.40 (41.00)	5.30 (27.67)	6.86 (46.67)	6.08 (37.17)	5.48 (30.00)	5.14 (26.33)	5.31 (28.17)	6.35 (40.33)	5.66 (31.67)	6.00 (36.00)
N_1W_4	3.38 (11.00)	3.37 (11.00)	3.38 (11.00)	4.17 (17.00)	4.30 (18.00)	4.23 (17.50)	2.79 (7.33)	3.07 (9.00)	2.93 (8.17)	3.84 (14.33)	3.75 (13.67)	3.80 (14.00)
N_1W_5	5.44 (29.33)	6.76 (45.33)	6.10 (37.33)	8.42 (70.67)	8.71 (76.00)	8.57 (73.33)	9.37 (87.33)	9.60 91.67)	9.48 (89.50)	2.26 (4.67)	3.03 (8.67)	2.64 (6.67)
N_2W_1	6.34 (39.67)	7.29 (52.67)	6.81 (46.17)	9.42 (88.33)	9.68 (93.33)	9.55 (90.83)	10.76 (115.33)	10.82 (116.67)	10.79 (116.00)	10.79 (116.00)	11.08 (122.33)	10.94 (119.17)
N_2W_2	6.04 (36.00)	7.46 (55.33)	6.75 (45.67)	3.71 (13.33)	4.63 (21.00)	4.17 (17.17	2.73 (7.00)	3.23 (10.00)	2.98 (8.50)	2.20 (4.33)	2.77 (7.33)	2.49 (5.83)
N_2W_3	6.31 (39.33)	7.29 (53.00)	6.80 (46.17)	5.39 (28.67)	7.43 (54.67)	6.41 (41.67)	5.51 (30.67)	5.42 (29.67)	5.47 (30.17)	6.34 (40.00)	6.17 (38.00)	6.26 (39.00)
N_2W_4	3.56 (12.33)	4.19 (17.33)	3.88 (14.83)	4.34 (18.33)	4.84 (23.00)	4.59 (20.67)	2.91 (8.00)	3.19 (9.67)	3.05 (8.83)	4.09 (16.33)	3.88 (14.67)	3.99 (15.50)
N_2W_5	5.90 (34.33)	7.08 (49.67)	6.49 (42.00)	8.97 (80.00)	9.32 (87.00)	9.15 (83.50)	9.91 (98.00)	9.89 (97.33)	9.90 (97.67)	2.38 (5.33)	3.19 (9.67)	2.78 (7.50)
N_3W_1	5.80 (33.33)	6.62 (43.67)	6.21 (38.50)	8.45 (71.00)	8.91 (79.00)	8.68 (75.00)	9.62 (92.00)	9.79 (95.33)	9.70 (93.67)	9.70 (93.67)	10.16 (102.67)	9.93 (98.17)
N_3W_2	5.18 (26.33)	6.52 (42.00)	5.85 (34.17)	3.02 (8.67)	4.02 (15.67)	3.52 (12.17)	2.60 (6.33)	3.08 (9.00)	2.84 (9.67)	1.77 (2.67)	2.27 (4.67)	2.02 (3.67)
N_3W_3	5.27 (27.33)	6.82 (46.33)	6.05 (36.83)	4.89 (24.00)	6.38 (40.33)	5.63 (32.17)	5.22 (27.00)	4.79 (23.00)	5.00 (25.00)	5.79 (34.00)	5.71 (32.33)	5.75 (33.17)
N_3W_4	3.06 (9.00)	3.28 (10.33)	3.17 (9.67)	3.83 (14.33)	4.09 (16.33)	3.96 (15.33)	2.80 (7.33)	3.08 (9.00)	2.94 (8.17)	3.67 (13.00)	3.62 (12.67)	3.65 (12.83)
N_3W_5	5.05 (25.00)	6.39 (40.33)	5.72 (32.67)	8.05 (64.67)	8.30 (68.67)	8.18 (66.67)	9.06 (81.67)	9.35 (87.00)	9.21 (84.33)	1.94 (3.33)	2.91 (8.00)	2.43 (5.67)
SEm± (N×W)	**0.22**	**0.26**	**0.17**	**0.29**	**0.29**	**0.22**	**0.27**	**0.27**	**0.20**	**0.30**	**0.22**	**0.17**
SEm± (W×N)	**0.17**	**0.27**	**0.18**	**0.21**	**0.20**	**0.16**	**0.19**	**0.22**	**0.15**	**0.23**	**0.15**	**0.13**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

At 30, 45 and 60 DAS, average data of two years recorded significant variation among the nutrient treatments where lowest weed density (40.27, 43.77 and 30.70, respectively) of broad leaf weeds was recorded in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) and the highest weed density of broad leaf weeds was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment.

N_3 treatment comprised of only 50% RDF along with 50 % organic through *Rhizobium*+ PSB. The source of nutrients in the early phase was through only 50 % RDF, which might have resulted in higher competition between crops and weeds resulting in lower population of weeds.

4.5.2.16.2 Effect of weed management on weed density (no. m^{-2}) of broad leaf weeds.

Significant results were observed on weed density of broad leaf weeds at all stages of observations in both the years of experiment and average data of two years.

At 15 DAS, the average data of two years results recorded significantly lowest weed density of broad leaf weeds in W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). This might be due to pre-emergence application of Pendimethalin which helped in curbing *Ageratum conyzoides, Amaranthus viridis, Borreria latifolia, Cleome rutidosperma, Mimosa pudica and Mollugo pentaphylla*.

From the data recorded at 30 and 45 DAS, it was observed that post-emergence application of Propaquizafop (in W_5 treatment) did not control broad leaf weeds. This conforms to the findings of Lal *et al*. (2017). Selvakumar *et al*. (2021) reported that application of Propaquizafop was not effective against broad leaved weeds infested field in sunflower, though they were not phytotoxic to the crop. Propaquizafop belongs to aryloxyphenoxy propionate herbicides group that operate as acetyl CoA carboxylase inhibitors and are used to control annual and perennial grasses in broad leaved crops. As a result, propaquizafop had no effect on controlling broad leaved weeds.

At 30, 45 and 60 DAS, the average data of two years results significantly recorded lowest weed density of broad leaf weeds in W_2 (Hand weeding at 15, 30 and 45 DAS). This was due to elimination of broad leaf weeds through physical uprooting of both above and below ground parts of weeds. The highest weed density of broad leaf weeds was recorded in W_1 (Weedy check) at all stages of observations. At 60 DAS, W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) and W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) treatment also recorded lower broad leaf weeds density. This might be due to integration of herbicide with one hand weeding in both the treatments which helped to reduce the broad leaf weeds.

4.5.2.16.3 Interaction effect on weed density (no. m^{-2}) of broad leaf weeds.

The study found no significant effect on weed density of broad leaf weeds due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observations.

4.5.2.17 Weed density (no. m^{-2}) of total weeds.

The data on weed density (no. m^{-2}) of total weeds at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.55 and 4.56 and depicted as Figs 4.4, 4.5.

4.4.2.17.1 Effect of nutrient management on weed density (no. m^{-2}) of total weeds.

The average data of two years revealed significant results on weed density of total weeds at all stages of observations.

The average data of two years at 15 DAS recorded significantly lowest total weed density (89.17) in N_3 (50% RDF + 50% organic through *Rhizobium*

+ PSB). And the highest total weed density was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment which was at par with N_1 (100% RDF).

At 30 DAS, average data of two years recorded significantly lowest total weed density (129.40) in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). And the highest total weed density was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment.

The average data of two years at 45 DAS, revealed similar trend as recorded in the average data of two years at 15 DAS. Whereas the average data of two years at 60 DAS revealed similar trend as recorded in the average data of two years at 30 DAS.

The higher weed density in N_2 might be due to the presence of viable weed seeds in the FYM used in the experimental plots. The results are in conformity with the findings of Rao *et al.* (2007) and Borah *et al*. (2015). The addition of organic manure might have also made soil conditions favourable for weed emergence (Aggarwal and Ram, 2011). Kumar *et al*. (2011) concluded that the increase in fertilizer dose and addition of manures as source of nutrients might have increased weed emergence.

Table 4.55: Effect of nutrient and weed management treatments on weed density (no. m^{-2}) of total weeds at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	10.45 (109.07)	9.74 (95.67)	10.09 (102.37)	11.83 (150.67)	11.32 (136.53)	11.57 (143.57)	10.29 (134.07)	9.89 (123.80)	10.09 (128.93)	8.58 (103.00)	8.15 (93.80)	8.37 (98.40)
N_2	10.98 (120.67)	10.29 (106.47)	10.63 (113.57)	12.37 (163.47)	11.74 (146.07)	12.06 (154.77)	10.54 (142.73)	10.20 (130.93)	10.37 (136.83)	8.93 (111.00)	8.53 (102.80)	8.73 (106.90)
N_3	9.60 (92.00)	9.27 (86.33)	9.44 (89.17)	11.30 (137.67)	10.64 (121.13)	10.57 (129.40)	9.76 (120.73)	9.44 (111.73)	9.60 (116.23)	8.16 (93.33)	7.78 (87.00)	7.97 (90.17)
SEm±	**0.19**	**0.23**	**0.20**	**0.20**	**0.15**	**0.12**	**0.18**	**0.14**	**0.10**	**0.07**	**0.12**	**0.07**
CD (*p*=0.05)	**0.75**	**NS**	**0.77**	**NS**	**0.57**	**0.48**	**NS**	**0.56**	**0.38**	**0.26**	**0.44**	**0.29**
Weed management (W)												
W_1	10.94 (119.89)	10.54 (111.11)	10.74 (115.50)	15.86 (251.56)	15.06 (226.78)	15.46 (239.17)	17.91 (320.89)	17.39 (302.44)	17.65 (311.67)	18.21 (331.56)	17.74 (315.44)	17.99 (323.50)
W_2	10.22 (104.44)	10.05 (101.11)	10.14 (102.78)	6.31 (39.56)	6.31 (39.44)	6.31 (39.50)	4.28 (17.89)	4.16 (16.89)	2.77 (17.39)	3.18 (9.78)	3.15 (9.56)	1.41 (9.67)
W_3	10.78 (116.44)	10.38 (107.67)	10.58 (112.06)	10.34 (107.00)	10.4 (103.11)	10.24 (105.06)	9.46 (89.78)	8.97 (80.78)	9.22 (85.28)	10.40 (108.22)	9.78 (95.44)	10.09 (101.83)
W_4	9.62 (92.11)	7.99 (63.78)	8.80 (77.94)	13.44 (180.33)	12.37 (153.00)	12.91 (166.67)	4.78 (22.44)	5.08 (25.33)	2.87 (23.89)	6.69 (44.56)	6.13 (37.11)	3.60 (40.83)
W_5	10.16 (103.33)	9.86 (97.11)	10.01 (100.22)	13.21 (174.44)	12.28 (150.56)	12.75 (162.50)	14.55 (211.56)	13.63 (185.33)	8.58 (198.44)	4.31 (18.11)	3.93 (15.11)	1.77 (16.61)
SEm±	**0.14**	**0.18**	**0.12**	**0.16**	**0.17**	**0.12**	**0.18**	**0.15**	**0.13**	**0.18**	**0.11**	**0.10**
CD (*p*=0.05)	**0.40**	**0.53**	**0.35**	**0.47**	**0.51**	**0.34**	**0.53**	**0.43**	**0.37**	**0.52**	**0.30**	**0.29**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

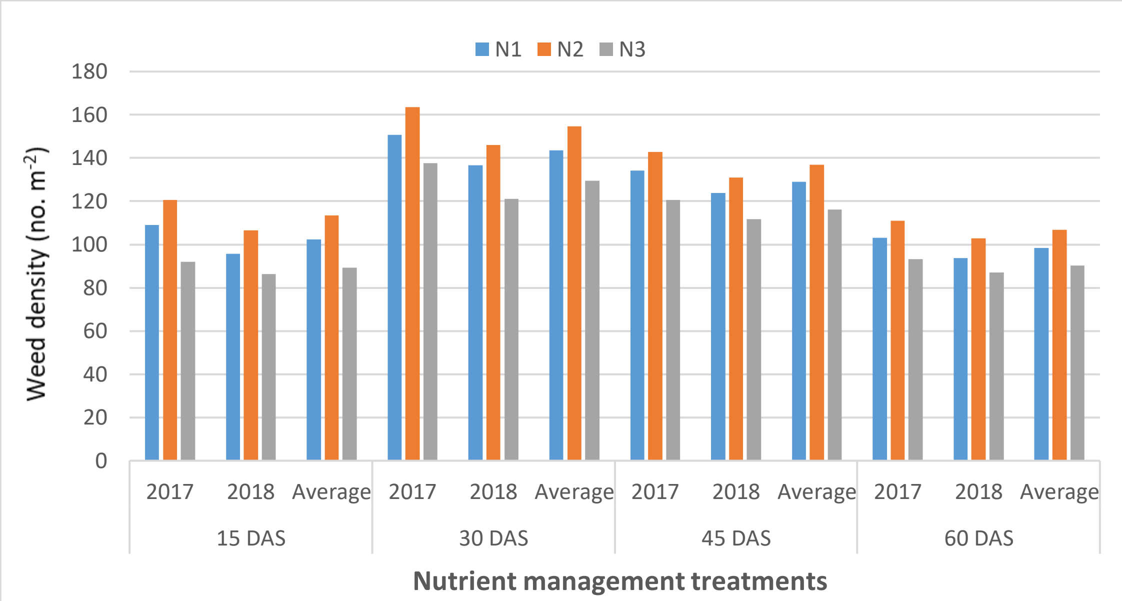


Fig 4.4 Effect of nutrient management treatments on weed density (no. m^{-2}) of total weeds at 15, 30, 45 and 60 DAS.

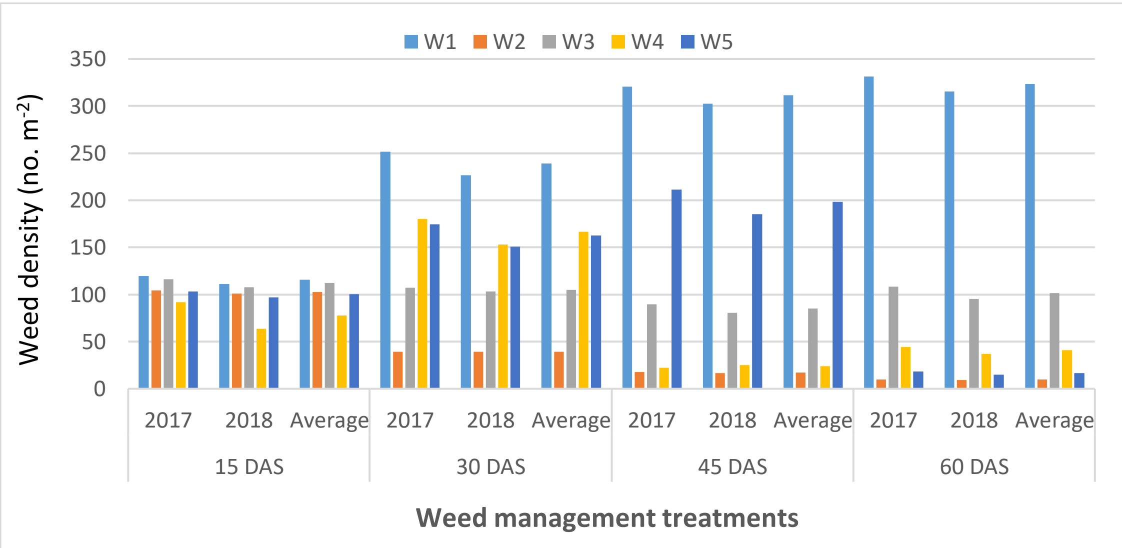


Fig 4.5 Effect of weed management treatments on weed density (no. m^{-2}) of total weeds at 15, 30, 45 and 60 DAS

Table 4.56: Interaction effect of nutrient and weed management treatments on weed density (no. m^{-2}) of total weeds at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Av.**	**2017**	**2018**	**Av.**	**2017**	**2018**	**Av.**	**2017**	**2018**	**Av.**
N_1W_1	10.98 (120.33)	10.63 (113.00)	10.81 (116.67)	15.83 (250.00)	15.21 (231.33)	15.52 (240.67)	17.99 (323.00)	17.56 (308.00)	17.77 (315.50)	18.28 (333.67)	17.71 (313.33)	18.00 (323.50)
N_1W_2	10.46 (109.00)	10.00 (100.00)	10.23 (104.50)	6.20 (38.00)	6.28 (39.00)	6.24 (38.50)	4.45 (19.33)	4.06 (16.00)	4.25 (17.67)	3.27 (10.33)	3.19 (9.67)	3.23 (10.00)
N_1W_3	10.79 (116.33)	10.36 (107.00)	10.58 (111.67)	10.34 (106.67)	10.27 (105.00)	10.31 (105.83)	9.57 (91.33)	9.05 (83.00)	9.31 (87.17)	10.42 (109.00)	9.67 (93.00)	10.05 (101.00)
N_1W_4	9.89 (97.33)	7.91 (63.00)	8.90 (80.17)	13.53 (182.67)	12.46 (155.00)	12.99 (168.83)	4.81 (22.67)	5.15 (26.00)	4.98 (24.33)	6.68 (44.33)	6.12 (37.00)	6.40 (40.67)
N_1W_5	10.13 (102.33)	9.79 (95.33)	9.96 (98.83)	13.26 (175.67)	12.36 (152.33)	12.81 (164.00)	14.64 (214.00)	13.65 (186.00)	14.15 (200.00)	4.26 (17.67)	4.06 (16.00)	4.16 (16.83)
N_2W_1	11.78 (138.67)	10.93 (119.33)	11.35 (129.00)	16.71 (278.67)	15.57 (242.00)	16.14 (260.33)	18.71 (349.67)	18.11 (327.67)	18.41 (338.67)	18.90 (357.00)	18.49 (341.33)	18.69 (349.17)
N_2W_2	10.84 (117.00)	10.57 (111.67)	10.71 (114.33)	6.89 (47.00)	6.79 (45.67)	6.84 (46.33)	4.26 (17.67)	4.29 (18.00)	4.27 (17.83)	3.35 (11.00)	3.36 (11.00)	3.35 (11.00)
N_2W_3	11.61 (134.33)	11.00 (120.67)	11.30 (127.50)	10.83 (117.33)	10.73 (115.00)	10.78 (116.00)	9.86 (98.00)	9.48 (89.33)	9.67 (93.67)	10.91 (118.67)	10.25 (104.67)	10.58 (111.67)
N_2W_4	9.67 (93.00)	8.45 (71.00)	9.06 (82.00)	13.84 (101.33)	12.90 (166.00)	13.37 (178.67)	4.84 (23.00)	5.24 (27.00)	5.04 (25.00)	6.98 (48.33)	6.36 (40.00)	6.67 (44.17)
N_2W_5	10.99 (120.33)	10.49 (109.67)	10.74 (115.00)	13.55 (183.33)	12.73 (161.67)	13.14 (172.5)	15.02 (225.33)	13.90 (192.67)	14.46 (209.00)	4.52 (20.00)	4.17 (17.00)	4.35 (18.50)
N_3W_1	10.05 (100.67)	10.06 (101.00)	10.06 (100.83)	15.05 (226.00)	14.40 (207.00)	14.72 (216.50)	17.04 (290.00)	16.50 (271.67)	16.77 (280.83)	17.45 (304.00)	17.09 (291.67)	17.27 (297.83)
N_3W_2	9.36 (87.33)	9.58 (91.67)	9.47 (89.50)	5.84 (33.67)	5.84 (33.67)	5.84 (33.67)	4.14 (16.67)	4.14 (16.67)	4.14 (16.67)	2.91 (8.00)	2.91 (8.00)	2.91 (8.00)

N_3W_3	9.95 (98.67)	9.77 (95.33)	9.86 (97.00)	9.85 (97.33)	9.42 (89.33)	9.64 (93.33)	8.95 (80.00)	8.39 (70.00)	8.67 (75.00)	9.87 (97.00)	9.42 (88.67)	9.64 (92.83)
N_3W_4	9.30 (86.00)	7.60 (57.33)	8.45 (71.67)	12.93 (167.00)	11.76 (138.00)	12.35 (152.50)	4.68 (21.67)	4.85 (23.00)	4.76 (22.33)	6.42 (41.00)	5.90 (34.33)	6.16 (37.67)
N_3W_5	9.36 (87.33)	9.32 (86.33)	9.34 (86.83)	12.82 (164.33)	11.75 (137.67)	12.38 (151.00)	13.97 (195.33)	13.33 (177.33)	13.65 (186.33)	4.14 (16.67)	3.56 (12.33)	3.85 (14.50)
SEm± (N×W)	**0.24**	**0.31**	**0.21**	**0.28**	**0.30**	**0.20**	**0.32**	**0.26**	**0.22**	**0.31**	**0.18**	**0.17**
SEm± (W×N)	**0.24**	**0.31**	**0.24**	**0.27**	**0.24**	**0.18**	**0.27**	**0.22**	**0.17**	**0.20**	**0.16**	**0.13**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

4.4.2.17.2 Effect of weed management on weed density (no. m^{-2}) of total weeds.

Significant results were observed on weed density of total weeds at all stages of observations in both the years of experiment and average data of two years.

At early growth stage *i.e.*, 15 DAS, the average data of two years results recorded significantly lowest density of total weeds in W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). This might be due to pre-emergence application of pendimethalin which was found most effective to control particularly grasses and broad leaf weeds in soybean at early crop growth stage. These results are in line with that reported by Jangir *et al*. (2018). W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) treatment at 15 DAS, recorded higher weed density as immediate effect of propaquizafop was not noticed at the time of observation.

At 30 DAS, the average data of two years results recorded significantly lowest total weed density in W_2 (Hand weeding at 15, 30 and 45 DAS). This was followed by W_3 treatment which might be due to control of weeds due to mechanical weeding carried out at 20 DAS.

At 45 DAS, the average data of two years results recorded lowest total weed density in W_2 (Hand weeding at 15, 30 and 45 DAS) which was at par with W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatment.

A perusal of the data at 60 DAS indicated that all the weed management practices significantly reduced weed density over weedy check. The average data of two years results recorded lowest total weed density in W_2 which was followed by W_5 treatment and W_4 treatment. W_2 treatment recorded the lowest weed density of total weeds at 30, 45 and 60 DAS. This is due to three hand weeding performed at 15, 30 and 45 DAS which controlled the early flush of weeds and the second or late emerging weeds effectively (Sharma *et al*., 2016a).

At later stage *i.e.*, 60 DAS, W_4 and W_5 treatment also recorded lower weed density. In W_4 treatment, the emergence of early weed growth was inhibited by pre-emergence application of Pendimethalin and the late emerging weeds were effectively controlled by hand weeding performed at 30 DAS (Sharma *et al*., 2016b). Similarly, in W_5 treatment, the emergence of early weed growth was inhibited by post-emergence application of Propaquizafop and the late emerging weeds were effectively controlled by hand weeding performed at 45 DAS. The results also indicated that W_5 treatment recorded lower weed density as compared to W_4 treatment. Kumar *et al.* (2018b) reported that post-emergence application of herbicides was better than pre-emergence application of herbicides due to effective suppression of newly emerging weeds by the application of post-emergence herbicides in soybean. Another cause could be suppression of weed flora as a result of the herbicide's toxic effect (pendimethalin) which usually appears right after application when the herbicide's concentration in soil is at its peak. Later on microorganisms participate in the breakdown process, lowering the concentration of herbicides concentration and its toxic effect (Mekonnen *et al*., 2016).

The higher density in weedy check plot in all the stages of observations could be attributable to previous season's weed seed deposition, which could have resulted to increased weed seed bank in the soil that is undisturbed by any activity, and also due to no weed management measures taken in these plots.

4.4.2.17.3 Interaction effect on weed density (no. m^{-2}) of total weeds.

The study found no significant effect on weed density of total weeds due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observations.

4.5.3 WEED BIOMASS (g m^{-2}) AT 15, 30, 45 AND 60 DAS

4.5.3.1 Weed biomass (g m^{-2}) of *Cynodon dactylon* L.

The data on weed biomass (g m^{-2}) of *Cynodon dactylon* L. at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.57 and 4.58.

4.5.3.1.1 Effect of nutrient management on weed biomass (g m^{-2}) of *Cynodon dactylon* L.

An inquisition on two years' data and pooled data on weed biomass of *Cynodon dactylon* revealed no significant variation among the nutrient treatments at various stages of observations except at 30 DAS.

The average data of two years at 30 DAS significantly recorded lowest total weed biomass (1.62 g m^{-2}) of *Cynodon dactylon* in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). And the highest weed biomass of *Cynodon dactylon* was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment and was at par with N_1 (100% RDF).

4.5.3.1.2 Effect of weed management on weed biomass (g m^{-2}) of *Cynodon dactylon* L.

The data for both years and pooled data revealed significant variation on weed biomass of *Cynodon dactylon* among the different weed management treatments at all stages of observations.

At 15 DAS, the average results recorded significantly lowest weed biomass (0.95 g m^{-2}) of *Cynodon dactylon* in W_4 treatment over all the other weed management treatments. Application of Pendimethalin might have helped in reducing the weed growth and thereby also reducing its weed biomass.

At 30 DAS, W_2 treatment recorded the lowest weed biomass of *Cynodon dactylon* which was followed by W_5 treatment. Application of Propaquizafop as post-emergence at 15 DAS not only helped in reducing the density of *Cynodon dactylon* but also reduced its biomass.

A perusal of the data at 45 and 60 DAS indicated that all the weed management practices significantly reduced weed biomass of *Cynodon dactylon* over weedy check. Lowest weed biomass (0.17 g m^{-2}) at 60 DAS was recorded at W_2 (Hand weeding at 15, 30 and 45 DAS) which was statistically at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS). This was followed by W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) and W_3 (Mechanical weeding at 20 and 40 DAS).

4.5.3.1.3 Interaction effect on weed biomass (g m^{-2}) of *Cynodon dactylon* L.

The study found no significant effect on weed biomass of *Cynodon dactylon* due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observation.

4.5.3.2 Weed biomass (g m^{-2}) of *Digitaria sanguinalis* L.

The data on weed biomass (g m^{-2}) of *Digitaria sanguinalis* at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.59 and 4.60.

4.5.3.2.1 Effect of nutrient management on weed biomass (g m^{-2}) of *Digitaria sanguinalis* L.

An inquisition on two years' data and average data of two years on weed biomass of *Digitaria sanguinalis* revealed no significant variation among the nutrient treatments at various stages of observations.

Table 4.57: Effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Cynodon dactylon* L. at 15, 30, 45 DAS and 60 DAS.

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	1.05 (0.62)	1.00 (0.50)	1.03 (0.56)	1.50 (1.94)	1.38 (1.71)	1.44 (1.83)	1.54 (2.28)	1.49 (2.17)	1.51 (2.23)	1.48 (2.18)	1.39 (1.89)	1.43 (2.03)
N_2	1.08 (0.67)	1.02 (0.53)	1.05 (0.60)	1.53 (2.05)	1.36 (1.63)	1.45 (1.84)	1.58 (2.46)	1.47 (2.02)	1.52 (2.24)	1.49 (2.25)	1.43 (2.05)	1.46 (2.15)
N_3	1.01 (0.53)	0.98 (0.46)	0.99 (0.49)	1.45 (1.81)	1.28 (1.43)	1.37 (1.62)	1.48 (2.10)	1.35 (1.70)	1.41 (1.90)	1.47 (2.14)	1.40 (2.01)	1.43 (2.07)
SEm±	**0.03**	**0.02**	**0.01**	**0.06**	**0.05**	**0.01**	**0.05**	**0.04**	**0.04**	**0.03**	**0.03**	**0.01**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**0.05**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	1.13 (0.77)	1.03 (0.55)	1.08 (0.66)	2.00 (3.52)	2.00 (3.54)	2.00 (3.53)	2.70 (6.80)	2.59 (6.25)	2.65 (6.52)	2.79 (7.29)	2.72 (6.90)	2.75 (7.09)
W_2	1.05 (0.60)	1.00 (0.51)	1.02 (0.55)	0.95 (0.41)	0.89 (0.29)	0.92 (0.35)	0.92 (0.36)	0.84 (0.21)	0.88 (0.28)	0.84 (0.20)	0.80 (0.14)	0.82 (0.17)
W_3	1.05 (0.62)	1.03 (0.56)	1.04 (0.59)	1.35 (1.33)	1.25 (1.13)	1.30 (1.23)	1.51 (1.86)	1.35 (1.38)	1.43 (1.62)	1.59 (2.06)	1.53 (1.89)	1.56 (1.98)
W_4	0.96 (0.43)	0.93 (0.36)	0.95 (0.40)	2.00 (3.52)	1.86 (2.99)	1.93 (3.25)	0.94 (0.39)	1.02 (0.55)	0.98 (0.47)	1.18 (0.89)	1.13 (0.77)	1.15 (0.8)3
W_5	1.05 (0.61)	1.00 (0.52)	1.03 (0.56)	1.17 (0.89)	0.71 (0.00)	0.94 (0.44)	1.58 (2.00)	1.38 (1.43)	1.48 (1.71)	0.99 (0.48)	0.85 (0.22)	0.92 (0.35)
SEm±	**0.03**	**0.02**	**0.01**	**0.04**	**0.06**	**0.03**	**0.05**	**0.04**	**0.04**	**0.04**	**0.05**	**0.04**
CD (*p*=0.05)	**0.08**	**0.06**	**0.04**	**0.11**	**0.17**	**0.10**	**0.14**	**0.13**	**0.11**	**0.12**	**0.15**	**0.10**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.58: Interaction effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Cynodon dactylon* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average	2017	2018	Average	2017	2018	Average
N_1W_1	1.11 (0.73)	1.05 (0.60)	1.08 (0.67)	2.03 (3.64)	2.09 (3.98)	2.06 (3.81)	2.71 (6.85)	2.70 (6.82)	2.71 (6.84)	2.78 (7.22)	2.62 (6.37)	2.70 (6.80)
N_1W_2	1.08 (0.66)	0.96 (0.42)	1.02 (0.54)	0.98 (0.47)	0.89 (0.30)	0.94 (0.38)	0.93 (0.37)	0.84 (0.20)	0.88 (0.29)	0.84 (0.21)	0.80 (0.15)	0.82 (0.18)
N_1W_3	1.09 (0.70)	1.06 (0.62)	1.07 (0.66)	1.34 (1.31)	1.35 (1.35)	1.35 (1.33)	1.55 (1.91)	1.48 (1.71)	1.51 (1.81)	1.61 (2.13)	1.53 (1.92)	1.57 (2.03)
N_1W_4	0.97 (0.43)	0.92 (0.36)	0.94(0.40)	1.98 (3.46)	1.84 (2.94)	1.91 (3.20)	0.96 (0.42)	1.03 (0.56)	0.99 (0.49)	1.16 (0.84)	1.11 (0.73)	1.13 (0.79)
N_1W_5	1.03 (0.57)	1.01 (0.53)	1.02 (0.55)	1.16 (0.84)	0.71 (0.00)	0.93 (0.42)	1.54 (1.87)	1.41 (1.55)	1.47 (1.71)	0.99 (0.48)	0.87 (0.26)	0.93 (0.37)
N_2W_1	1.20 (0.93)	1.02 (0.55)	1.11 (0.74)	2.06 (3.78)	1.98 (3.43)	2.02 (3.61)	2.76 (7.15)	2.58 (6.16)	2.67 (6.66)	2.84 (7.55)	2.74 (7.05)	2.79 (7.30)
N_2W_2	1.06 (0.63)	1.01 (0.52)	1.04 (0.58)	0.95 (0.39)	0.91 (0.33)	0.93 (0.36)	0.93 (0.36)	0.85 (0.22)	0.89 (0.29)	0.84 (0.20)	0.80 (0.14)	0.82 (0.17)
N_2W_3	1.08 (0.67)	1.07 (0.65)	1.07 (0.66)	1.42 (1.52)	1.35 (1.37)	1.39 (1.45)	1.58 (2.02)	1.50 (1.76)	1.54 (1.89)	1.61 (2.13)	1.57 (1.99)	1.59 (2.06)
N_2W_4	1.00 (0.50)	0.94 (0.39)	0.97 (0.44)	2.03 (3.63)	1.87 (3.01)	1.95 (3.32)	0.94 (0.38)	1.04 (0.58)	0.99 (0.48)	1.17 (0.86)	1.15 (0.82)	1.16 (0.84)
N_2W_5	1.07 (0.64)	1.03 (0.57)	1.05 (0.61)	1.18 (0.91)	0.71 (0.00)	0.94 (0.46)	1.69 (2.37)	1.37 (1.40)	1.53 (1.88)	0.99 (0.48)	0.87 (0.25)	0.93 (0.37)
N_3W_1	1.07 (0.65)	1.00 (0.51)	1.04 (0.58)	1.90 (3.15)	1.92 (3.21)	1.91 (3.18)	2.62 (6.39)	2.50 (5.78)	2.56 (6.08)	2.76 (7.09)	2.79 (7.27)	2.77 (7.18)
N_3W_2	1.00 (0.50)	1.04 (0.59)	1.02 (0.55)	0.93 (0.37)	0.87 (0.25)	0.90 (0.31)	0.91 (0.34)	0.84 (0.20)	0.88 (0.27)	0.84 (0.20)	0.79 (0.12)	0.81 (0.16)
N_3W_3	1.00 (0.50)	0.96 (0.42)	0.98 (0.46)	1.28 (1.14)	1.05 (0.67)	1.16 (0.90)	1.41 (1.65)	1.07 (0.67)	1.24 (1.16)	1.54 (1.92)	1.50 (1.76)	1.52 (1.84)
N_3W_4	0.93 (0.36)	0.92 (0.34)	0.92 (0.35)	1.99 (3.47)	1.87 (3.01)	1.93 (3.24)	0.94 (0.38)	1.00 (0.50)	0.97 (0.44)	1.21 (0.98)	1.13 (0.77)	1.17 (0.88)
N_3W_5	1.05 (0.62)	0.97 (0.45)	1.01 (0.53)	1.18 (0.91)	0.71 (0.00)	0.94 (0.46)	1.50 (1.75)	1.35 (1.34)	1.43 (1.55)	0.99 (0.48)	0.80 (0.14)	0.89 (0.31)
SEm± (N×W)	**0.05**	**0.04**	**0.03**	**0.07**	**0.10**	**0.06**	**0.08**	**0.08**	**0.06**	**0.07**	**0.09**	**0.06**
SEm± (W×N)	**0.03**	**0.03**	**0.02**	**0.07**	**0.08**	**0.04**	**0.07**	**0.06**	**0.06**	**0.05**	**0.06**	**0.04**
CD (*p*=0.05) (W a same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N a same or differer level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.59: Effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Digitaria sanguinalis* L. at 15, 30, 45 and 60 DAS.

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	1.40 (1.48)	1.13 (0.79)	1.27 (1.14)	2.88 (8.90)	2.19 (5.83)	2.53 (7.36)	4.46 (29.70)	3.82 (22.70)	4.14 (26.20)	4.00 (25.97)	3.66 (22.92)	3.83 (24.44)
N_2	1.44 (1.60)	1.15 (0.83)	1.30 (1.22)	2.98 (9.62)	2.18 (5.77)	2.58 (7.70)	4.54 (31.20)	3.79 (22.84)	4.17 (27.02)	4.28 (28.47)	3.70 (23.43)	3.99 (25.95)
N_3	1.37 (1.39)	1.09 (0.71)	1.23 (1.05)	2.75 (8.22)	2.14 (5.60)	2.45 (6.91)	4.32 (27.51)	3.68 (21.39)	4.00 (24.45)	3.95 (24.89)	3.60 (21.63)	3.78 (23.26)
SEm±	**0.05**	**0.02**	**0.02**	**0.12**	**0.07**	**0.08**	**0.07**	**0.23**	**0.11**	**0.08**	**0.14**	**0.05**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	1.47 (1.71)	1.18 (0.91)	1.33 (1.31)	3.98 (15.41)	3.51 (11.86)	3.75 (13.63)	9.54 (90.64)	9.05 (81.51)	9.30 (86.08)	9.77 (95.07)	9.54 (90.58)	9.66 (92.82)
W_2	1.42 (1.53)	1.13 (0.79)	1.28 (1.16)	0.95 (0.41)	0.87 (0.25)	0.91 (0.33)	0.83 (0.19)	0.83 (0.18)	0.83 (0.19)	1.30 (1.46)	1.09 (0.85)	1.20 (1.15)
W_3	1.44 (1.58)	1.16 (0.86)	1.30 (1.22)	2.83 (7.70)	2.26 (4.64)	2.54 (6.17)	5.01 (24.75)	3.46 (12.13)	4.23 (18.44)	5.29 (28.01)	3.79 (14.28)	4.54 (21.14)
W_4	1.28 (1.14)	1.03 (0.56)	1.15 (0.85)	3.56 (12.36)	3.51 (11.91)	3.54 (12.13)	1.31 (1.35)	1.56 (1.97)	1.43 (1.66)	2.45 (5.62)	2.43 (5.66)	2.44 (5.64)
W_5	1.41 (1.49)	1.13 (0.77)	1.27 (1.13)	3.01 (8.68)	0.71 (0.00)	1.86 (4.34)	5.52 (30.41)	3.92 (15.76)	4.72 (23.09)	1.59 (2.07)	1.44 (1.93)	1.51 (2.00)
SEm±	**0.04**	**0.03**	**0.03**	**0.10**	**0.07**	**0.06**	**0.16**	**0.23**	**0.15**	**0.18**	**0.21**	**0.14**
CD (*p*=0.05)	**0.11**	**0.09**	**0.08**	**0.29**	**0.21**	**0.18**	**0.48**	**0.66**	**0.45**	**0.54**	**0.61**	**0.41**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.60: Interaction effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Digitaria sanguinalis* L. at 15, 30, 45 and 60 DAS.

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
N_1W_1	1.50 (1.76)	1.19 (0.92)	1.34 (1.34)	3.94 (15.04)	3.56 (12.21)	3.75 (13.63)	9.57 (91.03)	9.06 (81.67)	9.31 (86.35)	9.83 (96.13)	9.62 (92.07)	9.72 (94.10)
N_1W_2	1.44 (1.57)	1.16 (0.87)	1.30 (1.22)	0.95 (0.40)	0.84 (0.21)	0.89 (0.31)	0.84 (0.21)	0.82 (0.17)	0.83 (0.19)	1.31 (1.42)	1.16 (0.95)	1.23 (1.19)
N_1W_3	1.43 (1.53)	1.17 (0.87)	1.30 (1.20)	2.82 (7.48)	2.31 (4.88)	2.57 (6.18)	4.99 (24.50)	3.52 (12.60)	4.25 (18.55)	5.05 (25.68)	3.78 (14.46)	4.42 (20.07)
N_1W_4	1.23 (1.03)	1.02 (0.54)	1.13 (0.79)	3.63 (12.70)	3.51 (11.83)	3.57 (12.26)	1.29 (1.37)	1.65 (2.28)	1.47 (1.82)	2.25 (4.60)	2.44 (5.70)	2.35 (5.15)
N_1W_5	1.41 (1.50)	1.13 (0.78)	1.27 (1.14)	3.05 (8.87)	0.71 (0.00)	1.88 (4.43)	5.62 (31.37)	4.06 (16.78)	4.84 (24.08)	1.57 (1.99)	1.31 (1.43)	1.44 (1.71)
N_2W_1	1.51 (1.85)	1.22 (0.99)	1.36 (1.42)	4.17 (16.94)	3.52 (12.02)	3.85 (14.48)	9.88 (97.20)	9.26 (85.25)	9.57 (91.23)	10.04(100.33)	9.69 (93.33)	9.86 (96.83)
N_2W_2	1.42 (1.52)	1.13 (0.78)	1.27 (1.15)	0.99 (0.48)	0.90 (0.31)	0.94 (0.39)	0.83 (0.19)	0.84 (0.21)	0.84 (0.20)	1.45 (2.02)	1.09 (0.97)	1.27 (1.50)
N_2W_3	1.49 (1.73)	1.19 (0.92)	1.34 (1.33)	3.00 (8.54)	2.25 (4.59)	2.63 (6.56)	5.11 (25.90)	3.41 (11.90)	4.26 (18.90)	5.58 (31.03)	3.89 (14.91)	4.73 (22.97)
N_2W_4	1.35 (1.32)	1.08 (0.66)	1.21 (0.99)	3.67 (13.08)	3.52 (11.95)	3.59 (12.51)	1.29 (1.35)	1.66 (2.28)	1.47 (1.82)	2.66 (6.62)	2.56 (6.53)	2.61 (6.58)
N_2W_5	1.44 (1.58)	1.14 (0.82)	1.29 (1.20)	3.07 (9.06)	0.71 (0.00)	1.89 (4.53)	5.61 (31.36)	3.78(14.57)	4.69 (22.96)	1.68 (2.36)	1.30 (1.40)	1.49 (1.88)
N_3W_1	1.42 (1.52)	1.14 (0.81)	1.28 (1.17)	3.84 (14.24)	3.44 (11.35)	3.64 (12.80)	9.17 (83.70)	8.84 (77.62)	9.00 (80.66)	9.44 (88.73)	9.32 (86.33)	9.38 (87.53)
N_3W_2	1.41 (1.50)	1.11 (0.73)	1.26 (1.12)	0.92 (0.35)	0.86 (0.24)	0.89 (0.30)	0.82 (0.18)	0.82 (0.17)	0.82 (0.17)	1.15 (0.93)	1.03 (0.64)	1.09 (0.78)
N_3W_3	1.40 (1.47)	1.13 (0.78)	1.26 (1.13)	2.68 (7.07)	2.20 (4.46)	2.44 (5.76)	4.93 (23.85)	3.44 (11.90)	4.19 (17.88)	5.22 (27.31)	3.70 (13.45)	4.46 (20.38)
N_3W_4	1.26 (1.08)	0.99 (0.48)	1.12 (0.78)	3.39 (11.31)	3.52 (11.94)	3.45 (11.63)	1.35 (1.32)	1.36 (1.35)	1.35 (1.34)	2.43 (5.63	2.28 (4.77)	2.35 (5.20)
N_3W_5	1.38 (1.39)	1.11 (0.72)	1.24 (1.06)	2.90 (8.11)	0.71 (0.00)	1.80 (4.06)	5.32 (28.51)	3.93 (15.93)	4.63 (22.22)	1.51 (1.84)	1.70 (2.96)	1.61 (2.40)
SEm± (N×W)	**0.07**	**0.05**	**0.05**	**0.17**	**0.12**	**0.11**	**0.29**	**0.39**	**0.27**	**0.32**	**0.36**	**0.24**
SEm± (W×N)	**0.06**	**0.04**	**0.03**	**0.16**	**0.10**	**0.11**	**0.19**	**0.34**	**0.20**	**0.22**	**0.26**	**0.16**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

4.5.3.2.2 Effect of weed management on weed biomass (g m^{-2}) of *Digitaria sanguinalis* L.

Significant results were recorded on weed biomass of *Digitaria sanguinalis* at all stages of observations in both the years and average data of two years.

At 15 DAS, the average data of two years results recorded significantly lowest weed biomass (0.85 g m^{-2}) of *Digitaria sanguinalis* in W_4 treatment over all the other weed management treatments. Application of Pendimethalin might have helped in reducing the weed growth of this weed and thereby reduced its biomass.

At 30, 45 and 60 DAS, the average data of two years results revealed that all the weed management practices significantly reduced weed biomass of *Digitaria sanguinalis* over weedy check.

The trend observed in weed biomass of *Digitaria sanguinalis* was found to be similar with *Cynodon dactylon* where lowest weed biomass (1.15 g m^{-2}) at 60 DAS was recorded at W_2 (Hand weeding at 15, 30 and 45 DAS) which was statistically at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS). This was followed by W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) and W_3 (Mechanical weeding at 20 and 40 DAS).

4.5.3.2.3 Interaction effect on weed biomass (g m^{-2}) of *Digitaria sanguinalis* L.

The study found no significant effect on weed biomass of *Digitaria sanguinalis* due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observation.

4.5.3.3 Weed biomass (g m^{-2}) of *Eleusine indica* L.

The data on weed biomass of *Eleusine indica* L. at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.61 and 4.62.

4.5.3.3.1 Effect of nutrient management on weed biomass (g m^{-2}) of *Eleusine indica* L.

The effect of nutrient management on weed biomass of *Eleusine indica* did not show any significant effect at all stages of observation except at 30 DAS (2018 data) and 45 DAS (average data of two years).

The second year data (2018) at 30 DAS and average data of two years at 60 DAS revealed that significantly lowest weed biomass of *Eleusine indica* was found in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). N_2 (75% RDF + 25% organic through FYM + PSB) recorded the highest weed biomass and was at par with N_1 (100% RDF).

4.5.3.3.2 Effect of weed management on weed biomass (g m^{-2}) of *Eleusine indica* L.

Significant results were observed on weed biomass of *Eleusine indica* L. at all stages of observations in both the years and average data of two years.

At 15 DAS, the average data of two years results recorded significantly lowest weed biomass (0.90 g m^{-2}) of *Eleusine indica* in W_4 treatment over all the other weed management treatments. This might be due to application of Pendimethalin which reduced the weed growth and hence reduced its biomass.

At 30, 45 and 60 DAS, the average data of two years results revealed that all the weed management practices significantly reduced weed biomass of *Eleusine indica* over weedy check.

Table 4.61: Effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Eleusine indica* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	1.06 (0.63)	1.01 (0.54)	1.03 (0.59)	2.35 (5.81)	1.90 (4.07)	2.13 (4.94)	3.81 (17.75)	3.47 (15.22)	3.64 (16.49)	3.99 (21.76)	3.25 (17.43)	3.62 (19.59)
N_2	1.13 (0.78)	1.05 (0.62)	1.09 (0.70)	2.41 (6.19)	1.99 (4.26)	2.20 (5.23)	3.63 (16.52)	3.59 (17.09)	3.61 (16.80)	4.04 (23.06)	3.54 (21.07)	3.79 (22.06)
N_3	1.00 (0.52)	0.98 (0.48)	0.99 (0.50)	2.29 (5.44)	1.74 (3.33)	2.01 (4.38)	3.25 (14.20)	3.31 (13.54)	3.28 (13.87)	3.48 (18.06)	3.06 (15.62)	3.27 (16.84)
SEm±	**0.04**	**0.03**	**0.02**	**0.14**	**0.03**	**0.07**	**0.13**	**0.08**	**0.07**	**0.16**	**0.13**	**0.12**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**NS**	**0.13**	**NS**	**NS**	**NS**	**0.27**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	1.13 (0.80)	1.08 (0.67)	1.11 (0.74)	3.30 (10.46)	2.90 (8.04)	3.10 (9.25)	6.94 (47.80)	6.86 (46.83)	6.90 (47.32)	8.64 (74.38)	8.40 (70.34)	8.52 (72.36)
W_2	1.04 (0.60	1.04 (0.59)	1.04 (0.59)	0.96 (0.42)	0.91 (0.34)	0.94 (0.38)	1.65 (2.55)	1.56 (2.24)	1.61 (2.40)	1.65 (2.42)	1.00 (0.69)	1.33 (1.56)
W_3	1.14 (0.81)	1.04 (0.61)	1.09 (0.71)	2.22 (4.55)	1.86 (3.13)	2.04 (3.84)	2.87 (8.09)	3.04 (9.25)	2.96 (8.67)	3.33 (10.90)	3.26 (10.88)	3.30 (10.89)
W_4	0.92 (0.35)	0.88 (0.28)	0.90 (0.32)	3.12 (9.38)	2.82 (7.50)	2.97 (8.44)	2.17 (4.35)	2.02 (3.74)	2.10 (4.05)	3.60 (13.65)	2.81 (7.80)	3.21 (10.72)
W_5	1.08 (0.68)	1.03 (0.58)	1.06 (0.63)	2.14 (4.27)	0.90 (0.43)	1.52 (2.35)	4.19 (17.98)	3.78 (14.36)	3.99 (16.17)	1.95 (3.43)	0.91 (0.48)	1.43 (1.96)
SEm±	**0.04**	**0.04**	**0.03**	**0.11**	**0.12**	**0.05**	**0.23**	**0.23**	**0.19**	**0.21**	**0.21**	**0.14**
CD (*p*=0.05)	**0.10**	**0.11**	**0.08**	**0.32**	**0.34**	**0.15**	**0.68**	**0.68**	**0.56**	**0.62**	**0.63**	**0.41**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.62: Interaction effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Eleusine indica* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
N_1W_1	1.11 (0.75)	1.09 (0.69)	1.10 (0.72)	3.23 (10.00)	3.03 (8.71)	3.13 (9.36)	7.11 (50.14)	6.73 (44.87)	6.92 (47.50)	8.66 (74.56)	8.22 (67.09)	8.44 (70.82)
N_1W_2	1.07 (0.65)	1.09 (0.68)	1.08 (0.66)	0.94 (0.38)	0.90 (0.32)	0.92 (0.35)	2.12 (4.05)	1.64 (2.69)	1.88 (3.37)	1.78 (2.71)	1.00 (0.67)	1.39 (1.69)
N_1W_3	1.14 (0.79)	1.04 (0.64)	1.09 (0.72)	2.08 (3.85)	1.92 (3.20)	2.00 (3.53)	2.96 (8.45)	3.03 (9.25)	2.99 (8.85)	3.34 (10.88)	3.18 (10.88)	3.26 (10.88)
N_1W_4	0.91 (0.34)	0.89 (0.29)	0.90 (0.31)	3.21 (9.83)	2.94 (8.14)	3.07 (8.98)	2.30 (4.95)	2.11 (4.04)	2.21 (4.50)	4.22 (17.35)	2.83 (7.82)	3.52 (12.58)
N_1W_5	1.07 (0.64)	0.95 (0.40)	1.01 (0.52)	2.31 (4.98)	0.71 (0.00)	1.51 (2.49)	4.56 (21.16)	3.83 (15.25)	4.20 (18.21)	1.93 (3.28)	1.00 (0.68)	1.47 (1.98)
N_2W_1	1.22 (1.01)	1.09 (0.69)	1.16 (0.85)	3.43 (11.35)	3.05 (8.82)	3.24(10.09)	6.99 (48.55)	7.46 (55.24)	7.23 (51.89)	9.03 (81.15)	9.10 (82.34)	9.06 (81.74)
N_2W_2	1.12 (0.76)	1.04 (0.60)	1.08 (0.68)	1.00 (0.49)	0.96 (0.42)	0.98 (0.46)	1.76 (2.71)	1.43 (1.79)	1.60 (2.25)	1.60 (2.59)	1.02 (0.73)	1.31 (1.66)
N_2W_3	1.18 (0.91)	1.12 (0.76)	1.15 (0.83)	2.35 (5.17)	1.83 (3.13)	2.09 (4.15)	3.17 (9.78)	3.16 (10.02)	3.16 (9.90)	3.59 (12.61)	3.53 (12.44)	3.56 (12.52)
N_2W_4	0.94 (0.38)	0.91 (0.33)	0.93 (0.36)	3.18 (9.94)	2.85 (7.65)	3.01 (8.80)	2.09 (4.04)	2.06 (4.04)	2.07 (4.04)	3.88 (14.71)	2.99 (9.08)	3.44 (11.89)
N_2W_5	1.17 (0.87)	1.10 (0.72)	1.13 (0.79)	2.09 (4.02)	1.28 (1.30)	1.68 (2.66)	4.13 (17.51)	3.83 (14.36)	3.98 (15.93)	2.12 (4.23)	1.03 (0.77)	1.58 (2.50)
N_3W_1	1.07 (0.65)	1.07 (0.64)	1.07 (0.65)	3.24 (10.02)	2.63 (6.59)	2.94 (8.30)	6.72 (44.73)	6.39 (40.38)	6.56 (42.55)	8.24 (67.44)	7.88 (61.59)	8.06 (64.52)
N_3W_2	0.93 (0.39)	0.99 (0.48)	0.96 (0.44)	0.94 (0.39)	0.88 (0.27)	0.91 (0.33)	1.07 (0.90)	1.62 (2.24)	1.34 (1.57)	1.57 (1.96)	1.00 (0.66)	1.28 (1.31)
N_3W_3	1.10 (0.72)	0.97 (0.44)	1.03 (0.58)	2.24 (4.65)	1.82 (3.06)	2.03 (3.85)	2.47 (6.03)	2.95 (8.48)	2.71 (7.25)	3.05 (9.22)	3.07 (9.33)	3.06 (9.27)
N_3W_4	0.91 (0.33)	0.85 (0.22)	0.88 (0.28)	2.97 (8.36)	2.66 (6.72)	2.82 (7.54)	2.12 (4.06)	1.90 (3.14)	2.01 (3.60)	2.72 (8.89)	2.62 (6.50)	2.67 (7.70)
N_3W_5	1.01 (0.53)	1.04 (0.62)	1.03 (0.57)	2.03 (3.80)	0.71 (0.00)	1.37 (1.90)	3.88 (15.27)	3.70 (13.46)	3.79 (14.37)	1.80 (2.80)	0.71 (0.00)	1.25 (1.40)
SEm± (N×W)	**0.06**	**0.07**	**0.05**	**0.19**	**0.20**	**0.09**	**0.41**	**0.40**	**0.33**	**0.37**	**0.37**	**0.25**
SEm± (W×N)	**0.05**	**0.05**	**0.04**	**0.18**	**0.13**	**0.09**	**0.29**	**0.27**	**0.22**	**0.28**	**0.27**	**0.20**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

At 30 DAS, the lowest weed biomass (0.38 g m^{-2}) *Eleusine indica* was found at W_2 (Hand weeding at 15, 30 and 45 DAS) which was followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS). The lower weed biomass recorded in W_2 might be due to removal of this weed at 15 DAS through hand weeding therefore resulting in fewer emergence of this weed and hence resulted in lower biomass. W_5 also recorded lower weed biomass of this weed as the effect of Propaquizafop application at 15 DAS can be seen.

