PERFORMANCE OF BLACK RICE CULTIVARS TO INTEGRATED WEED MANAGEMENT IN NAGALAND CONDITIONS

Thesis

submitted to

NAGALAND UNIVERSITY

in partial fulfillment of requirements for the Degree

of

Doctor of Philosophy

in

Agronomy

by

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2024

DEDICATED

TO

MY BELOVED PARENTS AND BROTHERS

DECLARATION

I, **Hillel M Chishi,** 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.

This is being submitted to SAS, Nagaland University for the degree of Doctor of Philosophy in Agronomy.

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CERTIFICATE – I

This is to certify that the thesis entitled **"Performance of black rice cultivars to integrated weed management in Nagaland conditions"** submitted to Nagaland University in partial fulfillment of the requirements for the award of degree of Doctor of Philosophy (Agriculture) in the discipline of Agronomy, is the record of research work carried out by Ms. Hillel M Chishi, Registration No. Ph.D./AGR/00328, under my personal supervision and guidance.

The result of the investigation reported in the thesis has 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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CERTIFICATE – II

VIVA VOCE ON THESIS OF DOCTOR OF PHILOSOPHY IN AGRONOMY

This is to certify that the thesis entitled **"Performance of black rice cultivars to integrated weed management in Nagaland conditions"** submitted by **HILLEL M CHISHI**, Admission No. Ph- 276/19, Registration No. Ph.D./AGR/00328, 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 ………………….

The performance of the student has been found **Satisfactory/Unsatisfactory.**

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ACKNOWLEDGEMENTS

I would like to begin by expressing my deepest gratitude to God for his blessings and unwavering presence throughout this entire journey. I am truly humbled and thankful for his grace that blessed me with strength, wisdom and inspiration to overcome challenges to achieve this milestone.

I am incredibly grateful to my supervisor Dr. Debika Nongmaithem, Assistant Professor, Department of Agronomy, Nagaland University, School of Agricultural Sciences for her invaluable guidance, expertise, and unending support throughout the completion of this thesis. Her dedication to my growth as a research scholar has been instrumental in shaping the direction and quality of this work. I am truely fortunate to have had her mentorship and encouragement during the completion of my thesis.

I express my sincere and heartfelt thanks to my advisory committee members Prof. T. Gohain, Head, Department of Agronomy, Prof. Tongpang Longkumer, Department of Agronomy, Prof. Y.K Sharma, Department of Soil Science, Dr. Hijam Meronbala Devi, Department of Plant Pathology for their valuable cooperation, suggestions, guidance and liberal help rendered to me throughout the preparation of my manuscript.

With the same spirit, I express my fathomless gratitude to Prof. T. Gohain, Head, Department of Agronomy for his cordial support and providing all the requirements and facilities during the entire course of research.

My profound gratitude to Prof. Manoj Dutta, Head, and Sir. Y. Patton, STA, Department of Soil and Water Conservation for extending laboratory facilities and valuable help during the laboratory analysis required for the research work.

My sincere thanks to Sir. Zulutemjen Jamir, STA, Department of Agronomy, for his guidance and assistance throughout the completion of the laboratory analysis that was required during my thesis work. I would also like to further thank the non-teaching staffs and field workers for their tireless help during the entire research work.

I owe my sincere gratefulness to Dr. Damitre Lytan, Guest faculty, Department of Entomology and Dr. Shagolsem Herojit Singh, Department of Economics for their guidance and necessary facilities that was required for the statistical data analysis required for completion of my thesis.

I sincerely express my deepest gratitude and thankfulness to the Ministry of Tribal Affairs, Government of India under the central sector Scheme-National Fellowship of ST students (NFST) for providing financial assistance during my entire process of completing my research work.

I am immensely thankful to my wonderful batch mates, juniors and friends namely Lenmem Yosung, Takhelmayum Malemnganbi, Shivani Kumari, G.Zion, Paardensha Ivy Chinir, Mounika Kosgi, Kivi Yeptho, Kili Awomi, Debia Yashi, Chandrika Umbon, Centy Ngasainao, Sunya Pura, Rinu

Sakhong, Mum Taggu and Mimis for their kind help, companionship and moral support which enabled me in timely completion of my work.

I fall short of words in expressing my love and appreciation to my loving parents and brothers who have supported me through their unceasing prayer, encouragement and support in completing this milestone.

Lastly, though many have not been mentioned, rest assured that none are forgotten.

Date:

Place: (Hillel M Chishi)

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LIST OF ABBREVIATIONS

%	Percentage
@	at the rate of
₹	Rupees
$^{-1}$ or /	Per
ai	active ingredient
BCR	Benefit Cost ratio
CD	Critical Difference
cm	Centimetre
DAS	Days after sowing
df	Degree of freedom
et al.	*et allia* (and others/co- workers)
Fb	Followed by
Fig.	Figure
g	Gram
ha	Hectare
i.e.	Id est (that is)
kg	Kilogram
m	Metre
m^2	Metre square
Max.	Maximum
Min.	Minimum
mm	Millimetre
MOP	Muriate of Potash
msl	Mean sea level
MSS	Mean sum of squares
mt	Million tonnes
NPK	Nitrogen Phosphorus Potassium

NS	Not significant
NU	Nagaland University
ºC	Degree Celsius
RDF	Recommended Dose of Fertilizers
SAS	School of Agricultural Sciences
SEm±	Standard error of mean
Sl. No.	Serial number
SOV	Source of Variation
SS	Sum of square
SSP	Single Superphosphate
t	tonnes
viz.	Videlicet (Namely)

ABSTRACT

A field experiment was conducted to study the "**Performance of black rice cultivars to integrated weed management in Nagaland conditions**" at the experimental farm of School of Agricultural Sciences (SAS), Nagaland University, Medziphema campus during *kharif* seasons of 2021 and 2022. The experiment was laid out in split plot design with four weed management practices *viz.* W_1- Weedy check (Control), W_2- Hand weeding (15 and 30 DAS), W_3- Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS and W_4- Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS in the main plots and four cultivars *viz.* C_1-*Chakhao Poireiton*, C_2- *Chakhao Amubi*, C_3- *Wairi Chakhao* and C_4- *Khurukhul Chakhao* in the sub-plots and was replicated thrice. The pooled data results revealed that hand weeding at 15 and 30 DAS recorded significantly the highest growth and yield attributes and yield of black rice *viz.* plant height (110.71 cm), leaf area index (1.77), dry matter accumulation (19.64 g plant^{-1}) crop growth rate (20.23 g m^{-2} day^{-1}) , relative growth rate (0.032 g g^{-1} day^{-1}), no. of panicles m^{-2} (209.25), length of panicle (19.99 cm) , weight of panicle (2.64 g), no. of grains panicle^{-1} (161.94), grain filling percentage (91.67 %), grain yield (1871.75 kg ha^{-1}), straw yield (4053.08 kg ha^{-1}) and harvest index (31.60 %). Minimum weed population, weed dry weight and higher weed control efficiency were recorded with two hand weeding's at 15 and 30 DAS. It also recorded significantly lower nutrient depletion by weeds and higher nutrient uptake by crops. This was followed by pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS. The dominant weed flora observed in the experimental field were *Ageratum conyzoides, Alternanthera sessilis, Borreria latifolia, Mollugo pentaphylla, Cyperus rotundus, Cyperus iria, Cynodon dactylon, Eleusine indica* and *Digiteria sanguinalis*. Among the different cultivars, *Chakhao Poireiton* recorded higher growth, phenology, yield attributes and yield of black rice. Hand weeding at 15 and 30 DAS recorded lowest weed population (12.16 m^{2}), weed dry weight (11.49 g), nutrient depletion by weed (9.84 kg ha^{-1}

nitrogen, 5.57 kg ha^{-1} phosphorous and 16.50 kg ha^{-1} potassium) and higher weed control efficiency (64.11 %), nutrient content and uptake by crops. Economic analysis revealed that the highest cost of cultivation was recorded under two hand weeding at 15 and 30 DAS for all the four cultivars. The maximum gross return (161246.17 ₹ ha^{-1}) and net return (113205.99 ₹ ha^{-1}) were obtained from the treatment combination of two hand weeding at 15 and 30 DAS and cultivar *Chakhao Poireiton*. However, the highest B:C (2.47) was obtained with the application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS and cultivar *Chakhao Poireiton*. Thus, from the economic point of view, for profitable production of black rice it can be concluded that application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS with cultivar *Chakhao Poireiton* could be beneficial for cultivation in Nagaland conditions.

Keywords: Bispyribac sodium, black rice, cultivar, pretilachlor, weeding

CHAPTER I

INTRODUCTION

INTRODUCTION

Rice (*Oryza sativa* L.) belonging to family Poaceae, is the most important and extensively cultivated food crop grown extensively in tropical and subtropical regions, which provides half of the daily food for one of every three persons on the earth. The slogan “Rice is life” is most appropriate for India as this crop plays a vital role in our national food security and is a means of livelihood for millions of rural households (Jagtap *et al.* 2018). It is an indispensable food for more than half of the world’s population within Asia and Africa as it consists of a decent amount of protein, fiber, vitamin and minerals like iron and manganese. Hence, it secures the food and nutrient demands of the country simultaneously (Satapathy *et al*. 2021). In India, Rice is cultivated in an area of 48.00 million hectare with annual production of 134.00 million tonnes and productivity of 4.2 t ha^{-1} (Anonymous, 2024). World’s rice demand is projected to increase by 25% from 2001 to 2025; therefore, it is a great challenge to meet the ever increasing rice demand in a sustainable way with shrinking natural resources.

Rice is used widely in Asian and Indian cuisines, but it can be found in all kinds of dishes from around the world. The popular edible seeds from the plant *Oryza sativa* come in several shapes, sizes, textures, and unique flavours. Some of which are basmati rice, black rice, jasmine rice, sticky rice, brown rice, arborio rice etc. Black rice is a special type of rice species *Oryza sativa* L. which is black in colour, glutinous, packed with high level of nutrients and mainly cultivated in Asia. Black rice, also called forbidden rice or "emperor's rice" with a thin layer of black bran, is gaining popularity for its high levels of antioxidants and superior nutritional value. Forbidden rice earned its name because it was once reserved for the Chinese emperor to ensure his health and longevity, and forbidden to anyone else. It was found to be of short duration, photo insensitive, non-responsive and low productive towards the fertilizer doses. Despite its long history, the origins of black rice have not been clear. Black rice cultivars are found in locations scattered throughout Asia. In India, black rice variety is cultivated popularly in Manipur and the name “Chakhao Amubi” originates from the Manipuri language, “Chakhao” means delicious and “Amubi” means black, thus translating the name to ‘Delicious Black Rice’. Black rice, however, is unique its purplish-black colour is a result of its high concentration of anthocyanin. Japanese researchers found that a change in a gene that controls anthocyanin rearranged to create black rice; this mutation occurred in a subspecies of rice. Since then, the rice has been replicated and transferred to other rice species through cross-breeding. The grain is cultivated in Southeast Asian countries such as India, Indonesia, Thailand, and China. Owing to its popularity in Western countries, it is now also grown in small amounts in the Southern United States as well. It contains 18 amino acids. Black rice is not only the type of rice that is richest in powerful disease fighting antioxidants but also it contains anti-inflammatory, anti-carcinogenic properties and has an ability to stop the development of diabetes mellitus, heart disease and even weight gain. Continuous consumption of white rice as staple food grain has resulted in malnutrition, anaemia and aggravated diabetes (Jena and Misra, 2019). In such cases, black rice becomes an alternative as it consumed as functional food due to its health benefits. Black rice has drawn attention of the scientific community and gained importance in recent times due to its high nutritive, curative effect, anti-carcinogenic and anti-oxidant properties. Thus, black rice is a kind of food that can make us healthy and save our life and also known as long life rice.

Rice is cultivated in India in a very wide range of ecosystem from irrigated to shallow lowlands, mid-deep lowlands, deep water to uplands. Crop establishment methods, such as transplanting and direct sowing, resulted in significant changes in weed flora composition. In comparison to flooded transplanted rice, weeds flourish fast in direct seeding of rice (DSR) (Rathika *et* *al.* 2020). Irrespective of the method of rice establishment, weeds are a major impediment to rice production through their ability to compete for resources and their impact on product quality. Direct-seeded rice can increase yield, decrease fertilizer and land preparation costs, increase household income, and improve soil productivity (Devkota *et al.* 2020). Direct- seeded rice germinates together with weeds, eliminating the 'head start' of seedling thereby subjecting it to higher weed pressure (Rao *et al*. 2017). A significant obstacle to the effectiveness of the direct seeded rice technology is weed infestation (Zia-Ul-Haq *et al.* 2019). Weeds are emerging as most important cause of damage to direct seeding of rice (DSR) due to early crop-weed competition and lack of standing water for suppressing weed (Kumar *et al*. 2016b). Yield reductions up to 40-100% are reported under heavy weed infestations (Pooja and Saravanane 2021, Shekhawat *et al*. 2020).

Weed management during the critical period of crop weed competition in direct seeding of rice (DSR) can be accomplished by various physical, chemical or cultural practices (Banik *et al.* 2020). Physical methods like hand weeding was found to be the most effective and ecofriendly method of weed control, but due to slow, cumbersome and labour intensive nature, it proved uneconomical (Dnyaneshwar *et al.* 2018). Various herbicides have been used for controlling weeds but efficiency of chemical methods based on a single herbicide may be unsatisfactory, because of their narrow-spectrum of weed management (Kumar and Jnanesha 2017, Mishra and Kumar 2017). Therefore, application of herbicides in combination or sequence can be more useful. Herbicides provide more accessible, timelier, cost-effective, and convenient weed control in rice, compared to the higher expense, drudgery, and lesser efficacy of other weed control solutions (Sen *et al.* 2020). There are many cultivars of black rice but the cultivation is not popular owing to the lack of knowledge and farmer's reluctance and hence the tradition of growing the normal white rice continues which ultimately will lead to loss of such landraces. Cultivars play an important role in crop-weed competition because of their diverse morphological traits, canopy structure and relative growth rate. A quick growing and early canopy cover enables a cultivar to compete better against weeds (Mishra *et al.* 2016). Traditional tall cultivars of rice exert effective smothering effect on weeds (Kumar and Jnanesha 2017). Rice cultivars with weed-suppressing characters are an important aspect to manage weeds (Kumar *et al.* 2016a). Competitive ability of different rice varieties has become a focus of research; cultivar selection based on an ideal type has contributed remarkably to increased rice yield. Cultivars with fewer tillers, lower panicle weights with thick roots and culms are suitable for DSR. Further, it has been observed that early maturing rice cultivars have smothering effect on weeds due to improved vigour and having the tendency of early canopy cover. The introduction of weed-competitive rice cultivars represents a low-cost and safe non-chemical addition to an integrated weed management (IWM) program. In addition, the use of more competitive cultivars can minimize yield losses and herbicide dependence, because these cultivars can suppress weed seed production, limit future weed infestations and fit easily into current agronomic practices. Weed competitive cultivars are able to grow better even in the presence of weeds by providing them competition for survival without much loss of yield and quality of crop (Schreiber *et al.* 2018). The use of competitive crop cultivars may therefore be considered as an important component for integrated weed management. (Ramesh *et al*. 2017). Many such rice cultivars harbour many desirable traits such as tolerance or resistance to many biotic and abiotic stresses. It is a fact that the black rice cultivars could provide food security apart from its contribution to interesting diet with multiple medicinal properties. So, conservation of such cultivars is important by cultivation through adoption of better agronomic practices. In addition, black rice in comparison with other rice when grown in upland conditions are more susceptible to weed infestation and is a serious problem due to the weed infestation during the entire crop growth period which results in huge reduction in the crop yield. Hence, keeping the above views into consideration, an experiment will be carried out to study the "**Performance of black rice cultivars to integrated weed management in Nagaland conditions**" with the following objectives:

1. To study the performance of black rice cultivars to integrated weed management practices.

2. To study the performance of weed suppressing ability of different black rice cultivars.

3. To study the weed dynamics in black rice cultivars.

4. To assess the economics of different treatments.

CHAPTER II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

A brief literature related to research work done so far on the topic of current study entitled **“Performance of black rice cultivars to integrated weed management in Nagaland conditions”** has been reviewed and presented in this chapter under different sub-headings:

2.1 Weed flora of rice ecosystem

2.2 Effect of hand weeding on rice and weed

2.3 Effect of herbicides on rice and weed

2.4 Effect integrated weed management on rice and weeds

2.5 Effect of cultivar on growth, yield attributes and yield of rice

2.6 Effect of cultivar on weed

2.7 Economic analysis

2.1 Weed flora of rice ecosystem

Kundu *et al.* (2017) conducted an experiment to evaluate the studies on bio efficacy and phytotoxicity of pretilachlor 30.7% EC in direct seeded rice. Result from the investigation revealed that the highest weed density was observed under the unwedded control treatment. The experimental field was predominantly infested with *Echinochloa crusgalli*, *Echinochloa colonum*, *Cyperus difformis*, *Cyperus iria*, *Phyllanthus niruri* and *Commelina benghalensis* etc.

Ezung *et al.* (2018) conducted an experiment to study weed growth and nutrient uptake in organically managed rice and maize as affected by nitrogen management and live mulching with cowpea. Result revealed that among the various categories of weed flora like grass, sedge and broad leaf weeds observed in the experimental field during *kharif* season of 2018, the dominant weeds were *Echinochloa colona*, *Leersia hexandra*, *Cyperus difformis*, *Fimbristylis dichotoma*, *Cynodon dactylon*, *Alternanthera philoxeroides*, *Cyperus iria, Ludwigia octovalvis, Ammania baccifera*, *Eclipta alba* etc.

Kashyap *et al.* (2019) conducted an experiment to study the effect of integrated weed control option for dry direct seeded rice under irrigated ecosystem. Result revealed that the field trial was conscientiously monitored throughout crop growth stages and the presence of the following three types of weeds were found in the field i.e. *Echinochloa crussgalli*, *Echinochloa colona* and *Leptochloa chinensis* among grassy weed; *Cyperus iria* and *Cyperus difformis* among sedges; *Ammania baccifera* and *Alternanthera sessilis* among broadleaf weeds.

Nagarjun *et al.* (2019) conducted a study entitled energy budgeting and economics of weed management in dry direct seeded rice. Study revealed that predominant category of weed was broad leaved followed by grasses and sedges. Among the weed species, the densities of *Cyperus rotundus*, *Cynodon dactylon*, *Digitaria marginata*, *Ageratum conyzoides*, *Commelina benghalensis* and *Alternenthra sessilis* were more than other weed species.

Ramesha *et al*. (2019) conducted an investigation to study weed management effect to increase grain yield in dry direct-seeded rice. Study revealead that the predominant grassy weeds in field were *Echinochloa sp*. *Panicum repens*, *Cynodon dactylon*, *Bracharia mutica*, *Digitarias sanguinalis* and *Leptochloa chinensis*.

Yoganada *et al.* (2019) conducted an experiment to study sequential application of pre and post-emergence herbicides for control of complex weed flora in dry direct-seeded rice under Cauvery command area of Karnataka. Result revealed that major weed flora associated with the direct seeded rice are

Echinochloa colonum, *Cynodon dactylon*, *Digitaria sanguinalis* and *Panicum repens* among the broad leaf weeds (BLW) major weeds were *Digera arvensis*, *Physalis minima*, *Ageratum conyzoides*, *Portulaca oleracea*, *Commelina Benghalensi*, *Trianthema portulacastrum*, *Parthenium hysterophorus*, *Abutilon indicum*, *Cyperus rotundus* and *Cyperus iria* among sedges.

Banik *et al.* (2020) conducted an experiment to study weed management approaches in direct–seeded rice in eastern Indian ecologies. Result revealed that major grasses causing yield losses includes *Echinochloa colona*, *Echinochloa crus-galli*, *Leptochloa chinensis*, *Dactyloctenium aegyptium*; sedges include *Cyperus iria*, *Cyperus difformis*, *Fimbristylis miliacea*; broad leaved weeds include *Eclipta prostrata*, *Sphenoclea zeylanica* and *Ludwigia hyssopifolia*.

Nazir *et al.* (2020) conducted a field experiment to study the crop establishment and weed management effect on weed parameters and rice yield under temperate zone of Kashmir and reported that the prominent grassy weeds were *Echinochloa crusgalli*, *Echinochloa colona* and *Cynodon dactylon*. Broad-leaved weeds were *Ammania baccifera, Marsilea qudrifolia, Monochoria vaginalis* and *Potamogeton distinctus* while the prominent sedges included *Cyperus iria*, *Cyperus defformis* and *Fimbristylis*.

Sharma and Hemant (2020) conducted an experiment to study changes in the weed seed bank in long-term establishment methods trials under rice-wheat cropping system. Result from study revealed that weed flora in direct seeding of rice (DSR) broadly included grasses (*Digitaria sanguinalis*, *Echinochloa* spp, *Dactyloctenium aegyptium*), sedges (*Cyperus* spp) and broad leaf weeds (*Ammannia baccifera*, *Caesulia axillaris*, *Commelina benghalensis*, *Eclipta alba*, *Euphorbia hirta*, *Ludwigia hyssopifolia*, *Phyllanthus niruri*).

Choudhary and Dixit (2021) conducted an investigation to determine bio-efficacy of sequential herbicide application for weed management in dry direct seeded rice. Result revealed that the common weed species found at the study site comprised sedges, for instance, *Cyperus iria*, *C. compressus, C. rotundus, Fimbristylis miliacea*, and important grasses such as *Digitaria ciliaris*, Echinochloa *colona*, *Dactyloctenium aegyptium, Eleusine indica, Leptochloa chinensis* and major broad-leaved weeds like *Celosia argentea*, *Alternanthera sessilis*, *Physalis minima*, *Ageratum conyzoids*, *Ludwigia octavalis*, *Portulaca oleracea*, *Phyllanthus niruri*.

Jehangir *et al.* (2021) carried out an experiment to study the crop establishment methods and weed management practices effect of grain yield and weed dynamics in temperate rice. Result revealed that weed floristic composition of the experimental plots was diverse and comprised of all the three major groups *viz*. BLW, sedges, and grasses. The predominant weed species observed were *Echinocloa colonum*, *E. crusgali, Setaria gluaca*, *Digitaria sanguinalis, Ammnania baccifera*, *Rorippa amphibia*, *Potamogeton distinctus*, *Aechynomene indica*, *Polygonum hydropiper*, *Cyprus rotundus*, *C. irria*, *C. difformis*, *Fimbristylis millicea*, and *Scripus juncoides*.

Meti *et al*. (2021) conducted an experiment to study the eco-friendly weed management in dry direct-seeded rice under organic production system. Study revealed that the predominant weed flora observed in the experimental field included grasses like, *Chloris barbata*, *Cynadon dactylon*, *Dactyloctenium aegyptium*, *Echinochloa colonum*, *Elusine indica* and *Panicum repens*. Among broad-leaved weeds, *Ageratum conyzoides,* Celosia *argentia*, *Commelina benghalensis, Parthenium hysterophorus, Phyllanthus niruri, Portulaca oleraceae*, *Tridax procumbens* and the sedge *Cyperus rotundus* were noticed. Among the weed species, the density of *Cyperus rotundus*, *Cynodon dactylon*, *Echinochloa colonum*, *Ageratum conyzoides*, *Commelina benghalensis* and *Portulaca oleraceae* were more than other weed species indicating their dominance and competitiveness with the dry direct-seeded organic rice.

Venkatesh *et al.* (2021) conducted an investigation to study the performance of herbicides and herbicide mixtures on weed control in transplanted rice. Result revealed that the weed species found in the experimental field were *Echinochloa colona*, *Echinochloa crusgalli*, *Paspalum distichum* and *Cynodon dactylon* among grasses, *Cyperus difformis*, *Cyperus iria* and *Fimbristylis dichotoma* among sedges and among the broad-leaved weeds *Eclipta alba*, *Ammania baccifera* and *Caesulia axillaris*. All the weed management practices significantly reduced weed population and weed dry weight over unweeded control.

Gogoi and Deka (2023) from the experiment entitled Effect of integrated weed-management practices in direct-seeded autumn rice (*Oryza sativa*) on growth, yield and soil micro flora revealed that altogether, 18 species comprising sedges, broad-leaf weeds and grasses were found and they consisted of *Cynodon dactylon*, *Digitaria setigera*, *Panicum repens*, *Eleusine indica*, *Phyllanthus urinaria*, *Chenopodium album*, *Ageratum conyzoides*, *Leersia hexandra*, *Gnaphalium polycaulom*, *Commelina diffusa*, *Scroparia dulcis*, *Mimosa pudica*, *Borreria articularis*, *Mimosa pudica*, *Cyperus pilosus*, *Cyperus iria*, *Cyperus rotundus*, and *Fimbristylis littoralis*.

Kokilam *et al*. (2023) carried an experiment to study weed dynamics and productivity of direct wet seeded rice under different weed management practices. Result revealed that weed flora of the experimental field was composite in nature comprising of grasses, sedges and broad-leaved weeds (BLW). The major grass weeds were *Echinochloa crus-galli* (L.), *Echinochloa colona* (L.) and *Cynodon dactylon* (L.) and common sedges included *Cyperus rotundus* (L.) and *Cyperus iria* (L.). Among the BLW, *Eclipta alba* (L.) and *Ammania baccifera* (L.) were the dominant species in direct wet seeded rice ecosystem.

Paul *et al*. (2023) conducted an experiment to determine the drone-based herbicide application for energy saving, higher weed control and economics in direct-seeded rice (*Oryza sativa*). Data from the study revealed that the dominant weed flora found in the experimental field consisted of *Echinochloa colona*, *Echinochola crugalli*, *Leptochloa chinensis*, *Cyperus difformis*, *Bergia capensis*, *Ludwigia parviflora* in both seasons. *Monochoria vaginalis* was found in *kharif* season and *Ammannia baccifera* and *Eclipta alba* were found in *rabi* season.

Verma *et al*. (2023) conducted an experimented on weed management in direct-seeded rice through herbicidal mixtures under diverse agro ecosystems. Result revealed from the experiment that the dominant grassy weed species were: jungle rice *Echinochloa colona* and *Cynodon dactylon*. Among sedges, *Cyperus iria* was the dominant one. In broad-leaf weeds, *Alternanthera sessilis* was found to be dominant**.**

2.2 Effect of hand weeding on rice and weed

Mandi *et al.* (2016) conducted an experiment to study the growth and yield of transplanted rice as affected by different cultivars and weed management practices. Result revealed that hand weeding promoted various growth attributes of rice as compared to other weed management treatments. Crop growth rate decreased with increase in age of crop due to senescence.

Bhargaw *et al.* (2018) conducted an investigation to evaluate the effect of integrated weed management practices on weed dynamics of dry direct seeded rice (*Oryza sativa* L.). Result from the study revealed that among all the integrated weed management practices, treatment where weed free was maintained (by hand weeding's at 20, 40 and 60 DAS) recorded highest weed control efficiency (WCE) of 77.54%, which might be due to decrease in weed biomass as compared to rest of the weed management practices.

Devi and Singh (2018) conducted an investigation to investigate the nutrient uptake and yield of direct seeded rice as influenced by nitrogen and weed management practices. It was reported from the experiment that two hand weeding at 20 and 40 DAS recorded maximum yield, NPK content in grain and straw in direct seeded rice.

Singh *et al*. (2018) conducted an experiment to study the effect of herbicides combinations and hand weeding on growth, yield and weed population in transplanted rice (*Oryza sativa* L.). Study from the investigation revealed that minimum weed population/m^2 was obtained in the treatment where weed free was maintained (2 hand weeding 25 and 45 DAT).

Muhammad *et al.* (2020) evaluated to study the assessment of different weed control methods on growth and yield performance of Transplanted Aus rice. Result revealed from the study that different weed control methods had significant effect on total number of tillers $hill^{-1}$, effective tillers $hill^{-1}$, number of grains $panicle^{-1}$, sterile grains $panicle^{-1}$, 1000 grain weight where plant height and panicle length remained non-significant in this experiment. The tallest plant was found in hand weeding at 15 & 30 DAT (95.56 cm) and shortest plant was observed in no weeding (91.78cm).

Gupta *et al*. (2021) carried out an experiment to determine the impact of weed control technique on rice (*Oryza sativa* L.) growth, yield and economics. Result revealed that there was significant increase in LAI with weed free (till maturity). Further, it was noted that all treatments produced higher LAI over control at 60 and 90 DAT. Treatment weed free (till maturity) recorded higher LAI which was at par with the hand weeding treatment (20 and 40 DAT) while being significant over rest of the treatments at 60 DAT.

Sanodiya and Singh (2021) evaluated to study the effect of integrated weed management on growth, yields and nutrient balance in direct seeded rice (*Oryza sativa*). Average data of 2 years showed that all integrated weed management treatments brought significant variation in nutrient uptake by rice as compared to weedy. Hand weeding at 15 and 35 DAS resulted in the highest nutrients (NPKZn) uptake by crop.

Sindhu *et al.* (2021) carried out an experiment to study the organic weed management in wet-seeded and transplanted aromatic rice. Study revealed that different weed management practices significantly influenced rice yield attributing characters and rice grain and straw yield. Hand weeding twice at 20 and 40 DAT enhanced rice effective tillers no./m^2, panicle length, panicle weight, number of filled grains per panicle, test weight, grain and straw yields as compared to the remaining treatments. Manual weeding has more advantage because of complete removal of weeds and helps in increasing grain and straw yields.

Mishra *et al.* (2022) conducted an experiment to determine the effect of crop establishment and weed management methods on weed dynamics and productivity of direct-seeded rice in middle Indo-Gangetic Plains. Result from the study revealed that manual weeding is the most common method to suppress weeds in rice but scarcity of labour for timely weeding and high labour cost are major limitations.

Shahane and Behera (2023) conducted an experiment to investigate comparision manual and mechanical weed management techniques for upland organic rice in acidic soil of Meghalaya. The result from the study revealed that the dry matter accumulation at 60 DAS was highest in manual weeding three times (209.0 g/m^2). The growth variations across weed management treatments arose due to higher weed dry matter accumulation and weed density.

Verma *et al.* (2023) conducted an experiment to study the weed management in direct-seeded rice through herbicidal mixtures under diverse agro ecosystems. Data from the study revealed that influence of weed management practices on direct-seeded rice grown under rainfed and irrigated agro ecosystems. Under treatments, there was a strong inverse association between weed control efficiency and weed dry weight. Hand weeding treatment registered maximum efficiency in rainfed (97%) and irrigated agro ecosystems (97.4%) than all other treatments at 90 DAS due to the production of less dry matter of the weeds over the weedy check.

2.3 Effect of herbicides on rice and weed

Manjunatha *et al*. (2012) observed from their study that among the herbicidal treatments post emergence application of bispyribac sodium @ 25 g a.i ha^{-1} recorded lower weed dry weight and higher grain yield (2.40 g m^2 and 5012 kg ha^{-1}). However, this treatment was at par with pre- emergence application of bensulfuron methyl @ 60 g a.i ha^{-1} + pretilachlor @ 600 g a.i ha^{-1} in transplanted rice in coastal Karnataka.

Reddy *et al.* (2012) conducted an experiment entitled efficacy of bensulfuron methyl plus pretilachlor for controlling weeds in transplanted rice. Result from the experiment revealed that herbicides like pretilachlor applied alone are more effective against grasses, but less effective against sedges.

Naseeruddin and Subramanyam (2013) reported from the study entitled performance of low dose high efficacy herbicides in drum seeded rice that the pre-emergence application of oxadiargyl @ 75 g a.i. ha^{-1} followed by post-emergence application of bispyribac-Na @ 30 g a.i. ha^{-1} reduced the dry weight of grasses and broad-leaved weeds in rice by 90.8 percent and 88 percent, compared to unweeded check at harvest.

Duary *et al.* (2015) conducted a field investigation to study weed management in lowland rice. Result revealed that bispyribac sodium has been found effective in rice nursery as well as main field where *Echinichloa crusgalli*, *Echinochloa glabrescens* are major problem.

Prashanth *et al.* (2016) conducted a field investigation entitled bispyribac-sodium influence on nutrient uptake by weed and transplanted rice. Result from the study reported that application of bispyribac sodium 25 g ha^{-1} at 15 DAT recorded significantly lower total weed population and higher grain (6.47 t ha^{-1}) and straw yield (7.66 t ha^{-1}) of rice compared to pretilachlor 750 g ha^{-1} at 5 DAT.

Singh *et al.* (2016) conducted an experiment to study the herbicide options for effective weed management in dry direct-seeded rice under scented rice-wheat rotation of western Indo-Gangetic plains. Result from the study revealed that significantly higher effective tillers m^{-2} and grains per panicle were observed in plots treated with pre and post emergence herbicide as compared to untreated weedy control.

Mou *et al.* (2017) conducted an experiment to study the effect of weeding regime on the performance of transplanted aman rice. Result from investigation revealed that the highest number of total tillers hill^{-1} (8.78) was observed in application of early post emergence herbicide Changer and the lowest number of total tiller hill^{-1} (5.27) was observed in no weeding treatment. In no weeding condition weed-crop competition was higher and rice crop was suppressed by weed, thus tiller production was suppressed by weed. On the other hand, in different weed management treated plots, weed was effectively controlled and thus crop growth was vigorous and tiller production was higher.

Islam *et al.* (2018) conducted an experiment to study herbicidal based weed management in aromatic rice of Bangladesh. The result from the investigation revealed that the highest number of grains panicle^{-1} (172.5) was found in weed free weed free treatment followed by pre + post emergence herbicide application (2.5 t ha^{-1}). The lowest grain yield (1.4 t ha^{-1}) was found in no weeding treatment.

Rathika and Ramesh (2018) conducted a field experiment to investigate the weed management effect in system of rice intensification. Result revealed that any delay in weeding will lead to increased weed biomass which has a negative correlation with yield. Though manual weeding is considered to be the best, non-availability of labour and escalating labour cost in many cases have made it imperative to use of new chemicals for weed control.

Kalaisudarson and Srinivasaperumal (2019) evaluated to study effect of new herbicides on weed management in transplanted rice. Based on the result it was revealed that application of pre-emergence herbicide bensulfuron methyl + pretilachlor 0.66 kg ha^{-1} on 3 DAT followed by post emergence herbicide bispyribac sodium 0.02 kg ha^{-1} on 30 DAT significantly registered the highest grain yield of 5226 kg ha^{-1}. Unweeded control recorded the lowest grain yield of 2543 kg ha^{-1}.

Sivakumar *et al.* (2019) conducted an investigation to study the weed management practices in direct seeded rice ecosystem in north western zone of Tamil Nadu. Result from the study revealed that application of pre-emergence herbicide pendimethalin 1.0 kg a.i ha^{-1} at 8 DAS with PoE bispyribac sodium 25g ha^{-1} at 25 DAS and HW on 45 DAS recorded the higher no. of panicle m^{-2} (291.3), no. of grains panicle^{-1} (265.3) and 1000 grain weight (17.8 g). This was followed by PE pendimethalin 1.0 kg a.i ha^{-1} at 8 DAS with hand weeding (HW) 25 DAS, it recorded the no. of panicle m^{-2} (274.3), no. of grains panicle^{-1} (257.3) and 1000 grain weight (17.3 g). The lower no. of panicle m^{-2} (241.3), no. of grains panicle^{-1} (205.0) and 1000 grain weight (16.9 g) were recorded in control (weedy check).

Biswas *et al.* (2020) carried out an experiment to study the weed control in transplanted rice with post emergence herbicides and their effects on subsequent rapeseed in Eastern India. Result revealed that herbicide application improved yield and yield related traits of rice over the weedy check. The weed-free check had the maximum number of panicles (264 m^{-2}) followed by bispyribac-sodium treatment (241 m^{-2}), while the weedy check had the minimum number of panicles (136 m^{-2}). The weed free check and bispyribac-sodium treatments had the longest panicles, the highest number of grains per panicle, and the maximum 1000-grain weight. The highest grain yield was recorded in the weed free check (5.98 t ha^{-1}), followed by bispyribac sodium treatment (5.45 t ha^{-1}), while the lowest grain yield was in the weedy check (2.13 t ha^{-1}). Herbicide application was also effective in increasing effective tillers and improving harvest index over the weedy check.

Muhammad *et al.* (2020) carried out an experiment to study the assessment of different weed control methods on growth and yield performance of T. Aus Rice. Result revealed that grain yield influenced significantly in different weed control methods. The highest grain yield (3.67 t ha^{-1}) was obtained from pre-emergence herbicide which was statistically similar with hand weeding twice as a result of less weed crop competition and the lowest (1.87 t ha^{-1}) was found from no weeding treatment. Different weed control methods had non-significant effect on straw yield. The highest straw yield of 7.1 t ha^{-1} was found in post-emergence herbicide application and the lowest straw yield was obtained from no weeding (5.46 t ha^{-1}). The highest harvest index was obtained from pre-emergence herbicide (37.17 %) which was statistically identical with hand weeding twice and lowest (25.69 %) harvest index was found in no weeding.

Parihar *et al.* (2020) conducted an experiment to study weed dynamics, weed control efficiency and yield of aerobic rice as influenced by weed management practices in eastern UP. It was concluded from the experiment that among herbicidal treatments, pre-emergence application of pendimethalin at 3-4 DAS *fb* bispyribac-Na at 15-20 DAS as post-emergence was most effective in minimizing weed density (4.81 m), biomass (6.20 g m), weed index (1.11%) and in enhancing the weed control efficiency (84.50%), grain yield (3.68 t ha) and straw yield (4.87 t ha) over rest of the treatments.

Barla *et al.* (2021) conducted an experiment to determine the performance of direct-seeded rice under different nutrient and weed management practices. Result revealed that among weed management practices, application of pretilachlor 750 g/ha *fb* bispyribac-Na 25 g/ha being similar to hand weeding at 20 and 40 DAS recorded significantly higher yield attributes like effective tillers (305/m^2), number of grains/panicle (102), panicle length (20.88 cm) and 1000 grain weight (23.69 g) which resulted in significantly higher grain yield (4095 kg/ha) and straw yield (5422 kg/ha).

Mohapatra *et al.* (2021) conducted an investigation to study the effect of sequential application of herbicides on productivity and profitability of transplanted rice. Result from data revealed that pre-emergence application of pretilachlor 750 g/ha *fb* post-emergence application of triafamone + ethoxysulfuron 60 g/ha recorded significantly higher number of tillers/hill (9.7) and grains/panicle (148), which was at par with pretilachlor 750 g/ha *fb* bispyribac-sodium 25 g/ha (9.3 and 141).

Pooja and Saravanane (2021) conducted an experiment to study the performance of rice cultivars with weed management practices in dry direct-seeded rice. Result from the study revealed that rice cultivar ADT 46 integrated with sequential application of pendimethalin *fb* bispyribac sodium (1.0 kg/ha *fb* 0.02 kg/ha) reduced the weed density and weed dry weight, and increased the growth, yield attributes and rice grain yield.

Bhattacharya *et al.* (2022) conducted an investigation to study response of Rice (*Oryza sativa* L.) to weed management methods in the lower Gangetic plain zone. Result from the investigation exhibited that the density of weed species varied significantly at 60 days after sowing (DAS) due to different weed control treatments. The total weed density of grasses, sedges and broad-leaf was minimum by applying bispyribac sodium at 25 g/ha and was significantly superior to the rest of the herbicidal treatments under both the agro ecosystems.

Kokilam *et al.* (2023) conducted an experiment to study the weed dynamics and productivity of direct wet seeded rice under different weed management practices. Result from the study revealed that weed management practices significantly influenced the total weed density and dry weight at all the stages of observation. The data on total weed density and dry weight revealed that application of PE pyrazosulfuron ethyl 25 g/ha *fb* EPoE bispyribac sodium 25 g/ha, PE pyrazosulfuron ethyl 25 g/ha *fb* EPoE metsulfuron methyl + chlorimuron ethyl 4 g/ha and PE pyrazosulfuron ethyl 25 g/ha *fb* cono weeder weeding on 20 and 40 DAS resulted in greater reduction in density and dry weight of total weeds at 20 DAS and this was comparable with other treatments applied with PE pretilachlor 0.75 kg/ha.

Sivanesan *et al*. (2023) conducted an investigation to study the effect of herbicides combination on weed management and yield of direct wet seeded rice (*Oryza sativa* L.) Data from the evaluation revealed that higher weed dry weight was recorded in weedy check with 9.69 g m^{-2} ,11.33 g m^{-2} , 13.11 g m^{-2} at 20, 40 and 60 DAS and lower weed dry weight was recorded in weed free with 0.71 g m^{-2} at 20, 40 and 60 DAS followed by pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS + bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} (Tank Mix) on 15 DAS and 40 DAS (T_9) with 3.44 g m^{-2} , 4.11 g m^{-2} and 6.41 g m^{-2} at 20, 40 and 60 DAS, respectively.

Swain *et al.* (2023) conducted an investigation to study the effect of fertility levels and weed management practices on weed dynamics, yield and economics of transplanted rice (*Oryza sativa* L.). Result from that data revealed that the grain yield in unweeded control treatment is the lowest value (2.39 t/ha). This was due to severe competition between crop and weeds for growth and development of rice. Post emergence application of bispyribac sodium @25g/ha recorded higher grain yield of 3.22 t/ha. Among all the weed control treatments post emergence application of bispyribac sodium @ 25g/ha recorded significantly higher straw yield of 4.35 t/ha than others treatments.

Bagale and Kumari (2024) carried out an experiment to determine the effect of weed management practices on weeds in spring rice in Nepal. Study revealed that weed density and dry weight varied greatly under different weed management practices. Up to 30 DAT, use of pretilachlor significantly reduced weed density which was observed in treatments Pre + Bis20 (9.33), Pre + HW30 (2.67), Pre + Bis30 (2.67), and Pre + Bis20 + HW40 (1.33). At 60 DAT, treatments Pre + Bis20 (1.33), Pre + Bis30 (4.67), and Pre + Bis20 + HW40 (1.33) had significantly lower weed density than that of treatment Pre + HW30 (22.67) indicating that the use of bispyribac sodium offered better weed control than manual weeding performed around the same time.

2.4 Effect integrated weed management on rice and weeds

Mandi *et al.* (2016) conducted an investigation to evaluate to study growth and yield of transplanted rice as affected by different cultivars and weed management practices. The results indicated that hand weeding and bispyribac-sodium weed control treatments resulted in significantly higher yield over weedy check. Higher grain yield under these treatments is due to better growth of crop in terms of higher dry matter accumulation in addition to low density and dry matter accumulation of weeds.

Dubey *et al.* (2017) conducted a field experiment to study the effect of weed management practices and establishment methods on growth, productivity and economics of rice. Result from the study showed that the plots treated with pretilachlor plus hand-weeding at 20, 40 DAT had the longest panicle length of 27.64 cm the lowest panicle length (23.42cm) was observed in the control plots, which was found statistically similar with the plots treated with hand-weeding. The remaining readings were found to be statistically similar to each other.

Kumar and Jnanesha (2017) conducted an experiment to study the effect of crop establishment methods on growth yield and water productivity of rice. Result from the data exhibited that when necessary; herbicides should be used in an integrated management strategy, such as the rotation of herbicides with various modes of action (MOAs), the mixing of herbicides with various MOAs and best application techniques, or the use of soil-active pre-emergence and post-emergence herbicides.

Islam *et al.* (2018) conducted an experiment to study the herbicide based weed management in aromatic rice of Bangladesh. Result from the study revealed that at 65 DAT, the highest percentage of reduction in weed density (17.8%) and biomass (50.7%) were observed in pre + post–emergence herbicide application and the lowest weed density (7.3%) was in post–emergence herbicide + manual weeding, and the lowest biomass (33.1%) in pre–emergence herbicide + manual weeding.

Pandian and Thavaprakaash (2018) conducted an investigation to study the effect of weed management practices on growth and yield of machine transplanted rice. Study revealed that grain yield of rice was significantly different due to imposing different weed management practices. Higher yield was recorded in pretilachlor @ 1 kg a.i. ha^{-1} at 3 DAT applied as pre-emergence followed by hand weeding @ 20 DAT (5678 kg ha^{-1}). Lower grain yield was recorded in unweeded check (2890 kg ha^{-1}). Higher number of productive tillers, filled grains panicle^{-1}, panicle length recorded in these treatments resulted higher grain yield of rice.

Afroz *et al.* (2019) conducted an investigation on effect of weeding regime on the performance of Boro rice cultivars. Data from the study revealed that the highest weed density was revealed with no weeding treatment and the lowest was exhibited with the application of pre-emergence herbicide pretilachlor followed by one hand weeding at 40 DAT at 20, 40 and 60 DATs.

Weed dry weight was the highest in no weeding treatment and the lowest in application of early post-emergence herbicide followed by one hand weeding at 40 DAT.

Dhakal *et al.* (2019) conducted an investigation to study the integrated weed management in direct-seeded rice: Dynamics and economics. Result from the investigation showed that a pre-emergence application of pendimethalin and a post-emergence application of bispyribac sodium herbicides, followed by hand weeding at 45 DAS, offered up to 85% weed control and higher yield over weedy check than other weed control strategies.

Paul *et al*. (2019) conducted an experiment to investigate the influence of weeding regime on the performance of aromatic Boro rice and found that the highest weed density and dry weight were observed in no weeding condition compared to other treatments. The tallest plant, the highest number of total tillers hill^{-1}, number of effective tillers hill^{-1}, total spikelet's panicle^{-1}, grains panicle^{-1}, 1000-grain weight, grain yield, straw yield, biological yield and harvest index were obtained from weed free treatment. The highest grain yield (5.92 t ha^{-1}) was obtained from weed free throughout the growth period. The highest benefit-cost ratio (2.28) was obtained from application of pre-emergence herbicide followed by post-emergence herbicide + one hand weeding at 40 DAT.

Tasmin *et al.* (2019) evaluated the effect of integrated weed management practices on weed suppression and on the performance of boro rice cultivars and revealed that the highest weed dry weight was observed in no weeding treatment and lowest one was recorded in application of pre-emergence herbicide followed by one hand weeding at 35 DAT resulting in higher grain yield.

Suseendran *et al*. (2020) conducted an experiment to investigate the studies on integrated nutrient and weed management practices on growth, yield and economics of rice (*Oryza sativa* L.). Result from study concluded that application of pre-emergence herbicide of pretilachlor 0.75 kg a.i. ha^{-1} + one hand weeding at 25 DAT proved to be an agronomically efficient, ecofriendly and economically viable technology for improving growth, yield and economics of rice. The lowest values for plant height, LAI at flowering, no. of tillers hill^{-1}, and dry matter production and yield attributes and yield was observed in the unweeded control.

Ahmed *et al.* (2021) conducted an experiment to study the integrated weed management in transplanted rice: options for addressing labor constraints and improving farmer’s income in Bangladesh. The results indicated that either pre-emergence *fb* hand weeding or pre-emergence *fb* post emergence *fb* hand-weeding can be effective weed management options and can assist in achieving yields similar to the weed-free treatment.

Phukan and Deka (2021) conducted an investigation to study the weed dynamics, crop growth and yield as affected by different weed management practices and plant growth-promoting rhizobacteria in direct-seeded upland rice. Data from the study revealed that among all the weed management practices, the highest panicle length, number of panicles/m^2 and number of grains/panicles were recorded in three hand weeding’s at 15, 30 and 45 DAS in both the years. This was closely followed by pretilachlor 0.75 kg/ha + hand weeding at 30 DAS.

Reddy and Ameena (2021) conducted an experiment to study the influence of weed management practices on weed flora, crop yield and nutrient uptake in direct seeded rainfed lowland rice. Result revealed that the NPK uptake by the crop could be increased by 49.42, 60.07 and 51.73 per cent respectively in contrast to weedy check plot by adopting weed control practices. Among the weed management treatments pre-emergent or post emergent herbicide application with subsequent hand weeding at 40 DAS extended the period of effective weed control and helped the crop to utilize the inputs effectively for better growth and dry matter production resulting in lesser nutrient exhaustion by the weeds and greater nutrient uptake by rice.

Subramanian *et al.* (2021) conducted an experiment to study nitrogen and weed management treatments effect on productivity of aerobic rice. Result revealed that among the weed management methods, pre-emergence (PE) herbicide followed by mechanical weeding twice at 20 and 40 DAS resulted in greater rice plant height, number of tillers/m^2, number of panicles/m^2 and panicle weight. Whereas, lower grain and straw yield were found in un-weeded control owing to severe crop-weed competition which resulted in the reduction of growth and yield components of aerobic rice.