At 45 DAS, the average data of two years revealed that the lowest weed biomass (2.40 g m^{-2}) of *Eleusine indica* was found at W_2 which was statistically at par with W_4. The removal of this weed through hand weeding at 30 DAS in both the above treatments resulted in fewer emergence of this weed and therefore recorded lesser biomass.

At 60 DAS, lowest weed biomass (1.56 g m^{-2}) of *Eleusine indica* was recorded at W_2 which was statistically at par with W_5. The removal of weeds in W_2 treatment at regular intervals (*i.e*., at 15, 30 and 45 DAS) have resulted in good control of weeds and therefore resulted in least biomass of *Eleusine indica*. The removal of weeds through hand weeding at 45 DAS in W_5 treatment has also resulted in effective control of weeds and hence reduction of this weed biomass.

4.5.3.3.3 Interaction effect on weed biomass (g m^{-2}) of *Eleusine indica* L.

The study found no significant effect on weed biomass of *Eleusine indica* due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observation.

4.5.3.4 Weed biomass (g m^{-2}) of *Bulbostylis barbata* (Rottb.) C.B.Clarke

The data on weed biomass of *Bulbostylis barbata* at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.63 and 4.64.

4.5.3.4.1 Effect of nutrient management on weed biomass (g m^{-2}) of *Bulbostylis barbata* (Rottb.) C.B.Clarke.

An inquisition on two years' data and average data of two years on weed of *Bulbostylis barbata* revealed no significant variation among the nutrient treatments at various stages of observations except at 60 DAS.

The average data of two years at 60 DAS revealed that the lowest weed biomass (2.43 g m^{-2}) of *Bulbostylis barbata* was found in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). N_2 (75% RDF + 25% organic through FYM + PSB) recorded the highest weed biomass.

4.5.3.4.2 Effect of weed management on weed biomass (g m^{-2}) of *Bulbostylis barbata* (Rottb.) C.B.Clarke

Significant results were observed on weed biomass of *Bulbostylis barbata* at all stages of observations except at 15 DAS in both the years and average data of two years. This indicated that application of Pendimethalin has no effect on the biomass of *Bulbostylis barbata.*

At 30 DAS, the average data of two years results recorded significantly lowest weed biomass of *Bulbostylis barbata* in W_2 (Hand weeding at 15, 30 and 45 DAS) treatment followed by W_3 treatment where manual weeding was carried out at 20 DAS. The application of Propaquizafop at 15 DAS also could not reduce the biomass of *Bulbostylis barbata.*

The highest weed biomass of *Bulbostylis barbata* was significantly recorded in W_1 (Weedy check) at 45 and 60 DAS. At 45 DAS, the average data

Table 4.63: Effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Bulbostylis barbata* (Rottb.) C.B.Clarke. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average	2017	2018	Average	2017	2018	Average
Nutrient management (N)												
N_1	0.73 (0.03)	0.72 (0.03)	0.73 (0.03)	1.17 (0.95)	1.17 (0.93)	1.17 (0.94)	1.64 (3.42)	1.65 (2.99)	1.65 (3.21)	1.53 (3.22)	1.49 (2.72)	1.51 (2.97)
N_2	0.73 (0.04)	0.73 (0.03)	0.73 (0.03)	1.22 (1.07)	1.21 (1.04)	1.21 (1.05)	1.74 (3.96)	1.78 (3.82)	1.76 (3.89)	1.58 (3.67)	1.53 (2.99)	1.55 (3.33)
N_3	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	1.15 (0.89)	1.18 (0.97)	1.16 (0.93)	1.53 (2.94)	1.60 (2.76)	1.56 (2.85)	1.39 (2.59)	1.40 (2.26)	1.39 (2.43)
SEm±	**0.003**	**0.001**	**0.002**	**0.03**	**0.03**	**0.02**	**0.08**	**0.09**	**0.05**	**0.03**	**0.05**	**0.02**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.11**	**NS**	**0.09**
Weed management (W)												
W_1	0.73 (0.03)	0.72 (0.02)	0.73 (0.03)	1.38 (1.42)	1.42 (1.52)	1.40 (1.47)	3.29 (10.42)	2.80 (7.38)	3.04 (8.90)	3.73 (13.46)	3.04 (8.81)	3.38 (11.14)
W_2	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00
W_3	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	1.10 (0.73)	1.14 (0.81)	1.12 (0.77)	0.90 (0.44)	1.61 (2.41)	1.25 (1.43)	1.65 (2.34)	2.21 (4.48)	1.93 (3.41)
W_4	0.73 (0.04)	0.73 (0.03)	0.73 (0.01)	1.37 (1.39)	1.34 (1.33)	1.35 (1.36)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_5	0.73 (0.03)	0.72 (0.02)	0.73 (0.03)	1.34 (1.31)	1.32 (1.26)	1.33 (1.28)	2.58 (6.34)	2.56 (6.16)	2.57 (6.25)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm±	**0.002**	**0.002**	**0.001**	**0.03**	**0.05**	**0.03**	**0.10**	**0.11**	**0.07**	**0.06**	**0.06**	**0.04**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**0.10**	**0.16**	**0.10**	**0.30**	**0.33**	**0.20**	**0.19**	**0.17**	**0.11**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.64: Interaction effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Bulbostylis barbata* (Rottb.) C.B.Clarke. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average	2017	2018	Average	2017	2018	Average
N_1W_1	0.73 (0.04)	0.72 (0.02)	0.73 (0.03)	1.42 (1.52)	1.38 (1.41)	1.40 (1.47)	3.27 (10.19)	2.77 (7.20)	3.02 (8.70)	3.68 (13.06)	3.07 (8.96)	3.38 (11.01)
N_1W_2	0.73 (0.04)	0.73 (0.03)	0.73 (0.03)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_3	0.73 (0.03)	0.72 (0.02)	0.73 (0.03)	1.08 (0.66)	1.14 (0.82)	1.11 (0.74)	1.00 (0.67)	1.57 (1.97)	1.28 (1.32)	1.87 (3.02)	2.26 (4.65)	2.06 (3.83)
N_1W_4	0.73 (0.04)	0.73 (0.03)	0.73 (0.03)	1.37 (1.41)	1.31 (1.26)	1.34 (1.34)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_5	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	1.29 (1.17)	1.29 (1.18)	1.29 (1.17)	2.53 (6.26)	2.50 (5.77)	2.51 (6.02)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_1	0.73 (0.04)	0.72 (0.02)	0.73 (0.03)	1.44 (1.58)	1.47 (1.65)	1.45 (1.62)	3.55 (12.21)	3.05 (8.83)	3.30 (10.52)	4.06 (15.96)	3.27 (10.17)	3.66 (13.07)
N_2W_2	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_3	0.73 (0.04)	0.74 (0.04)	0.73 (0.04)	1.18 (0.91)	1.12 (0.79)	1.15 (0.85)	1.00 (0.67)	1.61 (2.67)	1.31 (1.67)	1.70 (2.40)	2.27 (4.80)	1.99 (3.60)
N_2W_4	0.71 (0.03)	0.72 (0.02)	0.73 (0.03)	1.40 (1.46)	1.40 (1.46)	1.40 (1.46)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 0.00)
N_2W_5	0.73 (0.04)	0.72 (0.02)	0.73 (0.03)	1.37 (1.38)	1.34 (1.32)	1.36 (1.35)	2.72 (6.90)	2.83 (7.59)	2.77 (7.25)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_1	0.73 (0.03)	0.72 (0.02)	0.72 (0.02)	1.29 (1.16)	1.40 (1.49)	1.35 (1.33)	3.04 (8.84)	2.57 (6.11)	2.80 (7.47)	3.44 (11.37)	2.79 (7.31)	3.11 (9.34)
N_3W_2	0.72 (0.03)	0.73 (0.03)	0.73 (0.03)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_3	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	1.05 (0.62)	1.15 (0.84)	1.10 (0.73)	0.71 (0.00)	1.63 (2.60)	1.17 (1.30)	1.37 (1.61)	2.10 (3.99)	1.74 (2.80)
N_3W_4	0.73 (0.04)	0.73 (0.03)	0.73 (0.03)	1.34 (1.30)	1.30 (1.26)	1.32 (1.28)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_5	0.73 (0.03)	0.72 (0.02)	0.72 (0.02)	1.37 (1.37)	1.33 (1.27)	1.35 (1.32)	2.51 (5.86)	2.36 (5.11)	2.44 (5.48)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm± (N×W)	**0.003**	**0.004**	**0.003**	**0.06**	**0.09**	**0.06**	**0.18**	**0.20**	**0.12**	**0.11**	**0.10**	**0.06**
SEm± (W×N)	**0.004**	**0.002**	**0.002**	**0.05**	**0.07**	**0.04**	**0.15**	**0.15**	**0.09**	**0.08**	**0.08**	**0.05**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.19**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.15**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

of two years revealed that the lowest weed biomass was found at W_2 and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS) treatment. At 60 DAS, the average data of two years revealed that weed biomass of *Bulbostylis barbata* was found effectively controlled in W_2, W_4 and W_5 treatments.

4.5.3.4.3 Interaction effect on weed biomass (g m^{-2}) of *Bulbostylis barbata* (Rottb.) C.B.Clarke

The study found no significant effect on weed biomass of *Bulbostylis barbata* due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observation except at 60 DAS (average data of two years). At 60 DAS, the average data of two years recorded highest weed biomass (13.07 g m^{-2}) of *Bulbostylis barbata* in $N_2 \times W_2$ interaction.

4.5.3.5 Weed biomass (g m^{-2}) of *Cyperus iria* L.

The data on weed biomass (g m^{-2}) of *Cyperus iria* L. at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.31 and 4.32.

4.5.3.5.1 Effect of nutrient management on weed biomass (g m^{-2}) of *Cyperus iria* L.

An inquisition on two years' data and average data of two years on weed biomass of *Cyperus iria* revealed no significant variation among the nutrient treatments at various stages of observations except at 15 DAS.

At 15 DAS, the average data of two years revealed significantly lowest weed biomass (0.70 g m^{-2}) of *Cyperus iria* in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). And the highest weed biomass was recorded in N_1 (100% RDF) treatment.

Table 4.65: Effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Cyperus iria* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	1.20 (0.95)	1.16 (0.87)	1.18 (0.91)	2.56 (6.90)	2.35 (5.70)	2.45 (6.30)	3.50 (16.65)	3.32 (14.93)	3.41 (15.79)	3.03 (14.87)	2.92 (12.72)	2.98 (13.80)
N_2	1.35 (1.33)	1.21 (0.97)	1.28 (1.15)	2.51 (6.62)	2.42 (6.08)	2.46 (6.35)	3.54 (17.23)	3.36 (15.36)	3.45 (16.30)	3.12 (15.67)	2.99 (13.66)	3.06 (14.67)
N_3	1.07 (0.67)	1.10 (0.73)	1.09 (0.70)	2.40 (6.00)	2.32 (5.65)	2.36 (5.83)	3.17 (13.74)	3.17 (13.41)	3.17 (13.57)	2.86 (12.50)	2.74 (11.67)	2.80 (12.08)
SEm±	**0.03**	**0.02**	**0.02**	**0.07**	**0.08**	**0.05**	**0.10**	**0.09**	**0.09**	**0.10**	**0.19**	**0.09**
CD (*p*=0.05)	**0.10**	**NS**	**0.09**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	1.25 (1.08)	1.18 (0.89)	1.21 (0.99)	3.20 (9.79)	3.00 (8.49)	3.10 (9.14)	6.57 (42.79)	6.01 (35.82)	6.29 (39.31)	7.37 (54.00)	6.61 (43.31)	6.99 (48.65)
W_2	1.20 (0.96)	1.15 (0.84)	1.18 (0.90)	0.96 (0.42)	0.92 (0.35)	0.94 (0.39)	0.71 (0.00)	0.73 (0.04)	0.72 (0.02)	0.71 (0.00)	0.78 (0.14)	0.74 (0.07)
W_3	1.23 (1.04)	1.13 (0.81)	1.18 (0.92)	2.08 (3.91)	1.95 (3.47)	2.02 (3.69)	3.34 (10.99)	3.86 (14.81)	3.60 (12.90)	3.51 (12.24)	3.96 (15.85)	3.73 (14.04)
W_4	1.17 (0.88)	1.15 (0.86)	1.16 (0.87)	3.01 (8.65)	3.07 (8.93)	3.04 (8.79)	1.51 (1.97)	1.14 (0.92)	1.33 (1.45)	2.11 (4.06)	1.82 (2.84)	1.97 (3.45)
W_5	1.19 (0.95)	1.17 (0.88)	1.18 (0.92)	3.19 (9.77)	2.88 (7.82)	3.03 (8.79)	4.90 (23.62)	4.66 (21.23)	4.78 (22.43)	1.33 (1.44)	1.26 (1.28)	1.30 (1.36)
SEm±	**0.04**	**0.06**	**0.04**	**0.09**	**0.08**	**0.06**	**0.14**	**0.15**	**0.12**	**0.15**	**0.16**	**0.10**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**0.26**	**0.24**	**0.19**	**0.40**	**0.44**	**0.36**	**0.45**	**0.47**	**0.29**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.66: Interaction effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Cyperus iria* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
N_1W_1	1.24 (1.04)	1.17 (0.89)	1.21 (0.96)	3.25 (10.06)	3.03 (8.68)	3.14 (9.37)	6.77 (45.41)	6.20 (38.13)	6.48 (41.77)	7.56 (56.67)	6.58 (42.83)	7.07 (49.75)
N_1W_2	1.18 (0.90)	1.19 (0.91)	1.18 (0.91)	0.93 (0.36)	0.93 (0.36)	0.93 (0.36)	0.71 (0.00)	0.75 (0.06)	0.73 (0.03)	0.71 (0.00)	0.91 (0.42)	0.81 (0.21)
N_1W_3	1.22 (0.99)	1.10 (0.77)	1.16 (0.88)	2.24 (4.54)	1.95 (3.36)	2.10 (3.95)	3.43 (11.45)	3.84 (14.48)	3.64 (12.96)	3.52 (12.24)	3.98 (15.98)	3.75 (14.11)
N_1W_4	1.17 (0.88)	1.16 (0.89)	1.16 (0.88)	3.20 (9.75)	2.95 (8.22)	3.08 (8.99)	1.61 (2.09)	1.18 (1.04)	1.40 (1.57)	2.23 (4.58)	1.88 (3.05)	2.05 (3.82)
N_1W_5	1.19 (0.95)	1.18 (0.89)	1.19 (0.92)	3.19 (9.79)	2.87 (7.84)	3.03 (8.82)	4.97 (24.32)	4.63 (20.93)	4.80 (22.63)	1.14 (0.88)	1.27 (1.31)	1.20 (1.10)
N_2W_1	1.41 (1.51)	1.21 (0.96)	1.31 (1.23)	3.40 (11.09)	3.11 (9.14)	3.25 (10.12)	6.81 (45.87)	6.21 (38.13)	6.51 (42.00)	7.66 (58.25)	6.87 (46.67)	7.26 (52.46)
N_2W_2	1.34 (1.30)	1.19 (0.91)	1.26 (1.10)	1.01 (0.53)	0.93 (0.37)	0.97 (0.45)	0.71 (0.00)	0.73 (0.03)	0.72 (0.02)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_3	1.37 (1.39)	1.20 (0.93)	1.29 (1.16)	2.06 (3.84)	2.07 (3.90)	2.06 (3.87)	3.68 (13.43)	3.95 (15.82)	3.82 (14.63)	3.75 (14.28)	4.13 (17.00)	3.94 (15.64)
N_2W_4	1.30 (1.20)	1.22 (1.00)	1.26 (1.10)	2.93 (8.21)	3.13 (9.28)	3.03 (8.75)	1.51 (2.11)	1.18 (1.04)	1.35 (1.57)	2.13 (4.17)	1.85 (2.96)	1.99 (3.56)
N_2W_5	1.33 (1.27)	1.24 (1.05)	1.29 (1.16)	3.14 (9.40)	2.86 (7.72)	3.00 (8.56)	5.01 (24.75)	4.72 (21.78)	4.86 (23.26)	1.36 (1.67)	1.40 (1.69)	1.38 (1.68)
N_3W_1	1.09 (0.69)	1.15 (0.84)	1.12 (0.76)	2.95 (8.20)	2.85 (7.63)	2.90 (7.92)	6.13 (37.09)	5.63 (31.20)	5.88 (34.15)	6.90 (47.08)	6.39 (40.42)	6.64 (43.75)
N_3W_2	1.09 (0.69)	1.09 (0.70)	1.09 (0.70)	0.93 (0.37)	0.91 (0.32)	0.92 (0.35)	0.71 (0.00)	0.73 (0.03)	0.72 (0.02)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_3	1.11 (0.74)	1.10 (0.72)	1.10 (0.73)	1.95 (3.36)	1.84 (3.14)	1.90 (3.25)	2.92 (8.08)	3.79 (14.14)	3.35 (11.11)	3.26 (10.20)	3.76 (14.57)	3.51 (12.38)
N_3W_4	1.03 (0.57)	1.07 (0.70)	1.05 (0.64)	2.90 (7.97)	3.13 (9.28)	3.02 (8.63)	1.40 (1.72)	1.06 (0.69)	1.23 (1.21)	1.96 (3.43)	1.74 (2.52)	1.85 (2.98)
N_3W_5	1.06 (0.64)	1.09 (0.70)	1.08 (0.67)	3.24 (10.11)	2.89 (7.89)	3.07 (9.00)	4.72 (21.80)	4.63 (20.98)	4.68 (21.39)	1.49 (1.78)	1.12 (0.84)	1.31 (1.31)
SEm± (N×W)	**0.07**	**0.10**	**0.06**	**0.15**	**0.14**	**0.11**	**0.24**	**0.26**	**0.22**	**0.27**	**0.28**	**0.17**
SEm± (W×N)	**0.05**	**0.07**	**0.05**	**0.12**	**0.12**	**0.09**	**0.18**	**0.19**	**0.16**	**0.20**	**0.26**	**0.14**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x+0.5}$ transformation.

4.5.3.5.2 Effect of weed management on weed biomass (g m^{-2}) of *Cyperus iria* L.

Significant results were observed on weed biomass of *Cyperus iria* at all stages of observations except at 15 DAS in both the years and average data of two years.

At 30 DAS, W_2 recorded the lowest weed biomass of *Cyperus iria* followed by W_3 where manual weeding was carried out at 20 DAS. The application of Propaquizafop at 15 DAS could not decrease the biomass of *Cyperus iria*. At 45 DAS, W_2 continued to exhibit lowest weed biomass followed by W_4 where hand weeding was incorporated at 30 DAS. The data at 60 DAS showed lowest weed biomass in W_2 treatment which was followed by W_5 treatment and W_4 treatment.

4.5.3.5.3 Interaction effect on weed biomass (g m^{-2}) of *Cyperus iria* L.

The study found no significant effect on weed biomass of *Cyperus iria* L. due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observation.

4.5.3.6 Weed biomass (g m^{-2}) of *Cyperus kyllingia* L.

The data on weed biomass of *Cyperus kyllingia* L. at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.67 and 4.68.

4.5.3.6.1 Effect of nutrient management on weed biomass (g m^{-2}) of *Cyperus kyllingia* L.

An inquisition on two years' data and average data of two years on weed of *Cyperus kyllingia* L. revealed no significant variation among the nutrient treatments at various stages of observations except at 45 DAS.

The average data of two years at 45 DAS revealed that significantly lowest weed biomass (1.18 g m^{-2}) of *Cyperus kyllingia* was found in N_3 (50% RDF +

50% organic through *Rhizobium* + PSB). The highest weed biomass was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment which was at par with N_1 (100% RDF) treatment.

4.5.3.6.2 Effect of weed management on weed biomass (g m^{-2}) of *Cyperus kyllingia* L.

Significant results were observed on weed biomass of *Cyperus kyllingia* at all stages of observations in both the years of experiment and average data of two years.

The highest weed biomass of *Cyperus kyllingia* was recorded in W_1 (Weedy check) at all stages of observations.

At 15 DAS, the lowest biomass of this weed was found in W_4 treatment. This might be due to the application of Pendimethalin which did not significantly reduced density of *Cyperus kyllingia* but reduced the weed biomass.

The average data of two years results revealed that the lowest weed biomass at 30 DAS was found at W_2. It can be seen from the table that application of Propaquizafop at 15 DAS, had no effect of this crop. In the case of Pendimethalin, from 30 DAS data, there has been slight increase in the biomass of this weed which might be due to shorter half-life of this herbicide as a result of soil moisture and temperature. Kočárek *et al*. (2016) concluded that the pendimethalin half-life ranged from 24.4 to 34.4 days.

At 45 DAS, the average data of two years revealed that the weed biomass of *Cyperus kyllingia* was effectively controlled in W_2 and W_4 treatments. This might be due to hand weeding carried out at 30 DAS. The mechanical weeding carried out in W_3 treatment also helped in reducing this weed biomass.

Table 4.67: Effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Cyperus kyllingia* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	0.77 (0.09)	0.75 (0.07)	0.76 (0.08)	1.12 (0.83)	1.00 (0.54)	1.06 (0.68)	1.31 (1.55)	1.24 (1.27)	1.27 (1.41)	1.22 (1.46)	1.09 (0.96)	1.16 (1.21)
N_2	0.77 (0.09)	0.76 (0.09)	0.77 (0.09)	1.13 (0.84)	1.04 (0.63)	1.08 (0.74)	1.37 (1.78)	1.23 (1.23)	1.30 (1.50)	1.28 (1.74)	1.04 (0.88)	1.16 (1.31)
N_3	0.76 (0.07)	0.74 (0.05)	0.75 (0.06)	1.07 (0.69)	0.96 (0.46)	1.01 (0.58)	1.27 (1.43)	1.13 (0.93)	1.20 (1.18)	1.22 (1.48)	1.00 (0.68)	1.11 (1.08)
SEm±	**0.004**	**0.01**	**0.01**	**0.05**	**0.04**	**0.04**	**0.02**	**0.03**	**0.02**	**0.02**	**0.03**	**0.02**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.07**	**NS**	**0.06**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	0.79 (0.12)	0.79 (0.13)	0.79 (0.13)	1.37 (1.39)	1.19 (0.92)	1.28 (1.15)	2.22 (4.47)	1.83 (2.89)	2.03 (3.68)	2.50 (5.80)	1.97 (3.40)	2.24 (4.60)
W_2	0.76 (0.08)	0.75 (0.07)	0.76 (0.07)	0.73 (0.04)	0.71 (0.00)	0.72 (0.02)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_3	0.77 (0.09)	0.76 (0.08)	0.77 (0.09)	0.94 (0.40)	0.86 (0.25)	0.90 (0.33)	1.26 (1.09)	1.25 (1.07)	1.25 (1.08)	1.57 (1.99)	1.10 (0.75)	1.34 (1.37)
W_4	0.74 (0.04)	0.72 (0.02)	0.73 (0.03)	1.30 (1.20)	1.17 (0.89)	1.24 (1.04)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_5	0.76 (0.08)	0.74 (0.05)	0.75 (0.07)	1.18 (0.90)	1.06 (0.65)	1.12 (0.78)	1.69 (2.38)	1.50 (1.75)	1.60 (2.06)	0.71 (0.00)	0.74 (0.05)	0.72 (0.03)
SEm±	**0.01**	**0.01**	**0.004**	**0.04**	**0.04**	**0.03**	**0.03**	**0.02**	**0.02**	**0.03**	**0.04**	**0.03**
CD (*p*=0.05)	**0.02**	**0.02**	**0.012**	**0.10**	**0.12**	**0.08**	**0.07**	**0.07**	**0.05**	**0.09**	**0.11**	**0.08**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.68: Interaction effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Cyperus kyllingia* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average	2017	2018	Average	2017	2018	Average
N_1W_1	0.79 (0.12)	0.79 (0.12)	0.79 (0.12)	1.41 (1.49)	1.19 (0.91)	1.30 (1.20)	2.17 (4.25)	1.93 (3.26)	2.05 (3.75)	2.41 (5.33)	2.03 (3.62)	2.22 (4.47)
N_1W_2	0.78 (0.11)	0.75 (0.07)	0.77 (0.09)	0.72 (0.02)	0.71 (0.00)	0.72 (0.01)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_3	0.77 (0.09)	0.75 (0.07)	0.76 (0.08)	0.97 (0.48)	0.88 (0.29)	0.92 (0.38)	1.26 (1.09)	1.26 (1.09)	1.26 (1.09)	1.56 (1.95)	1.23 (1.03)	1.40 (1.49)
N_1W_4	0.73 (0.04)	0.73 (0.03)	0.73 (0.04)	1.32 (1.24)	1.18 (0.91)	1.25 (1.07)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_5	0.76 (0.08)	0.75 (0.07)	0.76 (0.07)	1.19 (0.91)	1.03 (0.57)	1.11 (0.74)	1.71 (2.41)	1.57 (1.98)	1.64 (2.20)	0.71 (0.00)	0.80 (0.16)	0.75 (0.08)
N_2W_1	0.79 (0.13)	0.82 (0.17)	0.80 (0.15)	1.43 (1.54)	1.21 (0.98)	1.32 (1.26)	2.35 (5.02)	1.89 (3.09)	2.12 (4.05)	2.63 (6.43)	2.06 (3.76)	2.35 (5.10)
N_2W_2	0.75 (0.06)	0.77 (0.10)	0.76 (0.08)	0.76 (0.08)	0.71 (0.00)	0.73 (0.04)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_3	0.78 (0.10)	0.77 (0.10)	0.78 (0.10)	0.96 (0.43)	0.89 (0.31)	0.92 (0.37)	1.35 (1.33)	1.34 (1.31)	1.35 (1.32)	1.66 (2.26)	1.03 (0.62)	1.34 (1.44)
N_2W_4	0.74 (0.05)	0.72 (0.02)	0.73 (0.03)	1.33 (1.28)	1.18 (0.92)	1.26 (1.10)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_5	0.78 (0.11)	0.74 (0.05)	0.76 (0.08)	1.15 (0.88)	1.20 (0.95)	1.18 (0.91)	1.74 (2.54)	1.50 (1.74)	1.62 (2.14)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_1	0.78 (0.12)	0.77 (0.10)	0.78 (0.11)	1.28 (1.13)	1.17 (0.87)	1.22 (1.00)	2.15 (4.14)	1.68 (2.32)	1.91 (3.23)	2.48 (5.65)	1.82 (2.82)	2.15 (4.24)
N_3W_2	0.76 (0.07)	0.73 (0.03)	0.74 (0.05)	0.72 (0.02)	0.71 (0.00)	0.71 (0.01)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_3	0.75 (0.07)	0.76 (0.08)	0.76 (0.08)	0.89 (0.30)	0.80 (0.17)	0.85 (0.23)	1.16 (0.85)	1.15 (0.82)	1.16 (0.84)	1.50 (1.76)	1.05 (0.60)	1.27 (1.18)
N_3W_4	0.74 (0.04)	0.72 (0.02)	0.73 (0.03)	1.26 (1.08)	1.15 (0.84)	1.21 (0.96)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_5	0.75 (0.07)	0.73 (0.03)	0.74 (0.05)	1.19 (0.91)	0.95 (0.44)	1.07 (0.67)	1.63 (2.17)	1.42 (1.53)	1.53 (1.85)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm± (N×W)	**0.01**	**0.01**	**0.01**	**0.06**	**0.07**	**0.05**	**0.04**	**0.04**	**0.03**	**0.05**	**0.07**	**0.05**
SEm± (W×N)	**0.01**	**0.01**	**0.01**	**0.06**	**0.06**	**0.05**	**0.03**	**0.04**	**0.02**	**0.04**	**0.05**	**0.04**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.11**	**0.08**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.13**	**0.08**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

At 60 DAS, the average data of two years revealed that hand weeding at 30 DAS and 45 DAS in W_2 and W_4 treatments, respectively effectively controlled biomass of *Cyperus kyllingia*. This was followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) treatment. In both W_4 and W_5 treatments, with the integration of hand weeding at 30 and 45 DAS, respectively the biomass of this weed was controlled.

4.5.3.6.3 Interaction effect on weed biomass (g m^{-2}) of *Cyperus kyllingia* L.

The study found no significant effect on weed biomass of *Cyperus kyllingia* L. due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observation except at 45 DAS.

At 45 DAS, the average data of two years results revealed that significantly highest weed biomass (4.05 g m^{-2}) of *Cyperus kyllingia* was recorded in $N_2 \times W_1$ interaction.

4.5.3.7 Weed biomass (g m^{-2}) of *Cyperus rotundus* L.

The data on weed biomass (g m^{-2}) of *Cyperus rotundus* L. at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.69 and 4.70.

4.5.3.7.1 Effect of nutrient management on weed biomass (g m^{-2}) of *Cyperus rotundus* L.

An inquisition on two years' data and average data of two years on weed of *Cyperus rotundus* revealed no significant variation among the nutrient treatments at all stages of observation.

4.5.3.7.2 Effect of weed management on weed biomass (g m^{-2}) of *Cyperus rotundus* L.

Significant results were observed on weed biomass of *Cyperus rotundus* at all stages of observations in both the years of experiment and average data of two years.

The data recorded at 30 DAS showed lowest weed biomass in W_2 treatment which is due to hand weeding carried out at 15 DAS followed by W_3 as manual weeding was done at 20 DAS. At this stage (*i.e*. 30 DAS) increase in weed biomass of *Cyperus rotundus* from 15 DAS indicated that application of Propaquizafop at 15 DAS did not reduce the biomass of this weed.

At 45 DAS, W_2 continued to exhibit lowest weed biomass which was followed by W_3 which was at par with W_4. At 60 DAS, it was found that where hand weeding was carried out at 45 DAS there was complete control of this weed.

4.5.3.7.3 Interaction effect on weed biomass (g m^{-2}) of *Cyperus rotundus* L.

The study found no significant effect on weed biomass of *Cyperus rotundus* due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observations.

4.5.3.8 Weed biomass (g m^{-2}) of *Ageratum conyzoides* L.

The data on weed biomass (g m^{-2}) of *Ageratum conyzoides* at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.71 and 4.72.

Table 4.69: Effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Cyperus rotundus* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	0.86 (0.24)	0.83 (0.19)	0.84 (0.21)	1.28 (1.25)	1.21 (1.06)	1.24 (1.16)	1.47 (2.22)	1.59 (2.57)	1.53 (2.39)	1.39 (2.18)	1.45 (2.39)	1.42 (2.28)
N_2	0.84 (0.20)	0.85 (0.22)	0.84 (0.21)	1.32 (1.37)	1.21 (1.05)	1.26 (1.21)	1.53 (2.51)	1.63 (2.81)	1.58 (2.66)	1.49 (2.62)	1.52 (2.73)	1.50 (2.68)
N_3	0.84 (0.20)	0.81 (0.17)	0.83 (0.18)	1.23 (1.11)	1.18 (0.99)	1.20 (1.05)	1.42 (1.98)	1.54 (2.35)	1.48 (2.16)	1.33 (1.94)	1.39 (2.10)	1.36 (2.02)
SEm±	**0.01**	**0.01**	**0.01**	**0.03**	**0.04**	**0.03**	**0.04**	**0.06**	**0.03**	**0.03**	**0.06**	**0.03**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	0.88 (0.27)	0.89 (0.29)	0.88 (0.28)	1.56 (1.95)	1.55 (1.91)	1.55 (1.93)	2.48 (5.70)	2.75 (7.10)	2.62 (6.40)	3.00 (8.56)	3.09 (9.09)	3.05 (8.82)
W_2	0.82 (0.17)	0.80 (0.14)	0.81 (0.16)	0.73 (0.04)	0.73 (0.04)	0.73 (0.04)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_3	0.86 (0.24)	0.83 (0.19)	0.84 (0.21)	1.06 (0.62)	1.00 (0.55)	1.03 (0.59)	0.78 (0.13)	1.24 (1.08)	1.01 (0.61)	0.94 (0.41)	1.40 (1.55)	1.17 (0.98)
W_4	0.87 (0.25)	0.84 (0.21)	0.85 (0.23)	1.54 (1.89)	1.39 (1.45)	1.47 (1.67)	1.22 (1.06)	1.17 (0.90)	1.19 (0.98)	1.64 (2.27)	1.37 (1.40)	1.50 (1.83)
W_5	0.80 (0.14)	0.79 (0.13)	0.80 (0.13)	1.49 (1.71)	1.31 (1.23)	1.40 (1.47)	2.19 (4.30)	2.07 (3.80)	2.13 (4.05)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm±	**0.01**	**0.01**	**0.01**	**0.03**	**0.05**	**0.03**	**0.06**	**0.06**	**0.04**	**0.06**	**0.06**	**0.04**
CD (*p*=0.05)	**0.03**	**0.04**	**0.02**	**0.08**	**0.13**	**0.08**	**0.17**	**0.16**	**0.11**	**0.16**	**0.18**	**0.12**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.70: Interaction effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Cyperus rotundus* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average	2017	2018	Average	2017	2018	Average
N_1W_1	0.90 (0.31)	0.87 (0.26)	0.89 (0.29)	1.56 (1.94)	1.58 (2.00)	1.57 (1.97)	2.51 (5.83)	2.75 (7.05)	2.63 (6.44)	2.98 (8.40)	3.08 (9.00)	3.03 (8.70)
N_1W_2	0.85 (0.22)	0.80 (0.14)	0.82 (0.18)	0.73 (0.03)	0.73 (0.04)	0.73 (0.03)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_3	0.87 (0.26)	0.81 (0.16)	0.84 (0.21)	1.05 (0.62)	0.98 (0.51)	1.02 (0.56)	0.82 (0.20)	1.28 (1.17)	1.05 (0.68)	0.94 (0.41)	1.33 (1.34)	1.13 (0.88)
N_1W_4	0.87 (0.26)	0.85 (0.23)	0.86 (0.25)	1.55 (1.90)	1.43 (1.55)	1.49 (1.73)	1.14 (0.80)	1.20 (0.94)	1.17 (0.87)	1.59 (2.07)	1.45 (1.60)	1.52 (1.83)
N_1W_5	0.80 (0.14)	0.80 (0.14)	0.80 (0.14)	1.50 (1.76)	1.31 (1.21)	1.41 (1.49)	2.19 (4.29)	2.04 (3.67)	2.11 (3.98)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_1	0.87 (0.26)	0.92 (0.34)	0.90 (0.30)	1.66 (2.25)	1.60 (2.08)	1.63 (2.16)	2.68 (6.72)	2.91 (7.99)	2.80 (7.35)	3.21 (9.83)	3.27 (10.20)	3.24 (10.02)
N_2W_2	0.77 (0.10)	0.81 (0.16)	0.79 (0.13)	0.75 (0.07)	0.74 (0.05)	0.75 (0.06)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_3	0.87 (0.26)	0.87 (0.26)	0.87 (0.26)	1.10 (0.73)	1.00 (0.50)	1.05 (0.61)	0.71 (0.00)	1.26 (1.10)	0.98 (0.55)	1.05 (0.61)	1.56 (2.07)	1.31 (1.34)
N_2W_4	0.86 (0.24)	0.83 (0.19)	0.84 (0.21)	1.59 (2.05)	1.36 (1.39)	1.48 (1.72)	1.32 (1.26)	1.16 (0.96)	1.24 (1.11)	1.76 (2.67)	1.36 (1.40)	1.56 (2.03)
N_2W_5	0.80 (0.15)	0.81 (0.16)	0.81 (0.16)	1.50 (1.76)	1.32 (1.25)	1.41 (1.51)	2.25 (4.57)	2.11 (4.00)	2.18 (4.28)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_1	0.86 (0.24)	0.88 (0.27)	0.87 (0.26)	1.47 (1.66)	1.46 (1.67)	1.46 (1.67)	2.24 (4.54)	2.60 (6.25)	2.42 (5.40)	2.82 (7.43)	2.93 (8.07)	2.87 (7.75)
N_3W_2	0.83 (0.19)	0.78 (0.12)	0.81 (0.16)	0.73 (0.03)	0.72 (0.02)	0.72 (0.02)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_3	0.83 (0.19)	0.80 (0.14)	0.81 (0.17)	1.01 (0.53)	1.03 (0.64)	1.02 (0.59)	0.82 (0.20)	1.19 (0.97)	1.00 (0.58)	0.82 (0.21)	1.30 (1.24)	1.06 (0.72)
N_3W_4	0.87 (0.26)	0.84 (0.21)	0.86 (0.24)	1.49 (1.71)	1.38 (1.42)	1.43 (1.56)	1.22 (1.12)	1.14 (0.80)	1.18 (0.96)	1.57 (2.07)	1.29 (1.20)	1.43 (1.63)
N_3W_5	0.78 (0.12)	0.77 (0.09)	0.78 (0.11)	1.45 (1.61)	1.31 (1.22)	1.38 (1.42)	2.12 (4.03)	2.06 (3.73)	2.09 (3.88)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm± (N×W)	**0.02**	**0.02**	**0.01**	**0.05**	**0.08**	**0.05**	**0.10**	**0.10**	**0.06**	**0.10**	**0.11**	**0.07**
SEm± (W×N)	**0.01**	**0.02**	**0.01**	**0.04**	**0.06**	**0.04**	**0.08**	**0.08**	**0.05**	**0.07**	**0.09**	**0.05**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

4.5.3.8.1 Effect of nutrient management on weed biomass (g m^{-2}) of *Ageratum conyzoides* L.

An inquisition on two years' data and average data of two years on weed of *Ageratum conyzoides* revealed no significant variation among the nutrient treatments at all stages of observations except at 15 DAS.

At 15 DAS, the first year data (2017) significantly highest weed biomass was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment.

4.5.3.8.2 Effect of weed management on weed biomass (g m^{-2}) of *Ageratum conyzoides* L.

Significant results were observed on weed biomass of *Ageratum conyzoides* at all stages of observations in both the years of experiment and average data of two years. The highest weed biomass was recorded in W_1 (Weedy check) at all stages of observations.

At 15 DAS, the average data of two years results recorded significantly lowest weed biomass of *Ageratum conyzoides* in W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatment over all the other weed management treatments.

At 30 DAS, the average data of two years revealed that W_2 treatment reduced the weed biomass of *Ageratum conyzoides* due to hand weeding at 15 DAS and showed lowest weed density followed by W_4. It is seen from the Table 4.71 at 30 DAS that application of Propaquizafop in W_5 treatment did not significantly reduce the weed biomass of *Ageratum conyzoides.*

At 45 DAS, lowest weed biomass of *Ageratum conyzoides* is recorded in W_4 followed by W_3 treatment. The hand weeding carried out at 30 DAS in W_4 treatment might have resulted in lowest weed biomass. The weed biomass reduction of *Ageratum conyzoides* in W_3 treatment might be due to effect of mechanical weeding carried out at 40 DAS.

At 60 DAS, the average data of two years revealed significantly lowest weed biomass was at W_2 (Hand weeding at 15, 30 and 45 DAS) treatment followed by W_5, W_4 and W_3 treatments.

Three hand weeding in W_2 treatment effectively eliminated *Ageratum conyzoides.* The integration of Pendimethalin and one hand weeding resulted in effective control of *Ageratum conyzoides* over weedy check. Similar findings were reported by Chander *et al*. (2013). The data from 15, 30 and 45 DAS, indicated that W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) treatments could not reduce the dry weight of *Ageratum conyzoides*. Kumar *et al.* (2018c) also reported that propaquizafop could not significantly reduce the dry weight of *Ageratum conyzoides* over weedy check. The weed in concern was effectively controlled in W_5 treamtent only after integration of one hand weeding at 45 DAS.

4.5.3.8.3 Interaction effect on weed biomass (g m^{-2}) of *Ageratum conyzoides* L.

The study found no significant effect on weed biomass of *Ageratum conyzoides* due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observations.

Table 4.71: Effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Ageratum conyzoides* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	0.73 (0.03)	0.72 (0.02)	0.73 (0.03)	0.95 (0.43)	0.89 (0.31)	0.92 (1.16)	1.06 (0.74)	1.02 (0.61)	1.04 (0.67)	1.12 (0.90)	1.13 (0.84)	1.13 (0.87)
N_2	0.73 (0.04)	0.74 (0.03)	0.73 (0.03)	0.98 (0.48)	0.92 (0.36)	0.95 (1.21)	1.10 (0.86)	1.10 (0.75)	1.10 (0.81)	1.16 (1.01)	1.19 (1.00)	1.18 (1.00)
N_3	0.73 (0.03)	0.73 (0.02)	0.73 (0.03)	0.95 (0.42)	0.88 (0.29)	0.92 (1.05)	1.03 (0.69)	1.04 (0.62)	1.04 (0.66)	1.07 (0.78)	1.10 (0.76)	1.08 (0.77)
SEm±	**0.001**	**0.003**	**0.001**	**0.02**	**0.02**	**0.02**	**0.04**	**0.02**	**0.02**	**0.04**	**0.03**	**0.03**
CD (*p*=0.05)	**0.004**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	0.74 (0.05)	0.72 (0.02)	0.73 (0.04)	1.13 (0.78)	1.04 (0.59)	1.09 (1.93)	1.69 (2.36)	1.45 (1.60)	1.57 (1.98)	1.85 (2.95)	1.56 (1.93)	1.71 (2.44)
W_2	0.73 (0.04)	0.73 (0.03)	0.73 (0.03)	0.82 (0.18)	0.81 (0.16)	0.82 (0.04)	0.97 (0.46)	0.92 (0.36)	0.94 (0.41)	0.82 (0.19)	0.86 (0.25)	0.84 (0.22)
W_3	0.74 (0.04)	0.73 (0.04)	0.73 (0.04)	0.94 (0.39)	0.89 (0.30)	0.92 (0.59)	0.81 (0.17)	0.97 (0.43)	0.89 (0.30)	1.05 (0.62)	1.05 (0.63)	1.05 (0.62)
W_4	0.71 (0.00)	0.71 (0.01)	0.71 (0.00)	0.86 (0.24)	0.78 (0.11)	0.82 (1.67)	0.71 (0.00)	0.82 (0.18)	0.77 (0.09)	0.91 (0.34)	1.20 (0.96)	1.06 (0.65)
W_5	0.73 (0.04)	0.73 (0.03)	0.73 (0.03)	1.06 (0.63)	0.96 (0.44)	1.01 (1.47)	1.14 (0.82)	1.11 (0.74)	1.13 (0.78)	0.94 (0.40)	1.03 (0.56)	0.98 (0.48)
SEm±	**0.003**	**0.003**	**0.002**	**0.02**	**0.02**	**0.02**	**0.03**	**0.03**	**0.02**	**0.04**	**0.04**	**0.03**
CD (*p*=0.05)	**0.01**	**0.01**	**0.01**	**0.07**	**0.07**	**0.06**	**0.10**	**0.09**	**0.06**	**0.12**	**0.11**	**0.08**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.72: Interaction effect of nutrient and weed management treatments on weed biomass (g m^{-2}) *Ageratum conyzoides* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
N_1W_1	0.74 (0.04)	0.72 (0.02)	0.73 (0.03)	1.09 (0.70)	1.02 (0.55)	1.06 (1.97)	1.63 (2.18)	1.48 (1.68)	1.55 (1.93)	1.82 (2.81)	1.57 (1.97)	1.69 (2.39)
N_1W_2	0.73 (0.03)	0.72 (0.02)	0.73 (0.03)	0.81 (0.16)	0.80 (0.14)	0.80 (0.03)	0.97 (0.48)	0.79 (0.14)	0.88 (0.31)	0.85 (0.24)	0.82 (0.17)	0.83 (0.20)
N_1W_3	0.73 (0.04)	0.73 (0.03)	0.73 (0.04)	0.94 (0.40)	0.90 (0.30)	0.92 (0.56)	0.85 (0.23)	0.94 (0.38)	0.89 (0.31)	1.11 (0.74)	1.06 (0.64)	1.09 (0.69)
N_1W_4	0.71 (0.00)	0.71 (0.01)	0.71 (0.00)	0.86 (0.24)	0.78 (0.11)	0.82 (1.73)	0.71 (0.00)	0.79 (0.12)	0.75 (0.06)	0.90 (0.32)	1.17 (0.87)	1.03 (0.60)
N_1W_5	0.73 (0.04)	0.73 (0.03)	0.73 (0.03)	1.06 (0.64)	0.97 (0.44)	1.02 (1.49)	1.13 (0.79)	1.10 (0.73)	1.12 (0.76)	0.93 (0.40)	1.02 (0.55)	0.98 (0.48)
N_2W_1	0.75 (0.06)	0.73 (0.03)	0.74 (0.04)	1.16 (0.85)	1.06 (0.63)	1.11 (2.16)	1.77 (2.65)	1.49 (1.73)	1.63 (2.19)	1.95 (3.30)	1.60 (2.07)	1.78 (2.69)
N_2W_2	0.74 (0.05)	0.73 (0.04)	0.74 (0.04)	0.84 (0.21)	0.82 (0.19)	0.83 (0.06)	0.98 (0.47)	0.99 (0.50)	0.99 (0.48)	0.86 (0.24)	0.90 (0.33)	0.88 (0.28)
N_2W_3	0.74 (0.04)	0.74 (0.04)	0.74 (0.04)	0.94 (0.40)	0.91 (0.33)	0.93 (0.61)	0.79 (0.13)	1.01 (0.53)	0.90 (0.33)	1.08 (0.67)	1.13 (0.81)	1.11 (0.74)
N_2W_4	0.71 (0.00)	0.72 (0.01)	0.71 (0.01)	0.86 (0.24)	0.78 (0.11)	0.82 (1.72)	0.71 (0.00)	0.85 (0.23)	0.78 (0.11)	0.94 (0.38)	1.27 (1.12)	1.10 (0.75)
N_2W_5	0.74 (0.05)	0.72 (0.02)	0.73 (0.04)	1.10 (0.72)	1.02 (0.54)	1.06 (1.51)	1.24 (1.04)	1.14 (0.80)	1.19 (0.92)	0.96 (0.47)	1.06 (0.64)	1.01 (0.56)
N_3W_1	0.74 (0.05)	0.72 (0.02)	0.73 (0.04)	1.13 (0.78)	1.04 (0.59)	1.09 (1.67)	1.66 (2.26)	1.37 (1.38)	1.52 (1.82)	1.80 (2.73)	1.50 (1.75)	1.65 (2.24)
N_3W_2	0.73 (0.04)	0.73 (0.03)	0.73 (0.03)	0.82 (0.17)	0.80 (0.14)	0.81 (0.02)	0.96 (0.42)	0.97 (0.44)	0.96 (0.43)	0.76 (0.08)	0.86 (0.25)	0.81 (0.17)
N_3W_3	0.73 (0.04)	0.73 (0.03)	0.73 (0.04)	0.94 (0.39)	0.88 (0.28)	0.91 (0.59)	0.79 (0.13)	0.95 (0.39)	0.87 (0.26)	0.97 (0.44)	0.96 (0.44)	0.97 (0.44)
N_3W_4	0.71 (0.00)	0.71 (0.01)	0.71 (0.00)	0.86 (0.24)	0.78 (0.11)	0.82 (1.56)	0.71 (0.00)	0.84 (0.20)	0.77 (0.10)	0.91 (0.33)	1.16 (0.87)	1.03 (0.60)
N_3W_5	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	1.01 (0.52)	0.91 (0.33)	0.96 (1.42)	1.06 (0.62)	1.09 (0.69)	1.07 (0.66)	0.91 (0.33)	1.00 (0.49)	0.95 (0.41)
SEm± (N×W)	**0.005**	**0.005**	**0.003**	**0.04**	**0.04**	**0.03**	**0.06**	**0.05**	**0.03**	**0.07**	**0.07**	**0.05**
SEm± (W×N)	**0.003**	**0.004**	**0.003**	**0.04**	**0.03**	**0.03**	**0.05**	**0.04**	**0.03**	**0.06**	**0.05**	**0.04**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

4.5.3.9 Weed biomass (g m^{-2}) of *Amaranthus viridis* Hook. F.

The data on weed biomass (g m^{-2}) of *Amaranthus viridis* at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.73 and 4.74.

4.5.3.9.1 Effect of nutrient management on weed biomass (no. m^{-2}) of *Amaranthus viridis* Hook. F.

An inquisition on two years' data and average data of two years on weed of *Amaranthus viridis* revealed no significant variation among the nutrient treatments at all stages of observations except at 30 DAS.

At 30 DAS, the average data of two years significantly recorded highest weed biomass was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment. And the lowest weed biomass was recorded in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) treatment and was at par with N_1 (100% RDF) treatment.

4.5.3.9.2 Effect of weed management on weed biomass (g m^{-2}) of *Amaranthus viridis* Hook. F.

Significant results were observed on weed biomass of *Amaranthus viridis* at all stages of observations in both the years of experiment and average data of two years. The highest weed biomass was significantly recorded in W_1 (Weedy check) at all stages of observations.

At 15 DAS, the average data of two years results recorded significantly lowest weed biomass of *Amaranthus viridis* in W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatment. This indicated that application of Pendimethalin has effect on weed biomass of *Amaranthus viridis.*

Table 4.73: Effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Amaranthus viridis* Hook. F. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average	2017	2018	Average	2017	2018	Average
Nutrient management (N)												
N_1	0.73 (0.04)	0.74 (0.04)	0.74 (0.04)	0.99 (0.53)	1.00 (0.55)	1.00 (0.54)	1.36 (1.82)	1.21 (1.28)	1.29 (1.55)	1.21 (1.47)	1.15 (1.25)	1.18 (1.36)
N_2	0.74 (0.04)	0.74 (0.05)	0.74 (0.04)	1.04 (0.66)	1.03 (0.61)	1.04 (0.64)	1.43 (2.16)	1.26 (1.43)	1.34 (1.79)	1.24 (1.72)	1.15 (1.32)	1.19 (1.52)
N_3	0.73 (0.03)	0.74 (0.04)	0.73 (0.04)	1.00 (0.54)	0.97 (0.48)	0.98 (0.51)	1.30 (1.63)	1.15 (1.08)	1.23 (1.36)	1.14 (1.25)	1.11 (1.07)	1.13 (1.16)
SEm±	**0.003**	**0.004**	**0.001**	**0.03**	**0.02**	**0.005**	**0.03**	**0.04**	**0.03**	**0.02**	**0.04**	**0.02**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**0.02**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	0.75 (0.06)	0.75 (0.06)	0.75 (0.06)	1.31 (1.21)	1.24 (1.06)	1.27 (1.13)	2.54 (6.02)	2.15 (4.16)	2.35 (5.09)	2.59 (6.29)	2.34 (4.99)	2.47 (5.64)
W_2	0.74 (0.04)	0.74 (0.05)	0.74 (0.05)	0.72 (0.02)	0.71 (0.00)	0.71 (0.01)	0.71 (0.00)	0.73 (0.04)	0.72 (0.02)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_3	0.74 (0.05)	0.74 (0.05)	0.74 (0.05)	0.92 (0.35)	1.03 (0.57)	0.98 (0.46)	1.10 (0.73)	0.98 (0.49)	1.04 (0.61)	1.26 (1.11)	1.22 (1.08)	1.24 (1.09)
W_4	0.71 (0.00)	0.72 (0.02)	0.71 (0.01)	0.91 (0.34)	0.87 (0.27)	0.89 (0.30)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_5	0.73 (0.04)	0.74 (0.04)	0.73 (0.04)	1.20 (0.97)	1.16 (0.84)	1.18 (0.90)	1.76 (2.61)	1.46 (1.63)	1.61 (2.12)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm±	**0.003**	**0.003**	**0.002**	**0.03**	**0.03**	**0.02**	**0.04**	**0.04**	**0.03**	**0.04**	**0.05**	**0.03**
CD (*p*=0.05)	**0.008**	**0.009**	**0.006**	**0.09**	**0.08**	**0.07**	**0.12**	**0.10**	**0.09**	**0.10**	**0.16**	**0.08**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.74: Interaction effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Amaranthus viridis* Hook. F. at 15 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average	2017	2018	Average	2017	2018	Average
N_1W_1	0.74 (0.05)	0.75 (0.06)	0.74 (0.06)	1.28 (1.14)	1.22 (1.01)	1.25 (1.08)	2.48 (5.70)	2.18 (4.25)	2.33 (4.98)	2.54 (6.00)	2.39 (5.23)	2.47 (5.62)
N_1W_2	0.74 (0.05)	0.74 (0.05)	0.74 (0.05)	0.73 (0.03)	0.71 (0.00)	0.72 (0.02)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_3	0.74 (0.05)	0.74 (0.05)	0.74 (0.05)	0.98 (0.46)	1.02 (0.54)	1.00 (0.50)	1.20 (0.95)	1.00 (0.51)	1.10 (0.73)	1.36 (1.37)	1.23 (1.03)	1.30 (1.20)
N_1W_4	0.71 (0.00)	0.71 (0.01)	0.71 (0.01)	0.91 (0.33)	0.87 (0.27)	0.89 (0.30)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_5	0.73 (0.04)	0.73 (0.04)	0.73 (0.04)	1.08 (0.71)	1.20 (0.94)	1.14 (0.82)	1.72 (2.45)	1.47 (1.66)	1.59 (2.05)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_1	0.75 (0.06)	0.74 (0.05)	0.75 (0.06)	1.40 (1.46)	1.35 (1.34)	1.37 (1.40)	2.75 (7.04)	2.27 (4.64)	2.51 (5.84)	2.83 (7.53)	2.47 (5.60)	2.65 (6.57)
N_2W_2	0.74 (0.05)	0.74 (0.05)	0.74 (0.05)	0.72 (0.01)	0.71 (0.00)	0.71 (0.01)	0.71 (0.00)	0.79 (0.13)	0.75 (0.07)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_3	0.74 (0.05)	0.75 (0.06)	0.74 (0.06)	0.88 (0.28)	1.04 (0.59)	0.96 (0.43)	1.09 (0.71)	1.01 (0.58)	1.05 (0.65)	1.25 (1.07)	1.15 (1.00)	1.20 (1.03)
N_2W_4	0.71 (0.00)	0.72 (0.02)	0.72 (0.01)	0.93 (0.37)	0.90 (0.31)	0.91 (0.34)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_5	0.74 (0.05)	0.74 (0.05)	0.74 (0.05)	1.29 (1.18)	1.15 (0.83)	1.22 (1.01)	1.88 (3.05)	1.51 (1.78)	1.70 (2.41)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_1	0.75 (0.07)	0.75 (0.06)	0.75 (0.06)	1.24 (1.04)	1.15 (0.82)	1.19 (0.93)	2.40 (5.31)	2.02 (3.58)	2.21 (4.44)	2.41 (5.33)	2.15 (4.13)	2.28 (4.73)
N_3W_2	0.73 (0.03)	0.74 (0.04)	0.73 (0.04)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_3	0.74 (0.05)	0.74 (0.05)	0.74 (0.05)	0.90 (0.31)	1.04 (0.58)	0.97 (0.45)	1.01 (0.52)	0.93 (0.39)	0.97 (0.45)	1.18 (0.90)	1.29 (1.20)	1.23 (1.05)
N_3W_4	0.71 (0.00)	0.72 (0.02)	0.71 (0.01)	0.90 (0.32)	0.85 (0.23)	0.88 (0.27)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_5	0.73 (0.03)	0.73 (0.04)	0.73 (0.04)	1.23 (1.01)	1.12 (0.76)	1.17 (0.88)	1.69 (2.34)	1.39 (1.45)	1.54 (1.89)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm± (N×W)	**0.005**	**0.005**	**0.003**	**0.06**	**0.05**	**0.04**	**0.07**	**0.06**	**0.05**	**0.06**	**0.09**	**0.05**
SEm± (W×N)	**0.004**	**0.005**	**0.002**	**0.04**	**0.04**	**0.03**	**0.06**	**0.06**	**0.05**	**0.04**	**0.07**	**0.03**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.18**	**NS**	**0.14**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.14**	**NS**	**0.11**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

At 30 DAS, the average data of two years revealed that significantly lowest weed biomass of *Amaranthus viridis* was found at W_2 (Hand weeding at 15, 30 and 45 DAS) which was followed by W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatment. At this stage, application of Propaquizafop in W_5 treatment at 15 DAS did not show control of this weed and therefore higher biomass was observed.

At 45 DAS, W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) and W_2 (Hand weeding at 15, 30 and 45 DAS) treatments reduced biomass of *Amaranthus viridis* significantly over weedy check. The mechanical weeding treatment at 40 DAS resulted in better control of this weed biomass than W_5.

At 60 DAS, the average data of two years revealed that W_2 (Hand weeding at 15, 30 and 45 DAS), W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) and W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) treatments effectively reduced biomass of *Amaranthus viridis*.

4.5.3.9.3 Interaction effect on weed biomass (g m^{-2}) of *Amaranthus viridis* Hook. F.

The study found no significant effect on weed biomass of *Amaranthus viridis* due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observations except at 60 DAS. At 60 DAS, the average data of two years results revealed that significantly highest weed biomass of *Amaranthus viridis* was recorded in $N_2 \times W_1$ interactions (2.65 g m^{-2}).

4.5.3.10 Weed biomass (g m^{-2}) of *Borreria latifolia* (Aubl.) K. Schum.

The data on weed biomass (g m^{-2}) of *Borreria latifolia* at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.75 and 4.76.

4.5.3.10.1 Effect of nutrient management on weed biomass (g m^{-2}) of *Borreria latifolia* (Aubl.) K. Schum.

An inquisition on two years' data and average data of two years on weed of *Borreria latifolia* revealed no significant variation among the nutrient treatments at all stages of observations except at 30 DAS. The average data of two years at 30 DAS significantly recorded the highest weed biomass (7.51 g m^{-2}) of *Borreria latifolia* in N_2 (75% RDF + 25% organic through FYM + PSB) treatment. And the lowest weed biomass was recorded in N_1 (100% RDF) treatment and was at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) treatment.

4.5.3.10.2 Effect of weed management on weed biomass (g m^{-2}) of *Borreria latifolia* (Aubl.) K. Schum.

Significant results were observed on weed biomass of *Borreria latifolia* at all stages of observations in both the years of experiment and average data of two years.

At 15 DAS, the average data of two years results recorded significantly lowest weed biomass of *Borreria latifolia* in W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatment. This result showed that Pendimethalin helped in reducing this weed biomass.

At 30 DAS, the average data of two years significantly recorded lowest weed biomass (0.42 g m^{-2}) of *Borreria latifolia* at W_2 (Hand weeding at 15, 30 and 45 DAS) followed by W_4. The application of Propaquizafop at 15 DAS did not seem to control this weed biomass as shown in the Table 4.75.

At 45 DAS, the average data of two years lowest weed biomass of *Borreria latifolia* was recorded at W_2 which was at par with W_4. This might be due to hand weeding carried out at 30 DAS in both the treatments.

Table 4.75: Effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Borreria latifolia* (Aubl.) K. Schum. at 15, 30, 45 and 60 DAS

TREATMENTS	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	0.94 (0.39)	1.14 (0.84)	1.04 (0.62)	2.28 (6.00)	2.51 (7.11)	2.40 (6.55)	4.01 (22.98	3.79 (21.82)	3.90 (22.40)	3.12 (17.82)	2.86 (16.13)	2.99 (16.97)
N_2	0.97 (0.47)	1.15 (0.86)	1.06 (0.66)	2.44 (6.90)	2.68 (8.12)	2.56 (7.51)	4.15 (25.16	3.94 (23.60)	4.05 (24.38)	3.27 (19.75)	2.98 (17.80)	3.12 (18.77)
N_3	0.91 (0.33)	1.08 (0.68)	0.99 (0.51)	2.18 (5.57)	2.48 (7.14)	2.33 (6.36)	3.95 (22.19	3.77 (21.15)	3.86 (21.67)	3.01 (16.54)	2.85 (15.73)	2.93 (16.13)
SEm±	**0.02**	**0.04**	**0.02**	**0.03**	**0.06**	**0.03**	**0.20**	**0.12**	**0.13**	**0.10**	**0.11**	**0.07**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**0.13**	**NS**	**0.10**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	1.01 (0.52)	1.18 (0.90)	1.09 (0.71)	3.73 (13.44)	3.83 (14.25)	3.78 (13.84)	7.71 (59.25)	8.03 (64.09)	7.87 (61.67)	8.10 (65.40)	8.47 (71.38)	8.29 (68.39)
W_2	1.00 (0.50)	1.20 (0.97)	1.10 (0.73)	0.89 (0.29)	1.02 (0.55)	0.96 (0.42)	0.90 (0.32)	1.01 (0.52)	0.96 (0.42)	0.81 (0.16)	0.87 (0.26)	0.84 (0.21)
W_3	0.99 (0.48)	1.19 (0.93)	1.09 (0.71)	1.95 (3.42)	2.56 (6.30)	2.26 (4.86)	4.72 (22.61)	3.06 (9.42)	3.89 (16.02)	4.86 (23.76)	3.20 (10.23)	4.03 (16.99)
W_4	0.72 (0.02)	0.84 (0.21)	0.78 (0.11)	1.42 (1.54)	1.59 (2.05)	1.50 (1.80)	0.94 (0.38)	1.01 (0.52)	0.97 (0.45)	1.10 (0.71)	1.02 (0.53)	1.06 (0.62)
W_5	0.98 (0.47)	1.21 (0.97)	1.10 (0.72)	3.51 (12.08)	3.80 (14.14)	3.65 (13.11)	5.92 (34.66)	6.06 (36.42)	5.99 (35.54)	0.80 (0.15)	0.93 (0.38)	0.87 (0.26)
SEm±	**0.02**	**0.04**	**0.02**	**0.12**	**0.13**	**0.10**	**0.18**	**0.15**	**0.12**	**0.16**	**0.14**	**0.09**
CD (*p*=0.05)	**0.05**	**0.11**	**0.06**	**0.35**	**0.37**	**0.30**	**0.53**	**0.44**	**0.34**	**0.46**	**0.39**	**0.27**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.76: Interaction effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Borreria latifolia* (Aubl.) K. Schum. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
N_1W_1	1.00 (0.50)	1.22 (0.98)	1.11 (0.74)	3.68 (13.09)	3.79 (13.87)	3.73 (13.48)	7.66 (58.50)	7.99 (63.42)	7.83 (60.96)	8.00 (63.80)	8.43 (70.58)	8.21 (67.19)
N_1W_2	1.00 (0.50)	1.19 (0.95)	1.10 (0.72)	0.88 (0.28)	1.03 (0.56)	0.95 (0.42)	0.91 (0.33)	1.01 (0.52)	0.96 (0.42)	0.81 (0.16)	0.87 (0.26)	0.84 (0.21)
N_1W_3	0.98 (0.46)	1.24 (1.06)	1.11 (0.76)	1.87 (3.09)	2.54 (6.09)	2.21 (4.59)	4.72 (22.26)	2.93 (9.19)	3.83 (15.72)	4.89 (24.25)	3.06 (8.93)	3.98 (16.59)
N_1W_4	0.73 (0.04)	0.84 (0.21)	0.78 (0.12)	1.45 (1.63)	1.60 (2.07)	1.53 (1.85)	0.95 (0.40)	1.01 (0.52)	0.98 (0.46)	1.10 (0.70)	1.02 (0.55)	1.06 (0.63)
N_1W_5	0.99 (0.48)	1.22 (0.99)	1.10 (0.73)	3.51 (11.89)	3.61 (12.94)	3.56 (12.42)	5.82 (33.43)	5.99 (35.48)	5.91 (34.46)	0.81 (0.16)	0.91 (0.33)	0.86 (0.25)
N_2W_1	1.05 (0.62)	1.21 (0.97)	1.13 (0.79)	3.85 (14.34)	3.95 (15.12)	3.90 (14.73)	8.07 (64.80)	8.35 (69.25)	8.21 (67.03)	8.51 (72.02)	8.77 (76.37)	8.64 (74.19)
N_2W_2	1.02 (0.55)	1.25 (1.08)	1.14 (0.81)	0.91 (0.34)	1.06 (0.62)	0.99 (0.48)	0.91 (0.33)	1.01 (0.53)	0.96 (0.43)	0.82 (0.18)	0.91 (0.32)	0.86 (0.25)
N_2W_3	1.05 (0.60)	1.18 (0.92)	1.12 (0.76)	2.14 (4.28)	2.85 (7.79)	2.50 (6.03)	4.79 (24.03)	3.14 (9.89)	3.97 (16.96)	5.05 (25.60)	3.29 (11.41)	4.17 (18.51)
N_2W_4	0.71 (0.00)	0.86 (0.24)	0.78 (0.12)	1.50 (1.75)	1.67 (2.33)	1.59 (2.04)	0.95 (0.40)	1.01 (0.53)	0.98 (0.46)	1.13 (0.78)	1.02 (0.55)	1.08 (0.66)
N_2W_5	1.03 (0.57)	1.26 (1.08)	1.14 (0.82)	3.77 (13.81)	3.89 (14.75)	3.83 (14.28)	6.04 (36.27)	6.19 (37.82)	6.11 (37.04)	0.82 (0.17)	0.92 (0.35)	0.87 (0.26)
N_3W_1	0.97 (0.44)	1.11 (0.74)	1.04 (0.59)	3.66 (12.89)	3.76 (13.74)	3.71 (13.32)	7.41 (54.45)	7.75 (59.60)	7.58 (57.03)	7.80 (60.38)	8.23 (67.18)	8.01 (63.78)
N_3W_2	0.97 (0.45)	1.17 (0.87)	1.07 (0.66)	0.87 (0.27)	0.98 (0.47)	0.93 (0.37)	0.90 (0.30)	1.00 (0.50)	0.95 (0.40)	0.79 (0.13)	0.83 (0.19)	0.81 (0.16)
N_3W_3	0.94 (0.38)	1.13 (0.81)	1.04 (0.60)	1.83 (2.88)	2.30 (5.02)	2.06 (3.95)	4.64 (21.55)	3.11 (9.19)	3.88 (15.37)	4.63 (21.41)	3.23 (10.34)	3.93 (15.88)
N_3W_4	0.72 (0.02)	0.82 (0.17)	0.77 (0.10)	1.31 (1.25)	1.49 (1.74)	1.40 (1.49)	0.92 (0.35)	1.00 (0.50)	0.96 (0.43)	1.07 (0.65)	1.00 (0.50)	1.04 (0.58)
N_3W_5	0.93 (0.37)	1.15 (0.83)	1.04 (0.60)	3.25 (10.55)	3.89 (14.75)	3.57 (12.65)	5.89 (34.28)	6.01 (35.97)	5.95 (35.13)	0.78 (0.10)	0.97 (0.45)	0.87 (0.28)
SEm± (N×W)	**0.03**	**0.06**	**0.03**	**0.21**	**0.22**	**0.18**	**0.32**	**0.26**	**0.20**	**0.27**	**0.23**	**0.16**
SEm± (W×N)	**0.03**	**0.06**	**0.03**	**0.14**	**0.15**	**0.11**	**0.28**	**0.20**	**0.18**	**0.20**	**0.18**	**0.12**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

At 60 DAS, W_2 continued to record the lowest weed biomass of *Borreria latifolia*. It was found at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 treatments. The hand weeding alone at 45 DAS in W_5 treatment might have reduced the biomass of this weed. At 60 DAS, the manual weeding done in W_3 could not prove better than W_4 and W_5.

4.5.3.10.3 Interaction effect on weed biomass (g m^{-2}) of *Borreria latifolia* (Aubl.) K. Schum.

The study found no significant effect on weed biomass of *Borreria latifolia* due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observations.

4.5.3.11 Weed biomass (g m^{-2}) of *Cleome rutidosperma* DC.

The data on weed biomass (g m^{-2}) of *Cleome rutidosperma* at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.77 and 4.78.

4.5.3.11.1 Effect of nutrient management on weed biomass (g m^{-2}) of *Cleome rutidosperma* DC.

The two years' data and average data of two years on weed of *Cleome rutidosperma* revealed no significant variation among the nutrient treatments at all stages of observations except at 45 DAS.

At 45 DAS, the average data of two years recorded significantly lowest weed biomass (1.00 g m^{-2}) of *Cleome rutidosperma* in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). And the highest weed biomass (1.30 g m^{-2}) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment.

4.5.3.11.2 Effect of weed management on weed biomass (g m^{-2}) of *Cleome rutidosperma* DC.

Significant results were observed on weed biomass of *Cleome rutidosperma* at all stages of observations in both the years of experiment and average data of two years. The highest weed biomass was recorded in W_1 (Weedy check) at all stages of observations.

At 15 DAS, the average data of two years results recorded significantly lowest weed biomass of *Cleome rutidosperma* in W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatment which indicated that Pendimethalin was able to reduce biomass of *Cleome rutidosperma.*

At 30 DAS, the average data of two years revealed lowest weed biomass of *Cleome rutidosperma* in W_2 (Hand weeding at 15, 30 and 45 DAS) treatment which might be due to hand weeding carried out at 15 DAS. This was then followed W_4 where pendimethalin as pre-emergence application has exerted its effect. The increase in the weed biomass from 15 DAS to 30 DAS in W_5 treatment might be because of Propaquizafop at 15 DAS had no effect on the control of weeds.

At 45 DAS, the average data of two years revealed that W_2 and W_4 treatments effectively controlled weed biomass of *Cleome rutidosperma*. This is due to hand weeding carried out at 30 DAS on W_2 and W_4 treatments which resulted in no more appearance of *Cleome rutidosperma*.

At 60 DAS, all the weed control treatments were found capable to reduce weed biomass of *Cleome rutidosperma* as compared to weedy check. W_2 (Hand weeding at 15, 30 and 45 DAS), W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) and W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) treatments completely check the growth of *Cleome rutidosperma.*

Table 4.77: Effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Cleome rutidosperma* DC. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.79 (0.12)	0.78 (0.11)	0.78 (0.12)	1.19 (1.22)	1.14 (1.02)	1.16 (1.12)	1.08 (0.95)	1.05 (0.81)	1.06 (0.88)
N_2	0.74 (0.04)	0.72 (0.02)	0.73 (0.03)	0.81 (0.16)	0.79 (0.14)	0.80 (0.15)	1.27 (1.54)	1.15 (1.06)	1.21 (1.30)	1.12 (1.20)	1.18 (1.13)	1.15 (1.17)
N_3	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.79 (0.13)	0.78 (0.11)	0.78 (0.12)	1.18 (1.20)	1.07 (0.81)	1.12 (1.00)	1.08 (0.99)	1.04 (0.83)	1.06 (0.91)
SEm±	**0.003**	**0.004**	**0.004**	**0.005**	**0.007**	**0.005**	**0.01**	**0.02**	**0.009**	**0.02**	**0.04**	**0.03**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.05**	**NS**	**0.03**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	0.74 (0.05)	0.74 (0.05)	0.74 (0.05)	0.87 (0.26)	0.87 (0.26)	0.87 (0.26)	2.00 (3.53)	1.64 (2.20)	1.82 (2.86)	2.21 (4.42)	1.97 (3.37)	2.09 (3.89)
W_2	0.73 (0.04)	0.72 (0.02)	0.73 (0.03)	0.72 (0.01)	0.71 (0.01)	0.72 (0.01)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_3	0.74 (0.05)	0.73 (0.03)	0.74 (0.04)	0.74 (0.04)	0.76 (0.08)	0.75 (0.06)	0.79 (0.14)	0.85 (0.24)	0.82 (0.19)	1.14 (0.82)	1.09 (0.75)	1.11 (0.78)
W_4	0.72 (0.01)	0.71 (0.01)	0.71 (0.01)	0.78 (0.12)	0.74 (0.05)	0.76 (0.09)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_5	0.73 (0.03)	0.72 (0.02)	0.72 (0.02)	0.86 (0.24)	0.83 (0.19)	0.84 (0.22)	1.85 (2.95)	1.70 (2.38)	1.78 (2.67)	0.71 (0.00)	0.97 (0.50)	0.84 (0.25)
SEm±	**0.002**	**0.002**	**0.002**	**0.013**	**0.013**	**0.008**	**0.03**	**0.03**	**0.02**	**0.03**	**0.05**	**0.02**
CD (*p*=0.05)	**0.007**	**0.007**	**0.004**	**0.04**	**0.04**	**0.02**	**0.08**	**0.08**	**0.05**	**0.09**	**0.14**	**0.07**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.78: Interaction effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Cleome rutidosperma* DC. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average	2017	2018	Average	2017	2018	Average
N_1W_1	0.74 (0.05)	0.75 (0.06)	0.74 (0.05)	0.86 (0.24)	0.87 (0.27)	0.87 (0.25)	1.88 (3.04)	1.73 (2.51)	1.81 (2.78)	2.07 (3.81)	1.91 (3.14)	1.99 (3.47)
N_1W_2	0.73 (0.03)	0.72 (0.01)	0.72 (0.02)	0.72 (0.01)	0.72 (0.01)	0.72 (0.01)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_3	0.74 (0.05)	0.73 (0.03)	0.73 (0.04)	0.74 (0.04)	0.76 (0.08)	0.75 (0.06)	0.79 (0.14)	0.85 (0.24)	0.82 (0.19)	1.20 (0.93)	0.94 (0.41)	1.07 (0.67)
N_1W_4	0.72 (0.02)	0.71 (0.01)	0.72 (0.01)	0.78 (0.11)	0.73 (0.03)	0.75 (0.07)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_5	0.73 (0.03)	0.73 (0.04)	0.73 (0.03)	0.85 (0.22)	0.80 (0.14)	0.82 (0.18)	1.86 (2.94)	1.69 (2.36)	1.77 (2.65)	0.71 (0.00)	0.98 (0.50)	0.84 (0.25)
N_2W_1	0.75 (0.06)	0.74 (0.04)	0.74 (0.05)	0.90 (0.30)	0.89 (0.30)	0.90 (0.30)	2.17 (4.23)	1.69 (2.37)	1.93 (3.30)	2.41 (5.30)	2.03 (3.64)	2.22 (4.47)
N_2W_2	0.75 (0.06)	0.73 (0.03)	0.74 (0.05)	0.72 (0.02)	0.72 (0.01)	0.72 (0.02)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_3	0.75 (0.06)	0.73 (0.03)	0.74 (0.04)	0.74 (0.05)	0.76 (0.08)	0.75 (0.06)	0.79 (0.14)	0.91 (0.34)	0.85 (0.24)	1.08 (0.70)	1.21 (1.02)	1.15 (0.86)
N_2W_4	0.72 (0.01)	0.71 (0.01)	0.71 (0.01)	0.80 (0.15)	0.73 (0.03)	0.77 (0.09)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_5	0.73 (0.03)	0.71 (0.01)	0.72 (0.02)	0.87 (0.26)	0.87 (0.26)	0.87 (0.26)	1.96 (3.35)	1.76 (2.60)	1.86 (2.97)	0.71 (0.00)	1.22 (0.99)	0.96 (0.50)
N_3W_1	0.75 (0.06)	0.74 (0.05)	0.74 (0.05)	0.86 (0.25)	0.85 (0.22)	0.85 (0.23)	1.95 (3.31)	1.49 (1.72)	1.72 (2.51)	2.15 (4.14)	1.95 (3.33)	2.05 (3.73)
N_3W_2	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.72 (0.01)	0.71 (0.01)	0.71 (0.01)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_3	0.74 (0.05)	0.73 (0.03)	0.73 (0.04)	0.73 (0.04)	0.75 (0.07)	0.74 (0.05)	0.79 (0.14)	0.79 (0.14)	0.79 (0.14)	1.14 (0.82)	1.11 (0.82)	1.13 (0.82)
N_3W_4	0.72 (0.01)	0.71 (0.01)	0.71 (0.01)	0.77 (0.09)	0.77 (0.10)	0.77 (0.10)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_5	0.73 (0.03)	0.72 (0.01)	0.72 (0.02)	0.86 (0.24)	0.82 (0.17)	0.84 (0.21)	1.75 (2.55)	1.64 (2.20)	1.69 (2.38)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm± (N×W)	**0.004**	**0.004**	**0.003**	**0.02**	**0.02**	**0.01**	**0.05**	**0.05**	**0.03**	**0.05**	**0.09**	**0.04**
SEm± (W×N)	**0.004**	**0.005**	**0.004**	**0.02**	**0.02**	**0.01**	**0.03**	**0.04**	**0.02**	**0.04**	**0.07**	**0.04**
CD (*p*=0.05) (W at same level of N)	**NS**	**0.012**	**0.008**	**NS**	**NS**	**NS**	**0.14**	**NS**	**0.08**	**0.15**	**NS**	**0.12**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**0.019**	**0.015**	**NS**	**NS**	**NS**	**0.10**	**NS**	**0.06**	**0.13**	**NS**	**0.13**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

4.5.3.11.3 Interaction effect on weed biomass (g m^{-2}) of *Cleome rutidosperma* DC.

The study found significant effect on weed biomass of *Cleome rutidosperma* due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observation except at 30 DAS. At 15 DAS, the average data of two years results recorded highest weed biomass of *Cleome rutidosperma* in $N_1 \times W_1$, $N_2 \times W_1$, $N_2 \times W_2$ and $N_3 \times W_1$ interactions. At 45 and 65 DAS, the average data of two years results revealed that significantly highest weed biomass (3.30 g m^{-2} and 4.47 g m^{-2}, respectively) of *Cleome rutidosperma* was recorded in $N_2 \times W_1$ interactions.

4.5.3.12 Weed biomass (g m^{-2}) of *Mimosa pudica* L.

The data on weed biomass (g m^{-2}) of *Mimosa pudica* at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.79 and 4.80.

4.5.3.12.1 Effect of nutrient management on weed biomass (g m^{-2}) of *Mimosa pudica* L.

The two years' data and average data of two years on weed biomass of *Mimosa pudica* revealed no significant variation among the nutrient treatments at all stages of observations except at 45 DAS (2017 data) and 60 DAS (2017 data) where significantly lowest weed biomass (1.19 and 0.75 g m^{-2}, respectively) of *Mimosa pudica* was recorded in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). And the highest weed biomass was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment which was at par with N_1 (100% RDF).

4.5.3.12.2 Effect of weed management on weed biomass (g m^{-2}) of *Mimosa pudica* L.

Significant results were observed on weed biomass of *Mimosa pudica* at all stages of observations in both the years of experiment and average data of two years. Significantly highest weed biomass of *Mimosa pudica* was recorded in W_1 (Weedy check) at 30, 45 and 60 DAS.

At 15 DAS, the average data of two years results recorded significantly lowest weed biomass of *Mimosa pudica* in W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatment. The application of Pendimethalin could result in reduction of this weed biomass.

At 30 and 45 DAS, the average data of two years recorded significantly lowest weed biomass of *Mimosa pudica* was found at W_2 (Hand weeding at 15, 30 and 45 DAS) which was followed by W_4 treatment. The application of Propaquizafop at 15 DAS did not cause reduction in biomass of this weed as there was increase in biomass from 15 to 30 DAS. W_3 proved to be better than W_5 as it recorded lesser weed biomass at this date of observation.

At 60 DAS, the average data of two years revealed that weed biomass of *Mimosa pudica* was effectively controlled in W_2, W_4 and W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) treatments.

4.5.3.12.3 Interaction effect on weed biomass (g m^{-2}) of *Mimosa pudica* L.

The study found no significant effect on weed biomass of *Mimosa pudica* due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observations except at 45 DAS (2017 data) and 60 DAS (2017 data) where the highest weed biomass of *Mimosa pudica* was recorded in $N_2 \times W_1$ interactions.

Table 4.79: Effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Mimosa pudica* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	0.73 (0.03)	0.74 (0.04)	0.73 (0.04)	1.16 (0.93)	1.24 (1.17)	1.20 (1.05)	1.34 (1.59)	1.49 (2.17)	1.42 (1.88)	1.09 (1.06)	1.25 (1.63)	1.17 (1.35)
N_2	0.73 (0.04)	0.74 (0.05)	0.74 (0.04)	1.14 (0.88)	1.28 (1.27)	1.21 (1.08)	1.36 (1.63)	1.53 (2.31)	1.45 (1.97)	1.09 (1.05)	1.28 (1.82)	1.19 (1.44)
N_3	0.73 (0.03)	0.73 (0.04)	0.73 (0.03)	1.09 (0.76)	1.18 (1.01)	1.14 (0.89)	1.23 (1.19)	1.42 (1.90)	1.32 (1.54)	1.01 (0.75)	1.20 (1.42)	1.10 (1.09)
SEm±	**0.003**	**0.005**	**0.003**	**0.04**	**0.04**	**0.04**	**0.02**	**0.04**	**0.03**	**0.02**	**0.04**	**0.02**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.08**	**NS**	**NS**	**0.06**	**NS**	**NS**
Weed management (W)												
W_1	0.73 (0.04)	0.75 (0.06)	0.74 (0.05)	1.43 (1.55)	1.65 (2.24)	1.54 (1.90)	1.96 (3.36)	2.39 (5.23)	2.17 (4.29)	2.16 (4.20)	2.63 (6.44)	2.39 (5.32)
W_2	0.73 (0.03)	0.74 (0.05)	0.74 (0.04)	0.71 (0.00)	0.73 (0.03)	0.72 (0.01)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_3	0.73 (0.04)	0.75 (0.06)	0.74 (0.05)	1.14 (0.81)	1.30 (1.23)	1.22 (1.02)	0.94 (0.39)	1.38 (1.44)	1.16 (0.92)	1.02 (0.56)	1.45 (1.67)	1.23 (1.11)
W_4	0.72 (0.02)	0.72 (0.01)	0.72 (0.02)	1.05 (0.62)	0.96 (0.42)	1.00 (0.52)	1.12 (0.76)	0.91 (0.35)	1.02 (0.56)	0.72 (0.02)	0.72 (0.02)	0.72 (0.02)
W_5	0.73 (0.03)	0.74 (0.04)	0.73 (0.04)	1.34 (1.31)	1.52 (1.83)	1.43 (1.57)	1.82 (2.84)	2.02 (3.62)	1.92 (3.23)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm±	**0.002**	**0.004**	**0.002**	**0.04**	**0.04**	**0.03**	**0.03**	**0.05**	**0.03**	**0.03**	**0.05**	**0.03**
CD (*p*=0.05)	**0.005**	**0.012**	**0.007**	**0.11**	**0.12**	**0.09**	**0.09**	**0.16**	**0.10**	**0.08**	**0.15**	**0.09**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.80: Interaction effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Mimosa pudica* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
N_1W_1	0.74 (0.04)	0.75 (0.06)	0.74 (0.05)	1.47 (1.66)	1.66 (2.24)	1.56 (1.95)	2.06 (3.74)	2.40 (5.27)	2.23 (4.50)	2.26 (4.63)	2.64 (6.48)	2.45 (5.56)
N_1W_2	0.73 (0.03)	0.74 (0.05)	0.73 (0.04)	0.71 (0.00)	0.72 (0.02)	0.72 (0.01)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_3	0.74 (0.04)	0.74 (0.05)	0.74 (0.05)	1.15 (0.81)	1.29 (1.19)	1.22 (1.00)	0.96 (0.43)	1.37 (1.40)	1.17 (0.92)	1.07 (0.67)	1.47 (1.67)	1.27 (1.17)
N_1W_4	0.72 (0.02)	0.71 (0.01)	0.72 (0.02)	1.08 (0.71)	0.94 (0.40)	1.01 (0.55)	1.04 (0.59)	0.91 (0.35)	0.97 (0.47)	0.72 (0.02)	0.72 (0.02)	0.72 (0.02)
N_1W_5	0.73 (0.03)	0.74 (0.05)	0.74 (0.04)	1.40 (1.47)	1.57 (1.98)	1.49 (1.72)	1.92 (3.20)	2.09 (3.85)	2.00 (3.53)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_1	0.75 (0.04)	0.75 (0.07)	0.74 (0.05)	1.47 (1.66)	1.73 (2.51)	1.60 (2.08)	2.05 (3.71)	2.52 (5.85)	2.28 (4.78)	2.27 (4.64)	2.78 (7.22)	2.52 (5.93)
N_2W_2	0.75 (0.03)	0.75 (0.06)	0.74 (0.05)	0.71 (0.01)	0.73 (0.03)	0.72 (0.02)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_3	0.75 (0.05)	0.75 (0.06)	0.74 (0.05)	1.18 (0.93)	1.35 (1.39)	1.27 (1.16)	0.99 (0.50)	1.44 (1.60)	1.22 (1.05)	1.05 (0.60)	1.49 (1.87)	1.27 (1.23)
N_2W_4	0.72 (0.02)	0.72 (0.02)	0.72 (0.02)	1.08 (0.67)	1.01 (0.53)	1.05 (0.60)	1.17 (0.87)	0.92 (0.34)	1.04 (0.61)	0.72 (0.02)	0.72 (0.02)	0.72 (0.02)
N_2W_5	0.73 (0.04)	0.74 (0.05)	0.74 (0.04)	1.27 (1.13)	1.55 (1.91)	1.41 (1.52)	1.89 (3.08)	2.06 (3.74)	1.97 (3.41)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_1	0.75 (0.04)	0.74 (0.05)	0.74 (0.05)	1.35 (1.33)	1.57 (1.98)	1.46 (1.65)	1.77 (2.64)	2.24 (4.56)	2.01 (3.60)	1.96 (3.33)	2.47 (5.62)	2.21 (4.47)
N_3W_2	0.73 (0.03)	0.74 (0.04)	0.73 (0.04)	0.71 (0.00)	0.72 (0.02)	0.71 (0.01)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_3	0.74 (0.03)	0.75 (0.06)	0.74 (0.04)	1.09 (0.69)	1.25 (1.12)	1.17 (0.91)	0.85 (0.23)	1.33 (1.33)	1.09 (0.78)	0.93 (0.40)	1.39 (1.47)	1.16 (0.93)
N_3W_4	0.72 (0.02)	0.71 (0.01)	0.72 (0.01)	0.98 (0.47)	0.91 (0.33)	0.94 (0.40)	1.15 (0.83)	0.91 (0.35)	1.03 (0.59)	0.72 (0.02)	0.72 (0.02)	0.72 (0.02)
N_3W_5	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	1.35 (1.33)	1.44 (1.58)	1.39 (1.46)	1.65 (2.24)	1.93 (3.25)	1.79 (2.74)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm± (N×W)	**0.004**	**0.007**	**0.004**	**0.07**	**0.07**	**0.05**	**0.06**	**0.09**	**0.06**	**0.05**	**0.09**	**0.05**
SEm± (W×N)	**0.004**	**0.007**	**0.004**	**0.06**	**0.06**	**0.05**	**0.04**	**0.07**	**0.05**	**0.04**	**0.07**	**0.04**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.16**	**NS**	**NS**	**0.14**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.13**	**NS**	**NS**	**0.11**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

4.5.3.13 Weed biomass (g m^{-2}) of *Mollugo pentaphylla* L.

The data on weed biomass (g m^{-2}) of *Mollugo pentaphylla* at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.81 and 4.82.

4.5.3.13.1 Effect of nutrient management on weed biomass (g m^{-2}) of *Mollugo pentaphylla* L.

The two years' data and average data of two years on weed of *Mollugo pentaphylla* revealed no significant variation among the nutrient treatments at all stages of observations except at 30 DAS.

At 30 DAS, the average data of two years recorded significantly lowest weed biomass (1.42 g m^{-2}) of *Mollugo pentaphylla* in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). The highest weed biomass was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment and was at par with N_1 (100% RDF).

4.5.3.13.2 Effect of weed management on weed biomass (g m^{-2}) of *Mollugo pentaphylla* L.

Significant results were observed on weed biomass of *Mollugo pentaphylla* at all stages of observations in both the years of experiment and average data of two years.

At 15 DAS, the average data of two years results recorded significantly lowest weed biomass of *Mollugo pentaphylla* in W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatment.

At 30 DAS, the average data of two years revealed that lowest weed biomass of *Mollugo pentaphylla* was found at W_2 (Hand weeding at 15, 30 and 45 DAS) followed by W_4. In W_5 treatment, the post emergence application of Propaquizafop at 15 DAS did not result in reduction of this weed biomass.

Table 4.81: Effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Mollugo pentaphylla* L. at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	0.77 (0.10)	0.86 (0.24)	0.82 (0.17)	1.24 (1.20)	1.56 (2.12)	1.40 (1.66)	1.01 (0.62)	1.13 (0.97)	1.07 (0.80)	0.91 (0.44)	1.02 (0.75)	0.97 (0.59)
N_2	0.78 (0.11)	0.90 (0.31)	0.84 (0.21)	1.27 (1.30)	1.69 (2.57)	1.48 (1.94)	1.03 (0.68)	1.17 (1.08)	1.10 (0.88)	0.92 (0.48)	1.03 (0.77)	0.98 (0.62)
N_3	0.76 (0.07)	0.85 (0.23)	0.80 (0.15)	1.17 (0.99)	1.48 (1.85)	1.33 (1.42)	0.99 (0.56)	1.10 (0.87)	1.04 (0.71)	0.89 (0.37)	0.99 (0.63)	0.94 (0.50)
SEm±	**0.01**	**0.012**	**0.009**	**0.014**	**0.03**	**0.02**	**0.013**	**0.02**	**0.011**	**0.01**	**0.012**	**0.009**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**0.05**	**0.12**	**0.06**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	0.79 (0.13)	0.92 (0.34)	0.86 (0.24)	1.69 (2.38)	1.98 (3.43)	1.84 (2.91)	1.45 (1.60)	1.71 (2.43)	1.58 (2.01)	1.52 (1.82)	1.81 (2.78)	1.66 (2.30)
W_2	0.78 (0.10)	0.89 (0.29)	0.83 (0.19)	0.79 (0.12)	0.87 (0.26)	0.83 (0.19)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_3	0.78 (0.11)	0.89 (0.29)	0.83 (0.20)	1.16 (0.85)	1.77 (2.67)	1.46 (1.76)	0.80 (0.15)	0.99 (0.49)	0.90 (0.32)	0.90 (0.32)	1.14 (0.80)	1.02 (0.56)
W_4	0.72 (0.02)	0.78 (0.11)	0.75 (0.06)	0.87 (0.26)	1.31 (1.25)	1.09 (0.76)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_5	0.77 (0.10)	0.88 (0.27)	0.83 (0.19)	1.64 (2.21)	1.94 (3.29)	1.79 (2.75)	1.36 (1.36))	1.56 (1.94)	1.46 (1.65)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm±	**0.007**	**0.011**	**0.006**	**0.04**	**0.04**	**0.03**	**0.02**	**0.02**	**0.02**	**0.02**	**0.03**	**0.02**
CD (*p*=0.05)	**0.02**	**0.03**	**0.02**	**0.12**	**0.13**	**0.09**	**0.05**	**0.07**	**0.05**	**0.05**	**0.08**	**0.05**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.82: Interaction effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of *Mollugo pentaphylla* L. at 15, 30, 45 and 60 DAS.

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
N_1W_1	0.81 (0.16)	0.92 (0.36)	0.87 (0.26)	1.73 (2.52)	1.95 (3.31)	1.84 (2.92)	1.46 (1.64)	1.70 (2.38)	1.58 (2.01)	1.54 (1.88)	1.85 (2.93)	1.69 (2.40)
N_1W_2	0.78 (0.11)	0.87 (0.26)	0.82 (0.18)	0.76 (0.08)	0.87 (0.26)	0.81 (0.17)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_3	0.78 (0.11)	0.86 (0.25)	0.82 (0.18)	1.16 (0.86)	1.83 (2.85)	1.49 (1.85)	0.79 (0.13)	0.99 (0.50)	0.89 (0.31)	0.90 (0.32)	1.13 (0.80)	1.02 (0.56)
N_1W_4	0.72 (0.02)	0.77 (0.10)	0.75 (0.06)	0.85 (0.23)	1.25 (1.09)	1.05 (0.66)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_1W_5	0.78 (0.11)	0.85 (0.23)	0.82 (0.17)	1.68 (2.32)	1.89 (3.08)	1.78 (2.70)	1.36 (1.35)	1.57 (1.95)	1.46 (1.65)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_1	0.80 (0.13)	0.94 (0.38)	0.87 (0.26)	1.83 (2.84)	2.09 (3.86)	1.96 (3.35)	1.52 (1.80)	1.79 (2.69)	1.65 (2.25)	1.60 (2.07)	1.86 (2.97)	1.73 (2.52)
N_2W_2	0.79 (0.12)	0.93 (0.36)	0.86 (0.24)	0.80 (0.14)	0.87 (0.27)	0.84 (0.20)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_3	0.80 (0.14)	0.91 (0.34)	0.86 (0.24)	1.17 (0.88)	1.88 (3.04)	1.53 (1.96)	0.79 (0.13)	1.04 (0.60)	0.92 (0.37)	0.89 (0.32)	1.17 (0.88)	1.03 (0.60)
N_2W_4	0.72 (0.02)	0.80 (0.14)	0.76 (0.08)	0.90 (0.33)	1.51 (1.78)	1.21 (1.06)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_5	0.78 (0.11)	0.91 (0.33)	0.85 (0.22)	1.68 (2.32)	2.09 (3.90)	1.88 (3.11)	1.40 (1.47)	1.61 (2.11)	1.51 (1.79)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_1	0.78 (0.10)	0.89 (0.29)	0.83 (0.20)	1.51 (1.79)	1.90 (3.11)	1.71 (2.45)	1.36 (1.36)	1.65 (2.22)	1.50 (1.79)	1.42 (1.51)	1.71 (2.44)	1.57 (1.98)
N_3W_2	0.76 (0.08)	0.86 (0.24)	0.81 (0.16)	0.80 (0.15)	0.87 (0.27)	0.84 (0.21)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_3	0.77 (0.09)	0.88 (0.28)	0.83 (0.19)	1.13 (0.81)	1.61 (2.11)	1.37 (1.46)	0.83 (0.20)	0.93 (0.37)	0.88 (0.28)	0.90 (0.32)	1.10 (0.72)	1.00 (0.52)
N_3W_4	0.72 (0.01)	0.76 (0.08)	0.74 (0.05)	0.85 (0.23)	1.17 (0.87)	1.01 (0.55)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_5	0.76 (0.08)	0.87 (0.25)	0.82 (0.17)	1.58 (1.99)	1.83 (2.88)	1.70 (2.43)	1.32 (1.24)	1.50 (1.76)	1.41 (1.50)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm± (N×W)	**0.012**	**0.02**	**0.01**	**0.07**	**0.08**	**0.06**	**0.03**	**0.04**	**0.03**	**0.03**	**0.05**	**0.03**
SEm± (W×N)	**0.012**	**0.02**	**0.01**	**0.05**	**0.06**	**0.04**	**0.02**	**0.03**	**0.02**	**0.02**	**0.03**	**0.02**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

At 45 DAS, the average data of two years revealed that weed biomass of *Mollugo pentaphylla* in W_2 and W_4 treatments were effectively controlled. This might be due to hand weeding carried out at 30 DAS. Mechanical weeding carried out at 40 DAS also helped in reducing this weed biomass in W_3 treatment.

At 60 DAS, the average data of two years revealed that weed biomass of *Mollugo pentaphylla* was totally controlled in W_2, W_4 and W_5 treatments. This might be due to effect of hand weeding at various intervals.

4.5.3.13.3 Interaction effect on weed biomass (g m^{-2}) of *Mollugo pentaphylla* L.

The study found no significant effect on weed biomass of *Mollugo pentaphylla* due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observations.

4.5.3.14 Weed biomass (g m^{-2}) of grasses

The data on weed biomass (no. m^{-2}) of grasses at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.83 and 4.84.

4.5.3.14.1 Effect of nutrient management on weed biomass (g m^{-2}) of grasses.

The two years' data and average data of two years on weed biomass of grasses revealed significant variation among the nutrient treatments in average data of two years at 15, 45 and 60 DAS.

At 15 and 45 DAS, significantly lowest weed biomass (2.05 and 42.17 g m^{-2}, respectively) of grasses were recorded in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) treatment. And the highest weed biomass of grasses was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment and was at par with N_1 (100% RDF).

At 60 DAS, significantly lowest weed biomass (42.17 g m^{-2}) of grasses were recorded in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) treatment. And the highest weed biomass of grasses was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment.

The availability of nutrients in N_2 treatment from both inorganic and organic sources may be the probable reason for weeds to assimilate the nutrients resulting in higher dry matter accumulation. While the lower biomass in N_3 might be due to availability of lesser nutrients due to supply of only 50% RDF. The rest 50 % organic through *Rhizobium* will be benefitting mainly the crop and lesser to the weeds and hence resulting in lesser weed biomass.

4.5.3.14.2 Effect of weed management on weed biomass (g m^{-2}) of grasses.

Significant results were observed on weed biomass of grasses at all stages of observations in both the years of experiment and average data of two years. The highest weed biomass of grasses was recorded in W_1 (Weedy check) at all stages of observations.

At 15 DAS, the average data of two years results recorded significantly lowest weed biomass of grasses in W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatment. Pendimethalin are known to be absorbed by germinating weeds and disrupts the cell division especially mitotic process mostly in meristematic tissue of weeds which are responsible for lateral and secondary root formation (Bijarnia *et al*., 2017).

At 30 DAS, the average data of two years results recorded significantly lowest weed biomass of grasses in W_2 (Hand weeding at 15, 30 and 45 DAS) which was followed by W_5. The hand weeding carried out on 15 DAS might have helped in reducing biomass of grasses. The reduction in weed biomass in

Table 4.83: Effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of grasses at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average	2017	2018	Average	2017	2018	Average
Nutrient management (N)												
N_1	1.79 (2.73)	1.52 (1.84)	1.65 (2.28)	3.87 (16.65)	2.97 (11.61)	3.42 (14.13)	6.07 (49.73)	5.33 (40.09)	5.70 (44.91)	5.81 (49.90)	4.98 (42.24)	5.40 (46.07)
N_2	1.88 (3.06)	1.57 (1.99)	1.73 (2.52)	4.00 (17.86)	3.07 (11.67)	3.54 (14.76)	6.01 (50.17)	5.35 (41.95)	5.68 (46.06)	6.02 (53.78)	5.22 (46.55)	5.62 (50.16)
N_3	1.71 (2.44)	1.46 (1.65)	1.58 (2.05)	3.72 (15.46)	2.82 (10.35)	3.27 (12.91)	5.56 (43.81)	5.06 (36.63)	5.31 (40.22)	5.44 (45.08)	4.79 (39.26)	5.12 (42.17)
SEm±	**0.03**	**0.04**	**0.01**	**0.17**	**0.06**	**0.09**	**0.11**	**0.20**	**0.08**	**0.12**	**0.15**	**0.07**
CD (*p*=0.05)	**0.12**	**NS**	**0.04**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.32**	**NS**	**NS**	**0.27**
Weed management (W)												
W_1	1.94 (3.28)	1.62 (2.13)	1.78 (2.71)	5.46 (29.39)	4.88 (23.44)	5.17 (26.41)	12.07 (145.25)	11.61 (134.59)	11.84 (139.92)	13.30 (176.73)	12.96 (167.81)	13.13 (172.27)
W_2	1.79 (2.73)	1.54 (1.89)	1.67 (2.31)	1.32 (1.24)	1.17 (0.88)	1.25 (1.06)	1.83 (3.10)	1.70 (2.63)	1.76 (2.87)	2.04 (4.08)	1.39 (1.68)	1.71 (2.88)
W_3	1.87 (3.01)	1.58 (2.03)	1.73 (2.52)	3.72 (13.57)	3.04 (8.90)	3.38 (11.24)	5.91 (34.70)	4.74 (22.76)	5.32 (28.73)	6.39 (40.97)	5.22 (27.05)	5.80 (34.01)
W_4	1.55 (1.93)	1.30 (1.21)	1.43 (1.57)	5.06 (25.25)	4.78 (22.40)	4.92 (23.82)	2.54 (6.09)	2.57 (6.25)	2.56 (6.17)	4.51 (20.16)	3.79 (14.24)	4.15 (17.20)
W_5	1.81 (2.78)	1.54 (1.87)	1.67 (2.32)	3.76 (13.83)	0.90 (0.43)	2.33 (7.13)	7.06 (50.39)	5.60 (31.55)	6.33 (40.97)	2.53 (5.98)	1.64 (2.63)	2.08 (4.31)
SEm±	**0.04**	**0.03**	**0.03**	**0.11**	**0.11**	**0.07**	**0.24**	**0.25**	**0.19**	**0.20**	**0.21**	**0.15**
CD (*p*=0.05)	**0.11**	**0.09**	**0.08**	**0.32**	**0.33**	**0.19**	**0.69**	**0.71**	**0.55**	**0.59**	**0.62**	**0.44**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.84: Interaction effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of grasses at 15, 30, 45 and 60 DAS.

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
N_1W_1	1.93 (3.24)	1.64 (2.20)	1.78 (2.72)	5.40 (28.68)	5.03 (24.89)	5.22 (26.79)	12.19 (148.02)	11.57 (133.35)	11.88 (140.69)	13.36 (177.92)	12.88 (165.53)	13.12 (171.72)
N_1W_2	1.84 (2.87)	1.57 (1.96)	1.70 (2.42)	1.32 (1.25)	1.15 (0.82)	1.24 (1.04)	2.25 (4.63)	1.78 (3.06)	2.01 (3.85)	2.18 (4.34)	1.42 (1.76)	1.80 (3.05)
N_1W_3	1.88 (3.03)	1.61 (2.12)	1.74 (2.58)	3.62 (12.65)	3.15 (9.43)	3.38 (11.04)	5.93 (34.86)	4.78 (23.55)	5.35 (29.21)	6.20 (38.70)	5.24 (27.26)	5.72 (32.98)
N_1W_4	1.51 (1.80)	1.30 (1.19)	1.41 (1.50)	5.14 (25.98)	4.83 (22.91)	4.99 (24.44)	2.64 (6.74)	2.70 (6.87)	2.67 (6.81)	4.82 (22.79)	3.78 (14.25)	4.30 (18.52)
N_1W_5	1.79 (2.71)	1.49 (1.71)	1.64 (2.21)	3.88 (14.69)	0.71 (0.00)	2.29 (7.34)	7.36 (54.40)	5.84 (33.59)	6.60 (44.00)	2.50 (5.76)	1.59 (2.38)	2.05 (4.07)
N_2W_1	2.06 (3.79)	1.65 (2.23)	1.86 (3.01)	5.70 (32.07)	4.97 (24.28)	5.34 (28.17)	12.38 (152.90)	12.13 (146.65)	12.26 (149.77)	13.76 (189.03)	13.53 (182.72)	13.65 (185.87)
N_2W_2	1.85 (2.91)	1.54 (1.90)	1.69 (2.41)	1.36 (1.36)	1.25 (1.06)	1.31 (1.21)	1.92 (3.26)	1.59 (2.23)	1.75 (2.74)	2.06 (4.82)	1.45 (1.84)	1.75 (3.33)
N_2W_3	1.95 (3.31)	1.68 (2.33)	1.82 (2.82)	3.95 (15.23)	3.06 (9.08)	3.50 (12.15)	6.15 (37.70)	4.85 (23.68)	5.50 (30.69)	6.77 (45.77)	5.46 (29.34)	6.12 (37.56)
N_2W_4	1.64 (2.20)	1.37 (1.38)	1.51 (1.79)	5.20 (26.64)	4.80 (22.62)	5.00 (24.63)	2.49 (5.77)	2.69 (6.90)	2.59 (6.33)	4.75 (22.19)	4.08 (16.42)	4.42 (19.31)
N_2W_5	1.90 (3.09)	1.61 (2.10)	1.75 (2.60)	3.78 (13.99)	1.28 (1.30)	2.53 (7.64)	7.11 (51.24)	5.48 (30.32)	6.29 (40.78)	2.73 (7.07)	1.59 (2.42)	2.16 (4.75)
N_3W_1	1.82 (2.83)	1.57 (1.96)	1.70 (2.39)	5.28 (27.41)	4.64 (21.14)	4.96 (24.28)	11.63 (134.82)	11.14 (123.77)	11.39 (129.29)	12.79 (163.26)	12.48 (155.19)	12.64 (159.23)
N_3W_2	1.70 (2.40)	1.52 (1.80)	1.61 (2.10)	1.27 (1.10)	1.12 (0.76)	1.19 (0.93)	1.31 (1.41)	1.73 (2.61)	1.52 (2.01)	1.89 (3.09)	1.29 (1.42)	1.59 (2.26)
N_3W_3	1.78 (2.69)	1.46 (1.64)	1.62 (2.16)	3.59 (12.85)	2.91 (8.19)	3.25 (10.52)	5.64 (31.53)	4.59 (21.05)	5.12 (26.29)	6.20 (38.45)	4.95 (24.54)	5.58 (31.49)
N_3W_4	1.51 (1.79)	1.24 (1.04)	1.37 (1.41)	4.85 (23.14)	4.70 (21.67)	4.77 (22.40)	2.49 (5.76)	2.34 (4.99)	2.42 (5.37)	3.96 (15.50)	3.51 (12.04)	3.74 (13.77)
N_3W_5	1.74 (2.54)	1.51 (1.79)	1.62 (2.17)	3.61 (12.82)	0.71 (0.00)	2.16 (6.41)	6.71 (45.54)	5.49 (30.74)	6.10 (38.14)	2.37 (5.12)	1.73 (3.10)	2.05 (4.11)
SEm± (N×W)	**0.07**	**0.06**	**0.05**	**0.19**	**0.19**	**0.11**	**0.41**	**0.42**	**0.33**	**0.35**	**0.37**	**0.26**
SEm± (W×N)	**0.05**	**0.05**	**0.03**	**0.21**	**0.14**	**0.11**	**0.28**	**0.33**	**0.22**	**0.25**	**0.28**	**0.18**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

W_5 treatment compared to 15 DAS indicated that application of Propaquizafop at 15 DAS might have some effect on the grass biomass at this stage.