Kashyap *et al*. (2022) carried out an experiment to study the effect of integrated weed management on weed and yield of direct seeded rice. Study revealed that integrated weed management (IWM) practices had a remarkable influence on total weed density and weed dry weight at 40 and 60 DAS. The highest and lowest weed density and dry weight at both stages were observed under weedy check and weed free conditions, respectively. However, among the integrated management of weeds, recommended practice *i.e*. PE *fb* PoE *fb* 1 HW resulted in the lowest weed density (no. /m^2) and dry weight (g/m^2) during 40 DAS (10.7 and 8.8, respectively) and 60 DAS (7.1 and 12.3) respectively.

Kotresh *et al.* (2022) conducted an investigation to determine effect of integrated weed management practices on weed parameters in direct seeded aerobic rice. Result from the study revealed that during early stage of crop growth, at 30 DAS, the treatments that combined the pre- emergence application of either pendimethalin (1kg a.i./ha) or pyrazosulfuron ethyl (30g a.i./ha) with hand weeding or early post-emergence spray of bispyribac sodium (40g a.i./ha) achieved significantly lower weed hand weeding (17.07g/m^2) and bispyribac sodium (40g a.i./ha) as early post-emergence *fb* one hand weeding (17.81g/m^2).

Bhargaw *et al.* (2023) conducted an experiment to evaluate integrated weed management practices on productivity and profitability of direct seeded rice under aerobic condition. Result from data revealed that grain and straw yields of dry direct seeded rice were influenced significantly by different weed control treatments. The weed free had significantly higher grain (38.79 q/ha) and straw yield (60.05 q/ ha). The weedy check treatment resulted significantly lowest grain yield (21.25 q/ha) and straw yield (33.62 q/ha) among all the treatments. In herbicidal treatment, pendimethalin at 0-2 days after sowing *fb* two manual weeding's at 20 and 40 DAS was significantly superior over all other treatments, recorded grain yield (37.35 q/ha) and straw yield (58.05 q/ ha). The treatment manual weeding's at 20, 40 and 60 DAS and pendimethalin at 1 kg/ha at 0-2 DAS followed by two hand weeding's at 20 and 40 DAS yielded 182.54% and 175.76% more than the weedy check, respectively.

Gogoi and Deka (2023) evaluated on the title effect of integrated weed-management practices in direct-seeded autumn rice (*Oryza sativa*) on growth, yield and soil micro flora. Study revealed that application of pretilachlor followed by mechanical weeding at 30 DAS resulted in higher harvest index in both the years. It followed the pattern of the dry matter production, grain and straw yields of these treatments. It is notable that, plant species growing under stress conditions always strives for efficient partitioning of the dry matter accumulated to the reproductive parts *i.e*. grains in cereal.

Kafle and Simkhada (2023) conducted an experiment to study performances of transplanted spring rice under different weed management techniques in Kapilbastu, Nepal. Result from the study revealed that the plot treated with Pretilachlor plus hand weeding at 20, 40 DAT had the highest plant height (99.00 cm) while the control plots had the lowest plant height (94.31 cm) at 90 DAT.

Kumari *et al*. (2023a) conducted an investigation to evaluate yield attributes, yield and economics of direct seeded rice as influenced by integrated weed management practices under medium land condition. Result from investigation revealed that the highest values of effective tillers (282 per m^2 at maturity), total grain per panicle (143 per panicle at maturity), fertile grain per panicle (122 per panicle at maturity) and 1000 grain weight (23.77 g) were recorded under 3 hand weeding at 25, 40 and 55 DAS which was on par with pretilachlor @ 1.00 kg a.i /ha (PE) *fb* bispyribac sodium @ 0.025 kg a.i/ha PoE 20 DAS and pendimethalin @ 0.75 kg a.i /ha (PE) *fb* bispyribac sodium @ 0.025 kg a.i/ha PoE 20 DAS. The lowest data was observed in weedy check.

Maurya *et al.* (2023) carried out an investigation to study the effect of different crop establishment methods and weed management practices on growth indices and yield of rice (*Oryza sativa* L.). Data revealed that among the weed management practices weed free (two hand weeding) recorded maximum grain yield (58.99 and 59.60, during 2021 and 2022 respectively) which was at par with application of bispyribac sodium (10%) 25 g a.i ha^{-1} at 15 DAS/DAT *fb* one hand weeding at 35 DAS while, significantly higher than rest of the treatments during both years.

Mishra *et al.* (2023) conducted an experiment to determine weed competitive ability and productivity of transplanted rice cultivars as influenced by weed management practices. Data from study revealed that uncontrolled weeds (high weed pressure) reduced rice grain yield by 31.37% as compared to low weed pressure. Maintaining low weed pressure with pretilachlor PE *fb* bispyribac sodium PoE *fb* 1 HW at 35 DAT recorded significantly higher growth and yield attributes and grain yield of rice due to lesser crop-weed competition, followed by medium and high weed pressure treatments which can be attributed to lesser crop-weed competition for nutrients and moisture supply, resulting in maximum use of inputs for crop growth, yield attributes and yield.

Niraula and Karki (2023) conducted an investigation to study efficacy of different weed management practices on growth and yield of spring rice under system of rice intensification. Result from the study revealed that the plant height was significantly influenced by weed management practices. The average plant height varied from 51.34 cm (30 DAT) to 106.58 cm (90 DAT) and increasing up to 90 DAT. At 30 DAT, plant height was statistically at par in all the treatments except control. The plot treated with pretilachlor plus hand-weeding at 20, 40 DAT had the taller plant height (54.50 cm) as compared to others and it was statistically similar with other plots except the control plot.

Wahid *et al*. (2023) conducted an experiment to study the effect of free-floating plants on weed emergence, growth, and yield of transplanted aman rice varieties. Result from the study revealed that the combined effect of variety and weed control significantly affected weed control efficiency at 30 and 60 DAT. Experiment results revealed that the application of IWM along with the Tulshimala rice variety recorded the maximum weed control efficiency (100 and 100% respectively) at 30 and 60 DAT, respectively, which was statistically similar to the application of IWM along with the BR11 rice variety (100 and 100 % respectively), application of IWM along with BRRI hybrid dhan6 rice variety (100 and 100 % respectively). The minimum weed control efficiency (0.0 and 0.0 %, respectively) at 30 and 60 DAT respectively, was recorded in the weedy check along with the Tulshimala rice variety.

2.5 Effect of cultivar on growth, yield attributes and yield of rice

Kumar and Jnanesha (2017) conducted an experiment to determine in validation of common salt application on productivity, profitability, nutrient uptake and soil health of upland rice (*Oryza sativa* L.) under shifting cultivation area of Nagaland and revealed that competitive ability of different rice varieties has become a focus of research; cultivar selection based on an ideal type has contributed remarkably to increased rice yield.

Grace *et al.* (2018) conducted an experiment to study the effects of NPK fertilizer on growth and yield of several rice varieties grown in Sabah. Results from the study revealed that based on morphological characters it showed that the Basmati-370 resulted in significantly higher plant height (cm), dry matter accumulation, leaf area index at all the growth intervals till physiological maturity of crop. Such significant variation among the different cultivars might be owing to differences in their parental origin which caused variation in their genetically inheritance for such traits.

Schreiber *et al.* (2018) conducted an experiment to study competitive ability of rice cultivars in the era of weed resistance. Result revealed that weed competitive cultivars are able to grow better even in the presence of weeds by providing them competition for survival without much loss of yield and quality of crop. It may be because of the advantage due to some added morphological traits like bigger leaves which can shade growing weeds deep roots for better water uptake and other identified traits/characteristics.

Kumar *et al*. (2020) conducted an investigation to study the evaluation of weed competitiveness of direct-seeded rice (*Oryza sativa*) genotypes under different weed management practices. Result from the findings revealed that rice varieties vary in their weed competitive ability due to their diverse morphological traits, *viz.* plant height, tillering ability, canopy structure and relative growth rate, etc.

Nargave *et al.* (2020) carried out an experiment to determine the influence of varying environment on rice varieties under upland condition of Madhya Pradesh, India. Data revealed that, at harvest stage, among the varieties Kranti produced significantly highest effective tillers (370 m^{-2}) as compared to Sahbhagi (354 m^{-2}) and IR 36 (341 m^{-2}), while MTU 1010 variety gave lowest effective tillers (330 m^{-2}). Among the varieties, Kranti produced significantly higher length of panicle (24.71 cm) as compared to Sahbhagi (23.53 cm) and IR 36 (22.71 cm), while MTU 1010 exhibited minimum length of panicle (22.19 cm), which was at par to that of IR 36. Among the varieties Kranti recorded significantly higher number of filled grains $panicle^{-1}$ (130) followed by Sahbhagi (123), IR 36 (123) and MTU 1010 (118).

Mrudhula and Rama (2020) carried out an experiment to study the effect of sowing window on growth parameters and yield of different rice varieties in Krishna western delta. Study revealed that all the varieties were also showed significant differences in panicle length under observation. Among the varieties, BPT 2231 showed significantly higher panicle length (22.3 cm) and it was on a par with BPT 2270 (22.2 cm) variety. Significantly the lowest panicle length was observed in BPT 5204 variety (20.3 cm). Such type of variation in physiological parameters among the different varieties might be owing to differences in their parental origin which caused variation in their genetically inheritance for such traits.

Shrestha *et al.* (2020) conducted an experiment to study competitive ability of weedy rice: Toward breeding weed– suppressive rice cultivars. Result revealed that the traits in rice that are likely to be most helpful for weed management and related to weed competitiveness includes; seed size, quicker emergence, plant height, high and early seedling vigour with rapid leaf area development during the early vegetative stage for weed suppression, rapid growth, high tillering ability, orientation of leaves (droopy), high early biomass accumulation rates, high leaf area index , rapid ground cover by canopy, deep and prolific roots, ability to withstand biotic and abiotic stresses, cultivars having an allelopathic effect, early maturity, herbicide-resistance and many more.

Pooja and Saravanane (2021) conducted an experiment to determine the performance of rice cultivars with weed management practices in dry direct-seeded rice. Data from the study revealed that cultivars and weed management influenced the growth, yield parameters and yield except plant height under cultivars. ADT 46 has recorded better growth, yield parameters and in turn, resulted in 19 and 31% higher rice yield compared to Co 52 and WP. This might be due to better weed competitive environment prevailed under ADT 46.

Zaman *et al.* (2022) carried out an experiment to study the effect of variety and weed management on the yield performance of Boro rice. Study revealed that the number of grains panicle^{-1} was significantly influenced by different varieties. The highest no. of grains panicle^{-1} (99.92) was observed in V_2 (BRRI dhan58) and the lowest (93.53) was observed in V_1 (BRRI dhan50). Differences in the number of grains panicle^{-1} were due to varietal difference which was also reported by BRRI. The number of grains panicle^{-1} varied significantly among the weed management practices. The highest number of grains panicle^{-1} (104.18) was found with application of pre-emergence herbicide + post-emergence herbicide. The lowest one (87.53) was found in with no weeding.

Kheya *et al.* (2023) carried out an investigation to study integrated nitrogen management on weed growth and yield performance of transplant Aman Rice. Result revealed that Binadhan-7 produced the highest grain yield (4.42 t ha^{-1}) than the other varieties and BRRI dhan 66 produced the lowest grain yield (3.87 t ha^{-1}). Similarly, Binadhan-7 produced the highest straw yield (5.47 t ha^{-1}), which was similar with rest of the varieties except BRRI dhan 75 which produced the lowest straw yield (5.03 t ha^{-1}). This was might be due to genetic heredity of the cultivars.

2.6 Effect of cultivar on weed

Mishra *et al.* (2016) conducted an experiment to study weed management in major crops. Data from the study revealed that cultivars play an important role in crop-weed competition because of their diverse morphological traits, canopy structure and relative growth rate. A quick growing and early canopy cover enables a cultivar to compete better against weeds.

Raj and Syriac (2017) revealed from the finding weed management in direct seeded rice: a review that in general, there are two aspects of cultivar competitiveness, weed suppression and weed tolerance ability. Weed tolerance is the ability to maintain high yields despite weed pressure while weed suppression is the ability of cultivar to reduce seed production in weeds or to suppress the weed growth via competition.

Ramesh *et al.* (2017) conducted an investigation to determine the role of crop competition in managing weeds in rice, wheat, and maize in India. Data from the study revealed that cultivars within a crop species vary considerably in their competitiveness with weeds. Morphological and physiological traits of a strongly competitive crop will enable it to capture resources from a weed and utilize them more efficiently. The use of competitive crop cultivars may therefore be considered as an important component for integrated weed management.

Sardana *et al.* (2017) revealed from the findings entitled role of competition in managing weeds: An introduction to the special issue that development and use of competitive cultivars in crops will reduce the need for mechanical weed control, besides reduction in herbicide load and ultimately cost of production.

Shekhawat *et al.* (2020) determined from weed management in dry direct seeded rice: A review on challenges and opportunities for sustainable rice production that morphological, physiological and biochemical traits collectively control plants competitiveness. Use of strong weed competitive cultivars is a low cost and environmentally safe strategy for weed management.

Dhillon *et al.* (2021) conducted an experiment to study the seed priming with potassium nitrate and gibberellic acid enhances the performance of dry direct seeded rice (*Oryza sativa* L.) in North–Western India. Data revealed from the study that weed competitive cultivars are characterized by higher early vigour, higher leaf-area and biomass accumulation, rapid ground cover by canopy, deep and prolific roots, more tillering ability, taller plant, early maturity and allelopathy.

Harish *et al.* (2022) conducted a field experiment to study the productivity, profitability nutrient uptake and soil health of boro rice as influenced by cultivars and herbicides. Result from the data revealed that rice cultivars with weed-suppressing characters are an important aspect to manage weeds in direct seeding of rice (DSR).

Hashim *et al.* (2022) conducted an experiment to study herbicidal weed-management options for dry direct-seeded rice (*Oryza sativa*) in North-Eastern Plains of India. Result from the data revealed that the weed-control efficiency varied with the varieties. Among the varieties, 'Inglongkiri' showed the highest weed-control efficiency at all growth stages over 2 years. Higher weed-control efficiency was observed with the application of pretilachlor followed by mechanical weeding at early stages during both the years and oxadiargyl followed by mechanical weeding during the later growth stages of rice in the first year.

2.7 Economic analysis

Dass *et al.* (2017) from the findings titled weed management in rice using crop competition. It revealed that highest gross return Rs. 125103.2 Rs. ha^{-1} recorded with Hand weeding (20 and 40 DAT) and highest net return Rs. 85577 ha^{-1} also recorded with pretilachlor @ 1.25 kg ha^{-1} (PE) + bispyribac sodium @ 25g a.i ha^{-1} (POE). However, the highest benefit: cost ratio 2.21per rupee invested was recorded from pretilachlor @ 1.25 Kg ha^{-1} (PE) + bispyribac sodium @ 25g a.i ha^{-1} (PoE).

Tiwari *et al*. (2018) conducted an investigation to evaluate effect of sowing dates on physiological parameters, productivity and economical gain of different rice varieties under rainfed condition in case of rice varieties, PS-3 proved its superiority by giving highest net income up to Rs. 49778 ha^{-1} with B:C ratio 3.55. However, the second equally best variety was PS-5 giving net income up to Rs. 48652 ha^{-1} with B:C ratio 3.49. The third best variety was IR-

64 nearly giving net income up to Rs. 39.485 ha^{-1} with B:C ratio 3.04. This was followed by Danteshwari and then Vandana giving lowest net income up to Rs. 25504 ha^{-1} in related to the crop productivity and the gross income received.

Mukherjee (2019) conducted an investigation to evaluate the effect of various crop establishment methods and herbicides on growth and yield of rice. Data from the evaluation revealed that due to the integration of selective herbicide with hand weeding it effectively controlled weeds, reduced competition and improved rice yield. This, along with the relatively lower costs of weeding, translated to significantly higher gross returns, net returns and B:C ratios compared to the weedy check and sole herbicide applications which involved higher costs but were less effective in improving yield. Therefore, integrating herbicide with hand weeding proved to be the most economically viable weed management option.

Singh *et al.* (2019b) conducted an experiment to determine efficacy of pendimethalin and cyhalofop–butyl + penoxsulam against major grass weeds of direct–seeded rice. Result from data revealed that cultivars and weed management practices markedly influenced economics during both the years. Among cultivars, Arize 6129 performed significantly better in terms of gross returns (65963 and 63365/ ha), net returns (40402 and 37804 ha^{-1}), and benefit: cost ratio (1.61 and 1.51) and economic efficiency (316 and 298 ha^{-1} day^{-1}) over rest of treatments. The lowest values of these attributes were recorded with Sarjoo 52. This might be due to the better yield and net returns associated with respective treatment.

Dangol *et al*. (2020) determined to study the effects of different weed management practices on growth and yield of direct-seeded spring rice in Jhapa, Nepal. Result from the study revealed that weed is major concern in direct seeding of rice (DSR). Improper management if weed in Direct seeded rice led to severe loss in the yield and less economic returns.

Salam *et al.* (2020) conducted an investigation to study effect of weed management on the growth and yield performances of Boro rice cultivars. From the economic analysis of the study, it is observed that the highest B:C ratio was obtained from BRRI dhan29 with application of pre-emergence herbicide followed by one hand weeding at 40 DAT which was close to BRRI dhan29 with application of early post emergence herbicide, BRRI dhan74 with application of pre-emergence herbicide and BRRI dhan74 with application of early post emergence herbicide.

Bhattacharya *et al*. (2022) conducted a field experiment response of rice (*Oryza sativa* L.) to weed management methods in the lower Gangetic plain zone. Result from the findings revealed that significantly higher net return was observed in those treatments in which weed control measures were adopted twice during the crop growth period. Highest yield achieved in the said treatment contributed to the highest net return and B:C. This was followed by treatment receiving two hand weeding's at 25 DAT and 50 DAT with the untreated control treatment recording lowest net return (Rs. 32369.33 ha^{-1}).

Kumari *et al*. (2023b) conducted an investigation to evaluate integrated weed management on weed dynamics, crop growth and yield of direct seeded rice. Data on economics revealed that the highest gross returns (Rs. 85228 ha^{-1}) was obtained with 3 hand weeding at 25, 40 and 55 DAS but also higher cost of cultivation in 3 hand weeding at 25, 40 and 55 DAS may be due to engagement of more laborers for weeding.

CHAPTER III

MATERIALS AND METHODS

MATERIALS AND METHODS

This chapter describes the details of the materials used and research methodology adopted during the entire course of experimentation to study the "**Performance of black rice cultivars to integrated weed management in Nagaland conditions"**.

3.1 GENERAL INFORMATION

3.1.1 Site of experiment

The experiment was carried out in the experimental farm of the School of Agricultural Sciences (SAS), Medziphema campus, Nagaland University during the *kharif* season of 2021 and 2022. The experimental farm is located in the foothill of Nagaland with the geographical location of 20˚45'43" N latitude and 93˚53'04" E longitude at an altitude of 310 m above mean sea level.

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 mean temperature ranges from 21ºC to 32 ºC during summer and rarely goes below 8ºC in winter due to high atmospheric humidity. The detailed information on meteorological data recorded during the experiment is presented in Table 3.1(a) and Table 3.1 (b) and illustrated in Fig 3.1 (a) and Fig 3.1 (b).

Table 3.1(a) Meteorological data recorded during the cropping season (2021)

Week No.	Temperature		Relative humidity		Rainfall (mm)	Rainy days	Sunshine hours
	Max (˚C)	Min (˚C)	Max (%)	Min (%)			
22	33.1	22.9	91	61	17.4	1	4.4
23	33.5	23.6	91	63	39.1	1	2.8
24	33.0	24.7	93	75	19.5	3	3.8
25	33.0	24.5	93	67	43.4	4	4.3
26	33.0	25.0	92	69	37.6	1	1.9
27	33.1	24.7	88	73	19.2	2	2.5
28	32.4	24.6	92	70	105.7	5	3.9
29	33.6	24.6	94	69	53.3	2	3.9
30	34.4	24.8	89	70	74.9	2	6.6
31	32.2	25.1	91	78	34.0	3	3.9
32	33.2	24.5	92	67	25.2	3	3.4
33	32.4	24.9	95	77	41.8	2	1.6
34	32.3	24.2	91	67	7.0	0	3.2
35	32.3	24.2	92	72	52.9	4	3.0
36	33.1	24.0	94	68	49.1	3	6.5
37	33.7	23.9	93	67	42.2	1	5.8
38	32.1	23.3	94	67	13.1	2	5.0
39	33.7	23.7	93	66	8.1	2	7.1
40	32.2	23.0	94	71	5.0	1	5.0
41	33.8	23.5	91	62	53.8	2	7.8
42	33.3	23.6	95	70	69.1	3	5.4
43	29.9	18.9	96	71	2.1	0	7.2
44	30.0	19.0	95	57	0	0	7.5
45	29.4	15.2	96	49	0	0	8.4
46	28.6	16.3	94	54	0	0	7.5
47	27.7	13.3	96	49	0	0	8.0
48	26.9	11.4	95	45	0	0	7.9
49	26.4	15.2	95	57	8.5	1	5.0
50	25.3	11.6	94	51	0	0	6.7
51	24.9	8.9	95	46	4.7	1	6.7
52	23.3	9.6	96	50	3.2	1	6.2

Source: ICAR Research Centre for NEH Region, Nagaland Centre, Medziphema

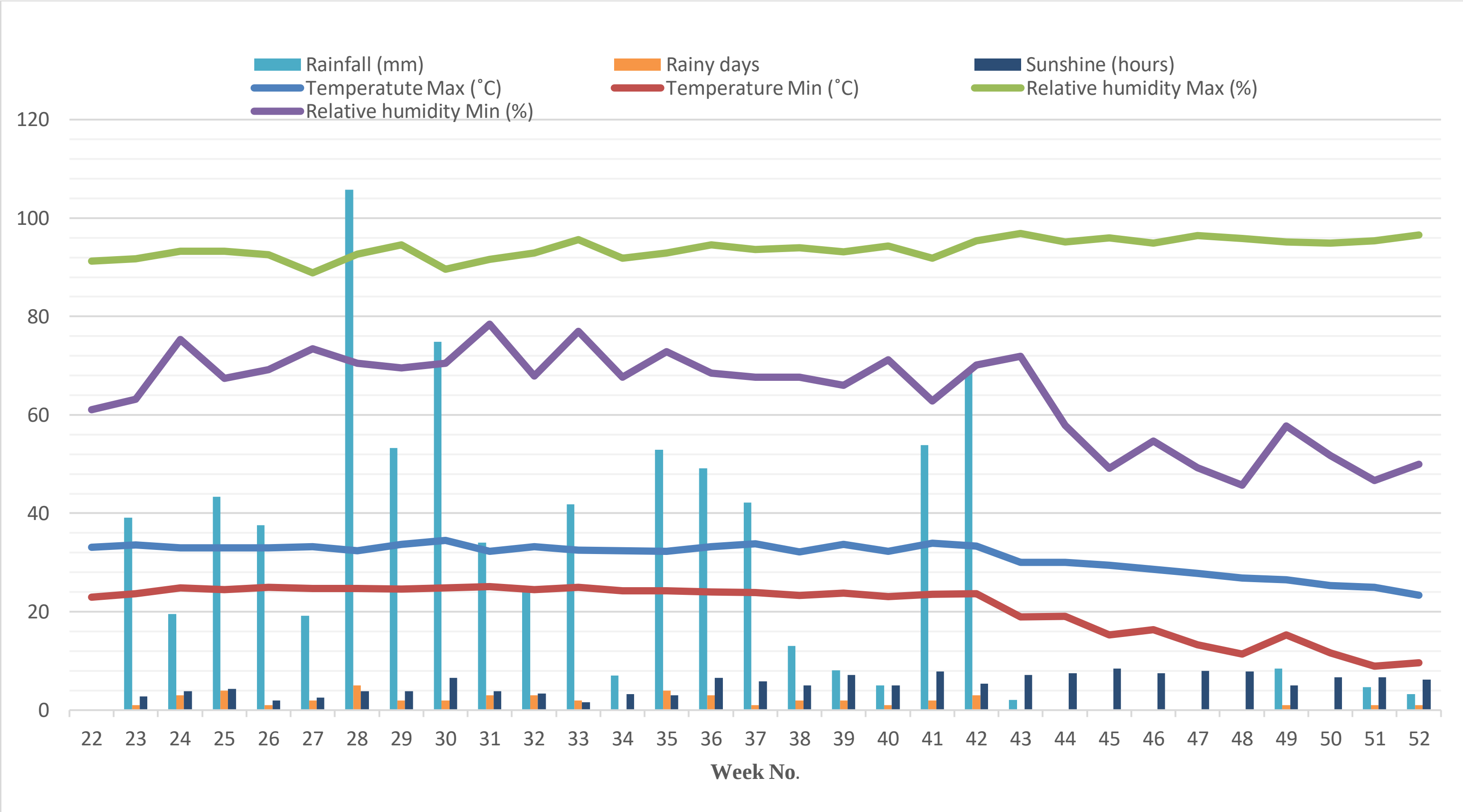


Fig 3.1(a) Graphical representation of meteorological data during crop growing season (*Kharif* 2021)

Table 3.1(b): Meteorological data recorded during the cropping season (2022)

Week No.	Temperature		Relative humidity		Rainfall (mm)	Rainy days	Sunshine hours
	Max (˚C)	Min (˚C)	Max (%)	Min (%)			
22	33.3	23.3	93	65	22.5	2	4.8
23	33.0	24.0	94	74	51.1	4	2.9
24	30.3	23.3	95	74	46.7	4	1.3
25	31.2	23.4	95	75	34.8	3	1.8
26	33.3	24.9	93	68	9.9	2	4.5
27	34.2	24.7	91	66	77.1	3	7.2
28	34.1	24.5	90	69	22.9	3	6.9
29	33.9	24.5	92	75	135.3	4	3.4
30	31.8	23.2	96	70	135.3	5	3.6
31	33.6	23.9	93	68	48.8	2	3.1
32	33.3	23.9	96	71	114.7	5	5.1
33	33.6	24.2	91	72	27.5	2	6.1
34	34.1	24.5	94	68	64.2	1	4.1
35	32.7	24.3	93	68	9.0	1	4.6
36	33.4	24.4	89	67	21.7	2	4.9
37	31.9	23.5	91	72	42.8	3	4.1
38	33.5	24.0	91	65	15.3	2	5.6
39	32.8	23.2	91	70	81.2	2	6.3
40	31.9	23.5	95	74	31.0	3	4.4
41	31.8	22.7	91	71	2.9	1	5.0
42	30.9	20.6	94	65	19.7	3	5.9
43	28.1	19.9	95	71	41.0	2	4.7
44	29.8	17.1	96	60	0	0	8.0
45	29.3	16.7	96	57	0	0	8.2
46	27.9	14.6	98	56	0	0	8.2
47	27.7	12.8	96	52	0	0	8.0
48	27.8	14.3	96	67	0	0	7.4
49	27.6	12.0	95	49	0	0	8.0
50	26.4	11.3	96	50	0	0	7.0
51	25.7	11.0	96	51	0.2	0	6.4
52	22.7	11.2	97	60	15.2	1	3.9

Source: ICAR Research Centre for NEH Region, Nagaland Centre, Medziphema

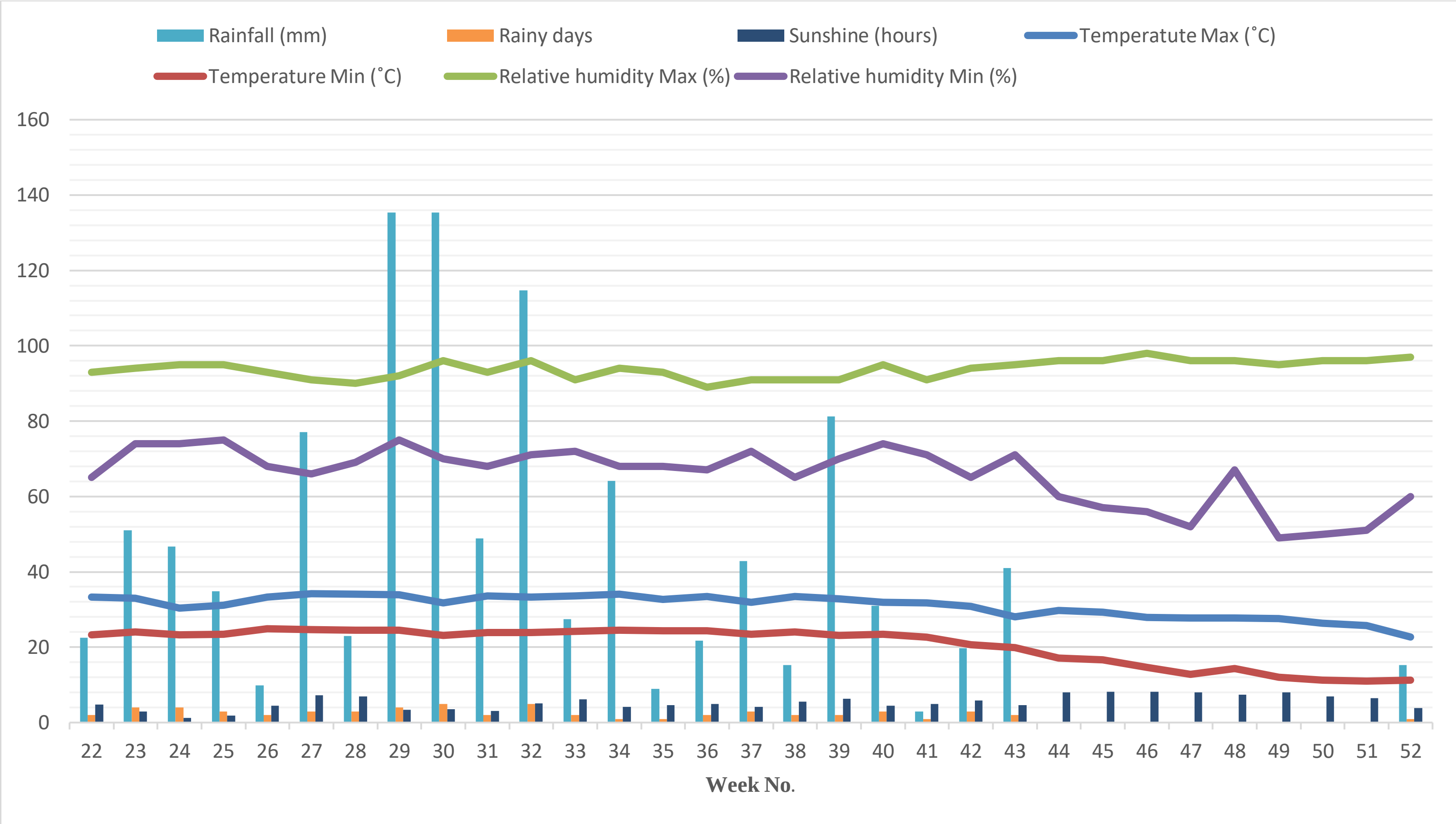


Fig 3.1(b) Graphical representation of meteorological data during crop growing season (*Kharif* 2022)

3.1.3 Soil Condition

The soil condition of the experimental plot was grouped as clayey loam. The fertility status of soil was determined by collecting soil samples randomly from each experimental plot taken at a depth of 0-15 cm. The samples were then mixed, air dried, grinded and sieved for analysis following standard procedures as mentioned in Table 3.2.

Table 3.2: Initial soil fertility status of the experimental field

Characteristics	**Method followed**	**2021**		**2022**	
		Status	**Remark**	**Status**	**Remark**
Soil pH	Digital pH meter (Jackson,1973)	4.73	Strongly acidic	4.75	Strongly acidic
Electrical conductivity (dS m^{-1})	Solubridge method (Richard, 1954)	0.21	Normal	0.22	Normal
Organic carbon (%)	Titrimetric determination (Walkley and Black method,1934)	1.49	High	1.52	High
Available N (kg ha^{-1})	Alkaline potassium permanganate method (Subbiah and Asija, 1956)	252.09	Low	250.55	Low
Available P (kg ha^{-1})	Bray’s No. 1 method (Bray and Kurtz, 1945)	34.51	High	34.88	High
Available K (kg ha^{-1})	Neutral normal ammonium acetate method (Hanway and Heidal, 1952)	148.63	Medium	148.21	Medium

3.2 DETAILS OF THE EXPERIMENT

3.2.1 Design and experimental layout

The experiment was conducted in split plot design with three replications, three main treatments and five sub-plot treatments. The whole experimental field was divided into three equal size blocks and each block was subdivided into three main blocks to accommodate the main factors and each main plot was further sub-divided into six sub-plots to accommodate the sub factors. Altogether there were 45 plots with each plot sizes of 4 m × 3 m. The layout plan of the experimental field is presented in Fig 3.2.

Details of the experiment are as follows:

Crop	*Oryza sativa* L.
Design of the experiment	Split Plot Design (SPD)
Number of Replications	3
Number of treatments	16
Total number of plots	48
System of cultivation	Dry direct seeding (Upland)
Gross plot	4 m x 3 m
Net plot size	3.2 m x 2.4 m
Spacing	20 cm x 10 cm
Block border	1 m

Plot border	0.5 m
Length of the experimental field	57.5 m
Width of the experimental field	16 m
Total area of the experimental field	920 m^2

3.2.2 Treatment details

Four integrated weed management and four different cultivars were assigned in main and sub-plot respectively. The detailed description of the treatments and their corresponding symbols are as given below:

A. MAIN PLOT	**B. SUB-PLOT**
Weed management	**Cultivar**
W_1: Weedy check (Control)	C_1: *Chakhao Poireiton*
W_2: Hand weeding (15 and 30 DAS)	C_2: *Chakhao Amubi*
W3: Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	C_3: *Wairi Chakhao*
W4: Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	C_4: *Khurukhul Chakhao*

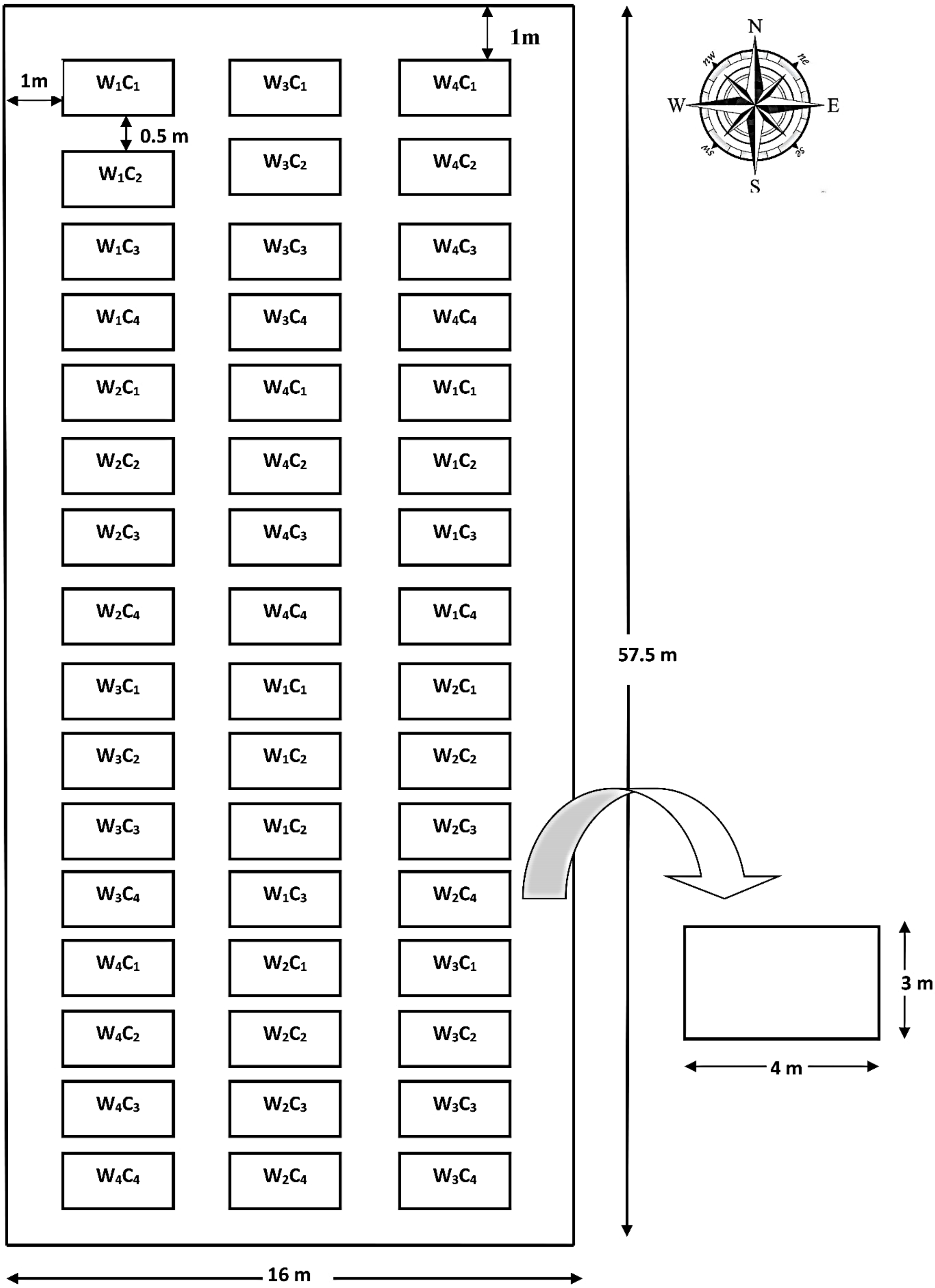


Fig 3.2 Layout of the experimental field in Split Plot Design

3.2.3 Source of seed

The four black rice cultivars utilized in this study were obtained from Mr. Potsangbam Devakanta, a renowned awardee for his exceptional contributions to the conservation of diverse rice landraces in Manipur. *Chakhao*, a distinctive black rice variety, is characterized by a variety of traits like plant: height, number of panicles, number of days to flowering, physiological maturity and maturity; leaf: length and width; panicle: length, weight and density; grain: length, weight, colour and stickiness and aroma: aromatic or non-aromatic.

3.2.4 Treatment Combinations

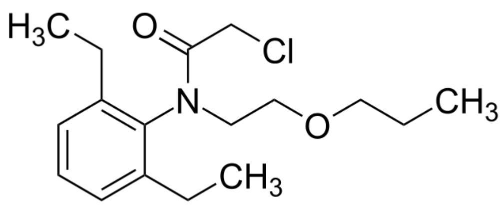
A total of 16 treatment combinations as obtained from the multiplication of four main factors and four sub-factors.

$W_1 C_1$	$W_2 C_1$	$W_3 C_1$	$W_4 C_1$
$W_1 C_2$	$W_2 C_2$	$W_3 C_2$	$W_4 C_2$
$W_1 C_3$	$W_2 C_3$	$W_3 C_3$	$W_4 C_3$
$W_1 C_4$	$W_2 C_4$	$W_3 C_4$	$W_4 C_4$

3.2.5 Herbicide used

a. <u>Pretilachlor</u>

Structural formula:



Chemical Name: 2-chloro-N-(2,6-diethylphenyl)-N-(2-propoxyethyl) acetamide

Molecular formula: $C_{17}H_{26}ClNO_2$

Active ingredient: 95%, 97%, 98% min.

Molecular weight: 311.9 g mol-1

Group: Acetamide

Appearance: Colorless liquid

Melting point: -20°C

Boiling point: 4420C at 760 mm Hg

Solubility: 0.50gl^{-1} in water, Miscible in benzene, methane, methanol, dichloromethane n-hexane

Corrosive properties: Corrosive to iron

Dosage form: 72% missible oil, 50% missible oil, 30% missible oil

Pretilachlor Formulations: 50%w/v EC, 30%w/v EC, 360g l^{-1} EC

Pretilachlor Application: Pretilachlor is 2-chloro-aceba nilide selective herbicide.

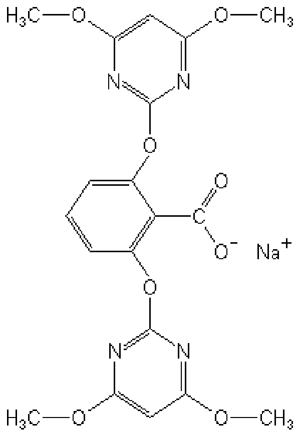
Mode of action: It involves inhibiting the biosynthesis of fatty acids in the target weeds. Specifically, it interferes with the Acetyl-CoA carboxylase (ACCase) enzyme, which plays a crucial role in fatty acid synthesis.

Uses: It is used either as pre-emergence or early post-emergence to control annual grasses and broad leaf weeds but mainly used as a grass killer in transplanted rice. It is selective broad spectrum pre-mergence herbicide for use in early season in transplanted rice with cell division inhibitor as mode of action.

Manufacturer: Indogulf crop sciences ltd.

b. <u>Bispyribac-sodium</u>

Structural formula



Chemical name: 2,6-Bis[(4,6-dimethoxy-2-pyrimidinyl) oxy]-benzoate

Molecular Formula: $C_{19}H_{17}N_4NaO_8$

Molecular Weight: 452.35 g mol^{-1}

Group: Pyrimidinalthiobenzoate

Physical form: White powder.

Density: Bulk density 0.0737 (20 °C, CIPAC MT 3)

Melting point: 223-224 °C

Boiling point: Decomposes before boiling

Solubility: In water 73.3 gl^{-1} (25°C).

Stability: Stable in water; DT50 >1 y (pH 7 - 9), 448 h (pH 4).

Mode of action: The mode of action for bispyribac-sodium is to inhibit the enzyme acetolactate synthase (ALS) and the subsequent biosynthesis of essential amino acids, which in turn interferes with cell division and causes cessation of plant growth, leading to chlorosis, necrosis, and death of sensitive plants.

Uses: Bispyribac-sodium is used for controlling of grasses, sedges and broadleaved weeds, especially *Echinochloa* spp. (Barnyard-grass), in direct-seeded rice, at rates of 15-45 g ha^{-1}. It is also used to stunt growth of weeds in non-crop situations.

Toxicity to mammals: Acute oral LD50 for male rats 4111, female rats 2635 mg kg^{-1}, male and female mice 3524 mg kg^{-1}. Acute percutaneous LD50 for rats >2000 mg kg^{-1}.

Purity: The minimum purity of bispyribac-sodium as manufactured should not be less than 930 g kg^{-1}.

Manufacturer: Seino Logix Co. Ltd.

3.3 CULTIVATION DETAILS

3.3.1 Field preparation and layout

Initially the upland experimental field was ploughed by tractor drawn mould board plough during the last week of June which was followed by harrowing using a disc harrow. This was followed by removal of stubbles and weeds and planking was carried out thereafter. After planking, with the help of measuring tape, pegs and rope the experimental plots were laid out in the field as per the statistical design (Split plot design). The plot consisted of four main plots and four sub plots respectively. There were 48 plots in total with each plot having gross plot size of 4m x 3m. Figure 3.2 depicts the layout of the experiment.

3.3.2 Manure and Fertilizer application

Well decomposed FYM @ 2.5 t ha^{-1} was applied uniformly over the entire experimental field and mixed thoroughly during the final land preparation in both the years. The recommended dose of fertilizer (RDF) at 60-40-40 kg NPK ha^{-1} in the form of urea, single super phosphate and muriate of potash were applied in all the plots irrespective of the treatment under study. Nitrogen was applied in split dose with half being applied during sowing along with the full dosage of phosphatic and potassic fertilizers while the remaining nitrogen was top-dressed during tillering.

3.3.3 Seed treatment and method of sowing

The seeds of four different cultivars were soaked in water separately and the empty floating seeds were discarded after which it was allowed to be soaked for about 12 hours. The soaked seeds were then treated with bavistin at 2 g kg^{-1} seed and were then transferred into a gunny bag which was allowed to be kept for 24 hours before sowing. The seeds were then sown in lines with seed rate of 80 kg ha^{-1} maintaining a spacing of 20 cm from row to row and 10 cm between plant to plant.

3.3.4 Weeding and herbicide operation

As per the treatment, pretilachlor (50 EC) @ 1 kg ha^{-1} was applied on the same day of sowing and bispyribac sodium (10% SC) @ 25 g ha^{-1} was applied at twenty days after sowing with flat fan nozzle using 500 litres of water per hectare. Hand weeding was done manually at 15, 30 and 40 DAS as per the requirement in the plots of the respective treatments.

3.3.5 Harvesting, threshing and winnowing

Maturity of the crop was evaluated based on the visual appearance and harvesting was done once the panicles turned golden yellow and attained proper maturity. The crop was harvested plot wise with the help of sickles which was then sundried, threshed and winnowed manually. The grain and straw were then carefully bundled, tagged, sundried, weighed and recorded treatment wise.

3.4 OBSERVATION ON DATA

3.4.1 GROWTH ATTRIBUTES

Three hills were randomly selected and tagged in each plot. Their growth attributes were recorded.

3.4.1.1 Plant height (cm)

Plant height was measured from the base of the plant to the tip of the topmost leaf prior to panicle emergence and to the tip of the tallest panicle after emergence from the randomly tagged plants in centimeters from each plot and average value was recorded at 30, 60, 90 DAS and at harvest.

3.4.1.2 Leaf Area Index

Leaf area plant^{-1} was measured by leaf area meter (LICOR Model LI 3100). Based on the leaf area plant^{-1}, LAI was worked out with the concept proposed by Watson (1947). Leaf area index (LAI) was recorded at 30, 60 and 90 DAS by using the following formula:

$$\text{LAI} = \frac{\text{Total leaf area}(\text{cm}^2)}{\text{Ground area }(\text{cm}^2)}$$

3.4.1.3 Number of plants m^{-2}

The number of plants m^{-2} from randomly selected row was recorded at 30, 60 and at harvest in each plot excluding the borders.

3.4.1.4 Dry matter accumulation (g plant^{-1})

Dry matter accumulation was taken at 30, 60 and 90 DAT by uprooting three randomly selected plants from each treatment plot excluding the border rows. After removal of root portion, the samples were then sun dried and oven dried at 65˚C for 48 hours. When the plant samples attained constant weight, the dry matter accumulation was recorded in g plant^{-1}.

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

Crop growth rate (CGR) was worked out at 30-60 DAT and 60-90 DAT using the dry matter accumulation of plants by adopting the formula given by Watson (1952).

$$CGR = \frac{W_2 - W_1}{(t_2 - t_1)S} \text{ g m}^{-2} \text{ day}^{-1}$$

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

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

Relative growth rate was recorded at 30-60 DAT and 60-90 DAT using the dry matter accumulation of plant and calculated by using the formula given by Radford (1967).

$$RGR = \frac{\ln W_2 - \ln W_1}{(t_2 - t_1)} \text{ g g}^{-1} \text{ day}^{-1}$$

Where, W_1 and W_2 are plant dry weight at time t_1 and t_2 respectively.

3.4.2 PHENOLOGY

3.4.2.1 Days to 50% flowering

Days to 50% flowering was recorded from each plot by counting the number of days from the date of sowing consecutively till the date when 50% of the plants flowered.

3.4.2.2 Days to 50% physiological maturity

Days to 50% physiological maturity was recorded by counting the number of days from the date of sowing till the date when 50% of the plants matured and turned golden yellow in colour.

3.4.2.3 Days to maturity

Days to maturity was observed visually and recorded from each plot when around 90% of the panicles have attained maturity.

3.4.3 YIELD ATTRIBUTES

3.4.3.1 Number of panicles m^{-2}

Number of panicles m^{-2} was counted in each plot excluding the border rows.

3.4.3.2 Length of panicle (cm)

Length of panicle was worked out by measuring the length (cm) of five random panicles from the tagged plants and the average length was recorded. It was measured from the neck node to the tip of the topmost grain.

3.4.3.3 Weight of panicle (g)

Five randomly selected panicles from each plot were weighed and the average value was recorded.

3.4.3.4 Number of grains panicle^{-1}

Number of grains panicle^{-1} was counted from five randomly selected panicles from each plot and the average value was recorded.

3.4.3.5 Grain filling percentage (%)

Five panicles were randomly selected and the number of fertile and unfertile grains per panicle was counted and thereafter calculated using the given formula. The average was then recorded.

$$\text{Grain filling percentage (\%)} = \frac{\text{Number of filled grain per panicle}}{\text{Total number of grains per panicle}} \times 100$$

3.4.3.6 Test weight (g)

From the grain yield of individual plot, test weight was taken randomly by counting thousand grains.

3.4.3.7 Grain yield (kg ha^{-1})

The grains from each plot after threshing were winnowed manually. The grains separated after threshing were sundried to bring down moisture content to 14 % and thereafter the weight of the grain was recorded plot wise and expressed in kg ha^{-1} using the formula:

$$\text{Grain yield (kg ha}^{-1}\text{)} = \frac{\text{Weight of the grain per plot (kg)}}{\text{Size of the plot}(\text{m}^2)} \times 10000$$

3.4.3.8 Straw yield (kg ha^{-1})

The straws collected from each plot after threshing of grains were sundried properly and the weight was recorded and expressed in kg ha^{-1} using the formula:

$$\text{Straw yield (kg ha}^{-1}\text{)} = \frac{\text{Weight of the straw per plot(kg)}}{\text{Size of the plot}(\text{m}^2)} \times 10000$$

3.4.3.9 Biological yield (kg ha^{-1})

Biological yield was calculated by using the formula:

$$\text{Biological yield (kg ha}^{-1}\text{)} = \frac{\text{Weight of the grain+straw per plot(kg)}}{\text{Size of the plot}(\text{m}^2)} \times 10000$$

3.4.3.10 Harvest index (%)

Harvest index was calculated by using the formula given by Donald (1962).

$$\text{Harvest index (\%)} = \frac{\text{Economic yield(grain yield)}}{\text{Biological yield(grain+straw yield)}} \times 100$$

3.4.4 QUALITY PARAMETERS

3.4.4.1 Milling percentage (%)

Grain sample of 1 kg was hulled, milled and the weight of milled rice was recorded from each treatment. Milling percentage was calculated by using the formula Ghosh *et al.* (1971).

$$\text{Milling percentage} = \frac{\text{Weight of milled rice(g)}}{\text{Weigh of rough rice(g)}} \text{ x } 100$$

3.4.4.2 Hulling percentage (%)

100 g sample of unhusked rice from each plot were collected and dehusked. The dehusked rice was weighed and percentage was determined by the following formula (Ghosh *et al.*1971).

$$\text{Hulling percentage} = \frac{\text{Weight of brown rice(g)}}{\text{Weigh of rough rice(g)}} \text{ x } 100$$

3.4.4.3 Head rice recovery (%)

After milling, the milled rice was passed through 5 mm sieve to separate the whole and broken grains and the weight of whole grains were recorded from each treatment. The percentage head rice recovery was calculated using the formula (Ghosh *et al.*1971).

$$\text{Head rice recovery (\%)} = \frac{\text{Weight of whole polished rice(g)}}{\text{Weigh of rough rice(g)}} \text{ x } 100$$

3.4.4.4 Protein content (%)

Protein content in grain was worked out by using the formula.

$$\text{Protein content (\%)} = \text{\% N content} \times 6.25$$

3.4.4.5 Organoleptic analysis

Dry milled head rice (300 g each) of all the cultivars were rinsed twice and cooked in pressure cooker keeping 1:1.5 water to rice ratio. After the rice were cooked, it was allowed to cool for 10 minutes and the organoleptic test were conducted for the appearance, cohesiveness, tenderness on touching, tenderness on chewing, taste, aroma, elongation and overall acceptability of cooked rice and evaluated by fifteen assessors using the above descriptive analysis Lestari *et al.* (2009).

3.5 OBSERVATION ON WEEDS

3.5.1 Weed flora

The weed flora present in the experimental field was surveyed periodically and identified to assess the species composition.

3.5.2 Weed population (no.m^{-2})

Weed population of each plot was counted with the help of a quadrate of 1 m^2 randomly and average weed population m^{-2} was recorded. Observations were recorded at 20, 40 and 60 DAS. The population of grasses, sedges and broad leaf weeds were counted category wise from the same quadrate and subjected to square root transformation. The weed data was subjected to square root transformation before statistical analysis with the help of the formula $\sqrt{x} + 0.5$, where x is the actual weed count.

3.5.3 Weed dry weight (g m^{-2})

The weed samples collected in each quadrate were washed, sundried and finally oven dried at 105^{o} C for 48 hrs. The weight of the weed samples was recorded at 20, 40 and 60 DAS after it attained a constant weight.

3.5.4 Weed control efficiency (%)

Weed control efficiency (WCE) was calculated by using the formula,

$$\text{WCE (\%)} = \frac{\text{DWC} - \text{DWT}}{\text{DWC}} \times 100$$

Where,

DWC = Dry weight of weeds per unit area in control plots

DWT = Dry weight of weeds in treated plots to be compared

3.6 CHEMICAL ANALYSIS

3.6.1 SOIL ANALYSIS

Soil samples after the harvest of the crop were collected treatment wise from the experimental field to determine the nutrient status of the soil. The sample were analysed for pH, EC, organic carbon, available nitrogen, available phosphorus and available potassium.

3.6.1.1 Soil pH

Soil pH was determined in soil: water (1:2) ratio by Glass electrode method Jackson (1973).

3.6.1.2 EC (dsm^{-1})

EC of the soil sample was determined in soil-water suspension (1:2) at room temperature by conductivity meter Jackson (1973).

3.6.1.3 Organic carbon (%)

Organic carbon was determined by rapid titration method (Walkley and Black, 1934) and the results were expressed in terms of percentage.

3.6.1.4 Available Nitrogen (kg ha^{-1})

The available nitrogen of soil was determined by alkaline potassium permanganate ($KMnO_4$) method proposed by Subbiah and Asija (1956) with the help of 'Kel Plus' nitrogen distillation machine. The data was calculated in terms of kg ha^{-1}.

3.6.1.5 Available Phosphorus (kg ha^{-1})

The available soil phosphorus was determined by Bray's No. 1 method proposed by Bray and Kurtz (1945) using 0.03 N NH_4F + 0.025 N HCL (pH 3.5) as extracting solution. In the filtered extract, phosphorus was estimated colorimetrically by adding ammonium molybdate and stannous chloride. The intensity (% transmittance) of characteristics blue colour in the solution gives the measure for the concentration of P in the test solution, which was read in the spectrometer at 660 nm wavelength. After getting % transmittance of the P in the test solution, concentration of P was read from the standard curve. The results were expressed in kg ha^{-1}. This method is primarily meant for soils which are moderate to strong acids with pH around 5.5 or less.

3.6.1.6 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 5 minutes and the extract was filtered immediately through a dry filter paper (Whatman No. 1) and then potassium concentration in the extract was determined using Flame Photometer Hanway and Heidal (1952). It was expressed in terms of kg ha^{-1}.

3.6.2 PLANT ANALYSIS

3.6.1 N, P and K content in weeds

Randomly selected weed samples were collected treatment wise for chemical estimation. Weed samples were air-dried and oven dried at a temperature of 65°C and grinded. The samples were then analyzed for nitrogen by modified Kjeldahl's method Jackson (1973), phosphorus by di-acid digestion and yellow colour development method Jackson (1973) and potassium by flame photometric method Jackson (1973).

3.6.2 N, P and K depletion by weeds

Weed samples were drawn from each plot at 60 DAT of crop for determination of N, P and K content in weed plant. Collected samples were dried and grinded thoroughly and analyzed as per standard procedure of modified Kjeldahl method for N, Vanadomolybdo-phosphoric yellow colour method Jackson (1973) for P and flame photometric method for K as suggested by Jackson (1973).

$$\text{Nutrient depletion (kg ha}^{-1}\text{)} = \frac{\text{Nutrient (\%)in weeds x weed dry matter production kg ha}^{-1}}{100}$$

3.6.3 N, P and K content and uptake in grain and straw

Randomly selected plant samples were collected treatment wise for chemical estimation. Straw and grains were separated, air-dried and finally oven dried at a temperature of 65°C and grinded. Seed and straw samples were analyzed for nitrogen by modified Kjeldahl's method Jackson (1973), phosphorus by di-acid digestion and yellow colour development method Jackson (1973) and potassium by flame photometric method (Jackson, 1973).

The uptake was further calculated by using the formula

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (\%) in grain or straw x grain or straw yield kg ha}^{-1}}{100}$$

3.7 ECONOMICS

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

3.7.1 Cost of cultivation (₹ ha^{-1})

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

3.7.2 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.

3.7.3 Net return (₹ ha^{-1})

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

Net return= Gross return-total cost of cultivation

3.7.4 Benefit Cost Ratio

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

$$\text{B: C} = \frac{\text{Net returns}}{\text{Cost of cultivation}} \times 100$$

3.8 Statistical analysis

Data obtained from various studies were statistically analyzed in split plot design using the technique of Analysis of Variance as described by Gomez and Gomez (1984). The significance differences were tested by ‘F’ test. Critical difference of different groups of treatments and their interactions at 5 per cent probability level were calculated whenever ‘F’ test was significance.

Field preparation

at 30 DAS

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

at 60 DAS

at maturity

Harvesting and drying

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

C$_1$: *Chakhao Poireiton*

C$_2$: *Chakhao Amubi*

C$_3$: *Wairi Chakhao*

C$_4$: *Khurukhul Chakhao*

Plate 2: Different black rice cultivars at vegetative stage

C_1: ***Chakhao Poireiton***

C_2: ***Chakhao Amubi***

C_3: ***Wairi Chakhao***

C_4: ***Khurukhul Chakhao***

Plate 3: Different black rice cultivars at flowering stage

C$_1$: ***Chakhao Poireiton***

C$_2$: ***Chakhao Amubi***

C$_3$: ***Wairi Chakhao***

C$_4$: ***Khurukhul Chakhao***

Plate 4: Different black rice cultivars at maturity

CHAPTER IV

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

This chapter discusses in detail the results exhibited during the period of two years experiment entitled **“Performance of black rice cultivars to integrated weed management in Nagaland conditions”**. The results of two years (2021 and 2022) that was obtained through the experiment were statistically analyzed, presented and discussed with the help of tables, figures and available literature wherever necessary in this chapter.

4.1 Observations on crop

4.1.1 Growth attributes

4.1.1.1 Plant height (cm)

The data on plant height of black rice recorded at 30, 60, 90 DAS and at harvest are presented in Table 4.1 (a) and Table 4.1 (b).

4.1.1.1.1 Effect of integrated weed management on plant height of black rice

The result pertaining to plant height due to integrated weed management as illustrated in Table 4.1 (a) significantly influenced the plant height of black rice at all the growth stages in both the years. Analysis of data clearly indicated that plant height increased with the age of the crop till the harvest. All the weed management practices were significantly superior with respect to plant height when compared with weedy check at all the stages of observation. Hand weeding at 15 and 30 DAS recorded significantly highest plant height at all stages while the lowest plant height was observed in weedy check. This may be due to the fact that stress free environment gives better weed control ultimately resulting in lower weed density and weed dry weight under the effect of this treatment that may have provided congenial conditions to utilize various inputs that are required for growth more efficiently and resulting in higher plant height of the crop. Similar findings have also been reported by Verma *et al.* (2022). Further, data also revealed that higher plant height was followed by application of pretilachlor @ 1.0 kg ha $^{-1}$ (PE) *fb* HW at 40 DAS and pretilachlor @1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25 g ha^{-1} (PoE) at 20 DAS respectively. Sanodiya and Singh (2021) also opined in their findings that this may have been attributed due to effective control of weeds at critical crop-weed competition resulting in higher availability of nutrients and resulted in higher plant height.

4.1.1.1.2 Effect of cultivars on plant height of black rice

Analysis of data showed that different black rice cultivars showed variations in plant height at different stages of observation in both the years of experiment. At all growth stages highest plant height was recorded with cultivar *Chakhao Poireiton* which was found to be at par with *Chakhao Amubi*. Kumar and Jnanesha (2017) also revealed from his study that the tall cultivars of rice exerted smothering effect on weeds. While data also revealed that at 30 DAS significantly lowest plant height was revealed with cultivar *Wairi Chakhao* and at 60, 90 and at harvest lowest plant height was revealed with *Wairi Chakhao* which was at par with *Khurukhul Chakhao*. Grace *et al*. (2018) opined from the findings of the study that such differences among the different cultivars may be owing to the variation in their parental origin which caused the variation in their genetically inheritance for such traits.

4.1.1.1.3 Interaction effect of integrated weed management and cultivars on plant height

The data depicted in Table 4.1 (b) revealed that interaction of integrated weed management and different cultivars did not show any significant effect on the plant height in both the years.

Table 4.1(a): Effect of integrated weed management and cultivars on plant height (cm) of black rice

Treatment	30 DAS			60 DAS			90 DAS			Harvest		
Weed Management	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
W_1 -Weedy check (Control)	42.66	43.91	43.29	55.15	56.35	55.75	76.44	78.17	77.31	87.01	88.36	87.68
W_2 - Hand weeding (15 and 30 DAS)	70.65	72.03	71.34	83.70	84.67	84.18	100.21	101.99	101.10	110.19	111.22	110.71
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	61.13	62.50	61.82	73.08	73.90	73.49	92.74	93.79	93.26	101.80	103.72	102.76
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	49.61	51.28	50.45	64.96	66.68	65.82	86.05	87.76	86.91	97.85	99.64	98.74
SEm±	0.88	1.10	0.71	1.32	1.18	0.89	1.30	1.36	0.94	1.68	1.88	1.26
CD (P=0.05)	3.06	3.81	2.17	4.57	4.08	2.73	4.49	4.69	2.89	5.80	6.49	3.87
Cultivar												
C_1- *Chakhao Poireiton*	58.28	59.81	59.05	71.41	72.55	71.98	91.69	92.97	92.33	102.04	103.21	102.63
C_2 -*Chakhao Amubi*	56.71	57.98	57.34	69.71	70.93	70.32	89.43	91.46	90.45	100.48	102.09	101.28
C_3 -*Wairi Chakhao*	53.35	54.81	54.08	67.30	68.14	67.72	86.08	87.11	86.59	96.10	97.40	96.75
C_4 -*Khurukhul Chakhao*	55.71	57.13	56.42	68.46	69.98	69.22	88.25	90.18	89.21	98.23	100.24	99.23
SEm±	0.81	0.90	0.60	1.00	1.02	0.72	1.30	1.43	0.97	1.47	1.46	1.04
CD (P=0.05)	2.36	2.62	1.72	2.93	2.98	2.03	3.80	4.16	2.75	4.30	4.26	2.95

Table 4.1(b): Interaction effect of integrated weed management and cultivars on plant height (cm) of black rice

Treatments	30 DAS			60 DAS			90 DAS			Harvest		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	46.02	47.70	46.86	57.89	58.73	58.31	80.38	81.84	81.11	90.96	91.91	91.44
W_1C_2	43.33	44.47	43.90	55.24	56.54	55.89	77.37	79.05	78.21	88.84	90.49	89.67
W_1C_3	39.51	40.45	39.98	53.41	54.35	53.88	72.25	74.14	73.20	82.78	84.55	83.66
W_1C_4	41.78	43.03	42.40	54.05	55.80	54.93	75.78	77.67	76.73	85.46	86.47	85.97
W_2C_1	72.38	74.29	73.34	85.11	86.21	85.66	102.56	104.25	103.40	111.91	112.65	112.28
W_2C_2	71.35	72.38	71.87	84.58	85.02	84.80	100.18	102.73	101.46	110.65	111.79	111.22
W_2C_3	67.95	69.50	68.73	82.00	82.93	82.46	98.18	99.13	98.66	108.91	109.14	109.02
W_2C_4	70.92	71.95	71.44	83.13	84.51	83.82	99.93	101.85	100.89	109.30	111.30	110.30
W_3C_1	63.14	64.78	63.96	74.80	75.69	75.25	94.81	95.30	95.05	104.91	106.41	105.66
W_3C_2	62.02	63.41	62.72	73.98	74.81	74.40	93.07	94.40	93.73	103.26	105.50	104.38
W_3C_3	58.28	59.45	58.87	70.82	71.60	71.21	90.77	91.67	91.22	98.13	99.42	98.78
W_3C_4	61.07	62.37	61.72	72.72	73.49	73.10	92.30	93.81	93.05	100.91	103.57	102.24
W_4C_1	51.58	52.48	52.03	67.86	69.58	68.72	89.00	90.48	89.74	100.39	101.88	101.14
W_4C_2	50.13	51.66	50.90	65.04	67.33	66.19	87.12	89.69	88.40	99.14	100.58	99.86
W_4C_3	47.66	49.84	48.75	62.97	63.68	63.33	83.11	83.50	83.31	94.59	96.49	95.54
W_4C_4	49.08	51.15	50.12	63.96	66.11	65.04	84.98	87.37	86.18	97.26	99.61	98.44
SEm±(W×C)	1.62	1.80	1.21	2.01	2.04	1.43	2.61	2.85	1.93	2.95	2.92	2.07
SEm±(C×W)	1.88	2.13	1.91	2.42	2.39	2.28	2.98	3.25	3.01	3.45	3.50	3.30
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

4.1.1.2 Leaf area index (LAI)

The data on leaf area index were recorded at 30, 60 and 90 DAS and the results are presented in Table 4.2(a) and Table 4.2(b).

4.1.1.2.1 Effect of integrated weed management on leaf area index of black rice

Data presented in Table 4.2 (a) revealed that there was significant effect on leaf area index due to integrated weed management in both the years of experiment. At 30 DAS, hand weeding twice at 15 and 30 DAS revealed significantly superior leaf area index which was followed by application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS. Effective control of weeds under hand weeding may have utilized more growth resources which resulted in better plant growth with increase in crop canopy. Additionally, it might be also attributed to an increased number of tillers per running meter and higher plant height, which ultimately increased the size and number of green leaves due to more favorable utilization of nutrient and hence contributed to increase leaf area index. Integration of herbicide and hand weeding also recorded better LAI similarly. It is in similar confirmation to the results of Moe *et al.* (2017) and Gupta *et al.* (2021) while further data also revealed that the minimum LAI was recorded significantly with weedy check. Similar results on leaf area index were also observed at 60 and 90 DAS as well

4.1.1.2.2 Effect of cultivars on number of leaf area index of black rice

Different cultivars showed significant effect on leaf area index at all the growth stages. At 30 and 90 DAS, it was revealed that highest leaf area index was recorded with cultivar *Chakhao Poireiton* which was seen to be at par with *Chakhao Amubi* and *Khurukhul Chakhao* while lowest LAI was recorded with

Table 4.2(a): Effect of integrated weed management and cultivars on leaf area index of black rice

Treatments	**30 DAS**			**60 DAS**			**90 DAS**		
Weed Management	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
W_1 -Weedy check (Control)	0.40	0.42	0.41	0.85	0.87	0.86	0.52	0.53	0.52
W_2 - Hand weeding (15 and 30 DAS)	1.13	1.15	1.14	1.95	1.97	1.96	1.76	1.78	1.77
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	1.01	1.05	1.03	1.82	1.85	1.84	1.34	1.36	1.35
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	0.85	0.86	0.86	1.23	1.26	1.25	1.00	1.01	1.00
SEm±	0.01	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.01
CD at 5%	0.04	0.06	0.03	0.07	0.07	0.05	0.06	0.06	0.04
Cultivar									
C_1- *Chakhao Poireiton*	0.88	0.89	0.88	1.51	1.53	1.52	1.18	1.20	1.19
C_2 -*Chakhao Amubi*	0.86	0.88	0.87	1.48	1.50	1.49	1.17	1.18	1.17
C_3 -*Wairi Chakhao*	0.81	0.84	0.83	1.42	1.44	1.43	1.11	1.13	1.12
C_4 -*Khurukhul Chakhao*	0.85	0.87	0.86	1.45	1.47	1.46	1.15	1.17	1.16
SEm±	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01
CD at 5%	0.04	0.04	0.03	0.06	0.06	0.04	0.05	0.05	0.03

Table 4.2(b): Interaction effect of integrated weed management and cultivars on leaf area index of black rice

Treatments	30 DAS			60 DAS			90 DAS		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	0.41	0.43	0.42	0.88	0.90	0.89	0.55	0.56	0.55
W_1C_2	0.40	0.42	0.41	0.87	0.89	0.88	0.52	0.53	0.53
W_1C_3	0.38	0.39	0.39	0.82	0.83	0.83	0.48	0.49	0.49
W_1C_4	0.39	0.41	0.40	0.84	0.85	0.84	0.51	0.52	0.52
W_2C_1	1.16	1.18	1.17	2.01	2.03	2.02	1.78	1.79	1.79
W_2C_2	1.14	1.15	1.15	1.95	1.96	1.96	1.77	1.78	1.78
W_2C_3	1.11	1.12	1.12	1.89	1.92	1.90	1.74	1.75	1.75
W_2C_4	1.13	1.14	1.13	1.94	1.95	1.95	1.76	1.77	1.77
W_3C_1	1.07	1.08	1.08	1.85	1.88	1.87	1.38	1.39	1.38
W_3C_2	1.03	1.06	1.04	1.83	1.86	1.84	1.36	1.37	1.37
W_3C_3	0.95	0.99	0.97	1.79	1.82	1.81	1.28	1.30	1.29
W_3C_4	1.01	1.05	1.03	1.81	1.85	1.83	1.34	1.36	1.35
W_4C_1	0.87	0.88	0.88	1.30	1.31	1.30	1.03	1.05	1.04
W_4C_2	0.86	0.87	0.87	1.25	1.30	1.28	1.02	1.02	1.02
W_4C_3	0.82	0.84	0.83	1.16	1.21	1.19	0.94	0.96	0.95
W_4C_4	0.85	0.86	0.86	1.20	1.24	1.22	0.99	1.01	1.00
SEm±(W×C)	0.03	0.03	0.02	0.04	0.04	0.03	0.03	0.03	0.02
SEm±(C×W)	0.03	0.03	0.03	0.05	0.05	0.05	0.04	0.04	0.04
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Wairi Chakhao. Further at 60 DAS, maximum leaf area index was recorded with cultivar *Chakhao Poireiton* which was statistically at par with *Chakhao Amubi* while *Wairi Chakhao* observed statistically least leaf area index which was at par with *Khurukhul Chakhao*. LAI is an important physiological parameter that determines crop yield. The leaf area index is a determinant of dry matter production, and hence increased total dry matter production results in increased grain yield for a given rice variety. It may also be due to the advantage because of some added morphological traits like bigger leaves which can shade growing weeds, deeper roots for better water uptake and other identified traits/ characteristics. A similar result was also determined by Schreiber *et al.* (2018).

4.1.1.2.3 Interaction effect of integrated weed management and cultivars on leaf area index of black rice

Data depicted on Table 4.2 (b) showed interaction effect of integrated weed management and different cultivars and results indicated that there was no significant effect on leaf area index in all the growth stages in both the years.

4.1.1.3 Number of plants m^{-2}

The data on number of plants m^{-2} of black rice due to various treatments on integrated weed management and different cultivars recorded at 30, 60 and at harvest are presented in Table 4.2 (a) and Table 4.2 (b) where it showed that it did not exhibit any significant effect on number of plants m^{-2} in both the years.

4.1.1.4 Dry matter accumulation (g $plant^{-1}$)

The result presented in 4.3 (a) and 4.3 (b) showed the effect of integrated weed management and different cultivars and its interaction on dry matter accumulation (g $plant^{-1}$) recorded at 30, 60 and 90 DAS.

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Table 4.3 (a): Effect of integrated weed management and cultivars on number of plants m^{-2} of black rice

Treatments	30 DAS			60 DAS			Harvest		
Weed Management	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
W_1 -Weedy check (Control)	49.33	49.58	49.46	48.17	48.25	48.21	48.17	48.25	48.21
W_2 - Hand weeding (15 and 30 DAS)	49.67	49.67	49.67	48.67	48.67	48.67	48.67	48.67	48.67
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	49.58	49.67	49.63	48.50	48.58	48.54	48.50	48.58	48.54
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	49.42	49.58	49.50	48.17	48.42	48.29	48.17	48.42	48.29
SEm±	0.09	0.12	0.07	0.17	0.16	0.12	0.17	0.16	0.12
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cultivar									
C_1- *Chakhao Poireiton*	49.83	49.92	49.88	48.58	48.75	48.67	48.58	48.75	48.67
C_2 -*Chakhao Amubi*	49.50	49.58	49.54	48.42	48.58	48.50	48.42	48.58	48.50
C_3 -*Wairi Chakhao*	49.17	49.42	49.29	48.17	48.17	48.17	48.17	48.17	48.17
C_4 -*Khurukhul Chakhao*	49.50	49.58	49.54	48.33	48.42	48.38	48.33	48.42	48.38
SEm±	0.16	0.16	0.11	0.14	0.17	0.11	0.14	0.17	0.11
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 4.3 (b): Interaction effect of integrated weed management and cultivars on number of plants m^{-2} of black rice

Treatments	30 DAS			60 DAS			Harvest		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	49.67	50.00	49.83	48.67	48.33	48.50	48.67	48.33	48.50
W_1C_2	49.33	49.33	49.33	48.33	48.67	48.50	48.33	48.67	48.50
W_1C_3	49.00	49.67	49.33	47.67	48.00	47.83	47.67	48.00	47.83
W_1C_4	49.33	49.33	49.33	48.00	48.00	48.00	48.00	48.00	48.00
W_2C_1	50.00	50.00	50.00	49.00	49.00	49.00	49.00	49.00	49.00
W_2C_2	49.67	49.67	49.67	48.67	49.00	48.83	48.67	49.00	48.83
W_2C_3	49.33	49.33	49.33	48.33	48.33	48.33	48.33	48.33	48.33
W_2C_4	49.67	49.67	49.67	48.67	48.33	48.50	48.67	48.33	48.50
W_3C_1	50.00	50.00	50.00	48.67	49.00	48.83	48.67	49.00	48.83
W_3C_2	49.67	49.67	49.67	48.67	48.33	48.50	48.67	48.33	48.50
W_3C_3	49.33	49.33	49.33	48.33	48.33	48.33	48.33	48.33	48.33
W_3C_4	49.33	49.67	49.50	48.33	48.67	48.50	48.33	48.67	48.50
W_4C_1	49.67	49.67	49.67	48.00	48.67	48.33	48.00	48.67	48.33
W_4C_2	49.33	49.67	49.50	48.00	48.33	48.17	48.00	48.33	48.17
W_4C_3	49.00	49.33	49.17	48.33	48.00	48.17	48.33	48.00	48.17
W_4C_4	49.67	49.67	49.67	48.33	48.67	48.50	48.33	48.67	48.50
SEm±(W×C)	0.32	0.32	0.23	0.28	0.35	0.22	0.28	0.35	0.22
SEm±(C×W)	0.35	0.36	0.35	0.33	0.39	0.35	0.33	0.39	0.35
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS

4.1.1.4.1 Effect of integrated weed management on dry matter accumulation (g plant^{-1}) of black rice

The data on dry matter accumulation recorded at 30, 60 and 90 DAS clearly indicated that integrated weed management had significant effect on dry matter accumulation at all stages of crop growth. Data revealed that maximum dry matter accumulation was significantly recorded by hand weeding twice at 15 and 30 DAS. This may be due to the weed free environment that helped the crops for better plant dry matter production. The possibility may have been because of increased plant growth due to lower weed competition during the initial stages of crop development, which promotes their ability to access the nutrients and light culminating in efficient accumulation of photosynthates. Similar opinion was expressed by Sen *et al.* (2020) and Shahane and Behera (2023). This was followed by application of pretilachlor @ 1.0 kg ha $^{-1}$ (PE) *fb* HW at 40 DAS and pretilachlor @1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25 g ha^{-1} (PoE) at 20 DAS respectively. A sequential application of pre-emergence herbicide with early post-emergence herbicide or hand weeding would help to obtain higher dry matter and this result is supported by findings of Singh *et al.* (2016). Additionally, significantly lowest dry matter accumulation was observed under weedy check at all the stages of observation during both the years

4.1.1.4.2 Effect of cultivars on dry matter accumulation (g plant^{-1}) of black rice

Critical analysis on the data revealed that dry matter accumulation was influenced by different cultivars in both the years. At 30 DAS, it revealed that highest dry matter was seen with cultivar *Chakhao Poireiton* which was at par with *Chakhao Amubi* while data also revealed that *Wairi Chakhao* recorded lowest dry which was also seen to be at par with *Khurukhul Chakhao*. Similar

Table 4.4 (a): Effect of integrated weed management and cultivars on dry matter accumulation (g plant^{-1}) of black rice

Treatments	**30 DAS**			**60 DAS**			**90 DAS**		
Weed Management	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
W_1 -Weedy check (Control)	1.97	1.98	1.97	5.00	5.02	5.01	12.18	12.29	12.24
W_2 - Hand weeding (15 and 30 DAS)	2.80	2.83	2.82	7.46	7.54	7.50	19.45	19.82	19.64
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	2.53	2.62	2.57	6.46	6.54	6.50	16.05	16.41	16.23
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	2.18	2.20	2.19	5.70	5.73	5.71	13.78	13.91	13.85
SEm±	0.03	0.05	0.03	0.11	0.12	0.08	0.23	0.32	0.20
CD (P=0.05)	0.12	0.17	0.09	0.37	0.40	0.24	0.79	1.10	0.60
Cultivar									
C_1- *Chakhao Poireiton*	2.47	2.49	2.48	6.58	6.60	6.59	17.03	17.19	17.11
C_2 -*Chakhao Amubi*	2.39	2.43	2.41	6.25	6.32	6.29	15.87	16.14	16.01
C_3 -*Wairi Chakhao*	2.28	2.32	2.30	5.71	5.76	5.73	13.74	13.99	13.86
C_4 -*Khurukhul Chakhao*	2.34	2.38	2.36	6.08	6.13	6.11	14.82	15.12	14.97
SEm±	0.04	0.04	0.03	0.10	0.09	0.07	0.27	0.23	0.18
CD (P=0.05)	0.11	0.11	0.07	0.28	0.26	0.19	0.78	0.66	0.50

Table 4.4(b): Interaction effect of integrated weed management and cultivars on dry matter accumulation (g plant^{-1}) of black rice

Treatments	30 DAS			60 DAS			90 DAS		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	2.03	2.05	2.04	5.31	5.35	5.33	13.16	13.30	13.23
W_1C_2	2.00	2.01	2.01	5.26	5.30	5.28	12.75	12.83	12.79
W_1C_3	1.90	1.91	1.91	4.46	4.49	4.47	10.79	10.81	10.80
W_1C_4	1.93	1.94	1.94	4.96	4.94	4.95	12.02	12.24	12.13
W_2C_1	2.96	3.00	2.98	8.01	8.03	8.02	21.21	21.45	21.33
W_2C_2	2.80	2.83	2.82	7.53	7.55	7.54	20.38	20.43	20.41
W_2C_3	2.69	2.72	2.71	7.02	7.13	7.08	17.84	18.33	18.09
W_2C_4	2.76	2.75	2.76	7.30	7.43	7.37	18.36	19.08	18.72
W_3C_1	2.66	2.68	2.67	7.02	7.03	7.03	18.58	18.71	18.65
W_3C_2	2.56	2.67	2.62	6.44	6.65	6.55	16.17	17.02	16.60
W_3C_3	2.41	2.49	2.45	6.00	6.06	6.03	13.99	14.32	14.16
W_3C_4	2.48	2.63	2.55	6.35	6.41	6.38	15.46	15.59	15.52
W_4C_1	2.24	2.25	2.24	5.96	5.99	5.97	15.15	15.31	15.23
W_4C_2	2.20	2.22	2.21	5.77	5.80	5.79	14.18	14.29	14.23
W_4C_3	2.12	2.15	2.14	5.34	5.37	5.36	12.34	12.48	12.41
W_4C_4	2.18	2.19	2.19	5.72	5.75	5.74	13.45	13.58	13.52
SEm±(W×C)	0.07	0.07	0.05	0.19	0.18	0.13	0.54	0.45	0.35
SEm±(C×W)	0.08	0.09	0.08	0.23	0.22	0.21	0.60	0.56	0.55
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS

trend of observation was recorded at 60 and 90 DAS as well. Findings reported by Mahajan *et al.* (2014) revealed that the rice cultivars having tall and higher dry matter at the initial stages contributed to its higher weed suppression ability in contrast with cultivars which are shorter in height and produced lower dry matter.

4.1.1.4.3 Interaction effect of integrated weed management and cultivars on dry matter accumulation (g plant^{-1})

Data pertaining to interaction effect of integrated weed management and different cultivars failed to show any significant effect on the dry matter accumulation at all the stages of growth in both the years of experiment.

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

The data on crop growth rate (g m^{-2} day^{-1}) due to integrated weed management and different cultivars recorded at 30-60 DAS and 60-90 DAS are presented in Table 4.5 (a) and Table 4.5 (b).

4.1.1.5.1 Effect of integrated weed management on crop growth rate (g m^{-2} day^{-1}) of black rice

A perusal on the data presented in Table 4.5 (a) observed that there was significant effect of integrated weed management on CGR of black rice for all the growth stages in the both years of experiment. It was exhibited that hand weeding twice at 15 and 30 DAS significantly showed maximum crop growth rate which was followed by pretilachlor @ 1.0 kg ha $^{-1}$ (PE) *fb* HW at 40 DAS and pretilachlor @1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25 g ha^{-1} (PoE) at 20 DAS respectively. Crop growth rate was found to respond positively to a reduction in weed pressure, presumably because the reduced competition for resources meant that the crop plants were able to out-compete the weeds better.

Table 4.5(a): Effect of integrated weed management and cultivars on crop growth rate (g m^{-2} day^{-1}) of black rice

Treatment	**30-60 DAS**			**60-90 DAS**		
	2021	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
Weed Management						
W_1 -Weedy check (Control)	5.05	5.07	5.06	11.97	12.12	12.05
W_2 - Hand weeding (15 and 30 DAS)	7.77	7.85	7.81	19.97	20.48	20.23
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	6.55	6.53	6.54	15.99	16.45	16.22
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	5.86	5.87	5.87	13.47	13.64	13.56
SEm±	0.15	0.18	0.12	0.25	0.49	0.27
CD at 5%	0.53	0.62	0.36	0.86	1.70	0.85
Cultivar						
C_1- *Chakhao Poireiton*	6.84	6.85	6.84	17.42	17.65	17.54
C_2 -*Chakhao Amubi*	6.43	6.49	6.46	16.03	16.36	16.20
C_3 -*Wairi Chakhao*	5.71	5.74	5.72	13.39	13.71	13.55
C_4 -*Khurukhul Chakhao*	6.24	6.25	6.25	14.57	14.98	14.77
SEm±	0.16	0.13	0.10	0.43	0.38	0.29
CD at 5%	0.46	0.39	0.29	1.27	1.12	0.83

Table 4.5(b): Interaction effect of integrated weed management and cultivars on crop growth rate (g m^{-2} day^{-1}) of black rice

Treatments	30-60 DAS			60-90 DAS		
	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	5.47	5.51	5.49	13.09	13.24	13.16
W_1C_2	5.43	5.48	5.46	12.48	12.55	12.51
W_1C_3	4.26	4.29	4.28	10.56	10.53	10.54
W_1C_4	5.05	4.99	5.02	11.77	12.17	11.97
W_2C_1	8.41	8.39	8.40	22.00	22.37	22.19
W_2C_2	7.89	7.86	7.88	21.41	21.48	21.44
W_2C_3	7.21	7.35	7.28	18.04	18.67	18.35
W_2C_4	7.56	7.80	7.68	18.44	19.41	18.92
W_3C_1	7.28	7.26	7.27	19.27	19.46	19.36
W_3C_2	6.47	6.63	6.55	16.22	17.28	16.75
W_3C_3	5.99	5.95	5.97	13.31	13.78	13.54
W_3C_4	6.46	6.30	6.38	15.17	15.30	15.24
W_4C_1	6.21	6.23	6.22	15.32	15.54	15.43
W_4C_2	5.95	5.97	5.96	14.01	14.14	14.08
W_4C_3	5.37	5.36	5.36	11.66	11.84	11.75
W_4C_4	5.91	5.92	5.92	12.88	13.05	12.97
SEm±(W×C)	0.32	0.27	0.21	0.87	0.77	0.58
SEm±(C×W)	0.36	0.32	0.33	0.95	0.92	0.90
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS

The results are in compliance with those of Matloob *et al.* (2015b). Similarly, control of weeds through hand weeding may have resulted in more nutrients to be utilized by crops which helped in assimilation of more plant biomass resulting in better CGR. Findings are in close confirmation with Kabdal *et al.* (2018). Further, minimum crop growth rate was significantly recorded with weedy check for both 30-60 as well as 60-90 DAS. This may be due to the fact that the rate of dry matter accumulation per unit time was directly connected with crop weed competition that occurred during the period of crop growth. This corroborates with the findings of Gill and Walia (2013).

4.1.1.5.2 Effect of cultivars on crop growth rate (g m^{-2} day^{-1}) of black rice

The crop growth rate varied significantly among the different treatments in both years of experiment. During 30-60 DAS, it was recorded that in both the years of experiment significantly lowest CGR was recorded with *Wairi Chakhao* while highest CGR was seen with *Chakhao Poireiton* which was at par with *Chakhao Amubi* while pooled data showed significant results with *Chakhao Poireiton* resulting in highest CGR. Further, at 60- 90 DAS it was recorded that significantly maximum and minimum crop growth rate was seen with cultivar *Chakhao Poireiton* and *Wairi Chakhao* respectively. The differences in the rate of the growth of crop between the cultivars may be mainly due to varietal variation which was also supported by the findings of Kujur *et al.* (2017).

4.1.1.5.3 Interaction effect of integrated weed management and cultivars on crop growth rate (g m^{-2} day^{-1})

An inquisition on two years data revealed no significant effect of integrated weed management and different cultivars on the crop growth rate of black rice at all the growth stages.

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

The data on relative growth rate (g g^{-1} day^{-1}) due to integrated weed management and different cultivars recorded at 30-60 DAS and 60-90 DAS are depicted in Table 4.6 (a) and Table 4.6 (b).

4.1.1.6.1 Effect of integrated weed management on relative growth rate (g g^{-1} day^{-1}) of black rice

Integrated weed management did not show any significant effect on relative growth rate in either of the years at 30-60 DAS. Further, at 60-90 DAS the first year and pooled data also did not show any significant effect but in the second year it exhibited significant effect where it was observed that maximum relative growth rate was recorded with hand weeding at 15 and 30 DAS followed by application of pretilachlor @ 1.0 kg ha $^{-1}$ (PE) *fb* HW at 40 DAS and pretilachlor @1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25 g ha^{-1} (PoE) at 20 DAS respectively while minimum relative growth rate was recorded with weedy check. It may be because of the fact that the rate of dry matter accumulation per unit time was directly related with crop weed competition which occurred during the period of crop growth. These findings are in close conformity with Matloob *et al.* (2015a). Additionally, control of weeds through herbicide and hand weeding have helped the plant to record more growth rate Borana *et al*. (2017).

4.1.1.6.2 Effect of cultivars on relative growth rate (g g^{-1} day^{-1}) of black rice

The effect of different cultivars on relative growth rate revealed that at 30-60 DAS it failed to show any significant effect in the first year however in the second year and pooled data it was seen that significantly highest and lowest rate was recorded with cultivar *Chakhao Poireiton* and *Wairi Chakhao* respectively. Furthermore at 60-90 DAS, it was revealed that in second year significant result was not observed but in first year and pooled data it was seen

Table 4.6(a): Effect of integrated weed management and cultivars on relative growth rate (g g^{-1} day^{-1}) of black rice

Treatment	30-60 DAS			60-90 DAS		
	2021	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
Weed Management						
W_1 -Weedy check (Control)	0.031	0.031	0.031	0.030	0.030	0.030
W_2 - Hand weeding (15 and 30 DAS)	0.033	0.033	0.033	0.032	0.032	0.032
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	0.031	0.031	0.031	0.030	0.031	0.030
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	0.032	0.032	0.032	0.029	0.030	0.029
SEm±	0.0006	0.0006	0.0004	0.0003	0.0007	0.0004
CD at 5%	NS	NS	NS	0.0010	NS	0.0011
Cultivar						
C_1- *Chakhao Poireiton*	0.033	0.032	0.033	0.032	0.032	0.032
C_2 -*Chakhao Amubi*	0.032	0.032	0.032	0.031	0.031	0.031
C_3 -*Wairi Chakhao*	0.030	0.030	0.030	0.029	0.029	0.029
C_4 -*Khurukhul Chakhao*	0.032	0.032	0.032	0.030	0.030	0.030
SEm±	0.0006	0.0005	0.0004	0.0006	0.0006	0.0004
CD at 5%	NS	0.0014	0.0011	0.0018	NS	0.0013

Table 4.6(b): Interaction effect of integrated weed management and cultivars on relative growth rate (g g^{-1} day^{-1}) of black rice

Treatments	30-60 DAS			60-90 DAS		
	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	0.032	0.032	0.032	0.030	0.030	0.030
W_1C_2	0.032	0.032	0.032	0.030	0.029	0.029
W_1C_3	0.028	0.028	0.028	0.029	0.029	0.029
W_1C_4	0.031	0.031	0.031	0.030	0.030	0.030
W_2C_1	0.033	0.033	0.033	0.032	0.033	0.033
W_2C_2	0.033	0.033	0.033	0.033	0.033	0.033
W_2C_3	0.032	0.032	0.032	0.031	0.031	0.031
W_2C_4	0.032	0.033	0.033	0.031	0.031	0.031
W_3C_1	0.032	0.032	0.032	0.032	0.033	0.033
W_3C_2	0.031	0.030	0.031	0.031	0.031	0.031
W_3C_3	0.030	0.030	0.030	0.028	0.029	0.028
W_3C_4	0.031	0.030	0.031	0.030	0.030	0.030
W_4C_1	0.033	0.033	0.033	0.031	0.031	0.031
W_4C_2	0.032	0.032	0.032	0.030	0.030	0.030
W_4C_3	0.031	0.030	0.031	0.028	0.028	0.028
W_4C_4	0.032	0.032	0.032	0.028	0.029	0.029
SEm±(W×C)	0.0013	0.0010	0.0008	0.0013	0.0013	0.0009
SEm±(C×W)	0.0014	0.0012	0.0013	0.0014	0.0015	0.0014
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS

that cultivar *Chakhao Poireiton* and *Wairi Chakhao* recoded highest and lowest RGR respectively. Differences in the average growth rates of different cultivars may be due to the differences in their growth in relation to their current weight. Variable relative growth rates were also in sync with the results reported by Khatun *et al.* (2020).

4.1.1.6.3 Interaction effect of integrated weed management and different cultivars on relative growth rate (g g^{-1} day^{-1})

Data depicted in Table 4.6 (b) exhibited no significant effect due to interaction of integrated weed management and different cultivars on relative growth rate of black rice.

4.1.2 Phenology

4.1.2.1 Days to 50% flowering

The days taken by black rice to 50 % flowering as influenced by integrated weed management and different cultivars are presented in 4.7 (a) and 4.7(b).

4.1.2.1.1 Effect of integrated weed management on days to 50% flowering on black rice

The variation in number of days taken to 50 % flowering due to integrated weed management were found to be non-significant for both the years however pooled data revealed varying difference on 50% flowering due to integrated weed management. It showed that the highest number of days to 50% flowering was recorded with two hand weeding at 15 and 30 DAS which was statistically at par with application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS. Further it was also revealed that lowest days to 50 % flowering was exhibited under weedy check which was at par with application of pretilachlor @ 1.0 kg ha $^{-1}$ (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS.

4.1.2.1.2 Effect of cultivars on days to 50% flowering on black rice

Different cultivars showed significant effect on 50% flowering. Significantly highest number of days taken to 50 % flowering was observed with cultivar *Chakhao Poireiton* while further data revealed that the lowest number of days to 50% flowering was significantly recorded with *Wairi Chakhao* in both the years of experiment. Purwanto *et al.* (2020) also opined from his study that rice plants flowering time was affected by environmental conditions during pollination and flowering also as *Wairi Chakhao* suffered most from weed, it may be due to biotic stress that the cultivar had earlier flowering.

4.1.2.1.3 Interaction effect of integrated weed management and cultivars on days to 50% flowering on black rice

The interaction effect between integrated weed management and different cultivars did not show any significant effect on days to 50 % flowering of black rice.

4.1.2.2 Days to 50% physiological maturity

The data on days to 50 % physiological maturity as influenced by integrated weed management and different cultivars are presented in 4.7 (a) and 4.7(b).

4.1.2.2.1 Effect of integrated weed management on days to 50% physiological maturity on black rice

The data on days to 50 % physiological maturity as influenced by

Table 4.7(a): Effect of integrated weed management and cultivars on phenology of black rice

Treatment	Days to 50 % flowering			Days to 50% physiological maturity			Days to maturity		
Weed Management	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
W_1 -Weedy check (Control)	104.08	104.42	104.25	115.25	115.58	115.42	134.50	134.08	134.29
W_2 - Hand weeding (15 and 30 DAS)	104.83	105.00	104.92	115.83	115.83	115.83	135.83	135.25	135.54
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	104.58	104.92	104.75	115.58	115.58	115.58	135.42	135.50	135.46
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	104.42	104.25	104.33	115.33	115.50	115.42	134.50	134.58	134.54
SEm±	0.17	0.18	0.12	0.16	0.17	0.12	0.50	0.67	0.42
CD at 5%	NS	NS	0.38	NS	NS	NS	NS	NS	NS
Cultivar									
C_1- *Chakhao Poireiton*	105.58	105.50	105.54	116.75	116.67	116.71	137.92	138.00	137.96
C_2 -*Chakhao Amubi*	104.58	104.83	104.71	116.00	116.00	116.00	136.25	136.33	136.29
C_3 -*Wairi Chakhao*	103.50	103.75	103.63	114.33	114.33	114.33	131.25	131.50	131.38
C_4 -*Khurukhul Chakhao*	104.25	104.50	104.38	114.92	115.50	115.21	134.83	133.58	134.21
SEm±	0.20	0.20	0.14	0.13	0.15	0.10	0.46	0.69	0.41
CD at 5%	0.57	0.57	0.39	0.37	0.44	0.28	1.33	2.02	1.18

Table 4.7(b): Interaction effect of integrated weed management and cultivars on phenology of black rice

Treatments	Days to 50 % flowering			Days to 50% physiological maturity			Days to maturity		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	104.67	105.33	105.00	116.00	117.00	116.50	137.67	138.00	137.83
W_1C_2	104.67	104.67	104.67	115.67	115.33	115.50	135.33	135.00	135.17
W_1C_3	103.33	103.67	103.50	114.33	114.67	114.50	131.67	131.67	131.67
W_1C_4	103.67	104.00	103.83	115.00	115.33	115.17	133.33	131.67	132.50
W_2C_1	106.00	106.00	106.00	117.00	116.67	116.83	138.00	138.00	138.00
W_2C_2	105.00	105.33	105.17	116.67	116.67	116.67	137.67	138.00	137.83
W_2C_3	103.67	104.00	103.83	114.67	114.00	114.33	131.67	130.00	130.83
W_2C_4	104.67	104.67	104.67	115.00	116.00	115.50	136.00	135.00	135.50
W_3C_1	106.00	106.00	106.00	117.00	116.33	116.67	138.00	138.00	138.00
W_3C_2	104.67	104.67	104.67	116.00	116.00	116.00	137.00	138.00	137.50
W_3C_3	103.67	103.67	103.67	114.33	114.67	114.50	131.67	131.67	131.67
W_3C_4	104.00	105.33	104.67	115.00	115.33	115.17	135.00	134.33	134.67
W_4C_1	105.67	104.67	105.17	117.00	116.67	116.83	138.00	138.00	138.00
W_4C_2	104.00	104.67	104.33	115.67	116.00	115.83	135.00	134.33	134.67
W_4C_3	103.33	103.67	103.50	114.00	114.00	114.00	130.00	132.67	131.33
W_4C_4	104.67	104.00	104.33	114.67	115.33	115.00	135.00	133.33	134.17
SEm±(W×C)	0.39	0.39	0.28	0.25	0.30	0.20	0.91	1.39	0.83
SEm±(C×W)	0.44	0.44	0.43	0.30	0.35	0.31	1.06	1.58	1.30
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS

integrated weed management did not show any significant effect for both the years.

4.1.2.2.2 Effect of cultivars on days to 50% physiological maturity on black rice

Critical analysis on the data presented in Table 4.7 (a) revealed that different cultivars significantly affected days to 50% physiological maturity. The data revealed that maximum days to 50 % physiological maturity was recorded significantly with cultivar *Chakhao Poireiton* in comparison with other cultivars while *Wairi Chakhao* recorded significantly minimum days to 50 % physiological maturity in both the years of experiment.

4.1.2.2.3 Interaction effect of integrated weed management and cultivars on days to 50% physiological maturity on black rice

Table 4.7 (b) depicted that interaction between integrated weed management and different cultivars did not show any significant effect on 50 % physiological maturity of the crop.

4.1.2.2 Days to maturity

The data on days to maturity as influenced by integrated weed management and different cultivars are illustrated in 4.7 (a) and 4.7(b).

4.1.2.2.1 Effect of integrated weed management on days maturity on black rice

The data on days to maturity as influenced by integrated weed management failed to show any significant effect for both the years.