At 45 DAS also, W_2 continued to exhibit the lowest biomass followed by W_4 treatment where hand weeding at 30 DAS might have contributed to its reduction. It has been found that there has been increase in grasses biomass in W_5 treatment compared to 30 DAS. This might be due to reduction in its effect with increase in duration after its application.

At 60 DAS, average data of two years recorded lowest weed biomass of grasses in W_2 which was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS). This was followed by W_4 treatment. The results showed that W_2, W_5 and W_4 treatments effectively reduced weed biomass of this weed. The timely hand weeding (at 15, 30 and 45 DAS) carried out in W_2 effectively reduced the grasses biomass. The integration of one hand weeding in W_4 and W_5 treatment gave effective reduction in grass biomass.

4.5.3.14.3 Interaction effect on weed biomass (g m^{-2}) of grasses.

The study found no significant effect on weed biomass of grasses due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observations.

4.5.3.15 Weed biomass (g m^{-2}) of sedges.

The data on weed biomass (g m^{-2}) of sedges at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.85 and 4.86.

4.5.3.15.1 Effect of nutrient management on weed biomass (g m^{-2}) of sedges.

The two years' data and average data of two years on weed of sedges revealed significant variation among the nutrient treatments at all stages of observations except at 15 DAS.

At 15 DAS, the average data of two years recorded significantly lowest weed biomass (0.97 g m^{-2}) of sedges in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). And the highest weed biomass of sedges was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment which was at par with N_1 (100% RDF).

4.5.3.15.2 Effect of weed management on weed biomass (g m^{-2}) of sedges.

Significant results were observed on weed biomass of grasses at all stages of observations in both the years of experiment and average data of two years except at 15 DAS.

At 30, DAS, the average data of two years results recorded significantly lowest weed biomass of sedges in W_2 (Hand weeding at 15, 30 and 45 DAS) which is due to hand weeding operation at 15 DAS. This was then followed by W_3 treatment where mechanical weeding was done at 20 DAS.

At 45 DAS, the average data of two years results recorded significantly lowest weed biomass of sedges in W_2 followed by W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). This might be due to hand weeding at 30 DAS carried out in both W_2 and W_4 treatments.

At 60 DAS, the average data of two years results recorded significantly lowest weed biomass of sedges in W_2 followed by W_5 and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatments. This results indicated that weed biomass of sedges were effectively reduced by W_2 treatment where

Table 4.85: Effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of sedges at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	1.34 (1.31)	1.27 (1.15)	1.31 (1.23)	3.02 (9.93)	2.77 (8.23)	2.89 (9.08)	4.10 (23.85)	3.98 (21.75)	4.04 (22.80)	3.58 (21.72)	3.47 (18.79)	3.52 (20.26)
N_2	1.47 (1.66)	1.34 (1.31)	1.40 (1.48)	3.02 (9.89)	2.86 (8.81)	2.94 (9.35)	4.24 (25.47)	4.08 (23.22)	4.16 (24.35)	3.74 (23.71)	3.54 (20.27)	3.64 (21.99)
N_3	1.21 (0.97)	1.21 (0.98)	1.21 (0.97)	2.83 (8.69)	2.73 (8.08)	2.78 (8.39)	3.75 (20.09)	3.78 (19.46)	3.77 (19.77)	3.37 (18.52)	3.21 (16.71)	3.29 (17.62)
SEm±	**0.02**	**0.02**	**0.02**	**0.04**	**0.08**	**0.04**	**0.10**	**0.09**	**0.09**	**0.09**	**0.19**	**0.09**
CD (*p*=0.05)	**0.08**	**0.09**	**0.09**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	1.41 (1.50)	1.35 (1.33)	1.38 (1.42)	3.87 (14.55)	3.65 (12.84)	3.76 (13.69)	7.98 (63.37)	7.32 (53.19)	7.65 (58.28)	9.06 (81.82)	8.06 (64.60)	8.56 (73.21)
W_2	1.32 (1.24)	1.25 (1.07)	1.28 (1.16)	1.00 (0.50)	0.94 (0.39)	0.97 (0.45)	0.71 (0.00)	0.73 (0.04)	0.72 (0.02)	0.71 (0.00)	0.78 (0.14)	0.74 (0.07)
W_3	1.37 (1.40)	1.26 (1.11)	1.32 (1.26)	2.47 (5.67)	2.34 (5.09)	2.41 (5.38)	3.58 (12.65)	4.40 (19.38)	3.99 (16.01)	4.13 (16.98)	4.74 (22.63)	4.43 (19.80)
W_4	1.30 (1.22)	1.26 (1.12)	1.28 (1.17)	3.68 (13.13)	3.62 (12.59)	3.65 (12.86)	1.81 (3.03)	1.49 (1.83)	1.65 (2.43)	2.59 (6.33)	2.17 (4.24)	2.38 (5.29)
W_5	1.29 (1.20)	1.26 (1.08)	1.27 (1.14)	3.76 (13.68)	3.38 (10.95)	3.57 (12.32)	6.08 (36.63)	5.78 (32.94)	5.93 (34.79)	1.33 (1.44)	1.28 (1.33)	1.31 (1.39)
SEm±	**0.04**	**0.05**	**0.03**	**0.09**	**0.06**	**0.06**	**0.14**	**0.15**	**0.12**	**0.15**	**0.16**	**0.10**
CD (*p*=0.05)	**0.11**	**NS**	**NS**	**0.25**	**0.19**	**0.17**	**0.42**	**0.44**	**0.34**	**0.45**	**0.45**	**0.30**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.86: Interaction effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of sedges at 15, 30, 45 and 60 DAS.

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
N_1W_1	1.42 (1.51)	1.33 (1.28)	1.37 (1.40)	3.94 (15.01)	3.67 (13.01)	3.81 (14.01)	8.13 (65.68)	7.49 (55.65)	7.81 (60.66)	9.16 (83.45)	8.05 (64.41)	8.61 (73.93)
N_1W_2	1.33 (1.26)	1.28 (1.14)	1.30 (1.20)	0.95 (0.41)	0.95 (0.40)	0.95 (0.41)	0.71 (0.00)	0.75 (0.06)	0.73 (0.03)	0.71 (0.00)	0.91 (0.42)	0.81 (0.21)
N_1W_3	1.37 (1.38)	1.21 (1.02)	1.29 (1.20)	2.60 (6.29)	2.33 (4.98)	2.46 (5.64)	3.69 (13.40)	4.36 (18.70)	4.03 (16.05)	4.21 (17.62)	4.80 (23.00)	4.50 (20.31)
N_1W_4	1.31 (1.21)	1.27 (1.18)	1.29 (1.20)	3.85 (14.30)	3.52 (11.94)	3.69 (13.12)	1.84 (2.89)	1.55 (1.98)	1.69 (2.44)	2.66 (6.65)	2.26 (4.65)	2.46 (5.65)
N_1W_5	1.29 (1.19)	1.27 (1.12)	1.28 (1.16)	3.75 (13.63)	3.35 (10.80)	3.55 (12.22)	6.14 (37.29)	5.73 (32.36)	5.94 (34.82)	1.14 (0.88)	1.33 (1.47)	1.23 (1.18)
N_2W_1	1.55 (1.93)	1.41 (1.49)	1.48 (1.71)	4.12 (16.47)	3.79 (13.85)	3.95 (15.16)	8.38 (69.81)	7.65 (58.04)	8.02 (63.93)	9.53 (90.48)	8.44 (70.80)	8.99 (80.64)
N_2W_2	1.41 (1.49)	1.30 (1.20)	1.35 (1.34)	1.08 (0.67)	0.96 (0.43)	1.02 (0.55)	0.71 (0.00)	0.73 (0.03)	0.72 (0.02)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_2W_3	1.51 (1.79)	1.35 (1.33)	1.43 (1.56)	2.52 (5.91)	2.44 (5.49)	2.48 (5.70)	3.95 (15.43)	4.52 (20.90)	4.24 (18.16)	4.43 (19.55)	4.95 (24.48)	4.69 (22.02)
N_2W_4	1.42 (1.52)	1.31 (1.23)	1.36 (1.38)	3.66 (13.01)	3.68 (13.05)	3.67 (13.03)	1.90 (3.37)	1.53 (2.00)	1.71 (2.68)	2.68 (6.83)	2.19 (4.36)	2.44 (5.60)
N_2W_5	1.44 (1.56)	1.33 (1.28)	1.38 (1.42)	3.72 (13.42)	3.43 (11.24)	3.57 (12.33)	6.25 (38.76)	5.97 (35.12)	6.11 (36.94)	1.36 (1.67)	1.40 (1.69)	1.38 (1.68)
N_3W_1	1.25 (1.07)	1.31 (1.23)	1.28 (1.15)	3.56 (12.16)	3.49 (11.66)	3.52 (11.91)	7.42 (54.61)	6.81 (45.87)	7.11 (50.24)	8.48 (71.53)	7.69 (58.61)	8.08 (65.07)
N_3W_2	1.22 (0.98)	1.17 (0.88)	1.19 (0.93)	0.96 (0.42)	0.92 (0.34)	0.94 (0.38)	0.71 (0.00)	0.73 (0.03)	0.72 (0.02)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
N_3W_3	1.23 (1.02)	1.21 (0.98)	1.22 (1.00)	2.29 (4.81)	2.26 (4.79)	2.28 (4.80)	3.09 (9.13)	4.33 (18.53)	3.71 (13.83)	3.75 (13.77)	4.47 (20.39)	4.11 (17.08)
N_3W_4	1.18 (0.92)	1.19 (0.95)	1.19 (0.94)	3.54 (12.07)	3.64 (12.79)	3.59 (12.43)	1.69 (2.84)	1.41 (1.50)	1.55 (2.17)	2.42 (5.50)	2.05 (3.72)	2.23 (4.61)
N_3W_5	1.16 (0.86)	1.16 (0.85)	1.16 (0.85)	3.80 (14.00)	3.36 (10.82)	3.58 (12.41)	5.86 (33.86)	5.64 (31.35)	5.75 (32.60)	1.49 (1.78)	1.12 (0.84)	1.31 (1.31)
SEm± (N×W)	**0.07**	**0.09**	**0.06**	**0.15**	**0.11**	**0.10**	**0.25**	**0.26**	**0.20**	**0.27**	**0.27**	**0.18**
SEm± (W×N)	**0.05**	**0.06**	**0.04**	**0.10**	**0.11**	**0.07**	**0.19**	**0.19**	**0.16**	**0.19**	**0.25**	**0.14**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

three hand weeding at 15, 30 and 45 DAS were carried out. The application of pendimethalin and propaquizafop could not reduce the weed biomass of sedges. However, with the integration of one hand weeding, the treatments W_4 and W_5 effectively controlled weed biomass of sedges over weedy check effectively. At this stage, biomass in W_3 is found to be increased.

4.5.3.15.3 Interaction effect on weed biomass (g m^{-2}) of sedges.

The study found no significant effect on weed biomass of sedges due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observations.

4.5.3.16 Weed biomass (g m^{-2}) of broad leaf weeds.

The data on weed biomass (g m^{-2}) of broad leaf weeds at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.87 and 4.88.

4.5.3.16.1 Effect of nutrient management on weed biomass (g m^{-2}) of broad leaf weeds.

The two years' data and average data of two years on broad leaf weeds biomass revealed significant variation among the nutrient treatments at all stages of observations except at 30 and 45 DAS.

At 30 DAS, the average data of two years significantly recorded lowest biomass of broad leaf weeds (9.64 g m^{-2}) in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). And the highest weed biomass was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment.

At 60 DAS, the average data of two years significantly recorded lowest biomass of broad leaf weeds (20.56 g m^{-2}) in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). The highest weed biomass was recorded in N_2 (75%

Table 4.87: Effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of broad leaved weeds at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	1.05 (0.63)	1.29 (1.21)	1.17 (0.92)	2.82 (9.21)	3.16 (11.36)	2.99 (10.28)	4.52 (28.98)	4.30 (27.88)	4.41 (28.43)	3.52 (22.64)	3.40 (21.41)	3.46 (22.03)
N_2	1.10 (0.73)	1.33 (1.31)	1.21 (1.02)	2.99 (10.38)	3.40 (13.08)	3.20 (11.73)	4.72 (32.04)	4.52 (30.24)	4.62 (31.14)	3.69 (25.21)	3.63 (23.84)	3.66 (24.52)
N_3	1.01 (0.54)	1.23 (1.04)	1.12 (0.79)	2.69 (8.40)	3.08 (10.88)	2.88 (9.64)	4.43 (27.46)	4.25 (26.43)	4.34 (26.95)	3.36 (20.67)	3.33 (20.44)	3.34 (20.56)
SEm±	**0.02**	**0.04**	**0.03**	**0.02**	**0.04**	**0.01**	**0.17**	**0.12**	**0.11**	**0.09**	**0.09**	**0.06**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**0.09**	**0.16**	**0.05**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.22**
Weed management (W)												
W_1	1.16 (0.85)	1.38 (1.43)	1.27 (1.14)	4.48 (19.63)	4.72 (21.83)	4.60 (20.73)	8.74 (76.12)	8.95 (79.70)	8.84 (77.91)	9.24 (85.07)	9.55 (90.89)	9.40 (87.98)
W_2	1.12 (0.75)	1.37 (1.40)	1.25 (1.08)	1.06 (0.63)	1.23 (1.01)	1.14 (0.82)	1.12 (0.78)	1.18 (0.92)	1.15 (0.85)	0.91 (0.34)	1.00 (0.51)	0.95 (0.42)
W_3	1.13 (0.78)	1.37 (1.39)	1.25 (1.08)	2.50 (5.86)	3.39 (11.15)	2.95 (8.51)	4.89 (24.18)	3.55 (12.52)	4.22 (18.35)	5.20 (27.17)	3.91 (15.15)	4.56 (21.16)
W_4	0.76 (0.07)	0.92 (0.36)	0.84 (0.21)	1.89 (3.12)	2.15 (4.15)	2.02 (3.64)	1.28 (1.14)	1.24 (1.05)	1.26 (1.10)	1.25 (1.08)	1.41 (1.51)	1.33 (1.29)
W_5	1.10 (0.71)	1.36 (1.37)	1.23 (1.04)	4.21 (17.43)	4.59 (20.73)	4.40 (19.08)	6.75 (45.23)	6.86 (46.73)	6.81 (45.98)	1.01 (0.54)	1.38 (1.43)	1.20 (0.99)
SEm±	**0.02**	**0.03**	**0.02**	**0.10**	**0.11**	**0.09**	**0.18**	**0.13**	**0.11**	**0.15**	**0.11**	**0.09**
CD (*p*=0.05)	**0.04**	**0.10**	**0.05**	**0.30**	**0.31**	**0.26**	**0.51**	**0.39**	**0.33**	**0.45**	**0.32**	**0.25**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

Table 4.88: Interaction effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of broad leaved weeds at 15, 30, 45 and 60 DAS.

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
N_1W_1	1.15 (0.83)	1.43 (1.54)	1.29 (1.19)	4.45 (19.35)	4.66 (21.25)	4.55 (20.30)	8.67 (74.80)	8.94 (79.50)	8.80 (77.15)	9.12 (82.93)	9.53 (90.34)	9.33 (86.63)
N_1W_2	1.11 (0.74)	1.35 (1.35)	1.23 (1.04)	1.03 (0.56)	1.22 (0.99)	1.12 (0.78)	1.13 (0.81)	1.07 (0.65)	1.10 (0.73)	0.94 (0.40)	0.96 (0.43)	0.95 (0.41)
N_1W_3	1.11 (0.75)	1.40 (1.48)	1.26 (1.11)	2.46 (5.66)	3.39 (11.06)	2.93 (8.36)	4.92 (24.14)	3.46 (12.22)	4.19 (18.18)	5.29 (28.27)	3.73 (13.48)	4.51 (20.87)
N_1W_4	0.77 (0.10)	0.91 (0.33)	0.84 (0.22)	1.94 (3.25)	2.11 (3.97)	2.02 (3.61)	1.22 (0.99)	1.21 (0.99)	1.21 (0.99)	1.23 (1.04)	1.39 (1.44)	1.31 (1.24)
N_1W_5	1.10 (0.72)	1.37 (1.37)	1.24 (1.05)	4.20 (17.24)	4.44 (19.51)	4.32 (18.38)	6.68 (44.16)	6.82 (46.03)	6.75 (45.10)	1.02 (0.56)	1.36 (1.37)	1.19 (0.97)
N_2W_1	1.21 (0.96)	1.42 (1.54)	1.32 (1.25)	4.68 (21.46)	4.92 (23.76)	4.80 (22.61)	9.20 (84.24)	9.33 (86.53)	9.26 (85.39)	9.76 (94.86)	9.92 (97.87)	9.84 (96.36)
N_2W_2	1.17 (0.86)	1.46 (1.62)	1.31 (1.24)	1.11 (0.72)	1.27 (1.12)	1.19 (0.92)	1.14 (0.79)	1.28 (1.16)	1.21 (0.98)	0.96 (0.41)	1.06 (0.66)	1.01 (0.53)
N_2W_3	1.20 (0.95)	1.39 (1.44)	1.29 (1.19)	2.70 (6.81)	3.70 (13.21)	3.20 (10.01)	4.97 (25.64)	3.68 (13.54)	4.33 (19.59)	5.39 (28.95)	4.12 (16.99)	4.75 (22.97)
N_2W_4	0.74 (0.05)	0.97 (0.44)	0.86 (0.25)	2.00 (3.51)	2.37 (5.10)	2.18 (4.30)	1.33 (1.26)	1.26 (1.10)	1.30 (1.18)	1.29 (1.18)	1.48 (1.69)	1.39 (1.44)
N_2W_5	1.16 (0.85)	1.42 (1.53)	1.29 (1.19)	4.45 (19.41)	4.75 (22.19)	4.60 (20.80)	6.97 (48.25)	7.02 (48.85)	6.99 (48.55)	1.05 (0.64)	1.58 (1.99)	1.31 (1.31)
N_3W_1	1.12 (0.76)	1.30 (1.21)	1.21 (0.98)	4.31 (18.07)	4.57 (20.47)	4.44 (19.27)	8.35 (69.32)	8.58 (73.06)	8.46 (71.19)	8.82 (77.43)	9.22 (84.45)	9.02 (80.94)
N_3W_2	1.08 (0.66)	1.32 (1.24)	1.20 (0.95)	1.04 (0.59)	1.19 (0.91)	1.11 (0.75)	1.10 (0.73)	1.20 (0.94)	1.15 (0.84)	0.84 (0.21)	0.97 (0.44)	0.90 (0.33)
N_3W_3	1.06 (0.63)	1.32 (1.26)	1.19 (0.95)	2.35 (5.12)	3.09 (9.18)	2.72 (7.15)	4.78 (22.77)	3.50 (11.80)	4.14 (17.29)	4.93 (24.29)	3.89 (14.99)	4.41 (19.64)
N_3W_4	0.75 (0.07)	0.89 (0.29)	0.82 (0.18)	1.75 (2.60)	1.97 (3.38)	1.86 (2.99)	1.29 (1.18)	1.24 (1.05)	1.27 (1.11)	1.22 (1.00)	1.37 (1.39)	1.30 (1.19)
N_3W_5	1.03 (0.56)	1.30 (1.20)	1.17 (0.88)	3.98 (15.63)	4.57 (20.47)	4.28 (18.05)	6.61 (43.28)	6.75 (45.31)	6.68 (44.29)	0.96 (0.43)	1.20 (0.94)	1.08 (0.69)
SEm± (N×W)	**0.03**	**0.06**	**0.03**	**0.18**	**0.19**	**0.15**	**0.30**	**0.23**	**0.19**	**0.27**	**0.19**	**0.15**
SEm± (W×N)	**0.02**	**0.05**	**0.03**	**0.12**	**0.12**	**0.10**	**0.25**	**0.19**	**0.16**	**0.19**	**0.15**	**0.11**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

RDF + 25% organic through FYM + PSB) treatment which was at par with N_1 (100% RDF).

The increase in weed biomass under N_2 treatment could be ascribed to the increased availability of nutrients in balanced form and improved physico-chemical properties of soil (Bhatia *et al*. 2012).

4.5.3.16.2 Effect of weed management on weed biomass (g m^{-2}) of broad leaf weeds.

Significant results were observed on weed biomass of broad leaf weeds at all stages of observations in both the years of experiment and average data of two years. The highest weed biomass of broad leaf weeds was significantly recorded in W_1 (Weedy check) at 30, 45 and 60 DAS.

At 15 DAS, the average data of two years results recorded significantly lowest weed biomass of broad leaf weeds in W_4. The reduction in weed biomass of broad leaf weeds in this treatment is due to the effectiveness of pre-emergence application of pendimethalin which did not allow the weeds to emerge and keep them under control. Pendimethalin's primary mode of action is to inhibit microtubule formation in cells of susceptible monocot and dicot weeds, which are an important part of the cell division process. So, the emerging weed's growth is prevented as a result of the restricted cell division, eventually leading to death due to lack of food reserves (Prachand *et al*., 2015).

At 30 DAS, the average data of two years results significantly recorded lowest weed biomass of broad leaf weeds in W_2 which was followed by W_4 treatment. This was due to elimination of broad leaf weeds through hand weeding carried out at 15 DAS in W_2 treatment and the effect of Pendimethalin applied in W_4 treatment.

At 45 DAS, the average data of two years results recorded lowest weed biomass of broad leaf weeds in W_2 and was at par with W_4 treatment. From the data recorded at 30 and 45 DAS, it can be seen that post-emergence application of Propaquizafop (in W_5 treatment) did not reduce weed biomass of broad leaf weeds.

At 60 DAS, the average data of two years results significantly recorded lowest weed biomass of broad leaf weeds in W_2 treatment. This was due to elimination of broad leaf weeds through physical uprooting of both above and below ground parts of weeds. This was followed by W_5 treatment which was at par with W_4 treatment. This might be due to integration of herbicide with one hand weeding in both the treatments which helped to reduce the broad leaf weeds. The highest weed biomass of broad leaf weeds was recorded in W_1 (Weedy check) at all stages of observations.

4.5.3.16.3 Interaction effect on weed biomass (g m^{-2}) of broad leaf weeds.

The study found no significant effect on weed biomass of broad leaf weeds due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years in all the stages of observations.

4.5.3.17 Weed biomass (g m^{-2}) of total weeds.

The data on weed biomass (g m^{-2}) of total weeds at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.89 and 4.90 and depicted in Figs 4.6, 4.7.

It was observed that the weed density and weed biomass was higher in the first year of experimentation (2017) compared to second year (2018). This might be due to favourable environmental conditions leading to vigorous growth of weeds (Nagar *et al*., 2009).

Table 4.89: Effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of total weeds at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	2.26 (4.67)	2.16 (4.20)	2.21 (4.44)	5.61 (35.79)	5.25 (31.19)	5.43 (33.49)	8.58 (102.56)	7.90 (89.71)	8.24 (96.14)	7.66 (94.26)	6.90 (82.44)	7.28 (88.35)
N_2	2.43 (5.45)	2.25 (4.61)	2.34 (5.03)	5.80 (38.13)	5.46 (33.56)	5.63 (35.85)	8.70 (107.68)	8.11 (95.41)	8.41 (101.55)	7.98 (102.69)	7.22 (90.65)	7.60 (96.67)
N_3	2.10 (3.95)	2.03 (3.67)	2.06 (3.81)	5.35 (32.56)	5.09 (29.31)	5.22 (30.94)	7.98 (91.36)	7.60 (82.52)	7.79 (86.94)	7.18 (84.27)	6.57 (76.41)	6.88 (80.34)
SEm±	**0.03**	**0.05**	**0.03**	**0.11**	**0.07**	**0.07**	**0.16**	**0.18**	**0.14**	**0.10**	**0.19**	**0.08**
CD (*p*=0.05)	**0.11**	**NS**	**0.11**	**NS**	**0.26**	**0.27**	**NS**	**NS**	**NS**	**0.40**	**NS**	**0.33**
Weed management (W)												
W_1	2.47 (5.64)	2.32 (4.89)	2.39 (5.27)	7.99 (63.56)	7.65 (58.10)	7.82 (60.83)	16.88 (284.73)	16.36 (267.48)	16.62 (276.11)	18.54 (343.63)	17.98 (323.31)	18.26 (333.47)
W_2	2.28 (4.72)	2.20 (4.37)	2.24 (4.54)	1.69 (2.36)	1.66 (2.28)	1.68 (2.32)	2.04 (3.88)	1.97 (3.59)	2.01 (3.73)	2.13 (4.43)	1.62 (2.32)	1.87 (3.37)
W_3	2.38 (5.18)	2.24 (4.54)	2.31 (4.86)	5.04 (25.11)	5.04 (25.14)	5.04 (25.12)	8.44 (71.53)	7.38 (54.66)	7.91 (63.09)	9.22 (85.12)	8.06 (64.83)	8.64 (74.97)
W_4	1.92 (3.22)	1.78 (2.68)	1.85 (2.95)	6.47 (41.50)	6.29 (39.14)	6.38 (40.32)	3.24 (10.27)	3.08 (9.13)	3.16 (9.70)	5.27 (27.56)	4.49 (19.99)	4.88 (23.78)
W_5	2.27 (4.69)	2.19 (4.32)	2.23 (4.51)	6.73 (44.94)	5.70 (32.11)	6.22 (38.53)	11.50 (132.26)	10.56 (111.22)	11.03 (121.74)	2.88 (7.97)	2.33 (5.40)	2.61 (6.68)
SEm±	**0.04**	**0.04**	**0.03**	**0.11**	**0.10**	**0.08**	**0.23**	**0.19**	**0.17**	**0.20**	**0.18**	**0.15**
CD (*p*=0.05)	**0.13**	**0.11**	**0.09**	**0.31**	**0.30**	**0.23**	**0.66**	**0.55**	**0.49**	**0.59**	**0.52**	**0.44**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

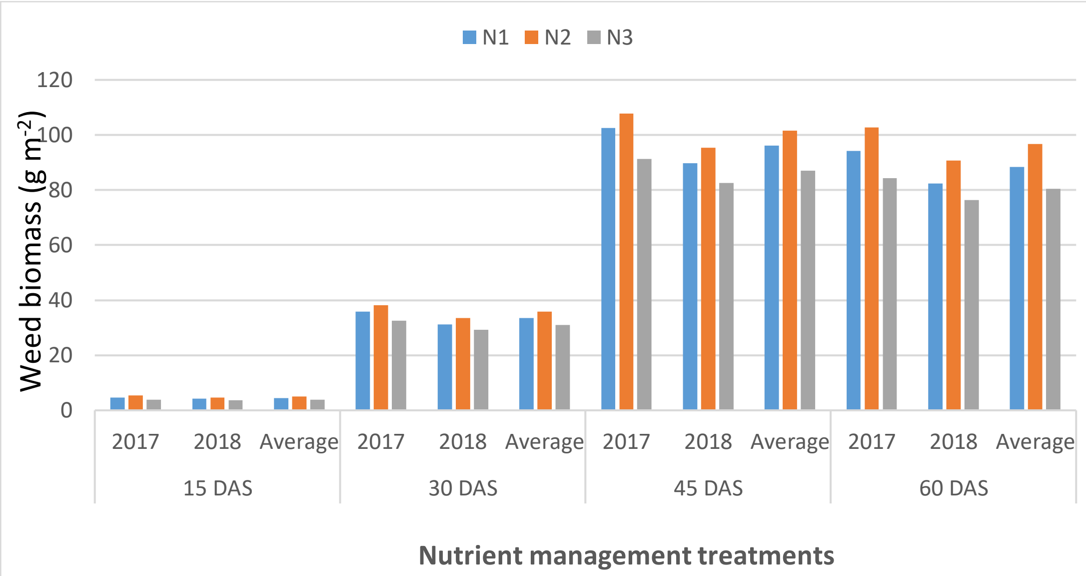


Fig 4.6 Effect of nutrient management treatments on weed biomass (g m^{-2}) of total weeds at 15, 30, 45 and 60 DAS

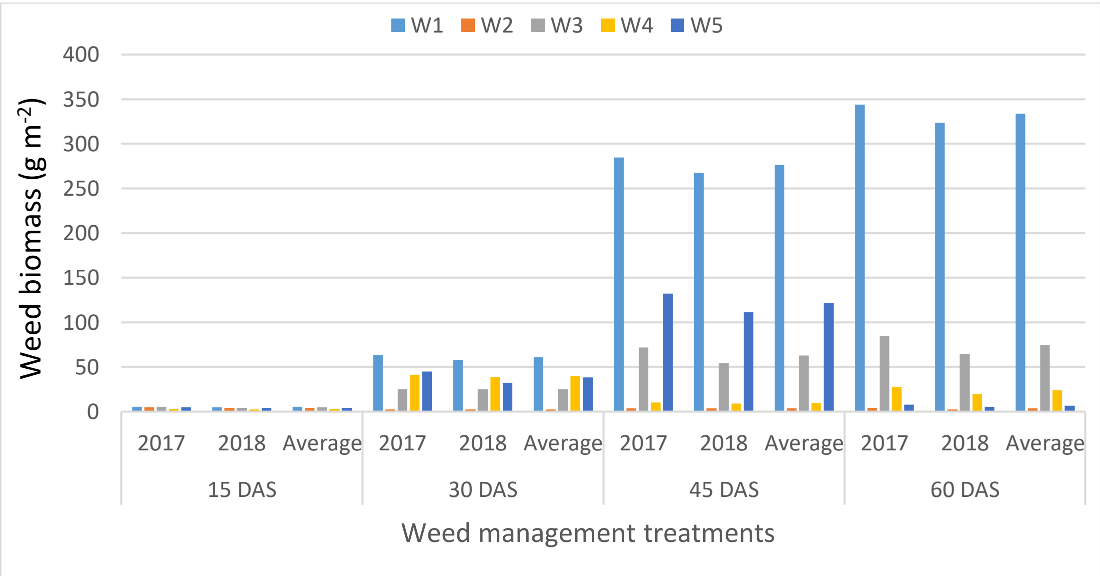


Fig 4.7 Effect of weed management treatments on weed biomass (g m^{-2}) of total weeds at 15, 30, 45 and 60 DAS

Table 4.90: Interaction effect of nutrient and weed management treatments on weed biomass (g m^{-2}) of total weeds at 15, 30, 45 and 60 DAS

Treatments	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
N_1W_1	2.46 (5.58)	2.35 (5.02)	2.41 (5.30)	7.97 (63.04)	7.72 (59.15)	7.84 (61.09)	17.00 (288.50)	16.40 (268.50)	16.70 (278.50)	18.57 (344.30)	17.91 (320.67)	18.24 (332.29)
N_1W_2	2.32 (4.88)	2.22 (4.45)	2.27 (4.66)	1.65 (2.22)	1.65 (2.22)	1.65 (2.22)	2.43 (5.44)	1.98 (3.77)	2.21 (4.61)	2.26 (4.74)	1.74 (2.61)	2.00 (3.67)
N_1W_3	2.38 (5.16)	2.26 (4.62)	2.32 (4.89)	5.01 (24.60)	5.09 (25.47)	5.05 (25.03)	8.51 (72.40)	7.30 (54.47)	7.91 (63.43)	9.15 (84.58)	8.01 (63.74)	8.58 (74.16)
N_1W_4	1.89 (3.11)	1.78 (2.71)	1.84 (2.91)	6.64 (43.53)	6.27 (38.82)	6.45 (41.18)	3.31 (10.62)	3.20 (9.85)	3.25 (10.24)	5.57 (30.48)	4.54 (20.35)	5.05 (25.41)
N_1W_5	2.26 (4.62)	2.17 (4.21)	2.21 (4.41)	6.78 (45.56)	5.54 (30.32)	6.16 (37.94)	11.67 (135.85)	10.60 (111.97)	11.14 (123.91)	2.77 (7.20)	2.29 (5.22)	2.53 (6.21)
N_2W_1	2.68 (6.68)	2.40 (5.25)	2.54 (5.97)	8.39 (69.99)	7.90 (61.89)	8.15 (65.94)	17.53 (306.95)	17.08 (291.23)	17.31 (299.09)	19.36 (374.36)	18.76 (351.39)	19.06 (362.87)
N_2W_2	2.40 (5.26)	2.28 (4.72)	2.34 (4.99)	1.80 (2.76)	1.76 (2.61)	1.78 (2.68)	2.12 (4.05)	1.93 (3.42)	2.02 (3.73)	2.18 (5.23)	1.65 (2.50)	1.92 (3.86)
N_2W_3	2.56 (6.05)	2.36 (5.10)	2.46 (5.57)	5.32 (27.95)	5.31 (27.78)	5.32 (27.86)	8.80 (78.76)	7.63 (58.12)	8.22 (68.44)	9.72 (94.27)	8.43 (70.82)	9.08 (82.54)
N_2W_4	2.07 (3.77)	1.88 (3.06)	1.97 (3.42)	6.60 (43.16)	6.42 (40.76)	6.51 (41.96)	3.27 (10.40)	3.22 (10.00)	3.24 (10.20)	5.53 (30.21)	4.77 (22.48)	5.15 (26.34)
N_2W_5	2.45 (5.50)	2.33 (4.91)	2.39 (5.21)	6.87 (46.82)	5.93 (34.74)	6.40 (40.78)	11.77 (138.25)	10.71 (114.28)	11.24 (126.26)	3.09 (9.38)	2.51 (6.10)	2.80 (7.74)
N_3W_1	2.27 (4.66)	2.21 (4.40)	2.24 (4.53)	7.62 (57.65)	7.33 (53.27)	7.48 (55.46)	16.10 (258.75)	15.59 (242.71)	15.85 (250.73)	17.68 (312.23)	17.28 (298.26)	17.48 (305.24)
N_3W_2	2.13 (4.04)	2.10 (3.92)	2.11 (3.98)	1.62 (2.11)	1.58 (2.01)	1.60 (2.06)	1.59 (2.14)	2.00 (3.59)	1.79 (2.86)	1.94 (3.31)	1.46 (1.86)	1.70 (2.58)
N_3W_3	2.20 (4.34)	2.09 (3.88)	2.14 (4.11)	4.78 (22.77)	4.72 (22.16)	4.75 (22.47)	8.00 (63.44)	7.19 (51.38)	7.59 (57.41)	8.77 (76.51)	7.74 (59.92)	8.26 (68.21)
N_3W_4	1.80 (2.76)	1.67 (2.29)	1.73 (2.52)	6.18 (37.81)	6.19 (37.84)	6.18 (37.82)	3.16 (9.78)	2.83 (7.54)	3.00 (8.66)	4.71 (22.00)	4.17 (17.15)	4.44 (19.58)
N_3W_5	2.10 (3.96)	2.08 (3.84)	2.09 (3.90)	6.54 (42.45)	5.64 (31.29)	6.09 (36.87)	11.07 (122.68)	10.37 (107.39)	10.72 (115.03)	2.79 (7.33)	2.19 (4.88)	2.49 (6.10)
SEm± (N×W)	**0.08**	**0.07**	**0.05**	**0.19**	**0.18**	**0.13**	**0.39**	**0.33**	**0.29**	**0.35**	**0.31**	**0.26**
SEm± (W×N)	**0.06**	**0.07**	**0.04**	**0.16**	**0.13**	**0.11**	**0.29**	**0.28**	**0.23**	**0.24**	**0.27**	**0.18**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Data in parenthesis indicates original values which were subjected to $\sqrt{x + 0.5}$ transformation.

4.5.3.17.1 Effect of nutrient management on weed biomass (g m^{-2}) of total weeds.

The average data of two years revealed significant results on weed biomass of total weeds at all stages of observations except at 45 DAS.

The average data of two years at 15, 30 and 60 DAS recorded significantly lowest total weed biomass (3.81 g m^{-2}, 30.94 g m^{-2}, and 80.34 g m^{-2}, respectively) in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). The highest total weed biomass was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment which was at par with N_1 (100% RDF).

The higher weed biomass in N_2 treatment might be due to the application of organic manures *i.e*, FYM to the crops which resulted in higher weed density as the organic manures might have brought weed seeds with them and made soil conditions favourable for weed emergence. Therefore, more availability of nutrients resulted in higher growth and development of weeds. These findings are in conformity with those reported by Kumar *et al*. (2011) and Bijarnia *et al*. (2017).

4.5.3.17.2 Effect of weed management on weed biomass (g m^{-2}) of total weeds.

Significant results were observed on weed biomass of total weeds in both the years of experiment and average data of two years at all stages of observations.

At 15 DAS, the average data of two years results significantly recorded lowest weed biomass of total weeds in W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). Similarly, Virk *et al*. (2018) also reported reduction in weed dry weight due to application of Pendimethalin. Kalhapure *et al*. (2013) reported that pre-emergence application of pendimethalin prevents emergence of monocot and grassy weeds by inhibiting root and shoot growth.

At 30 DAS, the average data of two years results significantly recorded lowest weed biomass of total weeds in W_2 (Hand weeding at 15, 30 and 45 DAS) followed by W_3 treatment. At 45 DAS, the average data of two years results recorded lowest weed biomass of broad leaf weeds in W_2. This was followed by W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatment.

At 60 DAS, the average data of two years results significantly recorded lowest weed biomass of broad leaf weeds in W_2 (Hand weeding at 15, 30 and 45 DAS). This was followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) treatment and W_4 treatment. Mekonnen *et al.* (2016) also reported lower weed dry weight due to effective weed control with integrated use of pendimethalin and hand weeding in cowpea.

Under W_2 treatment weed biomass decreased drastically as weeds of all categories were removed at 15, 30 and 45 DAS effectively. The higher weed biomass in weedy check might be attributed to a higher weed density, which allowed the weeds to compete fiercely for nutrients, space, light, water and carbon dioxide, resulting in higher weed biomass. These results are in agreement with the findings of Merga and Alemu (2019).

4.5.4 WEED CONTROL EFFICIENCY (%)

4.5.4.1 Weed control efficiency (%) of grasses

The data on weed control efficiency (WCE) of grasses at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.91 and 4.92.

Table 4.91: Effect of nutrient and weed management treatments on weed control efficiency (%) of grasses at 15, 30, 45 and 60 DAS

Treat-ments	15 DAS			30 DAS			45DAS			60 DAS		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
Nutrient management (N)												
N_1	12.81	16.45	14.63	41.98	53.19	47.59	66.40	70.00	68.20	71.93	74.47	73.20
N_2	16.85	10.95	13.90	44.11	51.86	47.98	67.18	71.37	69.27	71.55	74.55	73.05
N_3	13.36	15.11	14.24	43.64	50.16	46.90	67.43	70.31	68.87	72.42	74.70	73.56
Weed management (W)												
W_1	-	-	-	-	-	-	-	-	-	-	-	-
W_2	14.22	11.07	12.65	95.79	96.19	95.99	97.90	98.06	97.98	97.72	99.00	98.36
W_3	5.85	5.45	5.65	53.68	61.00	57.34	76.11	83.09	79.60	76.80	83.93	80.36
W_4	39.50	43.28	41.39	13.89	3.28	8.58	95.78	95.37	95.58	88.70	91.53	90.12
W_5	12.13	11.05	11.59	52.86	98.21	75.54	65.23	76.26	70.74	96.61	98.41	97.51

N_1: 100 % RDF (NPKS), N_2: 75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB), N_3: 50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB), W_1: Weedy check, W_2: Weed free (Hand weeding at 15, 30 and 45 DAS), W_3: Mechanical weeding at 20 and 40 DAS, W_4: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS, W_5: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS

Table 4.92: Interaction effects of nutrient and weed management treatments of weed control efficiency (%) of grasses at 15, 30, 45 and 60 DAS

Treat-ments	15 DAS			30 DAS			45DAS			60 DAS		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
N_1W_1	-	-	-	-	-	-	-	-	-	-	-	-
N_1W_2	7.31	10.94	9.13	95.66	96.66	96.16	96.87	97.75	97.31	97.56	98.91	98.24
N_1W_3	2.33	5.11	3.72	55.87	61.55	58.71	76.39	82.57	79.48	78.14	83.57	80.86
N_1W_4	42.20	44.97	43.58	9.33	7.76	8.54	95.42	94.86	95.14	87.20	91.29	89.24
N_1W_5	12.20	21.23	16.72	49.03	100.00	74.52	63.32	74.80	69.06	96.76	98.55	97.66
N_2W_1	-	-	-	-	-	-	-	-	-	-	-	-
N_2W_2	20.01	15.73	17.87	95.72	95.59	95.66	97.85	98.49	98.17	97.47	99.00	98.24
N_2W_3	10.37	-4.54	2.92	51.96	62.05	57.00	75.35	83.81	79.58	75.72	83.95	79.84
N_2W_4	39.42	38.03	38.73	16.61	7.01	11.81	96.21	95.27	95.74	88.30	91.08	89.69
N_2W_5	14.44	5.52	9.98	56.26	94.63	75.45	66.49	79.26	72.88	96.24	98.71	97.48
N_3W_1	-	-	-	-	-	-	-	-	-	-	-	-
N_3W_2	15.35	6.55	10.95	95.98	96.32	96.15	98.98	97.93	98.46	98.12	99.08	98.60
N_3W_3	4.84	15.77	10.30	53.20	59.40	56.30	76.58	82.90	79.74	76.54	84.26	80.40
N_3W_4	36.89	46.85	41.87	15.71	-4.92	5.40	95.70	95.99	95.85	90.61	92.21	91.41
N_3W_5	9.74	6.39	8.06	53.30	100.00	76.65	65.87	74.72	70.29		97.98	97.41

4.5.4.1.1 Effect of nutrient management on weed control efficiency (%) of grasses.

At 15 DAS, the average data of two years recorded highest WCE (14.63%) in N_1 and lowest WCE (13.90%) in N_2 treatment. At 30 DAS, the average data of two years recorded highest WCE (47.98%) in N_2 and lowest WCE (46.90%) in N_3 treatment. At 45 DAS, the average data of two years recorded highest WCE (69.27%) in N_2 and lowest WCE (68.20%) in N_1 treatment. At 60 DAS, the average data of two years recorded highest WCE (73.56%) in N_3 and lowest WCE in N_2 treatment.

4.5.4.1.2 Effect of weed management on weed control efficiency (%) of grasses.

At 15 DAS, the average data of two years results recorded highest WCE (41.39%) of grasses in W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatment. This might be due to lesser biomass of grasses due to pre-emergence application of pendimethalin which reduced the early flush of grasses and as a result higher WCE was recorded.

At 30 DAS, the average data of two years results recorded WCE (95.99%) of grasses in W_2 (Hand weeding at 15, 30 and 45 DAS). This is due to less dry matter production of grasses as a result of successful control of grasses through hand weeding carried out at 15 DAS. W_4 (75.54%) and W_3 (57.34%) also recorded higher WCE compared to W_5 (3.28%). The higher WCE in W_5 treatment compared to 15 DAS indicated that application of Propaquizafop at 15 DAS might have some effect on the grass biomass at this stage as it recorded reduction in weed biomass at 30 DAS. The mechanical weeding done at 20 DAS in W_3 treatment also resulted in higher WCE at 30 DAS. The lower WCE recorded in W_4 at this stage might be due to lesser effect of Pendimethalin on grasses.

At 45 DAS, the average data of two years results recorded highest WCE (97.98%) of grasses in W_2 treatment. This is due to lowest biomass as a result of hand weeding carried out at 30 DAS. W_4 (95.58%) treatment also recorded higher WCE as hand weeding at 30 DAS contributed to reduction of grasses biomass. It can be seen from Table 4.91 that there has been decrease in grasses WCE at 45 DAS in W_5 treatment (70.74%) compared to observation recorded at 30 DAS (75.54%). This might be due to reduction in the effect of Propaquizafop with increase in duration after its application (*i.e*., at 15 DAS).

At 60 DAS, the average data of two years results recorded highest WCE (98.36%) of grasses in W_2 (Hand weeding at 15, 30 and 45 DAS). This is due to less dry matter production and density of grasses which was successfully controlled by three hand weeding. W_5 (97.51%) and W_4 (90.12%) treatment also recorded higher WCE of grasses followed by W_3 (80.36%). This result showed that higher WCE was recorded in W_5 and W_4 treatments when one hand weeding was integrated with herbicide.

4.5.4.1.3 Interaction effect on weed control efficiency (%) of grasses.

The average data of two years at 15 DAS recorded highest WCE (43.58%) of grasses in $N_1 \times W_4$ interaction. The average data of two years at 30 DAS recorded highest WCE (96.16%) of grasses in $N_1 \times W_2$ interaction. At 45 and 60 DAS, the average data of two years recorded highest WCE (98.46% and 98.60%, respectively) of grasses in $N_3 \times W_2$ interactions. Under these treatments higher WCE was recorded due to lower weed biomass as a result of better weed control.

4.5.4.2 Weed control efficiency (%) of sedges.

The data on weed control efficiency (WCE) of sedges at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.93 and 4.94.

Table 4.93: Effect of nutrient and weed management treatments on weed control efficiency (%) of sedges at 15, 30, 45 and 60 DAS

Treat-ments	15 DAS			30 DAS			45DAS			60 DAS		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
Nutrient management (N)												
N_1	12.83	8.15	10.49	33.84	36.86	35.35	63.65	60.67	62.16	73.94	70.89	72.41
N_2	10.69	11.51	11.10	39.59	36.38	37.99	63.28	60.02	61.65	73.71	71.39	72.55
N_3	5.61	17.97	11.79	28.17	30.68	29.42	63.29	57.63	60.46	74.07	71.64	72.86
Weed management (W)												
W_1	-	-	-	-	-	-	-	-	-	-	-	-
W_2	12.91	15.69	14.30	96.58	96.96	96.77	100.00	99.92	99.96	100.00	99.79	99.90
W_3	4.23	19.03	11.63	60.68	60.38	60.53	80.04	63.25	71.64	79.03	65.30	72.16
W_4	15.47	12.08	13.78	8.46	1.53	5.00	95.29	96.52	95.91	92.31	93.42	92.87
W_5	15.95	15.92	15.93	3.61	14.33	8.97	41.70	37.50	39.60	98.19	98.02	98.11

N_1: 100 % RDF (NPKS), N_2: 75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB), N_3: 50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB), W_1: Weedy check, W_2: Weed free (Hand weeding at 15, 30 and 45 DAS), W_3: Mechanical weeding at 20 and 40 DAS, W_4: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS, W_5: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS

Table 4.94: Interaction effects of nutrient and weed management treatments on weed control efficiency (%) of sedges at 15, 30, 45 and 60 DAS

Treat-ments	15 DAS			30 DAS			45DAS			60 DAS		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
N_1W_1	-	-	-	-	-	-	-	-	-	-	-	-
N_1W_2	15.92	7.72	11.82	97.27	96.90	97.09	100.00	99.89	99.94	100.00	99.37	99.69
N_1W_3	8.26	25.51	16.89	57.91	61.93	59.92	79.35	65.82	72.58	78.68	64.56	71.62
N_1W_4	16.80	0.82	8.81	4.59	8.32	6.45	95.60	96.26	95.93	92.06	92.72	92.39
N_1W_5	23.16	6.68	14.92	9.42	17.17	13.29	43.32	41.38	42.35	98.96	97.79	98.37
N_2W_1	-	-	-	-	-	-	-	-	-	-	-	-
N_2W_2	16.90	18.89	17.89	95.90	96.91	96.41	100.00	99.95	99.97	100.00	100.00	100.00
N_2W_3	1.59	9.80	5.70	63.49	60.37	61.93	77.37	64.09	70.73	77.98	65.41	71.70
N_2W_4	19.43	15.74	17.59	19.84	5.81	12.83	95.32	96.54	95.93	92.45	93.87	93.16
N_2W_5	15.54	13.14	14.34	18.73	18.81	18.77	43.70	39.50	41.60	98.13	97.66	97.89
N_3W_1	-	-	-	-	-	-	-	-	-	-	-	-
N_3W_2	5.90	20.47	13.19	96.57	97.07	96.82	100.00	99.94	99.97	100.00	100.00	100.00
N_3W_3	2.84	21.77	12.30	60.64	58.82	59.73	83.41	59.84	71.62	80.42	65.94	73.18
N_3W_4	10.17	19.68	14.93	0.95	-9.53	-4.29	94.95	96.76	95.86	92.43	93.66	93.05
N_3W_5	9.14	27.93	18.54	-17.32	7.02	-5.15	38.08	31.63	34.85	97.49	98.61	98.05

4.5.4.2.1 Effect of nutrient management on weed control efficiency (%) of sedges.

At 15 DAS, the average data of two years recorded highest WCE (11.79%) in treatment and lowest in WCE (10.20%) in N_1 treatment. At 30 DAS, the average data of two years recorded highest WCE (37.99%) in N_2 treatment and lowest in WCE (29.42%) in N_3 treatment. At 45 DAS, the average data of two years recorded highest WCE (62.16%) in N_1 treatment and lowest in WCE (60.46%) in N_3 treatment. At 60 DAS, the average data of two years recorded highest WCE (72.86%) in N_3 treatment and lowest in WCE (72.41) in N_1 treatment.

4.5.4.2.2 Effect of weed management on weed control efficiency (%) of sedges.

At 15 DAS, the average data of two years results recorded lower WCE in treatments-W_2, W_3 and W_4 which might be due to no weed control at this stage. The lower WCE obtained in W_4 in this stage of observation indicated that the application of Pendimethalin did not show significant reduction in biomass of sedges.

At 30 DAS, the average data of two years results recorded highest WCE (96.77%) of sedges in W_2 (Hand weeding at 15, 30 and 45 DAS) followed W_3. The higher WCE in W_2 is due to significantly lowest weed biomass of sedges as a result of hand weeding operation at 15 DAS. The mechanical weeding done at 20 DAS in W_3 recorded higher WCE as a result of lower biomass of sedges.

At 45 DAS, the average data of two years results recorded highest WCE (99.96%) of sedges in W_2 (Hand weeding at 15, 30 and 45 DAS) which was followed by W_4 (96.49%). This might be due to hand weeding at 30 DAS carried out in both W_2 and W_4 treatments which resulted in lower biomass of sedges.

At 60 DAS, the average data of two years results recorded highest WCE (99.90%) of sedges in W_2 (Hand weeding at 15, 30 and 45 DAS) followed by W_5 and W_4 and W_3 treatments. Higher WCE were obtained as sedges were effectively controlled as reflected from reduced dry matter production of sedges. The application of pendimethalin and propaquizafop could not reduce the weed biomass of sedges. However, with the integration of one hand weeding, the treatments W_4 and W_5 effectively controlled weed biomass of sedges and gave higher WCE of sedges.

4.5.4.2.3 Interaction effect on weed control efficiency (%) of sedges.

The average data of two years at 15 and 30 DAS recorded highest WCE (19.26% and 97.09%, respectively) of sedges in $N_3 \times W_5$ and $N_1 \times W_2$ treatments, respectively. At 45 DAS, the average data of two years recorded highest WCE (99.97%) of sedges both in $N_2 \times W_2$ and $N_3 \times W_2$ interactions. Similarly at 60 DAS, the average data of two years recorded highest WCE (100%) of sedges both in $N_2 \times W_2$ and $N_3 \times W_2$ interactions. The higher WCE of these treatments indicated lower weed biomass due to better weed control.

4.5.4.3 Weed control efficiency (%) of broad leaf weeds.

The data on weed control efficiency (%) of broad leaf weeds at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.95 and 4.96.