4.1.2.2.2 Effect of cultivars on days to maturity on black rice

The data presented in Table 4.7 (a) showed that maximum days to maturity was recorded significantly with cultivar *Chakhao Poireiton* in comparison with other cultivars while *Wairi Chakhao* recorded significantly minimum days to maturity in both the years of experiment. The presence of nutritionally complete nutrients that crop can absorb influences crop growth performance and harvest age which are in sync with the results of Dewanto *et al.* (2013). Haque *et al.* (2015) also expressed that the difference in harvesting age is because the reproductive and ripening stages may be affected by the variety and the environment as well.

4.1.2.2.3 Interaction effect of integrated weed management and cultivars on days to maturity on black rice

Table 4.7 (b) revealed that interaction between integrated weed management and different cultivars did not show any significant effect on maturity of the crop.

4.1.3 Yield attributes

4.1.3.1 Number of panicles m^{-2}

The data on number of panicles m^{-2} as influenced by integrated weed management and different cultivars are presented in Table 4.8 (a) and 4.8 (b).

4.1.3.1.1 Effect of integrated weed management on number of panicles m^{-2} of black rice

The data presented in Table 4.8(a) on number of panicles m $^{-2}$ revealed that integrated weed management had significant effect on number of panicles m^{-2} in both the years. The highest number of panicles m^{-2} was significantly observed with hand weeding at 15 and 30 DAS followed by application of pretilachlor @ 1.0 kg ha $^{-1}$ (PE) *fb* HW at 40 DAS and pretilachlor @1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25 g ha^{-1} (PoE) at 20 DAS respectively. Phukan and Deka (2021) also revealed from their findings that this might be due to reduced weed density and dry weight as well as higher weed control efficiency leading to efficient control of weeds at critical growth period and improved establishment of crop. In addition, it also revealed that weedy check significantly recorded lowest number of panicles m^{-2} in both the years. All weed management treatments revealed significantly greater values of yield attributes over weedy check. The improvement in yield attribute components could be due to reduced competition from weeds for the crop. The reduced competition by weeds throughout plant growth may be due to control of early-emerging weeds prior to planting through pre-emergence herbicide application and control of late-emerging weeds through manual weeding and post-emergence application of herbicides. Similar result is in corroboration with Kumari *et al*. (2023a).

4.1.3.1.2 Effect of cultivars on number of panicles m^{-2} of black rice

Different cultivars had significant effect on number of panicles m^{-2} in both the years. It was observed that highest number of panicles m^{-2} was observed with cultivar *Chakhao Poireiton* which was at par with *Chakhao Amubi*. Further, it was also recorded that *Chakhao Amubi* was at par with *Khurukhul Chakhao*. The variation in number of panicles m^{-2} among the different cultivars might be due to the different genetic characteristic while the lowest number of panicles m^{-2} was recorded with *Wairi Chakhao* which was statistically at par with *Khurukhul Chakhao*.

4.1.3.1.3 Interaction effect of integrated weed management and cultivars on number of panicles m^{-2}

Data on interaction of integrated weed management and different cultivars failed to show any significant effect on number of panicles m^{2} in both the years of experiment.

4.1.3.2 Length of panicles (cm)

The data on length of panicles (cm) as influenced by integrated weed management and different cultivars are presented in Table 4.8 (a) and 4.8 (b).

4.1.3.2.1 Effect of integrated weed management on length of panicles (cm) of black rice

The data depicted in Table 4.8(a) on length of panicles (cm) resulted that integrated weed management had significant effect on length of panicles (cm) in both the years. Hand weeding at 15 and 30 DAS exhibited significantly maximum length of panicles in both the years. This may be due to the reason that minimum weed population had provided favorable and low crop-weed competition environment to the crop, which may have resulted in higher photosynthetic accumulation rate and better translocation of photosynthates compared to weedy check. It was then followed with application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS which was statistically at par with pretilachlor @1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25 g ha^{-1} (PoE) at 20 DAS. Further it was exhibited that weedy check recorded minimum length of panicles (cm) in both the years. The shorter length of panicle in the control plots may be due to draining of nutrients by weeds. A similar result was obtained by Dubey *et al.* (2017) and Dangol *et al.* (2020).

Table 4.8(a): Effect of integrated weed management and cultivars on yield attributes of black rice

Treatments	Number of panicle m^{-2}			Length of panicles (cm)			Weight of panicles (g)		
Weed Management	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
W_1 -Weedy check (Control)	145.67	147.08	146.38	18.78	18.59	18.68	1.13	1.15	1.14
W_2 - Hand weeding (15 and 30 DAS)	208.33	210.17	209.25	19.86	20.12	19.99	2.60	2.68	2.64
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	188.67	189.92	189.29	19.18	19.49	19.33	1.84	1.86	1.85
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	168.17	170.25	169.21	19.01	19.37	19.19	1.55	1.57	1.56
SEm±	3.33	2.94	2.22	0.29	0.31	0.21	0.03	0.03	0.02
CD at 5%	11.53	10.18	6.85	NS	NS	0.65	0.10	0.11	0.07
Cultivar									
C_1- *Chakhao Poireiton*	182.17	184.08	183.13	19.88	20.25	20.06	1.87	1.90	1.88
C_2 -*Chakhao Amubi*	180.75	181.67	181.21	19.32	19.61	19.47	1.83	1.86	1.84
C_3 -*Wairi Chakhao*	172.17	173.75	172.96	18.55	18.65	18.60	1.69	1.72	1.71
C_4 -*Khurukhul Chakhao*	175.75	177.92	176.83	19.08	19.06	19.07	1.73	1.77	1.75
SEm±	2.58	2.60	1.83	0.28	0.36	0.23	0.03	0.03	0.02
CD at 5%	7.52	7.58	5.20	0.82	1.06	0.65	0.10	0.08	0.06

Table 4.8(b): Interaction effect of integrated weed management and cultivars on yield attributes of black rice

Treatments	Number of panicles m $^{-2}$			Length of panicles (cm)			Weight of panicles (g)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	148.33	150.00	149.17	19.29	19.54	19.42	1.19	1.22	1.20
W_1C_2	146.67	147.00	146.83	18.84	18.88	18.86	1.14	1.15	1.15
W_1C_3	143.67	145.33	144.50	18.19	17.87	18.03	1.09	1.10	1.10
W_1C_4	144.00	146.00	145.00	18.81	18.05	18.43	1.11	1.12	1.12
W_2C_1	212.33	214.00	213.17	20.56	20.92	20.74	2.84	2.88	2.86
W_2C_2	210.67	211.33	211.00	19.96	20.27	20.12	2.77	2.85	2.81
W_2C_3	204.33	206.67	205.50	19.28	19.54	19.41	2.36	2.44	2.40
W_2C_4	206.00	208.67	207.33	19.63	19.77	19.70	2.45	2.53	2.49
W_3C_1	191.00	193.00	192.00	19.98	20.03	20.01	1.87	1.90	1.88
W_3C_2	190.67	191.00	190.83	19.33	19.83	19.58	1.85	1.88	1.87
W_3C_3	185.33	186.33	185.83	18.24	18.78	18.51	1.81	1.82	1.81
W_3C_4	187.67	189.33	188.50	19.17	19.30	19.23	1.83	1.83	1.83
W_4C_1	177.00	179.33	178.17	19.70	20.49	20.10	1.58	1.60	1.59
W_4C_2	175.00	177.33	176.17	19.16	19.46	19.31	1.55	1.56	1.56
W_4C_3	155.33	156.67	156.00	18.48	18.41	18.44	1.51	1.53	1.52
W_4C_4	165.33	167.67	166.50	18.72	19.12	18.92	1.54	1.58	1.56
SEm±(W×C)	5.15	5.19	3.66	0.56	0.73	0.46	0.07	0.05	0.04
SEm±(C×W)	6.18	6.07	5.81	0.65	0.81	0.71	0.08	0.06	0.07
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	0.20	0.16	0.12
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	0.22	0.18	0.19

4.1.3.2.2 Effect of cultivars on length of panicles (cm) of black rice

The data related to length of panicle as influenced by different cultivars were found to be significant. In both the years it was exhibited that cultivar *Chakhao Poireiton* observed highest length of panicle which was statistically at par with *Chakhao Amubi* where further it also showed that the same cultivar was at par with *Khurukhul Chakhao*. Additionally, data also revealed *Wairi Chakhao* showing the minimum length of panicle.

4.1.3.3 Weight of panicles (g)

The data on weight of panicle (g) as influenced by integrated weed management and different cultivars are presented in Table 4.8 (a) and 4.8 (b).

4.1.3.3.1 Effect of integrated weed management on weight of panicles (g) of black rice

The data related to weight of panicle (g) as influenced by integrated weed management was influenced significantly. Weedy check recorded significantly lowest weight of panicles during both the years while hand weeding at 15 and 30 DAS recorded maximum weight of panicles in both years. Sree *et al*. (2021) revealed from his finding that this may be due to complete removal of weeds with the help of hand weeding at two intervals during critical stages. It was followed by application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS and pretilachlor @1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25 g ha^{-1} (PoE) at 20 DAS respectively. This might be because of effective elimination of weeds throughout the critical period of crop-weed competition offered by integrated weed management treatments minimizing the nutrient depletion by weeds allowing the crops to accelerate their nutrient absorption and ultimately resulted in increased weight of panicle Suseendran *et al.* (2020).

4.1.3.3.2 Effect of cultivars on weight of panicles (g) of black rice

The variations on weight of panicles (g) influenced by different cultivars showed significant effects in both the years. Among the cultivars it was recorded that maximum weight of panicles was observed with *Chakhao Poireiton* which was statistically at par with *Chakhao Amubi*. All treatment produced significantly heavier panicles than the unweeded one under all the cultivars. Similar results were also reported by Shebl *et al.* (2009) and Abou EL-Darag, (2012). Further it was also observed that *Wairi Chakhao* recorded minimum weight of panicles (g) which was at par with *Khurukhul Chakhao*.

4.1.3.3.3 Interaction effect of integrated weed management and cultivars on weight of panicles (g)

Interaction effects between integrated weed management and different cultivars in both the years depicted in Table 4.8 (b) showed significant effect on weight of panicles (g) in both the years. Hand weeding at 15 and 30 DAS along with cultivar *Chakhao Poireiton* exhibited maximum weight of panicles which was closely followed by application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS and *Chakhao Amubi* in both the years.

4.1.3.4 Number of grains panicles^{-1}

The data on number of grains panicles^{-1} a**s** influenced by integrated weed management and different cultivars are presented in Table 4.9 (a) and 4.9 (b).

4.1.3.4.1 Effect of integrated weed management on number of grains panicles^{-1} of black rice

The relevant data on effect of integrated weed management showed significant effect on number of grains panicles^{-1}. Weedy check observed minimum number of grains panicles^{-1} in both the years. Control plots produced

Table 4.9(a): Effect of integrated weed management and cultivars on yield attributes of black rice

Treatments	**No. of grains panicle $^{-1}$**			**Grain filling %**			**Test weight (g)**		
Weed Management	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
W_1 -Weedy check (Control)	143.67	144.90	144.28	91.05	91.10	91.08	19.74	20.03	19.89
W_2 - Hand weeding (15 and 30 DAS)	161.14	162.73	161.94	91.90	91.44	91.67	20.30	20.33	20.31
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	155.82	157.10	156.46	89.83	88.45	89.14	20.07	20.15	20.11
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	151.65	153.94	152.80	89.41	87.79	88.60	20.04	20.11	20.08
SEm±	2.27	2.26	1.60	1.13	1.03	0.76	0.17	0.20	0.13
CD at 5%	7.85	7.83	4.94	NS	NS	NS	NS	NS	NS
Cultivar									
C_1- *Chakhao Poireiton*	157.72	159.40	158.56	90.03	90.20	90.11	20.44	20.58	20.51
C_2 -*Chakhao Amubi*	154.78	157.21	156.00	89.94	88.66	89.30	20.30	20.13	20.22
C_3 -*Wairi Chakhao*	147.93	148.97	148.45	91.19	89.99	90.59	19.59	19.83	19.71
C_4 -*Khurukhul Chakhao*	151.85	153.09	152.47	91.04	89.94	90.49	19.82	20.08	19.95
SEm±	2.26	2.46	1.67	0.98	1.32	0.82	0.23	0.24	0.17
CD at 5%	6.60	7.18	4.75	NS	NS	NS	NS	NS	NS

Table 4.9(b): Interaction effect of integrated weed management and cultivars on yield attributes of black rice

Treatments	No. of grains panicle $^{-1}$			Grain filling %			Test weight (g)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	149.83	151.87	150.85	91.73	93.13	92.43	20.33	20.40	20.37
W_1C_2	145.10	146.33	145.72	89.47	88.71	89.09	20.13	20.13	20.13
W_1C_3	136.87	137.77	137.32	93.44	91.88	92.66	19.03	19.47	19.25
W_1C_4	142.87	143.63	143.25	89.57	90.69	90.13	19.47	20.13	19.80
W_2C_1	164.30	165.07	164.68	91.13	91.99	91.56	20.43	21.00	20.72
W_2C_2	162.17	164.30	163.23	90.87	90.58	90.72	20.30	20.33	20.32
W_2C_3	158.10	159.61	158.86	93.16	92.15	92.65	20.20	19.73	19.97
W_2C_4	160.00	161.93	160.97	92.46	91.05	91.75	20.27	20.23	20.25
W_3C_1	161.77	162.63	162.20	87.66	86.79	87.22	20.80	20.63	20.72
W_3C_2	158.60	160.30	159.45	89.36	88.12	88.74	20.63	20.03	20.33
W_3C_3	149.30	150.54	149.92	91.09	89.70	90.39	19.33	20.20	19.77
W_3C_4	153.60	154.93	154.27	91.21	89.21	90.21	19.50	19.73	19.62
W_4C_1	154.97	158.03	156.50	89.60	88.90	89.25	20.20	20.30	20.25
W_4C_2	153.27	157.90	155.58	90.06	87.24	88.65	20.13	20.03	20.08
W_4C_3	147.43	147.97	147.70	87.06	86.23	86.64	19.80	19.90	19.85
W_4C_4	150.93	151.87	151.40	90.92	88.80	89.86	20.03	20.20	20.12
SEm±(W×C)	4.52	4.92	3.34	1.96	2.64	1.65	0.47	0.49	0.34
SEm±(C×W)	5.18	5.57	5.20	2.30	2.94	2.56	0.52	0.54	0.52
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS

a reduction in number of grains per panicles due to presence of weeds throughout the crop cycle that caused the depletion and less absorption of nutrients by the crop, especially during grain filling period. A similar result was obtained by Dubey *et al.* (2017). In addition, it was also revealed that the maximum number of grains panicles^{-1} was recorded with hand weeding at 15 and 30 DAS. Kumar *et al*. (2020) also opined in his study that due to lower infestation of weeds in low and medium weed pressure compared to high weed pressure reduced the crop-weed competition for nutrients and moisture supply, resulting in proper pollination and seed setting in rice. Further, it was also revealed that application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS was statistically at par with pretilachlor @1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25 g ha^{-1} (PoE) at 20 DAS. Similar results were also reported by Salam *et al.* (2020) and Afroz *et al.* (2019). The possible cause was that the herbicides impact on weeds may have led to the plants receiving more water, air, light, space and nutrients for optimum growth and development which supported the development of more attributes that contributed to better yield. In addition, the increase in foliage may have aided in photosynthesis because of minimal crop-weed competition, which serves as a contributing factor to the treatments increased production. An identical finding was reported by Dhakal *et al.* (2019).

4.1.3.4.2 Effect of cultivars on number of grains panicles^{-1} of black rice

Data with regard to effect of different cultivars on number of grains panicles^{-1} was significantly influenced where it was observed that *Chakhao Poireiton* recorded higher number of grains panicles^{-1} which was at par with *Chakhao Amubi* statistically. Further it was also recorded that minimum number of grains panicles^{-1} was observed with *Wairi Chakhao* which was statistically at par with *Khurukhul Chakhao* in both the years of experiment. The variation in filled grains panicles^{-1} observed may be due to genotypic differences. Similar results are confirmed by Kumhar *et al.* (2016a) and Kumhar *et al.* (2016b).

4.1.3.5 Grain filling %

The data on grain filling % as influenced by integrated weed management and different cultivars presented in Table 4.9 (a) and 4.9 (b) revealed that it did not show any significant effect in both the years of experiment.

4.1.3.6 Test weight (g)

The data on test weight (g) as influenced by integrated weed management and different cultivars depicted that test weight failed to show any significant effect in either of the years of experiment.

4.1.3.7 Grain yield (kg ha^{-1})

The data related to grain yield as influenced by integrated weed management and different cultivars recorded during both the cropping seasons have been presented in Table 4.10 (a) and 4.10(b).

4.1.3.7.1 Effect of integrated weed management on grain yield of black rice

Data in context with grain yield as influenced by integrated weed management in both the years was found to significantly affect grain yield of black rice. The grain yield under two hand weeding at 15 and 30 DAS was found to be significantly maximum. Zhang *et al.* (2022) also revealed through his findings that improvement in yield of rice may be due to lower weed density and dry matter which reduced the crop weed competition and had positive effect on crop leading to enhanced nitrogen, phosphorous and potassium uptake by the crop with additional efficient use of moisture, space, light and carbon dioxide. Better use of these resources led to improved crop growth and efficient transfer of assimilates from source (leaf) to sink (grain) thus resulting in higher number of panicles with increased number of grains and grain size which boost the grain yield of crop. Data also showed that higher yield with hand weeding was followed by application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS and pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS. Application of pre-emergence pretilachlor offered a broad spectrum of weed control at initial stages and attributed to higher yield while subsequent flush of weeds was effectively controlled by application of bispyribac sodium. Similar findings were also reported by Soren *et al.* (2017), Chinnamani *et al.* (2018) and Kalaisudarson and Srinivasaperumal (2019). Further the data also depicted that lowest grain yield was recorded under weedy check. It may be because of severe competition by weeds, which may have affected the growth, nutrient uptake and yield parameters of the crop drastically. Similar results are in conformity with Yogananda *et al*. (2017).

4.1.3.7.2 Effect of cultivars on grain yield of black rice

The variation in grain yield due to different cultivars was found to be significantly affected. It was revealed that among all the cultivars, grain yield in both the years and pooled data was found highest in *Chakhao Poireiton* which was found to be statistically at par with *Chakhao Amubi*. Further, it was also found that *Wairi Chakhao* exhibited minimum grain yield in both the years which was at par with *Khurukhul Chakhao*. Differences in grain yield due to varieties were also reported by Siddeque *et al.* (2002). Kumar *et al.* (2016b) in his findings also reported that taller cultivar was successful in suppressing weeds as they intercept greater proportion of photosynthetically active radiations (PAR) for effective weed suppression while short statured cultivars was found to be overpowered by aggressive weeds and thus gave lower crop yield.

4.1.3.7.3 Interaction effect of integrated weed management and cultivars on grain yield of black rice

Interaction between integrated weed management and different cultivars did not show any significant effect on grain yield in both the years of experiment.

4.1.3.8 Straw yield (kg ha^{-1})

The data related to straw yield as influenced by integrated weed management and different cultivars recorded during both the cropping seasons have been presented in Table 4.10 (a) and 4.10(b).

4.1.3.8.1 Effect of integrated weed management on straw yield

The differences in data of straw yield among the integrated weed were showed significant variation. Data revealed that minimum straw yield was significantly exhibited with weedy check treatment. Kumari *et al.* (2023b) also revealed through his findings that the minimum straw yield in control could be due to strong weed competition, which is reflected in the maximum weed density and weed dry matter, which led to less tillering, less dry weight of the plants and lower height of the plants. The greater remobilization of stem reserves towards grain resulted in higher grain yield. A certain amount of the carbohydrates formed before flowering are stored in the culms and leaf sheaths and then re-translocated back into the grain. The data also revealed that significantly maximum straw yield was depicted under two hand weeding at 15 and 30 DAS. This is in line with the findings of Mewada *et al.* (2016) where maximum yield was recorded in treatment where hand weeding was done twice maintaining its superiority over the rest of the treatments. The rice crop may have synthesized more chlorophyll because of effective weed control that improved the accumulation of photosynthesis and increased translocation that ultimately

Table 4.10(a): Effect of integrated weed management and cultivars on yield attributes of black rice

Treatments	Grain yield (kg ha^{-1})			Straw yield (kg ha^{-1})			Biological yield (kg ha^{-1})			Harvest index (%)		
Weed Management	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
W_1 -Weedy check (Control)	1067.92	1086.75	1077.33	2950.42	3027.67	2989.04	4018.33	4114.42	4066.38	26.55	26.37	26.46
W_2 - Hand weeding (15 and 30 DAS)	1870.08	1873.42	1871.75	4005.17	4101.00	4053.08	5875.25	5974.42	5924.83	31.83	31.37	31.60
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	1686.67	1693.42	1690.04	3702.75	3733.42	3718.08	5389.42	5426.83	5408.13	31.29	31.23	31.26
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	1268.00	1272.33	1270.17	3351.67	3405.67	3378.67	4619.67	4678.00	4648.83	27.45	27.22	27.34
SEm±	26.94	32.15	20.97	52.13	52.34	36.94	60.55	48.79	38.88	0.50	0.66	0.41
CD at 5%	93.21	111.27	64.62	180.41	181.11	113.81	209.53	168.84	119.80	1.73	2.28	1.27
CV %	6.33	7.52	6.95	5.16	5.08	5.12	4.22	3.35	3.80	5.90	7.86	6.94
Cultivar												
C_1- *Chakhao Poireiton*	1553.92	1561.08	1557.50	3595.92	3672.17	3634.04	5149.83	5233.25	5191.54	29.89	29.57	29.73
C_2 -*Chakhao Amubi*	1508.67	1520.58	1514.63	3561.00	3631.75	3596.38	5069.67	5152.33	5111.00	29.48	29.27	29.38
C_3 -*Wairi Chakhao*	1389.17	1397.67	1393.42	3368.75	3431.83	3400.29	4757.92	4829.50	4793.71	28.83	28.59	28.71
C_4 -*Khurukhul Chakhao*	1440.92	1446.58	1443.75	3484.33	3532.00	3508.17	4925.25	4978.58	4951.92	28.92	28.77	28.84
SEm±	21.42	21.46	15.16	50.51	61.87	39.93	62.46	67.44	45.96	0.34	0.46	0.29
CD at 5%	62.52	62.64	43.11	147.42	180.59	113.55	182.31	196.84	130.69	NS	NS	NS
CV %	5.04	5.02	5.03	5.00	6.01	5.53	4.35	4.63	4.49	3.97	5.51	4.80

Table 4.10(b): Interaction effect of integrated weed management and cultivars on yield attributes of black rice

Treatments	Grain yield (kg ha^{-1})			Straw yield (kg ha^{-1})			Biological yield (kg ha^{-1})			Harvest index (%)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	1135.67	1148.00	1141.83	3000.00	3081.67	3040.83	4135.67	4229.67	4182.67	27.45	27.08	27.27
W_1C_2	1109.67	1137.67	1123.67	2988.33	3060.33	3024.33	4098.00	4198.00	4148.00	27.01	27.07	27.04
W_1C_3	991.00	1014.00	1002.50	2857.67	2938.00	2897.83	3848.67	3952.00	3900.33	25.81	25.65	25.73
W_1C_4	1035.33	1047.33	1041.33	2955.67	3030.67	2993.17	3991.00	4078.00	4034.50	25.93	25.67	25.80
W_2C_1	1962.00	1966.00	1964.00	4090.33	4162.00	4126.17	6052.33	6128.00	6090.17	32.43	32.11	32.27
W_2C_2	1898.67	1900.33	1899.50	4075.33	4127.67	4101.50	5974.00	6028.00	6001.00	31.77	31.57	31.67
W_2C_3	1793.67	1796.67	1795.17	3864.67	3990.67	3927.67	5658.33	5787.33	5722.83	31.72	31.05	31.39
W_2C_4	1826.00	1830.67	1828.33	3990.33	4123.67	4057.00	5816.33	5954.33	5885.33	31.42	30.75	31.08
W_3C_1	1747.00	1752.00	1749.50	3763.33	3828.67	3796.00	5510.33	5580.67	5545.50	31.70	31.45	31.58
W_3C_2	1723.00	1735.33	1729.17	3728.00	3800.67	3764.33	5451.00	5536.00	5493.50	31.64	31.34	31.49
W_3C_3	1613.00	1619.33	1616.17	3597.33	3601.67	3599.50	5210.33	5221.00	5215.67	30.93	31.03	30.98
W_3C_4	1663.67	1667.00	1665.33	3722.33	3702.67	3712.50	5386.00	5369.67	5377.83	30.89	31.10	30.99
W_4C_1	1371.00	1378.33	1374.67	3530.00	3616.33	3573.17	4901.00	4994.67	4947.83	27.97	27.64	27.81
W_4C_2	1303.33	1309.00	1306.17	3452.33	3538.33	3495.33	4755.67	4847.33	4801.50	27.52	27.08	27.30
W_4C_3	1159.00	1160.67	1159.83	3155.33	3197.00	3176.17	4314.33	4357.67	4336.00	26.86	26.63	26.75
W_4C_4	1238.67	1241.33	1240.00	3269.00	3271.00	3270.00	4507.67	4512.33	4510.00	27.45	27.54	27.50
SEm±(W×C)	42.84	42.92	30.32	101.01	123.74	79.87	124.92	134.88	91.92	0.67	0.92	0.57
SEm±(C×W)	51.08	53.37	48.98	116.27	138.85	124.00	142.50	149.17	141.93	0.83	1.13	0.93
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

increased yield of the crop. Findings are in corroboration with those of Santiago *et al.* (2022) and Zhang *et al.* (2023). Further higher straw yield after hand weeding was followed by pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS and pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS. Weed management practices not only reduced the weed density and dry weight but it also allows plant to use available resources efficiently which gave higher yield over unweeded control. Similar findings were reported by Choudhary and Dixit (2018) and Kashid (2019).

4.1.3.8.2 Effect of cultivars on straw yield of black rice

Data pertaining to straw yield influenced by different cultivars are exhibited in Table 4.10(a) where it was revealed that for both the years, *Chakhao Poireiton* recorded maximum straw yield and it was found to be at par with *Chakhao Amubi* statistically. Islam *et al.* (2012) and Tyeb *et al.* (2013) reported that variety exerted variable effect on yield contributing characters and yield of rice. Further the data also revealed that *Wairi Chakhao* recorded the lowest straw yield and it was found to be at par with *Khurukhul Chakhao*.

4.1.3.8.3 Interaction effect of integrated weed management and cultivars on straw yield of black rice

Interaction between integrated weed management and different cultivars illustrated in Table 4.10 (b) did not show any significant effect on straw yield in both the years of experiment.

4.1.3.9 Biological yield (kg ha^{-1})

The data related to biological yield as influenced by integrated weed

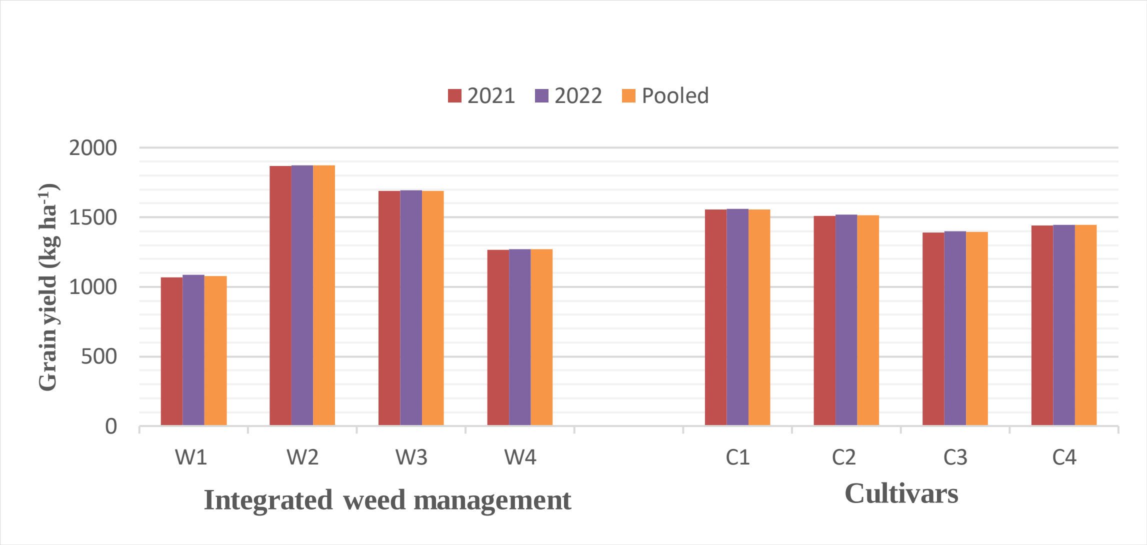

Fig 4.1: Effect of integrated weed management and cultivar on grain yield (kg ha^{-1})

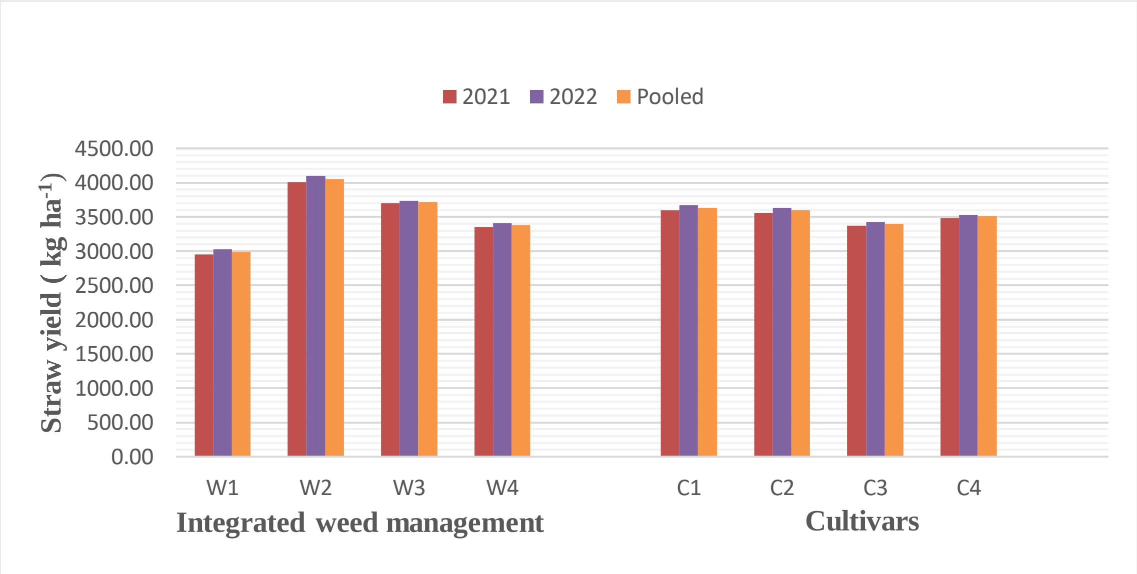

Fig 4.2: Effect of integrated weed management and cultivar on straw yield (kg ha^{-1})

management and different cultivars recorded during both the cropping seasons have been depicted in Table 4.10 (a) and 4.10 (b).

4.1.3.9.1 Effect of integrated weed management on biological yield

The data on biological yield as influenced by integrated weed management showed significant effect where hand weeding twice at 15 and 30 DAS revealed highest biological yield in both the years of experiment. This was followed by application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS. The higher yield was perhaps as a result of higher availability of nutrients when needed and better weed control efficiency. Similar findings are in conformity with the results of Kumawat *et al.* (2017). Higher yield and less crop weed competition was due to better weed control throughout the crop growth seasons, effective utilization of moisture, nutrients, light and space as a whole Munda *et al*. (2019) findings are also in sync with the same. In addition, the lowest biological yield was revealed with weedy check in both the years of experiment.

4.1.3.9.2 Effect of cultivars on biological yield of black rice

The variation in data as influenced by different cultivars on biological yield revealed that highest biological yield was observed with the cultivar *Chakhao Poireiton* which was statistically at par with *Chakhao Amubi* in both the years and pooled data. Similar results were also reported by Amanullah and Inamulah (2016) where due to superiority in grain yield (because of higher percentage of filled grains) and straw yield (due to traits such as plant height, panicle length) respectively. However, data further revealed that in both the years of experiment *Chakhao Amubi* was observed to be at par with *Khurukhul Chakhao*. In addition, pooled data revealed that significantly lowest biological yield was recorded with cultivar *Wairi Chakhao*.

4.1.3.9.3 Interaction effect of integrated weed management and cultivars on biological yield of black rice

Interaction between integrated weed management and different cultivars illustrated in Table 4.10 (b) did not show any significant effect on biological yield in both the years of experiment.

4.1.3.10 Harvest index (%)

The data related to harvest index as influenced by integrated weed management and different cultivars recorded during both the cropping seasons have been depicted in Table 4.10 (a) and 4.10(b).

4.1.3.9.1 Effect of integrated weed management on harvest index (%)

The variation in data as influenced by integrated weed management illustrated that both the years of experiment as well as the pooled data showed that the highest harvest index was recorded with hand weeding twice at 15 and 30 DAS which was found statistically to be at par with application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS. The weed free (hand weeding) and chemical integrated with one hand weeding plots recorded greater harvest index values than weedy check which may be due to higher availability of water and nutrients resulting in improved sink capacity and higher grain productivity. This is in close conformity with the results of Raj *et al.* (2019) and Biswas *et al*. (2020). Further data also showed that lowest harvest index was observed with weedy check which was at par with pretilachlor @1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25 g ha^{-1} (PoE) at 20 DAS statistically.

4.1.3.9.2 Effect of cultivars on harvest index (%) of black rice

The data as influenced by different cultivars illustrated in Table 4.10 (a) failed to show any significant effect on harvest index of black rice in both the years of experiment.

4.1.3.9.3 Interaction effect of integrated weed management and cultivars on harvest index (%) of black rice

Interaction between integrated weed management and different cultivars illustrated in Table 4.10 (b) did not show any significant effect on harvest index in both the years of experiment.

4.1.4 Quality Parameters

4.1.4.1 Milling percentage (%)

Data with regard to milling percentage as influenced with integrated weed management and different cultivars are illustrated in Table 4.11 (a) and 4.11 (b).

4.1.4.1.1 Effect of integrated weed management on milling percentage (%)

Data with regard to milling percentage as depicted in Table 4.11 (a) showed that integrated weed management did not show any significant effect in both the years of experiment however pooled data showed that maximum milling percentage was significantly recorded with hand weeding at 15 and 30 DAS which was followed with application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS. Data further revealed that significantly lowest milling percentage was recorded in weedy check.

4.1.4.1.2 Effect of cultivars on milling percentage (%)

Variation in data pertaining to milling percentage as influenced by different cultivars in both the years of experiment revealed that maximum milling percentage was observed with cultivar *Chakhao Poireiton* which was statistically at par with *Chakhao Amubi*. Data further revealed that cultivar *Chakhao Amubi* was at par with *Khurukhul Chakhao*. In addition, the lowest milling percentage was observed in *Wairi Chakhao* which was also at par with *Khurukhul Chakhao*.

4.1.4.1.3 Interaction effect of integrated weed management and cultivars on milling percentage (%) of black rice

Interaction between integrated weed management and different cultivars illustrated in Table 4.11 (b) did not show any significant effect on milling percentage in both the years of experiment.

4.1.4.2 Hulling percentage (%)

Data with regard to hulling percentage as influenced with integrated weed management and different cultivars are depicted in Table 4.11 (a) and 4.11 (b).

4.1.4.2.1 Effect of integrated weed management on hulling percentage (%)

Data with regard to hulling percentage as depicted in Table 4.11 (a) showed that integrated weed management did not show any significant effect in both the years of experiment.

4.1.4.2.2 Effect of cultivars on hulling percentage (%)

Data pertaining to hulling percentage as influenced by different cultivars revealed that in the both years maximum hulling percentage was recorded with

Table 4.11(a): Effect of integrated weed management and cultivars on quality parameters of black rice

Treatment	Milling %			Hulling %			Head rice recovery %			Protein content (%)		
Weed Management	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
W_1 -Weedy check (Control)	60.04	59.93	59.98	68.05	67.99	68.02	48.32	48.47	48.39	9.54	9.55	9.54
W_2 - Hand weeding (15 and 30 DAS)	61.24	61.10	61.17	68.88	68.47	68.67	49.86	50.05	49.95	10.65	10.84	10.74
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	60.59	60.38	60.49	68.28	68.18	68.23	48.62	48.82	48.72	10.06	10.26	10.16
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	60.88	60.32	60.60	68.11	68.17	68.14	48.34	48.48	48.41	9.78	9.88	9.83
SEm±	0.27	0.24	0.18	0.22	0.38	0.22	0.52	0.42	0.33	0.09	0.11	0.07
CD at 5%	NS	NS	0.56	NS	NS	NS	NS	NS	NS	0.32	0.36	0.22
Cultivar												
C_1- *Chakhao Poireiton*	61.68	61.14	61.41	69.11	69.03	69.07	49.83	50.11	49.97	9.93	10.11	10.02
C_2 -*Chakhao Amubi*	61.04	60.66	60.85	68.54	68.28	68.41	49.19	49.48	49.33	10.04	10.28	10.16
C_3 -*Wairi Chakhao*	59.73	59.74	59.73	67.43	67.37	67.40	47.56	47.43	47.50	9.96	9.97	9.96
C_4 -*Khurukhul Chakhao*	60.30	60.18	60.24	68.23	68.13	68.18	48.55	48.79	48.67	10.10	10.16	10.13
SEm±	0.33	0.31	0.23	0.30	0.37	0.24	0.49	0.39	0.31	0.10	0.09	0.07
CD at 5%	0.96	0.90	0.64	0.88	1.08	0.68	1.42	1.12	0.88	NS	NS	NS

Table 4.11(b): Interaction effect of integrated weed management and cultivars on quality parameters of black rice

Treatments	Milling %			Hulling %			Head rice recovery %			Protein content (%)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	60.80	60.40	60.60	69.13	69.57	69.35	49.40	49.70	49.55	9.40	9.60	9.50
W_1C_2	60.53	60.33	60.43	67.90	68.13	68.02	48.93	49.40	49.17	9.50	9.50	9.50
W_1C_3	58.77	59.20	58.98	67.10	66.83	66.97	46.63	46.30	46.47	9.69	9.35	9.52
W_1C_4	60.07	59.77	59.92	68.07	67.43	67.75	48.30	48.47	48.38	9.56	9.73	9.65
W_2C_1	63.07	61.87	62.47	69.90	69.50	69.70	50.57	51.03	50.80	10.69	10.79	10.74
W_2C_2	61.20	61.50	61.35	69.73	68.17	68.95	50.07	50.13	50.10	10.73	10.92	10.82
W_2C_3	60.20	60.33	60.27	67.23	67.50	67.37	49.03	49.17	49.10	10.44	10.83	10.64
W_2C_4	60.50	60.70	60.60	68.63	68.70	68.67	49.77	49.87	49.82	10.75	10.81	10.78
W_3C_1	61.20	61.17	61.18	68.63	68.40	68.52	49.57	49.87	49.72	10.02	10.33	10.18
W_3C_2	60.83	60.37	60.60	68.20	68.20	68.20	48.83	49.70	49.27	10.25	10.54	10.40
W_3C_3	60.13	59.87	60.00	68.30	68.00	68.15	47.97	47.03	47.50	10.10	10.00	10.05
W_3C_4	60.20	60.13	60.17	68.00	68.10	68.05	48.10	48.67	48.38	9.88	10.15	10.01
W_4C_1	61.67	61.13	61.40	68.77	68.63	68.70	49.80	49.83	49.82	9.60	9.71	9.66
W_4C_2	61.60	60.43	61.02	68.33	68.60	68.47	48.93	48.67	48.80	9.69	10.17	9.93
W_4C_3	59.80	59.57	59.68	67.10	67.13	67.12	46.60	47.23	46.92	9.60	9.69	9.65
W_4C_4	60.43	60.13	60.28	68.23	68.30	68.27	48.03	48.17	48.10	10.23	9.96	10.09
SEm±(W×C)	0.66	0.62	0.45	0.60	0.74	0.48	0.97	0.77	0.62	0.20	0.18	0.13
SEm±(C×W)	0.73	0.69	0.69	0.67	0.85	0.74	1.12	0.90	0.97	0.23	0.21	0.21
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

cultivar *Chakhao Poireiton* which was at par with *Chakhao Amubi*. Data further revealed that *Chakhao Amubi* was at par with *Khurukhul Chakhao* while the lowest hulling percentage was observed with cultivar *Wairi Chakhao* which was also seen to be at par with *Khurukhul Chakhao*. Further pooled data also revealed similar results however in addition the lowest hulling percentage was recorded significantly with *Wairi Chakhao*. Sahu *et al*. (2017) and Sharma *et al*. (2022) in their findings also reported varietal differences being the cause of variation in hulling percentage among the different cultivars.

4.1.4.2.3 Interaction effect of integrated weed management and cultivars on hulling percentage (%) of black rice

Interaction between integrated weed management and different cultivars illustrated in Table 4.11 (b) did not show any significant effect on hulling percentage in both the years of experiment.

4.1.4.3 Head rice recovery (%)

Data with regard to head rice recovery as influenced with integrated weed management and different cultivars are depicted in Table 4.11 (a) and 4.11 (b).

4.1.4.3.1 Effect of integrated weed management on head rice recovery (%)

Data with regard to head rice recovery as depicted in Table 4.11 (a) showed that integrated weed management did not show any significant effect in both the years of experiment.

4.1.4.3.2 Effect of cultivars on head rice recovery (%)

Variation in data as influenced by different cultivars on head rice recovery showed that highest head rice recovery was recorded with cultivar *Chakhao*

Poireiton which was seen to be at par with *Chakhao Amubi* statistically which was followed with cultivar *Khurukhul Chakhao*. In addition, significantly the minimum head rice recovery was exhibited with *Wairi Chakhao*.

4.1.4.3.3 Interaction effect of integrated weed management and cultivars on head rice recovery (%) of black rice

Interaction between integrated weed management and different cultivars illustrated in Table 4.11 (b) witnessed that it did not show any significant effect on head rice recovery in both the years of the experiment.

4.1.4.4 Protein content (%)

Data pertaining to protein content as influenced with integrated weed management and different cultivars are depicted in Table 4.11 (a) and 4.11 (b).

4.1.4.4.1 Effect of integrated weed management on protein content (%)

Data with regard to protein content as exhibited in Table 4.11 (a) showed that integrated weed management observed significant effect on protein content in both the years of experiment. Data revealed that the maximum protein content was significantly exhibited with hand weeding twice at 15 and 30 DAS which was followed with application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS. Chaudhary *et al*. (2022) from his findings reported that increase in protein content was due to reduced crop-weed competition for limited resources. The reduction in competition led to an overall improvement in growth of crop as reflected by plant height and dry matter accumulation which in return led to higher development of reproductive structure and translocation of photosynthates to the sink. It was also further observed that significantly lowest protein content was exhibited with weedy check in both the years of experiment.

4.1.4.4.2 Effect of cultivars on protein content (%)

Variation in data as influenced by different cultivars on head rice recovery showed no significant effect on protein content in both the years of experiment.

4.1.4.4.3 Interaction effect of integrated weed management and cultivars on protein content (%) of black rice

Interaction between integrated weed management and different cultivars illustrated in Table 4.11 (b) showed that it did not show any significant effect on protein content in both the years of the experiment.

4.1.4.5 Organoleptic test

Based on the scores graded by the 15 assessors, mean grades were evaluated. In context with the grades, it was revealed that on the basis of appearance, cultivar *Chakhao Poireiton*, *Chakhao Amubi* and *Wairi Chakhao* were light purple in colour while *Khurukhul Chakhao* was light brown in appearance. In regard to cohesiveness, *Chakhao Poireiton*, *Wairi Chakhao* and *Khurukhul Chakhao* were found to be very sticky however *Chakhao Amubi* was found to be moderately separated. Tenderness on touching revealed that *Chakhao Poireiton* was soft, *Chakhao Amubi* was moderately soft while with *Wairi Chakhao* and *Khurukhul Chakhao* was found to be very soft. All the four cultivars were found to be soft on tenderness on chewing and good on basis of taste. Aroma was found optimal with *Chakhao Poireiton* and *Khurukhul Chakhao* while mild with *Chakhao Amubi* and *Wairi Chakhao* respectively. Cultivar *Chakhao Poireiton* and *Wairi Chakhao* was found excellent with regard to elongation and *Chakhao Amubi* and *Khurukhul Chakhao* were found to be good. The overall acceptability revealed that *Chakhao Poireiton* and *Wairi Chakhao* were found to be excellent while *Chakhao Amubi* and *Khurukhul Chakhao* were found to be good respectively.

Table 4.12: Organoleptic test of four black rice cultivars

	Characteristics	Rice cultivars			
		Chakhao Poireiton	***Chakhao Amubi***	***Wairi Chakhao***	***Khurukhul Chakhao***
A	**Appearance**				
5	Light purple	+	+		+
4	Variegated purple				
3	Light brown			+	
2	White with brown streaks				
1	White				
B	**Cohesiveness**				
5	Well separated				
4	Partially separated				
3	Slightly separated				
2	Moderately separated		+		
1	Very sticky	+		+	+
C	**Tenderness on touching**				
5	Soft	+			
4	Moderately soft		+		
3	Moderately hard				
2	Hard				
1	Very soft			+	+
D	**Tenderness on chewing**				
5	Soft	+	+	+	+
4	Moderately soft				
3	Moderately hard				
2	Hard				
1	Very soft				
E	**Taste**				
4	Good	+	+	+	+
3	Desirable				
2	Tasteless				
1	Undesirable				
F	**Aroma**				
5	Strong				
4	Optimal	+			+
3	Mild		+	+	

2	Other than basmati				
1	No scent				
G	**Elongation**				
4	Excellent	+		+	
3	Good		+		+
2	Moderate				
1	None				
H	**Overall acceptability**				
4	Excellent	+		+	
3	Good		+		+
2	Acceptable				
1	Undesirable				

4.2 Observation on weeds

4.2.1 Weed flora

The weed flora observed in the experimental field were identified and recorded as grasses, sedges and broad leaved weeds and are presented in Table 4.13. The dominant species of grasses were *Digiteria sanguinalis*, *Cynodon dactylon* and *Eleusine indica* while *Cyperus iria* and *Cyperus rotundus* were dominant among sedges and *Borreria latifolia*, *Mollugo pentaphylla*, *Alternanthera sessilis*, *Ageratum conyzoides*, *Phyllanthus niruri* and *Commelina benghalensis* were dominant in case of broad leaved weeds respectively.

Table 4.13: Weed flora of the experiment field

Sl.No.	Scientific name	Common name	Family	Ontogeny
Grasses				
1.	*Digiteria sanguinalis*	Crab grass	Poaceae	Annual
2.	*Cynodon dactylon*	Doob grass	Poaceae	Perennial
3.	*Eleusine indica*	Goose grass	Poaceae	Annual
Sedges				
4.	*Cyperus iria*	Yellow nut sedge	Cyperaceae	Annual
5.	*Cyperus rotundus*	Purple nut sedge	Cyperaceae	Annual
Broad leaved weeds				
6.	*Alternanthera sessilis*	Dwarf copperleaf	Amaranthaceae	Perennial
7.	*Mollugo pentaphylla*	Carpet weed	Molluginaceae	Annual
8.	*Borreria latifolia*	Button weed	Rubiaceae	Annual
9.	*Commelina benghalensis*	Day flower	Commelinaceae	Perennial
10	*Ageratum conyzoides*	Billy goat weed	Asteraceae	Annual
11.	*Phyllanthus niruri*	Haiardana	Phyllanthaceae	Annual

4.2.2 Weed population (no. m^2)

4.2.2.1 Grasses (no.m^{-2})

Observation on population of grasses and their interaction recorded at 20, 40 and 60 DAS are presented in Table 4.14 (a) and Table 4.14 (b).

4.2.2.1.1 Effect of integrated weed management on population of grasses

The variation in data with regard to population of grasses due to integrated weed management were found to be significant where at all the stages of observation the lowest and highest population of grasses was recorded with two hand weeding at 15 and 30 DAS and weedy check respectively. It may be due to effective control of weeds during critical period of crop-weed competition. Similar findings were reported by Saranraj *et al*. (2018) and Sreedevi *et al.* (2018). Further, lower population was recorded with application of pretilachlor

@ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS which was found to be statistically at par with pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS at all the growth stages in both the years of experiment. This result confirms the findings of Afroz *et al.* (2019) who found maximum weed density in no weeding treatment and the minimum was seen with application of pre-emergence herbicide pretilachlor followed by one hand weeding. A close similarity was also noted by Soujanya *et al.* (2020) where it may be due to broad spectrum and longer period control of weeds by sequential application of herbicides and integrated management of weeds combined with mechanical weeding.

4.2.2.1.2 Effect of different cultivars on population of grasses

The perusal on data with effect of different cultivars on population of grasses revealed that at 20 DAS significantly lowest population of grasses was exhibited with cultivar *Chakhao Poireiton* in first year and pooled data. However, the second-year data showed that lowest population of grasses was recorded with *Chakhao Poireiton* which was at par with *Chakhao Amubi*. Additionally, cultivar *Wairi Chakhao* recorded highest population of grasses. At 40 and 60 DAS, data revealed that in both years of experiment and pooled data lowest population of grasses was recorded with *Chakhao Poireiton* while it was also seen that cultivar *Chakhao Amubi* was at par with *Khurukhul Chakhao*. Further, cultivar *Wairi Chakhao* recorded highest population of grasses which was at par with *Khurukhul Chakhao* respectively. Kumar *et al.* (2020) revealed from his findings that rice cultivars may vary in their weed competitive ability which might be because of their diverse morphological traits, *viz.* plant height, canopy structure, relative growth rate etc.

Eleusine indica

Digiteria sanguinalis

Cynodon dactylon

Plate 5(a): Weed flora in the experimental field

Cyperus iria

Cyperus rotundus

Plate 5(b): Weed flora in the experimental field

Mollugo pentaphylla

Alternanthera sessilis

Ageratum conyzoides

Borreria latifolia

Plate 5(c): Weed flora in the experimental field

Table 4.14(a): Effect of integrated weed management and cultivars on population of grasses (no. m^{-2}) at different growth stages

Treatments	20 DAS			40 DAS			60 DAS		
Weed Management	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
W_1 -Weedy check (Control)	9.70 (94.67)	9.61 (93.00)	9.66 (93.83)	12.06 (147.33)	11.78 (139.67)	11.92 (143.50)	13.90 (196.00)	13.52 (192.00)	13.71 (194.00)
W_2 - Hand weeding (15 and 30 DAS)	5.59 (32.00)	5.20 (28.00)	5.40 (30.00)	6.17 (41.67)	6.23 (40.33)	6.20 (41.00)	7.00 (57.33)	6.66 (46.00)	6.83 (51.67)
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	7.63 (59.67)	7.30 (54.33)	7.47 (57.00)	8.74 (78.00)	8.57 (75.67)	8.66 (76.83)	9.46 (91.67)	9.26 (88.33)	9.36 (90.00)
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	7.73 (61.67)	7.69 (60.33)	7.71 (61.00)	8.91 (80.33)	8.65 (76.33)	8.78 (78.33)	9.91 (99.00)	9.77 (96.00)	9.84 (97.50)
SEm±	0.25	0.23	0.17	0.30	0.25	0.20	0.33	0.59	0.34
CD (P=0.05)	0.88	0.80	0.53	1.05	0.88	0.61	1.13	2.05	1.04
Cultivar									
C_1- *Chakhao Poireiton*	6.32 (42.33)	6.29 (42.33)	6.31 (42.33)	7.29 (61.33)	7.36 (59.33)	7.33 (60.33)	8.16 (75.00)	7.63 (62.67)	7.89 (68.83)
C_2 -*Chakhao Amubi*	7.14 (53.00)	6.94 (51.00)	7.04 (52.00)	8.64 (79.00)	8.45 (76.67)	8.55 (77.83)	9.14 (94.00)	9.72 (104.00)	9.43 (99.00)
C_3 -*Wairi Chakhao*	9.06 (84.33)	8.83 (80.33)	8.94 (82.33)	10.48 (114.00)	10.42 (112.67)	10.45 (113.33)	12.15 (154.00)	11.37 (138.33)	11.76 (146.17)
C_4 -*Khurukhul Chakhao*	8.14 (68.33)	7.74 (62.00)	7.94 (65.17)	9.46 (93.00)	8.99 (83.33)	9.23 (88.17)	10.82 (121.00)	10.48 (117.33)	10.65 (119.17)
SEm±	0.26	0.27	0.19	0.38	0.29	0.24	0.41	0.40	0.29
CD (P=0.05)	0.76	0.79	0.54	1.11	0.84	0.68	1.20	1.17	0.82

Original values were subjected to square root transformation. Figures in parenthesis are the original values

Table 4.14 (b): Interaction effect of integrated weed management and cultivars on population of grasses (no. m^{-2}) at different growth stages

Treatments	20 DAS			40 DAS			60 DAS		
	2021	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
W_1C_1	8.57 (73.33)	8.86 (78.67)	8.72 (76.00)	10.77 (117.33)	10.91 (118.67)	10.84 (118.00)	11.61 (134.67)	9.16 (86.67)	10.39 (110.67)
W_1C_2	9.25 (85.33)	9.21 (85.33)	9.23 (85.33)	11.64 (136.00)	11.62 (134.67)	11.63 (135.33)	13.53 (182.67)	14.34 (210.67)	13.93 (196.67)
W_1C_3	10.70 (114.67)	10.85 (117.33)	10.78 (116.00)	13.57 (184.00)	13.45 (181.33)	13.51 (182.67)	16.31 (266.67)	15.85 (253.33)	16.08 (260.00)
W_1C_4	10.28 (105.33)	9.52 (90.67)	9.90 (98.00)	12.25 (152.00)	11.13 (124.00)	11.69 (138.00)	14.15 (200.00)	14.72 (217.33)	14.44 (208.67)
W_2C_1	4.20 (17.33)	4.04 (16.00)	4.12 (16.67)	3.67 (17.33)	4.64 (21.33)	4.15 (19.33)	4.27 (24.00)	4.65 (22.67)	4.46 (23.33)
W_2C_2	5.55 (30.67)	4.61 (21.33)	5.08 (26.00)	5.91 (34.67)	5.73 (33.33)	5.82 (34.00)	5.29 (36.00)	6.73 (45.33)	6.01 (40.67)
W_2C_3	6.61 (44.00)	6.35 (40.00)	6.48 (42.00)	7.78 (61.33)	7.91 (62.67)	7.85 (62.00)	9.40 (88.00)	8.03 (64.00)	8.72 (76.00)
W_2C_4	6.02 (36.00)	5.78 (34.67)	5.90 (35.33)	7.32 (53.33)	6.64 (44.00)	6.98 (48.67)	9.03 (81.33)	7.21 (52.00)	8.12 (66.67)
W_3C_1	6.08 (37.33)	5.91 (34.67)	6.00 (36.00)	6.66 (44.00)	6.15 (37.33)	6.40 (40.67)	7.41 (54.67)	8.05 (66.67)	7.73 (60.67)
W_3C_2	6.86 (46.67)	6.85 (46.67)	6.86 (46.67)	8.43 (70.67)	8.51 (72.00)	8.47 (71.33)	8.71 (76.00)	8.78 (78.67)	8.74 (77.33)
W_3C_3	9.26 (85.33)	8.79 (77.33)	9.02 (81.33)	10.41 (108.00)	10.44 (109.33)	10.43 (108.67)	11.09 (122.67)	10.44 (112.00)	10.77 (117.33)
W_3C_4	8.32 (69.33)	7.66 (58.67)	7.99 (64.00)	9.46 (89.33)	9.19 (84.00)	9.32 (86.67)	10.63 (113.33)	9.79 (96.00)	10.21 (104.67)
W_4C_1	6.42 (41.33)	6.36 (40.00)	6.39 (40.67)	8.07 (66.67)	7.76 (60.00)	7.91 (63.33)	9.33 (86.67)	8.67 (74.67)	9.00 (80.67)
W_4C_2	6.92 (49.33)	7.08 (50.67)	7.00 (50.00)	8.60 (74.67)	7.94 (66.67)	8.27 (70.67)	9.03 (81.33)	9.04 (81.33)	9.04 (81.33)
W_4C_3	9.66 (93.33)	9.31 (86.67)	9.49 (90.00)	10.14 (102.67)	9.88 (97.33)	10.01 (100.00)	11.79 (138.67)	11.15 (124.00)	11.47 (131.33)
W_4C_4	7.92 (62.67)	8.00 (64.00)	7.96 (63.33)	8.82 (77.33)	9.00 (81.33)	8.91 (79.33)	9.48 (89.33)	10.21 (104.00)	9.84 (96.67)
SEm±(W×C)	0.52	0.54	0.38	0.76	0.58	0.48	0.82	0.80	0.58
SEm±(C×W)	0.59	0.61	0.58	0.85	0.65	0.74	0.92	0.99	0.91
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Original values were subjected to square root transformation. Figures in parenthesis are the original value

4.2.2.1.3 Interaction effect of integrated weed management and cultivars on population of grasses

Results illustrated in Table 4.14 (b) revealed that interaction of integrated weed management and different cultivars did not show any significant effect on population of grasses in both the years of experiment at all stages of observation.

4.2.2.2 Sedges (no.m^{-2})

The data on population of sedges as influenced by integrated weed management and different cultivars recorded at 20, 40 and 60 DAS are presented in Table 4.15 (a) and Table 4.15 (b).

4.2.2.2.1 Effect of integrated weed management on population of sedges

The perusal on data of population of sedges as influenced by integrated weed management revealed significant results in both the years of experiment at all stages of growth. Significantly mimumum and maximum population of sedges was observed with two hand weeding at 15 and 30 DAS and weedy check respectively. This may have been because of lesser competition of weeds achieved by effective control of first and second flush of weeds which resulted in reduction of weed density Rathika and Ramesh (2019). Further, data also showed that apart from hand weeding lower population was seen with sequential application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS and it was statistically at par with pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS. Similar observation was also found by Mondal *et al.* (2019) where both monocot and dicot weeds were controlled effectively by pretilachlor and also by bispyribac sodium respectively.

Table 4.15 (a): Effect of integrated weed management and cultivars on population of sedges (no. m^{-2}) at different growth stages

Treatments	20 DAS			40 DAS			60 DAS		
Weed Management	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
W_1 -Weedy check (Control)	6.33 (40.33)	6.25 (39.00)	6.29 (39.67)	7.90 (62.33)	7.69 (59.00)	7.80 (60.67)	9.39 (88.00)	9.28 (86.00)	9.34 (87.00)
W_2 - Hand weeding (15 and 30 DAS)	3.53 (13.00)	3.18 (10.33)	3.35 (11.67)	4.52 (20.67)	4.44 (19.67)	4.48 (20.17)	5.05 (25.33)	4.75 (22.67)	4.90 (24.00)
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	5.05 (26.00)	4.95 (25.33)	5.00 (25.67)	6.05 (37.00)	5.97 (35.67)	6.01 (36.33)	6.50 (42.67)	6.36 (40.67)	6.43 (41.67)
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	5.17 (27.67)	5.10 (27.00)	5.14 (27.33)	6.33 (40.00)	6.29 (39.67)	6.31 (39.83)	6.65 (45.00)	6.52 (43.00)	6.58 (44.00)
SEm±	0.20	0.13	0.12	0.10	0.16	0.09	0.09	0.12	0.07
CD (P=0.05)	0.71	0.45	0.37	0.34	0.55	0.29	0.30	0.40	0.22
Cultivar									
C_1- *Chakhao Poireiton*	4.02 (17.00)	3.79 (15.67)	3.90 (16.33)	5.30 (29.67)	5.48 (31.33)	5.39 (30.50)	6.21 (41.33)	5.98 (38.33)	6.09 (39.83)
C_2 -*Chakhao Amubi*	4.73 (23.33)	4.73 (23.67)	4.73 (23.50)	6.08 (38.33)	5.91 (36.00)	5.99 (37.17)	6.67 (47.00)	6.52 (45.00)	6.59 (46.00)
C_3 -*Wairi Chakhao*	6.00 (37.00)	5.93 (36.33)	5.96 (36.67)	7.05 (50.67)	6.78 (47.00)	6.91 (48.83)	7.67 (60.67)	7.62 (60.33)	7.65 (60.50)
C_4 -*Khurukhul Chakhao*	5.33 (29.67)	5.02 (26.00)	5.18 (27.83)	6.36 (41.33)	6.22 (39.67)	6.29 (40.50)	7.03 (52.00)	6.80 (48.67)	6.92 (50.33)
SEm±	0.26	0.23	0.17	0.18	0.19	0.13	0.22	0.19	0.15
CD (P=0.05)	0.75	0.66	0.49	0.54	0.56	0.38	0.65	0.55	0.42

Original values were subjected to square root transformation. Figures in parenthesis are the original values

Table 4.15(b): Interaction effect of integrated weed management and cultivars on population of sedges (no. m^{-2}) at different growth stages

Treatments	20 DAS			40 DAS			60 DAS		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	5.42 (29.33)	5.55 (30.67)	5.49 (30.00)	7.13 (50.67)	7.15 (50.67)	7.14 (50.67)	9.10 (82.67)	8.74 (76.00)	8.92 (79.33)
W_1C_2	6.24 (38.67)	6.25 (38.67)	6.24 (38.67)	8.03 (64.00)	7.60 (57.33)	7.81 (60.67)	9.33 (86.67)	9.18 (84.00)	9.26 (85.33)
W_1C_3	7.00 (49.33)	6.93 (48.00)	6.96 (48.67)	8.43 (70.67)	8.18 (66.67)	8.31 (68.67)	9.68 (93.33)	9.75 (94.67)	9.71 (94.00)
W_1C_4	6.66 (44.00)	6.25 (38.67)	6.45 (41.33)	8.01 (64.00)	7.83 (61.33)	7.92 (62.67)	9.46 (89.33)	9.47 (89.33)	9.47 (89.33)
W_2C_1	2.39 (5.33)	2.12 (4.00)	2.25 (4.67)	3.45 (12.00)	3.66 (13.33)	3.56 (12.67)	4.65 (21.33)	4.04 (16.00)	4.35 (18.67)
W_2C_2	3.45 (12.00)	3.03 (9.33)	3.24 (10.67)	4.37 (18.67)	4.22 (17.33)	4.29 (18.00)	4.90 (24.00)	4.61 (21.33)	4.76 (22.67)
W_2C_3	4.40 (20.00)	4.04 (16.00)	4.22 (18.00)	5.30 (28.00)	5.08 (25.33)	5.19 (26.67)	5.58 (30.67)	5.44 (29.33)	5.51 (30.00)
W_2C_4	3.89 (14.67)	3.50 (12.00)	3.70 (13.33)	4.94 (24.00)	4.80 (22.67)	4.87 (23.33)	5.07 (25.33)	4.92 (24.00)	4.99 (24.67)
W_3C_1	4.22 (17.33)	3.59 (13.33)	3.91 (15.33)	5.07 (25.33)	5.20 (26.67)	5.13 (26.00)	5.88 (34.67)	5.56 (30.67)	5.72 (32.67)
W_3C_2	4.91 (24.00)	4.91 (24.00)	4.91 (24.00)	5.75 (33.33)	5.79 (33.33)	5.77 (33.33)	6.21 (38.67)	6.12 (37.33)	6.17 (38.00)
W_3C_3	5.92 (34.67)	6.00 (36.00)	5.96 (35.33)	7.33 (53.33)	6.86 (46.67)	7.10 (50.00)	7.51 (56.00)	7.30 (53.33)	7.41 (54.67)
W_3C_4	5.15 (28.00)	5.31 (28.00)	5.23 (28.00)	6.04 (36.00)	6.02 (36.00)	6.03 (36.00)	6.39 (41.33)	6.46 (41.33)	6.42 (41.33)
W_4C_1	4.04 (16.00)	3.89 (14.67)	3.96 (15.33)	5.55 (30.67)	5.90 (34.67)	5.73 (32.67)	5.20 (26.67)	5.57 (30.67)	5.39 (28.67)
W_4C_2	4.34 (18.67)	4.74 (22.67)	4.54 (20.67)	6.15 (37.33)	6.04 (36.00)	6.10 (36.67)	6.25 (38.67)	6.15 (37.33)	6.20 (38.00)
W_4C_3	6.67 (44.00)	6.75 (45.33)	6.71 (44.67)	7.14 (50.67)	6.98 (49.33)	7.06 (50.00)	7.92 (62.67)	7.99 (64.00)	7.96 (63.33)
W_4C_4	5.42 (32.00)	5.55 (25.33)	5.49 (28.67)	6.47 (41.33)	6.23 (38.67)	6.35 (40.00)	7.22 (52.00)	6.36 (40.00)	6.79 (46.00)
SEm±(W×C)	0.51	0.45	0.34	0.37	0.39	0.27	0.45	0.38	0.29
SEm±(C×W)	0.57	0.50	0.52	0.40	0.43	0.41	0.48	0.41	0.44
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Original values were subjected to square root transformation. Figures in parenthesis are the original values

4.2.2.2.2 Effect of different cultivars on population of sedges

Data in context with different cultivars on population of sedges revealed that at 20, 40 as well as 60 DAS showed variation in data where mimumum population was recorded with *Chakhao Poireiton* in both the years of experiment. While further data also revealed that highest population was observed with *Wairi Chakhao* which was at par with *Khurukhul Chakhao* respectively.

4.2.2.2.3 Interaction effect of integrated weed management and cultivars on population of sedges

Results portrayed in Table 4.15(b) revealed that interaction of integrated weed management and different cultivars showed no significant effect on population of sedges in both the years of experiment at all stages of observation.

4.2.2.3 Broad leaved weeds (no.m^{-2})

The data on population of broad leaved weeds as influenced by integrated weed management and different cultivars recorded at 20, 40 and 60 DAS are presented in Table 4.16 (a) and Table 4.16 (b).

4.2.2.3.1 Effect of integrated weed management on population of broad leaved weeds

The variation in data of population of broad leaved weeds as influenced by integrated weed management revealed significant results in both the years of experiment at all stages of growth. Significantly mimumum and maximum population of broad leaved weeds was observed with two hand weeding at 15 and 30 DAS and weedy check respectively. A similar result was also reported by

Ramesha *et al.* (2019) and Singh *et al.* (2019b) in their respective findings where manual weeding was successful in resulting lesser weeds. In addition, data further revealed that lower population was revealed with application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS was statistically at par with pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS. Karthika *et al*. (2019) in his result also found pre-emergence and hand weeding an ideal combination for managing weeds. The inhibition of long chain fatty acid in the germinating weeds by pretilachlor along with the inhibition of acetolactate synthase by bispyribac sodium might have resulted in lesser weed population by weeds.

4.2.2.3.2 Effect of cultivars on population of broad leaved weeds

Data in context with different cultivars with effect on population of broad leaved weeds revealed that in all the growth stages significantly mimumum population was recorded with *Chakhao Poireiton* which was followed by *Chakhao Amubi* and *Khurukhul Chakhao* respectively. While further it was also revealed that maximum population was significantly recorded with *Wairi Chakha*o in both the years of experiment.

4.2.2.3.3 Interaction effect of integrated weed management and cultivars on population of broad leaved weeds

Results depicted in Table 4.16 (b) revealed that interaction of integrated weed management and different cultivars did not show any significant effect on population of broad leaved weeds in both the years of experiment at all stages of observation.

Table 4.16(a): Effect of integrated weed management and cultivars on population of broad leaved weeds (no. m^{-2}) at different growth stages

Treatments	20 DAS			40 DAS			60 DAS		
Weed Management	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
W_1 -Weedy check (Control)	7.64 (59.00)	7.42 (55.67)	7.53 (57.33)	9.58 (92.00)	9.36 (88.33)	9.47 (90.17)	10.83 (117.33)	10.50 (110.67)	10.66 (114.00)
W_2 - Hand weeding (15 and 30 DAS)	4.74 (23.67)	4.13 (20.33)	4.44 (22.00)	5.58 (32.33)	5.35 (30.00)	5.46 (31.17)	6.36 (41.00)	6.10 (38.00)	6.23 (39.50)
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	6.28 (40.33)	6.03 (36.75)	6.15 (38.54)	7.17 (53.00)	6.97 (49.67)	7.07 (51.33)	8.24 (69.00)	8.05 (66.33)	8.14 (67.67)
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	6.40 (42.00)	6.13 (38.67)	6.27 (40.33)	7.12 (52.00)	6.88 (48.67)	7.00 (50.33)	8.19 (68.33)	8.01 (65.00)	8.10 (66.67)
SEm±	0.13	0.18	0.11	0.21	0.16	0.13	0.14	0.10	0.08
CD (P=0.05)	0.43	0.61	0.33	0.72	0.54	0.40	0.47	0.35	0.26
Cultivar									
C_1- *Chakhao Poireiton*	4.80 (24.33)	4.16 (20.33)	4.48 (22.33)	5.76 (36.33)	5.58 (33.33)	5.67 (34.83)	6.95 (51.00)	6.71 (47.33)	6.83 (49.17)
C_2 -*Chakhao Amubi*	5.89 (35.33)	5.75 934.08)	5.82 (34.71)	7.05 (51.33)	6.77 (48.00)	6.91 (49.67)	8.15 (69.33)	7.81 (63.33)	7.98 (66.33)
C_3 -*Wairi Chakhao*	7.81 (61.67)	7.42 (56.00)	7.61 (58.83)	8.86 (80.00)	8.69 (77.33)	8.78 (78.67)	9.78 (97.33)	9.68 (96.00)	9.73 (96.67)
C_4 -*Khurukhul Chakhao*	6.58 (43.67)	6.38 (41.00)	6.48 (42.33)	7.77 (61.67)	7.53 (58.00)	7.65 (59.83)	8.73 (78.00)	8.47 (73.33)	8.60 (75.67)
SEm±	0.14	0.18	0.12	0.17	0.21	0.13	0.13	0.16	0.10
CD (P=0.05)	0.42	0.54	0.33	0.48	0.61	0.38	0.39	0.46	0.30

Original values were subjected to square root transformation. Figures in parenthesis are the original value

Table 4.16(b): Interaction effect of integrated weed management and cultivars on population of broad leaved weeds (no. m^{-2}) at different growth stages

Treatments	20 DAS			40 DAS			60 DAS		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	6.25 (38.67)	6.15 (37.33)	6.20 (38.00)	8.74 (76.00)	8.01 (64.00)	8.37 (70.00)	9.88 (97.33)	9.33 (86.67)	9.61 (92.00)
W_1C_2	7.33 (53.33)	7.21 (52.00)	7.27 (52.67)	9.16 (84.00)	9.18 (84.00)	9.17 (84.00)	10.90 (118.67)	10.28 (105.33)	10.59 (112.00)
W_1C_3	8.97 (80.00)	8.82 (77.33)	8.90 (78.67)	10.67 (113.33)	10.79 (116.00)	10.73 (114.67)	11.62 (134.67)	11.84 (140.00)	11.73 (137.33)
W_1C_4	8.03 (64.00)	7.51 (56.00)	7.77 (60.00)	9.75 (94.67)	9.47 (89.33)	9.61 (92.00)	10.91 (118.67)	10.54 (110.67)	10.73 (114.67)
W_2C_1	2.86 (8.00)	1.18 (1.33)	2.02 (4.67)	3.66 (13.33)	3.50 (12.00)	3.58 (12.67)	5.08 (25.33)	4.78 (22.67)	4.93 (24.00)
W_2C_2	4.51 (20.00)	4.27 (18.67)	4.39 (19.33)	5.46 (29.33)	5.08 (25.33)	5.27 (27.33)	5.81 (33.33)	5.69 (32.00)	5.75 (32.67)
W_2C_3	6.15 (37.33)	5.77 (33.33)	5.96 (35.33)	6.95 (48.00)	6.81 (46.67)	6.88 (47.33)	7.69 (58.67)	7.48 (56.00)	7.58 (57.33)
W_2C_4	5.46 (29.33)	5.31 (28.00)	5.38 (28.67)	6.25 (38.67)	5.99 (36.00)	6.12 (37.33)	6.86 (46.67)	6.46 (41.33)	6.66 (44.00)
W_3C_1	4.91 (24.00)	4.80 (22.67)	4.86 (23.33)	5.33 (28.00)	5.46 (29.33)	5.39 (28.67)	6.47 (41.33)	6.25 (38.67)	6.36 (40.00)
W_3C_2	5.93 (34.67)	5.70 (32.33)	5.82 (33.50)	6.56 (42.67)	6.61 (44.00)	6.58 (43.33)	7.86 (61.33)	7.42 (54.67)	7.64 (58.00)
W_3C_3	7.93 (62.67)	7.24 (52.00)	7.59 (57.33)	9.11 (82.67)	8.42 (70.67)	8.76 (76.67)	10.02 (100.00)	9.96 (98.67)	9.99 (99.33)
W_3C_4	6.36 (40.00)	6.36 (40.00)	6.36 (40.00)	7.67 (58.67)	7.41 (54.67)	7.54 (56.67)	8.59 (73.33)	8.58 (73.33)	8.59 (73.33)
W_4C_1	5.17 (26.67)	4.53 (20.00)	4.85 (23.33)	5.30 (28.00)	5.33 (28.00)	5.32 (28.00)	6.36 (40.00)	6.47 (41.33)	6.41 (40.67)
W_4C_2	5.79 (33.33)	5.81 (33.33)	5.80 (33.33)	7.02 (49.33)	6.24 (38.67)	6.63 (44.00)	8.02 (64.00)	7.85 (61.33)	7.93 (62.67)
W_4C_3	8.19 (66.67)	7.83 (61.33)	8.01 (64.00)	8.73 (76.00)	8.73 (76.00)	8.73 (76.00)	9.79 (96.00)	9.45 (89.33)	9.62 (92.67)
W_4C_4	6.46 (41.33)	6.35 (40.00)	6.40 (40.67)	7.42 (54.67)	7.22 (52.00)	7.32 (53.33)	8.57 (73.33)	8.27 (68.00)	8.42 (92.00)
SEm±(W×C)	0.29	0.37	0.23	0.33	0.41	0.27	0.27	0.32	0.21
SEm±(C×W)	0.32	0.42	0.36	0.39	0.46	0.41	0.31	0.35	0.32
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Original values were subjected to square root transformation. Figures in parenthesis are the original values

4.2.2.4 Total weeds population (no.m^{-2})

The data on total weeds population as influenced by integrated weed management and different cultivars recorded at 20, 40 and 60 DAS are presented in Table 4.17 (a) and Table 4.17 (b).

4.2.2.4.1 Effect of integrated weed management on total weeds population

The variation on data of total weeds population as influenced by integrated weed management revealed significant results in both the years of experiment at all stages of growth. Significantly lowest and highest total weeds population was observed with two hand weeding at 15 and 30 DAS and weedy check respectively. The higher total weed population could be due to higher weed intensity and its dominance in utilization of resources like nutrients, moisture, light etc. This finding corroborates with Parihar *et al.* (2020). Further data also revealed that lesser total weeds population was revealed with application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS and was statistically at par with pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS. This might be because of the inherent capability of the chemical to affect the cell division, cell growth and hindering the germination of weeds. Additionally, bispyribac sodium being a systemic herbicide inhibits the synthesis of branched-chain amino acid. It effectively suppresses various weeds by hindering the enzyme acetolactate synthase (ALS) which is responsible for the growth. Similar findings are in agreement with Bhattacharya *et al.* 2022.

4.2.2.4.2 Effect of cultivars on total weeds population

Data in context with different cultivars with effect on total weeds population revealed that in all the growth stages significantly minimum population was recorded with *Chakhao Poireiton* while it was also revealed that maximum population was recorded significantly with *Wairi Chakhao* in both the

Table 4.17 (a): Effect of integrated weed management and different cultivars on total weed population of (no. m^{-2}) at different growth stages

Treatments	20 DAS			40 DAS			60 DAS		
Weed Management	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
W_1 -Weedy check (Control)	13.87 (194.00)	13.65 (187.67)	13.76 (190.83)	17.32 (301.67)	16.89 (287.00)	17.11 (294.33)	19.97 (401.33)	19.55 (388.67)	19.76 (395.00)
W_2 - Hand weeding (15 and 30 DAS)	8.14 (68.67)	7.45 (58.67)	7.79 (63.67)	9.49 (94.67)	9.32 (90.00)	9.41 (92.33)	10.90 (123.67)	10.21 (106.67)	10.55 (115.17)
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	11.10 (126.00)	10.67 (116.42)	10.88 (121.21)	12.80 (168.00)	12.55 (161.00)	12.67 (164.50)	14.13 (203.33)	13.86 (195.33)	14.00 (199.33)
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	11.28 (131.33)	11.06 (126.00)	11.17 (128.67)	13.06 (172.33)	12.74 (164.67)	12.90 (168.50)	14.47 (212.33)	14.20 (204.00)	14.34 (208.17)
SEm±	0.23	0.15	0.14	0.22	0.22	0.16	0.21	0.37	0.21
CD (P=0.05)	0.79	0.52	0.42	0.77	0.77	0.49	0.72	1.27	0.65
Cultivar									
C_1- *Chakhao Poireiton*	8.86 (83.67)	8.47 (78.33)	8.66 (81.00)	10.76 (127.33)	10.72 (124.00)	10.74 (125.67)	12.47 (167.33)	11.85 (148.33)	12.16 (157.83)
C_2 -*Chakhao Amubi*	10.39 (111.67)	10.20 (108.75)	10.29 (110.21)	12.70 (168.67)	12.36 (160.67)	12.53 (164.67)	14.03 (210.33)	14.09 (212.33)	14.06 (211.33)
C_3 -*Wairi Chakhao*	13.38 (183.00)	12.96 (172.67)	13.17 (177.83)	15.42 (244.67)	15.16 (237.00)	15.29 (240.83)	17.38 (312.00)	16.80 (294.67)	17.09 (303.33)
C_4 -*Khurukhul Chakhao*	11.75 (141.67)	11.21 (129.00)	11.48 (135.33)	13.79 (196.00)	13.26 (181.00)	13.53 (188.50)	15.59 (251.00)	15.08 (239.33)	15.34 (245.17)
SEm±	0.21	0.24	0.16	0.27	0.25	0.18	0.26	0.27	0.19
CD (P=0.05)	0.61	0.70	0.45	0.79	0.72	0.52	0.77	0.78	0.53

Original values were subjected to square root transformation. Figures in parenthesis are the original value

Table 4.17 (b): Interaction effect of integrated weed management and different cultivars on total weed population (no. m^{-2}) at different growth stages

Treatments	20 DAS			40 DAS			60 DAS		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	11.90 (141.33)	12.12 (146.67)	12.01 (144.00)	15.62 (244.00)	15.29 (233.33)	15.45 (238.67)	17.75 (314.67)	15.78 (249.33)	16.77 (282.00)
W_1C_2	13.32 (177.33)	13.28 (176.00)	13.30 (176.67)	16.86 (284.00)	16.62 (276.00)	16.74 (280.00)	19.71 (388.00)	19.95 (400.00)	19.83 (394.00)
W_1C_3	15.63 (244.00)	15.59 (242.67)	15.61 (243.33)	19.19 (368.00)	19.09 (364.00)	19.14 (366.00)	22.24 (494.67)	22.06 (488.00)	22.15 (491.33)
W_1C_4	14.62 (213.33)	13.62 (185.33)	14.12 (199.33)	17.61 (310.67)	16.57 (274.67)	17.09 (292.67)	20.20 (408.00)	20.42 (417.33)	20.31 (412.67)
W_2C_1	5.55 (30.67)	4.67 (21.33)	5.11 (26.00)	6.35 (42.67)	6.83 (46.67)	6.59 (44.67)	8.30 (70.67)	7.85 (61.33)	8.07 (66.00)
W_2C_2	7.94 (62.67)	7.05 (49.33)	7.50 (56.00)	9.12 (82.67)	8.72 (76.00)	8.92 (79.33)	9.54 (93.33)	9.95 (98.67)	9.74 (96.00)
W_2C_3	10.08 (101.33)	9.47 (89.33)	9.77 (95.33)	11.71 (137.33)	11.58 (134.67)	11.65 (136.00)	13.34 (177.33)	12.24 (149.33)	12.79 (163.33)
W_2C_4	8.97 (80.00)	8.61 (74.67)	8.79 (77.33)	10.79 (116.00)	10.15 (102.67)	10.47 (109.33)	12.40 (153.33)	10.82 (117.33)	11.61 (135.33)
W_3C_1	8.84 (78.67)	8.41 (70.67)	8.62 (74.67)	9.89 (97.33)	9.68 (93.33)	9.79 (95.33)	11.45 (130.67)	11.66 (136.00)	11.55 (133.33)
W_3C_2	10.29 (105.33)	10.15 (103.00)	10.22 (104.17)	12.11 (146.67)	12.23 (149.33)	12.17 (148.00)	13.28 (176.00)	13.04 (170.67)	13.16 (173.33)
W_3C_3	13.53 (182.67)	12.85 (165.33)	13.19 (174.00)	15.63 (244.00)	15.05 (226.67)	15.34 (235.33)	16.71 (278.67)	16.24 (264.00)	16.47 (271.33)
W_3C_4	11.73 (137.33)	11.26 (126.67)	11.50 (132.00)	13.56 (184.00)	13.22 (174.67)	13.39 (179.33)	15.11 (228.00)	14.52 (210.67)	14.81 (219.33)
W_4C_1	9.15 (84.00)	8.67 (74.67)	8.91 (79.33)	11.17 (125.33)	11.08 (122.67)	11.13 (124.00)	12.40 (153.33)	12.13 (146.67)	12.26 (150.00)
W_4C_2	10.02 (101.33)	10.30 (106.67)	10.16 (104.00)	12.71 (161.33)	11.84 (141.33)	12.28 (151.33)	13.58 (184.00)	13.43 (180.00)	13.51 (182.00)
W_4C_3	14.29 (204.00)	13.91 (193.33)	14.10 (198.67)	15.15 (229.33)	14.92 (222.67)	15.04 (226.00)	17.25 (297.33)	16.66 (277.33)	16.95 (287.33)
W_4C_4	11.68 (136.00)	11.35 (129.33)	11.52 (132.67)	13.18 (173.33)	13.12 (172.00)	13.15 (172.67)	14.66 (214.67)	14.57 (212.00)	14.61 (213.33)
SEm±(W×C)	0.42	0.48	0.32	0.54	0.49	0.36	0.52	0.53	0.37
SEm±(C×W)	0.48	0.53	0.49	0.60	0.56	0.56	0.58	0.65	0.59
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Original values were subjected to square root transformation. Figures in parenthesis are the original values

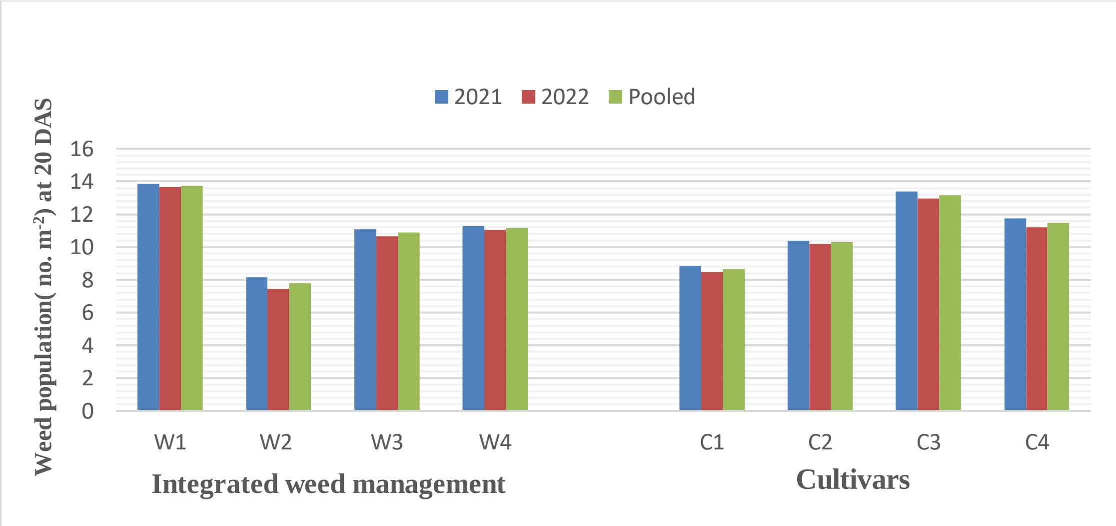

Fig 4.3 Effect of integrated weed management and cultivar on total weed population (no. m^{-2}) at 20 DAS

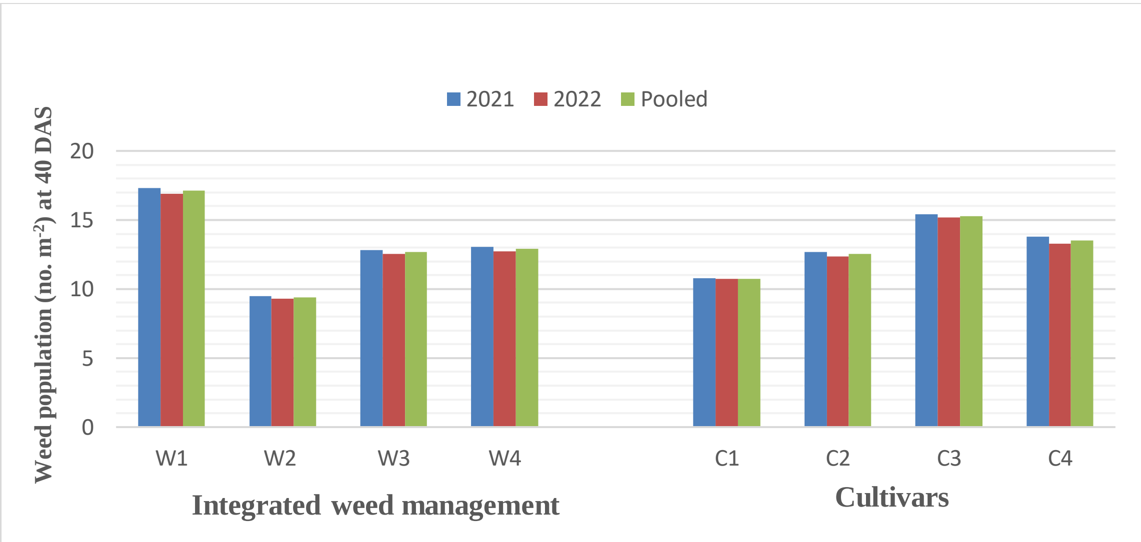

Fig 4.4 Effect of integrated weed management and cultivar on total weed population (no. m^{-2}) at 40 DAS

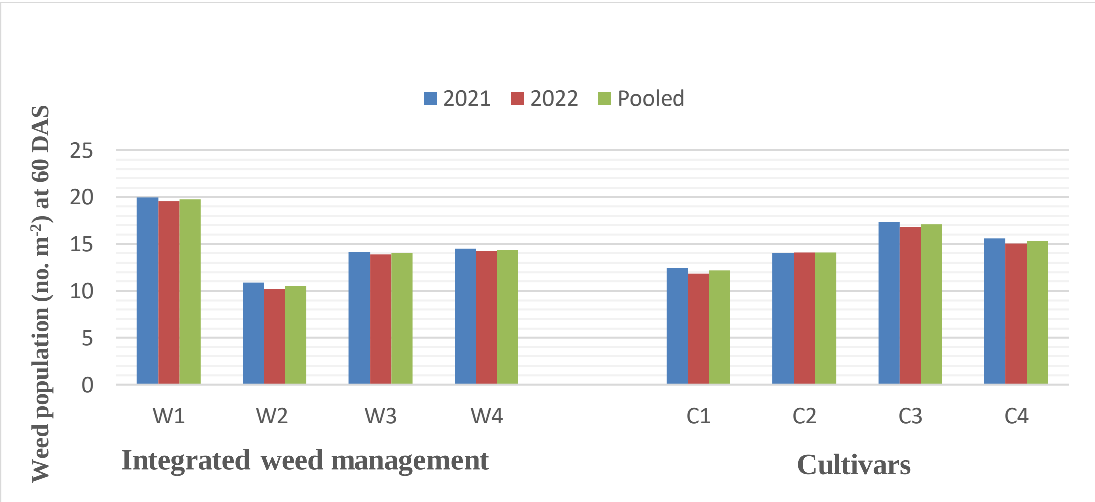

Fig 4.5 Effect of integrated weed management and cultivar on total weed population (no. m^{-2}) at 60 DAS

years of experiment. Afroz *et al.* (2019) also opined in his study that cultivar which gave shorter height revealed highest weed density and the taller height cultivar had the lowest weed density which might be due to suppressing ability of the taller cultivars over the weeds present in the plots.

4.2.2.4.3 Interaction effect of integrated weed management and cultivars on population of total weeds

Results depicted in Table 4.17(b) revealed that interaction of integrated weed management and different cultivars did not show any significant effect on total weeds population in both the years of experiment at all stages of observation.

4.2.3 Weed dry weight (g m^{-2})

4.2.3.1 Grasses (g m^{-2})

Observation on dry weight of grasses as influenced by integrated weed management and different cultivars and their interaction recorded at 20, 40 and 60 DAS are presented in Table 4.18 (a) and Table 4.18 (b).

4.2.3.1.1 Effect of integrated weed management on dry weight of grasses

The perusal on data of dry weight of grasses as affected by integrated weed management revealed significant results in both the years of experiment at all stages of growth. Significantly lowest dry weight of grasses was observed with two hand weeding at 15 and 30 DAS which was followed with application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS which was statistically at par with pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS. It was revealed that sequential application of pre- emergence and post emergence herbicides was found to be effective against wide spectrum of weeds. Early control of weeds by pretilachlor herbicide was due to inhibiting the

Table 4.18 (a): Effect of integrated weed management and different cultivars on dry weight of grasses (g m^{-2}) at different growth stages

Treatments	20 DAS			40 DAS			60 DAS		
Weed Management	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
W_1 -Weedy check (Control)	5.42 (29.32)	5.36 (28.60)	5.39 (28.96)	7.49 (56.62)	7.40 (54.78)	7.45 (55.70)	15.14 (231.19)	14.96 (229.79)	15.05 (230.49)
W_2 - Hand weeding (15 and 30 DAS)	3.22 (10.46)	3.09 (9.60)	3.15 (10.03)	4.77 (23.96)	4.59 (21.77)	4.68 (22.86)	5.40 (36.28)	5.18 (28.90)	5.29 (32.59)
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	4.34 (18.88)	4.27 (18.16)	4.31 (18.52)	6.01 (36.03)	6.09 (37.73)	6.05 (36.88)	8.13 (68.00)	8.02 (66.81)	8.08 (67.40)
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	4.35 (19.23)	4.37 (19.23)	4.36 (19.23)	6.22 (38.83)	6.09 (36.89)	6.15 (37.86)	8.27 (70.62)	8.40 (70.59)	8.33 (70.61)
SEm±	0.17	0.16	0.12	0.22	0.14	0.13	0.33	0.55	0.32
CD at 5%	0.56	0.56	0.36	0.77	0.48	0.41	1.13	1.90	0.98
Cultivar									
C_1- *Chakhao Poireiton*	3.57 (13.22)	3.66 (13.83)	3.62 (13.52)	5.18 (29.04)	5.08 (27.08)	5.13 (28.06)	7.10 (64.55)	7.23 (62.27)	7.16 (63.41)
C_2 -*Chakhao Amubi*	4.05 (16.85)	4.03 (16.88)	4.04 (16.87)	6.04 (36.99)	5.83 (34.80)	5.94 (35.90)	8.68 (91.59)	9.06 (99.50)	8.87 (95.55)
C_3 -*Wairi Chakhao*	5.17 (26.78)	4.98 (25.02)	5.07 (25.90)	6.90 (48.30)	7.07 (50.45)	6.98 (49.37)	11.46 (143.26)	10.46 (123.96)	10.96 (133.61)
C_4 -*Khurukhul Chakhao*	4.53 (21.05)	4.43 (19.87)	4.48 (20.46)	6.37 (41.11)	6.19 (38.83)	6.28 (39.97)	9.70 (106.69)	9.81 (110.36)	9.76 (108.53)
SEm±	0.17	0.17	0.12	0.27	0.16	0.16	0.37	0.38	0.27
CD at 5%	0.50	0.51	0.35	0.78	0.48	0.45	1.09	1.10	0.75

Original values were subjected to square root transformation. Figures in parenthesis are the original value

Table 4.18(b): Interaction effect of integrated weed management and different cultivars on dry weight of grasses (g m^{-2}) at different growth stages

Treatments	20 DAS			40 DAS			60 DAS		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	4.67(21.60)	5.05(25.25)	4.86(23.43)	6.65(44.36)	6.80(45.87)	6.72(45.11)	13.05(169.96)	11.58(135.75)	12.32(152.85)
W_1C_2	5.31(27.76)	5.20(27.07)	5.25(27.41)	7.28(52.93)	7.15(50.75)	7.21(51.84)	14.78(217.96)	15.65(249.79)	15.21(233.87)
W_1C_3	5.92(34.73)	5.92(34.63)	5.92(34.68)	8.42(70.51)	8.42(70.53)	8.42(70.52)	17.25(297.81)	16.58(276.69)	16.91(287.25)
W_1C_4	5.79(33.19)	5.27(27.45)	5.53(30.32)	7.63(58.69)	7.23(51.96)	7.43(55.33)	15.47(239.03)	16.02(256.95)	15.75(247.99)
W_2C_1	2.25(4.60)	2.50(5.85)	2.38(5.23)	3.51(15.76)	3.31(10.61)	3.41(13.19)	2.66(8.25)	2.91(8.32)	2.79(8.29)
W_2C_2	3.10(9.29)	2.67(6.87)	2.88(8.08)	4.78(22.43)	4.37(18.88)	4.58(20.65)	4.42(27.60)	5.07(26.03)	4.75(26.81)
W_2C_3	4.25(17.71)	3.76(13.69)	4.01(15.70)	5.51(30.11)	6.04(36.32)	5.77(33.21)	8.63(74.05)	6.91(47.35)	7.77(60.70)
W_2C_4	3.26(10.24)	3.43(12.00)	3.35(11.12)	5.29(27.53)	4.64(21.27)	4.96(24.40)	5.90(35.23)	5.83(33.91)	5.86(34.57)
W_3C_1	3.65(13.25)	3.46(11.53)	3.55(12.39)	5.12(25.84)	4.57(20.67)	4.85(23.25)	6.20(38.23)	7.08(51.39)	6.64(44.81)
W_3C_2	3.92(14.91)	4.34(18.41)	4.13(16.66)	5.91(34.45)	5.97(35.19)	5.94(34.82)	7.76(60.49)	7.38(56.40)	7.57(58.45)
W_3C_3	5.13(25.91)	4.89(23.59)	5.01(24.75)	6.71(44.55)	7.22(52.01)	6.96(48.28)	9.16(85.01)	9.10(86.77)	9.13(85.89)
W_3C_4	4.66(21.45)	4.41(19.11)	4.53(20.28)	6.30(39.27)	6.60(43.04)	6.45(41.15)	9.40(88.27)	8.52(72.67)	8.96(80.47)
W_4C_1	3.71(13.41)	3.62(12.67)	3.67(13.04)	5.46(30.19)	5.63(31.19)	5.54(30.69)	6.48(41.77)	7.35(53.63)	6.91(47.70)
W_4C_2	3.88(15.44)	3.92(15.19)	3.90(15.31)	6.19(38.16)	5.84(34.40)	6.02(36.28)	7.77(60.29)	8.14(65.80)	7.96(63.05)
W_4C_3	5.39(28.76)	5.33(28.16)	5.36(28.46)	6.95(48.03)	6.59(42.93)	6.77(45.48)	10.80(116.16)	9.25(85.01)	10.02(100.59)
W_4C_4	4.42(19.32)	4.60(20.91)	4.51(20.11)	6.28(38.93)	6.29(39.05)	6.28(38.99)	8.05(64.25)	8.85(77.93)	8.45(71.09)
SEm±(W×C)	0.34	0.35	0.24	0.54	0.33	0.31	0.75	0.75	0.53
SEm±(C×W)	0.39	0.39	0.38	0.60	0.37	0.48	0.84	0.93	0.84
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Original values were subjected to square root transformation. Figures in parenthesis are the original values

biosynthesis of fatty acid and also reduces cell division while late emergence weed control by bispyribac sodium due to its ALS (acetolactate synthase) enzyme inhibition. The results are in close conformity with Saravanane (2020). Further, data observed that highest dry weight of grasses was observed weedy check in both the years of experiment.

4.2.3.1.2 Effect of cultivars on dry weight of grasses

Data with regard to different cultivars with effect on dry weight of grasses revealed that in all the growth stages significantly mimumum dry weight was recorded with *Chakhao Poireiton* which was followed by *Chakhao Amubi* while maximum dry weight was significantly recorded with *Wairi Chakhao* in both the years of experiment.

4.2.3.1.3 Interaction effect of integrated weed management and cultivars on dry weight of grasses

Results with regard to interaction of integrated weed management and different cultivars as depicted in Table 4.18 (b) did not show any significant effect on dry weight of grasses in both the years of experiment at all stages of observation.