4.5.4.3.1 Effect of nutrient management on weed control efficiency (%) of broad leaf weeds.

At 15 DAS, the average data of two years recorded highest WCE (22.87 %) in N_1 treatment and lowest WCE (17.55%) in N_2 treatment. At 30 DAS, the average data of two years recorded highest WCE (49.50%) in N_3 and WCE (48.32%) in N_2 treatment. At 45 and 60 DAS, the average data of two years

Table 4.95: Effect of nutrient and weed management treatments on weed control efficiency (%) of broad leaved weeds at 15, 30, 45 and 60 DAS

Treat-ments	15 DAS			30 DAS			45DAS			60 DAS		
	2017	**2018**	**Av.**	**2017**	**2018**	**Av.**	**2017**	**2018**	**Av.**	**2017**	**2018**	**Av.**
Nutrient management (N)												
N_1	24.24	21.50	22.87	51.76	46.17	48.96	61.23	65.01	63.12	72.74	76.29	74.51
N_2	23.15	11.96	17.55	51.64	44.99	48.32	61.99	65.06	63.52	73.48	75.61	74.54
N_3	28.63	10.54	19.59	53.30	45.70	49.50	60.30	63.82	62.06	73.20	75.81	74.50
Weed management (W)												
W_1	-	-	-	-	-	-	-	-	-	-	-	-
W_2	10.58	-2.83	3.88	96.82	95.39	96.10	98.96	98.85	98.91	99.61	99.45	99.53
W_3	8.52	0.46	4.49	69.88	48.59	59.23	68.17	84.43	76.30	68.01	83.27	75.64
W_4	90.68	74.16	82.42	84.18	80.97	82.57	98.47	98.68	98.57	98.72	98.34	98.53
W_5	16.91	1.54	9.22	10.29	3.14	6.71	40.25	41.18	40.71	99.36	98.45	98.90

N_1: 100 % RDF (NPKS), N_2: 75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB), N_3: 50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB), W_1: Weedy check, W_2: Weed free (Hand weeding at 15, 30 and 45 DAS), W_3: Mechanical weeding at 20 and 40 DAS, W_4: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS, W_5: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS

Table 4.96: Interaction effects of nutrient and weed management treatments of weed control efficiency (%) of broad leaved weeds at 15, 30, 45 and 60 DAS

Treat-ments	15 DAS			30 DAS			45DAS			60 DAS		
	2017	**2018**	**Av.**	**2017**	**2018**	**Av.**	**2017**	**2018**	**Av.**	**2017**	**2018**	**Av.**
N_1W_1	-	-	-	-	-	-	-	-	-	-	-	-
N_1W_2	10.02	14.34	12.18	97.10	95.34	96.22	98.87	99.19	99.03	99.54	99.52	99.53
N_1W_3	10.51	3.98	7.25	69.92	48.19	59.06	68.18	84.94	76.56	66.18	85.05	75.61
N_1W_4	87.37	78.65	83.01	83.07	81.22	82.14	98.64	98.75	98.70	98.69	98.41	98.55
N_1W_5	13.29	10.52	11.90	8.69	6.09	7.39	40.47	42.15	41.31	99.28	98.48	98.88
N_2W_1	-	-	-	-	-	-	-	-	-	-	-	-
N_2W_2	10.08	-9.87	0.11	96.62	95.31	95.96	99.04	98.67	98.86	99.56	99.33	99.45
N_2W_3	0.26	1.20	0.73	68.16	44.59	56.38	69.75	84.56	77.15	69.73	82.48	76.11
N_2W_4	94.35	71.70	83.03	83.64	78.54	81.09	98.48	98.73	98.60	98.75	98.27	98.51
N_2W_5	11.03	-3.24	3.89	9.80	6.50	8.15	42.66	43.33	42.99	99.34	97.98	98.66
N_3W_1	-	-	-	-	-	-	-	-	-	-	-	-
N_3W_2	11.64	-12.96	-0.66	96.75	95.51	96.13	98.96	98.70	98.83	99.73	99.48	99.61
N_3W_3	14.80	-3.81	5.50	71.57	52.97	62.27	66.60	83.79	75.19	68.13	82.29	75.21
N_3W_4	90.33	72.14	81.23	85.82	83.16	84.49	98.29	98.55	98.42	98.71	98.36	98.54
N_3W_5	26.40	-2.67	11.87	12.37	-3.16	4.60	37.63	38.05	37.84	99.44	98.89	99.17

recorded highest WCE (63.52% and 75.54 %, respectively) in N_2 treatment and lowest WCE (62.06 % and 74.50%, respectively) in N_3 treatment.

4.5.4.3.2 Effect of weed management on weed control efficiency (%) of broad leaf weeds.

At 15 DAS, the Average results recorded highest WCE (82.42 %) of broad leaf weeds in W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). The higher WCE obtained under this treatment might be due to the pre-emergence application of pendimethalin which reduced the weed biomass of broad leaf weeds.

At 30 DAS, the average data of two years results recorded highest WCE (96.10%) of broad leaf weeds in W_2 (Hand weeding at 15, 30 and 45 DAS) followed by W_4 treatment. Higher WCE was obtained under this treatments due to elimination of broad leaf weeds through hand weeding carried out at 15 DAS in W_2 treatment and the effect of Pendimethalin applied in W_4 treatment.

At 45 DAS, the average data of two years results recorded highest WCE (98.91%) of broad leaf weeds in W_2 (Hand weeding at 15, 30 and 45 DAS) followed by W_4 (98.57%) treatment and W_3 (76.30%) treatments. From the data recorded at 30 and 45 DAS, it can be seen that post-emergence application of Propaquizafop (in W_5 treatment) did not reduce weed biomass of broad leaf weeds and hence resulted in lower WCE (40.71%).

At 60 DAS, the average data of two years results recorded highest WCE (99.53%) of broad leaf weeds in W_2 (98.90%) followed by W_5 (98.90%), W_4 (98.53%) and W_3 (75.64%) treatments. The highest WCE obtained under W_2 treatment was attributable to lower weed dry weight because of effective removal of broad leaf weeds by hand weeding. Higher WCE was also observed in W_5 which indicated that only one hand weeding at 45 DAS was effective in reducing the broad leaf weeds biomass even though Propaquizafop application at 15 DAS was not effective in reducing weed biomass of broad leaf weeds. At 60 DAS, W_4 treatments recorded lower WCE compared to W_4 treatment which indicated that Pendimethalin did not control the later flushes of broad leaf weeds and after one hand weeding at 30 DAS, there were new flushes of broad leaf weeds.

4.5.4.3.3 Interaction effect on weed control efficiency (%) of broad leaf weeds.

The average data of two years at 15 DAS recorded highest WCE (83.03%) of broad leaf weeds in $N_2 \times W_4$ treatment. At 30 and 45 DAS, the average data of two years recorded highest WCE (96.22% and 99.03%, respectively) of broad leaf weeds in $N_1 \times W_2$ interaction. At 60 DAS, the average data of two years recorded highest WCE (99.61%) of broad leaf weeds in $N_3 \times W_2$ interaction. The higher WCE of this treatments indicated lower weed biomass due to better weed control.

4.5.4.4 Weed control efficiency (%) of total weeds.

The data on weed control efficiency (%) of total weeds at 15, 30, 45 and 60 DAS as influenced by nutrient and weed management treatments in both the years and average data of two years is presented in Table 4.97 and 4.98 and depicted in Fig 4.8 to 4.13.

4.5.4.4.1 Effect of nutrient management on weed control efficiency (%) of total weeds.

At 15 DAS, the average data of two years recorded highest WCE (15.95%) in N_1 treatment and lowest WCE (14.98%) in N_2 treatment. At 30 and 45 DAS, the average data of two years recorded highest WCE (45.57% and 66.08%, respectively) in N_2 treatment and lowest WCE (44.04% and 65.33%, respectively) in N_3 treatment. At 60 DAS, the average data of two years recorded highest WCE (73.70%) in N_3 treatment and lowest WCE (73.38%) in N_2. The

Table 4.97: Effect of nutrient and weed management treatments on weed control efficiency (%) of total weeds at 15, 30, 45 and 60 DAS

Treat-	15 DAS			30 DAS			45DAS			60 DAS		
ments	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
Nutrient management (N)												
N_1	15.48	16.43	15.95	43.13	47.15	45.14	64.45	66.62	65.54	72.62	74.26	73.44
N_2	17.98	12.11	15.05	45.36	45.79	45.57	64.93	67.23	66.08	72.56	74.20	73.38
N_3	14.86	15.11	14.98	43.39	44.69	44.04	64.69	65.97	65.33	73.01	74.39	73.70
Weed management (W)												
W_1	-	-	-	-	-	-	-	-	-	-	-	-
W_2	15.28	9.48	12.38	96.29	96.08	96.19	98.65	98.66	98.66	98.73	99.28	99.01
W_3	7.57	7.38	7.47	60.33	56.52	58.42	74.91	79.56	77.24	75.20	79.94	77.57
W_4	41.97	45.13	43.55	34.37	32.36	33.37	96.39	96.59	96.49	92.03	93.84	92.94
W_5	15.73	10.77	13.25	28.82	44.43	36.63	53.49	58.21	55.85	97.68	98.34	98.01

N_1: 100 % RDF (NPKS), N_2: 75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB), N_3: 50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB), W_1: Weedy check, W_2: Weed free (Hand weeding at 15, 30 and 45 DAS), W_3: Mechanical weeding at 20 and 40 DAS, W_4: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS, W_5: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS

Table 4.98: Interaction effects of nutrient and weed management treatments of weed control efficiency (%) of total weeds at 15, 30, 45 and 60 DAS

Treat-	15 DAS			30 DAS			45DAS			60 DAS		
ments	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
N_1W_1	-	-	-	-	-	-	-	-	-	-	-	-
N_1W_2	11.53	11.48	11.51	96.49	96.24	96.36	98.11	98.62	98.37	98.63	99.18	98.91
N_1W_3	6.87	7.85	7.36	60.93	56.84	58.89	74.94	79.87	77.41	75.39	80.10	77.75
N_1W_4	42.70	46.63	44.66	30.73	34.38	32.56	96.34	96.32	96.33	91.15	93.64	92.40
N_1W_5	16.30	16.19	16.24	27.52	48.30	37.91	52.87	58.27	55.57	97.91	98.37	98.14
N_2W_1	-	-	-	-	-	-	-	-	-	-	-	-
N_2W_2	20.85	10.34	15.59	96.04	95.78	95.91	98.67	98.83	98.75	98.61	99.30	98.95
N_2W_3	9.07	2.63	5.85	59.74	55.00	57.37	74.35	80.01	77.18	74.74	79.77	77.26
N_2W_4	42.97	41.37	42.17	37.97	34.18	36.08	96.60	96.56	96.58	91.95	93.63	92.79
N_2W_5	17.04	6.22	11.63	33.05	43.98	38.52	55.01	60.76	57.88	97.49	98.29	97.89
N_3W_1	-	-	-	-	-	-	-	-	-	-	-	-
N_3W_2	13.45	6.63	10.04	96.34	96.22	96.28	99.18	98.54	98.86	98.95	99.37	99.16
N_3W_3	6.75	11.66	9.21	60.32	57.72	59.02	75.45	78.81	77.13	75.46	79.94	77.70
N_3W_4	40.23	47.38	43.81	34.41	28.51	31.46	96.23	96.90	96.56	93.00	94.25	93.62
N_3W_5	13.85	9.89	11.87	25.89	41.02	33.45	52.59	55.59	54.09	97.64	98.37	98.00

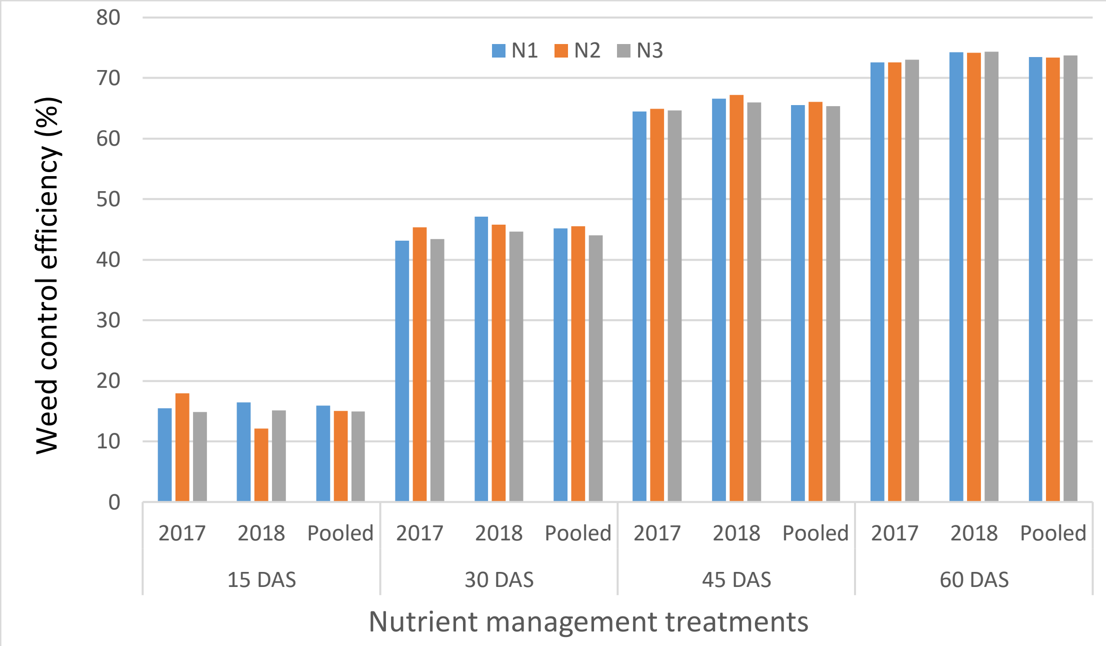


Fig 4.8 Effect of nutrient management treatments on weed control efficiency (%) of total weeds at 15, 30, 45 and 60 DAS

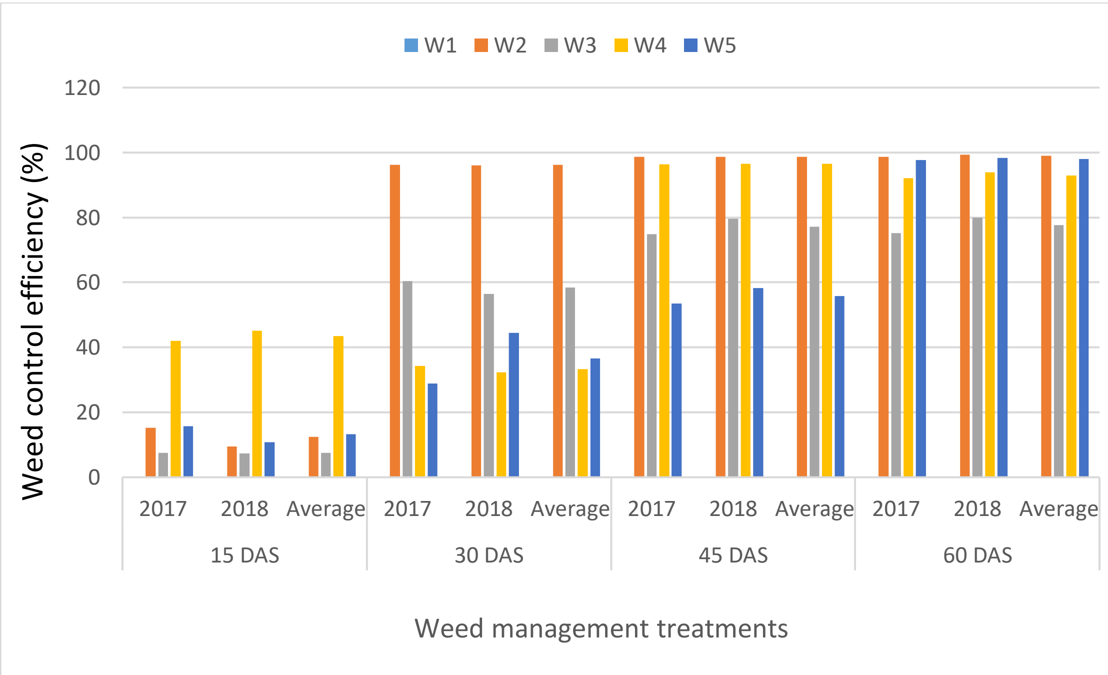


Fig 4.9 Effect of weed management treatments on weed control efficiency (%) of total weeds at 15, 30, 45 and 60 DAS

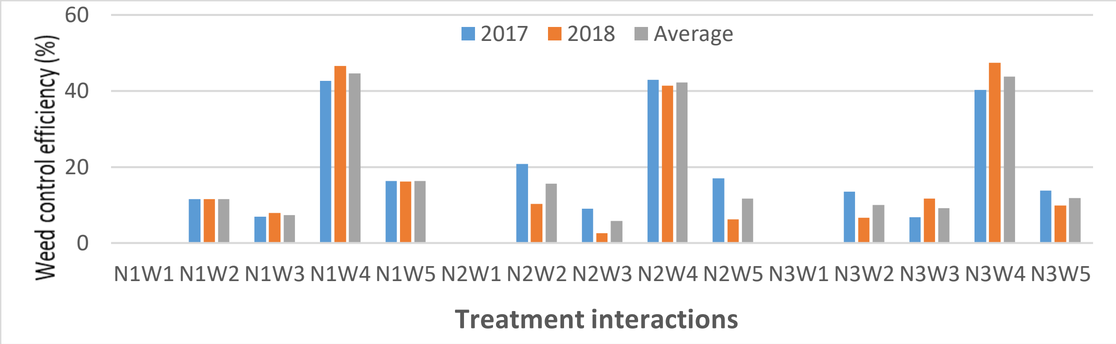


Fig 4.10 Interaction effect of treatments on weed control efficiency (%) of total weeds at 15 DAS

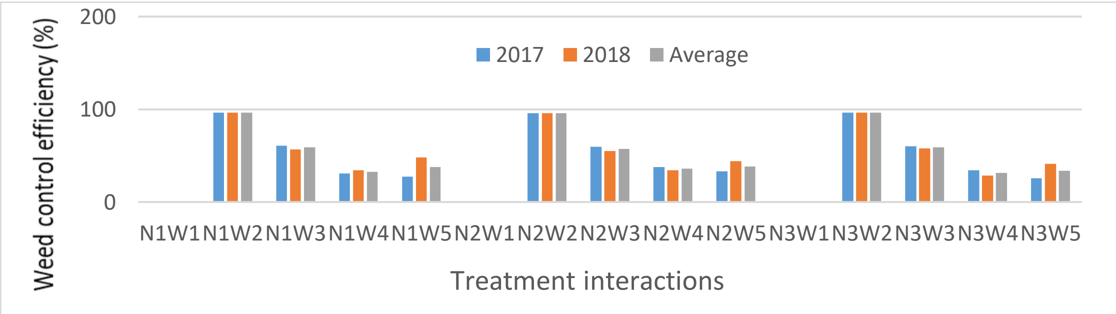


Fig 4.11 Interaction effect of treatments on weed control efficiency (%) of total weeds at 30 DAS

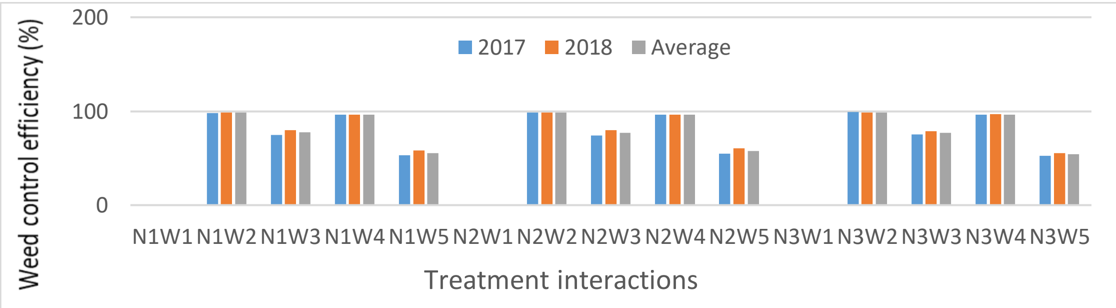


Fig 4.12 Interaction effect of treatments on weed control efficiency (%) of total weeds at 45 DAS

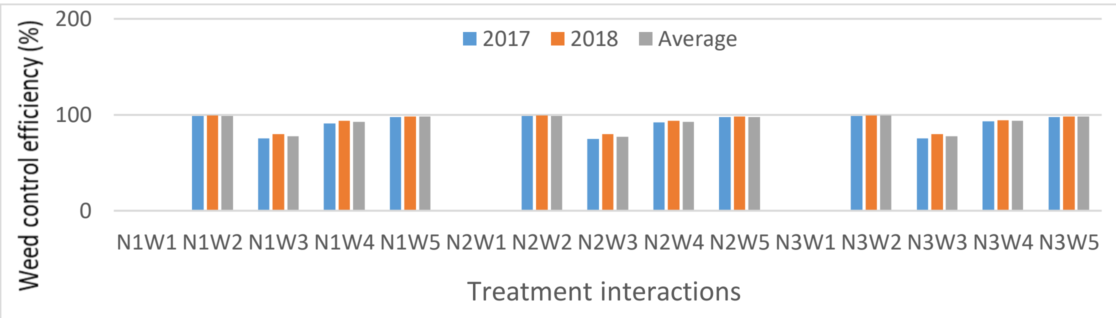


Fig 4.13 Interaction effect of treatments on weed control efficiency (%) of total weeds at 60 DAS

variation in weed control efficiency is directly associated with the weed density under these treatments.

4.5.4.4.2 Effect of weed management on weed control efficiency (%) of total weeds.

At 15 DAS, the average data of two years results recorded highest WCE (43.55%) of total weeds in W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). This might be due to pre-emergence application of Pendimethalin which reduced the weed growth resulting in reduction in weed dry matter and hence increased weed control efficiency.

At 30 DAS, the average data of two years results recorded highest WCE (96.19%) of total weeds in W_2 (Hand weeding at 15, 30 and 45 DAS) followed by W_3. The highest WCE in W_2 is due to effective removal of weeds resulting in lower weed dry weight and hence higher weed control efficiencies. Similar, mechanical weeding carried out at 20 DAS in W_3 treatment might have gave higher WCE due to lower weed biomass as a result of reduced weed density.

At 45 DAS, the average data of two years results recorded highest WCE (98.66%) of total weeds in W_2 (Hand weeding at 15, 30 and 45 DAS) followed by W_4 (96.49%). This is due to effective removal of weeds through hand weeding carried out at 30 DAS in both the treatments resulting in lower weed dry weight and hence higher weed control efficiencies.

At 60 DAS, the average data of two years results recorded highest WCE of total weeds in W_2 (99.01%) followed by W_5 (98.01%), W_4 (92.94%) and W_3 (77.57%) treatments. This might be due to good crop canopy development which dwarfed the weeds emerged in these treatments resulting in lower dry matter production of weeds and as a result higher weed control efficiencies was obtained. At 60 DAS, W_3 (Mechanical weeding at 20 and 40 DAS) recorded lower WCE compared to the other three weed management treatments

(W_2,W_4,W_5) which may be due to lesser efficiency of the mechanical treatments in the intra row area (Weber *et al*., 2016).

4.5.4.4.3 Interaction effect on weed control efficiency (%) of total weeds.

The average data of two years at 15 DAS recorded highest WCE (44.66%, respectively) of total weeds in $N_1 \times W_4$ treatment. At 30 DAS, the average data of two years recorded highest WCE (96.36%) of total weeds in $N_1 \times W_2$ interaction. At 45 and 60 DAS, the average data of two years recorded highest WCE (98.86% and 99.16% respectively) of total weeds in $N_3 \times W_2$ interaction. Higher WCE in these treatment combinations might be attributed to the effective weed control.

4.6 SOIL STATUS AFTER HARVEST

The data on soil physical properties *viz*. bulk density (g/cc) and water holding capacity (%) and soil chemical properties *viz*. pH (soil reaction), soil organic carbon (%) after crop harvest is presented in Table 4.99 and 4.100

The data concerning other soil chemical properties *viz.* available nitrogen (kg ha^{-1}), available phosphorus (kg ha^{-1}), available potassium (kg ha^{-1}) and available sulphur (kg ha^{-1}) is presented in Table 4.101 and 4.102.

4.6.1 Bulk density

4.6.1.1 Effect of nutrient management treatments on soil bulk density (g/cc) after harvest

The data of both years of experiments and average data of two years on soil bulk density after harvest showed significant effect due to different nutrient management treatments. The average data of two years results revealed that N_2 (75% RDF + 25% organic through FYM + PSB) treatment recorded the lowest bulk density (1.33 g/cc). This could be because organic matter resulted in considerable increase in polysaccharides and microbial gum synthesis in the soil. The microbial decomposition product works as a binding substance since it is resistant to further decomposition. This may aid in soil aggregation, resulting in reduced soil bulk density. Similar findings were reported by Sarkar *et al*. (2003).

4.6.1.2 Effect of weed management treatments on soil bulk density (g/cc) after harvest

The data for both years and average data of two years did not reveal any significant variation in soil bulk density after harvest among the different weed management treatments.

4.6.1.3 Interaction effect of treatments on soil bulk density (g/cc) after harvest

The study found no significant effect on soil bulk density after harvest due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years.

4.6.2 Water Holding Capacity (%)

4.6.2.1 Effect of nutrient management on water holding capacity after harvest

The data of both years of experiments and average data of two years on water holding capacity after harvest showed significant effect due to different nutrient management treatments. The average data of two years recorded significantly maximum water holding capacity (41.28%) in N_2 (75% RDF + 25% organic through FYM + PSB) treatment. This was followed by N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) which was at par with N_1 (100% RDF) treatment. The maximum water holding capacity in N_2 treatment could be due to the addition of organic manures, which provides the majority of the essential plant nutrients and improves soil structure by providing binding substances to soil aggregates, resulting in increased cation exchange capacity and water holding capacity. The results are in accordance with the findings of Mere *et al*. (2013) and Parewa *et al*. (2014).

4.6.2.2 Effect of weed management treatments on water holding capacity after harvest

The data for both years and average data of two years did not reveal any significant variation on water holding capacity after harvest among the different weed management treatments.

4.6.2.3 Interaction effect of treatments on water holding capacity after harvest

The study revealed no significant effect on water holding capacity after harvest due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years.

4.6.3 Soil pH

4.6.3.1 Effect of nutrient management on soil pH after harvest

The data of both years of experiments and average data of two years showed no significant effect on soil pH after harvest due to different nutrient management treatments. All the nutrient management treatments recorded slightly decreased soil pH than the initial value (4.63). Similar findings were reported by Parewa *et al*. (2014). This might be due to the formation of organic acids during the decomposition of organic manure and crop residues (Shirale *et al*., 2014). The N_1 (100% RDF) treatment recorded a maximum reduction in soil pH which corresponds with the findings of Devi *et al*. (2013).

4.6.3.2 Effect of weed management treatments on soil pH after harvest

The data for both years and average data of two years revealed no significant variation in soil pH after harvest among the different weed management treatments.

4.6.3.3 Interaction effect of treatments on soil pH after harvest

There was no significant effect on soil pH after harvest due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years.

4.6.4 Soil organic carbon

4.6.4.1 Effect of nutrient management treatments on soil organic carbon after harvest

A close scrutiny of data on soil organic carbon after harvest of both years of experiments and average data of two years showed significant variation among different nutrient management treatments. The two years data and average data of two years recorded significantly the highest soil organic carbon (1.36, 1.40 and 1.38 % in 2017, 2018 and average data of two years, respectively) in N_2 (75% RDF + 25% organic through FYM + PSB) treatment. And the lowest soil organic carbon was recorded in N_1 (100% RDF) treatment.

The increased microbial activity and enzymatic activity in N_2 treatment due to FYM and biofertilizer may have led to lower bulk density and subsequently increase in organic content. Similar findings had been reported by Sharma and Thakur (2016). Sharma (2011) stated that biofertilizer improve soil texture, structure, supply of nutrients, water holding capacity, and proliferate useful microorganisms which enhances the root biomass and ultimately soil organic carbon. Singh *et al*. (1999) reported a drastic reduction in organic carbon concentration on a continuous application of chemical fertilizer, whereas

Table 4.99: Effect of nutrient and weed management treatments on soil status after harvest

Treat-ments	Bulk density (g/cc)			Water Holding Capacity (%)			Soil pH			Organic carbon (%)		
	2017	**2018**	**Av.**	**2017**	**2018**	**Av.**	**2017**	**2018**	**Av.**	**2017**	**2018**	**Av.**
Nutrient management (N)												
N_1	1.37	1.35	1.36	38.78	39.96	39.37	4.47	4.35	4.41	1.29	1.31	1.30
N_2	1.34	1.32	1.33	40.51	42.05	41.28	4.47	4.41	4.44	1.36	1.40	1.38
N_3	1.36	1.34	1.35	39.30	40.30	39.80	4.55	4.43	4.49	1.30	1.33	1.31
SEm±	**0.002**	**0.004**	**0.003**	**0.29**	**0.42**	**0.32**	**0.04**	**0.04**	**0.03**	**0.01**	**0.01**	**0.01**
CD (*p*=0.05)	**0.010**	**0.016**	**0.013**	**1.21**	**1.64**	**1.26**	**NS**	**NS**	**NS**	**0.05**	**0.05**	**0.03**
Weed management (W)												
W_1	1.35	1.33	1.34	40.35	41.80	41.08	4.48	4.32	4.40	1.28	1.31	1.29
W_2	1.37	1.34	1.36	38.17	39.86	39.51	4.52	4.44	4.48	1.33	1.38	1.35
W_3	1.35	1.33	1.34	39.59	40.54	40.07	4.46	4.39	4.42	1.30	1.33	1.31
W_4	1.36	1.34	1.35	39.24	40.56	39.90	4.50	4.40	4.45	1.32	1.35	1.34
W_5	1.36	1.34	1.35	39.30	40.10	40.20	4.52	4.43	4.48	1.34	1.37	1.36
SEm±	**0.011**	**0.009**	**0.012**	**0.34**	**0.60**	**0.35**	**0.04**	**0.06**	**0.03**	**0.02**	**0.03**	**0.02**
CD (*p*=0.05	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 4.100: Interaction effect of nutrient and weed management treatments on soil status after harvest

Treatments	Bulk density (g/cc)			Water Holding Capacity (%)			Soil pH			Organic carbon (%)		
	2017	**2018**	**Av.**	**2017**	**2018**	**Av.**	**2017**	**2018**	**Av.**	**2017**	**2018**	**Av.**
N_1W_1	1.37	1.34	1.36	39.19	40.86	40.03	4.43	4.20	4.32	1.27	1.26	1.26
N_1W_2	1.38	1.35	1.37	38.42	39.12	38.77	4.50	4.47	4.48	1.30	1.34	1.32
N_1W_3	1.36	1.35	1.36	38.88	39.40	39.14	4.40	4.33	4.37	1.28	1.30	1.29
N_1W_4	1.38	1.36	1.37	38.60	39.97	39.28	4.47	4.40	4.43	1.28	1.30	1.29
N_1W_5	1.37	1.35	1.36	38.83	40.46	39.65	4.53	4.37	4.45	1.33	1.34	1.34
N_2W_1	1.33	1.32	1.33	41.60	43.09	42.35	4.43	4.33	4.38	1.30	1.38	1.34
N_2W_2	1.36	1.33	1.34	39.78	40.60	40.19	4.53	4.50	4.52	1.39	1.44	1.41
N_2W_3	1.34	1.32	1.33	41.02	42.85	41.94	4.43	4.30	4.37	1.35	1.36	1.36
N_2W_4	1.35	1.33	1.34	40.04	41.51	40.77	4.50	4.47	4.48	1.37	1.41	1.39
N_2W_5	1.35	1.33	1.34	40.09	42.22	41.16	4.47	4.43	4.45	1.38	1.42	1.40
N_3W_1	1.35	1.33	1.34	40.27	41.44	40.85	4.57	4.43	4.50	1.27	1.28	1.27
N_3W_2	1.37	1.35	1.36	39.30	39.87	39.59	4.53	4.37	4.45	1.31	1.35	1.33
N_3W_3	1.35	1.33	1.34	38.86	39.38	39.12	4.53	4.53	4.53	1.28	1.32	1.30
N_3W_4	1.36	1.35	1.36	39.08	40.20	39.64	4.53	4.33	4.43	1.31	1.35	1.33
N_3W_5	1.36	1.34	1.35	38.99	40.62	39.81	4.57	4.50	4.53	1.31	1.36	1.34
SEm± (N×W)	**0.019**	**0.016**	**0.017**	**0.60**	**1.04**	**0.61**	**0.07**	**0.10**	**0.05**	**0.04**	**0.05**	**0.03**
SEm± (W×N)	**0.012**	**0.011**	**0.011**	**0.47**	**0.78**	**0.50**	**0.06**	**0.07**	**0.04**	**0.03**	**0.03**	**0.02**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

addition of 5 t FYM ha^{-1} helped in maintaining the original organic nutrient status in soil. The improvement in organic carbon due to FYM application along with chemical fertilizer is in line with the reports of Kundu *et al*. (2008).

4.6.4.2 Effect of weed management treatments on soil organic carbon after harvest

The data for both years and average data of two years revealed no significant variation in soil organic carbon after harvest among the different weed management treatments.

4.6.4.3 Interaction effect of treatments on soil organic carbon after harvest

The study found no significant effect on soil organic carbon after harvest due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years.

4.6.5 Soil available nitrogen (kg ha^{-1})

4.6.5.1 Effect of nutrient management treatments on soil available nitrogen after harvest

The data on soil available nitrogen after harvest for both years of experiments and average data of two years showed significant effect due to different nutrient management treatments. In 2017, 2018 and average data of two years, significantly highest soil available nitrogen (358.01 kg ha^{-1}, 362.13 kg ha^{-1} and 360.07 kg ha^{-1}, respectively) was recorded maximum in N_2 (75% RDF + 25% organic through FYM + PSB) treatment. And the lowest soil available nitrogen after harvest was recorded in N_1 (100% RDF) treatment which might be due to the maximum utilisation of applied nutrients by the crop in readily available form. Similar results were reported by Chakarborty and Hazari (2016) and Bairwa *et al*. (2021).

The higher value of soil available nitrogen in N_2 (75% RDF + 25% organic through FYM + PSB) treatment might be attributed to the slow release of nutrients through organic manures and enriching the available pool of nitrogen and a greater multiplication of soil microbes as a result of which organically bound nitrogen was converted to inorganic form of nitrogen. Moreover, the seed inoculation with PSB in N_2 treatment enhanced root residues and exudates which increased the soil available nitrogen (Solanki *et al*., 2018b). Bahadur *et al*. (2012) reported that integrated use of chemical fertilizer and organic manure and biofertilizer was more effective in increasing the soil available N.

4.6.5.2 Effect of weed management treatments on soil available nitrogen after harvest

The critical analysis on data of soil available nitrogen after harvest for both years and average data of two years revealed significant variation among the different weed management treatments. In 2017, 2018 and average data of two years, significantly highest soil available nitrogen (369.02 kg ha^{-1}, 373.11 kg ha^{-1} and 371.16 kg ha^{-1}, respectively) was recorded in W_2 (hand weeding at 15, 30 and 45 DAS) treatment. This was followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) treatment which was at par with W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatment. The lowest soil available nitrogen was recorded under weedy check. These findings indicated that better weed control right from the early stages prevented weeds from removing nutrients. It conforms with the studies conducted by Kumara *et al*. (2014).

Table 4.101: Effect of nutrient and weed management treatments on soil nutrient status after harvest

Treatments	Soil available nitrogen (kg ha^{-1})			Soil available P (kg ha^{-1})			Soil available K (kg ha^{-1})			Soil available sulphur (kg ha^{-1})		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	349.02	349.76	349.39	15.01	15.69	15.35	174.92	178.84	176.88	16.64	16.96	16.80
N_2	358.01	362.13	360.07	17.08	17.65	17.37	180.00	185.67	182.83	16.72	17.30	17.01
N_3	351.78	355.01	353.39	16.20	16.39	16.30	176.97	180.45	178.71	15.79	16.24	16.02
SEm±	**1.46**	**1.56**	**1.13**	**0.17**	**0.09**	**0.06**	**0.68**	**1.25**	**0.84**	**0.37**	**0.31**	**0.34**
CD (p=0.05)	**5.74**	**6.14**	**4.43**	**0.66**	**0.36**	**0.23**	**2.69**	**4.92**	**3.28**	**NS**	**NS**	**NS**
Weed Management (W)												
W_1	335.06	337.67	336.37	15.06	15.05	15.06	170.00	176.91	173.45	14.86	15.24	15.05
W_2	369.20	373.11	371.16	17.17	17.42	17.30	180.72	186.14	183.43	17.77	18.11	17.94
W_3	346.65	347.72	347.19	15.56	16.43	15.99	176.93	179.77	178.35	15.70	16.40	16.05
W_4	356.67	357.41	357.04	16.05	16.77	16.41	178.67	181.88	180.28	16.66	17.10	16.88
W_5	357.09	362.24	359.66	16.65	17.22	16.93	180.16	183.57	181.86	16.92	17.30	17.11
SEm±	**3.81**	**2.93**	**3.07**	**0.35**	**0.32**	**0.21**	**2.22**	**2.78**	**2.33**	**0.52**	**0.47**	**0.49**
CD (p=0.05)	**11.11**	**8.55**	**8.97**	**1.02**	**0.94**	**0.63**	**6.47**	**8.11**	**6.79**	**1.52**	**1.38**	**1.43**

N_1: 100 % RDF (NPKS), N_2: 75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB), N_3: 50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB), W_1: Weedy check, W_2: Weed free (Hand weeding at 15, 30 and 45 DAS), W_3: Mechanical weeding at 20 and 40 DAS, W_4: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS, W_5: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS

Table 4.102: Effect of nutrient and weed management treatments on soil nutrient status after harvest

Treatments	Soil available nitrogen (kg ha^{-1})			Soil available P (kg ha^{-1})			Soil available K (kg ha^{-1})			Soil available sulphur (kg ha^{-1})		
	2017	**2018**	**Av.**	**2017**	**2018**	**Av.**	**2017**	**2018**	**Av.**	**2017**	**2018**	**Av.**
N_1W_1	329.91	330.47	330.19	13.81	13.51	13.66	167.29	173.15	170.22	15.59	15.58	15.59
N_1W_2	367.79	369.63	368.71	16.80	16.80	16.80	177.93	182.71	180.32	17.74	17.86	17.80
N_1W_3	342.01	344.54	343.28	14.19	15.68	14.93	174.91	177.11	176.01	16.16	16.92	16.54
N_1W_4	349.98	346.63	348.31	14.93	16.05	15.49	176.98	179.56	178.27	16.92	17.25	17.09
N_1W_5	355.41	357.51	356.46	15.31	16.43	15.87	177.48	181.70	179.59	16.77	17.16	16.96
N_2W_1	340.36	344.54	342.45	16.05	16.35	16.20	174.35	181.33	177.84	14.60	15.60	15.10
N_2W_2	371.30	377.99	374.65	17.55	18.29	17.92	185.02	192.64	188.83	17.53	18.23	17.88
N_2W_3	349.98	350.40	350.19	16.43	17.55	16.99	178.78	184.02	181.40	16.58	16.92	16.75
N_2W_4	366.28	368.51	367.40	17.55	17.84	17.69	180.06	184.13	182.09	17.27	17.90	17.59
N_2W_5	362.10	369.21	365.66	17.84	18.21	18.03	181.78	186.22	184.00	17.60	17.87	17.74
N_3W_1	334.93	338.00	336.46	15.31	15.31	15.31	168.35	176.25	172.30	14.39	14.54	14.47
N_3W_2	368.51	371.72	370.11	17.17	17.17	17.17	179.20	183.08	181.14	18.02	18.24	18.13
N_3W_3	347.97	348.24	348.10	16.05	16.05	16.05	177.10	178.18	177.64	14.37	15.37	14.88
N_3W_4	353.74	357.08	355.41	15.68	16.43	16.05	178.98	181.96	180.47	15.78	16.16	15.97
N_3W_5	353.74	360.01	356.88	16.80	17.01	16.91	181.22	182.79	182.00	16.40	16.87	16.64
SEm± (N×W)	**6.59**	**5.07**	**5.32**	**0.60**	**0.56**	**0.37**	**3.84**	**4.82**	**4.03**	**0.90**	**0.82**	**0.85**
SEm± (W×N)	**4.42**	**3.57**	**3.55**	**0.42**	**0.36**	**0.24**	**2.52**	**3.29**	**2.68**	**0.68**	**0.60**	**0.63**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

4.6.5.3 Interaction effect treatments on soil available nitrogen after harvest

The study found no significant effect on soil available nitrogen after harvest due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years.

4.6.6 Soil available phosphorus (kg ha^{-1})

4.6.6.1 Effect of nutrient management treatments on soil available phosphorus after harvest

The data of both years of experiments and average data of two years on soil available phosphorus after harvest showed significant effect due to different nutrient management treatments. The highest soil available phosphorus (17.08, 17.65 and 17.37 kg ha^{-1} in 2017, 2018, average data of two years, respectively) was significantly recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment and the lowest soil available phosphorus after harvest in N_1 (100% RDF) treatment. The N_1 treatment where chemical fertilizer was applied alone compared to the integration of organic and inorganic treatments gave lower soil available phosphorus after harvest. This may be due to the lack of addition of organic matter (Chakarborty and Hazari, 2016). The higher phosphorus content in N_2 treatment might be due to release of organic acid during microbial decomposition of organic matter which might help in increasing solubility of native phosphates, thus increased available phosphorus pool in the soil (Devi *et al*., 2013). Chen *et al*. (2006) reported that use of PSB also increase the soil available P which might be due to secretion of some organic acids (*i.e*., citric acid, gluconic acid, lactic acid, oxalic acid, etc.) which solubilize the fixed phosphorus and convert into plant available form.

4.6.6.2 Effect of weed management treatments on soil available phosphorus after harvest

An inquisition on two years data and average data of two years revealed significant variation in soil available phosphorus after harvest among the different weed management treatments. The average data of two years revealed that the highest soil available phosphorus after harvest (17.30 kg ha^{-1}) was found significant in W_2 (hand weeding at 15, 30 and 45 DAS) treatment and was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS). The lowest soil available phosphorus after harvest was recorded under weedy check.

The higher availability of available phosphorus in soil in weed control treatments (W_2 and W_4) might be due to effective control of weeds, reducing nutrient depletion by weeds, resulting in increased P availability. These results confirm with the findings of Panneerselvam *et al*. (2000).

4.6.6.3 Interaction effect treatments on soil available phosphorus after harvest

The study found no significant effect on soil available phosphorus after harvest due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years.

4.6.7 Soil available potassium (kg ha^{-1})

4.6.7.1 Effect of nutrient management treatments on soil available potassium after harvest

The data of both years of experiments and average data of two years showed significant effect on soil available potassium after harvest due to different nutrient management treatments. The maximum soil available potassium (180.00 kg ha^{-1}, 185.67 kg ha^{-1} and 182.83 kg ha^{-1} in 2017, 2018 and average data of two years) was found significantly in N_2 (75% RDF + 25% organic through FYM + PSB) treatment. The lowest soil available potassium after harvest was recorded in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) treatment. The higher value of soil available potassium in N_2 treatment may be due to the beneficial effects of organic manures *i.e.*, FYM. The organic manure application may have resulted in a decrease in K fixation and, as a result, an increase in K content in soil due to interaction of organic matter with clay, in addition to the direct addition of available K pools of soil (Yadav, 1998 and Singh *et al*., 2008)

4.6.7.2 Effect of weed management treatments on soil available potassium after harvest

The data for second year experiment and average data of two years revealed significant variation in soil available potassium after harvest among the different weed management treatments. The highest soil available potassium after harvest (180.72 kg ha^{-1}, 186.14 kg ha^{-1} and 183.43 kg ha^{-1} in 2017, 2018 and average data of two years) was recorded in W_2 (hand weeding at 15, 30 and 45 DAS) treatment and was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS), W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) and W_3 (Mechanical weeding at 20 and 40 DAS). The lowest soil available potassium after harvest was recorded under weedy check. The uncontrolled weed growth under weedy check allowed weeds to constantly remove nutrients, resulting in the lowest soil available potassium.

4.6.7.3 Interaction effect treatments on soil available potassium after harvest

The study found no significant effect on soil available potassium after harvest due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years.

4.6.8 Soil available sulphur (kg ha^{-1})

4.6.8.1 Effect of nutrient management treatments on soil available sulphur after harvest

The data of both years of experiments and average data of two years on soil available sulphur after harvest showed no significant effect due to different nutrient management treatments. However, soil available sulphur after harvest was recorded maximum in N_2 (75% RDF + 25% organic through FYM + PSB) treatment and the lowest in N_1 (100% RDF) treatment. The higher value of soil available sulphur after harvest in N_2 treatment might be due to the initial dose of S and better microbial activity which increased sulphur in the soil (Raja and Takankhar, 2017).

4.6.8.2 Effect of weed management treatments on soil available sulphur after harvest

The data for both years and average data of two years on soil available sulphur after harvest revealed significant variation among the different weed management treatments. In 2017, the highest soil available sulphur after harvest (17.77 kg ha^{-1}) was recorded in W_2 (hand weeding at 15, 30 and 45 DAS) treatment and was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatments. The lowest soil available sulphur after harvest was recorded under weedy check. The second year (2018) and average data of two years showed results having the same trend as first year (2017). These results could be attributed to differences in weed control efficiency of the weed control treatments allowing variations in crop growth and uptake of this nutrient by crop (Jha *et al*., 2014).

4.6.8.3 Interaction effect of treatments on soil available sulphur after harvest

In both years of experiment and average data of two years, the results recorded no significant effect on soil available sulphur after harvest due to the interaction of nutrient and weed management treatments.

4.7 SOIL MICROBIOLOGICAL ANALYSIS

The data on soil microbiological analysis *viz*. soil bacteria population (Cfu $\times 10^7$ g^{-1} of soil), soil fungi population (Cfu$\times 10^4$ g^{-1} of soil) and soil actinomycetes population (Cfu$\times 10^5$ g^{-1} of soil) is presented in Table 4.103 and 4.104

4.7.1 Soil bacteria

4.7.1.1 Effect of nutrient management treatments on soil bacteria

A perusal of the data on both years and average data of two years revealed that there was significant variation in soil bacterial population among the different nutrient management treatments.

In 2017 and 2018 years of experimentation and average data of two years, significantly maximum soil bacterial population (38.91, 39.09 and 39.00 Cfu$\times 10^7$ g^{-1} of soil, respectively) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) significantly. The minimum soil bacterial population (29.53, 32.67 and 31.10 Cfu$\times 10^7$ g^{-1} of soil, respectively) was observed in N_1 (100% RDF).

The higher bacterial population in N_2 treatment could be attributed to the influence of residues added and biological activity due to legume crop with

Table 4.103: Effect of nutrient and weed management treatments on soil microbial population after crop harvest

Treatments	Soil bacteria ($Cfu \times 10^7$ g^{-1} of soil)			Soil fungi ($Cfu \times 10^4$ g^{-1} of soil)			Soil actinomycetes ($Cfu \times 10^5$ g^{-1} of soil)		
Initial value	15×10^7			8×10^7			10×10^7		
	2017	2018	Average	2017	2018	Average	2017	2018	Average
Nutrient management (N)									
N_1	29.53	33.87	31.70	18.18	18.11	18.14	20.80	24.40	22.60
N_2	38.91	39.09	39.00	22.87	22.24	22.56	33.02	37.80	35.41
N_3	33.67	35.60	34.63	19.07	19.56	19.31	29.40	33.29	31.34
SEm±	**0.37**	**0.51**	**0.26**	**0.28**	**0.16**	**0.11**	**0.34**	**0.44**	**0.25**
CD (*p*=0.05)	**1.44**	**2.01**	**1.02**	**1.12**	**0.61**	**0.43**	**1.35**	**1.72**	**0.99**
Weed management (W)									
W_1	33.22	34.33	34.11	19.44	19.63	19.54	27.04	31.56	29.19
W_2	34.85	37.89	36.00	20.78	20.30	20.54	28.89	32.67	30.78
W_3	34.00	35.89	35.78	20.22	19.96	20.09	27.11	31.33	29.33
W_4	34.44	36.11	34.67	19.30	19.89	19.59	27.56	31.48	29.52
W_5	33.67	36.70	35.00	20.44	20.07	20.26	28.11	32.11	30.11
SEm±	**0.63**	**0.83**	**0.48**	**0.39**	**0.30**	**0.28**	**0.470**	**0.66**	**0.47**
CD (*p*=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

N_1: 100 % RDF (NPKS), N_2: 75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB), N_3: 50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB), W_1: Weedy check, W_2: Weed free (Hand weeding at 15, 30 and 45 DAS), W_3: Mechanical weeding at 20 and 40 DAS, W_4: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS, W_5: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS

Table 4.104: Interaction effect of nutrient and weed management treatments on soil microbial population after crop harvest

Treatments	Soil bacteria ($Cfu \times 10^7$ g^{-1} of soil)			Soil fungi ($Cfu \times 10^4$ g^{-1} of soil)			Soil actinomycetes ($Cfu \times 10^5$ g^{-1} of soil)		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
N_1W_1	29.67	31.67	30.67	18.11	17.67	17.89	21.00	23.00	21.17
N_1W_2	28.33	35.33	31.83	18.56	18.56	18.56	21.33	26.00	23.67
N_1W_3	29.33	34.67	32.00	18.56	17.89	18.22	20.67	23.00	21.67
N_1W_4	31.00	34.67	32.83	17.67	17.78	17.72	20.33	24.33	21.50
N_1W_5	29.33	33.00	31.17	18.00	18.67	18.33	20.67	25.67	23.17
N_2W_1	38.33	38.00	38.17	21.44	21.56	21.50	31.78	35.33	36.17
N_2W_2	39.56	41.33	39.33	24.44	22.67	23.56	35.00	39.67	36.50
N_2W_3	40.33	38.67	40.83	22.89	21.89	22.39	31.33	38.67	33.56
N_2W_4	37.67	38.33	38.00	21.67	22.67	22.17	33.33	38.00	34.67
N_2W_5	38.67	39.11	38.67	23.89	22.44	23.17	33.67	37.33	36.17
N_3W_1	31.67	33.33	33.50	18.78	19.67	19.22	28.33	35.67	30.67
N_3W_2	36.67	37.00	36.83	19.33	19.67	19.50	30.33	32.33	31.33
N_3W_3	32.33	34.33	34.50	19.22	20.11	19.67	29.33	33.00	32.50
N_3W_4	34.67	35.33	33.17	18.56	19.23	18.89	29.00	32.11	31.06
N_3W_5	33.00	38.00	35.17	19.44	19.11	19.28	30.00	33.33	30.17
SEm± (N×W)	**1.09**	**1.43**	**0.83**	**0.68**	**0.51**	**0.49**	**0.81**	**1.14**	**0.69**
SEm± (W×N)	**0.78**	**1.04**	**0.59**	**0.51**	**0.36**	**0.33**	**0.62**	**0.84**	**0.48**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

fertilizers. The balanced application had more ammonifying, nitrifying and cellulose-decomposing bacteria and similar amount of N_2 fixing bacteria and less denitrifying bacteria than the unbalanced fertilizer application treatments (Patel *et al.*, 2018; Bairwa *et al.*, 2021). Dhage *et al.* (2008) reported that the degradation of nodules at later stage of crop might have increased the bacterial population. This clearly demonstrated that using a balanced amount of organic and inorganic fertilizer in the soil does not harm the microflora population (Dhok, 2011).

4.7.1.2 Effect of weed management treatments on soil bacteria

The data for both years and average data of two years revealed no significant variation in soil bacterial population among the different weed management treatments.

4.7.1.3 Interaction effect of treatments on soil bacteria

The interaction effect of treatments on soil bacterial population was non-significant for both years and average data of two years.

4.7.2 Soil fungi

4.7.2.1 Effect of nutrient management treatments on soil fungi

The data of both years of experiments and average data of two years showed significant effect on soil fungal population due to different nutrient management treatments. The highest soil fungal population (22.87, 22.24 and 22.56 Cfu × 10^4 g^{-1} of soil in 2017, 2018 and average data of two years, respectively) was significantly recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment. And the least soil fungal population was observed in N_1 (100% RDF).

The increase in fungal population in N_2 treatment could be attributed to the crop's ability to produce adequate nitrogen through integrated means. It also might be due to the application of FYM along with biofertilizers *viz*. PSB resulted in build-up of nutrients in the soil. The addition of FYM serves as a source of nutrients as well as a substrate for nutrient degradation and mineralisation, resulting in a favourable environment for a microbial proliferation in the soil, directly indicating an improvement in soil health. Parewa *et al*. (2014) reported that the addition of FYM with inorganic fertilizer showed an increase in the microbial population in comparison to the chemical fertzer used alone. Similar findings were reported by Badole and More (2000) and Patel *et al.* (2018).

4.7.2.2 Effect of weed management on soil fungi

A perusal of the data for both years and average data of two years of soil fungal population revealed no significant variation among the different weed management treatments.

4.7.2.3 Interaction effect on soil fungi

The study found no significant effect on soil fungal population due to the interaction of nutrient and weed management treatments in both years of experiment and average data of two years.

4.7.3 Soil actinomycetes

4.7.3.1 Effect of nutrient management treatments on soil actinomycetes

The data for both years and average data of two years of soil actinomycetes population revealed significant variation among the different nutrient management treatments. In 2017 and 2018 years of experimentation and average data of two years, significantly maximum soil actinomycetes population (33.02, 37.80 and 35.41 Cfu × 10^5 g^{-1} of soil, respectively) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB). This was followed by N_3 (50%

RDF + 50% organic through *Rhizobium* + PSB). The minimum soil actinomycetes population was recorded in N_1 (100% RDF).