4.2.3.2 Sedges (g m^{-2})

Observation on dry weight of sedges as influenced by integrated weed management and different cultivars and their interaction recorded at 20, 40 and 60 DAS are presented in Table 4.19 (a) and Table 4.19 (b).

4.2.3.2.1 Effect of integrated weed management on dry weight of sedges

Analysis on data of dry matter of sedges as influenced by integrated weed management revealed significant results in both the years of experiment at all

Table 4.19 (a): Effect of integrated weed management and different cultivars on dry weight of sedges (g m^{-2}) at different growth stages

Treatments	20 DAS			40 DAS			60 DAS		
Weed Management	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
W_1 -Weedy check (Control)	2.13 (4.09)	2.07 (3.86)	2.10 (3.98)	7.59 (57.38)	7.34 (53.74)	7.46 (55.56)	8.22 (67.16)	8.31 (68.64)	8.26 (67.90)
W_2 - Hand weeding (15 and 30 DAS)	1.27 (1.19)	1.21 (1.03)	1.24 (1.11)	4.08 (16.66)	4.06 (16.39)	4.07 (16.53)	4.96 (24.34)	4.82 (23.02)	4.89 (23.68)
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	1.72 (2.55)	1.70 (2.53)	1.71 (2.54)	5.84 (34.41)	5.80 (33.71)	5.82 (34.06)	6.31 (39.73)	6.23 (38.61)	6.27 (39.17)
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	1.79 (2.85)	1.78 (2.79)	1.78 (2.82)	6.14 (37.70)	6.13 (37.81)	6.14 (37.76)	6.46 (41.78)	6.39 (40.63)	6.43 (41.21)
SEm±	0.05	0.04	0.03	0.10	0.17	0.10	0.06	0.09	0.06
CD at 5%	0.18	0.15	0.11	0.33	0.60	0.31	0.21	0.32	0.17
Cultivar									
C_1- *Chakhao Poireiton*	1.43 (1.65)	1.40 (1.60)	1.41 (1.62)	5.14 (27.80)	5.27 (29.17)	5.20 (28.49)	6.05 (37.72)	5.98 (37.06)	6.01 (37.39)
C_2 -*Chakhao Amubi*	1.62 (2.27)	1.64 (2.32)	1.63 (2.29)	5.75 (34.47)	5.70 (33.47)	5.72 (33.97)	6.32 (40.94)	6.29 (40.77)	6.30 (40.85)
C_3 -*Wairi Chakhao*	2.04 (3.81)	2.00 (3.67)	2.02 (3.74)	6.70 (46.00)	6.44 (42.74)	6.57 (44.37)	7.02 (49.97)	7.01 (50.09)	7.01 (50.03)
C_4 -*Khurukhul Chakhao*	1.81 (2.96)	1.74 (2.62)	1.78 (2.79)	6.06 (37.88)	5.93 (36.27)	5.99 (37.08)	6.58 (44.40)	6.47 (42.99)	6.52 (43.69)
SEm±	0.08	0.07	0.05	0.18	0.20	0.13	0.15	0.12	0.10
CD at 5%	0.24	0.21	0.15	0.52	0.59	0.38	0.43	0.36	0.27

Original values were subjected to square root transformation. Figures in parenthesis are the original value

Table 4.19(b): Interaction effect of integrated weed management and different cultivars on dry weight of sedges (g m^{-2}) at different growth stages

Treatments	20 DAS			40 DAS			60 DAS		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	1.85 (2.93)	1.86 (2.99)	1.85 (2.96)	6.90 (47.39)	6.83 (46.23)	6.87 (46.81)	8.00 (63.69)	8.00 (63.52)	8.00 (63.61)
W_1C_2	2.10 (3.92)	2.06 (3.76)	2.08 (3.84)	7.59 (57.21)	7.29 (52.63)	7.44 (54.92)	8.12 (65.55)	8.19 (66.76)	8.16 (66.15)
W_1C_3	2.35 (5.12)	2.30 (4.85)	2.32 (4.99)	8.07 (64.72)	7.75 (59.88)	7.91 (62.30)	8.46 (71.12)	8.57 (73.09)	8.52 (72.11)
W_1C_4	2.21 (4.40)	2.08 (3.85)	2.15 (4.13)	7.77 (60.19)	7.50 (56.24)	7.64 (58.21)	8.29 (68.29)	8.46 (71.20)	8.38 (69.75)
W_2C_1	0.99 (0.48)	0.94 (0.39)	0.96 (0.43)	3.32 (10.93)	3.41 (11.69)	3.37 (11.31)	4.65 (21.25)	4.27 (17.73)	4.46 (19.49)
W_2C_2	1.21 (1.03)	1.18 (0.95)	1.20 (0.99)	3.92 (14.89)	3.99 (15.52)	3.96 (15.21)	4.88 (23.57)	4.69 (21.72)	4.78 (22.65)
W_2C_3	1.51 (1.88)	1.45 (1.61)	1.48 (1.75)	4.80 (22.88)	4.53 (20.03)	4.66 (21.45)	5.40 (28.67)	5.37 (28.52)	5.39 (28.59)
W_2C_4	1.36 (1.36)	1.29 (1.17)	1.32 (1.27)	4.27 (17.93)	4.33 (18.32)	4.30 (18.13)	4.92 (23.87)	4.94 (24.12)	4.93 (23.99)
W_3C_1	1.44 (1.59)	1.31 (1.32)	1.38 (1.45)	4.95 (24.16)	5.08 (25.45)	5.02 (24.81)	5.89 (34.43)	5.75 (32.67)	5.82 (33.55)
W_3C_2	1.67 (2.33)	1.68 (2.36)	1.68 (2.35)	5.53 (30.85)	5.65 (31.75)	5.59 (31.30)	6.18 (37.92)	6.10 (36.89)	6.14 (37.41)
W_3C_3	1.98 (3.43)	2.02 (3.64)	2.00 (3.53)	7.03 (49.00)	6.66 (43.97)	6.85 (46.49)	6.92 (47.49)	6.81 (46.13)	6.87 (46.81)
W_3C_4	1.78 (2.87)	1.81 (2.80)	1.79 (2.83)	5.84 (33.64)	5.82 (33.65)	5.83 (33.65)	6.27 (39.09)	6.26 (38.75)	6.26 (38.92)
W_4C_1	1.44 (1.59)	1.48 (1.71)	1.46 (1.65)	5.37 (28.72)	5.76 (33.31)	5.57 (31.01)	5.65 (31.49)	5.90 (34.33)	5.78 (32.91)
W_4C_2	1.50 (1.79)	1.63 (2.21)	1.56 (2.00)	5.95 (34.93)	5.87 (33.99)	5.91 (34.46)	6.10 (36.72)	6.18 (37.69)	6.14 (37.21)
W_4C_3	2.30 (4.80)	2.25 (4.59)	2.27 (4.69)	6.91 (47.39)	6.81 (47.09)	6.86 (47.24)	7.28 (52.59)	7.27 (52.60)	7.28 (52.59)
W_4C_4	1.90 (3.23)	1.77 (2.65)	1.84 (2.94)	6.34 (39.76)	6.08 (36.87)	6.21 (38.31)	6.83 (46.33)	6.20 (37.89)	6.51 (42.11)
SEm±(W×C)	0.16	0.14	0.11	0.35	0.40	0.27	0.29	0.25	0.19
SEm±(C×W)	0.18	0.16	0.17	0.38	0.45	0.41	0.31	0.27	0.29
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Original values were subjected to square root transformation. Figures in parenthesis are the original value

stages of growth. Significantly minimum and maximum dry weight of sedges was observed with two hand weeding at 15 and 30 DAS and weedy check respectively. Rathika and Ramesh (2018) also opined from their finding that any delay in weeding may lead to increased dry weight which also has a negative correlation with yield. Additionally, data also revealed that lower dry weight was seen with application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS and was statistically at par with pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS at all stages of growth. The pre-emergence application of herbicide has selective systemic adsorption by roots and acts as a seed germination inhibitor by virtue of interfering with protein synthesis and proteinase activity, which obstruct the chained amino acids on weedy plants and inhibit the growth of weed. The results are in close findings with that of Reddy *et al.* (2016).

4.2.3.2.2 Effect of cultivars on dry weight of sedges

Data related to different cultivars with effect on dry weight of sedges in both the years revealed that at 20 and 40 DAS significantly lowest and highest dry weight was exhibited with *Chakhao Poireiton* and *Wairi Chakhao* respectively. Further, *Chakhao Amubi* was seen to be at par with *Khurukhul Chakhao* at 40 DAS. However, at 60 DAS it was revealed that in both the years of experiment lowest dry weight was recorded with *Chakhao Poireiton* which was at par with *Chakhao Amubi* while significantly highest dry weight was observed with *Wairi Chakhao*. Additionally, *Chakhao Amubi* was seen to be at par with *Khurukhul Chakhao*.

4.2.3.2.3 Interaction effect of integrated weed management and cultivars on dry weight of sedges

Data with regard to interaction of integrated weed management and different cultivars as depicted in Table 4.19 (b) did not show any significant effect on dry weight of sedges in both the years of experiment at all stages of observation.

4.2.3.3 Broad leaved weeds (g m^{-2})

Observation on dry weight of broad leaved weeds as influenced by integrated weed management and different cultivars and their interaction recorded at 20, 40 and 60 DAS are presented in Table 4.20 (a) and Table 4.20 (b).

4.2.3.3.1 Effect of integrated weed management on dry weight of broad leaved weeds

The examination on data of dry weight of broad leaved weeds as influenced by integrated weed management observed significant results in both the years of experiment at 20,40 and 60 DAS as well. Significantly lowest and highest dry weight of broad leaved weeds was observed with two hand weeding at 15 and 30 DAS and weedy check respectively. Mahanta *et al.* (2019) opined in his findings that this may be due to timely eradication of weeds by intercultural tools, which uprooted and killed the weeds Additionally, data further revealed that lesser dry weight was revealed with application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS and was statistically at par with pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS respectively Bagale and Kumari (2024) also revealed from his findings it may be due to plant enzyme acetolactate synthase (ALS) was inhibited by bispyribac sodium without which, synthesis of protein and development are slowed that eventually resulted in dead of weeds.

Table 4.20(a): Effect of integrated weed management and different cultivars on dry weight of broad leaved weeds (g m^{-2}) at different growth stages

Treatments	20 DAS			40 DAS			60 DAS		
Weed Management	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
W_1 -Weedy check (Control)	2.80 (7.50)	2.76 (7.34)	2.78 (7.42)	8.05 (64.87)	8.01 (64.71)	8.03 (64.79)	10.48 (110.01)	10.28 (106.47)	10.38 (108.24)
W_2 - Hand weeding (15 and 30 DAS)	1.71 (2.60)	1.55 (2.16)	1.63 (2.38)	4.61 (21.73)	4.47 (20.56)	4.54 (21.14)	5.90 (35.18)	5.75 (33.67)	5.83 (34.43)
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	2.28 (4.86)	2.20 (4.44)	2.24 (4.65)	5.69 (33.32)	5.47 (30.59)	5.58 (31.96)	7.67 (59.48)	7.39 (55.34)	7.53 (57.41)
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	2.38 (5.47)	2.25 (4.82)	2.32 (5.15)	5.46 (30.34)	5.34 (29.31)	5.40 (29.83)	7.25 (53.56)	7.29 (53.54)	7.27 (53.55)
SEm±	0.04	0.06	0.04	0.17	0.13	0.11	0.17	0.18	0.12
CD at 5%	0.15	0.21	0.12	0.59	0.45	0.33	0.58	0.62	0.38
Cultivar									
C_1- *Chakhao Poireiton*	1.78 (2.90)	1.58 (2.29)	1.68 (2.60)	4.67 (24.07)	4.50 (21.62)	4.58 (22.85)	6.60 (46.71)	6.43 (43.62)	6.51 (45.17)
C_2 -*Chakhao Amubi*	2.16 (4.34)	2.10 (4.16)	2.13 (4.25)	5.83 (34.96)	5.51 (32.17)	5.67 (33.57)	7.62 (60.95)	7.41 (57.38)	7.51 (59.17)
C_3 -*Wairi Chakhao*	2.86 (7.90)	2.74 (7.26)	2.80 (7.58)	7.14 (52.04)	7.15 (52.62)	7.14 (52.33)	9.02 (83.65)	8.94 (83.40)	8.98 (83.53)
C_4 -*Khurukhul Chakhao*	2.38 (5.29)	2.33 (5.06)	2.35 (5.17)	6.17 (39.18)	6.14 (38.76)	6.16 (38.97)	8.07 (66.91)	7.94 (64.62)	8.01 (65.77)
SEm±	0.08	0.07	0.05	0.14	0.17	0.11	0.16	0.18	0.12
CD at 5%	0.22	0.20	0.15	0.40	0.48	0.30	0.46	0.52	0.34

Original values were subjected to square root transformation. Figures in parenthesis are the original value

Table 4.20(b): Interaction effect of integrated weed management and different cultivars on dry weight of broad leaved weeds (g m^{-2}) at different growth stages

Treatments	20 DAS			40 DAS			60 DAS		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	2.26 (4.63)	2.20 (4.33)	2.23 (4.48)	7.41 (54.41)	6.70 (44.60)	7.05 (49.51)	9.77 (95.08)	9.00 (80.51)	9.38 (87.79)
W_1C_2	2.71 (6.89)	2.67 (6.72)	2.69 (6.81)	7.68 (58.97)	7.95 (62.96)	7.82 (60.97)	10.50 (109.97)	10.05 (100.47)	10.27 (105.22)
W_1C_3	3.36 (10.77)	3.38 (10.93)	3.37 (10.85)	8.89 (78.72)	9.35 (87.04)	9.12 (82.88)	11.35 (128.81)	11.86 (140.77)	11.61 (134.79)
W_1C_4	2.86 (7.72)	2.80 (7.36)	2.83 (7.54)	8.23 (67.36)	8.04 (64.25)	8.14 (65.81)	10.31 (106.16)	10.23 (104.15)	10.27 (105.15)
W_2C_1	1.08 (0.69)	0.77 (0.11)	0.93 (0.40)	3.11 (9.29)	3.12 (9.33)	3.12 (9.31)	4.72 (21.81)	4.58 (21.04)	4.65 (21.43)
W_2C_2	1.62 (2.13)	1.50 (1.83)	1.56 (1.98)	4.61 (20.72)	4.22 (17.35)	4.41 (19.03)	5.43 (29.00)	5.38 (28.43)	5.40 (28.71)
W_2C_3	2.18 (4.27)	2.04 (3.68)	2.11 (3.97)	5.61 (31.27)	5.64 (31.71)	5.62 (31.49)	7.00 (48.71)	6.70 (45.21)	6.85 (46.96)
W_2C_4	1.95 (3.31)	1.87 (3.04)	1.91 (3.17)	5.11 (25.64)	4.90 (23.84)	5.01 (24.74)	6.45 (41.21)	6.35 (40.00)	6.40 (40.61)
W_3C_1	1.88 (3.09)	1.75 (2.59)	1.81 (2.84)	4.04 (16.01)	4.10 (16.39)	4.07 (16.20)	6.16 (37.44)	6.15 (37.41)	6.15 (37.43)
W_3C_2	2.16 (4.16)	2.11 (4.00)	2.13 (4.08)	5.53 (30.23)	5.16 (26.59)	5.35 (28.41)	7.37 (53.91)	6.83 (46.25)	7.10 (50.08)
W_3C_3	2.75 (7.16)	2.61 (6.32)	2.68 (6.74)	7.28 (52.65)	6.77 (45.48)	7.02 (49.07)	9.06 (81.59)	8.93 (79.49)	8.99 (80.54)
W_3C_4	2.34 (5.01)	2.31 (4.87)	2.33 (4.94)	5.90 (34.40)	5.86 (33.92)	5.88 (34.16)	8.09 (64.97)	7.65 (58.21)	7.87 (61.59)
W_4C_1	1.90 (3.19)	1.62 (2.13)	1.76 (2.66)	4.12 (16.57)	4.08 (16.17)	4.10 (16.37)	5.73 (32.51)	5.99 (35.53)	5.86 (34.02)
W_4C_2	2.14 (4.19)	2.13 (4.08)	2.13 (4.13)	5.49 (29.93)	4.70 (21.77)	5.09 (25.85)	7.17 (50.93)	7.38 (54.36)	7.27 (52.65)
W_4C_3	3.13 (9.40)	2.92 (8.11)	3.03 (8.75)	6.77 (45.52)	6.83 (46.27)	6.80 (45.89)	8.65 (75.51)	8.26 (68.12)	8.45 (71.81)
W_4C_4	2.36 (5.12)	2.33 (4.96)	2.35 (5.04)	5.46 (29.32)	5.76 (33.04)	5.61 (31.18)	7.45 (55.31)	7.51 (56.13)	7.48 (55.72)
SEm±(W×C)	0.15	0.14	0.10	0.27	0.33	0.21	0.31	0.36	0.24
SEm±(C×W)	0.17	0.15	0.16	0.32	0.37	0.33	0.36	0.41	0.37
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Original values were subjected to square root transformation. Figures in parenthesis are the original value

4.2.3.3.2 Effect of cultivars on dry weight of broad leaved weeds

Variation in data with regard to different cultivars with effect on dry weight of broad leaved weeds as depicted in Table 4.19 (a) revealed that in all the growth stages significantly mimumum dry weight was recorded with *Chakhao Poireiton* which was followed by *Chakhao Amubi* while maximum dry weight was significantly recorded with *Wairi Chakhao* in both the years of experiment.

4.2.3.3.3 Interaction effect of integrated weed management and cultivars on dry weight of broad leaved weeds

Results in context with interaction of integrated weed management and different cultivars as depicted in Table 4.20 (b) did not show any significant effect on dry weight of broad leaved weeds in both the years of experiment at all stages of observation.

4.2.3.4 Total dry weight of weeds (g m^{-2})

The data on total dry weight of weeds as influenced by integrated weed management and cultivars at 20, 40 and 60 DAS are presented in Table 4.21 (a) and Table 4.21 (b).

4.2.3.4.1 Effect of integrated weed management on total dry weight of weeds

Integrated weed management observed significant results on total dry weight of weeds in both the years of experiment at all stages of growth. Significantly lowest and highest total dry weight of weeds was observed with two hand weeding at 15 and 30 DAS and weedy check respectively. Nazir *et al.* (2020) in his study found that among the weed management practices, low weed pressure maintenance treatment revealed significantly lower infestation of weeds

Table 4.21 (a): Effect of integrated weed management and different cultivars on total dry weight of weeds (g m^{-2}) at different growth stages

Treatments	20 DAS			40 DAS			60 DAS		
Weed Management	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
W_1 -Weedy check (Control)	6.40 (40.92)	6.31 (39.80)	6.36 (40.36)	13.36 (178.87)	13.13 (173.23)	13.24 (176.05)	20.16 (408.36)	20.00 (404.91)	20.08 (406.64)
W_2 - Hand weeding (15 and 30 DAS)	3.73 (14.25)	3.55 (12.80)	3.64 (13.52)	7.79 (62.35)	7.56 (58.72)	7.68 (60.53)	9.59 (95.81)	9.14 (85.59)	9.37 (90.70)
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	5.11 (26.29)	5.01 (25.13)	5.06 (25.71)	10.10 (103.76)	10.01 (102.03)	10.06 (102.90)	12.84 (167.21)	12.60 (160.76)	12.72 (163.99)
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	5.19 (27.56)	5.14 (26.84)	5.16 (27.20)	10.29 (106.86)	10.15 (104.02)	10.22 (105.44)	12.75 (165.97)	12.80 (164.76)	12.78 (165.36)
SEm±	0.16	0.13	0.10	0.20	0.18	0.13	0.23	0.33	0.20
CD at 5%	0.56	0.45	0.32	0.68	0.61	0.41	0.81	1.14	0.62
Cultivar									
C_1- *Chakhao Poireiton*	4.12 (17.76)	4.11 (17.72)	4.11 (17.74)	8.70 (80.91)	8.56 (77.88)	8.63 (79.39)	11.53 (148.98)	11.44 (142.96)	11.49 (145.97)
C_2 -*Chakhao Amubi*	4.77 (23.46)	4.74 (23.36)	4.76 (23.41)	10.15 (106.43)	9.83 (100.44)	9.99 (103.44)	13.31 (193.48)	13.37 (197.65)	13.34 (195.56)
C_3 -*Wairi Chakhao*	6.18 (38.48)	5.94 (35.95)	6.06 (37.22)	11.96 (146.33)	11.93 (145.82)	11.94 (146.08)	16.22 (276.88)	15.51 (257.44)	15.87 (267.16)
C_4 -*Khurukhul Chakhao*	5.36 (29.30)	5.21 (27.54)	5.28 (28.42)	10.72 (118.17)	10.53 (113.86)	10.63 (116.02)	14.28 (218.00)	14.22 (217.98)	14.25 (217.99)
SEm±	0.15	0.16	0.11	0.20	0.18	0.13	0.22	0.25	0.17
CD at 5%	0.44	0.47	0.31	0.59	0.52	0.38	0.65	0.74	0.48

Original values were subjected to square root transformation. Figures in parenthesis are the original value

Table 4.21 (b): Interaction effect of integrated weed management and different cultivars on total dry weight of weeds (g m^{-2}) at different growth stages

Treatments	20 DAS			40 DAS			60 DAS		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	5.43 (29.16)	5.73 (32.57)	5.58 (30.87)	12.10 (146.16)	11.71 (136.69)	11.91 (141.43)	18.14 (328.73)	16.72 (279.77)	17.43 (304.25)
W_1C_2	6.25 (38.57)	6.14 (37.55)	6.20 (38.06)	13.02 (169.12)	12.91 (166.33)	12.96 (167.73)	19.84 (393.48)	20.37 (417.01)	20.11 (405.25)
W_1C_3	7.14 (50.63)	7.13 (50.41)	7.14 (50.52)	14.64 (213.95)	14.76 (217.45)	14.70 (215.70)	22.32 (497.75)	22.13 (490.56)	22.22 (494.15)
W_1C_4	6.76 (45.31)	6.25 (38.67)	6.50 (41.99)	13.66 (186.24)	13.14 (172.45)	13.40 (179.35)	20.34 (413.48)	20.79 (432.29)	20.56 (422.89)
W_2C_1	2.50 (5.77)	2.61 (6.35)	2.55 (6.06)	5.85 (35.99)	5.64 (31.64)	5.74 (33.81)	7.18 (51.32)	6.89 (47.09)	7.03 (49.21)
W_2C_2	3.58 (12.45)	3.17 (9.64)	3.38 (11.05)	7.65 (58.04)	7.23 (51.75)	7.44 (54.89)	8.86 (80.17)	8.73 (76.17)	8.80 (78.17)
W_2C_3	4.91 (23.85)	4.41 (18.99)	4.66 (21.42)	9.20 (84.25)	9.39 (88.05)	9.30 (86.15)	12.32 (151.43)	11.01 (121.08)	11.67 (136.25)
W_2C_4	3.92 (14.91)	4.01 (16.21)	3.97 (15.56)	8.45 (71.11)	7.99 (63.43)	8.22 (67.27)	10.01 (100.31)	9.92 (98.03)	9.97 (99.17)
W_3C_1	4.24 (17.93)	3.98 (15.44)	4.11 (16.69)	8.14 (66.01)	7.92 (62.51)	8.03 (64.26)	10.51 (110.09)	11.03 (121.47)	10.77 (115.78)
W_3C_2	4.68 (21.40)	5.01 (24.77)	4.84 (23.09)	9.77 (95.53)	9.69 (93.52)	9.73 (94.53)	12.36 (152.32)	11.79 (139.55)	12.07 (145.93)
W_3C_3	6.08 (36.49)	5.82 (33.55)	5.95 (35.02)	12.11 (146.20)	11.90 (141.47)	12.00 (143.83)	14.62 (214.09)	14.56 (212.40)	14.59 (213.25)
W_3C_4	5.45 (29.33)	5.21 (26.77)	5.33 (28.05)	10.37 (107.31)	10.53 (110.61)	10.45 (108.96)	13.88 (192.33)	13.04 (169.63)	13.46 (180.98)
W_4C_1	4.31 (18.19)	4.12 (16.51)	4.22 (17.35)	8.69 (75.48)	8.99 (80.67)	8.84 (78.07)	10.31 (105.77)	11.14 (123.49)	10.72 (114.63)
W_4C_2	4.59 (21.41)	4.65 (21.48)	4.62 (21.45)	10.17 (103.03)	9.51 (90.16)	9.84 (96.59)	12.18 (147.95)	12.58 (157.85)	12.38 (152.90)
W_4C_3	6.58 (42.96)	6.41 (40.85)	6.50 (41.91)	11.88 (140.93)	11.66 (136.29)	11.77 (138.61)	15.63 (244.25)	14.36 (205.73)	15.00 (224.99)
W_4C_4	5.29 (27.67)	5.36 (28.52)	5.33 (28.09)	10.41 (108.01)	10.46 (108.96)	10.44 (141.43)	12.89 (165.89)	13.13 (171.96)	13.01 (168.93)
SEm±(W×C)	0.30	0.32	0.22	0.40	0.36	0.27	0.44	0.51	0.34
SEm±(C×W)	0.35	0.36	0.34	0.46	0.41	0.42	0.51	0.61	0.53
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Original values were subjected to square root transformation. Figures in parenthesis are the original value

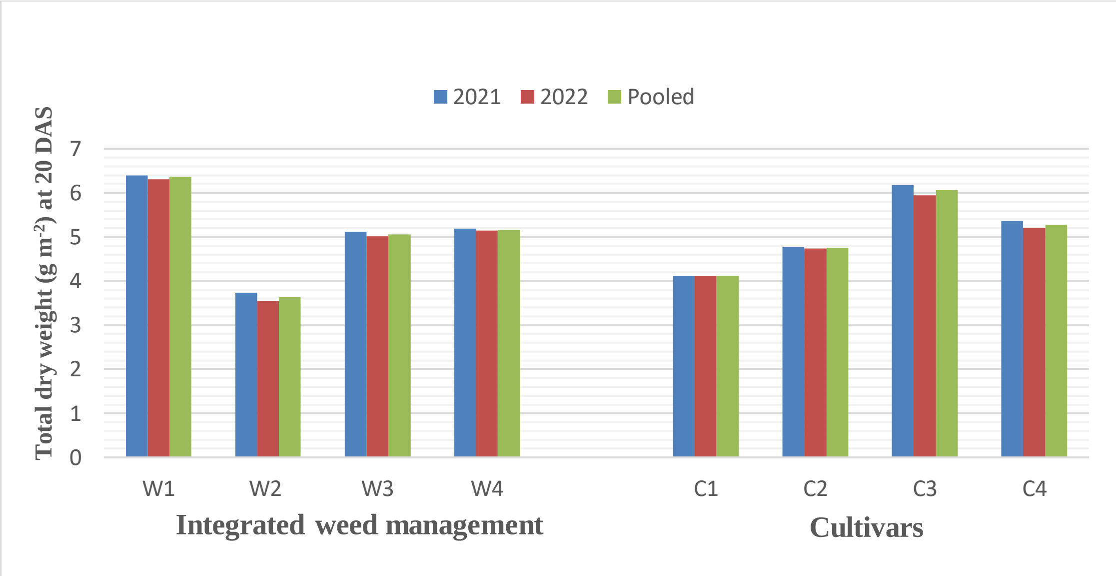

Fig: 4.6 Effect of integrated weed management and cultivar on total dry weight of weed (g m^{-2}) at 20 DAS

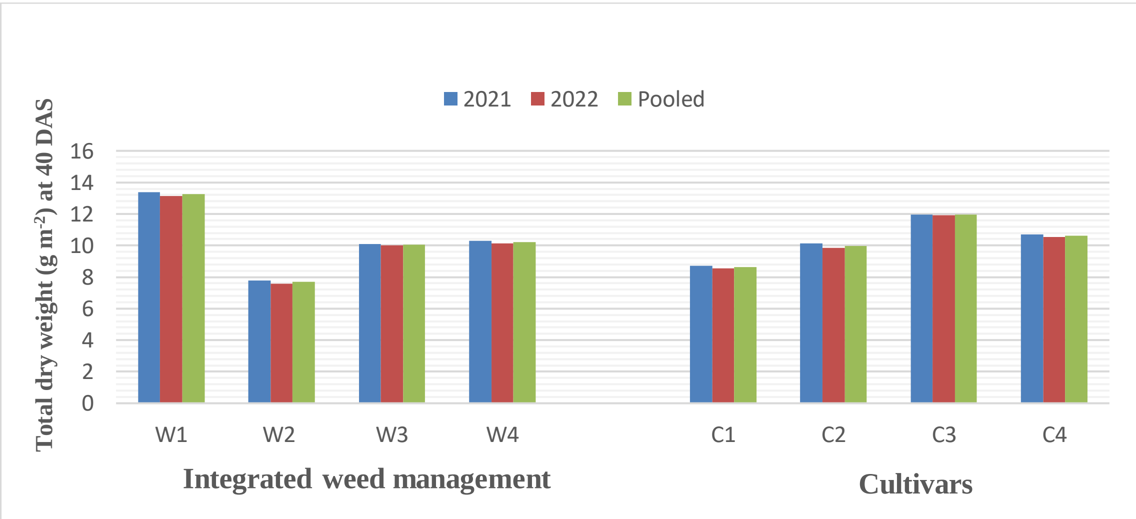

Fig 4.7 Effect of integrated weed management and cultivar on total dry weight of weed (g m^{-2}) at 40 DAS

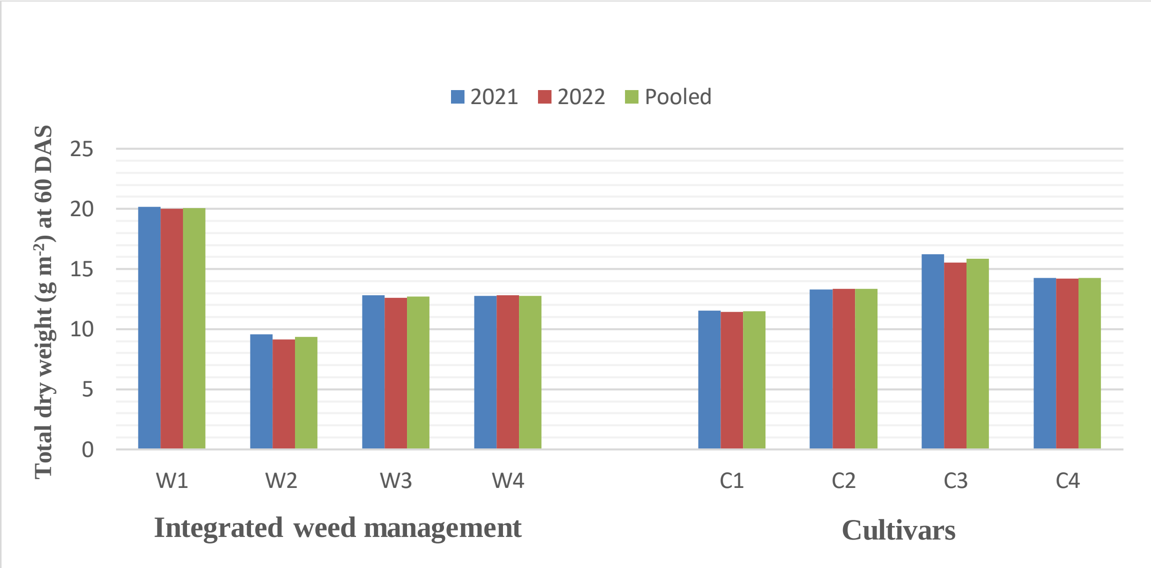

Fig 4.8 Effect of integrated weed management and cultivar on total dry weight of weed (g m^{-2}) at 60 DAS

compared to medium and high pressure. Further, data further revealed that application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS was found to be statistically at par with pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS respectively. Suryakala *et al.* (2019) in his study revealed through his findings that data showed a significant reduction in weed biomass in all the herbicide treated plots in comparison to control. This may be due to their wide spectrum of activity providing satisfactory and season long weed control.

4.2.3.4.2 Effect of cultivars on total dry weight of weeds

Data with regard to different cultivars with effect on total dry weight of weeds as depicted in Table 4.21 (a) revealed that in all the growth stages significantly mimumum total dry weight was recorded with *Chakhao Poireiton* which was followed with *Chakhao Amubi*. Schreiber *et al.* (2018) revealed through his findings that the early and increasing ground cover during the early stages by rice cultivars resulted in reduction of weed dry matter. Further, data also recorded that *Wairi Chakhao* recorded maximum dry weight significantly in both the years of experiment.

4.2.3.4.3 Interaction effect of integrated weed management and cultivars on total dry weight of weeds

Results in context with interaction of integrated weed management and different cultivars as depicted in Table 4.21 (b) did not show any significant effect on dry weight of broad leaved weeds in both the years of experiment at all stages of observation.

Table 4.22(a): Effect of integrated weed management and different cultivars on weed control efficiency at 60 DAS

Treatment	Weed control efficiency (%)		
Weed Management	**2021**	**2022**	**Mean**
W_1 -Weedy check (Control)	0	0	0
W_2 - Hand weeding (15 and 30 DAS)	76.54	78.86	77.70
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	59.05	60.30	59.68
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	59.36	59.31	59.33
Cultivar			
C_1- *Chakhao Poireiton*	63.52	64.69	64.11
C_2 -*Chakhao Amubi*	52.62	51.19	51.90
C_3 -*Wairi Chakhao*	32.20	36.42	34.31
C_4 -*Khurukhul Chakhao*	46.61	46.17	46.39

Table 4.22 (b): Interaction effect of integrated weed management and different cultivars on weed control efficiency at 60 DAS

Treatments	Weed control efficiency (%)		
	2021	**2022**	**Mean**
W_1C_1	0	0	0
W_1C_2	0	0	0
W_1C_3	0	0	0
W_1C_4	0	0	0
W_2C_1	84.39	83.17	83.78
W_2C_2	79.62	81.73	80.68
W_2C_3	69.58	75.32	72.45
W_2C_4	75.74	77.32	76.53
W_3C_1	66.51	56.58	61.55
W_3C_2	61.29	66.54	63.91
W_3C_3	56.99	56.70	56.85
W_3C_4	53.48	60.76	57.12
W_4C_1	67.82	55.86	61.84
W_4C_2	62.40	62.15	62.27
W_4C_3	50.93	58.06	54.49
W_4C_4	59.88	60.22	60.05

4.2.4 Weed control efficiency (%)

The data on weed control efficiency as influenced by integrated weed management and different cultivars are presented in Table 4.22 (a) and Table 4.22 (b).

4.2.4.1 Effect of integrated weed management on weed control efficiency

Data pertaining to weed control efficiency as influenced by integrated weed management revealed that in both the year's highest weed control efficiency was observed with hand weeding at 15 and 30 DAS. A similar finding was also reported by Hashim *et al.* (2022) and Verma *et al*. (2023). Higher weed control efficiency was achieved as a result of decreased weed dry weight which was possible by successful weed management strategies. Similar result was in corroboration with those of Choudhary *et al.* (2022). In addition, hand weeding was followed by pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS and pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS. Pretilachlor was reported to have a half-life period of 7.52-9.58 days and bispyribac sodium is comparatively more persistent with a half-life of 9.93 days and persists up to 42-115 days in soil and may have obtained the highest weed control efficiency. These findings are in similar findings of Chinnamani *et al*. (2018) and Rathika and Ramesh (2018). While further data also revealed that lowest weed control efficiency was recorded with weedy check in both the years of experiment.

4.2.4.2 Effect of cultivar on weed control efficiency

The differences in weed control efficiency in both the years at 60 DAS due to different cultivars revealed that highest weed control efficiency was recorded with cultivar *Chakhao Poireiton* which was followed by *Chakhao*

Amubi while further data also revealed that lowest WCE was observed with cultivar *Wairi Chakhao* respectively.

4.2.4.3 Effect of treatment combination of integrated weed management and cultivar on weed control efficiency

Observation on the data with regard to treatment combination of integrated weed management and different cultivar on weed control efficiency was revealed with hand weeding at 15 and 30 DAS with cultivar *Chakhao Poireiton* which was followed by hand weeding at 15 and 30 DAS with cultivar *Chakhao Amubi* in both the years of experiment.

4.3 Soil Parameters

4.3.1 Soil analysis

4.3.1.1 pH (Soil reaction)

Effect of integrated weed management and different cultivars were found to be non significant on pH in both the years of experiment and are presented in Table 4.23 (a) and Table 4.23(b).

4.3.1.2 Electrical conductivity (dS m^{-1})

Variation in data as influenced by integrated weed management and different cultivars on electrical conductivity depicted in Table 4.23 (a) and Table 4.23 (b) was found to be non significant in both the years of experiment.

4.3.1.3 Organic carbon (%)

The perusal on data as affected by integrated weed management and different cultivars in both years of experimentation showed no significant effect on organic carbon as presented in Table 4.23 (a) and Table 4.23 (b).

Table 4.23(a): Effect of integrated weed management and different cultivars on soil pH, electrical conductivity and organic carbon content of soil after harvest

Treatment	pH			Electrical conductivity (dSm^{-1})			Organic carbon (%)		
	2021	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
Weed Management									
W_1 -Weedy check (Control)	4.80	4.86	4.83	0.24	0.24	0.24	1.46	1.47	1.47
W_2 - Hand weeding (15 and 30 DAS)	4.81	4.87	4.84	0.24	0.24	0.24	1.49	1.51	1.50
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	4.74	4.91	4.83	0.20	0.21	0.21	1.49	1.52	1.51
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	4.80	4.87	4.83	0.20	0.21	0.21	1.52	1.54	1.53
SEm±	0.06	0.06	0.04	0.01	0.01	0.01	0.04	0.01	0.02
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cultivar									
C_1- *Chakhao Poireiton*	4.81	4.89	4.85	0.22	0.22	0.22	1.45	1.53	1.49
C_2 -*Chakhao Amubi*	4.80	4.89	4.84	0.21	0.23	0.22	1.53	1.50	1.51
C_3 -*Wairi Chakhao*	4.73	4.89	4.81	0.22	0.24	0.23	1.50	1.51	1.51
C_4 -*Khurukhul Chakhao*	4.82	4.84	4.83	0.23	0.21	0.22	1.49	1.49	1.49
SEm±	0.06	0.03	0.03	0.01	0.01	0.01	0.04	0.02	0.02
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 4.23(b): Interaction effect of integrated weed management and different cultivars on soil pH, electrical conductivity and organic carbon content of soil after harvest

Treatments	pH			Electrical conductivity (dS m^{-1})			Organic carbon (%)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	4.80	4.94	4.87	0.23	0.24	0.24	1.35	1.54	1.45
W_1C_2	4.83	4.77	4.80	0.23	0.23	0.23	1.44	1.43	1.44
W_1C_3	4.73	4.90	4.82	0.25	0.23	0.24	1.51	1.48	1.50
W_1C_4	4.83	4.83	4.83	0.24	0.27	0.25	1.54	1.43	1.48
W_2C_1	4.80	4.80	4.80	0.22	0.25	0.24	1.43	1.49	1.46
W_2C_2	4.80	4.91	4.86	0.24	0.25	0.24	1.59	1.56	1.58
W_2C_3	4.83	4.87	4.85	0.26	0.24	0.25	1.53	1.53	1.53
W_2C_4	4.82	4.88	4.85	0.24	0.23	0.24	1.39	1.47	1.43
W_3C_1	4.83	5.00	4.92	0.22	0.20	0.21	1.58	1.58	1.58
W_3C_2	4.80	4.98	4.89	0.19	0.22	0.21	1.56	1.52	1.54
W_3C_3	4.63	4.87	4.75	0.19	0.26	0.22	1.40	1.52	1.46
W_3C_4	4.70	4.80	4.75	0.20	0.17	0.18	1.43	1.45	1.44
W_4C_1	4.80	4.80	4.80	0.19	0.19	0.19	1.43	1.51	1.47
W_4C_2	4.77	4.90	4.83	0.20	0.21	0.20	1.51	1.50	1.51
W_4C_3	4.70	4.93	4.82	0.20	0.25	0.22	1.55	1.51	1.53
W_4C_4	4.92	4.83	4.88	0.23	0.19	0.21	1.60	1.63	1.61
SEm±(W×C)	0.11	0.06	0.06	0.03	0.02	0.02	0.08	0.04	0.04
SEm±(C×W)	0.13	0.09	0.10	0.03	0.03	0.03	0.09	0.05	0.07
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS

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

Data pertaining to available nitrogen as influenced by integrated weed management and different cultivars presented in Table 4.24 (a) and 4.24(b) revealed no significant effect in both the years of experiment.

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

Examination in data presented in Table 4.24(a) and 4.24(b) as influenced by integrated weed management and different cultivars did not show any significant effect on available phosphorous in both the years of experiment.

4.3.1.6 Available potassium (kg ha $^{-1}$)

Detailed examination on data of available potassium in both the years revealed that it did not show any significant effect as influenced by integrated weed management and different cultivars as presented in Table 4.24(a) and 4.24(b).

The levels of nitrogen, phosphorous and potassium did not show any significant results which might be because it was applied only as per the recommended dosage.

4.3.2 Plant analysis

4.3.2.1 NPK content of weeds (%)

4.3.2.1.1 Nitrogen content of weeds (%)

The data on nitrogen content of weeds recorded during 2021 and 2022 are depicted in Table 4.25(a) and Table 4.25(b).

Table 4.24(a): Effect of integrated weed management and different cultivars on available nutrient status of soil after harvest

Treatment	Available nitrogen (kg ha^{-1})			Available phosphorous (kg ha^{-1})			Available potassium (kg ha^{-1})		
	2021	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
Weed Management									
W_1 -Weedy check (Control)	221.85	222.95	222.40	35.12	35.45	35.28	150.17	148.37	149.27
W_2 - Hand weeding (15 and 30 DAS)	231.10	232.12	231.61	35.36	35.40	35.38	150.31	157.16	153.73
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	224.75	227.70	226.23	34.32	34.89	34.60	143.34	148.63	145.99
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	224.18	224.42	224.30	34.74	35.12	34.93	148.64	148.96	148.80
SEm±	4.60	5.95	3.76	0.40	0.31	0.25	3.72	2.21	2.16
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cultivar									
C_1- *Chakhao Poireiton*	222.65	227.16	224.90	34.71	35.20	34.95	149.18	150.98	150.08
C_2 -*Chakhao Amubi*	221.03	224.53	222.78	35.18	35.30	35.24	147.35	152.57	149.96
C_3 -*Wairi Chakhao*	230.50	224.00	227.25	35.64	35.28	35.46	148.03	150.08	149.06
C_4 -*Khurukhul Chakhao*	227.71	231.50	229.61	34.01	35.08	34.54	147.89	149.49	148.69
SEm±	4.18	3.76	2.81	0.41	0.45	0.30	3.15	3.04	2.19
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 4.24(b): Interaction effect of integrated weed management and different cultivars on available nutrient status of soil after harvest

Treatments	Available nitrogen (kg ha^{-1})			Available phosphorous (kg ha^{-1})			Available potassium (kg ha^{-1})		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	235.46	228.41	231.93	34.52	35.69	35.11	143.13	146.32	144.72
W_1C_2	218.34	231.10	224.72	35.24	35.14	35.19	158.08	145.72	151.90
W_1C_3	224.55	214.47	219.51	35.56	35.89	35.73	155.11	151.24	153.18
W_1C_4	209.07	217.82	213.45	35.16	35.07	35.12	144.37	150.21	147.29
W_2C_1	218.57	220.58	219.57	34.77	35.55	35.16	156.16	156.39	156.28
W_2C_2	228.18	232.10	230.14	35.40	35.31	35.36	151.25	160.07	155.66
W_2C_3	244.21	235.05	239.63	36.29	35.30	35.79	147.40	156.56	151.98
W_2C_4	233.43	240.73	237.08	34.97	35.43	35.20	146.42	155.63	151.03
W_3C_1	217.85	223.26	220.56	34.64	34.74	34.69	141.63	147.29	144.46
W_3C_2	217.03	222.94	219.99	34.84	35.15	35.00	140.34	152.47	146.41
W_3C_3	236.25	219.98	228.11	35.19	34.57	34.88	140.69	151.59	146.14
W_3C_4	227.88	244.64	236.26	32.61	35.09	33.85	150.71	143.17	146.94
W_4C_1	218.73	236.39	227.56	34.91	34.82	34.87	155.80	153.91	154.86
W_4C_2	220.55	211.98	216.26	35.25	35.59	35.42	139.75	152.03	145.89
W_4C_3	216.97	226.50	221.74	35.52	35.36	35.44	148.93	140.95	144.94
W_4C_4	240.46	222.82	231.64	33.29	34.73	34.01	150.06	148.93	149.50
SEm±(W×C)	8.37	7.53	5.63	0.82	0.90	0.61	6.29	6.07	4.37
SEm±(C×W)	9.73	9.50	9.05	0.94	0.99	0.94	7.41	6.72	6.82
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS

4.3.2.1.1.1 Effect of integrated weed management on nitrogen content of weeds

Data relating to nitrogen content as influenced by integrated weed management showed significant effect where among all the treatments hand weeding twice at 15 and 30 DAS revealed significantly the minimum nitrogen content which was followed with application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS. Further, it was also seen that significantly the highest nitrogen content was recorded with weedy check in both the years of experiment.

4.3.2.1.1.2 Effect of different cultivars on nitrogen content of weeds

The data on nitrogen content as affected by different cultivars presented in Table 4.25(a) did not show any significant effect in both the years of experiment.

4.3.2.1.1.3 Interaction effect of integrated weed management and cultivars on nitrogen content of weeds

Data pertaining to nitrogen content of weeds in relation with interaction effect of integrated weed management and different cultivars as depicted in Table 4.25 (b) did not show any significant effect in both the years of experiment.

4.3.2.1.2 Phosphorous content of weeds (%)

The data on phosphorous content of weeds recorded during 2021 and 2022 are depicted in Table 4.25(a) and Table 4.25(b).

4.3.2.1.2.1 Effect of integrated weed management on phosphorous content of weeds

Significant variation in phosphorous content was observed with effect of integrated weed management in both the years of experiment. It was observed that maximum and minimum phosphorous content was recorded with weedy check and two hand weeding at 15 and 30 days after sowing respectively which was followed by pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS in both the years of experiment.

4.3.2.1.2.2 Effect of different cultivars on phosphorous content of weeds

Variation in data related to phosphorous content with effect of different cultivars showed significant effect where it was observed that among all the treatments cultivar *Chakhao Poireiton* recorded minimum phosphorous content significantly which was followed by *Chakhao Amubi*. In addition, it was seen that highest phosphorous content was observed with cultivar *Wairi Chakhao* in both the years of experiment.

4.3.2.1.2.3 Interaction effect of integrated weed management and cultivars on phosphorous content of weeds

Data pertaining to phosphorous content of weeds as presented in Table 4.25(b) with regard to interaction effect of integrated weed management and different cultivars showed no significant effect in both the years of experiment.

4.3.2.1.3 Potassium content of weeds (%)

The data on potassium content of weeds recorded during 2021 and 2022 are presented in Table 4.25(a) and Table 4.25(b).