In N_2 treatment, the actinomycetes population increased when FYM and PSB were combined with chemical fertilizers. It could be because there was more organic matter decomposition in the soil, which led to an increase in microbial populations. According to Meena and Ghasolia (2013), the addition of FYM at 5 t ha^{-1} significantly increased the population of actinomycetes.

4.7.3.2 Effect of weed management treatments on soil actinomycetes

The data for both years and average data of two years revealed no significant variation in soil actinomycetes population among the different weed management treatments.

The use of herbicides at recommended application rates has been proven in most studies to have no negative impact on soil microbial activity (Lupwayi *et al*., 2004 and Nalayini *et al*., 2013). Adverse effect of chemicals (*i.e.*, pendimethalin and propaquizafop in W_4 and W_5 treatments, respectively) was not seen on soil microorganisms which may be due to observations taken directly only after harvest and also may be due to half-life of both chemicals. Bera and Ghosh (2014) reported that the toxic effects of herbicides are normally most severe immediately after application, when their concentration in soil is highest. Later on, microorganism take part in degradation process, and herbicide concentration and its toxic effect gradually decline up to half-life. Then the degraded organic herbicide provides the substrate with carbon, which leads to an increase of the soil microflora. Kewat *et al*. (2001) reported that half-life of Pendimethalin at 1.0 kg *a.i.* ha^{-1} was 24 days. Similarly, Kočárek *et al*. (2016) observed half-life values of pendimethalin in the range 24.4 to 34.4 days. Ramprakash *et al*. (2016) reported that half-life of Propaquizafop at 62.5 g ha^{-1} was 15.12 days. In another study, Hazra *et al*. (2016) reported that calculated

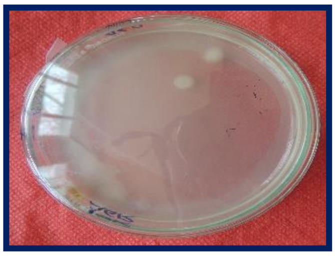
Blister beetle (*Mylabris phalerata*)

Leaf folder (*Nacoleia sp.*)

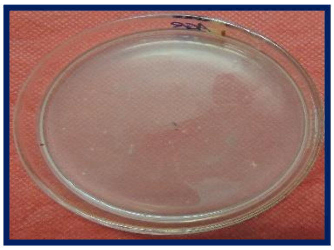
PLATE 6: Pests found in soybean experimental field.

PLATE 7: Mechanical weeding using wheel hoe at 40 DAS

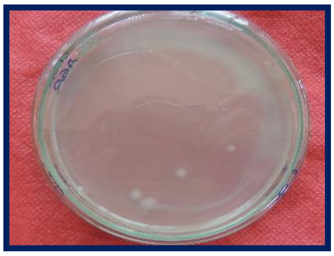
PLATE 8: Microbiological analysis



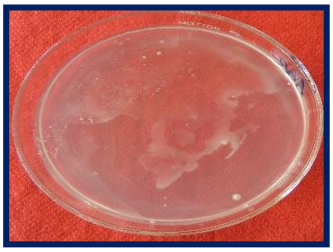
N_1W_1



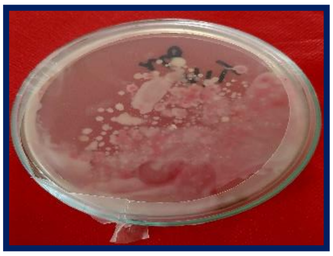
N_2W_1



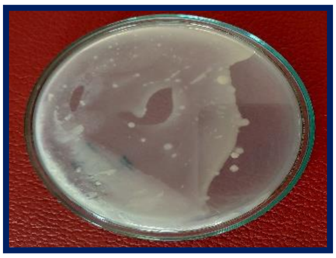
N_3W_1



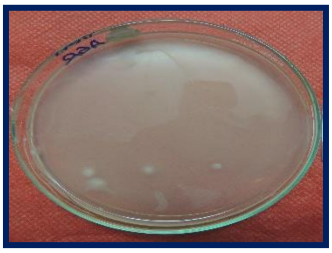
N_1W_2



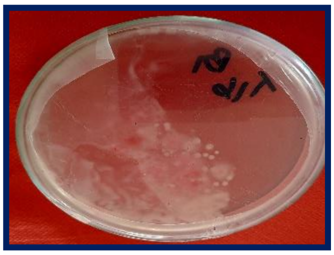
N_2W_2



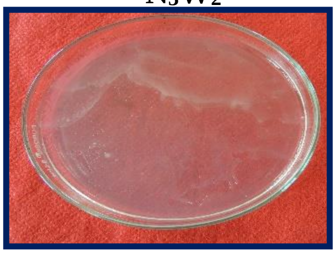
N_3W_2



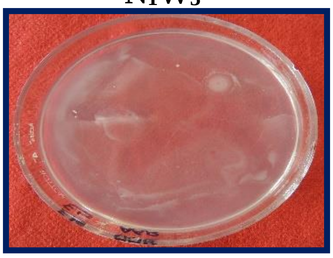
N_1W_3



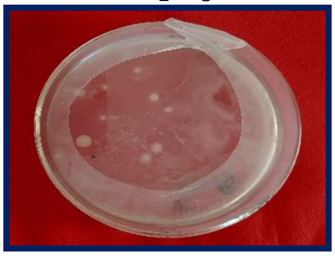
N_2W_3



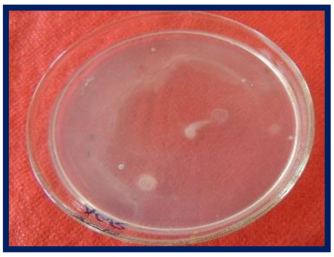
N_3W_3



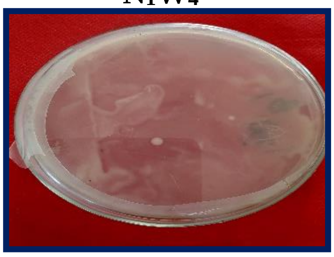
N_1W_4



N_2W_4

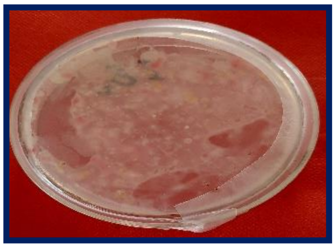


N_3W_4



N_1W_5

N_2W_5



N_3W_5

N_1: 100 % RDF; **N_2**: 75% RDF + 25% organic through FYM + PSB**;** **N_3**: 50% RDF + 50 % organic through *Rhizobium* + PSB**;** **W_1**: Weedy check; **W_2**: Weed free (Hand weeding at 15, 30 and 45 DAS); **W_3**: Mechanical weeding at 20 and 40 DAS; **W_4**: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS; **W_5**: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS

PLATE 9: Effect of nutrient and weed management treatments on soil bacteria at harvest.

N_1W_1

N_2W_1

N_3W_1

N_1W_2

N_2W_2

N_3W_2

N_1W_3

N_2W_3

N_3W_3

N_1W_4

N_2W_4

N_3W_4

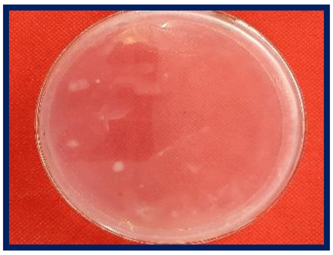
N_1W_5

N_2W_5

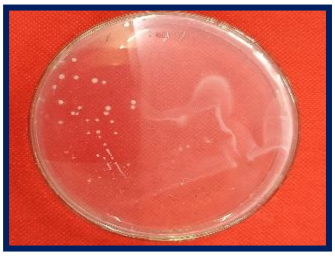
N_3W_5

N_1: 100 % RDF; **N_2**: 75% RDF + 25% organic through FYM + PSB**;** **N_3**: 50% RDF + 50 % organic through *Rhizobium* + PSB**;** **W_1**: Weedy check; **W_2**: Weed free (Hand weeding at 15, 30 and 45 DAS); **W_3**: Mechanical weeding at 20 and 40 DAS; **W_4**: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS; **W_5**: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS

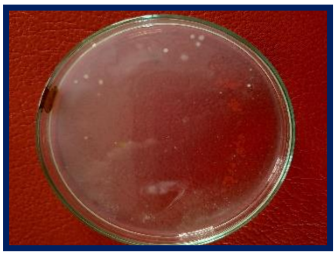
PLATE 10: Effect of nutrient and weed management treatments on soil fungi at harvest.



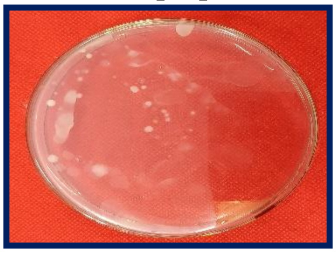
N_1W_1



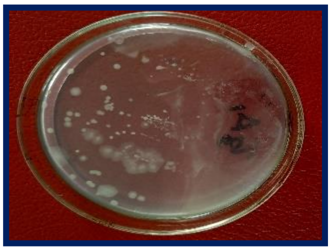
N_2W_1



N_3W_1



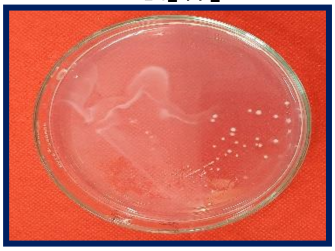
N_1W_2



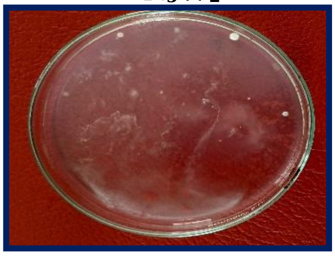
N_2W_2

N_3W_2

N_1W_3

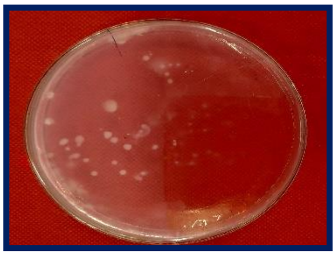


N_2W_3

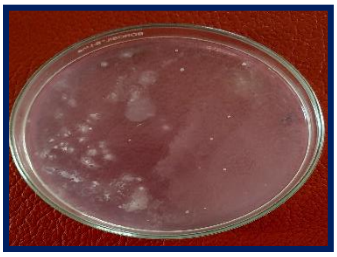


N_3W_3

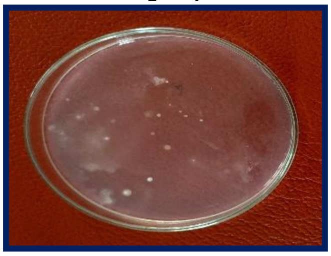
N_1W_4



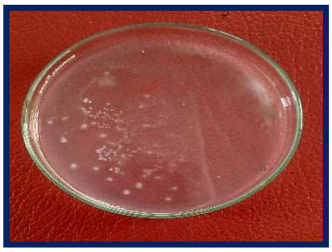
N_2W_4



N_3W_4



N_1W_5



N_2W_5

N_3W_5

N_1: 100 % RDF; **N_2**: 75% RDF + 25% organic through FYM + PSB**;** **N_3**: 50% RDF + 50 % organic through *Rhizobium* + PSB**;** **W_1**: Weedy check; **W_2**: Weed free (Hand weeding at 15, 30 and 45 DAS); **W_3**: Mechanical weeding at 20 and 40 DAS; **W_4**: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS; **W_5**: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS

PLATE 11: Effect of nutrient and weed management treatments on soil actinomycetes at harvest.

half-life of propaquizafop were found to be in the range of 25.29-27.63 days irrespective of dosage of application.

10.7.1.3Interaction effect of treatments on soil actinomycetes

The interaction effect of treatments on soil actinomycetes population gave no significant results in both years of the experiment (2017 and 2018) and average data of two years.

4.8 PLANT CHEMICAL ANALYSIS

4.8.1 NPKS content (%) in grain

The data on NPKS content (%) in grain for both years of experimentation and average data of two years are presented in Table 4.105 and 4.106.

4.8.1.1 Effect of nutrient management treatments on NPKS content (%) in grain

A perusal of the data for both years and average data of two years on N content (%) in grain revealed significant variation among the different nutrient management treatments. In 2017, significantly highest N content (6.11%) in grain was recorded in N_2 (75% RDF + 25% organic through FYM + PSB). This was followed by N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) which was at par with N_1 (100% RDF). In 2018 and average data of two years, the maximum N content in grain (6.08% and 6.10%, respectively) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) which was at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). The minimum N content in grain was recorded in N_1 (100% RDF).

The data for both years and average data of two years revealed no significant PKS content (%) variation in grain among the different nutrient management treatments.

The increased N content in grain in N_2 treatment might be due to more uptake of nitrogen under conjoint use of organic (*i.e.*, FYM) and inorganic (*i.e.*, fertilizers) form along with biofertilizers (*i.e.*, PSB). Similar findings were reported by Jadhav *et al*. (2007). The nutrient dilution effect during later growth stages and more nutrients translocated for the crop's reproductive process might have increased N content in N_2 and N_3 treatments. Dhage and Kachhave (2008) observed that grain inoculation with *Rhizobium* +PSB resulted in the highest N content. Kudi *et al*. (2017) reported that the N content of grain increased when either *Rhizobium* or PSB and combined was inoculated over uninoculation.

4.8.1.2 Effect of weed management treatments on NPKS content (%) in grain

The data for both years and average data of two years on NPKS content (%) in grain revealed significant variation among the different weed management treatments.

In 2017, 2018 and average data of two years, the highest N content (6.27%, 6.20% and 6.24%, respectively) in grain was observed in W_2 (hand weeding at 15, 30 and 45 DAS) and was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). The lowest N content in grain was significantly recorded in W_1 (Weedy check).

For P content (%) in grain, the first year data revealed the highest P content (0.35 %) in grain was recorded in W_2 (hand weeding at 15, 30 and 45 DAS) and was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). In the second year data, highest P content (0.34 %) in grain was recorded in W_2 (hand weeding at 15, 30 and 45 DAS) and was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS).

In the average data of two years, highest P content (0.35 %) in grain was recorded significantly in W_2 (hand weeding at 15, 30 and 45 DAS) which was followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS). In both the years and average data of two years, the grain's lowest P content (%) was significantly recorded in W_1 (Weedy check).

For K content (%) in grain, the average data of two years recorded highest K content in grain (1.84 %) in W_2 (hand weeding at 15, 30 and 45 DAS) and was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). The lowest P content in grain was significantly recorded in W_1 (Weedy check).

For S content in grain, the two years data and the average data of two years showed that W_2 (hand weeding at 15, 30 and 45 DAS) recorded the highest S content (%) in grain and was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatment. And the lowest S content (%) in grain was significantly recorded in W_1 (Weedy check).

The higher NPKS content in grain under W_2, W_5 and W_4 treatments might be due to effective weed control. Seed is the ultimate sink for the assimilation of nutrients in plants. More the control of weeds, less is the competition between crop and plants for nutrients. Therefore, in treatments which controlled weeds significantly, there is more absorption of nutrients by the crops which ultimately is reflected in higher NPKS content in grain.

4.8.1.3 Interaction effect on management treatments on NPKS content (%) in grain

The interaction effect of treatments on NPK content in grain gave no significant results in the two years of experimentations.

The two years data and average data of two years for S content in grain gave significant results among the treatment interactions. The average data of two years recorded the highest S content in grain (0.28 %) in N_2W_5 interaction and the lowest (0.11%) in N_1W_1 interaction. The higher nutrient content in grain under treatments interactions might be due to better nutrient and weed management practices.

4.8.2 NPKS content (%) in stover

The data on NPKS content (%) in stover for both years of experimentation and average data of two years are presented in Table 4.107 and 4.108

4.8.1.1 Effect of nutrient management treatments on NPKS content (%) in stover

A perusal of the data for both years and average data of two years revealed no significant variation on NPKS content in stover among the different nutrient management treatments.

4.8.1.2 Effect of weed management treatments on NPKS content (%) in stover

The data for both years of experiment and average data of two years revealed significant variation in NPKS content in stover among the different weed management treatments.

For N content in stover, the two years data (2017 and 2018) and average data of two years revealed that the highest N content (1.86%, 1.84% and 1.85%, respectively) in stover was observed in W_2 (hand weeding at 15, 30 and 45 DAS) and was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). The lowest N content in stover was significantly recorded in W_1 (Weedy check).

For P content in stover, the two years data and average data of two years revealed that the highest P content (%) in stover was recorded significantly in W_2 (hand weeding at 15, 30 and 45 DAS). The lowest P content in stover was recorded in W_1 (Weedy check).

For K content in stover, the two years data and average data of two years recorded the highest K content in stover in W_2 (hand weeding at 15, 30 and 45 DAS) and at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). And the lowest K content (%) in stover was significantly recorded in W_1 (Weedy check).

For S content (%) in stover, the first data showed that W_2 (hand weeding at 15, 30 and 45 DAS) recorded the highest S content (0.20 %) in stover and was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatment. In 2018 data and average data of two years, the highest S content (0.20 %) in stover was significantly recorded in W_2 (hand weeding at 15, 30 and 45 DAS). The lowest S content (0.09%, 0.08% and 0.08%, respectively) in stover was recorded in W_1 (Weedy check) in both the years (2017 and 2018) and average data of two years.

The higher NPKS content in stover under W_2, W_5 and W_4 treatments might be due to reduced crop weed competition.

4.8.2.3 Interaction effect of treatments on NPKS content (%) in stover

The interaction effect of treatments on NPK content (%) in stover gave no significant results in the two years of the experimentation and average data of two years.

Table 4.105: Effect of nutrient and weed management treatments on NPKS content (%) in grain

Treat-ments	N content (%)			P content (%)			K content (%)			S content (%)		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
Nutrient management (N)												
N_1	5.96	5.93	5.94	0.30	0.28	0.29	1.58	1.57	1.58	0.23	0.22	0.22
N_2	6.11	6.08	6.10	0.31	0.30	0.30	1.62	1.61	1.61	0.24	0.23	0.23
N_3	6.08	6.03	6.06	0.30	0.29	0.30	1.60	1.45	1.53	0.23	0.22	0.23
SEm±	**0.03**	**0.03**	**0.03**	**0.004**	**0.01**	**0.006**	**0.02**	**0.09**	**0.04**	**0.004**	**0.003**	**0.003**
CD (*p*=0.05)	**0.12**	**0.10**	**0.11**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	5.53	5.54	5.54	0.19	0.19	0.19	1.07	1.05	1.06	0.12	0.12	0.12
W_2	6.27	6.20	6.24	0.35	0.34	0.35	1.83	1.84	1.84	0.27	0.26	0.27
W_3	6.03	5.99	6.01	0.29	0.27	0.28	1.54	1.42	1.48	0.23	0.21	0.22
W_4	6.20	6.17	6.18	0.34	0.32	0.33	1.78	1.80	1.79	0.26	0.26	0.26
W_5	6.22	6.18	6.20	0.34	0.33	0.34	1.78	1.62	1.70	0.27	0.26	0.27
SEm±	**0.06**	**0.05**	**0.05**	**0.006**	**0.006**	**0.003**	**0.02**	**0.09**	**0.05**	**0.004**	**0.004**	**0.003**
CD (*p*=0.05)	**0.16**	**0.15**	**0.14**	**0.02**	**0.02**	**0.009**	**0.070**	**0.26**	**0.14**	**0.01**	**0.01**	**0.009**

N_1: 100 % RDF (NPKS), N_2: 75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB), N_3: 50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB), W_1: Weedy check, W_2: Weed free (Hand weeding at 15, 30 and 45 DAS), W_3: Mechanical weeding at 20 and 40 DAS, W_4: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS, W_5: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS

Table 4.106: Interaction effect of nutrient and weed management treatments on NPKS (%) content in grain

Treatments	N content (%)			P content (%)			K content (%)			S content (%)		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
N_1W_1	5.40	5.35	5.38	0.19	0.17	0.18	1.04	1.00	1.02	0.11	0.11	0.11
N_1W_2	6.19	6.13	6.16	0.35	0.34	0.34	1.83	1.84	1.84	0.28	0.26	0.27
N_1W_3	5.95	5.95	5.95	0.29	0.26	0.27	1.52	1.40	1.46	0.22	0.19	0.21
N_1W_4	6.10	6.11	6.11	0.31	0.29	0.30	1.76	1.79	1.78	0.27	0.26	0.27
N_1W_5	6.13	6.12	6.13	0.34	0.33	0.34	1.77	1.83	1.80	0.27	0.26	0.27
N_2W_1	5.57	5.68	5.63	0.19	0.19	0.19	1.08	1.12	1.10	0.13	0.13	0.13
N_2W_2	6.28	6.25	6.27	0.36	0.35	0.35	1.87	1.85	1.86	0.27	0.26	0.26
N_2W_3	6.12	6.05	6.08	0.29	0.28	0.29	1.56	1.43	1.50	0.25	0.22	0.23
N_2W_4	6.21	6.26	6.24	0.35	0.35	0.35	1.77	1.83	1.80	0.27	0.26	0.27
N_2W_5	6.35	6.19	6.27	0.35	0.33	0.34	1.81	1.82	1.82	0.28	0.27	0.28
N_3W_1	5.61	5.61	5.61	0.20	0.20	0.20	1.09	1.03	1.06	0.14	0.11	0.13
N_3W_2	6.34	6.22	6.28	0.35	0.34	0.34	1.79	1.82	1.81	0.27	0.27	0.27
N_3W_3	6.03	5.97	6.00	0.28	0.27	0.27	1.54	1.42	1.48	0.23	0.21	0.22
N_3W_4	6.28	6.13	6.21	0.34	0.32	0.33	1.82	1.79	1.81	0.25	0.24	0.25
N_3W_5	6.17	6.23	6.20	0.35	0.32	0.33	1.77	1.20	1.49	0.27	0.25	0.26
SEm± (N×W)	**0.10**	**0.09**	**0.08**	**0.01**	**0.01**	**0.005**	**0.04**	**0.15**	**0.08**	**0.007**	**0.006**	**0.005**
SEm± (W×N)	**0.07**	**0.06**	**0.06**	**0.007**	**0.01**	**0.007**	**0.03**	**0.13**	**0.07**	**0.006**	**0.005**	**0.004**
CD (*p*=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**0.02**	**NS**	**NS**	**NS**	**0.019**	**0.019**	**0.015**
CD (*p*=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**0.03**	**NS**	**NS**	**NS**	**0.021**	**0.017**	**0.015**

Table 4.107: Effect of nutrient and weed management treatments on NPKS content (%) in stover

Treat-ments	N content (%)			P content (%)			K content (%)			S content (%)		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
Nutrient management (N)												
N_1	1.69	1.69	1.69	0.22	0.20	0.21	2.10	2.07	2.08	0.17	0.16	0.16
N_2	1.74	1.72	1.73	0.23	0.22	0.22	2.16	2.18	2.17	0.17	0.16	0.16
N_3	1.72	1.69	1.71	0.22	0.21	0.22	2.13	2.11	2.12	0.16	0.15	0.15
SEm±	**0.016**	**0.021**	**0.015**	**0.004**	**0.003**	**0.003**	**0.038**	**0.021**	**0.027**	**0.004**	**0.002**	**0.002**
CD (p=0.05	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed management (W)												
W_1	1.44	1.43	1.44	0.13	0.12	0.13	1.19	1.17	1.18	0.09	0.08	0.08
W_2	1.85	1.84	1.85	0.28	0.27	0.27	2.45	2.43	2.44	0.20	0.20	0.20
W_3	1.65	1.62	1.63	0.20	0.18	0.19	2.16	2.16	2.16	0.15	0.14	0.14
W_4	1.80	1.80	1.80	0.26	0.24	0.25	2.40	2.41	2.41	0.20	0.18	0.19
W_5	1.83	1.81	1.82	0.26	0.25	0.25	2.42	2.41	2.42	0.20	0.18	0.19
SEm±	**0.022**	**0.019**	**0.017**	**0.004**	**0.003**	**0.003**	**0.027**	**0.030**	**0.021**	**0.003**	**0.002**	**0.002**
CD (p=0.05	**0.07**	**0.06**	**0.05**	**0.012**	**0.01**	**0.008**	**0.08**	**0.09**	**0.06**	**0.008**	**0.007**	**0.005**

Table 4.108: Interaction effect of nutrient and weed management treatments on NPKS (%) content in stover

Treatments	N content (%)			P content (%)			K content (%)			S content (%)		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
N_1W_1	1.45	1.46	1.45	0.12	0.12	0.12	1.17	1.16	1.16	0.09	0.08	0.09
N_1W_2	1.82	1.82	1.82	0.27	0.26	0.27	2.42	2.33	2.38	0.21	0.20	0.21
N_1W_3	1.63	1.61	1.62	0.18	0.17	0.17	2.10	2.18	2.14	0.15	0.13	0.14
N_1W_4	1.78	1.78	1.78	0.27	0.23	0.25	2.39	2.35	2.37	0.20	0.18	0.19
N_1W_5	1.75	1.78	1.77	0.26	0.25	0.25	2.40	2.33	2.37	0.21	0.18	0.19
N_2W_1	1.47	1.45	1.46	0.14	0.13	0.14	1.22	1.20	1.21	0.09	0.07	0.08
N_2W_2	1.89	1.88	1.89	0.29	0.28	0.28	2.50	2.53	2.51	0.21	0.21	0.21
N_2W_3	1.65	1.63	1.64	0.21	0.18	0.20	2.20	2.17	2.19	0.15	0.14	0.15
N_2W_4	1.82	1.80	1.81	0.25	0.24	0.25	2.41	2.48	2.45	0.20	0.18	0.19
N_2W_5	1.87	1.82	1.85	0.27	0.25	0.26	2.47	2.50	2.49	0.21	0.18	0.20
N_3W_1	1.41	1.40	1.40	0.13	0.12	0.13	1.20	1.16	1.18	0.09	0.07	0.08
N_3W_2	1.85	1.83	1.84	0.27	0.27	0.27	2.43	2.43	2.43	0.18	0.18	0.18
N_3W_3	1.65	1.62	1.64	0.20	0.19	0.20	2.19	2.13	2.16	0.14	0.14	0.14
N_3W_4	1.81	1.80	1.81	0.25	0.24	0.24	2.41	2.41	2.41	0.19	0.18	0.18
N_3W_5	1.87	1.82	1.84	0.28	0.25	0.26	2.40	2.41	2.41	0.19	0.17	0.18
SEm± (N×W)	**0.04**	**0.03**	**0.03**	**0.007**	**0.006**	**0.005**	**0.05**	**0.05**	**0.04**	**0.005**	**0.004**	**0.003**
SEm± (W×N)	**0.03**	**0.03**	**0.02**	**0.006**	**0.005**	**0.004**	**0.05**	**0.04**	**0.04**	**0.005**	**0.003**	**0.003**
CD (p=0.05) (W at same level of N)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.012**	**0.009**
CD (p=0.05) (N at same or different level of W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.011**	**0.011**

The interaction effect of treatments on S content in stover gave no significant results in the first year of the experiment (2017). However, the second year (2018) data gave significant results among the treatment interactions where the highest S content (0.21 %) in stover was recorded in N_2W_2 interaction. The average data of two years also gave significant results among the treatment interactions where the highest S content (0.21 %) in stover was recorded in N_2W_2 and N_1W_2 interactions. Better nutrition under a comparatively weed free environment may have resulted in the higher nutrient content of stover.

4.8.3 NPKS uptake (kg ha^{-1}) in grain

The data on NPKS uptake (kg ha^{-1}) in grain for both years of experimentation and average data of two years are presented in Table 4.109 and 4.110.

4.8.1.1 Effect of nutrient management treatments on NPKS uptake (kg ha^{-1}) in grain

A perusal of the data on N uptake in grain for both years (2017 and 2018) of experiment and average data of two years revealed significant variation among the different nutrient management treatments. In 2017 and 2018, the highest N uptake (105.32 and 95.90 kg ha^{-1}, respectively) in grain was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) and was at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). The average data of two years significantly recorded the maximum N uptake (100.61 kg ha^{-1}) in grain in N_2 (75% RDF + 25% organic through FYM + PSB). The minimum N uptake in grain was recorded in N_1 (100% RDF) in both years of experimentation and average data of two years.

A perusal of the data for 2017 on P uptake in grain revealed significant variation among the different nutrient management treatments. The highest P uptake (5.30 kg ha^{-1}) in grain was recorded significantly in N_2 (75% RDF + 25% organic through FYM + PSB). This was followed by N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) which was at par with N_1 (100% RDF) treatment. However, the 2018 data revealed that there was no significant variation in P uptake (kg ha^{-1}) in grain among the different nutrient management treatments. The average data of two years revealed a similar trend as observed in the first year data.

The 2018 and average data of two years revealed no significant variation on P uptake in grain among the different nutrient management treatments. However, a perusal of the data for 2017 revealed a significant variation in K uptake in grain among the different nutrient management treatments. The highest K uptake (29.31 kg ha^{-1}) in grain was recorded significantly in N_2 (75% RDF + 25% organic through FYM + PSB). This was followed by N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) which was at par with N_1 (100% RDF) treatment.

The data for both years and average data of two years on S uptake in grain revealed significant variation among the different nutrient management treatments. The average data of two years revealed that the highest S uptake (4.34 kg ha^{-1}) in grain was recorded significantly in N_2 (75% RDF + 25% organic through FYM + PSB). This was followed by N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) which was at par with N_1 (100% RDF) treatment.

The increased uptake of N, P, K and S in grain in N_2 treatment might be due to the higher nutrient content in the grain and higher grain yield. These results conform to the finding of Chaurasia *et al*. (2009), Singh *et al*. (2011) and Bijarnia *et al*. (2017).

4.8.1.2 Effect of weed management of treatments on NPKS uptake (kg ha^{-1}) in grain

Significant variation was revealed among the different weed management treatments on NPKS uptake in grain for both years (2017 and 2018) and average data of two years.

The two years data and average data of two years revealed that significantly highest NPKS uptake in grain was observed in W_2 (hand weeding at 15, 30 and 45 DAS). This was followed subsequently by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS). And the lowest NPKS uptake in grain was recorded in W_1 (Weedy check).

The better uptake of nutrient in W_2 treatment could be because this treatment controlled and suppressed the weed growth very effectively and provided a weed-free environment to the crop for a longer time to utilise the available and applied nutrients under reduced crop-weed competition. Therefore, crop grew more vigorously and accumulated more biomass, leading to higher uptake of these nutrients (Chander *et al*., 2013). Similar results were reported by Kour *et al*. (2014) and Mahatale *et al*. (2016). W_5 and W_4 treatment also recorded higher nutrient uptake in grain. This might be ascribed to higher yield (*i.e*., grain yield) and effective weed control under these treatments (Sharma *et al*., 2016a). Whereas, weedy check recorded the lowest uptake due to heavy weed infestation offering more competition at all stages of crop growth.

4.8.3.3 Interaction effect of treatments on NPKS uptake (kg ha^{-1}) in grain

The interaction effect of treatments on N and P uptake (kg ha^{-1}) in grain gave significant results in the two years of the experiment and the average data of two years. The highest N uptake (154.05 kg ha^{-1}, 131.02 kg ha^{-1} and 142.60 kg ha^{-1} in 2017, 2018 and average data of two years, respectively) and P uptake

(8.76 kg ha-1, 7.27 kg ha^{-1} and 8.00 kg ha^{-1} in 2017, 2018 and average data of two years, respectively) in grain was recorded in N_2W_2 interaction and lowest N uptake and P uptake in grain were recorded in N_1W_1 interaction.

The interaction effect of treatments on K uptake in grain gave significant results in the first year of the experiment and the average data of two years. The highest and lowest K uptake in grain was recorded in N_2W_2 and N_1W_1 interactions, respectively. The second year experiment did not give any significant results among the treatment interactions.

The two years data and average data of two years for S uptake in grain did not give any significant results among the treatment interactions. However, the average data of two years revealed the highest S uptake (5.96 kg ha^{-1}) in grain in N_2W_2 and the lowest (0.64 kg ha^{-1}) in N_1W_1.

These findings suggest that good nutrition under a comparatively weed free environment may have resulted in higher nutrients uptake by the crop. Similar findings were reported by Kalaiyarasan *et al*. (2019).

4.8.4 NPKS uptake (kg ha^{-1}) in stover

The data on NPKS uptake (kg ha^{-1}) in stover for both years of experimentation and average data of two years is presented in Table 4.101 and 4.102.

4.8.4.1 Effect of nutrient management on NPKS uptake (kg ha^{-1}) in stover

A perusal of the data for 2017 and average data of two years revealed significant variation on N uptake in stover among the different nutrient management treatments. The highest N uptake (41.94 kg ha^{-1} and 40.22 kg ha^{-1} in 2017 and average data of two years, respectively) in stover was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) and was at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). However, the 2018 data on N uptake in stover did not reveal significant results among the different nutrient management treatments.

A perusal of the two years data and average data of two years revealed significant variation on P uptake in stover among the different nutrient management treatments. Significantly, the highest P uptake (5.75, 5.02 and 5.38 kg ha^{-1}in 2017, 2018 and average data of two years, respectively) in stover was recorded in N_2 (75% RDF + 25% organic through FYM + PSB). The lowest P uptake in stover was recorded in N_1 (100% RDF) treatment.

A perusal of the data for K uptake in stover revealed significant variation among the different nutrient management treatments. The highest K uptake (53.41, 50.11 and 51.74 kg ha^{-1} in 2017, 2018 and average data of two years) in stover was recorded in N_2 (75% RDF + 25% organic through FYM + PSB).

The 2017 data on S uptake in stover revealed significant variation among the different nutrient management treatments. Significantly highest S uptake (4.28 kg ha^{-1}) in stover was recorded in N_2 (75% RDF + 25% organic through FYM + PSB). This was followed by N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) which was at par with N_1 (100% RDF) treatment. The second year (2018) data did not record any significant variation in S uptake in stover among the different nutrient management treatments. The average data of two years showed a similar trend as observed in the first year (2017).

The better nutrient uptake in stover in N_2 treatment might be due to higher stover yield and nutrient concentration (Arbad and Ismail, 2011). It can be seen that stover used more K than grain. This is due to higher K content in stover. This confirms to the findings of Bonde and Gawande (2017).

4.8.4.2 Effect of weed management treatments on NPKS uptake (kg ha^{-1}) in stover

The data for both years and average data of two years revealed significant variation in NPKS uptake (kg ha^{-1}) in stover among the different weed management treatments.

The two years data and average data of two years revealed that significantly highest NPKS uptake in stover was observed in W_2 (hand weeding at 15, 30 and 45 DAS) and the lowest NPKS uptake in stover was recorded significantly in W_1 (Weedy check).

The maximum NPKS uptake in W_2 treatment could be owing to successful weed control of both early and late-emerging weeds leading to decreased weed dry matter production and thus lower depletion of nutrients by weeds. Panneerselvam *et al*. (2000) reported similar findings. The reduced crop weed competition in W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatments also registered higher stover uptake which may be due to higher crop biomass along with more nutrient content (Nagar *et al*., 2009 and Jadon *et al*., 2019).

4.8.4.3 Interaction effect of treatments on NPKS uptake (kg ha^{-1}) in stover

The interaction effect of treatments on N uptake (kg ha^{-1}) in stover gave significant results in the first year of the experiment and the average data of two years where N_2W_2 interactions recorded the highest N uptake in stover. The second year experiment did not give any significant results.

The interaction effect of treatments on P uptake (kg ha^{-1}) in stover gave no significant results in both years of experiment and average data of two years.

Table 4.109: Effect of nutrient and weed management treatments on NPKS uptake (kg ha^{-1}) in grain

Treat-ments	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})			K uptake (kg ha^{-1})			S uptake (kg ha^{-1})		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
Nutrient management (N)												
N_1	84.80	82.81	83.81	4.41	4.14	4.27	23.56	23.20	23.38	3.52	3.25	3.38
N_2	105.32	95.90	100.61	5.62	4.99	5.30	29.31	26.74	28.02	4.34	3.85	4.09
N_3	94.12	91.00	92.57	4.89	4.56	4.73	25.79	22.72	24.29	3.78	3.54	3.66
SEm±	**3.22**	**1.42**	**1.51**	**0.14**	**0.18**	**0.14**	**0.87**	**1.71**	**1.07**	**0.13**	**0.11**	**0.09**
CD (*p*=0.05)	**12.65**	**5.56**	**5.91**	**0.55**	**NS**	**0.54**	**3.43**	**NS**	**NS**	**0.52**	**0.45**	**0.33**
Weed management (W)												
W_1	38.14	35.15	36.64	1.34	1.19	1.26	7.40	6.62	7.01	0.86	0.75	0.80
W_2	133.09	124.71	128.94	7.42	6.86	7.15	38.94	36.97	37.97	5.82	5.27	5.54
W_3	65.86	64.92	65.38	3.13	2.90	3.02	16.81	15.39	16.11	2.55	2.24	2.40
W_4	113.47	106.75	110.12	6.16	5.61	5.88	32.68	31.22	31.95	4.81	4.44	4.62
W_5	123.18	118.00	120.58	6.82	6.25	6.53	35.27	30.91	33.11	5.35	5.04	5.19
SEm±	**2.38**	**2.29**	**1.69**	**0.13**	**0.15**	**0.11**	**0.81**	**1.75**	**0.96**	**0.13**	**0.11**	**0.09**
CD (*p*=0.05)	**6.93**	**6.67**	**4.94**	**0.38**	**0.45**	**0.31**	**2.37**	**5.10**	**2.81**	**0.39**	**0.31**	**0.27**

Table 4.110: Interaction effect of nutrient and weed management treatments on NPKS uptake (kg ha^{-1}) in grain

Treat-ments	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})			K uptake (kg ha^{-1})			S uptake (kg ha^{-1})		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
N_1W_1	33.41	31.58	32.48	1.19	1.02	1.11	6.44	5.88	6.15	0.66	0.62	0.64
N_1W_2	112.84	121.26	117.09	6.32	6.72	6.52	33.34	36.46	34.90	5.17	5.08	5.13
N_1W_3	63.82	62.20	62.99	3.09	2.69	2.88	16.34	14.65	15.48	2.41	1.99	2.20
N_1W_4	103.71	90.16	96.96	5.32	4.33	4.81	29.92	26.42	28.20	4.55	3.88	4.21
N_1W_5	110.21	108.84	109.52	6.11	5.93	6.02	31.75	32.60	32.18	4.79	4.68	4.74
N_2W_1	40.25	37.62	38.95	1.40	1.28	1.34	7.83	7.39	7.62	0.94	0.88	0.91
N_2W_2	154.05	131.02	142.60	8.76	7.27	8.00	45.99	38.70	42.32	6.56	5.38	5.96
N_2W_3	67.61	63.97	65.80	3.23	2.96	3.09	17.26	15.18	16.23	2.74	2.33	2.53
N_2W_4	123.42	117.86	120.60	7.01	6.64	6.84	35.19	34.45	34.81	5.29	4.98	5.13
N_2W_5	141.26	129.05	135.11	7.71	6.81	7.25	40.28	37.95	39.12	6.16	5.70	5.93
N_3W_1	40.78	36.24	38.49	1.43	1.27	1.35	7.94	6.57	7.25	0.99	0.73	0.86
N_3W_2	132.38	121.86	127.13	7.18	6.58	6.92	37.49	35.77	36.70	5.72	5.37	5.55
N_3W_3	66.14	68.58	67.34	3.07	3.07	3.07	16.84	16.33	16.61	2.51	2.41	2.47
N_3W_4	113.28	112.23	112.78	6.15	5.85	6.00	32.92	32.79	32.84	4.58	4.46	4.52
N_3W_5	118.05	116.11	117.11	6.64	6.02	6.32	33.77	22.16	28.03	5.10	4.72	4.91
SEm± (N×W)	**4.11**	**3.96**	**2.93**	**0.23**	**0.27**	**0.18**	**1.41**	**3.03**	**1.67**	**0.23**	**0.18**	**0.16**
SEm± (W×N)	**4.14**	**2.88**	**2.39**	**0.20**	**0.25**	**0.18**	**1.25**	**2.57**	**1.51**	**0.20**	**0.16**	**0.13**
CD (*p*=0.05) (W at same level of N)	**12.01**	**11.55**	**8.55**	**0.66**	**0.78**	**0.53**	**4.11**	**NS**	**4.87**	**NS**	**NS**	**NS**
CD (*p*=0.05) (N at same or different level of W)	**14.61**	**9.10**	**7.93**	**0.68**	**0.87**	**0.63**	**4.26**	**NS**	**5.16**	**NS**	**NS**	**NS**

Table 4.111: Effect of nutrient and weed management treatments on NPKS uptake (kg ha^{-1}) in stover

Treatments	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})			K uptake (kg ha^{-1})			S uptake (kg ha^{-1})		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
Nutrient management (N)												
N_1	35.35	33.98	34.66	4.78	4.29	4.53	45.13	42.71	43.93	3.72	3.27	3.49
N_2	41.94	38.32	40.11	5.75	5.02	5.38	53.41	50.11	51.74	4.28	3.64	3.95
N_3	39.16	36.47	37.81	5.16	4.75	4.95	49.57	46.42	47.99	3.69	3.28	3.48
SEm±	**0.82**	**0.83**	**0.68**	**0.13**	**0.12**	**0.08**	**1.32**	**1.12**	**0.90**	**0.08**	**0.11**	**0.08**
CD (*p*=0.05)	**3.20**	**NS**	**2.68**	**0.52**	**0.46**	**0.32**	**5.17**	**4.39**	**3.55**	**0.33**	**NS**	**0.31**
Weed management (W)												
W_1	20.07	18.31	19.19	1.84	1.58	1.71	16.63	15.00	15.81	1.24	0.96	1.10
W_2	50.69	46.66	48.66	7.55	6.82	7.18	66.97	61.41	64.18	5.47	4.95	5.21
W_3	32.60	30.36	31.47	3.89	3.40	3.64	42.84	40.43	41.65	2.88	2.58	2.73
W_4	43.86	42.08	42.96	6.21	5.56	5.88	58.49	56.66	57.54	4.75	4.16	4.46
W_5	46.86	43.87	45.35	6.65	6.06	6.35	61.93	58.58	60.26	5.13	4.31	4.71
SEm±	**1.07**	**1.02**	**0.76**	**0.20**	**0.14**	**0.13**	**1.23**	**1.23**	**0.76**	**0.11**	**0.10**	**0.07**
CD (*p*=0.05)	**3.13**	**2.96**	**2.21**	**0.58**	**0.40**	**0.38**	**3.60**	**3.58**	**2.21**	**0.32**	**0.29**	**0.21**

Table 4.112: Interaction effect of nutrient and weed management treatments on NPKS uptake (kg ha^{-1}) in stover

Treatments	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})			K uptake (kg ha^{-1})			S uptake (kg ha^{-1})		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
N_1W_1	19.75	16.79	18.28	1.69	1.34	1.51	15.95	13.34	14.64	1.28	0.92	1.09
N_1W_2	43.03	44.30	43.67	6.46	6.39	6.43	57.31	56.46	56.91	5.03	4.94	4.99
N_1W_3	32.23	28.42	30.30	3.53	2.96	3.24	41.42	38.45	39.95	2.89	2.36	2.62
N_1W_4	41.23	39.57	40.39	6.21	5.10	5.64	55.56	52.09	53.83	4.64	3.99	4.31
N_1W_5	40.53	40.81	40.67	6.01	5.65	5.83	55.43	53.19	54.30	4.77	4.12	4.44
N_2W_1	20.92	18.87	19.89	2.04	1.69	1.86	17.26	15.71	16.47	1.23	0.96	1.09
N_2W_2	58.20	49.51	53.79	8.81	7.35	8.08	76.80	66.63	71.72	6.36	5.45	5.90
N_2W_3	32.06	31.47	31.77	4.02	3.53	3.77	42.69	41.85	42.26	2.85	2.76	2.80
N_2W_4	46.57	45.19	45.86	6.48	6.04	6.25	61.77	62.43	62.00	5.11	4.43	4.77
N_2W_5	51.96	46.57	49.23	7.40	6.47	6.93	68.51	63.94	66.24	5.83	4.60	5.20
N_3W_1	19.56	19.26	19.41	1.81	1.70	1.75	16.68	15.94	16.31	1.21	1.01	1.11
N_3W_2	50.85	46.17	48.52	7.37	6.73	7.04	66.80	61.14	63.92	5.03	4.46	4.74
N_3W_3	33.51	31.19	32.35	4.12	3.71	3.92	44.42	40.98	42.73	2.91	2.63	2.76
N_3W_4	43.78	41.47	42.64	5.95	5.53	5.74	58.14	55.45	56.79	4.51	4.07	4.29
N_3W_5	48.10	44.24	46.13	6.54	6.06	6.29	61.84	58.61	60.23	4.80	4.21	4.50
SEm± (N×W)	**1.86**	**1.76**	**1.31**	**0.34**	**0.23**	**0.23**	**2.14**	**2.13**	**1.31**	**0.19**	**0.18**	**0.13**
SEm± (W×N)	**1.43**	**1.39**	**1.08**	**0.25**	**0.19**	**0.17**	**1.89**	**1.75**	**1.23**	**0.15**	**0.15**	**0.11**
CD (*p*=0.05) (W at same level of N)	**5.43**	**NS**	**3.83**	**NS**	**NS**	**NS**	**6.23**	**NS**	**3.83**	**0.56**	**NS**	**0.36**
CD (*p*=0.05) (N at same or different level of W)	**4.65**	**NS**	**3.58**	**NS**	**NS**	**NS**	**6.43**	**NS**	**4.25**	**0.48**	**NS**	**0.38**

The interaction effect of treatments on K and S uptake (kg ha^{-1}) in stover gave significant results in the first year of the experiment as well as in the average data of two years where N_2W_2 interactions recorded the highest K uptake in stover. The second year experiment did not give any significant results.

The increase in nutrient uptake (NKS uptake in stover) under the respective treatments might be due to increased stover yield as a result of better nutrient and weed management practices.

4.9 ECONOMICS

The data on the cost of cultivation, gross return, net return and benefit cost ratio under different nutrient weed management treatments, weed management treatments and treatments combinations are presented in Table 4.113 and 4.114.

4.9.1 Cost of cultivation (₹ ha^{-1})

4.9.1.1Effect of nutrient management treatments on cost of cultivation

An inquisition on two years' data and average data of two years among nutrient management treatments showed that N_2 (75% RDF + 25% organic through FYM + PSB) and N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) treatment recorded the highest and lowest cost of cultivation, respectively. In addition to chemical fertilizers and biofertilizer, the high cost of FYM increased the cost of cultivation in N_2 treatment.

4.9.1.2Effect of weed management treatments on cost of cultivation

The two years' data and average data of two years among weed management treatments showed that W_2 (Hand weeding at 15, 30 and 45 DAS) recorded the highest cost of cultivation (₹ 48527.57 ha^{-1}) followed by W_3 (Mechanical weeding at 20 and 40 DAS), W_5 (Propaquizafop @ 0.075 kg *a.i.*

ha^{-1} PoE *fb* Hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS. And the lowest cost of cultivation (₹ 35927.57 ha^{-1}) was found in W_1 (Weedy check).

Due to the higher cost of manual weeding, the cost of cultivation in weed management treatment with three hand weeding (W_2) was highest. On the other hand, W_5 and W_4 treatments gave lower cost of cultivation than W_2 treatment due to lower herbicide costs, followed by only one hand weeding. Raj *et al*. (2019) reported similar findings where two hand weeding at 25 and 45 DAS recorded higher cost of cultivation than Pendimethalin 1.0 kg ha^{-1} + 1 hand weeding at 40 DAS.

4.9.1.3 Interaction effect of treatments on cost of cultivation

The two years' data and average data of two years due to the interaction of nutrient and weed management treatments showed that the highest and the lowest cost of cultivation was recorded in N_2W_2 (₹ 53527.50 ha^{-1}) and N_3W_1 (₹ 32064.00 ha^{-1}) interactions, respectively.

N_2W_2 interactions gave the highest cost of cultivation as it involved farmyard manure in addition to chemical fertilizers and PSB. It also required three hand weeding, which added to the cost of cultivation.

4.9.2 Gross return (₹ ha^{-1})

4.9.2.1Effect of nutrient management treatments on gross return

An inquisition on two years' data and average data of two years among nutrient management treatments showed that N_2 (75% RDF + 25% organic through FYM + PSB) and N_1 (100% RDF) treatment recorded the highest and lowest gross return, respectively.

The N_2 treatment resulted in the highest gross returns as it produced higher grain and stover yield.

4.9.2.2 Effect of weed management treatments on gross return

The two years' data and average data of two years among weed management treatments showed that W_2 (Hand weeding at 15, 30 and 45 DAS) recorded the highest gross return (₹ 130029.33 ha^{-1}, ₹ 143339.18 ha^{-1} and ₹ 136684.26 ha^{-1} in 2017. 2018 and average data of two years, respectively) followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS. And the lowest gross return was found in W_1 (Weedy check).

The higher yield produced in W_2 treatment, which included three hand weedings, resulted in higher gross returns among weed management treatments. W_5 and W_4 also recorded higher net returns, which might be because the higher weed control efficiency under these treatments produced higher grain and stover yield, thus contributing to higher gross returns. Jadhav (2013) and Raj *et al*. (2019) reported similar findings. The lowest economic yield *i.e*., grain yield due to heavy weed infestation in W_1 treatment, resulted in the lowest gross returns. Similar findings were reported by Singh *et al*. (2013).

4.9.2.3Interaction effect of treatments on gross return

The two years' data and average data of two years due to the interaction of nutrient and weed management treatments showed the highest gross return was recorded in N_2W_2 interaction and the lowest was recorded in N_1W_1 interaction.

N_2W_2 interactions gave the highest gross return due to higher yield as a result of better nutrient management and effective weed control.

4.9.3 Net return (₹ ha^{-1})

4.9.3.1Effect of nutrient management treatments on net return

An inquisition on first year data recorded the highest net return (₹ 58021.77 ha^{-1}) in N_2 (75% RDF + 25% organic through FYM + PSB) among the nutrient treatments. The second year data and average data of two years recorded the highest net return (₹ 69031.87 ha^{-1} and ₹ 62682.04 ha^{-1} in 2018 and average data of two years, respectively) in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) treatment.

N_2 (75% RDF + 25% organic through FYM + PSB) and N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) treatments gave higher net returns inspite of incurring highest cost of cultivation because these treatments resulted in superior grain and stover yields. Bhattarcharya *et al*. (2008) also reported that combining inorganic nutrient sources with biofertilizers resulted in the maximum crop yield and hence the highest net return. The lowest net return was recorded in N_1 (100% RDF) treatment in both the two years of experimentation and average data of two years. This might be due to the lower yield of soybean when only inorganic fertilizers were applied (Devi *et al*., 2013).

4.9.3.2 Effect of weed management treatments on net return

The first year (2017) data among weed management treatments showed that W_2 (Hand weeding at 15, 30 and 45 DAS) recorded the highest net return (₹ 81501.77 ha^{-1}), followed by W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS. The second year (2018) showed that W_5 recorded the highest net return (₹ 95511.66 ha^{-1}), followed by W_2 and W_4. The average data of two years revealed the same trend as that of the first year. The lowest net return was found in W_1 (Weedy check) in both the years and average data of two years.

W_2, W_5 and W_4 treatments had better yield levels, which resulted in larger net returns. Virk *et al*. (2018) and Jadhav and Kashid (2019) both reported similar findings. However, W_2 treatment failed to achieve the maximum net returns in the second year, which may be due to more human labour requirements and higher wages for weeding. Similar findings were reported by Pal *et al*. (2013) and Raj *et al*. (2020).

4.9.3.3 Interaction effect of treatments on net return

Under the interaction of nutrient and weed management treatments, both the first year and average data of two years recorded the highest net returns in N_2W_2 interaction. The second year recorded the highest net return in N_2W_5 interaction.

The N_2W_1 interaction recorded the lowest net return which might be due to the lowest economic yield *i.e*., grain yield. Whereas, N_2W_2 and N_2W_5 interactions recorded the highest net returns due to higher grain yield.

4.9.4 Benefit Cost Ratio

4.9.4.1 Effect of nutrient management treatments on Benefit Cost Ratio

An inquisition on first year data and average data of two years among the nutrient treatments recorded highest benefit cost ratio (1.46 and 1.63, respectively) in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) and the lowest (1.11 and 1.25, respectively) in N_1 (100% RDF) treatment. The second year data also recorded highest B:C ratio (1.63) in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) treatment but here, the lowest B:C ratio (1.36) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB).

Higher crop yield and net returns were achieved by combining inorganic nutrient sources with biofertilizers in N_3 treatment, thereby giving the highest B:C ratio. This is in line with the findings of Lynrah and Nongmaithem (2017). According to Reddy *et al*. (2011), the treatment with 50% RDF + dual inoculation with *Rhizobium* + PSB resulted in the highest B:C ratio in pigeon pea. The B:C ratio of N_2 treatment reflected the overall effect of the expense of applying farmyard manure beside inorganic nutrient sources and PSB.

4.9.4.2 Effect of weed management treatments on Benefit Cost Ratio

The two years' data and average data of two years among weed management treatments showed that W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS) recorded the highest B:C ratio (1.99, 2.36 and 2.18 in 2017, 2018 and average data of two years, respectively) followed by W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS and W_2. And the lowest B:C ratio (0.20, 0.28 and 0.24 in 2017, 2018 and average data of two years, respectively) was found in W_1 (Weedy check).

W_2 (Hand weeding at 15, 30, and 45 DAS) treatment inspite of giving highest yield did not outperform the two integrated weed management treatments (W_5 and W_4) in terms of B:C ratio due to the higher cost of cultivation due to higher labour expenditures. Similar findings were reported by Madhu and Ramana (2016). B:C ratio's behaviour under various treatments could be explained by variations in economic return and marginal cost (Idapuganti *et al*., 2005).

4.9.4.3 Interaction effect of treatments on Benefit Cost Ratio

The two years' data and average data of two years due to the interaction of nutrient and weed management treatments showed the highest B:C ratio was recorded in N_3W_5 followed by N_3W_4 interactions and the lowest B:C ratio was recorded in N_2W_1 interaction.

N_3W_5 and N_3W_4 interactions gave the highest B:C ratio because of lower cost of cultivation, higher yield and higher net returns. The treatment N_2W_1 interaction had the lowest B:C ratio because of low yield and the high cost of cultivation due to the inclusion of farmyard manure.

Table 4.113: Effect of nutrient and weed management treatments on economics of soybean.

Treat-ments	TOTAL COST OF CULTIVATION (₹ ha^{-1})			GROSS RETURNS (₹ ha^{-1})			NET RETURNS (₹ ha^{-1})			B:C RATIO		
	2017	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**	**2017**	**2018**	**Average**
Nutrient management (N)												
N_1	40163.40	40163.40	40163.40	86204.98	98047.30	92126.14	46062.38	57883.90	51962.74	1.11	1.39	1.25
N_2	46299.70	46299.70	46299.70	104300.67	111171.69	107736.18	58021.77	64871.99	61436.48	1.21	1.36	1.29
N_3	37436.20	37436.20	37436.20	93768.42	106468.07	100118.24	56353.02	69031.87	62682.04	1.46	1.80	1.63
Weed Management (W)												
W_1	35927.57	35927.57	35927.57	42737.22	45508.98	44123.10	6809.66	9581.41	8195.53	0.20	0.28	0.24
W_2	48527.57	48527.57	48527.57	130029.33	143339.18	136684.26	81501.77	94811.61	88156.69	1.68	1.96	1.82
W_3	40967.57	40967.57	40967.57	67518.98	77767.73	72643.35	26551.41	36800.16	31675.79	0.66	0.92	0.79
W_4	40449.57	40449.57	40449.57	112245.24	123391.00	117818.12	71899.68	82941.43	77368.56	1.79	2.07	1.93
W_5	40626.57	40626.57	40626.57	121259.33	136138.22	128698.78	80632.77	95511.66	88072.21	1.99	2.36	2.18

N_1: 100 % RDF (NPKS), N_2: 75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB), N_3: 50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB), W_1: Weedy check, W_2: Weed free (Hand weeding at 15, 30 and 45 DAS), W_3: Mechanical weeding at 20 and 40 DAS, W_4: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS, W_5: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS

Note: Cost of DAP @ 32 ₹ kg^{-1}, MOP @ 17 ₹ kg^{-1}, Sulphur @ 22 ₹ kg^{-1}
Price of FYM @ 1500 ₹ t^{-1}
Price of seed @ 60 ₹ kg^{-1} (2017), Price of seed @ 70 ₹ kg^{-1} (2018)**,** Price of stover @ 1 ₹ kg^{-1}
Labour charge @ 252 ₹ labour^{-1}

Table 4.114: Effect of nutrient and weed management treatment combinations on economics of soybean.

TREAT-MENTS	TOTAL COST OF CULTIVATION (₹ ha^{-1})			GROSS RETURNS (₹ ha^{-1})			NET RETURNS (₹ ha^{-1})			B:C RATIO		
	2017	2018	Average	2017	2018	Average	2017	2018	Average	2017	2018	Average
N_1W_1	34791.20	34791.20	34791.20	38426.67	42265.67	40346.17	3635.47	7474.47	5554.97	0.10	0.21	0.16
N_1W_2	47391.20	47391.20	47391.20	111682.50	140842.00	126262.25	64291.30	93450.80	78871.05	1.36	1.97	1.66
N_1W_3	39831.20	39831.20	39831.20	66454.40	74998.85	70726.63	26623.20	35167.65	30895.43	0.67	0.88	0.78
N_1W_4	39313.20	39313.20	39313.20	104334.00	105379.00	104856.50	65124.80	66065.80	65543.30	1.65	1.68	1.67
N_1W_5	39490.20	39490.20	39490.20	110127.33	126751.00	118439.17	70637.13	87260.80	78948.97	1.79	2.21	2.00
N_2W_1	40927.50	40927.50	40927.50	44739.00	47712.27	46225.63	3811.50	6784.77	5298.13	0.09	0.17	0.13
N_2W_2	53527.50	53527.50	53527.50	150353.33	149292.20	149822.77	96825.83	95764.70	96295.27	1.81	1.79	1.80
N_2W_3	45967.50	45967.50	45967.50	68380.67	75983.67	72182.17	22413.17	30016.17	26214.67	0.49	0.65	0.57
N_2W_4	45449.50	45449.50	45449.50	121736.33	134291.67	128014.00	76390.83	88842.17	82564.50	1.68	1.95	1.82
N_2W_5	45626.50	45626.50	45626.50	136294.00	148578.67	142436.33	90667.50	102952.17	96809.83	1.99	2.26	2.12
N_3W_1	32064.00	32064.00	32064.00	45046.00	46549.00	45797.50	12982.00	14485.00	13733.50	0.40	0.45	0.43
N_3W_2	44664.00	44664.00	44664.00	128052.17	139883.33	133967.75	83388.17	95219.33	89303.75	1.87	2.13	2.00
N_3W_3	37104.00	37104.00	37104.00	67721.87	82320.67	75021.27	30617.87	45216.67	37917.27	0.83	1.22	1.02
N_3W_4	36586.00	36586.00	36586.00	110665.40	130502.33	120583.87	74183.40	93916.33	83997.87	2.02	2.57	2.30
N_3W_5	36763.00	36763.00	36763.00	117356.67	133085.00	125220.83	80593.67	96322.00	88457.83	2.19	2.62	2.41

Note:

Cost of DAP @ 32 ₹ kg^{-1}, MOP @ 17 ₹ kg^{-1}, Sulphur @ 22 ₹ kg^{-1}

Price of FYM @ 1500 ₹ t^{-1}

Price of seed @ 60 ₹ kg^{-1} (2017); Price of seed @ 70 ₹ kg^{-1} (2018)

Price of stover @ 1 ₹ kg^{-1}

Labour charge @ 252 ₹ $labour^{-1}$

CHAPTER V

SUMMARY AND CONCLUSIONS

SUMMARY AND CONCLUSIONS

The present research work entitled "Effect of integrated nutrient and weed management on growth and yield of soybean (*Glycine max* L. Merrill)" was)" was conducted during the *Kharif* season of 2017 and 2018 at the experimental farm of School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema campus with the objectives to study the effect of integrated nutrient and weed management on growth, yield and quality of soybean, to study the effect of integrated nutrient and weed management on weed flora, to study the effect of integrated nutrient and weed management on soil and microbiological properties and to find out the economics of the treatments. The experiment was laid out in Split Plot Design (SPD) with three replications. The main plot treatments consisted of three nutrient management treatments: N_1: 100 % RDF (NPKS), N_2: 75% RDF + 25% organic through FYM + Phosphate solubilising bacteria (PSB), N_3: 50% RDF + 50 % organic through *Rhizobium* + Phosphate solubilising bacteria (PSB) while the sub-plot treatments consists of five weed management treatments: W_1: Weedy check, W_2: Weed free (Hand weeding at 15, 30 and 45 DAS), W_3: Mechanical weeding at 20 and 40 DAS, W_4: Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS and W_5: Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS.

The relevant experimental results from the average data of two years of the present experiment have been summarised below:

A. GROWTH ATTRIBUTES

1. Different nutrient management treatments influenced the plant height significantly at 60 DAS and at harvest. The highest plant height (46.12 cm and 47.39 cm at 60 DAS and at harvest, respectively) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) which was statistically at

par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). Different weed management treatments influenced the plant height significantly at 30, 60 DAS and at harvest. W_2 (hand weeding at 15, 30 and 45 DAS) recorded the highest plant height and was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) at harvest. The interaction effect did not show any significant influence on plant height at all stages of observations.

2. Significant difference was recorded on number of primary branches plant^{-1} due to nutrient management treatments at 60 DAS and at harvest where N_2 (75% RDF + 25% organic through FYM + PSB) recorded the highest number of primary branches plant^{-1} at harvest (4.07). Different weed management treatments influenced the plant height significantly at 30, 60 DAS and at harvest. W_2 (hand weeding at 15, 30 and 45 DAS) recorded significantly highest number of primary branches plant^{-1} (4.60) at harvest. The interaction effect did not show any significant effect on number of primary branches plant^{-1} at all stages of observations.
3. Different nutrient management treatments influenced the plant dry matter accumulation significantly at 60 DAS and at harvest. N_2 (75% RDF + 25% organic through FYM + PSB) recorded maximum plant dry matter accumulation (10.00 g plant^{-1} and 25.04 g plant^{-1} at 60 DAS and at harvest, respectively) and was statistically at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). Different weed management treatments influenced the plant dry matter accumulation significantly at 30, 60 DAS and at harvest. Significantly maximum plant dry matter accumulation (30.91 g plant^{-1}) was recorded in W_2 (hand weeding at 15, 30 and 45 DAS) at harvest. The interaction effect did not show any significant influence on plant dry matter accumulation at all stages of observations.
4. There was no significant difference found on LAI at 30 and 60 DAS. Different weed management treatments influenced the LAI significantly at

30 and 60 DAS. The highest LAI (2.67) at 60 DAS was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) which was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS). The interaction of different nutrient and weed management treatments did not show any significant effect.

5. Maximum number of root nodules $plant^{-1}$ at 30 and 60 DAS (17.33 and 36.75, respectively) was recorded in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) which was statistically at par with N_2 (75% RDF + 25% organic through FYM + PSB). At 30 DAS, W_2 (Hand weeding at 15, 30 and 45 DAS) recorded highest number of root nodules $plant^{-1}$ (19.13) and was statistically at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS). At 60 DAS, highest number of root nodules $plant^{-1}$ (51.02) was significantly recorded in W_2 (Hand weeding at 15, 30 and 45 DAS). The interaction of different nutrient and weed management treatments did not show any significant effect.
6. The highest nodules fresh and dry weight $plant^{-1}$ (0.33 g and 0.082 g, respectively) at 30 DAS was recorded in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) which was statistically at par with N_2 (75% RDF + 25% organic through FYM + PSB). At 60 DAS, significantly highest nodules fresh and dry weight $plant^{-1}$ (1.17 g and 0.37 g, respectively) was recorded in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). Among weed management treatments, the nodules fresh and dry weight $plant^{-1}$ at 30 and 60 DAS was found maximum in W_2 (Hand weeding at 15, 30 and 45 DAS). The interaction effect of treatments on nodules fresh and dry weight $plant^{-1}$ was found to be non-significant.
7. Among the nutrient management treatments, the maximum CGR (7.22 g m^{-2} day^{-1}) at 30-60 DAS was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) which was statistically at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). W_2 (Hand weeding at 15, 30 and 45 DAS)

recorded significantly maximum CGR (9.22 g m^{-2} day^{-1}) at 30-60 DAS. The interaction effect did not show any significant effect on CGR.

8. No significant variation among the nutrient treatments was found on RGR at (30-60 DAS). The maximum RGR (0.072 g g^{-1} day^{-1}) was found in W_2 (Hand weeding at 15, 30 and 45 DAS) which was found to be at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). The interaction effect did not show any significant effect on RGR.

B. YIELD AND YIELD ATTRIBUTES

1. The maximum number of pods $plant^{-1}$ (53.97) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) which was statistically at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). The maximum number of pods $plant^{-1}$ (62.37) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) and found to be at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS). Effect of nutrient and weed management treatments could not interact significantly on the number of pods $plant^{-1}$.
2. Different nutrient and weed management treatments significantly influenced the pod weight $plant^{-1}$. Significantly maximum pod weight $plant^{-1}$ (18.04 g) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB). Among weed management treatments, significantly maximum pod weight $plant^{-1}$ (24.05 g) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS). There was no significant effect on pod weight $plant^{-1}$ due to the interaction of nutrient and weed management treatments.
3. The number of seeds pod^{-1} revealed no significant variation among the nutrient treatments. Significant results were recorded among the weed management treatments on the number of seeds pod^{-1} where the maximum number of seeds pod^{-1} (2.88) recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) which was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE

fb Hand weeding at 45 DAS) only. There was no significant effect on the number of seeds pod^{-1} due to the interaction of nutrient and weed management treatments.

4. There was no significant variation among the nutrient treatments on 100-seed weight (g). Among weed management treatments, significant difference were observed on 100-seed weight. The maximum 100-seed weight (10.11 g) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) which was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS). There was no significant effect on 100-seed weight (g) due to the interaction of nutrient and weed management treatments.
5. Significantly highest grain yield (1.63 t ha^{-1}) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) among the nutrient treatments. Significantly highest grain yield (2.07 t ha^{-1}) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) among weed management treatments. There was a significant interaction effect of treatments on grain yield where the treatment combination $N_2 \times W_2$ (75% RDF + 25% organic through FYM + PSB and Hand weeding at 15, 30 and 45 DAS) gave the highest grain yield (2.27 t ha^{-1}).
6. The highest stover yield (2.27 t ha^{-1}) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) which was statistically at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). Significantly highest stover yield (2.63 t ha^{-1}) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS). The interaction of nutrient and weed management treatments on stover yield was found to be non-significant.
7. No significant variation among the nutrient treatments was found on harvest index. Among weed management treatments, the highest harvest index (44.03%) was recorded in W_2 (Hand weeding at 15, 30 and 45 DAS) which was found at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS). The interaction effect of nutrient and weed

management treatments on the harvest index was found to be non-significant.

C. PHENOLOGICAL OBSERVATION

1. No significant variation was found among the nutrient treatments on days to 50% flowering and days to maturity. Whereas, significant variation was found among the different weed management treatments. The minimum days to 50% flowering (48.33 days) and days to maturity (98.44 days) was found in W_2 (Hand weeding at 15, 30 and 45 DAS) which was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS). While the maximum days to 50% flowering (52.83 days) and days to maturity (104.61 days) was found in W_1 (Weedy check). There was no significant effect on days to maturity due to nutrient and weed management treatments' interaction.

D. SEED QUALITY ATTRIBUTES

1. The study found no significant effect on oil content (%) due to nutrient management treatments in both the years and average data of two years. The highest oil content (19.38%) was found in W_2 (Hand weeding at 15, 30 and 45 DAS) and at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS). No significant effect on oil content (%) was recorded due to the interaction of nutrient and weed management treatments.
2. The highest protein content (38.10%) was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) which was statistically at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). Among the weed management treatments, the maximum protein content (38.97%) was found in W_2 (Hand weeding at 15, 30 and 45 DAS) which was statistically at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* Hand weeding at 30 DAS). The study found no significant effect on protein content (%) due to the interaction of nutrient and weed management treatments.

E. WEEDS

1. The dominant weed species observed in the field were *Cynodon dactylon* L., *Digitaria sanguinalis* L., *Eleusine indica* L., *Bulbostylis barbata* (Rottb.) C.B.Clarke, *Cyperus iria* L., *Cyperus kyllingia* L., *Cyperus rotundus* L., *Ageratum conyzoides* L., *Amaranthus viridis* Hook. F., *Borreria latifolia* (Aubl.) K. Schum., *Cleome rutidosperma* DC., *Mimosa pudica* L. and *Mollugo pentaphylla* L.
2. The highest and lowest weed density and biomass of grasses, sedges, broad leaved weeds and total weeds was recorded in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) and N_2 (75% RDF + 25% organic through FYM + PSB) treatments, respectively.
3. Highest WCE of grasses, sedges and broad leaved weeds and total weeds at 60 DAS was recorded in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) treatment.
4. Weedy check recorded the highest density and weed biomass and lowest WCE at 30 DAS, 45 DAS and 60 DAS.
5. Application of Pendimethalin as pre-emergence in (W_4 treatment) proved to reduce density and weed biomass of broad leaved weeds *i.e., Ageratum conyzoides, Amaranthus viridis, Borreria latifolia, Cleome rutidosperma, Mimosa pudica* and *Mollugo pentaphylla.* Pendimethalin did not significantly reduce density of *Cynodon dactylon, Digitaria sanguinalis, Eleusine indica, Cyperus kyllingia* but helped in reducing its biomass.
6. Application of Propaquizafop at 15 DAS (W_5 treatment) proved to reduce weed density and biomass of grasses *i.e., Cynodon dactylon, Digitaria sanguinalis* and *Eleusine indica.*
7. All the weed species were effectively controlled under W_2 (Hand weeding at 15, 30 and 45 DAS) treatment. At 60 DAS, W_2 recorded the lowest weed density and weed biomass and highest WCE followed by W_5

(Propaquizafop @ 0.075 kg *a.i.* ha^{-1}+ hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i*. ha^{-1} + hand weeding at 30 DAS) treatments.

8. N_2W_1 interactions recorded the highest weed density and weed biomass.

F. SOIL STATUS

1. Soil bulk density (g/cc) after harvest showed significant effect due to different nutrient management treatments. N_2 (75% RDF + 25% organic through FYM + PSB) treatment recorded the lowest bulk density (1.33 g/cc). No significant effect on soil bulk density (g/cc) after harvest were found among the different weed management treatments. The interaction effect of treatments on soil bulk density (g/cc) after harvest was non-significant.
2. Water holding capacity (%) after harvest showed significant effect due to different nutrient management treatments. N_2 (75% RDF + 25% organic through FYM + PSB) treatment recorded significantly maximum water holding capacity (41.28%) in N_2 (75% RDF + 25% organic through FYM + PSB) treatment. No significant effect on water holding capacity (%) after harvest were found among the different weed management treatments. The interaction effect of treatments on water holding capacity (%) after harvest was non-significant.
3. Soil pH after harvest showed no significant effect due to different nutrient management treatments and weed management treatments as well as their interaction.
4. Soil organic carbon (%) after harvest showed significant effect due to different nutrient management treatments. N_2 (75% RDF + 25% organic through FYM + PSB) treatment recorded significantly the highest soil organic carbon (1.38 %) in N_2 (75% RDF + 25% organic through FYM + PSB) treatment. No significant effect on soil organic carbon (%) after harvest were found among the different weed management treatments. The

interaction effect of treatments on soil organic carbon (%) after harvest was non-significant.

5. Among nutrient management treatments, significantly highest soil available nitrogen (360.07 kg ha^{-1}) was recorded maximum in N_2 (75% RDF + 25% organic through FYM + PSB) treatment. And among weed management treatments, W_2 (hand weeding at 15, 30 and 45 DAS) treatment recorded significantly highest soil available nitrogen (371.16 kg ha^{-1}). There was no significant effect on soil available nitrogen after harvest due to the interaction of nutrient and weed management treatments.
6. The highest soil available phosphorus (17.37 kg ha^{-1}) was significantly recorded in N_2 (75% RDF + 25% organic through FYM + PSB) treatment among nutrient management treatments. And among weed management treatments, the highest soil available P after harvest (17.30 kg ha^{-1}) was recorded in W_2 (hand weeding at 15, 30 and 45 DAS) treatment and was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). No significant variations on soil available P after harvest was found due to the interaction of nutrient and weed management treatments.
7. Among the different nutrient management treatments, the maximum soil available potassium (182.83 kg ha^{-1}) was found significant in N_2 (75% RDF + 25% organic through FYM + PSB) treatment. In weed management, the highest soil available potassium after harvest (183.43 kg ha^{-1}) was recorded in W_2 (hand weeding at 15, 30 and 45 DAS) treatment and was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS), W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) and W_3 (Mechanical weeding at 20 and 40 DAS) treatments. No significant effect on soil available K after harvest was found due to the interaction of nutrient and weed management treatments.

8. The soil available sulphur after harvest showed no significant effect due to different nutrient management treatments. Significant variation was found among the different weed management treatments on soil available sulphur after harvest. The highest soil available sulphur after harvest (17.94 kg ha^{-1}) was recorded in W_2 (hand weeding at 15, 30 and 45 DAS) treatment and was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS) treatments. No significant variations on soil available sulphur after harvest was found due to the interaction of nutrient and weed management treatments.

G. SOIL MICROBIAL POPULATION

1. Significant maximum population of soil bacteria, fungi and actinomycetes was recorded in N_2 (75% RDF + 25% organic through FYM + PSB). No significant variation of population of soil bacteria, fungi and actinomycetes among the different weed management treatments was found. The interaction effect of treatments on soil microbial population was non-significant.

H. NUTRIENT CONTENT AND UPTAKE

1. The N content (%) in grain was found significant among the different nutrient management treatments. The highest N content (6.10%) in grain was recorded in N_2 (75% RDF + 25% organic through FYM + PSB and was at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). There was no significant variation on PKS content (%) in grain among the different nutrient management treatments.
2. Significant variation on NPKS content (%) in grain were found among the different weed management treatments. The highest NPKS content in grain was observed in W_2 (hand weeding at 15, 30 and 45 DAS) and was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45

DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS).

3. No significant variation was found in the interaction effect of treatments on NPK content (%) in grain. The average data of two years recorded the highest S content in grain (0.28 %) in N_2W_5 interaction.
4. No significant variation on NPKS content (%) in stover was found among the different nutrient management treatments.
5. Significant variation in NPKS content in stover was recorded among the different weed management treatments. The highest N and K content (1.85% and 2.44%, respectively) in stover was observed in W_2 (hand weeding at 15, 30 and 45 DAS) and was at par with W_5 (Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* hand weeding at 45 DAS) and W_4 (Pendimethalin @ 1 kg *a.i.* ha^{-1} PE *fb* hand weeding at 30 DAS). The highest P and S content (0.27% and 0.20%, respectively) in stover was recorded significantly in W_2 (hand weeding at 15, 30 and 45 DAS).
6. The interaction effect of treatments on NPK content (%) in stover gave no significant results. While, the interaction effect of treatments on S content in stover gave significant results where the highest S content (0.21 %) in stover was recorded in N_2W_2 and N_1W_2 interactions.
7. Among the different nutrient management treatments, NPK uptake in grain revealed significant variation where the highest NPS uptake in grain was recorded in N_2 (75% RDF + 25% organic through FYM + PSB). No significant variation on K uptake in grain was found among the different nutrient management treatments.
8. Significant variation was revealed among the different weed management treatments on NPKS uptake in grain. Significantly highest NPKS uptake in grain was observed in W_2 (hand weeding at 15, 30 and 45 DAS).
9. The interaction effect of treatments on NPK uptake (kg ha^{-1}) in grain gave significant results. The highest NPK uptake in grain was recorded in N_2W_2

interaction. The interaction effect of treatments on S uptake in grain gave no significant variations.

10. Among the different nutrient management treatments, significant variation on NPKS uptake in stover was found. The highest N uptake in stover was recorded in N_2 (75% RDF + 25% organic through FYM + PSB) and was at par with N_3 (50% RDF + 50% organic through *Rhizobium* + PSB). The highest PKS uptake in stover was significantly recorded in N_2 (75% RDF + 25% organic through FYM + PSB).
11. Significant variation in NPKS uptake (kg ha^{-1}) in stover was revealed among the different weed management treatments. Significantly highest NPKS uptake in stover was observed in W_2 (hand weeding at 15, 30 and 45 DAS).
12. The interaction effect of treatments on NKS uptake (kg ha^{-1}) in stover gave significant results where N_2W_2 interactions recorded the highest NKS uptake in stover. The interaction effect of treatments on P uptake (kg ha^{-1}) in stover gave no significant results.

I. ECONOMICS

1. Among nutrient management treatments, N_2 (75% RDF + 25% organic through FYM + PSB) and N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) treatment recorded the highest (₹ 46299.70 ha^{-1}) and lowest (₹ 37436.20 ha^{-1}) cost of cultivation, respectively. N_2 (75% RDF + 25% organic through FYM + PSB) recorded the highest gross return (₹ 107736.18 ha^{-1}). The highest net returns (₹ 62682.04 ha^{-1}) and B:C Ratio (1.63) was recorded in N_3 (50% RDF + 50% organic through *Rhizobium* + PSB) treatment.
2. Among weed management treatments, W_2 (Hand weeding at 15, 30 and 45 DAS) recorded the highest cost of cultivation (₹ 48527.57 ha^{-1}), gross returns (₹ 136684.26 ha^{-1}) and net return (₹ 88156.69 ha^{-1}). W_5

(Propaquizafop @ 0.075 kg *a.i.* ha^{-1} PoE *fb* Hand weeding at 45 DAS) recorded the highest B:C ratio.

3. N_2W_2 interaction recorded the highest cost of cultivation (₹ 53527.50 ha^{-1}), gross return (₹ 149822.77 ha^{-1}) and net returns (₹ 96295.27 ha^{-1}). Highest B:C ratio (2.41) was recorded in N_3W_5 interaction.

On the basis of the above findings the following conclusions may be drawn:

1. Application of 75% RDF + 25% organic through FYM + PSB proved to be the better integrated nutrient management option for obtaining higher growth, yield and quality of soybean. This integrated nutrient management treatment was also found to improve soil health as it gave higher nutrient availability and microbial population.
2. Balanced application of 50% RDF + 50% organic through *Rhizobium* + PSB recorded minimum weed density and biomass. This integrated nutrient management treatment resulted in highest weed control efficiency, net returns and B:C ratio.
3. Three hand weeding treatment was found to be the most effective weed management which gave the best results thereby improving growth, yield and quality of soybean. This was followed by the application of propaquizafop @ 0.075 kg *a.i.* ha^{-1} + hand weeding at 45 DAS and pendimethalin @ 1 kg *a.i.* ha^{-1} + hand weeding at 30 DAS. So, for economic profitability, propaquizafop @ 0.075 kg *a.i.* ha^{-1} + hand weeding at 45 DAS and pendimethalin @ 1 kg *a.i.* ha^{-1} + hand weeding at 30 DAS can be adopted as an alternative option to three hand weeding in soybean.
4. The combined effect of 75% RDF + 25% organic through FYM + PSB and three hand weeding were found to give higher growth and yield attributes of soybean. However, application of 50% RDF + 50% organic through *Rhizobium* + PSB combined with propaquizafop @ 0.075 kg *a.i.* ha^{-1} + hand

weeding at 45 DAS were found to be more efficient in controlling weed growth and obtaining the highest B:C ratio.

Recommendations:

Based on field experiment of two years on the topic "Effect of integrated nutrient and weed management on growth and yield of soybean (*Glycine max* L. Merrill)", the following recommendations are hereby suggested-

1. Application of 75% RDF + 5 t ha^{-1} of FYM + Phosphate solubilising bacteria (PSB) @ 20 g kg^{-1} seed can be adopted by farmers under rainfed conditions of Nagaland to obtain a higher yield and quality of soybean and to improve soil health.
2. Hand weeding at 15, 30 and 45 DAS performed best. However, from economic point of view, application of propaquizafop @ 0.075 kg *a.i.* ha^{-1}+ hand weeding at 45 DAS and application of pendimethalin @ 1 kg *a.i.* ha^{-1}+ hand weeding at 30 DAS can be adopted.

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APPENDICES

APPENDIX-A

Weed flora present in the experimental field (2017 and 2018).

Sl. No.	**Scientific name**	**Common name**	**Family**
GRASSES			
1.	*Cynodon dactylon* L.	Bermuda grass	Poaceae
2.	*Digitaria sanguinalis* L.	Finger grass, Purple or Large Crab- grass	Poaceae
3.	*Eleusine indica* L.	Indian goose grass, Crow-foot grass	Poaceae
SEDGES			
4.	*Bulbostylis barbata* (Rottb.) C.B.Clarke	Water grass/Hair sedge	Cyperaceae
5.	*Cyperus iria* L.	Rice field flat sedge	Cyperaceae
6.	*Cyperus kyllingia* L.	White head spike sedge	Cyperaceae
7.	*Cyperus rotundus* L.	Purple nutsedge	Cyperaceae
BROAD LEAF WEEDS			
8.	*Ageratum conyzoides* L.	Goat weed	Asteraceae
9.	*Amaranthus viridis* Hook. F.	Slender amaranth	Amaranthaceae
10.	*Borreria latifolia* (Aubl.) K. Schum.	Broad-leaf buttonweed	Rubiaceae
11.	*Cleome rutidosperma* DC.	Fringed spider flower	Cleomaceae
12.	*Mimosa pudica* L.	Sensitive plant	Fabaceae
13.	*Mollugo pentaphylla* L.	Five leaved carpet weed	Molluginaceaae

APPENDIX-B

Weed relative density in control at 15, 30, 45 and 60 DAS

RELATIVE DENSITY	15 DAS			30 DAS			45 DAS			60 DAS		
	2017	2018	Average	2017	2018	Average	2017	2018	Average	2017	2018	Average
GRASSES												
Cynodon dactylon L.	12.18	10.31	11.24	13.35	13.54	13.44	12.84	12.56	12.70	12.61	12.53	12.57
Digitaria sanguinalis L.	25.20	15.76	20.48	21.32	18.10	19.71	20.94	19.87	20.41	20.35	20.03	20.19
Eleusine indica L.	11.42	10.39	10.90	12.27	10.09	11.18	11.04	11.46	11.25	11.52	11.41	11.47
TOTAL GRASSES	**48.80**	**36.45**	**42.63**	**46.94**	**41.72**	**44.33**	**44.82**	**43.89**	**44.36**	**44.47**	**43.97**	**44.22**
SEDGES												
Bulbostylis barbata (Rottb.) C.B.Clarke	3.18	3.18	2.62	2.59	2.78	2.69	3.07	2.30	2.69	3.27	2.28	2.77
Cyperus iria L.	12.61	11.58	12.10	13.03	12.57	12.80	12.80	11.37	12.08	12.85	11.10	11.97
Cyperus kyllingia L.	1.98	1.98	1.94	2.60	1.92	2.26	3.60	2.38	2.99	3.73	2.29	3.01
Cyperus rotundus L.	3.19	3.19	3.31	3.58	3.28	3.43	3.75	4.91	4.33	4.21	4.71	4.46
TOTAL SEDGES	**20.96**	**18.98**	**19.97**	**21.80**	**20.55**	**21.18**	**23.22**	**20.96**	**22.09**	**24.06**	**20.37**	**22.22**
BROAD LEAF WEEDS												
Ageratum conyzoides L.	5.60	5.60	4.61	3.77	3.15	3.46	3.65	2.54	3.09	3.72	2.57	3.14
Amaranthus viridis Hook. F.	4.93	4.93	5.14	3.96	3.94	3.95	4.70	3.45	4.08	4.52	3.94	4.23
Borreria latifolia (Aubl.) K. Schum.	8.53	15.62	12.08	13.89	16.34	15.11	13.67	15.60	14.63	13.40	15.58	14.49
Cleome rutidosperma DC.	2.35	2.35	2.23	2.03	2.00	2.01	2.76	1.83	2.30	2.68	2.29	2.49
Mimosa pudica L.	4.07	4.07	5.16	2.96	5.00	3.98	2.96	4.91	3.94	2.90	4.71	3.81
Mollugo pentaphylla L.	4.76	4.76	8.18	4.65	7.30	5.98	4.21	6.83	5.52	4.24	6.57	5.41
TOTAL BLW	**30.24**	**44.57**	**37.40**	**31.26**	**37.73**	**34.50**	**31.95**	**35.15**	**33.55**	**31.47**	**35.66**	**33.56**
TOTAL WEEDS	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

APPENDIX-C

I. COMMON COST OF CULTIVATION (₹ ha^{-1})

Sl. no.	ITEM	NO. OF UNIT	RATE (₹ $unit^{-1}$)	COST (₹ ha^{-1})
1.	Land preparation	(Ploughing+ harrowing+ planking)	1000	2000
2.	Sowing			
	Seed	60 kg ha^{-1}	₹ 60 kg^{-1}	3600
	Seed treatment-Bavistin (2g/kg seed)	120 g	₹ 174 /100g	208.80
	Labour required for sowing	20 labours	252	5040
3.	Application of manures and fertilizers	7 labours	252	1764
4.	Plant protection measures	-	-	1000
5.	Harvesting, binding and carrying	40 labours	252	10080
6.	Drying	5 labours	252	1260
7.	Threshing and cleaning	24 labours	252	6048
TOTAL				**29,000.80**

II. COST OF VARIABLE INPUTS FOR NUTRIENT MANAGEMENT (₹ ha^{-1})

Sl no.	INPUTS	NO. OF UNIT	RATE (₹ $unit^{-1}$)	COST (₹ ha^{-1})
NUTRIENT MANAGEMENT				
B1	a) DAP	130.2 kg ha^{-1}	32 ₹ kg^{-1}	4166.40
	b) MOP	66.8 kg ha^{-1}	17 ₹ kg^{-1}	1135.60
	c) Elemental Sulphur	22.2 kg ha^{-1}	22 ₹ kg^{-1}	488.40
TOTAL				**5,790.4**
B2	a) DAP	97.65 kg ha^{-1}	32 ₹ kg^{-1}	3124.80
	b) MOP	50.1 kg ha^{-1}	17 ₹ kg^{-1}	851.70
	c) Elemental Sulphur	16.65 kg ha^{-1}	22 ₹ kg^{-1}	366.2
	d) FYM	5 t ha^{-1}	1500 ₹ t^{-1}	7500
	e) PSB (Phosphotika) 20 g/kg seed	1.2 kg	70 ₹ kg^{-1}	84
TOTAL				**11,926.7**
B3	a) DAP	65.1 kg ha^{-1}	32 ₹ kg^{-1}	2083.2
	b) MOP	33.4 kg ha^{-1}	17 ₹ kg^{-1}	567.80
	c) Elemental Sulphur	11.1 kg ha^{-1}	22 ₹ kg^{-1}	244.2
	d) PSB (20g/kg seed)	1.2 kg	70 ₹ kg^{-1}	84
	e) Rhizobium (20g/kg seed)	1.2 kg	70 ₹ kg^{-1}	84
TOTAL				**3063.2**

III. COST OF VARIABLE INPUTS FOR WEED MANAGEMENT (₹ ha^{-1})

Sl no.	INPUTS	NO. OF UNIT	RATE (₹ $unit^{-1}$)	COST (₹ ha^{-1})
WEED MANAGEMENT				
C1	Weedy check	-	-	**NIL**
C2	3 Hand weeding			
	Labour requirement for first weeding	20 labours	252	5040
	Labour requirement for second weeding	20 labours	252	5040
	Labour requirement for third weeding	10 labours	252	2520
	TOTAL			**12,600**
C3	2 Mechanical weeding			
	Labour charge for first mechanical weeding)	10 labours	252	2520
	Labour charge for second mechanical weeding	10 labours	252	2520
	TOTAL			**5,040**
C4	a) Pendimethalin (Dhanutop 30% EC)	3.33 l ha^{-1}	450₹ l^{-1}	1498
	b) Application cost	2 labours	252	504
	c) One hand weeding	10 labours	252	2520
	TOTAL			4,522
C5	a) Propaquizafop (AGIL 10% EC	0.75 l ha^{-1}	₹ 1117/500 ml	1675
	b) Application cost	2 labours	252	504
	c) One hand weeding	10 labours	252	2520
	TOTAL			**4,699**

IV. TOTAL COST OF CULTIVATION OF INDIVIDUAL TREATMENTS (₹ ha^{-1})

TREATMENT	COST OF CULTIVATION	TOTAL (₹ ha^{-1})
N1W1	A+B1+C1	34791.20
N1W2	A+B1+C2	47391.20
N1W3	A+B1+C3	39831.20
N1W4	A+B1+C4	39313.20
N1W5	A+B1+C5	39490.20
N2W1	A+B2+C1	40927.50
N2W2	A+B2+C2	53527.50
N2W3	A+B2+C3	45967.50
N2W4	A+B2+C4	45449.50
N2W5	A+B2+C5	45626.50
N3W1	A+B3+C1	32064.00
N3W2	A+B3+C2	44664.00
N3W3	A+B3+C3	37104.00
N3W4	A+B3+C4	36586.00
N3W5	A+B3+C5	36763.00

V. **Effect of treatments on seed income.**

Weed management treatments (W)	2017				2018				AVERAGE			
	Nutrient management (N)				Nutrient management (N)				Nutrient management (N)			
	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
W_1	37060.00	43320.00	43656.00	**41345.33**	41113.33	46403.93	45173.33	**44230.20**	39086.67	44861.97	44414.67	**42787.77**
W_2	109320.00	147280.00	125303.00	**127301.00**	138413.33	146658.87	137363.33	**140811.84**	123866.67	146969.43	131333.17	**134056.42**
W_3	64484.40	66440.00	65695.20	**65539.87**	73230.27	74057.67	80397.33	**75895.09**	68857.33	70248.83	73046.27	**70717.48**
W_4	102010.00	119180.00	108250.40	**109813.47**	103161.33	131782.00	128198.00	**121047.11**	102585.67	125481.00	118224.20	**115430.29**
W_5	107820.00	133520.00	114780.00	**118706.67**	124464.67	146024.67	130655.00	**133714.78**	116142.33	139772.33	122717.50	**126210.72**
Mean	**84138.88**	**101948.00**	**91536.92**		**96076.59**	**108985.43**	**104357.40**		**90107.73**	**105466.71**	**97947.16**	

VI. **Effect of treatments on straw income.**

Weed management treatments (W)	2017				2018				AVERAGE			
	Nutrient management (N)				Nutrient management (N)				Nutrient management (N)			
	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
W_1	1366.67	1419.00	1390.00	**1391.89**	1152.33	1308.33	1375.67	**1278.78**	1259.50	1363.67	1382.83	**1335.33**
W_2	2362.50	3073.33	2749.17	**2728.33**	2428.67	2633.33	2520.00	**2527.33**	2395.58	2853.33	2634.58	**2627.83**
W_3	1970.00	1940.67	2026.67	**1979.11**	1768.59	1926.00	1923.33	**1872.64**	1869.29	1933.33	1975.00	**1925.88**
W_4	2324.00	2556.33	2415.00	**2431.78**	2217.67	2509.67	2304.33	**2343.89**	2270.83	2533.00	2359.67	**2387.83**
W_5	2307.33	2774.00	2576.67	**2552.67**	2286.33	2554.00	2430.00	**2423.44**	2296.83	2664.00	2503.33	**2488.06**
Mean	**2066.10**	**2352.67**	**2231.50**		**1970.72**	**2186.27**	**2110.67**		**2018.41**	**2269.47**	**2171.08**	

APPENDIX-D

I. ANOVA table of effect of treatments on growth attributes of soybean (Average of two years).

ANOVA I (a): Analysis of Variance on effect of treatments on plant height (cm) of soybean at 30 DAS.

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	15.81	7.91	0.99	6.94	NS
Nutrient Management (N)	2	85.37	42.69	5.36	6.94	NS
Error I	4	31.87	7.97			
Weed Management (W)	4	493.38	123.35	31.23	2.78	*
NXW	8	8.03	1.00	0.25	2.36	NS
Error II	24	94.78	3.95			

ANOVA I (b): Analysis of Variance on effect of treatments on plant height (cm) of soybean at 60 DAS.

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	81.76	40.88	1.51	6.94	NS
Nutrient Management (N)	2	512.39	256.20	9.45	6.94	*
Error I	4	108.40	27.10			
Weed Management (W)	4	2341.75	585.44	103.54	2.78	*
NXW	8	59.76	7.47	1.32	2.36	NS
Error II	24	135.70	5.65			

ANOVA I (c): Analysis of Variance on effect of treatments on plant height (cm) of soybean at harvest.

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	159.02	79.51	3.66	6.94	NS
Nutrient Management (N)	2	525.59	262.80	12.09	6.94	*
Error I	4	86.95	21.74			
Weed Management (W)	4	2307.69	576.92	62.10	2.78	*
NXW	8	48.23	6.03	0.65	2.36	NS
Error II	24	222.97	9.29			

ANOVA I (d): Analysis of Variance on effect of treatments on primary branches plant^{-1} of soybean at 30 DAS.

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.16	0.08	1.53	6.94	NS
Nutrient Management (N)	2	0.53	0.26	4.97	6.94	NS
Error I	4	0.21	0.05			
Weed Management (W)	4	4.49	1.12	57.78	2.78	*
NXW	8	0.06	0.01	0.41	2.36	NS
Error II	24	0.47	0.02			

*Significant NS-Non-significant

ANOVA I (e): Analysis of Variance on effect of treatments on primary branches plant^{-1} of soybean at 60 DAS.

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.55	0.27	0.60	6.94	NS
Nutrient Management (N)	2	5.40	2.70	5.92	6.94	NS
Error I	4	1.82	0.46			
Weed Management (W)	4	15.43	3.86	42.26	2.78	*
NXW	8	0.27	0.03	0.37	2.36	NS
Error II	24	2.19	0.09			

ANOVA I (f): Analysis of Variance on effect of treatments on primary branches plant^{-1} of soybean at harvest.

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.18	0.09	1.82	6.94	NS
Nutrient Management (N)	2	2.72	1.36	28.01	6.94	*
Error I	4	0.19	0.05			
Weed Management (W)	4	23.35	5.84	81.31	2.78	*
NXW	8	0.16	0.02	0.29	2.36	NS
Error II	24	1.72	0.07			

ANOVA I (g): Analysis of Variance on effect of treatments on plant dry matter accumulation (g plant^{-1}) of soybean at 30 DAS.

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.30	0.15	4.64	6.94	NS
Nutrient Management (N)	2	0.23	0.11	3.43	6.94	NS
Error I	4	0.13	0.03			
Weed Management (W)	4	1.16	0.29	17.41	2.78	*
NXW	8	0.09	0.01	0.69	2.36	NS
Error II	24	0.40	0.02			

ANOVA I (h): Analysis of Variance on effect of treatments on plant dry matter accumulation (g plant^{-1}) of soybean at 60 DAS.

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.93	0.46	0.30	6.94	NS
Nutrient Management (N)	2	33.21	16.60	10.91	6.94	*
Error I	4	6.09	1.52			
Weed Management (W)	4	414.58	103.65	246.95	2.78	*
NXW	8	3.69	0.46	1.10	2.36	NS
Error II	24	10.07	0.42			

*Significant NS-Non-significant

ANOVA I (i): Analysis of Variance on effect of treatments on plant dry matter accumulation (g plant^{-1}) of soybean at harvest.

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	6.80	3.40	0.67	6.94	NS
Nutrient Management (N)	2	187.30	93.65	18.58	6.94	*
Error I	4	20.16	5.04			
Weed Management (W)	4	2547.78	636.95	164.20	2.78	*
NXW	8	26.72	3.34	0.86	2.36	NS
Error II	24	93.10	3.88			

ANOVA I (j): Analysis of Variance on effect of treatments on Leaf Area Index (LAI) of soybean at 30 DAS.

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.02	0.01	3.67	6.94	NS
Nutrient Management (N)	2	0.02	0.01	2.51	6.94	NS
Error I	4	0.01	0.00			
Weed Management (W)	4	0.29	0.07	79.75	2.78	*
NXW	8	0.01	0.00	1.07	2.36	NS
Error II	24	0.02	0.00			

ANOVA I (k): Analysis of Variance on effect of treatments on Leaf Area Index (LAI) of soybean at 60 DAS.

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.47	0.24	3.43	6.94	NS
Nutrient Management (N)	2	0.64	0.32	4.67	6.94	NS
Error I	4	0.27	0.07			
Weed Management (W)	4	19.44	4.86	56.99	2.78	*
NXW	8	0.12	0.02	0.18	2.36	NS
Error II	24	2.05	0.09			

ANOVA I (l): Analysis of Variance on effect of treatments on number of root nodules plant^{-1} of soybean at 30 DAS.

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	7.62	3.81	0.65	6.94	NS
Nutrient Management (N)	2	94.05	47.03	7.97	6.94	*
Error I	4	23.59	5.90			
Weed Management (W)	4	416.54	104.14	31.59	2.78	*
NXW	8	8.58	1.07	0.33	2.36	NS
Error II	24	79.12	3.30			

*Significant NS-Non-significant

ANOVA I (m): Analysis of Variance on effect of treatments on number of root nodules plant^{-1} of soybean at 60 DAS.

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	219.93	109.97	3.42	6.94	NS
Nutrient Management (N)	2	594.04	297.02	9.24	6.94	*
Error I	4	128.63	32.16			
Weed Management (W)	4	5977.04	1494.26	79.89	2.78	*
NXW	8	301.04	37.63	2.01	2.36	NS
Error II	24	448.88	18.70			

ANOVA I (n): Analysis of Variance on effect of treatments on nodules fresh weight plant^{-1} (g) at 30 DAS.

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.002	0.001	0.57	6.94	NS
Nutrient Management (N)	2	0.037	0.019	10.86	6.94	*
Error I	4	0.007	0.002			
Weed Management (W)	4	0.141	0.035	26.31	2.78	*
NXW	8	0.002	0.000	0.16	2.36	NS
Error II	24	0.032	0.001			

ANOVA I (o): Analysis of Variance on effect of treatments nodules fresh weight plant^{-1} (g) at 60 DAS.

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.22	0.11	3.32	6.94	NS
Nutrient Management (N)	2	0.57	0.29	8.57	6.94	*
Error I	4	0.13	0.03			
Weed Management (W)	4	5.58	1.40	86.80	2.78	*
NXW	8	0.30	0.04	2.31	2.36	NS
Error II	24	0.39	0.02			

ANOVA I (p): Analysis of Variance on effect of treatments on nodules dry weight plant^{-1} (g) at 30 DAS.

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.000095	0.0000477	0.396	6.94	NS
Nutrient Management (N)	2	0.002271	0.00114	9.45	6.94	*
Error I	4	0.000481	0.00012			
Weed Management (W)	4	0.009241	0.00231	0.291	2.78	*
NXW	8	0.000113	0.0000141	0.178	2.36	NS
Error II	24	0.001905	0.0000794			

ANOVA I (q): Analysis of Variance on effect of treatments on nodules dry weight plant^{-1} (g) at 60 DAS.

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.02	0.01	3.34	6.94	NS
Nutrient Management (N)	2	0.06	0.03	11.40	6.94	*
Error I	4	0.01	0.00			
Weed Management (W)	4	0.56	0.14	78.19	2.78	*
NXW	8	0.03	0.00	2.11	2.36	NS
Error II	24	0.04	0.00			

ANOVA I (r): Analysis of Variance on effect of treatments on crop growth rate (CGR) (g m^{-2} day^{-1}) at (30-60 DAS).

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	1.02	0.51	0.58	6.94	NS
Nutrient Management (N)	2	19.44	9.72	11.03	6.94	*
Error I	4	3.53	0.88			
Weed Management (W)	4	258.45	64.61	255.96	2.78	*
NXW	8	1.98	0.25	0.98	2.36	NS
Error II	24	6.06	0.25			

ANOVA I (s): Analysis of Variance on effect of treatments on relative growth rate (RGR) (g g^{-1} day^{-1}) of soybean at (30-60 DAS).

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.00029	0.00014	6.82110	6.94427	NS
Nutrient Management (N)	2	0.00019	0.00009	4.45487	6.94427	NS
Error I	4	0.00008	0.00002			
Weed Management (W)	4	0.00386	0.00096	98.06088	2.77629	*
NXW	8	0.00025	0.00003	3.20733	2.35508	*
Error II	24	0.00024	0.00001			

II. ANOVA table of effect of treatments on yield and yield attributes of soybean (Average of two years).

ANOVA II (a): Analysis of Variance on effect of treatments on number of pods $plant^{-1}$.

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	6.74	3.37	0.16	6.94	NS
Nutrient Management (N)	2	585.65	292.83	13.79	6.94	*
Error I	4	84.91	21.23			
Weed Management (W)	4	8372.88	2093.22	165.80	2.78	*
NXW	8	170.74	21.34	1.69	2.36	NS
Error II	24	303.00	12.63			

ANOVA II (b): Analysis of Variance on effect of treatments on pod weight $plant^{-1}$(g).

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	2.11	1.05	0.78	6.94	NS
Nutrient Management (N)	2	44.21	22.10	16.39	6.94	*
Error I	4	5.39	1.35			
Weed Management (W)	4	1787.88	446.97	355.59	2.78	*
NXW	8	9.61	1.20	0.96	2.36	NS
Error II	24	30.17	1.26			

*Significant NS-Non-significant

ANOVA II (c): Analysis of Variance on effect of treatments on number of seeds pod^{-1}.

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.23	0.11	2.24	6.94	NS
Nutrient Management (N)	2	0.28	0.14	2.79	6.94	NS
Error I	4	0.20	0.05			
Weed Management (W)	4	2.54	0.63	18.71	2.78	*
NXW	8	0.13	0.02	0.50	2.36	NS
Error II	24	0.81	0.03			

ANOVA II (d): Analysis of Variance on effect of treatments on 100-seed weight (g).

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.14	0.07	0.11	6.94	NS
Nutrient Management (N)	2	2.25	1.12	1.71	6.94	NS
Error I	4	2.64	0.66			
Weed Management (W)	4	30.52	7.63	23.72	2.78	*
NXW	8	2.25	0.28	0.88	2.36	NS
Error II	24	7.72	0.32			

ANOVA II (e): Analysis of Variance on effect of treatments on seed yield (t ha^{-1}).

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.04	0.02	3.05	6.94	NS
Nutrient Management (N)	2	0.43	0.22	32.84	6.94	*
Error I	4	0.03	0.01			
Weed Management (W)	4	13.24	3.31	489.23	2.78	*
NXW	8	0.21	0.03	3.88	2.36	*
Error II	24	0.16	0.01			

ANOVA II (f): Analysis of Variance on effect of treatments on stover yield (t ha^{-1}).

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.02	0.01	1.00	6.94	NS
Nutrient Management (N)	2	0.48	0.24	20.62	6.94	*
Error I	4	0.05	0.01			
Weed Management (W)	4	10.02	2.50	218.12	2.78	*
NXW	8	0.19	0.02	2.04	2.36	NS
Error II	24	0.28	0.01			

ANOVA II (g): Analysis of Variance on effect of treatments on Harvest index (%).

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	2.06	1.03	2.11	6.94	NS
Nutrient Management (N)	2	5.50	2.75	5.63	6.94	NS
Error I	4	1.95	0.49			
Weed Management (W)	4	912.95	228.24	299.99	2.78	*
NXW	8	13.92	1.74	2.29	2.36	NS
Error II	24	18.26	0.76			

*Significant NS-Non-significant

III. ANOVA table of effect of treatments on phenological observation of soybean (Average of two years).

ANOVA III (a): Analysis of Variance on effect of treatments on days to 50% flowering.

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	21.08	10.54	0.54	6.94	NS
Nutrient Management (N)	2	43.38	21.69	1.11	6.94	NS
Error I	4	77.86	19.46			
Weed Management (W)	4	132.52	33.13	3.28	2.78	*
NXW	8	25.18	3.15	0.31	2.36	NS
Error II	24	242.40	10.10			

ANOVA III (b): Analysis of Variance on effect of treatments on days to maturity.

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	4.04	2.02	0.09	6.94	NS
Nutrient Management (N)	2	52.08	26.04	1.16	6.94	NS
Error I	4	89.76	22.44			
Weed Management (W)	4	221.19	55.30	6.18	2.78	*
NXW	8	11.81	1.48	0.17	2.36	NS
Error II	24	214.70	8.95			

IV. ANOVA table of effect of treatments on seed quality attributes of soybean.

ANOVA IV (a): Average Analysis of Variance on effect of treatments on Oil content (%).

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.05	0.02	0.63	6.94	NS
Nutrient Management (N)	2	0.28	0.14	3.49	6.94	NS
Error I	4	0.16	0.04			
Weed Management (W)	4	25.96	6.49	41.68	2.78	*
NXW	8	0.18	0.02	0.15	2.36	NS
Error II	24	3.74	0.16			

ANOVA IV (b): Analysis of Variance on effect of treatments on Protein content (%).