4.3.2.1.3.1 Effect of integrated weed management on potassium content of weeds

Data with regard to phosphorous content with effect of integrated weed management showed significant effect. It was observed that significantly minimum potassium content was recorded with two hand weeding at 15 and 30

Table 4.25(a): Effect of integrated weed management and different cultivars on nutrient content by weeds

Treatment	Nitrogen (%)			Phosphorous (%)			Potassium (%)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
Weed Management									
W_1 -Weedy check (Control)	0.76	0.76	0.76	0.69	0.70	0.69	1.36	1.37	1.36
W_2 - Hand weeding (15 and 30 DAS)	0.50	0.52	0.51	0.49	0.50	0.49	0.38	0.38	0.38
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	0.59	0.61	0.60	0.52	0.51	0.52	1.06	1.06	1.06
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	0.70	0.71	0.71	0.63	0.62	0.63	1.12	1.13	1.12
SEm±	0.02	0.02	0.01	0.003	0.006	0.003	0.015	0.014	0.010
CD at 5%	0.05	0.07	0.04	0.011	0.020	0.010	0.052	0.047	0.031
Cultivar									
C_1- *Chakhao Poireiton*	0.63	0.64	0.63	0.57	0.56	0.56	0.94	0.95	0.95
C_2 -*Chakhao Amubi*	0.64	0.67	0.66	0.58	0.58	0.58	0.97	0.96	0.97
C_3 -*Wairi Chakhao*	0.63	0.63	0.63	0.60	0.60	0.60	1.02	1.02	1.02
C_4 -*Khurukhul Chakhao*	0.65	0.67	0.66	0.59	0.59	0.59	0.99	1.00	1.00
SEm±	0.02	0.01	0.01	0.004	0.003	0.002	0.011	0.011	0.008
CD at 5%	NS	NS	NS	0.012	0.008	0.007	0.032	0.032	0.022

Table 4.25(b): Interaction effect of integrated weed management and different cultivars on nutrient content by weeds

Treatments	Nitrogen (%)			Phosphorous (%)			Potassium (%)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	0.73	0.71	0.72	0.67	0.68	0.68	1.29	1.33	1.31
W_1C_2	0.74	0.82	0.78	0.68	0.69	0.69	1.36	1.34	1.35
W_1C_3	0.73	0.73	0.73	0.71	0.71	0.71	1.40	1.40	1.40
W_1C_4	0.83	0.78	0.81	0.69	0.71	0.70	1.39	1.39	1.39
W_2C_1	0.49	0.54	0.52	0.48	0.48	0.48	0.35	0.35	0.35
W_2C_2	0.53	0.53	0.53	0.48	0.49	0.49	0.37	0.36	0.36
W_2C_3	0.51	0.49	0.50	0.50	0.52	0.51	0.42	0.43	0.43
W_2C_4	0.47	0.51	0.49	0.49	0.50	0.49	0.38	0.39	0.39
W_3C_1	0.60	0.58	0.59	0.50	0.49	0.50	1.02	1.03	1.03
W_3C_2	0.61	0.62	0.61	0.52	0.51	0.51	1.06	1.05	1.06
W_3C_3	0.56	0.62	0.59	0.55	0.53	0.54	1.09	1.09	1.09
W_3C_4	0.61	0.62	0.62	0.53	0.52	0.52	1.08	1.08	1.08
W_4C_1	0.69	0.70	0.70	0.61	0.60	0.61	1.09	1.10	1.10
W_4C_2	0.70	0.71	0.71	0.62	0.62	0.62	1.10	1.09	1.10
W_4C_3	0.71	0.69	0.70	0.65	0.64	0.65	1.17	1.16	1.16
W_4C_4	0.71	0.75	0.73	0.64	0.63	0.63	1.13	1.15	1.14
SEm±(W×C)	0.031	0.024	0.019	0.008	0.005	0.005	0.022	0.022	0.015
SEm±(C×W)	0.035	0.031	0.031	0.009	0.008	0.008	0.027	0.026	0.025
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS

days after sowing which was followed with application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS. While data further revealed that significantly the highest phosphorous content was recorded with weedy check in both the years of experiment.

4.3.2.1.3.2 Effect of different cultivars on potassium content of weeds

Variation in data with respect to potassium content with effect of different cultivars observed that among all the treatments cultivar *Chakhao Poireiton* recorded minimum content which was found to be at par with *Chakhao Amubi*. Further, it was observed that highest phosphorous content was observed with cultivar *Wairi Chakhao* in both the years of experiment.

4.3.2.1.3.3 Interaction effect of integrated weed management and cultivars on potassium content of weeds

Data pertaining to potassium content of weeds with regard to interaction effect of integrated weed management and different cultivars presented in Table 4.25(b) showed no significant effect in both the years of experiment.

4.3.2.2 NPK depletion by weeds (kg ha^{-1})

4.3.2.2.1 Nitrogen depletion by weeds (kg ha^{-1})

The data on nitrogen depletion by weeds recorded during 2021 and 2022 are presented in Table 4.26(a) and Table 4.26(b).

4.3.2.2.1.1Effect of integrated weed management on nitrogen depletion by weeds

Data with regard to nitrogen depletion was significantly influenced with integrated weed management. Data revealed that lowest depletion of nitrogen by weeds were observed significantly with two hand weeding at 15 and 30 DAS which was followed with application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS. Similarly, reduction in depletion of nitrogen with application of herbicide at initial stage followed by hand weeding at later stages was also reported by Hassan and Upasani (2015) and Nazir *et al.* (2022). Further the data revealed that maximum depletion of nitrogen was significantly recorded with weedy check in both the years of experiment. Sharma *et al.* (2018) in his findings revealed that the weedy check treatment had significantly greatest removal of nutrient. This might be attributed to the luxuriant weed growth that went unchecked in weedy check plots, which accumulated higher dry matter and competed vigorously for nutrients with the crop plants.

4.3.2.2.1.2 Effect of different cultivars on nitrogen depletion by weeds

The data on nitrogen depletion by weeds as influenced by different cultivars depicted in Table 4.26(a) revealed significant results. The data showed that significantly minimum depletion of nitrogen by weeds was seen with cultivar *Chakhao Poireiton* which was followed by *Chakhao Amubi*. Further the data also showed that maximum depletion of nitrogen by weeds was recorded with *Wairi Chakhao* in both the years of experiment.

4.3.2.2.1.3 Interaction effect of integrated weed management and cultivars on nitrogen depletion by weeds

Significant effect on nitrogen depletion by weeds was recorded with regard to interaction between the integrated weed management and different cultivars in both the years of experiment which is depicted in Table 4.26(b). The lowest depletion by weeds was recorded under the treatment combination of two hand weeding at 15 and 30 DAS and cultivar *Chakhao Poireiton* while the highest depletion was observed with weedy check in combination with cultivar *Wairi Chakhao*.

4.3.2.2.2 Phosphorous depletion by weeds (kg ha^{-1})

The data on phosphorous depletion by weeds recorded during 2021 and 2022 are presented in Table 4.26(a) and Table 4.26(b).

4.3.2.2.2.1Effect of integrated weed management on phosphorous depletion by weeds

Data pertaining to phosphorous depletion was significantly influenced with integrated weed management in both the years of experiment. It was observed in Table 4.25(a) that lowest depletion of phosphorous by weeds was exhibited with two hand weeding at 15 and 30 DAS which was followed with application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS. Additionally, the data also revealed that maximum depletion of phosphorous was significantly recorded with weedy check in both the years of experiment. Singh *et al.* (2021) from his findings also reported similar result.

4.3.2.2.2.2 Effect of different cultivars on phosphorous depletion by weeds

The data on phosphorous depletion by weeds as influenced by different cultivars revealed significant results. The data showed that significantly lowest depletion of phosphorous by weeds was seen with cultivar *Chakhao Poireiton* which was followed with *Chakhao Amubi*. Further the data also showed that maximum depletion of phosphorous by weeds was recorded with *Wairi Chakhao* in both the years of experiment.

Table 4.26(a): Effect of integrated weed management and different cultivars on nutrient depletion by weeds

Treatment	Nitrogen (kg ha^{-1})			Phosphorous (kg ha^{-1})			Potassium (kg ha^{-1})		
	2021	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
Weed Management									
W_1 -Weedy check (Control)	30.85	30.94	30.89	19.98	20.23	20.11	55.73	55.40	55.57
W_2 - Hand weeding (15 and 30 DAS)	4.84	4.39	4.62	1.83	1.71	1.77	3.72	3.37	3.55
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	9.89	9.92	9.91	3.77	3.47	3.62	17.89	17.14	17.52
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	11.69	11.71	11.70	7.24	6.99	7.12	18.76	18.60	18.68
SEm±	0.59	1.13	0.64	0.25	0.44	0.25	0.82	1.51	0.86
CD at 5%	2.06	3.91	1.97	0.88	1.53	0.79	2.82	5.21	2.64
Cultivar									
C_1- *Chakhao Poireiton*	10.10	9.58	9.84	5.75	5.40	5.57	16.76	16.25	16.50
C_2 -*Chakhao Amubi*	13.28	14.47	13.88	7.48	7.85	7.66	22.19	22.56	22.38
C_3 -*Wairi Chakhao*	18.30	17.32	17.81	11.15	10.41	10.78	32.02	30.16	31.09
C_4 -*Khurukhul Chakhao*	15.59	15.58	15.59	8.45	8.76	8.60	25.13	25.53	25.33
SEm±	0.55	0.79	0.48	0.23	0.44	0.25	0.64	1.14	0.65
CD at 5%	1.61	2.31	1.37	0.66	1.29	0.71	1.87	3.31	1.85

Table 4.26(b): Interaction effect of integrated weed management and different cultivars on nutrient depletion by weeds

Treatments	Nitrogen (kg ha^{-1})			Phosphorous (kg ha^{-1})			Potassium (kg ha^{-1})		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	23.93	19.93	21.93	15.57	13.45	14.51	42.49	37.20	39.85
W_1C_2	29.20	34.02	31.61	18.87	20.43	19.65	53.40	55.63	54.51
W_1C_3	36.13	35.90	36.02	25.22	24.98	25.10	69.71	68.45	69.08
W_1C_4	34.13	33.90	34.02	20.28	22.08	21.18	57.32	60.32	58.82
W_2C_1	2.57	2.55	2.56	0.93	0.86	0.89	1.78	1.66	1.72
W_2C_2	4.35	4.00	4.17	1.46	1.43	1.44	2.89	2.70	2.80
W_2C_3	7.68	5.97	6.83	3.03	2.63	2.83	6.41	5.28	5.84
W_2C_4	4.77	5.04	4.90	1.88	1.92	1.90	3.80	3.85	3.83
W_3C_1	6.58	7.17	6.87	2.17	2.35	2.26	11.22	12.52	11.87
W_3C_2	9.23	8.65	8.94	3.30	2.89	3.10	16.16	14.67	15.41
W_3C_3	12.03	13.30	12.67	5.27	4.98	5.13	23.49	23.14	23.32
W_3C_4	11.73	10.55	11.14	4.34	3.68	4.01	20.69	18.23	19.46
W_4C_1	7.32	8.68	8.00	4.33	4.94	4.63	11.53	13.63	12.58
W_4C_2	10.36	11.22	10.79	6.27	6.64	6.45	16.33	17.26	16.80
W_4C_3	17.36	14.12	15.74	11.07	9.05	10.06	28.47	23.78	26.13
W_4C_4	11.74	12.84	12.29	7.31	7.34	7.32	18.69	19.72	19.21
SEm±(W×C)	1.11	1.58	0.96	0.45	0.89	0.50	1.28	2.27	1.30
SEm±(C×W)	1.28	1.94	1.55	0.53	1.01	0.78	1.53	2.74	2.09
CD (P=0.05) (WxC)	3.23	4.62	2.74	1.33	2.58	1.41	3.73	6.63	3.71
CD (P=0.05) (CxW)	3.74	5.67	4.41	1.55	2.96	2.21	4.46	7.99	5.95

4.3.2.2.2.3 Interaction effect of integrated weed management and cultivars on phosphorous depletion by weeds

A significant result on phosphorous depletion by weeds was recorded with regard to interaction between the integrated weed management and different cultivars in both the years of experiment which is illustrated in Table 4.26(b). The lowest phosphorous depletion by weeds was recorded under the treatment combination of two hand weeding at 15 and 30 DAS and cultivar *Chakhao Poireiton* while the highest depletion was observed with weedy check in combination with cultivar *Wairi Chakhao*.

4.3.2.2.3 Potassium depletion by weeds (kg ha^{-1})

The data on potassium depletion by weeds recorded during 2021 and 2022 are presented in Table 4.26(a) and Table 4.26(b).

4.3.2.2.3.1Effect of integrated weed management on potassium depletion by weeds

Variation in data with regard to phosphorous depletion was significantly influenced with integrated weed management. It was observed that lowest depletion of potassium by weeds was observed with two hand weeding at 15 and 30 DAS which was followed with application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS. This may be because of broad spectrum weed control by herbicide followed by hand weeding at later stages resulting in low weed dry weight accumulation. The results are in corroboration with those of Sanodiya and Singh (2021). In addition, data also revealed that maximum depletion of potassium was significantly recorded with weedy check in both the years of experiment.

4.3.2.2.3.2 Effect of different cultivars on potassium depletion by weeds

The data on potassium depletion by weeds illustrated in Table 4.26(b) revealed significant results with respect to different cultivars. The data revealed that significantly lowest depletion of potassium by weeds was recorded with cultivar *Chakhao Poireiton* which was followed with *Chakhao Amubi*. Further the data also showed that maximum depletion of potassium by weeds was recorded with *Wairi Chakhao* in both the years of experiment.

4.3.2.2.3.3 Interaction effect of integrated weed management and cultivars on potassium depletion by weeds

A significant result on potassium depletion by weeds was recorded with regard to interaction between the integrated weed management and different cultivars in both the years of experiment which is presented in Table 4.26(b). Minimum potassium depletion by weeds was recorded under the treatment combination of two hand weeding at 15 and 30 DAS and cultivar *Chakhao Poireiton* while the highest depletion was observed with weedy check along with cultivar *Wairi Chakhao*.

4.3.2.3 NPK content (%) in grain and straw

4.3.2.3.1 NPK content (%) in grain

The data on NPK content in grain for both years of experimentation and pooled data of two years are presented in Table 4.27(a) and Table 4.27(b).

4.3.2.3.1.1 Effect of integrated weed management on NPK content (%) in grain

Significant results were obtained with integrated weed management on N and P content in grain in both the years of experiment where significantly two

Table 4.27(a): Effect of integrated weed management and different cultivars on NPK content in grain

Treatment	N content (%)			P content (%)			K content (%)		
	2021	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
Weed Management									
W_1 -Weedy check (Control)	1.53	1.53	1.53	0.439	0.445	0.442	0.308	0.309	0.309
W_2 - Hand weeding (15 and 30 DAS)	1.70	1.73	1.72	0.463	0.469	0.466	0.335	0.336	0.335
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	1.61	1.64	1.63	0.448	0.456	0.452	0.332	0.333	0.333
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	1.57	1.58	1.57	0.456	0.458	0.457	0.318	0.320	0.319
SEm±	0.01	0.02	0.01	0.003	0.002	0.002	0.002	0.002	0.002
CD at 5%	0.05	0.06	0.03	0.009	0.009	0.005	0.008	0.007	0.005
Cultivar									
C_1- *Chakhao Poireiton*	1.59	1.62	1.60	0.461	0.470	0.465	0.330	0.331	0.330
C_2 -*Chakhao Amubi*	1.61	1.65	1.63	0.458	0.462	0.460	0.327	0.328	0.327
C_3 -*Wairi Chakhao*	1.59	1.60	1.59	0.440	0.443	0.442	0.316	0.318	0.317
C_4 -*Khurukhul Chakhao*	1.62	1.63	1.62	0.448	0.453	0.450	0.321	0.323	0.322
SEm±	0.02	0.01	0.01	0.004	0.004	0.003	0.004	0.004	0.003
CD at 5%	NS	NS	NS	0.011	0.011	0.007	NS	NS	NS

Table 4.27(b): Interaction effect of integrated weed management and different cultivars on NPK content in grain

Treatments	N content (%)			P content (%)			K content (%)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	1.50	1.54	1.52	0.447	0.463	0.455	0.313	0.313	0.313
W_1C_2	1.52	1.52	1.52	0.450	0.450	0.450	0.313	0.310	0.312
W_1C_3	1.55	1.50	1.52	0.423	0.427	0.425	0.300	0.303	0.302
W_1C_4	1.53	1.56	1.54	0.437	0.440	0.438	0.307	0.310	0.308
W_2C_1	1.71	1.73	1.72	0.473	0.480	0.477	0.343	0.343	0.343
W_2C_2	1.72	1.75	1.73	0.463	0.470	0.467	0.340	0.340	0.340
W_2C_3	1.67	1.73	1.70	0.453	0.457	0.455	0.330	0.330	0.330
W_2C_4	1.72	1.73	1.73	0.463	0.470	0.467	0.327	0.330	0.328
W_3C_1	1.60	1.65	1.63	0.460	0.473	0.467	0.343	0.347	0.345
W_3C_2	1.64	1.69	1.66	0.453	0.463	0.458	0.330	0.340	0.335
W_3C_3	1.62	1.60	1.61	0.437	0.437	0.437	0.320	0.320	0.320
W_3C_4	1.58	1.62	1.60	0.443	0.450	0.447	0.333	0.327	0.330
W_4C_1	1.54	1.55	1.55	0.463	0.463	0.463	0.320	0.320	0.320
W_4C_2	1.55	1.63	1.59	0.463	0.463	0.463	0.323	0.320	0.322
W_4C_3	1.54	1.55	1.54	0.447	0.453	0.450	0.313	0.317	0.315
W_4C_4	1.64	1.59	1.62	0.450	0.450	0.450	0.317	0.323	0.320
SEm±(W×C)	0.03	0.03	0.02	0.007	0.007	0.005	0.009	0.007	0.006
SEm±(C×W)	0.04	0.03	0.03	0.008	0.008	0.008	0.009	0.008	0.009
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS

hand weeding at 15 and 30 DAS exhibited highest N and P content in grain. This was followed by pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS. Likewise, data also revealed that lowest N and P content were exhibited with weedy check.

For K content in grain, in both the years of experiment highest K content was exhibited with hand weeding at 15 and 30 DAS and was statistically at par with application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS. Data further revealed lowest P content was significantly recorded with weedy check. Devi and Singh (2018) also reported from his study that two hand weeding revealed maximum NPK content in grain in direct seeded rice which may have been because lesser weeds created low competition between crop and weeds for nutrients.

4.3.2.3.1.2 Effect of different cultivars on NPK content (%) in grain

In both the years of experiment variations in data with regard to different cultivars failed to show any significant effect on N and K content in grain. However, it was seen that in terms of P content in grain examination in the data showed that highest P content in grain was recorded with cultivar *Chakhao Poireiton* which was observed to be at par with *Chakhao Amubi* while the lowest P content was significantly recorded with *Wairi Chakhao* in both the years of experiment. Different cultivars may have different traits that effected phosphorous uptake, usage and accumulation in the grains. Environmental factors like soil composition, nutrient availability and weather conditions can also have an impact absorption of phosphorous by plants. Neoh and Lum (2018) also reported similar findings.

4.3.2.3.1.3 Interaction effect of integrated weed management and cultivars on NPK content (%) in grain

Data in context with interaction between integrated weed management and different cultivars showed no significant effect on NPK content in grain in both the years of experiment as depicted in Table 4.27(b).

4.3.2.3.2 NPK content (%) in straw

The data on NPK content in straw for both years of experimentation and pooled data of two years are presented in Table 4.28(a) and Table 4.28(b).

4.3.2.3.2.1 Effect of integrated weed management on NPK content (%) in straw

Observation on the two-year data with respect to N and K content in straw showed that highest N and K was observed with hand weeding at 15 and 30 DAS which was at par with application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS. In addition, data also revealed that lowest nitrogen content was exhibited with weedy check which was at par with pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS.

For P content in straw data influenced to integrated weed management did not show any significant effect on P content in straw in both years of experiment.

4.3.2.3.2.2 Effect of different cultivars on NPK content (%) in straw

N content in straw was significantly affected with different cultivars in both the years of experiment as depicted in Table 4.28(a) where data showed that maximum N content was significantly recorded with cultivar *Chakhao Poireiton* while the minimum N content was recorded with *Wairi Chakhao* in comparison

Table 4.28(a): Effect of integrated weed management and different cultivars on NPK content in straw

Treatment	N content (%)			P content (%)			K content (%)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
Weed Management									
W_1 -Weedy check (Control)	0.71	0.73	0.72	0.154	0.158	0.156	1.212	1.213	1.213
W_2 - Hand weeding (15 and 30 DAS)	0.83	0.84	0.83	0.167	0.169	0.168	1.233	1.234	1.233
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	0.77	0.79	0.78	0.158	0.162	0.160	1.232	1.233	1.233
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	0.74	0.75	0.75	0.152	0.149	0.150	1.221	1.222	1.221
SEm±	0.02	0.02	0.01	0.008	0.004	0.005	0.003	0.002	0.002
CD at 5%	0.06	0.06	0.04	NS	NS	NS	0.010	0.007	0.005
Cultivar									
C_1- *Chakhao Poireiton*	0.83	0.84	0.84	0.160	0.166	0.163	1.224	1.231	1.228
C_2 -*Chakhao Amubi*	0.78	0.80	0.79	0.153	0.160	0.156	1.223	1.227	1.225
C_3 -*Wairi Chakhao*	0.69	0.70	0.70	0.159	0.156	0.158	1.223	1.222	1.223
C_4 -*Khurukhul Chakhao*	0.75	0.77	0.76	0.158	0.156	0.157	1.226	1.223	1.225
SEm±	0.01	0.01	0.01	0.007	0.006	0.005	0.004	0.003	0.003
CD at 5%	0.03	0.04	0.03	NS	NS	NS	NS	NS	NS

Table 4.28(b): Interaction effect of integrated weed management and different cultivars on NPK content in straw

Treatments	N content (%)			P content (%)			K content (%)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	0.807	0.813	0.810	0.157	0.150	0.153	1.217	1.213	1.215
W_1C_2	0.747	0.753	0.750	0.160	0.167	0.163	1.213	1.217	1.215
W_1C_3	0.627	0.653	0.640	0.147	0.150	0.148	1.207	1.213	1.210
W_1C_4	0.653	0.717	0.685	0.153	0.163	0.158	1.210	1.210	1.210
W_2C_1	0.860	0.883	0.872	0.167	0.180	0.173	1.233	1.243	1.238
W_2C_2	0.847	0.860	0.853	0.157	0.167	0.162	1.217	1.233	1.225
W_2C_3	0.797	0.793	0.795	0.173	0.167	0.170	1.240	1.230	1.235
W_2C_4	0.810	0.823	0.817	0.170	0.163	0.167	1.240	1.230	1.235
W_3C_1	0.827	0.843	0.835	0.160	0.177	0.168	1.233	1.237	1.235
W_3C_2	0.777	0.807	0.792	0.150	0.160	0.155	1.237	1.237	1.237
W_3C_3	0.717	0.730	0.723	0.163	0.153	0.158	1.223	1.227	1.225
W_3C_4	0.773	0.767	0.770	0.157	0.157	0.157	1.233	1.233	1.233
W_4C_1	0.833	0.837	0.835	0.157	0.157	0.157	1.213	1.230	1.222
W_4C_2	0.763	0.777	0.770	0.143	0.147	0.145	1.227	1.220	1.223
W_4C_3	0.623	0.627	0.625	0.153	0.153	0.153	1.223	1.217	1.220
W_4C_4	0.750	0.767	0.758	0.153	0.140	0.147	1.220	1.220	1.220
SEm±(W×C)	0.022	0.027	0.018	0.013	0.012	0.009	0.009	0.006	0.005
SEm±(C×W)	0.028	0.033	0.029	0.016	0.013	0.014	0.010	0.007	0.008
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS

with other cultivars.

For P and K content, the perusal on the data of different cultivars in both the years of experiment did not show any significant effect on straw content.

4.3.2.3.2.3 Interaction effect of integrated weed management and cultivars on NPK content (%) in straw

Data in context with interaction between integrated weed management and different cultivars showed no significant effect on NPK content in straw in both the years of experiment as depicted in Table 4.28(b).

4.3.2.4 NPK uptake (kg ha^{-1}) in grain and straw

4.3.2.4.1 NPK uptake (kg ha^{-1}) in grain

The data on NPK uptake in grain influenced by integrated weed management and different cultivars for both years of experimentation and pooled data are presented in Table 4.29(a) and Table 4.29 (b).

4.3.2.4.1.1 Effect of integrated weed management on NPK uptake (kg ha^{-1}) in grain

Perusal on the data with regard to NPK uptake in grain as influenced by integrated weed management showed significant results in both the years of experiment where it was seen that significantly maximum NPK uptake was exhibited with hand weeding at 15 and 30 DAS which was followed by pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS. Kalita *et al.* (2015) also revealed from their findings that better growth of roots may have favored the uptake with regard to higher production since it allows greater contact with the soil and ultimately higher uptake of moisture and nutrients. Data also further showed that the lowest NPK uptake was recorded significantly with weedy check. This may be due to low nutrient content in grain resulting in lower uptake

Table 4.29(a): Effect of integrated weed management and different cultivars on NPK uptake in grain

Treatment	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})			K uptake (kg ha^{-1})		
	2021	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
Weed Management									
W_1 -Weedy check (Control)	16.30	16.60	16.45	4.695	4.841	4.768	3.310	3.394	3.352
W_2 - Hand weeding (15 and 30 DAS)	31.87	32.47	32.17	8.669	8.793	8.731	6.267	6.357	6.312
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	27.16	27.80	27.48	7.569	7.727	7.648	5.600	5.648	5.624
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	19.84	20.12	19.98	5.781	5.824	5.802	4.047	4.071	4.059
SEm±	0.63	0.50	0.41	0.141	0.155	0.105	0.094	0.120	0.076
CD at 5%	2.20	1.75	1.25	0.489	0.535	0.323	0.327	0.414	0.235
Cultivar									
C_1- *Chakhao Poireiton*	24.92	25.48	25.20	7.186	7.356	7.271	5.101	5.244	5.173
C_2 -*Chakhao Amubi*	24.49	25.26	24.88	6.910	7.039	6.975	4.962	5.021	4.992
C_3 -*Wairi Chakhao*	22.30	22.56	22.43	6.137	6.216	6.177	4.468	4.518	4.493
C_4 -*Khurukhul Chakhao*	23.45	23.69	23.57	6.480	6.573	6.527	4.693	4.688	4.691
SEm±	0.39	0.40	0.28	0.101	0.101	0.071	0.103	0.083	0.066
CD at 5%	1.13	1.16	0.79	0.295	0.294	0.203	0.301	0.243	0.188

Table 4.29(b): Interaction effect of integrated weed management and different cultivars on NPK uptake in grain

Treatments	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})			K uptake (kg ha^{-1})		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	17.08	17.63	17.36	5.077	5.308	5.192	3.597	3.614	3.605
W_1C_2	16.90	17.28	17.09	4.992	5.120	5.056	3.464	3.535	3.499
W_1C_3	15.36	15.18	15.27	4.195	4.328	4.262	3.038	3.179	3.108
W_1C_4	15.86	16.31	16.08	4.517	4.609	4.563	3.140	3.251	3.195
W_2C_1	33.53	33.92	33.73	9.284	9.437	9.361	6.741	6.881	6.811
W_2C_2	32.58	33.19	32.89	8.799	8.930	8.865	6.200	6.462	6.331
W_2C_3	29.95	31.13	30.54	8.132	8.207	8.169	5.918	5.932	5.925
W_2C_4	31.41	31.64	31.52	8.460	8.598	8.529	6.211	6.153	6.182
W_3C_1	28.01	28.95	28.48	8.035	8.294	8.164	5.764	6.073	5.918
W_3C_2	28.27	29.29	28.78	7.814	8.042	7.928	5.924	5.900	5.912
W_3C_3	26.09	25.92	26.01	7.048	7.069	7.059	5.168	5.287	5.228
W_3C_4	26.27	27.06	26.66	7.377	7.502	7.440	5.546	5.333	5.440
W_4C_1	21.05	21.41	21.23	6.347	6.386	6.367	4.301	4.411	4.356
W_4C_2	20.21	21.29	20.75	6.035	6.065	6.050	4.260	4.188	4.224
W_4C_3	17.82	18.01	17.91	5.173	5.260	5.216	3.749	3.672	3.711
W_4C_4	20.28	19.77	20.03	5.569	5.584	5.576	3.877	4.014	3.946
SEm±(W×C)	0.77	0.80	0.56	0.202	0.202	0.143	0.206	0.166	0.133
SEm±(C×W)	0.99	0.95	0.90	0.247	0.252	0.232	0.234	0.205	0.210
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS

eventually. Similar results are in line with those of Rathika *et al*. (2020).

4.3.2.4.1.2 Effect of different cultivars on NPK uptake (kg ha^{-1}) in grain

Variations in data in context with N uptake as affected by different cultivars revealed that in both the years of experiment highest N uptake was observed with cultivar *Chakhao Poireiton* which was at par with *Chakhao Amubi*. Data further showed that *Wairi Chakhao* was statistically at par with *Khurukhul Chakhao*.

For P uptake, examination in the data revealed that highest P uptake was exhibited with *Chakhao Poireiton* which was at par with *Chakhao Amubi*. Further, the second year and pooled data showed that significantly highest P uptake was resulted with *Chakhao Poireiton*. In addition, significantly lowest P uptake was recorded with *Wairi Chakhao* in both the years of experiment.

For K uptake, both years of experiment as well as pooled data observed that highest K uptake was seen with cultivar *Chakhao Poireiton* which was at par with *Chakhao Amubi* statistically. Additionally, data also revealed lowest K uptake with *Wairi Chakhao* cultivar in all the years of experiment.

4.3.2.4.1.3 Interaction effect of integrated weed management and cultivars on NPK uptake (kg ha^{-1}) in grain

Data in context with interaction between integrated weed management and different cultivars showed no significant effect on NPK uptake in grain in both the years of experiment as depicted in Table 4.29 (b).

4.3.2.4.2 NPK uptake (kg ha^{-1}) in straw

The data on NPK uptake in straw influenced by integrated weed management and different cultivars for both years of experiment and pooled data are presented in Table 4.30 (a) and Table 4.30 (b).

4.3.2.4.2.1 Effect of integrated weed management on NPK uptake (kg ha^{-1}) in straw

A detail examination on the data with context to NPK uptake in straw as affected by integrated weed management showed significant results in both the years of experiment where it was seen that significantly maximum NPK uptake was observed with hand weeding at 15 and 30 DAS which was followed by application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS. Data further showed that the lowest NPK uptake was recorded with weedy check significantly. Similar result was also revealed with the findings of Prashanth *et al.* (2016) which may be due to higher crop dry weight along with more nutrient content.

4.3.2.4.2.2 Effect of different cultivars on NPK uptake (kg ha^{-1}) in straw

Variations in data with context to N uptake as affected by different cultivars revealed that in both the years of experiment significantly highest N uptake was observed with cultivar *Chakhao Poireiton* which was followed by *Chakhao Amubi*. In addition, *Wairi Chakhao* recorded lowest N uptake significantly.

For P uptake, observation in the data revealed that both the years of experiment failed to show any significant effect on P uptake.

For K uptake, both years of experiment as well as pooled data revealed that *Chakhao Poireiton* recorded maximum K uptake which was at par with *Chakhao Amubi*. In addition, lowest K uptake was observed with *Wairi Chakhao* which was seen to be statistically at par with *Khurukhul Chakhao*.

Table 4.30(a): Effect of integrated weed management and different cultivars on NPK uptake in straw

Treatment	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})			K uptake (kg ha^{-1})		
	2021	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
Weed Management									
W_1 -Weedy check (Control)	20.92	22.26	21.59	4.553	4.763	4.658	35.74	36.74	36.24
W_2 - Hand weeding (15 and 30 DAS)	33.20	34.46	33.83	6.670	6.931	6.801	49.36	50.69	50.02
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	28.67	29.37	29.02	5.831	6.030	5.931	45.68	46.08	45.88
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	24.99	25.72	25.36	5.074	5.075	5.075	40.93	41.72	41.32
SEm±	0.72	0.87	0.57	0.222	0.156	0.135	0.66	0.58	0.44
CD at 5%	2.51	3.02	1.75	0.768	0.538	0.417	2.30	2.00	1.36
Cultivar									
C_1- *Chakhao Poireiton*	29.98	31.07	30.53	5.772	6.125	5.948	44.06	45.24	44.65
C_2 -*Chakhao Amubi*	28.04	29.20	28.62	5.430	5.801	5.616	43.65	44.58	44.11
C_3 -*Wairi Chakhao*	23.52	24.28	23.90	5.395	5.372	5.383	41.25	42.04	41.64
C_4 -*Khurukhul Chakhao*	26.24	27.26	26.75	5.532	5.502	5.517	42.76	43.36	43.06
SEm±	0.57	0.60	0.41	0.254	0.194	0.160	0.68	0.81	0.53
CD at 5%	1.65	1.76	1.17	NS	NS	NS	2.00	2.36	1.51

Table 4.30(b): Interaction effect of integrated weed management and different cultivars on NPK uptake in straw

Treatments	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})			K uptake (kg ha^{-1})		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	24.20	25.07	24.63	4.700	4.624	4.662	36.50	37.38	36.94
W_1C_2	22.31	23.08	22.70	4.782	5.068	4.925	36.26	37.23	36.74
W_1C_3	17.86	19.19	18.52	4.199	4.413	4.306	34.45	35.65	35.05
W_1C_4	19.30	21.72	20.51	4.529	4.948	4.738	35.77	36.68	36.22
W_2C_1	35.18	36.73	35.95	6.823	7.468	7.146	50.47	51.74	51.10
W_2C_2	34.48	35.56	35.02	6.400	6.864	6.632	49.57	50.92	50.25
W_2C_3	30.78	31.63	31.20	6.683	6.651	6.667	47.93	49.09	48.51
W_2C_4	32.34	33.94	33.14	6.775	6.742	6.758	49.47	51.01	50.24
W_3C_1	31.12	32.24	31.68	6.031	6.758	6.394	46.42	47.36	46.89
W_3C_2	29.01	30.66	29.83	5.606	6.081	5.843	46.37	47.00	46.69
W_3C_3	25.79	26.30	26.04	5.865	5.533	5.699	44.01	44.31	44.16
W_3C_4	28.77	28.27	28.52	5.824	5.750	5.787	45.91	45.66	45.79
W_4C_1	29.44	30.24	29.84	5.533	5.649	5.591	42.85	44.47	43.66
W_4C_2	26.35	27.50	26.92	4.932	5.193	5.062	42.38	43.17	42.78
W_4C_3	19.66	20.02	19.84	4.833	4.891	4.862	38.60	39.12	38.86
W_4C_4	24.52	25.12	24.82	5.000	4.568	4.784	39.89	40.11	40.00
SEm±(W×C)	1.13	1.20	0.83	0.51	0.39	0.32	1.369	1.618	1.060
SEm±(C×W)	1.35	1.48	1.33	0.57	0.43	0.49	1.562	1.788	1.635
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS

4.3.2.4.2.3 Interaction effect of integrated weed management and cultivars on NPK uptake (kg ha^{-1}) in straw

Observation in data with interaction between integrated weed management and different cultivars showed no significant effect on NPK uptake in straw in both the years of experiment as illustrated in Table 4.30 (b).

4.3.2.4.2 Total NPK uptake (kg ha^{-1})

The data on total NPK uptake influenced by integrated weed management and different cultivars for both years of experiment and pooled data are presented in Table 4.31(a) and Table 4.31 (b).

4.3.2.4.2.1 Effect of integrated weed management on total NPK uptake (kg ha^{-1})

A detail examination on the data with regard to integrated weed management with context to total NPK uptake revealed significant results in both the years of experiment. Data revealed that significantly highest NPK uptake was recorded with two hand weeding at 15 and 30 DAS which was followed by pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS and pretilachlor @1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25 g ha^{-1} (PoE) at 20 DAS. Additionally, total NPK uptake was recorded lowest with weedy check significantly. Increase in nutrient uptake under these treatments was due to better control of weeds leading to decrease depletion of nutrients by weeds and increase in nutrient uptake by the crop while weedy check resulting in significantly lower nutrient. Multiple researchers have also reported that weeds have the capability of absorbing nutrients faster and in relatively higher amounts than the crop plants Goswami *et al*. (2017) and Gudi *et al*. (2017) also reported similar results.

Table 4.31(a): Effect of integrated weed management and different cultivars on total nutrient uptake of black rice

Treatment	Total N ($kg\ ha^{-1}$)			Total P ($kg\ ha^{-1}$)			Total K ($kg\ ha^{-1}$)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
Weed Management									
W_1 -Weedy check (Control)	89.83	93.12	91.48	23.97	24.81	24.39	61.07	62.66	61.87
W_2 - Hand weeding (15 and 30 DAS)	148.82	153.76	151.29	37.26	38.14	37.70	92.10	93.82	92.96
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	128.52	131.79	130.16	32.97	33.54	33.26	84.28	85.04	84.66
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	106.69	109.37	108.03	28.10	28.40	28.25	71.12	72.14	71.63
SEm±	2.34	2.31	1.64	0.46	0.47	0.33	0.95	0.70	0.59
CD at 5%	8.11	7.98	5.07	1.61	1.63	1.02	3.29	2.41	1.82
Cultivar									
C_1- *Chakhao Poireiton*	125.25	129.47	127.36	32.06	33.39	32.73	80.20	81.90	81.05
C_2 -*Chakhao Amubi*	121.94	126.80	124.37	30.96	32.09	31.53	78.67	80.23	79.45
C_3 -*Wairi Chakhao*	109.50	111.91	110.71	28.94	29.03	28.98	73.38	74.45	73.92
C_4 -*Khurukhul Chakhao*	117.15	119.87	118.51	30.34	30.37	30.36	76.33	77.07	76.70
SEm±	1.45	1.63	1.09	0.59	0.52	0.39	1.09	1.16	0.80
CD at 5%	4.23	4.75	3.10	1.73	1.51	1.12	3.19	3.40	2.27

Table 4.31(b): Interaction effect of integrated weed management and different cultivars on total nutrient uptake

Treatments	Total N (kg ha^{-1})			Total P (kg ha^{-1})			Total K (kg ha^{-1})		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
W_1C_1	95.54	99.38	97.46	24.96	25.93	25.44	63.28	64.59	63.94
W_1C_2	92.97	95.43	94.20	25.04	25.89	25.46	62.54	64.09	63.32
W_1C_3	83.65	84.98	84.32	22.20	22.81	22.50	57.96	59.94	58.95
W_1C_4	87.16	92.70	89.93	23.67	24.61	24.14	60.52	62.00	61.26
W_2C_1	155.48	159.81	157.64	38.73	40.42	39.58	95.45	97.20	96.33
W_2C_2	153.06	157.07	155.06	37.07	38.37	37.72	92.98	94.88	93.93
W_2C_3	139.58	146.14	142.86	36.20	36.08	36.14	88.83	90.29	89.56
W_2C_4	147.16	152.03	149.60	37.03	37.71	37.37	91.12	92.89	92.01
W_3C_1	133.89	139.26	136.57	34.17	36.27	35.22	86.88	88.38	87.63
W_3C_2	131.90	138.03	134.96	32.93	34.52	33.73	85.41	87.28	86.35
W_3C_3	121.61	121.67	121.64	31.60	30.82	31.21	80.43	80.75	80.59
W_3C_4	126.70	128.22	127.46	33.20	32.55	32.88	84.39	83.75	84.07
W_4C_1	116.11	119.42	117.76	30.38	30.94	30.66	75.18	77.41	76.29
W_4C_2	109.85	116.67	113.26	28.81	29.60	29.20	73.74	74.66	74.20
W_4C_3	93.17	94.86	94.02	25.74	26.43	26.09	66.29	66.83	66.56
W_4C_4	107.61	106.52	107.06	27.47	26.62	27.05	69.28	69.64	69.46
SEm±(W×C)	2.90	3.25	2.18	1.18	1.04	0.79	2.18	2.33	1.60
SEm±(C×W)	3.69	3.99	3.57	1.32	1.17	1.21	2.46	2.54	2.45
CD (P=0.05) (WxC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (P=0.05) (CxW)	NS	NS	NS	NS	NS	NS	NS	NS	NS

4.3.2.4.2.2 Effect of different cultivars on total NPK uptake (kg ha^{-1})

Variations in data with context to total N uptake as affected by different cultivars revealed that in both the years of experiment highest total N uptake was exhibited with *Chakhao Poireiton* which was at par with *Chakhao Amubi* while significantly lowest N uptake was seen with *Wairi Chakhao*.

For total P and K uptake, observation in the data revealed that in both the years of experiment *Chakhao Poireiton* was recorded with highest P uptake and was seen to be at par with *Chakhao Amubi* and *Khurukhul Chakhao* while lowest P uptake was exhibited with *Wairi Chakhao* and was statistically at par with *Khurukhul Chakhao*. In addition, pooled data revealed that significantly highest and lowest total P uptake was recorded with *Chakhao Poireiton* and *Wairi Chakhao* respectively.

4.3.2.4.2.3 Interaction effect of integrated weed management and cultivars on total NPK uptake (kg ha^{-1})

Observation in data with interaction between integrated weed management and different cultivars showed no significant effect on total NPK uptake in straw in both the years of experiment as illustrated in Table 4.31(b).

4.4 ECONOMIC ANALYSIS

The data on cost of cultivation, gross return, net return and benefit cost ratio with regard to integrated weed management and cultivars are presented in Table 4.32(a) and Table 4.32 (b).

Table 4.32(a): Effect of integrated weed management and different cultivars on cost of cultivation and gross returns of black rice production

Treatments	Cost of cultivation (₹ ha^{-1})			Gross returns (₹ ha^{-1})		
Weed Management	**2021**	**2022**	**Mean**	**2021**	**2022**	**Mean**
W_1 -Weedy check (Control)	36040.18	36040.18	36040.18	88383.75	89967.67	89175.71
W_2 - Hand weeding (15 and 30 DAS)	48040.18	48040.18	48040.18	153611.83	153974.33	153793.08
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	41440.18	41440.18	41440.18	138636.08	139206.75	138921.42
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	37530.18	37530.18	37530.18	104791.67	105192.33	104992.00
Cultivar						
C_1- *Chakhao Poireiton*	36040.18	36040.18	36040.18	127909.25	128558.83	128234.04
C_2 -*Chakhao Amubi*	36040.18	36040.18	36040.18	124254.33	125278.42	124766.38
C_3 -*Wairi Chakhao*	36040.18	36040.18	36040.18	114502.08	115245.17	114873.63
C_4 -*Khurukhul Chakhao*	36040.18	36040.18	36040.18	118757.67	119258.67	119008.17

4.4.1 Cost of cultivation (₹ ha^{-1})

4.4.1.1 Effect of integrated weed management and cultivars on cost of cultivation

Variation in data of cost of cultivation in black rice affected by integrated weed management and different cultivars for both the years were calculated and presented in Table 4.32(a). From the data it can be observed that among the integrated weed management, the highest cost of cultivation was incurred with two hand weeding at 15 and 30 DAS with ₹ 48040.18 ha^{-1} followed by pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS with ₹41440.18 ha^{-1} while further data revealed that lowest cost of cultivation was incurred with weedy check with ₹36040.18 ha^{-1} in both the years. The higher cost of cultivation may be because of higher cost and number of labours required for weeding. Similar results were confirmed with the findings of Tuti *et al.* (2016) and Yogananda *et al.* (2017). Among the cultivars, it was observed that all the four cultivars recorded the same cost of cultivation in both the years with ₹36040.18 ha^{-1}.

4.4.2 Gross returns (₹ ha^{-1})

The data on gross returns was calculated for two years of experiment and presented in Table 4.32 (a) and it was revealed that among the integrated weed management, maximum gross returns in both the years was recorded with two hand weeding at 15 and 30 DAS with ₹153611.83 ha^{-1} and ₹153974.33 ha^{-1}. Further, minimum gross returns were observed with weedy check with ₹88383.75 ha^{-1} and ₹89967.67 ha^{-1} for the year 2021 and 2022 respectively. Among the different cultivars, *Chakhao Amubi* recorded highest gross returns for the year 2021 and 2022 with ₹127909.25 ha^{-1} and ₹128558.83 ha^{-1} while *Wairi Chakhao* recorded lowest gross returns with ₹114502.08 ha^{-1} and ₹115245.17 ha^{-1} in 2021 and 2022 respectively. Gangireddy *et al.* (2019) in his study also revealed that it may be due to higher grain and straw yield associated with this treatment.

4.4.3 Net returns (₹ ha^{-1})

An inquisition on data of net returns in both the years was calculated and depicted in Table 4.33 (a). The data indicated that two hand weeding at 15 and 30 DAS exhibited maximum net returns in both the years with ₹105571.65 ha^{-1} and ₹105934.15 ha^{-1} which was followed by pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS with ₹97195.90 ha^{-1} and ₹97766.57 ha^{-1} respectively. In addition, data further observed minimum net returns with weedy check with ₹52343.57 $ha^{-1}$and ₹53927.49 ha^{-1} in 2021 and 2022 respectively. Unweeded control resulting in lowest net returns may be due to drastic reduction in grain yield by virtue of uncontrolled weed growth throughout the crop period. This finding is in harmony with the findings of Nagarjun *et al.* (2019) and Barla *et al.* (2021). Data on different cultivars in the year 2021 and 2022 revealed that highest gross returns was recorded with *Chakhao Poireiton* with ₹91869.07 ha^{-1} and ₹92518.65 ha^{-1} while *Wairi Chakhao* exhibited lowest gross returns incurring ₹78461.90 ha^{-1} and ₹79204.99 ha^{-1} respectively. Similar findings were also resulted with those of Nivetha *et al.* (2017) and Jagtap *et al.* (2018).

4.4.4 B:C ratio

Observation on data with context to B:C ratio as depicted in Table 4.33(a) influenced by integrated weed management and cultivars revealed that among the integrated weed management, pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS observed highest B:C ratio. Mukherjee (2019) and Salam *et al.* (2020) also reported from their findings that pre-emergence herbicide followed by hand weeding resulted in higher B:C ratio. The higher benefit:cost ratio under this treatment was mainly owing to more grain yield and comparatively lower

Table 4.32(b): Effect of treatment combination on cost of cultivation and gross returns of black rice production

Treatment	Cost of cultivation (₹ ha^{-1})			Gross returns (₹ ha^{-1})		
	2021	2022	Mean	2021	2022	Mean
W_1C_1	36040.18	36040.18	36040.18	93853.33	94921.67	94387.50
W_1C_2	36040.18	36040.18	36040.18	91761.67	94073.67	92917.67
W_1C_3	36040.18	36040.18	36040.18	82137.67	84058.00	83097.83
W_1C_4	36040.18	36040.18	36040.18	85782.33	86817.33	86299.83
W_2C_1	48040.18	48040.18	48040.18	161050.33	161442.00	161246.17
W_2C_2	48040.18	48040.18	48040.18	155968.67	156154.33	156061.50
W_2C_3	48040.18	48040.18	48040.18	147358.00	147724.00	147541.00
W_2C_4	48040.18	48040.18	48040.18	150070.33	150577.00	150323.67
W_3C_1	41440.18	41440.18	41440.18	143523.33	143988.67	143756.00
W_3C_2	41440.18	41440.18	41440.18	141568.00	142627.33	142097.67
W_3C_3	41440.18	41440.18	41440.18	132637.33	133148.33	132892.83
W_3C_4	41440.18	41440.18	41440.18	136815.67	137062.67	136939.17
W_4C_1	37530.18	37530.18	37530.18	113210.00	113883.00	113546.50
W_4C_2	37530.18	37530.18	37530.18	107719.00	108258.33	107988.67
W_4C_3	37530.18	37530.18	37530.18	95875.33	96050.33	95962.83
W_4C_4	37530.18	37530.18	37530.18	102362.33	102577.67	102470.00

Selling price of Black rice: ₹80/ kg^{-1}

Selling price of Straw: ₹1/ kg^{-1}

Table 4.33(a): Effect of integrated weed management and different cultivars on net returns and B: C ratio of black rice production

Treatments	**Net returns (₹ ha^{-1})**			**B:C ratio**		
Weed Management	**2021**	**2022**	**Mean**	**2021**	**2022**	**Mean**
W_1 -Weedy check (Control)	52343.57	53927.49	53135.5	1.45	1.50	1.47
W_2 - Hand weeding (15 and 30 DAS)	105571.65	105934.15	105752.9	2.20	2.21	2.20
W_3 -Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS	97195.90	97766.57	97481.2	2.35	2.36	2.35
W_4 -Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS	67261.49	67662.15	67461.8	1.79	1.80	1.80
Cultivar						
C_1- *Chakhao Poireiton*	91869.07	92518.65	92193.9	2.55	2.57	2.56
C_2 -*Chakhao Amubi*	88214.15	89238.24	88726.2	2.45	2.48	2.46
C_3 -*Wairi Chakhao*	78461.90	79204.99	78833.4	2.18	2.20	2.19
C_4 -*Khurukhul Chakhao*	82717.49	83218.49	82968.0	2.30	2.31	2.30

Table 4.33(b): Effect of treatment combination on net returns and B: C ratio of black rice production

Treatment	Net returns (₹ ha^{-1})			B:C ratio		
	2021	2022	Mean	2021	2022	Mean
W_1C_1	57813.15	58881.49	58347.32	1.60	1.63	1.62
W_1C_2	55721.49	58033.49	56877.49	1.55	1.61	1.58
W_1C_3	46097.49	48017.82	47057.65	1.28	1.33	1.31
W_1C_4	49742.15	50777.15	50259.65	1.38	1.41	1.39
W_2C_1	113010.15	113401.82	113205.99	2.35	2.36	2.36
W_2C_2	107928.49	108114.15	108021.32	2.25	2.25	2.25
W_2C_3	99317.82	99683.82	99500.82	2.07	2.08	2.07
W_2C_4	102030.15	102536.82	102283.49	2.12	2.13	2.13
W_3C_1	102083.15	102548.49	102315.82	2.46	2.47	2.47
W_3C_2	100127.82	101187.15	100657.49	2.42	2.44	2.43
W_3C_3	91197.15	91708.15	91452.65	2.20	2.21	2.21
W_3C_4	95375.49	95622.49	95498.99	2.30	2.31	2.30
W_4C_1	75679.82	76352.82	76016.32	2.02	2.03	2.03
W_4C_2	70188.82	70728.15	70458.49	1.87	1.88	1.88
W_4C_3	58345.15	58520.15	58432.65	1.55	1.56	1.56
W_4C_4	64832.15	65047.49	64939.82	1.73	1.73	1.73

variable cost of cultivation compared to manual weeding and other treatments Kashid *et al.* (2016) and Yogananda *et al.* (2021). This was followed by two hand weeding at 15 and 30 DAS Further, among the different cultivars data revealed that highest and lowest B:C ratio was observed with *Chakhao Poireiton* and *Wairi Chakhao* respectively in both the years of observation.