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	6.02	3.01	6.64	6.94	NS
Nutrient Management (N)	2	7.23	3.61	7.97	6.94	*
Error I	4	1.81	0.45			
Weed Management (W)	4	118.78	29.69	38.61	2.78	*
NXW	8	1.45	0.18	0.24	2.36	NS
Error II	24	18.46	0.77			

*Significant NS-Non-significant

V. ANOVA table of effect of treatments on weed density (Average of two years).

ANOVA V (a): Analysis of Variance on effect of treatments on weed density (no. m^{-2}) of *Cynodon dactylon* L. at 15, 30, 45 DAS and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.42	0.21	2.27	6.94	NS	0.04	0.02	0.22	6.94	NS	0.61	0.30	1.11	6.94	NS	0.04	0.02	0.39	6.94	NS
N	2	0.58	0.29	3.16	6.94	NS	1.25	0.62	6.87	6.94	NS	0.85	0.42	1.56	6.94	NS	0.14	0.07	1.40	6.94	NS
Error I	4	0.37	0.09				0.36	0.09				1.09	0.27				0.20	0.05			
W	4	0.50	0.12	1.42	2.78	NS	76.58	19.15	124.65	2.78	*	89.27	22.32	225.46	2.78	*	105.52	26.38	222.16	2.78	*
NXW	8	0.43	0.05	0.62	2.36	NS	0.81	0.10	0.66	2.36	NS	1.00	0.13	1.26	2.36	NS	0.19	0.02	0.20	2.36	NS
Error II	24	2.10	0.09				3.69	0.15				2.38	0.10				2.85	0.12			

ANOVA V (b): Analysis of Variance on effect of treatments on weed density (no. m^{-2}) of *Digitaria sanguinalis* L. at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	1.97	0.98	1.83	6.94	NS	0.21	0.11	0.41	6.94	NS	0.33	0.17	1.33	6.94	NS	0.26	0.13	6.42	6.94	NS
N	2	1.37	0.68	1.27	6.94	NS	0.58	0.29	1.13	6.94	NS	0.20	0.10	0.79	6.94	NS	0.28	0.14	6.91	6.94	NS
Error I	4	2.14	0.54				1.03	0.26				0.50	0.13				0.08	0.02			
W	4	0.45	0.11	0.58	2.78	NS	109.26	27.32	171.12	2.78	*	261.98	65.50	292.38	2.78	*	310.87	77.72	622.41	2.78	*
NXW	8	0.34	0.04	0.22	2.36	NS	0.27	0.03	0.21	2.36	NS	0.26	0.03	0.15	2.36	NS	0.13	0.02	0.13	2.36	NS
Error II	24	4.67	0.19				3.83	0.16				5.38	0.22				3.00	0.12			

*Significant NS-Non-significant

ANOVA V (c): Analysis of Variance on effect of treatments on weed density (no. m^{-2}) of *Eleusine indica* L. at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS
Replication	2	1.51	0.76	3.13	6.94	NS	0.11	0.06	0.13	6.94	NS	0.32	0.16	2.18	6.94	NS	0.52	0.26	2.55	6.94	NS
N	2	1.91	0.95	3.95	6.94	NS	0.89	0.45	1.00	6.94	NS	0.57	0.28	3.85	6.94	NS	1.16	0.58	5.70	6.94	NS
Error I	4	0.97	0.24				1.79	0.45				0.29	0.07				0.41	0.10			
W	4	1.61	0.40	2.12	2.78	NS	48.67	12.17	76.28	2.78	*	111.49	27.87	112.69	2.78	*	153.87	38.47	289.45	2.78	*
NXW	8	1.11	0.14	0.73	2.36	NS	0.44	0.05	0.34	2.36	NS	0.52	0.07	0.26	2.36	NS	0.62	0.08	0.58	2.36	NS
Error II	24	4.57	0.19				3.83	0.16				5.94	0.25				3.19	0.13			

ANOVA V (d): Analysis of Variance on effect of treatments on weed density (no. m^{-2}) of *Bulbostylis barbata* (Rottb.) C.B. Clarke. at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS
Replication	2	0.04	0.02	0.22	6.94	NS	0.10	0.05	1.27	6.94	NS	0.18	0.09	2.23	6.94	NS	0.02	0.01	1.70	6.94	NS
N	2	0.07	0.04	0.40	6.94	NS	0.19	0.09	2.29	6.94	NS	0.27	0.14	3.47	6.94	NS	0.15	0.08	14.73	6.94	*
Error I	4	0.36	0.09				0.16	0.04				0.16	0.04				0.02	0.01			
W	4	0.29	0.07	2.04	2.78	NS	23.07	5.77	95.10	2.78	*	40.04	10.01	247.82	2.78	*	39.12	9.78	1016.44	2.78	*
NXW	8	0.23	0.03	0.81	2.36	NS	0.18	0.02	0.38	2.36	NS	0.31	0.04	0.96	2.36	NS	0.29	0.04	3.79	2.36	*
Error II	24	0.84	0.04				1.46	0.06				0.97	0.04				0.23	0.01			

*Significant NS-Non-significant

ANOVA V (e): Analysis of Variance on effect of treatments on weed density (no. m^{-2}) of *Cyperus iria* L. at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS
Replication	2	1.22	0.61	1.88	6.94	NS	0.00	0.00	0.01	6.94	NS	0.27	0.14	1.20	6.94	NS	0.32	0.16	1.59	6.94	NS
N	2	4.30	2.15	6.61	6.94	NS	1.53	0.77	4.59	6.94	NS	0.74	0.37	3.24	6.94	NS	0.35	0.18	1.74	6.94	NS
Error I	4	1.30	0.33				0.67	0.17				0.46	0.11				0.41	0.10			
W	4	0.12	0.03	0.15	2.78	NS	73.43	18.36	165.73	2.78	*	225.74	56.43	402.30	2.78	*	186.43	46.61	656.31	2.78	*
NXW	8	0.37	0.05	0.22	2.36	NS	0.62	0.08	0.70	2.36	NS	0.46	0.06	0.41	2.36	NS	0.36	0.04	0.63	2.36	NS
Error II	24	5.06	0.21				2.66	0.11				3.37	0.14				1.70	0.07			

ANOVA V (f): Analysis of Variance on effect of treatments on weed density (no. m^{-2}) of *Cyperus kyllingia* L. at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS
Replication	2	0.19	0.10	1.43	6.94	NS	0.02	0.01	0.06	6.94	NS	0.02	0.02	0.01	1.10	6.94	0.05	0.03	1.26	6.94	NS
N	2	0.09	0.04	0.66	6.94	NS	0.45	0.23	1.88	6.94	NS	0.45	0.31	0.15	15.63	6.94	0.07	0.04	1.71	6.94	NS
Error I	4	0.27	0.07				0.48	0.12				0.48	0.04	0.01			0.08	0.02			
W	4	1.42	0.35	11.97	2.78	*	16.53	4.13	67.35	2.78	*	16.53	46.21	11.55	1624.96	2.78	45.46	11.37	539.75	2.78	*
NXW	8	0.29	0.04	1.23	2.36	NS	0.23	0.03	0.46	2.36	NS	0.23	0.28	0.03	4.86	2.36	0.17	0.02	1.01	2.36	NS
Error II	24	0.71	0.03				1.47	0.06				1.47	0.17	0.01			0.51	0.02			

*Significant NS-Non-significant

ANOVA V (g): Analysis of Variance on effect of treatments on weed density (no. m^{-2}) of *Cyperus rotundus* L. at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.27	0.13	2.71	6.94	NS	0.02	0.01	0.37	6.94	NS	0.13	0.06	1.05	6.94	NS	0.02	0.01	0.16	6.94	NS
N	2	0.16	0.08	1.60	6.94	NS	0.42	0.21	8.30	6.94	*	0.18	0.09	1.51	6.94	NS	0.45	0.22	4.43	6.94	NS
Error I	4	0.20	0.05				0.10	0.03				0.24	0.06				0.20	0.05			
W	4	1.76	0.44	20.57	2.78	*	27.02	6.75	120.79	2.78	*	69.93	17.48	514.28	2.78	*	59.62	14.90	299.91	2.78	*
NXW	8	0.31	0.04	1.78	2.36	NS	0.13	0.02	0.30	2.36	NS	0.50	0.06	1.83	2.36	NS	0.43	0.05	1.08	2.36	NS
Error II	24	0.51	0.02				1.34	0.06				0.82	0.03				1.19	0.05			

ANOVA V (h): Analysis of Variance on effect of treatments on weed density (no. m^{-2}) of *Ageratum conyzoides* L. at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.17	0.09	1.30	6.94	NS	0.05	0.03	0.29	6.94	NS	0.02	0.01	0.22	6.94	NS	0.09	0.05	0.35	6.94	NS
N	2	0.47	0.24	3.59	6.94	NS	0.33	0.17	1.75	6.94	NS	0.31	0.15	3.28	6.94	NS	0.39	0.20	1.50	6.94	NS
Error I	4	0.26	0.07				0.38	0.09				0.19	0.05				0.53	0.13			
W	4	4.27	1.07	12.91	2.78	*	13.97	3.49	37.22	2.78	*	33.98	8.50	96.50	2.78	*	23.29	5.82	123.63	2.78	*
NXW	8	0.29	0.04	0.44	2.36	NS	0.31	0.04	0.42	2.36	NS	0.38	0.05	1.11	2.36	NS	0.10	0.01	0.27	2.36	NS
Error II	24	1.98	0.08				2.25	0.09				1.04	0.04				1.13	0.05			

*Significant NS-Non-significant

ANOVA V (i): Analysis of Variance on effect of treatments on weed density (no. m^{-2}) of *Amaranthus viridis* Hook. F. at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**
Replication	2	0.01	0.01	0.32	6.94	NS	0.02	0.01	0.13	6.94	NS	0.06	0.03	0.39	6.94	NS	0.11	0.05	4.41	6.94	NS
N	2	0.47	0.24	12.42	6.94	*	0.40	0.20	3.12	6.94	NS	0.37	0.19	2.64	6.94	NS	0.07	0.03	2.83	6.94	NS
Error I	4	0.08	0.02				0.26	0.06				0.28	0.07				0.05	0.01			
W	4	6.94	1.73	37.00	2.78	*	31.86	7.96	176.55	2.78	*	69.73	17.43	625.39	2.78	*	64.62	16.16	552.18	2.78	*
NXW	8	0.15	0.02	0.40	2.36	NS	0.30	0.04	0.83	2.36	NS	0.36	0.04	1.60	2.36	NS	0.36	0.04	1.53	2.36	NS
Error II	24	1.13	0.05				1.08	0.05				0.67	0.03				0.70	0.03			

ANOVA V (j): Analysis of Variance on effect of treatments on weed density (no. m^{-2}) of *Borreria latifolia* (Aubl.) K. Schum. at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**
Replication	2	0.12	0.06	0.16	6.94	NS	0.08	0.04	3.81	6.94	NS	0.29	0.15	0.73	6.94	NS	0.22	0.11	3.35	6.94	NS
N	2	1.63	0.81	2.14	6.94	NS	1.74	0.87	83.99	6.94	*	0.33	0.17	0.83	6.94	NS	0.76	0.38	11.35	6.94	*
Error I	4	1.52	0.38				0.04	0.01				0.80	0.20				0.13	0.03			
W	4	28.21	7.05	97.42	2.78	*	104.23	26.06	120.66	2.78	*	154.25	38.56	297.45	2.78	*	138.84	34.71	322.53	2.78	*
NXW	8	0.18	0.02	0.31	2.36	NS	0.31	0.04	0.18	2.36	NS	0.27	0.03	0.26	2.36	NS	0.13	0.02	0.15	2.36	NS
Error II	24	1.74	0.07				5.18	0.22				3.11	0.13				2.58	0.11			

*Significant NS-Non-significant

ANOVA V (k): Analysis of Variance on effect of treatments on weed density (no. m^{-2}) of *Cleome rutidosperma* DC. at 15, 30, 45 and 60 DAS.

Source of Variance	**DF**	**AT 15 DAS**					**AT 30 DAS**					**AT 45 DAS**					**AT 60 DAS**				
		S.S	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**
Replication	2	0.05	0.02	0.17	6.94	NS	0.07	0.04	2.19	6.94	NS	0.01	0.01	0.34	6.94	NS	0.10	0.05	1.27	6.94	NS
N	2	0.06	0.03	0.22	6.94	NS	0.25	0.12	7.45	6.94	*	0.19	0.10	5.37	6.94	NS	0.11	0.05	1.41	6.94	NS
Error I	4	0.55	0.14				0.07	0.02				0.07	0.02				0.15	0.04			
W	4	3.42	0.86	51.14	2.78	*	9.28	2.32	43.82	2.78	*	39.37	9.84	495.06	2.78	*	34.55	8.64	283.46	2.78	*
NXW	8	0.37	0.05	2.79	2.36	*	0.41	0.05	0.96	2.36	NS	0.16	0.02	0.98	2.36	NS	0.18	0.02	0.74	2.36	NS
Error II	24	0.40	0.02				1.27	0.05				0.48	0.02				0.73	0.03			

ANOVA V (l): Analysis of Variance on effect of treatments on weed density (no. m^{-2}) of *Mimosa pudica* L. at 15, 30, 45 and 60 DAS.

Source of Variance	**DF**	**AT 15 DAS**					**AT 30 DAS**					**AT 45 DAS**					**AT 60 DAS**				
		S.S	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**
Replication	2	0.17	0.08	0.37	6.94	NS	0.06	0.03	0.20	6.94	NS	0.05	0.02	0.43	6.94	NS	0.12	0.06	1.49	6.94	NS
N	2	0.53	0.27	1.20	6.94	NS	0.55	0.27	1.70	6.94	NS	0.55	0.27	4.81	6.94	NS	0.31	0.16	3.75	6.94	NS
Error I	4	0.88	0.22				0.64	0.16				0.23	0.06				0.17	0.04			
W	4	5.55	1.39	15.20	2.78	*	20.26	5.07	84.07	2.78	*	48.61	12.15	288.32	2.78	*	51.40	12.85	246.00	2.78	*
NXW	8	0.15	0.02	0.21	2.36	NS	0.06	0.01	0.13	2.36	NS	0.46	0.06	1.37	2.36	NS	0.31	0.04	0.75	2.36	NS
Error II	24	2.19	0.09				1.45	0.06				1.01	0.04				1.25	0.05			

*Significant NS-Non-significant

ANOVA V (m): Analysis of Variance on effect of treatments on weed density (no. m^{-2}) of *Mollugo pentaphylla* L. at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S. S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**
Replication	2	1.91	0.95	4.40	6.94	NS	0.19	0.09	4.96	6.94	NS	0.13	0.07	1.21	6.94	NS	0.13	0.09	0.04	2.53	6.94
N	2	1.17	0.59	2.70	6.94	NS	1.15	0.57	30.04	6.94	*	0.27	0.14	2.55	6.94	NS	0.27	0.10	0.05	2.99	6.94
Error I	4	0.87	0.22				0.08	0.02				0.22	0.05				0.22	0.07	0.02		
W	4	11.70	2.93	59.83	2.78	*	40.67	10.17	145.64	2.78	*	102.18	25.54	496.98	2.78	*	102.18	85.45	21.36	677.56	2.78
NXW	8	0.08	0.01	0.20	2.36	NS	0.34	0.04	0.61	2.36	NS	0.29	0.04	0.71	2.36	NS	0.29	0.29	0.04	1.16	2.36
Error II	24	1.17	0.05				1.68	0.07				1.23	0.05				1.23	0.76	0.03		

ANOVA V (n): Analysis of Variance on effect of treatments on weed density (no. m^{-2}) of grasses at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**
Replication	2	0.35	0.17	0.78	6.94	NS	0.24	0.12	0.31	6.94	NS	0.85	0.43	5.42	6.94	NS	0.12	0.06	4.10	6.94	NS
N	2	3.27	1.64	7.33	6.94	*	2.23	1.11	2.86	6.94	NS	1.43	0.71	9.09	6.94	*	1.22	0.61	43.31	6.94	*
Error I	4	0.89	0.22				1.56	0.39				0.31	0.08				0.06	0.01			
W	4	1.53	0.38	2.45	2.78	NS	227.20	56.80	274.60	2.78	*	432.17	108.04	470.75	2.78	*	541.96	135.49	1401.80	2.78	*
NXW	8	0.66	0.08	0.53	2.36	NS	0.33	0.04	0.20	2.36	NS	0.68	0.08	0.37	2.36	NS	0.32	0.04	0.41	2.36	NS
Error II	24	3.73	0.16				4.96	0.21				5.51	0.23				2.32	0.10			

*Significant NS-Non-significant

ANOVA V (o): Analysis of Variance on effect of treatments on weed density (no. m^{-2}) of sedges at 15, 30, 45 and 60 DAS.

Source of Variance	**DF**	**AT 15 DAS**					**AT 30 DAS**					**AT 45 DAS**					**AT 60 DAS**				
		S.S	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**
Replication	2	0.90	0.45	1.66	6.94	NS	0.01	0.00	0.02	6.94	NS	0.51	0.26	2.23	6.94	NS	0.35	0.18	1.72	6.94	NS
N	2	4.04	2.02	7.46	6.94	*	2.58	1.29	11.84	6.94	*	1.68	0.84	7.30	6.94	*	1.05	0.52	5.10	6.94	NS
Error I	4	1.08	0.27				0.44	0.11				0.46	0.11				0.41	0.10			
W	4	0.95	0.24	1.64	2.78	NS	144.59	36.15	412.78	2.78	*	410.8	102.70	954.11	2.78	*	368.52	92.13	992.05	2.78	*
NXW	8	0.79	0.10	0.69	2.36	NS	0.60	0.08	0.86	2.36	NS	1.04	0.13	1.21	2.36	NS	0.90	0.11	1.21	2.36	NS
Error II	24	3.46	0.14				2.10	0.09				2.58	0.11				2.23	0.09			

ANOVA V (p): Analysis of Variance on effect of treatments on weed density (no. m^{-2}) of broad leaved weeds at 15, 30, 45 and 60 DAS.

Source of Variance	**DF**	**AT 15 DAS**					**AT 30 DAS**					**AT 45 DAS**					**AT 60 DAS**				
		S.S	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ N S**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5 %**	**S/ N S**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5 %**	**S/ N S**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5 %**	**S/ N S**
Replication	2	0.92	0.46	1.37	6.94	NS	0.20	0.10	1.36	6.94	NS	0.15	0.07	0.95	6.94	NS	0.24	0.12	1.62	6.94	NS
N	2	4.23	2.12	6.31	6.94	NS	4.60	2.30	31.50	6.94	*	1.90	0.95	12.29	6.94	*	2.14	1.07	14.66	6.94	*
Error I	4	1.34	0.34				0.29	0.07				0.31	0.08				0.29	0.07			
W	4	59.12	14.78	177.31	2.78	*	211.32	52.83	355.62	2.78	*	447.66	111.91	932.83	2.78	*	405.62	101.41	1209.79	2.78	*
NXW	8	0.15	0.02	0.22	2.36	NS	0.17	0.02	0.14	2.36	NS	1.04	0.13	1.08	2.36	NS	0.45	0.06	0.68	2.36	NS
Error II	24	2.00	0.08				3.57	0.15				2.88	0.12				2.01	0.08			

*Significant NS-Non-significant

ANOVA V (q): Analysis of Variance on effect of treatments on weed density (no. m^{-2}) of total weeds at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	1.11	0.56	0.97	6.94	NS	0.28	0.14	0.62	6.94	NS	0.99	0.50	3.46	6.94	NS	0.46	0.23	2.87	6.94	NS
N	2	10.77	5.39	9.42	6.94	*	8.91	4.46	19.96	6.94	*	4.58	2.29	15.98	6.94	*	4.37	2.18	27.42	6.94	*
Error I	4	2.29	0.57				0.89	0.22				0.57	0.14				0.32	0.08			
W	4	20.88	5.22	40.65	2.78	*	429.66	107.42	893.54	2.78	*	1214.8	303.7	2088.66	2.78	*	1300.16	325.04	3719.03	2.78	*
NXW	8	0.77	0.10	0.74	2.36	NS	0.33	0.04	0.35	2.36	NS	2.22	0.28	1.91	2.36	NS	1.09	0.14	1.56	2.36	NS
Error II	24	3.08	0.13				2.89	0.12				3.49	0.15				2.10	0.09			

VI. ANOVA table of effect of treatments on weed biomass (Average of two years).

ANOVA VI (a): Analysis of Variance on effect of treatments on weed biomass (g m^{-2}) of *Cynodon dactylon* L. at 15, 30, 45 DAS and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.005	0.003	1.288	6.944	NS	0.01	0.00	1.69	6.94	NS	0.06	0.03	1.32	6.94	NS	0.002	0.001	0.39	6.94	NS
N	2	0.023	0.011	5.509	6.944	NS	0.05	0.03	10.40	6.94	*	0.11	0.06	2.54	6.94	NS	0.006	0.003	1.02	6.94	NS
Error I	4	0.008	0.002				0.01	0.00				0.09	0.02				0.012	0.003			
W	4	0.083	0.021	10.832	2.776	*	9.80	2.45	246.08	2.78	*	17.72	4.43	371.57	2.78	*	22.310	5.577	519.25	2.78	*
NXW	8	0.010	0.001	0.677	2.355	NS	0.08	0.01	0.95	2.36	NS	0.11	0.01	1.15	2.36	NS	0.021	0.003	0.25	2.36	NS
Error II	24	0.046	0.002				0.24	0.01				0.29	0.01				0.258	0.011			

*Significant NS-Non-significant

ANOVA VI (b): Analysis of Variance on effect of treatments on weed biomass (g m^{-2}) of *Digitaria sanguinalis* L. at 15, 30, 45 and 60 DAS.

Source of Variance	**DF**	**AT 15 DAS**					**AT 30 DAS**					**AT 45 DAS**					**AT 60 DAS**				
		S.S	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/NS**
Replication	2	0.02	0.010	2.22	6.94	NS	0.18	0.092	0.96	6.94	0.18	0.26	0.13	0.70	6.94	NS	0.25	0.12	2.84	6.94	NS
N	2	0.03	0.015	3.17	6.94	NS	0.14	0.069	0.72	6.94	0.14	0.25	0.12	0.65	6.94	NS	0.37	0.19	4.29	6.94	NS
Error I	4	0.02	0.005				0.39	0.096			0.39	0.76	0.19				0.17	0.04			
W	4	0.16	0.040	6.72	2.78	*	50.13	12.533	366.05	2.78	50.13	407.02	101.76	476.03	2.78	*	438.06	109.52	611.39	2.78	*
NXW	8	0.01	0.002	0.26	2.36	NS	0.03	0.004	0.11	2.36	0.03	0.34	0.04	0.20	2.36	NS	0.40	0.05	0.28	2.36	NS
Error II	24	0.14	0.006				0.82	0.034			0.82	5.13	0.21				4.30	0.18			

ANOVA VI (c): Analysis of Variance on effect of treatments on weed biomass (g m^{-2}) of *Eleusine indica* L. at 15, 30, 45 and 60 DAS.

Source of Variance	**DF**	**AT 15 DAS**					**AT 30 DAS**					**AT 45 DAS**					**AT 60 DAS**				
		S.S	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/NS**
Replication	2	0.07	0.03	4.96	6.94	NS	0.01	0.003	0.03	6.94	NS	0.50	0.25	3.59	6.94	NS	0.93	0.47	2.24	6.94	NS
N	2	0.07	0.03	5.15	6.94	NS	0.27	0.13	1.78	6.94	NS	1.18	0.59	8.43	6.94	*	2.13	1.07	5.11	6.94	NS
Error I	4	0.03	0.01				0.30	0.08				0.28	0.07				0.83	0.21			
W	4	0.24	0.06	8.77	2.78	*	31.04	7.76	311.78	2.78	*	159.01	39.75	120.22	2.78	*	308.89	77.22	428.64	2.78	*
NXW	8	0.02	0.00	0.43	2.36	NS	0.15	0.02	0.75	2.36	NS	0.55	0.07	0.21	2.36	NS	1.30	0.16	0.90	2.36	NS
Error II	24	0.16	0.01				0.60	0.02				7.94	0.33				4.32	0.18			

*Significant NS-Non-significant

ANOVA VI (d): Analysis of Variance on effect of treatments on weed biomass (g m^{-2}) of *Bulbostylis barbata* (Rottb.) C.B. Clarke. at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS
Replication	2	0.00001	0.00001	0.16	6.94	NS	0.02	0.01	1.94	6.94	NS	0.18	0.09	2.13	6.94	NS	0.02	0.01	1.22	6.94	NS
N	2	0.00004	0.00002	0.50	6.94	NS	0.02	0.01	2.04	6.94	NS	0.28	0.14	3.32	6.94	NS	0.21	0.10	12.39	6.94	*
Error I	4	0.00018	0.00004				0.02	0.01				0.17	0.04				0.03	0.01			
W	4	0.00012	0.00003	1.54	2.78	NS	2.96	0.74	69.45	2.78	*	42.54	10.63	261.70	2.78	*	50.56	12.64	1034.91	2.78	*
NXW	8	0.00013	0.00002	0.83	2.36	NS	0.02	0.002	0.20	2.36	NS	0.31	0.04	0.95	2.36	NS	0.42	0.05	4.30	2.36	*
Error II	24	0.00046	0.00002				0.26	0.01				0.98	0.04				0.29	0.01			

ANOVA VI (e): Analysis of Variance on effect of treatments on weed biomass (g m^{-2}) of *Cyperus iria* L. at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS
Replication	2	0.05	0.02	2.93	6.94	NS	0.01	0.004	0.11	6.94	NS	0.18	0.09	0.85	6.94	NS	0.45	0.23	2.10	6.94	NS
N	2	0.28	0.14	17.70	6.94	*	0.10	0.05	1.32	6.94	NS	0.68	0.34	3.18	6.94	NS	0.50	0.25	2.32	6.94	NS
Error I	4	0.03	0.01				0.15	0.04				0.43	0.11				0.43	0.11			
W	4	0.01	0.00	0.27	2.78	NS	32.11	8.03	218.28	2.78	*	195.92	48.98	354.55	2.78	*	229.79	57.45	632.53	2.78	*
NXW	8	0.004	0.001	0.04	2.36	NS	0.19	0.02	0.63	2.36	NS	0.51	0.06	0.46	2.36	NS	0.51	0.06	0.70	2.36	NS
Error II	24	0.29	0.01				0.88	0.04				3.32	0.14				2.18	0.09			

*Significant NS-Non-significant

ANOVA VI (f): Analysis of Variance on effect of treatments on weed biomass (g m^{-2}) of *Cyperus kyllingia* L. at 15, 30, 45 and 60 DAS.

Source of Variance	**DF**	**AT 15 DAS**					**AT 30 DAS**					**AT 45 DAS**					**AT 60 DAS**				
		S.S	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**
Replication	2	0.002	0.001	2.67	6.94	NS	0.001	0.0004	0.02	6.94	NS	0.004	0.002	0.57	6.94	NS	0.01	0.01	0.97	6.94	NS
N	2	0.002	0.001	2.30	6.94	NS	0.04	0.02	0.91	6.94	NS	0.08	0.04	10.83	6.94	*	0.03	0.01	1.98	6.94	NS
Error I	4	0.002	0.0004				0.09	0.02				0.01	0.003				0.03	0.01			
W	4	0.017	0.004	26.31	2.78	*	2.03	0.51	78.54	2.78	*	11.84	2.96	1314.02	2.78	*	16.13	4.03	677.47	2.78	*
NXW	8	0.001	0.0001	0.76	2.36	NS	0.01	0.001	0.22	2.36	NS	0.07	0.01	3.63	2.36	*	0.06	0.01	1.29	2.36	NS
Error II	24	0.004	0.0002				0.15	0.01				0.05	0.002				0.14	0.01			

ANOVA VI (g): Analysis of Variance on effect of treatments on weed biomass (g m^{-2}) of *Cyperus rotundus* L. at 15, 30, 45 and 60 DAS.

Source of Variance	**DF**	**AT 15 DAS**					**AT 30 DAS**					**AT 45 DAS**					**AT 60 DAS**				
		S.S	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**
Replication	2	0.005	0.002	3.06	6.94	NS	0.02	0.01	1.25	6.94	NS	0.03	0.02	1.23	6.94	NS	0.01	0.01	0.39	6.94	NS
N	2	0.003	0.002	1.98	6.94	NS	0.03	0.01	1.40	6.94	NS	0.08	0.04	2.79	6.94	NS	0.17	0.08	5.85	6.94	NS
Error I	4	0.003	0.001				0.04	0.01				0.06	0.01				0.06	0.01			
W	4	0.045	0.011	23.02	2.78	*	4.29	1.07	170.50	2.78	*	23.34	5.83	495.60	2.78	*	33.63	8.41	565.27	2.78	*
NXW	8	0.006	0.001	1.59	2.36	NS	0.02	0.003	0.49	2.36	NS	0.17	0.021	1.80	2.36	NS	0.16	0.020	1.34	2.36	NS
Error II	24	0.012	0.000				0.15	0.01				0.28	0.01				0.36	0.01			

*Significant NS-Non-significant

ANOVA VI (h): Analysis of Variance on effect of treatments on weed biomass (g m^{-2}) of *Ageratum conyzoides* L. at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.00007	0.00003	1.47	6.94	NS	0.002	0.001	0.28	6.94	NS	0.004	0.002	0.65	6.94	NS	0.01	0.01	0.36	6.94	NS
N	2	0.00027	0.00014	5.92	6.94	NS	0.010	0.005	1.36	6.94	NS	0.034	0.017	4.96	6.94	NS	0.07	0.03	2.32	6.94	NS
Error I	4	0.00009	0.00002				0.014	0.004				0.014	0.003				0.06	0.01			
W	4	0.00345	0.00086	23.58	2.78	*	0.507	0.127	39.65	2.78	*	3.536	0.884	254.00	2.78	*	4.04	1.01	149.10	2.78	*
NXW	8	0.00005	0.00001	0.19	2.36	NS	0.012	0.002	0.48	2.36	NS	0.029	0.004	1.03	2.36	NS	0.02	0.002	0.31	2.36	NS
Error II	24	0.00088	0.00004				0.077	0.003				0.084	0.003				0.16	0.01			

ANOVA VI (i): Analysis of Variance on effect of treatments on weed biomass (g m^{-2}) of *Amaranthus viridis* Hook. F. at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	M.S.S	F-cal	F-tab at 5%	S/NS	S.S	M.S.S	F-cal	F-tab at 5 %	S/NS	S.S	M.S.S	F-cal	F-tab at 5 %	S/NS	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.00013	0.00007	3.15	6.94	NS	0.002	0.001	3.12	6.94	NS	0.01	0.01	0.44	6.94	NS	0.04	0.02	5.41	6.94	NS
N	2	0.00015	0.00008	3.56	6.94	NS	0.022	0.011	28.03	6.94	*	0.10	0.05	3.32	6.94	NS	0.04	0.02	5.20	6.94	NS
Error I	4	0.00008	0.00002				0.002	0.000				0.06	0.02				0.01	0.004			
W	4	0.00635	0.00159	45.09	2.78	*	1.800	0.450	99.01	2.78	*	17.52	4.38	546.36	2.78	*	20.94	5.23	767.70	2.78	*
NXW	8	0.00026	0.00003	0.93	2.36	NS	0.043	0.005	1.20	2.36	NS	0.10	0.01	1.59	2.36	NS	0.19	0.02	3.43	2.36	*
Error II	24	0.00084	0.00004				0.109	0.005				0.19	0.01				0.16	0.01			

*Significant NS-Non-significant

ANOVA VI (j): Analysis of Variance on effect of treatments on weed biomass (g m^{-2}) of *Borreria latifolia* (Aubl.) K. Schum. at 15, 30, 45 and 60 DAS.

Source of Variance	**DF**	**AT 15 DAS**					**AT 30 DAS**					**AT 45 DAS**					**AT 60 DAS**				
		S.S	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**
Replication	2	0.005	0.002	0.32	6.94	NS	0.05	0.03	2.60	6.94	NS	0.27	0.13	0.52	6.94	NS	0.26	0.13	2.02	6.94	NS
N	2	0.04	0.02	2.61	6.94	NS	0.41	0.21	21.08	6.94	*	0.28	0.14	0.55	6.94	NS	0.29	0.15	2.26	6.94	NS
Error I	4	0.03	0.008				0.04	0.01				1.03	0.26				0.26	0.06			
W	4	0.72	0.18	54.08	2.78	*	57.45	14.36	155.25	2.78	*	336.38	84.10	680.65	2.78	*	378.05	94.51	1213.25	2.78	*
NXW	8	0.01	0.001	0.36	2.36	NS	0.15	0.02	0.20	2.36	NS	0.43	0.05	0.43	2.36	NS	0.43	0.05	0.69	2.36	NS
Error II	24	0.08	0.003				2.22	0.09				2.97	0.12				1.87	0.08			

ANOVA VI (k): Analysis of Variance on effect of treatments on weed biomass (g m^{-2}) of *Cleome rutidosperma* DC. at 15, 30, 45 and 60 DAS.

Source of Variance	**DF**	**AT 15 DAS**					**AT 30 DAS**					**AT 45 DAS**					**AT 60 DAS**				
		S.S	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**
Replication	2	0.00004	0.00002	0.11	6.94	NS	0.002	0.001	2.95	6.94	NS	0.003	0.002	1.41	6.94	NS	0.009	0.004	0.40	6.94	NS
N	2	0.00005	0.00002	0.12	6.94	NS	0.003	0.001	3.61	6.94	NS	0.058	0.029	26.51	6.94	*	0.076	0.038	3.54	6.94	NS
Error I	4	0.00078	0.00020				0.002	0.000				0.004	0.001				0.043	0.011			
W	4	0.00431	0.00108	50.97	2.78	*	0.159	0.040	67.24	2.78	*	12.060	3.015	1390.32	2.78	*	12.180	3.045	568.11	2.78	*
NXW	8	0.00062	0.00008	3.68	2.36	*	0.004	0.0005	0.83	2.36	NS	0.058	0.007	3.37	2.36	*	0.118	0.015	2.76	2.36	*
Error II	24	0.00051	0.00002				0.014	0.001				0.052	0.002				0.129	0.005			

*Significant NS-Non-significant

ANOVA VI (l): Analysis of Variance on effect of treatments on weed biomass (g m^{-2}) of *Mimosa pudica* L. at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**
Replication	2	0.00014	0.00007	0.60	6.94	NS	0.006	0.003	0.16	6.94	NS	0.01	0.01	0.54	6.94	NS	0.03	0.01	1.72	6.94	NS
N	2	0.00030	0.00015	1.27	6.94	NS	0.046	0.023	1.11	6.94	NS	0.12	0.06	5.35	6.94	NS	0.06	0.03	4.07	6.94	NS
Error I	4	0.00047	0.00012				0.082	0.020				0.04	0.01				0.03	0.01			
W	4	0.00284	0.00071	13.00	2.78	*	3.979	0.995	115.26	2.78	*	14.01	3.50	362.16	2.78	*	19.19	4.80	630.95	2.78	*
NXW	8	0.00007	0.00001	0.17	2.36	NS	0.030	0.004	0.43	2.36	NS	0.12	0.02	1.59	2.36	NS	0.12	0.02	2.01	2.36	NS
Error II	24	0.00131	0.00005				0.207	0.009				0.23	0.01				0.18	0.01			

ANOVA VI (m): Analysis of Variance on effect of treatments on weed biomass (g m^{-2}) of *Mollugo pentaphylla* L. at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**
Replication	2	0.01	0.01	5.12	6.94	NS	0.01	0.00	1.29	6.94	NS	0.01	0.00	2.29	6.94	NS	0.01	0.003	2.35	6.94	NS
N	2	0.01	0.004	3.42	6.94	NS	0.18	0.09	28.12	6.94	*	0.02	0.01	6.32	6.94	NS	0.01	0.01	4.91	6.94	NS
Error I	4	0.005	0.001				0.01	0.003				0.01	0.002				0.01	0.001			
W	4	0.06	0.01	46.67	2.78	*	6.92	1.73	190.38	2.78	*	6.35	1.59	670.31	2.78	*	6.22	1.55	504.97	2.78	*
NXW	8	0.002	0.0003	0.88	2.36	NS	0.07	0.01	0.91	2.36	NS	0.03	0.003	1.34	2.36	NS	0.03	0.004	1.39	2.36	NS
Error II	24	0.01	0.0003				0.22	0.01				0.06	0.002				0.07	0.003			

*Significant   NS-Non-significant

ANOVA VI (n): Analysis of Variance on effect of treatments on weed biomass (g m^{-2}) of grasses at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS
Replication	2	0.01	0.01	3.80	6.94	NS	0.17	0.09	0.77	6.94	NS	0.81	0.41	4.12	6.94	NS	0.94	0.47	6.59	6.94	NS
N	2	0.15	0.07	42.18	6.94	*	0.54	0.27	2.47	6.94	NS	1.47	0.74	7.49	6.94	*	1.91	0.95	13.29	6.94	*
Error I	4	0.01	0.002				0.44	0.11				0.39	0.10				0.29	0.07			
W	4	0.65	0.16	22.63	2.78	*	101.22	25.30	674.00	2.78	*	571.81	142.95	440.16	2.78	*	775.07	193.77	964.05	2.78	*
NXW	8	0.02	0.003	0.40	2.36	NS	0.10	0.01	0.34	2.36	NS	0.74	0.09	0.29	2.36	NS	1.01	0.13	0.63	2.36	NS
Error II	24	0.17	0.01				0.90	0.04				7.79	0.32				4.82	0.20			

ANOVA VI (o): Analysis of Variance on effect of treatments on weed biomass (g m^{-2}) of sedges at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS	S.S	M.S.S	F-cal	F-tab at 5%	S/ NS
Replication	2	0.04	0.02	3.01	6.94	NS	0.03	0.01	0.57	6.94	NS	0.37	0.19	1.59	6.94	NS	0.45	0.22	1.90	6.94	NS
N	2	0.29	0.14	20.54	6.94	*	0.20	0.10	4.41	6.94	NS	1.21	0.60	5.20	6.94	NS	0.97	0.48	4.08	6.94	NS
Error I	4	0.03	0.01				0.09	0.02				0.47	0.12				0.47	0.12			
W	4	0.07	0.02	1.66	2.78	NS	51.39	12.85	444.36	2.78	*	299.70	74.92	599.83	2.78	*	361.45	90.36	960.14	2.78	*
NXW	8	0.01	0.001	0.11	2.36	NS	0.20	0.02	0.85	2.36	NS	0.80	0.10	0.80	2.36	NS	0.94	0.12	1.25	2.36	NS
Error II	24	0.25	0.01				0.69	0.03				3.00	0.12				2.26	0.09			

*Significant NS-Non-significant

ANOVA VI (p): Analysis of Variance on effect of treatments on weed biomass (g m^{-2}) of broad leaved weeds at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**
Replication	2	0.02	0.01	1.09	6.94	NS	0.02	0.01	3.45	6.94	NS	0.17	0.08	0.47	6.94	NS	0.28	0.14	2.90	6.94	NS
N	2	0.07	0.03	3.80	6.94	NS	0.76	0.38	140.20	6.94	*	0.62	0.31	1.74	6.94	NS	0.77	0.39	7.97	6.94	*
Error I	4	0.04	0.01				0.01	0.003				0.71	0.178				0.19	0.049			
W	4	1.22	0.31	111.23	2.78	*	80.35	20.09	291.54	2.78	*	413.73	103.43	914.28	2.78	*	471.29	117.82	1738.45	2.78	*
NXW	8	0.01	0.001	0.45	2.36	NS	0.15	0.02	0.27	2.36	NS	0.59	0.07	0.65	2.36	NS	0.55	0.07	1.01	2.36	NS
Error II	24	0.07	0.003				1.65	0.07				2.72	0.11				1.63	0.07			

ANOVA VI (q): Analysis of Variance on effect of treatments on weed biomass (g m^{-2}) of total weeds at 15, 30, 45 and 60 DAS.

Source of Variance	DF	AT 15 DAS					AT 30 DAS					AT 45 DAS					AT 60 DAS				
		S.S	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**	**S.S**	**M.S.S**	**F-cal**	**F-tab at 5%**	**S/ NS**
Replication	2	0.05	0.02	2.16	6.94	NS	0.15	0.07	1.07	6.94	NS	0.92	0.46	1.60	6.94	NS	1.40	0.70	6.60	6.94	NS
N	2	0.57	0.28	26.66	6.94	*	1.27	0.64	9.08	6.94	*	3.04	1.52	5.29	6.94	NS	3.96	1.98	18.65	6.94	*
Error I	4	0.04	0.01				0.28	0.07				1.15	0.29				0.42	0.11			
W	4	1.58	0.39	50.46	2.78	*	193.37	48.34	903.35	2.78	*	283.86	320.96	1276.53	2.78	*	1612.94	403.24	1994.9	2.78	*
NXW	8	0.02	0.002	0.25	2.36	NS	0.28	0.035	0.65	2.36	NS	1.61	0.201	0.80	2.36	NS	1.97	0.25	1.22	2.36	NS
Error II	24	0.19	0.01				1.28	0.05				6.03	0.25				4.85	0.20			

*Significant NS-Non-significant

VII. ANOVA table of effect of treatments on soil analysis after harvest (Average of two years).

ANOVA VII (a): Analysis of Variance on effect of treatments on bulk density (g/cc)

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.0005	0.0002	1.54	6.94	NS
Nutrient Management (N)	2	0.006	0.003	17.87	6.94	*
Error I	4	0.001	0.0002			
Weed Management (W)	4	0.002	0.0005	0.58	2.78	NS
NXW	8	0.0003	0.00003	0.04	2.36	NS
Error II	24	0.02	0.0008			

ANOVA VII (b): Analysis of Variance on effect of treatments on water holding capacity (%)

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	3.19	1.60	1.04	6.94	NS
Nutrient Management (N)	2	30.03	15.01	9.76	6.94	*
Error I	4	6.16	1.54			
Weed Management (W)	4	11.99	3.00	2.65	2.78	NS
NXW	8	4.81	0.60	0.53	2.36	NS
Error II	24	27.14	1.13			

ANOVA VII (c): Analysis of Variance on effect of treatments on Soil pH

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.06	0.03	2.32	6.94	NS
Nutrient Management (N)	2	0.05	0.02	2.01	6.94	NS
Error I	4	0.05	0.01			
Weed Management (W)	4	0.05	0.01	1.59	2.78	NS
NXW	8	0.08	0.01	1.45	2.36	NS
Error II	24	0.17	0.01			

ANOVA VII (d): Analysis of Variance on effect of treatments on soil organic carbon (%)

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.003	0.001	1.24	6.94	NS
Nutrient Management (N)	2	0.05	0.03	24.66	6.94	*
Error I	4	0.004	0.001			
Weed Management (W)	4	0.03	0.01	2.06	2.78	NS
NXW	8	0.002	0.0003	0.09	2.36	NS
Error II	24	0.08	0.003			

ANOVA VII (e): Analysis of Variance on effect of treatments on soil available nitrogen (kg ha^{-1})

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	4.44	2.22	0.12	6.94	NS
Nutrient Management (N)	2	873.28	436.64	22.89	6.94	*
Error I	4	76.31	19.08			
Weed Management (W)	4	6233.06	1558.26	18.34	2.78	*
NXW	8	205.90	25.74	0.30	2.36	NS
Error II	24	2039.35	84.97			

*Significant NS-Non-significant

ANOVA VII (f): Analysis of Variance on effect of treatments on soil available P (kg ha^{-1})

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.70	0.35	6.94	6.94	NS
Nutrient Management (N)	2	30.48	15.24	301.98	6.94	*
Error I	4	0.20	0.05			
Weed Management (W)	4	27.42	6.85	16.64	2.78	*
NXW	8	2.62	0.33	0.80	2.36	NS
Error II	24	9.89	0.41			

ANOVA VII (g): Analysis of Variance on effect of treatments on soil available K (kg ha^{-1})

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	29.40	14.70	0.98	6.94	NS
Nutrient Management (N)	2	401.36	200.68	13.33	6.94	*
Error I	4	60.21	15.05			
Weed Management (W)	4	771.50	192.87	2.75	2.78	NS
NXW	8	63.06	7.88	0.11	2.36	NS
Error II	24	1685.26	70.22			

ANOVA VII (h): Analysis of Variance on effect of treatments on soil available sulphur (kg ha^{-1})

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	2.79	1.39	0.82	6.94	NS
Nutrient Management (N)	2	8.23	4.12	2.42	6.94	NS
Error I	4	6.79	1.70			
Weed Management (W)	4	43.50	10.88	5.04	2.78	*
NXW	8	6.19	0.77	0.36	2.36	NS
Error II	24	51.82	2.16			

VIII. ANOVA table of effect of integrated nutrient and weed management on soil microbiological analysis after harvest (Average of two years).

ANOVA VIII (a): Analysis of Variance on effect of treatments on soil bacteria (Cfu × 10^7 g^{-1} of soil)

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	6.81	3.41	3.39	6.94	NS
Nutrient Management (N)	2	404.81	202.41	201.29	6.94	*
Error I	4	4.02	1.01			
Weed Management (W)	4	22.00	5.50	2.64	2.78	NS
NXW	8	27.80	3.47	1.67	2.36	NS
Error II	24	50.00	2.08			

*Significant NS-Non-significant

ANOVA VIII (b): Analysis of Variance on effect of treatments on soil fungi (Cfu × 10^4 g^{-1} of soil)

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	1.22	0.61	0.50	6.94	NS
Nutrient Management (N)	2	186.02	93.01	76.92	6.94	*
Error I	4	4.84	1.21			
Weed Management (W)	4	14.84	3.71	2.72	2.78	NS
NXW	8	9.64	1.20	0.88	2.36	NS
Error II	24	32.79	1.37			

ANOVA VIII (c): Analysis of Variance on effect of treatments on soil actinomycetes (Cfu × 10^5 g^{-1} of soil)

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	4.57	2.29	2.40	6.94	NS
Nutrient Management (N)	2	1285.63	642.81	673.81	6.94	*
Error I	4	3.82	0.95			
Weed Management (W)	4	15.54	3.89	1.98	2.78	NS
NXW	8	17.60	2.20	1.12	2.36	NS
Error II	24	47.10	1.96			

IX. ANOVA table of effect of integrated nutrient and weed management on plant analysis after harvest (Average of two years).

ANOVA IX (a): Analysis of Variance on effect of treatments on N content (%) in seed

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.15	0.08	6.64	6.94	NS
Nutrient Management (N)	2	0.19	0.09	7.97	6.94	*
Error I	4	0.05	0.01			
Weed Management (W)	4	3.04	0.76	38.61	2.78	*
NXW	8	0.04	0.005	0.24	2.36	NS
Error II	24	0.47	0.02			

ANOVA IX (b): Analysis of Variance on effect of treatments on P content (%) in seed

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.001	0.0005	0.90	6.94	NS
Nutrient Management (N)	2	0.002	0.001	1.93	6.94	NS
Error I	4	0.002	0.001			
Weed Management (W)	4	0.15	0.04	415.89	2.78	*
NXW	8	0.003	0.0003	3.58	2.36	*
Error II	24	0.002	0.0001			

*Significant NS-Non-significant

ANOVA IX (c): Analysis of Variance on effect of treatments on K content (%) in seed

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.08	0.04	1.29	6.94	NS
Nutrient Management (N)	2	0.06	0.03	0.97	6.94	NS
Error I	4	0.12	0.03			
Weed Management (W)	4	3.65	0.91	45.99	2.78	*
NXW	8	0.17	0.02	1.06	2.36	NS
Error II	24	0.48	0.02			

ANOVA IX (d): Analysis of Variance on effect of treatments on S content (%) in seed

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.0002	0.0001	0.86	6.94	NS
Nutrient Management (N)	2	0.001	0.0005	3.52	6.94	NS
Error I	4	0.001	0.0001			
Weed Management (W)	4	0.14	0.04	426.83	2.78	*
NXW	8	0.002	0.0003	3.49	2.36	*
Error II	24	0.002	0.0001			

ANOVA IX (e): Analysis of Variance on effect of treatments on N content (%) in stover

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.001	0.001	0.21	6.94	NS
Nutrient Management (N)	2	0.01	0.01	2.04	6.94	NS
Error I	4	0.01	0.003			
Weed Management (W)	4	1.07	0.27	104.47	2.78	*
NXW	8	0.01	0.002	0.67	2.36	NS
Error II	24	0.06	0.003			

ANOVA IX (f): Analysis of Variance on effect of treatments on P content (%) in stover

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.0003	0.0001	1.09	6.94	NS
Nutrient Management (N)	2	0.001	0.0005	4.50	6.94	NS
Error I	4	0.0005	0.0001			
Weed Management (W)	4	0.13	0.03	457.05	2.78	*
NXW	8	0.001	0.0001	2.13	2.36	NS
Error II	24	0.002	0.00007			

ANOVA IX (g): Analysis of Variance on effect of treatments on K content (%) in stover

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.0002	0.0001	0.01	6.94	NS
Nutrient Management (N)	2	0.06	0.03	2.55	6.94	NS
Error I	4	0.04	0.01			
Weed Management (W)	4	10.38	2.59	674.11	2.78	*
NXW	8	0.01	0.001	0.37	2.36	NS
Error II	24	0.09	0.004			

*Significant NS-Non-significant

ANOVA IX (h): Analysis of Variance on effect of treatments on S content (%) in stover

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.0001	0.0001	0.58	6.94	NS
Nutrient Management (N)	2	0.001	0.001	6.87	6.94	NS
Error I	4	0.0004	0.0001			
Weed Management (W)	4	0.085	0.021	734.64	2.78	*
NXW	8	0.001	0.0001	4.17	2.36	*
Error II	24	0.001	0.00003			

ANOVA IX (i): Analysis of Variance on effect of treatments on N uptake (kg ha^{-1}) in seed

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	298.77	149.39	4.39	6.94	NS
Nutrient Management (N)	2	2118.46	1059.23	31.13	6.94	*
Error I	4	136.09	34.02			
Weed Management (W)	4	56541.67	14135.42	549.30	2.78	*
NXW	8	886.12	110.77	4.30	2.36	*
Error II	24	617.61	25.73			

ANOVA IX (j): Analysis of Variance on effect of treatments on P uptake (kg ha^{-1}) in seed

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	1.08	0.54	1.88	6.94	NS
Nutrient Management (N)	2	8.07	4.03	14.08	6.94	*
Error I	4	1.15	0.29			
Weed Management (W)	4	228.20	57.05	572.56	2.78	*
NXW	8	4.32	0.54	5.42	2.36	*
Error II	24	2.39	0.10			

ANOVA IX (k): Analysis of Variance on effect of treatments on K uptake (kg ha^{-1}) in seed

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	28.86	14.43	0.84	6.94	NS
Nutrient Management (N)	2	181.24	90.62	5.25	6.94	NS
Error I	4	68.99	17.25			
Weed Management (W)	4	6164.75	1541.19	184.36	2.78	*
NXW	8	171.53	21.44	2.56	2.36	*
Error II	24	200.64	8.36			

ANOVA IX (l): Analysis of Variance on effect of treatments on S uptake (kg ha^{-1}) in seed

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.56	0.28	2.60	6.94	NS
Nutrient Management (N)	2	3.82	1.91	17.59	6.94	*
Error I	4	0.43	0.11			
Weed Management (W)	4	149.09	37.27	481.96	2.78	*
NXW	8	1.32	0.17	2.13	2.36	NS
Error II	24	1.86	0.08			

*Significant NS-Non-significant

ANOVA IX (m): Analysis of Variance on effect of treatments on N uptake (kg ha^{-1}) in stover

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	7.64	3.82	0.55	6.94	NS
Nutrient Management (N)	2	224.33	112.17	16.02	6.94	*
Error I	4	28.00	7.00			
Weed Management (W)	4	5286.41	1321.60	255.74	2.78	*
NXW	8	98.41	12.30	2.38	2.36	*
Error II	24	124.03	5.17			

ANOVA IX (n): Analysis of Variance on effect of treatments on P uptake (kg ha^{-1}) in stover

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.48	0.24	2.39	6.94	NS
Nutrient Management (N)	2	5.41	2.70	26.87	6.94	*
Error I	4	0.40	0.10			
Weed Management (W)	4	180.23	45.06	291.27	2.78	*
NXW	8	2.20	0.28	1.78	2.36	NS
Error II	24	3.71	0.15			

ANOVA IX (o): Analysis of Variance on effect of treatments on K uptake (kg ha^{-1}) in stover

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	8.98	4.49	0.37	6.94	NS
Nutrient Management (N)	2	458.10	229.05	18.73	6.94	*
Error I	4	48.91	12.23			
Weed Management (W)	4	14218.01	3554.50	688.89	2.78	*
NXW	8	207.09	25.89	5.02	2.36	*
Error II	24	8.98	4.49	0.37	6.94	NS

ANOVA IX (p): Analysis of Variance on effect of treatments on S uptake (kg ha^{-1}) in stover

Source of Variance	DF	S.S	M.S.S	F-cal	F-tab at 5%	S/NS
Replication	2	0.01	0.00	0.03	6.94	NS
Nutrient Management (N)	2	2.17	1.09	11.97	6.94	*
Error I	4	0.36	0.09			
Weed Management (W)	4	104.16	26.04	559.62	2.78	*
NXW	8	1.60	0.20	4.29	2.36	*
Error II	24	1.12	0.05			

*Significant NS-Non-significant