CHAPTER V

SUMMARY AND CONCLUSIONS

SUMMARY AND CONCLUSIONS

The present research entitled **“Performance of black rice cultivars to integrated weed management in Nagaland conditions”** was carried out in the experimental farm of School of Agricultural Sciences (SAS), Nagaland University, Medziphema during *kharif* season of 2021 and 2022 under the following objectives:

1. To study the performance of black rice cultivars to integrated weed management practices.

2. To study the performance of weed suppressing ability of different black rice cultivars.

3. To study the weed dynamics in black rice cultivars.

4. To assess the economics of different treatments.

The experiment was laid out in Split plot design (SPD) with three replications. The main plot consisted of four weed management treatments: W_1: Weedy check (Control), W_2: Hand weeding (15 and 30 DAS) W_3: Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS W_4: Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25g ha^{-1} (PoE) at 20 DAS and sub-plots consisted of cultivars namely C_1: *Chakhao Poireiton* C_2: *Chakhao Amubi* C_3: Wa*iri Chakhao* C_4: *Khurukhul Chakhao*. All the parameters under study were recorded as per standard procedures.

The relevant experimental results from the pooled data of two years of the present experiment have been summarized below:

5.1 Effect of integrated weed management and cultivars on growth, yield and quality parameters

1. Examination on the results revealed that among the weed management practices maximum plant height, dry matter accumulation, leaf area index, crop growth rate showed significant results with two hand weeding at 15 and 30 DAS which was followed by the application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS and minimum was recorded with weedy check respectively. Among the different cultivars, *Chakhao Poireiton* and *Wairi Chakhao* revealed highest and lowest plant height, dry matter accumulation, leaf area index, crop growth rate and relative growth rate respectively. However, both integrated weed management and cultivars did not show any significant effect on number of plants m^{-2} during both the years of experiment.
2. Integrated weed management did not show any significant effect on days to 50 % flowering, days to 50 % physiological maturity and days to maturity, however, it showed significant results with regards to different cultivars where *Chakhao Poireiton* and *Wairi Chakhao* revealed highest and lowest values respectively in comparison with the other cultivars in both the years of experiment.
3. Significantly maximum number of panicles m^{-2}, length of panicle, weight of panicle, number of grains panicle^{-1}, grain, straw and biological yields and harvest index were recorded with two hand weeding at 15 and 30 DAS which was followed by application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS. In the context with different cultivars, *Chakhao Poireiton* and *Wairi Chakhao* recorded significantly the maximum and minimum number of panicles m^{-2}, length of panicle, weight of panicle, number of grains panicle^{-1}, grain yield, straw yield and biological yield respectively. Further, grain filling percentage and test weight did not

show any significant effect on integrated weed management and different cultivar.

Interaction of integrated weed management and cultivars recorded significant results on weight of panicle where two hand weeding at 15 and 30 DAS in combination with *Chakhao Poireiton* recorded highest weight of panicle in both the years of experiment.

4. Result of integrated weed management showed no significant effect on milling percentage, hulling percentage and head rice recovery but recorded significant effect on protein content where two hand weeding at 15 and 30 DAS revealed highest protein content. Among the different cultivars, *Chakhao Poireiton* and *Wairi Chakhao* exhibited significantly highest and lowest milling percentage, hulling percentage and head rice recovery respectively however, protein content did not show any significant result in both the years of experiment.

5.2 Effect of integrated weed management and cultivars on weeds

1. The dominant species of grasses were *Digiteria sanguinalis*, *Cynodon dactylon* and *Eleusine indica* while *Cyperus iria* and *Cyperus rotundus* were dominant among sedges and *Borreria latifolia*, *Mollugo pentaphylla*, *Alternanthera sessilis*, *Ageratum conyzoides*, *Phyllanthus niruri* and *Commelina benghalensis* were dominant in case of broad leaved weeds respectively.
2. Integrated weed management recorded significant results on population and dry weight of grasses, sedges and broad leaved weeds where two hand weeding at 15 and 30 DAS recorded lowest population as well as dry weight of weeds which was closely followed with pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS and was found to be at par with pretilachlor @ 1.0 kg ha^{-1} (PE) + bispyribac sodium @ 25g ha^{-1} (PoE)

at 20 DAS while weedy check resulted with highest population as well as dry matter in both the years of experiment. Among the cultivars, minimum and maximum population and dry weight of grasses, sedges and broad leaved weeds was exhibited with cultivar *Chakhao Poireiton* and *Wairi Chakhao* respectively.

3. Results on weed control efficiency was recorded lowest with weedy check while highest was exhibited with two hand weeding at 15 and 30 DAS which was followed by pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS. Further, among the cultivars, *Chakhao Poireiton* and *Wairi Chakhao* revealed highest and lowest weed control efficiency respectively in both the years of experiment.
4. Integrated weed management revealed significant results on NPK content in weeds where two hand weeding at 15 and 30 DAS which was followed by pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS recorded lowest NPK content and weedy check with the highest NPK content. Among the cultivars, it did not show any significant results on Nitrogen however Phosphorus and Potassium content was recorded highest and lowest with *Wairi Chakhao* and *Chakhao Poireiton* respectively.
5. Integrated weed management and different cultivars showed significant results on NPK depletion by weeds in both the years of experiment where among integrated weed management lowest depletion was exhibited with two hand weeding at 15 and 30 DAS which was followed by application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS and highest was observed with weedy check. With regards to cultivars, *Chakhao Poireiton* and *Wairi Chakhao* recorded lowest and highest depletion by weeds respectively in both the years of experiment.

5.3 Effect of integrated weed management and cultivars on soil and plant analysis

1. Results on Integrated weed management and cultivars did not show any significant effect on pH, organic carbon, electrical conductivity, available nitrogen, phosphorus and potassium respectively.
2. Integrated weed management recorded significant results on NPK content in grain where maximum content was observed with two hand weeding at 15 and 30 DAS which was followed by pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS and weedy check recorded the lowest NPK content. Among the cultivars, nitrogen and potassium did not show any significant results however, with regard to phosphorus cultivar *Chakhao Poireiton* and *Wairi Chakhao* recorded the highest and the lowest P content in both the years.
3. Nitrogen and potassium content in straw revealed significant results with integrated weed management where lowest content was recorded with weedy check while highest was exhibited with two hand weeding at 15 and 30 DAS which was followed by pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS. However, phosphorus content in straw revealed no significant results in both the years of experiment. Among cultivars, Phosphorus and potassium content in straw did not show any significant results however; with regard to nitrogen content, it showed significant results where Cultivar *Chakhao Poireiton* and *Wairi Chakhao* recorded highest and lowest nitrogen content in straw in both the years of experiment.
4. NPK uptake in grain showed significant results with regard to integrated weed management and different cultivars in both the years where two hand weeding at 15 and 30 DAS and weedy check recorded highest and lowest NPK uptake in grain while in regards with cultivars,

Chakhao Poireiton and *Wairi Chakhao* observed highest and lowest NPK uptake in grain in both the years respectively.

5. Results on NPK uptake in straw showed significant results with regard to integrated weed management where two hand weeding at 15 and 30 DAS and weedy check recorded highest and lowest NPK uptake in straw respectively. Among cultivars, *Chakhao Poireiton* and *Wairi Chakhao* observed highest and lowest nitrogen and potassium uptake in straw. However, phosphorus did not show any significant results on straw uptake in both the years.
6. Examination on total NPK uptake showed significant results with regard to integrated weed management and different cultivars in both the years where two hand weeding at 15 and 30 DAS and weedy check recorded highest and lowest total NPK uptake respectively while among the cultivars, *Chakhao Poireiton* and *Wairi Chakhao* observed highest and lowest total NPK uptake in both the years.

5.4 Effect of integrated weed management and cultivars on economics

1. Data pertaining to economics revealed that two hand weeding at 15 and 30 DAS followed by pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS recorded highest cost of cultivation, gross return and net return while pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS exhibited highest B:C ratio in both the years of experiment. Among cultivars, highest cost of cultivation, gross return, net return and B:C was recorded with *Chakhao Poireiton* while lowest was revealed with cultivar *Wairi Chakhao*.

Based on the objectives and from the above findings the following conclusions may be drawn

1. Two hand weeding at 15 and 30 DAS resulted to be the best among the different weed management treatments resulting in higher growth, yield attributes, yield and protein content of black rice. Among cultivars, *Chakhao Poireiton* proved to result in maximum growth, yield attributes and yield of black rice.
2. Weed population and dry weight was found to be lowest in plots where *Chakhao Poireiton* was grown. It also recorded the highest weed control efficiency (WCE), which was followed by *Chakhao Amubi*. *Chakhao Poireiton* also resulted in higher growth attributes, phenology, quality, yield attributes, yield of black rice.
3. Results on integrated weed management and cultivars revealed that lowest weed population, weed dry weight and highest weed control efficiency was recorded with two hand weeding at 15 and 30 DAS and cultivar *Chakhao Poireiton* which was followed closely with pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS and cultivar *Chakhao Amubi* respectively. NPK content in weed and depletion by the same was obtained with significant result where lowest and highest content as well as depletion was exhibited with two hand weeding at 15 and 30 DAS and weedy check respectively. Additionally, among different cultivars *Chakhao Poireiton* and *Wairi Chakhao* was observed with lowest and highest NPK content and depletion by weeds respectively.
4. Two hand weeding at 15 and 30 DAS in combination with cultivar *Chakhao Poireiton* incurred highest gross and net return however highest B:C was recorded with application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS in combination with *Chakhao Poireiton*.

Recommendation

On the basis of the two of years experiment entitled **“Performance of black rice cultivars to integrated weed management in Nagaland conditions”** the recommendation may be suggested

1. For efficient control of weeds in black rice cultivation, two hand weeding at 15 and 30 DAS should be done for better growth, yield attributes, higher yield and quality enhancement. However, from the economic point pre-emergence application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS was found to be the most economical integrated weed management practice.
2. Among black rice cultivars the cultivar *Chakhao Poireiton* proved to be the best in terms of growth, phenological parameters, yield and quality of black rice for Nagaland conditions.

REFERENCES

REFERENCES

Abou, E. D. 2012. Integrating agricultural and chemical methods for efficient weed control and high yielding in drill- seeded rice. *Journal of Plant Production*, Mansoura University. **3**(4): 655- 664.

Afroz, R., Salam, M. A. and Begum, M. 2019. Effect of weeding regime on the performance of Boro rice cultivars. *Journal Bangladesh Agriculture University*. **17**(3): 265-273.

Ahmed, S., Kumar, V., Alam, M., Dewan, M. R., Bhuiyan, K. A., Miajy, A. A., Singh, S., Timsina, J. and Krupnik, T. J. 2021. Integrated weed management in transplanted rice: options for addressing labor constraints and improving farmers' income in Bangladesh. *Weed Technology*. **35**: 697-709.

Amanullah and Inamullah. 2016. Dry matter partitioning and harvest index differ in rice genotypes with variable rates of phosphorus and zinc nutrition. *Rice Science*. **23**: 78-87.

Anonymous.2024.https://ipad.fas.usda.gov/countrysummary/Default.aspx?id=IN&crop=Rice

Bagale, B. and Kumari, S. 2024. Effect of Weed Management Practices on Weeds in Spring Rice in Nepal. *Journal of Agricultural Sciences and Engineering*. **6**(1): 1-7.

Banik, N. C., Kumar, A., Mohapatra, B., Kumar, V., Sreenivas, C., Singh, S., Peramaiyan, P. and Kumar, V. 2020. Weed management approaches in direct–seeded rice in eastern Indian ecologies-A critical and updated review. *Indian Journal of Weed Science*. **52**: 1-9.

Barla, S., Upasani, R. R. and Beck, A. M. 2021. Performance of direct-seeded rice under different nutrient and weed management practices. *Indian Journal of Weed Science*. **53**(2): 135-141.

Bhargaw, P. K., Roy, D. K., Pandit, A., Kumar, A. and Singh, A. 2018. Effect of integrated weed management practices on weed dynamics of dry direct seeded rice (*Oryza sativa* L.). *Journal of Pharmacognosy and Phytochemistry*. **7**(6): 844- 847.

Bhargaw, P. K., Roy, D. K., Kumar, A. and Kumar, A. 2023. Integrated Weed Management Practices on Productivity and Profitability of Direct Seeded

Rice under Aerobic Condition. *Environment and Ecology*. **41**(4): 2396-2402.

Bhattacharya, U., Ghosh, A., Sarkar, S. and Maity, S. 2022. Response of Rice (*Oryza sativa* L.) to Weed Management Methods in the Lower Gangetic Plain Zone. *Indian Journal of Agricultural Research*. **1**: 7.

Biswas, B., Jagadish, T., Garai, S., Mondal, M., Banerjee, H., Adhikary, S. and Kanthal, S. 2020. Weed control in transplanted rice with post emergence herbicides and their effects on subsequent rapeseed in Eastern India. *International Journal of Pest Management*. **69**(1): 89-101.

Borana, M., Singh, D. and Jat, B. L. 2017. Production potential of [*Glycine max* (L.) Merrill] under different weed management practices. *The Asian Journal of Horticulture*. **12**(1): 1-21.

Bray, R. H. and Kurtz, L. T. 1945. Determination of soil organic and available form of phosphorus in soil. *Soil Science*. **59**: 39-45.

Chinnamani, I., Aasif, M., Kumar, N. S., Velayutham, A. and Suresh, S. 2018. Influence of weed management practices on weed dynamics and yield of drum seeded rice under puddled condition. *International Journal of Advances in Agricultural Science and Technology.* **5**(7): 17-23.

Choudhary, V. K. and Dixit, A. N. I. L. 2018. Herbicide weed management on weed dynamics, crop growth and yield in direct-seeded rice. *Indian Journal of Weed Science*. **50**(1): 6-12.

Choudhary, V. K. and Dixit, A. N. I. L. 2021. Bio-efficacy of sequential herbicide application for weed management in dry direct seeded rice. *Indian Journal of Agricultural Sciences*. **91**(1): 79-83.

Choudhary, V. K., Naidu, D. and Dixit, A., 2022. Weed prevalence and productivity of transplanted rice influences by varieties, weed management regimes and row spacing. *Archives of Agronomy and Soil Science*. **68**(13): 1872-1889.

Dangol, R., Pandey, S. R., Shrestha, B., Thapa, M. D. B. and Bhattarai, N. 2020. Effects of different weed management practices on growth and yield of direct-seeded spring rice in Jhapa, Nepal. *Cogent Food & Agriculture*. **6**(1) 18-25.

Dass, A., Shekhawat, K., Choudhary, A. K., Sepat, S., Rathore, S. S., Mahajan, G. and Chauhan, B. S. 2017. Weed management in rice using crop competition–a review. *Crop Protection.* **95**: 45-52.

Devi, R. B. and Singh, Y. 2018. Nutrient uptake and yield of direct seeded rice as influenced by nitrogen and weed management practices. *Indian Journal of Pure & Applied Biosciences*. **6**(5): 34-40.

Devkota, K. P., Khanda, C. M., Beebout, S. J., Mohapatra, B. K., Singleton, G. R. and Puskur, R. 2020. Assessing alternative crop establishment methods with a sustainability lens in rice production systems of Eastern India. *Journal of cleaner production*. **244**: 1-14.

Dewanto, F. G., Londok, J. J. M. R., Tuturoong, R. A. V. and Kaunang, W. B. 2013. Pengaruh Pemupukan Anorganik Dan Organik Terhadap Produksi Tanaman Jagung Sebagai Sumber Pakan. *Zootechnology*. **32**(5): 1-8.

Dhakal, M., Sah, S. K and Kharel, G. 2019. Integrated weed management in direct-seeded rice: Dynamics and economics. *International Journal of Agriculture Environment Food Science*. **3**: 81-84.

Dhillon, B. S., Kumar, V., Sagwal, P., Kaur, N., Singh, M. G. and Singh, S. 2021. Seed priming with potassium nitrate and gibberellic acid enhances the performance of dry direct seeded rice (*Oryza sativa* L.) in north-western India. *Agronomy*. **11**(5): 849.

Dnyaneshwar, J., Pawar, P. B., Sutar, M. W., Jadhav, M. S, Pinjari, S. S. and Meshram, N. A. 2018. Effect of weed management practices on Kharif rice–A review. *Journal of Research in Weed Scien*ce. **1**(2): 99-109.

Donald, C. M. 1962. In search of yield. Journal of the Australian Institute of Agricultural Science. **28**: 171-178.

Duary, B., Mishra, M. M., Dash, R. and Teja, K. C. 2015. Weed management in lowland rice. *Indian Journal of Weed Science*. **47**(3): 224-232.

Dubey, R., Singh, D. and Mishra, A. 2017. Effect of Weed Management Practices and Establishment Methods on Growth, Productivity and Economics of Rice. *International Journal of Current Microbiology and Applied Sciences*. **6**: 65-72.

Ezung, N. K., Choudhary, J. K., Das, J. C., Kikon, N. and Koutsu, R. 2018. Weed growth and nutrient uptake in organically managed rice and maize as affected by nitrogen management and live mulching with cowpea. *Indian Journal of Agricultural Research*. **52**(6): 631-636.

Gangireddy, G., Subramanyam, D., Hemalatha, S. and Murthy, B. R. 2019. Sequential application of herbicides for weed management in rainfed lowland rice. *Indian Journal of Weed Science*. **51**(2): 203-205.

Ghosh, A. K, Nanda, B. B, Govindaswami, S. and Nayak, B. B. 1971. Influence of nitrogen on the physio-chemical characteristics of rice grain. *Oryza*. **8**: 87-93.

Gill, J. S. and Walia, S. S. 2013. Effect of establishment methods and nitrogen levels on basmati rice (*Oryza sativa*). *Indian Journal of Agronomy*. **58**(4): 506-511.

Gogoi, B. and Deka, J. 2023. Effect of integrated weed-management practices in direct-seeded autumn rice (*Oryza sativa*) on growth, yield and soil microflora. *Indian Journal of Agronomy.* **68**(2): 140-146.

Gomez, K. A. and Gomez, A. A. 1984. Statistical procedures for agricultural research: An IRRI Book. A Wiley- Interscience Publication, Joh Wiley and Sons, New York, USA, pp 680.

Goswami, G., Gogoi, P. K. and Baruah, D. 2017. Nutrient content, uptake and yield of direct seeded upland autumn rice (*Oryza sativa*) varieties as influenced by integrated weed and nutrient management practices. *Journal of Agricultural Engineering and Food Technology*. **4**(1): 66-70

Grace, F. S., Jalloh, M. B., Rakib, M. R. M., Elisa, A. A. and Dandan, M. 2018. Effects of NPK fertilizer on growth and yield of several rice varieties grown in Sabah. *Proceedings of International Conference on Sustainable Agriculture*. 237-242.

Gudi, B., Rathod, S. and Somasundaram, E. 2017. Nutrient uptake by weeds and rice under different organic weed management practices. *International Journal of Chemical Studies*. **5**(4): 2050-2053.

Gupta, A., Singh, B. N., Mishra, H., Verma, D. and Singh, S. 2021. To determine the impact of weed control technique on rice (*Oryza sativa* L.) growth, yield and economics. *The Pharma Innovation Journal*. **10**(10): 1630-1635.

Haque, M. M., Pramanik, H. R., Biswas, J. K., Iftekharuddaula, K. M. and Hasanuzzaman, M. 2015. Comparative Performance of Hybrid and Elite Inbred Rice Varieties with respect to Their Source-Sink Relationship. *The Scientific World Journal*. 1-11.

Hanway, J. and Heidal, H. S. 1952. Soil testing laboratories procedures, Jowa Agriculture. **57**: 1-31.

Harish, M. N., Choudhary, A. K., Singh, Y. V., Pooniya, V. and Varatharajan, T. 2022. Improving rice productivity, quality and soil health sustenance in Eastern Himalayas using promising rice (*Oryza sativa* L.) varieties and integrated nutrient management-a review. *Annals of Agricultural Research*. **40**(3): 223-234.

Hashim, M., Singh, V. K., Singh, K. K. and Dhar, S. 2022. Herbicidal weed-management options for dry direct-seeded rice (*Oryza sativa*) in North-Eastern Plains of India. *Indian Journal of Agronomy*. **67**(4): 337-342.

Hassan, D. and Upasani, R. R. 2015. Effect of crop establishment and weed control methods on productivity of rice (*Oryza sativa* L.). *Journal Crop and Weed*. **11**: 228-230.

Islam, A. K. M., Azhiat, M., Sarkar, S. K. and Anwar, M. P. 2018. Herbicide based weed management in aromatic rice of Bangladesh. *Journal of Bangladesh Agricultural University*. **16**(1): 31-40.

Islam, M. S., Sarkar, M. A. R., Uddin, S. and Parvin, S. 2012. Yield of fine rice varieties as influenced by integrated management of poultry manure, urea super granules and prilled urea. *Journal of Environmental Science*. **5**(1): 129-132.

Jackson, M. L. 1973. Soil chemical analysis. Prentice hall of India, Pvt. Ltd., New Delhi.

Jagtap, D. N., Pawar, P. B., Sutar, M. W., Jadhav, M. S. and Pinjari, S. S. 2018. Response of rice to different fertilizer sources: A mini review. *Indian Journals. Com*. **3**(2): 146-152.

Jehangir, I. A., Hussain, A., Sofi, N. R., Wani, S. H., Ali, O. M., Abdel, L., Raja, W. and Bhat, M. A. 2021. Crop Establishment Methods and Weed Management Practices Affect Grain Yield and Weed Dynamics in Temperate Rice. *Agronomy.* **11**: 21-37.

Jena, J. and Misra, S. R. 2019. Nutritional outlook of rice. *Agriculture & Food: E-Newsletter*. **1**(22): 372-374.

Kabdal, P., Pratap, T. and Yadav, V. R. 2018. Weed management in transplanted rice–a review. *International Journal of Current Microbiology and Applied Sciences*. **7**(4): 1660-1669.

Kafle, K. R. and Simkhada, K. 2023. Performances of Transplanted Spring Rice Under Different Weed Management Techniques in Kapilbastu, Nepal. *Turkish Journal of Agriculture - Food Science and Technology*. **11**(4): 644-650.

Kalaisudarson, S. and Srinivasaperumal, A. P. 2019. Study of effect of new herbicides on weed management in transplanted rice. *Plant Archives*. **19**: 621-624.

Kalita, E., Nath, B. K., Deb, P., Agan, F., Islam, Md. R., Saikia, K. 2015. High quality fluorescent cellulose nanofibers from endemic rice husk: Isolation and characterization. *Carbohydrate Polymers*. **122**: 308-313.

Karthika, R., Subramanian, E., Ragavan, T. and Kumutha, K. 2019. Studies on crop weed competition and weed management in direct seeded rice under puddled and unpuddled conditions. *International Journal of Chemical Studies*. **7**(3): 2769-2773.

Kashid, N. V., Barate, K. K. and Aribam, P. D. 2016. Management of weeds in transplanted rice. *International Research Journal of Multidisciplinary Studies.* **2**(5): 1-3.

Kashid, N. V. 2019. Integration of post-emergence herbicide application with hand weeding for managing weeds in transplanted rice. *Indian Journal of Weed Science.* **51**(2): 206-208.

Kashyap, S., Singh, V. P., Guru, S. K., Pratap, T., Singh, S. P. and Kumar, R. 2022. Effect of Integrated Weed Management on Weed and Yield of Direct Seeded Rice. *Indian Journal of Agricultural Research*. **56** (1): 33-37.

Kashyap, S., Singh, V. P., Guru, S. K., Pratap, T., Singh, S. P. and Praharaj, S. 2019. Integrated weed control option for dry direct seeded rice under irrigated ecosystem. *International Journal of Current Microbiology and Applied Science*. **8**(2): 315-323.

Khatun, S., Mondal, M. M., Khalil, M. I., Roknuzzaman, M., Mollah, M. M. Growth and yield performance of six aman rice varieties of Bangladesh. *Asian Research Journal of Agriculture*. **12**(2): 1-7.

Kheya, S. A., Salam, M. A and Uddin, M. R 2023. Integrated Nitrogen Management on Weed Growth and Yield Performance of Transplant Aman Rice. *Journal of Bangladesh Agricultural University*. **21**(4): 439-451.

Kokilam, V., Rathika, S., Ramesh, T. and Baskar, M. 2023. Weed Dynamics and Productivity of Direct Wet Seeded Rice under Different Weed Management Practices. *Indian Journal of Agricultural Research*. **57**(3): 347-351.

Kotresh, D. J., Radhamani, S., Arthanari, P. M., Ravichandran, V., Bharathi, C. and Sangothari, A. 2022. Effect of Integrated Weed Management Practices on Weed Parameters in Direct Seeded Aerobic Rice. *Biological Forum – An International Journal.* **14**(2a): 539-544.

Kujur, N., Bhandarker, S., Shrivas, Y. and Tirkey, A. 2017. Assessment of Variability of Aromatic Rice Using Agro-Morphological Characterization. *International Journal of Current Microbiology and Applied Sciences*. **6**(11): 1835-1846

Kumar, A. and Jnanesha, A. C. 2017. Effect of Crop Establishment Methods on Growth Yield and Water Productivity of Rice. *International Journal on Agricultural Sciences*. **8**(1): 40-45.

Kumar, P., Singh, Y. and Kumar, R. 2016a. Productivity, profitability nutrient uptake and soil health of boro rice as influenced by cultivars and herbicides. *International Journal of Agricultural and Statistical Sciences*. **12**: 177-183.

Kumar, R., Kumawat, N., Kumar, S., Kumar, R., Kumar, M., Sah, R. P., Kumar, U. and Kumar, A. 2016b. Direct seeded rice: research strategies and opportunities for water and weed management. *ORYZA-An International Journal on Rice*. **53**(4): 354-365.

Kumar, R., Mishra, J. S., Kumar, S., Rao, K. K., Hans, H., Bhatt, B. P., Srivastava, A. K. and Singh, S. 2020. Evaluation of weed competitiveness of direct-seeded rice (*Oryza sativa*) genotypes under different weed management practices. *Indian Journal of Agricultural Science*. **90**(5): 914-918.

Kumari, M., Manjhi, R. P., Bharti, J., Kumar, S. P., Bharti, P., Tiwari, J. and Dehury, C. 2023b. Integrated weed management on weed dynamics, crop growth and yield of direct seeded rice. *The Pharma Innovation Journal*. **12**(10): 211-216.

Kumari, M., Manjhi, R. P., Bharti, J., Kumar, S. P., Gupta, P. and Bharti, P. 2023a. Yield attributes, yield and economics of direct seeded rice as influenced by integrated weed management practices under medium land condition. *The Pharma Innovation Journal.* **12**(4): 508-511.

Kumawat, A., Seema, S., Kumar, D., Singh, S., Jinger, D., Bamboriya, S. D. and Verma, A.K. 2017. Effect of irrigation scheduling and nitrogen application on yield, grain quality and soil microbial activities in direct-seeded rice. *International Journal of Current Microbiology and Applied Sciences.* **6**(5): 2855-2860.

Kumhar, B. L., Chavan, V. G., Rajemahadik, V. A., Kanade, V. M., Dhopavkar, R. V., Ameta, H. K. and Tilekar, R. N. 2016a. Effect of different rice establishment methods on growth, yield and different varieties during *kharif* season. *International Journal of Biodiversity and Environmental Science*. **6**(2): 127-131.

Kumhar, B. L., Chavan, V. G. and Tilekar, R. N. 2016b. Economic Analysis, dry matter accumulation and uptake of NPK of different rice establishment methods different varieties. *Research Journal of Agricultural Sciences*. **7**(3): 617-621.

Kundu, C. K., Biswas, U., Kundu, A., Bera, P. S. and Sathish, G. 2017. Studies on Bio efficacy and Phytotoxicity of Pretilachlor 30.7% EC in Direct Seeded Rice. *International Journal of Chemical Studies*. **5**(5): 1847-1850.

Lestari, P., Ham, T. H., Lee, H. H., Woo, M. O., Jiang, W., Chu, S. H., Kwon, S. W., Ma, K., Lee, J. H. and Cho, Y. C. 2009. PCR marker-based evaluation of the eating quality of japonica rice (*Oryza sativa* L.). *Journal of Agricultural and Food Chemistry*. **57**: 2754-2762.

Mahajan, G., Poonia, V. and Chauhan, B. S. 2014. Integrated weed management using planting pattern, cultivar, and herbicide in dry-seeded rice in North-west. *Indian Journal of Weed Science*. **62**: 350-359.

Mahanta, K., Bora, N., Deka, J. and Barua, I. C. 2019. Herbicide residues in rice–based cropping systems in Assam. In Herbicide Residue Research in India. *Springer: Environmental Chemistry for a Sustainable World book series (ECSW)*. **12**: 305-324.

Mandi, S., Dar, E. A., Datta, A., Singh, R. P. and Singh, M. K. 2016. Growth and yield of transplanted rice as affected by different cultivars and weed management practices. *Journal of Applied and Natural Science*. **8**(3): 1462-1466.

Manjunatha, B., Hanumanthappa, M., Nagesha, L., Kalyanamurthy, K. N. and Kamath, S. K. V. 2012. Effect of new herbicides molecules on nutrient uptake in transplanted rice in coastal Karnataka. *Mysore Journal of Agricultural sciences*. **46**(4): 928-930.

Matloob, A., Khaliq, A. and Chauhan, B. S. 2015a. Weeds of direct– seeded rice in Asia: problems and opportunities. *Advances in Agronomy*. **130**: 291-336.

Matloob, A., Khaliq, A., Tanveer, A. and Wahid, A. 2015b. Dry matter accumulation and growth response of zero tilled direct seeded fine rice to different weed competition durations and sowing times. *International Journal of Agriculture and Biology*. **17**(1): 41-50.

Maurya, S., Kumar, R., Verma, R., Kaptan, B., Prakash, R. and Singh, A. K. 2023. Effect of Different Crop Establishment Methods and Weed

Management Practices on Growth Indices and Yield of Rice (*Oryza sativa* L.). *International Journal of Plant & Soil Science*. **35**:(17): 31-37.

Meti, R. N., Rao, S., Desai, B. K., Koppalkar, B. G., Katti, P. and Bhat, S. N. 2021. Eco-friendly weed management in dry direct-seeded rice under organic production system. *Indian Journal of Weed Science.* **53**(4): 346-352.

Mewada, P., Chaudhary, S. K., Rathore, A. and Singh, Y. 2016. Optimization of suitable weed management practices for aerobic rice. *Indian Journal of Weed Science.* **48**(1): 64-66.

Mishra, J. S. and Kumar, R. 2017. Conservation tillage and weed management in smallholder agriculture: Issues and opportunities. *Current Advances in Agricultural Sciences*. **9**(2): 186-189.

Mishra, J. S., Kumar, R., Mondal, S., Poonia, S. P., Rao, K. K., Dubey, R., Raman, R. K., Dwivedi, S. K., Kumar, R., Saurabh, K. and Monobrullah, M. 2022. Tillage and crop establishment effects on weeds and productivity of a rice-wheat-mungbean rotation. *Field Crops Research*. **284**: 1-12.

Mishra, J. S., Kumar, R., Kumar, S., Choudhary, A. K., Singh, A. K., Hans, H., Srivastava, A. K. and Singh, S. 2023. Weed competitive ability and productivity of transplanted rice cultivars as influenced by weed management practices. *Indian Journal of Weed Science*. **55**(1): 13-17.

Mishra, J. S., Singh, V. P., Rao, A. N. and Kumar, R. 2016. Weed management in major crops. (In) Weed Science and management. *Indian Society of Weed Science* and *Indian Society of Agronomy*. 160-169.

Mishra, J. S., Srivastava, A. K., Kumar, R., Kumar, S., Hans, H. and Singh, S. 2022. Effect of crop establishment and weed management methods on weed dynamics and productivity of direct-seeded rice in middle Indo-Gangetic Plains. *Indian Journal of Weed Science*. **54**(2): 124-128.

Moe, K., Kumudra, M. W., Win, K. K., Yamakawa, T. 2017. Combined Effect of Organic manures and Inorganic Fertilizers on the Growth and Yield of Hybrid Rice. *American Journal of Plant Sciences*. **8**: 1022-1042.

Mohanty, D. K. and Bhuyan, J. 2020. Evaluation of different mechanical weed control methods in rice field. *Journal of Krishi Vigyan*. **8**(2): 115-119.

Mohapatra, S., Tripathy, S. K., Tripathy, S. and Mohanty, A. K. 2021. Effect of sequential application of herbicides on productivity and profitability of transplanted rice. *Indian Journal of Weed Science.* **53**(2): 129-134.

Mondal, D., Ghosh, A., Bera, S., Ghosh, R. and Bandopadhyay, P. 2019. Eco-efficacy of pretilachlor 50% EC in transplanted winter rice and its residual effect on lentil. *Indian Journal of Weed Science*. **51**(3): 220- 226.

Mou, M. R. J., Salam, M. A., Hossen, K., Kato-Noguchi, H. and Islam, M. S. 2017. Effect of weeding regime on the performance of transplanted aman rice. *Journal of Agroforestry and Environment.* **11**(1&2): 261-266.

Mrudhula, K. A. and Rama Rao, C. V. 2020. Effect of sowing window on growth parameters and yield of different rice varieties in Krishna western delta. *Journal of Pharmacognosy and Phytochemistry*. **9**(4): 1081-1085.

Muhammad, A. O., Kawsar, H., Rabiul, H. C., Chowdhury, N. T., Khairul, M. I., Rayhan, A. and Tahmina F. 2020. Assessment of Different Weed Control Methods on Growth and Yield Performance of Transplanted Aus Rice. *Agricultural Research & Technology: Open Access Journal*. **24**(3): 87-92.

Mukherjee, D. 2019. Effect of various crop establishment methods and herbicides on growth and yield of rice. *Wheat and Barley Research*. **11**(3):300-303.

Munda, S., Saha, S., Adak, T. and Jambhulkar, N. 2019. Weed management in aerobic rice: Role of establishment methods and herbicides. *Experimental Agriculture*. **55**: 88-104.

Nagarjun, P., Dhanapal, G. N., Sanjay, M. T., Yogananda, S. B. and Muthuraju, R. 2019. Energy budgeting and economics of weed management in dry direct seeded rice. *Indian Journal of Weed Science*. **51**(1): 1-5.

Nargave, G., Sharma, P. B., Sahu, R. P., Singh, V. and Patel, R. 2020. Influence of Varying Environment on Rice Varieties under Upland Condition of Madhya Pradesh, India. *International Journal of Current Microbiology and Applied Sciences*. **9**(8): 1317-1323.

Naseeruddin, R. and Subramanyam, D. 2013. Performance of low dose high efficacy herbicides in drum seeded rice. *Indian Journal of Weed Science*. **45**: 285-288.

Nazir, A., Bhat, M. A., Bhat, T. A., Fayaz, S., Mir, M. S., Basu, U., Ahanger, S. A., Altaf, S., Jan, B., Lone, B. A., Mushtaq, M., El-Sharnouby, M., Skalicky, M., Brestic, M. and Sabagh, A. E. 2022. Comparative analysis of rice and weeds and their nutrient partitioning under various establishment methods and weed management practices in temperate environment. *Agronomy*. **12**: 816.

Nazir, A., Bhat, M. A., Bhat, T. A., Rashid, Z., Mohi-ud-din, R., Fayaz, S. and Wani, S. A. 2020. Crop establishment and weed management effect on weed parameters and rice yield under temperate zone of Kashmir. *Indian Journal of Weed Science*. **52**(3): 217-221.

Neoh, W. T. and Lum, M. S. 2018. Nutritional Quality of Rice Variety in Sabah, Malaysia. *Transactions on Science and Technology*. **5**(2): 88-92.

Niraula, R. and Karki, R. B. 2023. Efficacy of different weed management practices on growth and yield of spring rice under system of rice intensification (SRI) in Bara, Nepal. *Journal of Plant Protection Sciences*. **8**: 125-136.

Nivetha, C., Srinivasan, G. and Shanmugam, P. M. 2017. Effect of weed management practices on growth and economics of transplanted rice under sodic soil. *International Journal of Current Microbiology and Applied Sciences*. **6**(12): 1909-1915.

Pandian, P. S. and Thavaprakaash, N. 2018. Effect of Weed Management Practices on Growth and Yield of Machine Transplanted Rice. *Madras Agriculture Journal*. **105**: 10-12.

Parihar, R. K., Srivastava, V. K., Kumar, S., Kumar, V. and Swasmi, S. 2020. Weed dynamics, weed control efficiency and yield of aerobic rice as influenced by weed management practices in eastern UP. *Journal of Environmental Biology*. **41**: 1735-1741.

Paul, R. A. I., Arthanari, P. M., Pazhanivelan, S., Kavitha, R. and Djanaguiraman, M. 2023. Drone-based herbicide application for energy saving, higher weed control and economics in direct-seeded rice (*Oryza sativa*). *Indian Journal of Agricultural Sciences*. **93**(7): 704-709.

Paul, S. K., Nahar, L. S., Paul, N. C. and Begum, M. 2019. Influence of weeding regime on the performance of aromatic boro rice (*Oryza sativa* L.). *Archives of Agriculture and Environmental Science*. **4**(2): 133-140.

Phukan, J. and Deka, J. 2021. Weed dynamics, crop growth and yield as affected by different weed management practices and plant growth-promoting rhizobacteria in direct-seeded upland rice. *Indian Journal of Weed Science.* **53**(1): 36–40.

Pooja, K. and Saravanane, P. 2021. Performance of rice cultivars with weed management practices in dry direct-seeded rice. *Indian Journal of Weed Science*. **53**(1): 92-94.

Prashanth, R., Murthy, K. K. N., Kumar, V. M., Murali, M. and Sunil, C. M. 2016. Bispyribac-Sodium influence on nutrient uptake by weed and transplanted rice. *Indian Journal of Weed Science*. **48**(2): 217-219.

Purwanto, O. D., Palobo, F. and Tirajoh, S. 2020. Growth and yield of superior rice (*Oryza sativa* L.) varieties on different planting systems in Papua, Indonesia. *SVU-International Journal of Agricultural Science.* **2**(2): 242 - 255.

Radford, P. J. 1967. Growth analysis formulae, their use abuse. *Crop Science*. **8**: 171-175.

Raj, R. K., Sinha, K. K., Pandey, I. B., Choubey, A. K. and Pandit, A. 2019. Effect of nutrient and weed management on growth and yield of Soybean [*Glycine max* (L.) Merrill] in Alluvial Soil of Bihar, India. *International Journal of Current Microbiology and Applied Sciences*. **8**(7): 2214-2220.

Raj, S. K and Syriac, E. K. 2017. Weed management in direct seeded rice: a review. *Agricultural Reviews.* **38**(1): 41-50.

Ramesh, K., Rao, A. N. and Chauhan, B. S. 2017. Role of crop competition in managing weeds in rice, wheat, and maize in India: A Review. *Crop Protection*. **97**: 14-21.

Ramesha, Y. M., Anand, S. R., Krishnamurthy, D. and Bhanuvally, M. 2019. Weed management effect to increase grain yield in dry direct-seeded rice. *Indian Journal of Weed Science*. **51**(1): 6-9.

Rao, A. N., Wani, S. P., Ahmed, S., Ali, H. H. and Marambe, B. 2017. An overview of weeds and weed management in rice of south asia. In: Weed management in Rice in the Asian-Pacific Region (Eds. Rao AN and Matsumoto H). *The Weed Science Society of Japan*, Japan and *Indian Society of Weed Science*. India. 247-281.

Rathika, S. and Ramesh, T. 2018. Weed management effect in system of rice intensification. *Indian Journal of Weed Science*. **50**(4): 388-390.

Rathika. S. and Ramesh, T. 2019. Weed management in direct wet seeded rice. *Journal of Pharmacognosy and Phytochemistry*. **2**: 978-981.

Rathika, S., Ramesh, T. and Shanmugapriya, P. 2020. Weed management in direct seeded rice: A review. *International Journal of Chemical Studies*. **8**(4): 925-933.

Reddy, B. G., Guruprasad, G. S., Shivayoganya, D. P., Gowdar, S. B. and Sridhar, D. 2016. Bio efficacy of penoxsulam 24% SC herbicide against weeds in direct seeded rice under puddled conditions. *Journal of Farm Sciences*. **29**:337-339.

Reddy, M. B. G., Ravishankar, G., Balganvi, S., Joshi, V. R., Negalur, R. K. 2012. Efficacy of bensulfuron methyl plus pretilachlor for controlling weeds in transplanted rice. *Oryza*. **49**(1): 65-67.

Reddy, M. S. S. K. and Ameena, M. 2021. Influence of weed management practices on weed flora, crop yield and nutrient uptake in direct seeded rainfed lowland rice. *Journal of Crop and Weed*. **17**(2): 206-210.

Richard, L. A. 1954. Diagnoses and improvement of saline and alkali soils. Agriculture Hand Book 60: USDA, USA.

Sahu, P. K., Sharma, D., Mondal, S., Kumar, V., Singh, S., Baghel, S., Tiwari, A., Vishwakarma, G. and Das, B. K. 2017. Genetic variability for grain quality traits in indigenous rice landraces of Chhattisgarh, India. *Journal of Experimental Biology and Agricultural Sciences*. **5**(4): 439-445.

Salam, A., Sarker, S. and Sultana, A. 2020. Effect of weed management on the growth and yield performances of Boro rice cultivars. *Journal of Agriculture Food and Environment*. **1**(4): 19-26.

Sanodiya, P. and Singh, M. K. 2021. Effect of integrated weed management on growth, yields and nutrient balance in direct seeded rice (*Oryza sativa*). *Journal of Scientific Research*. **65**(5): 129-134.

Santiago-Arenas, R., Soe, H. N., Ullah, H., Agarwal, A. and Datta, A. 2022. Optimum Sowing Date and Nitrogen Rate Ensure Sustainable Production of Wet Direct-Seeded Rice under Water-saving Irrigation Technique. *Journal of Soil Sciences and Plant Nutrition*. **22**: 2805-2820.

Saranraj, T., Devasenapathy, P. and Lokanadhan, S. 2018. Penoxsulam influence on weed control and rice yield and its residual effect on microorganisms and succeeding green gram. *Indian Journal of Weed Science*. **50**(1): 37-41.

Saravanane, P. 2020. Effect of different weed management options on weed flora, rice grain yield and economics in dry direct seeded rice. **52**(2): 102-106.

Sardana, V., Mahajan, G., Jabran, K. and Chauhan, B. S. 2017. Role of competition in managing weeds: An introduction to the special issue. *Crop Protection*. **95**: 1-7.

Satapathy, S. M., Srivastava, V. K., Majhi, P. K. and Gond, S. 2021. Effect of Delayed Time of Planting on Grain Yield and Agro-morphological Traits of Elite Rice (*Oryza sativa* L.) Varieties. *International Journal of Plant & Soil Science*. **33**(16): 68-79.

Schreiber, F., Scherner, A., Andres, A., Concenço, G. and Goulart, F., 2018. Competitive ability of rice cultivars in the era of weed resistance. *Plant Competition in Cropping Systems*. 39-58.

Sen, S., Kaur, R. and Das, T. K. 2020. Weed management in dry direct seeded rice: Assessing the impacts on weeds and crop. *Indian Journal of Weed Science*. **52**: 169-174.

Shahane, A. A. and Behera, U. K. 2023. Comparing manual and mechanical weed management techniques for upland organic rice in acidic soil of Meghalaya: A on-farm study. *Indian Journal of Weed Science*. **55**(3): 307-310.

Sharma, A. and Hemant, K. J. 2020. Coefficient of variation, heritability and correlation coefficient in basmati rice hybrids (*Oryza sativa* L.) for yield and quality traits. *Plant Archives*. **20**(2): 5854-5858.

Sharma, A. K., Singh, T., Patel, A. and Yadav, R. A. 2018. Influence of integrated nutrient management practices on scented rice (*Oryza sativa* L.) pertaining to eastern Uttar Pradesh. *Journal of Pharmacognosy and Phytochemistry*. **7**(5): 1448-1453.

Sharma, R. K., Kumar, S., Vatta, K., Bheemanahalli, R., Dhillon, J. and Reddy, K. N. 2022. Impact of recent climate change on corn, rice, and wheat in southeastern USA. *Scientific Reports*. **12**(1): 16928.

Shebl, S. M., Aboa EL-Darag, I. H. and E-Mwafi, H. F. 2009. Effects of varietals performance and weed control efficacy on weeds, growth and yield of hybrid rice. *Journal of Agriculture Research*. **35**(1): 127-148.

Shekhawat, K., Rathore, S. S. and Chauhan, B. S. 2020. Weed Management in Dry Direct Seeded Rice: A Review on challenges and opportunities for sustainable rice production. *Agronomy*. **10**: 1-19.

Shrestha, S., Sharma, G., Burgos, N. R. and Tseng, T. M. 2020. Competitive ability of weedy rice: Toward breeding weed– suppressive rice cultivars. *Journal of Crop Improvement*. **34**: 455-469.

Siddeque, S., Hossain, G., Ahmed, S. Q. and Farhad, A. 2002. Genotypic performance of rice in Pukhal of Mansehra, Sarhad. *Journal of Agricultural science*. **18**(1): 49-52.

Sindhu, Y. S., Sarmah, A. K. and Barua, I. C. 2021. Organic weed management in wet-seeded and transplanted aromatic rice. *Indian Journal of Weed Science*. **53**(4): 426-429.

Singh, G. P., Roy, D. K. and Yadav, S. 2018. Effect of herbicides combinations and hand weeding on growth, yield and weed population in transplanted rice (*Oryza sativa* L.). *International Journal of Chemical Studies.* **6**(5): 154-157.

Singh, K., Singh, S. and Pannu, R. K. 2019b. Efficacy of pendimethalin and cyhalofop–butyl + penoxsulam against major grass weeds of direct–seeded rice. *Indian Journal of Weed Science.* **51**(3): 227-231.

Singh, V., Jat, M. L., Ganie, Z. A., Chauhan, B. S and Gupta, R. K. 2016. Herbicide options for effective weed management in dry direct-seeded rice under scented rice-wheat rotation of western Indo-Gangetic plains. *Crop Protection*. **81**: 168-176.

Sivakumar, C., Krishnaveni, A. and Pandiyan, M. 2019. Weed management practices in direct seeded rice ecosystem in north western zone of Tamil Nadu. *Environment Conservation Journal*. **20**(3):145-151.

Sivanesan, V., Manivannan, V., Kumar, G. B., Sritharan, N. and Prabu, P. C. 2023. Effect of Herbicides Combination on Weed Management and Yield of Direct Wet Seeded Rice (*Oryza sativa* L.). *International Journal of Environment and Climate Change*. **13**(9): 3434-3442.

Soren, C., Bera, S., Mukhopadhyay, S. and Saren, D. 2017. Bio-efficacy and phytotoxicity studies of Bispyribac Sodium 10% in direct seeded rice. *Journal of Crop and Weed*. **13**(3): 165-167.

Soujanya, V., Goverdhan, M., Prakash, T. R. and Srinivas, A. 2020. Impact of Integrated Weed Management Practices on Yield and Economics of Semidry Rice. *International Research Journal of Pure and Applied Chemistry*. **21**(18): 25-32.

Sreedevi, B., Kumar, R. M., Singh, A. and Voleti, S. R. 2018. Assessing the efficacy of new low dose herbicide molecule in puddled direct seeded rice. *Journal of Rice Research.* **11**(2): 44-49.

Sree, Y. S., Anjan, K., Sarmah, and Barua, I. C. 2021. Organic weed management in wet-seeded and transplanted aromatic rice. *Indian Journal of Weed Science*. **53**(4): 426-429.

Subbiah, B. V. and Asija, G. L. 1956. A rapid procedure for the determination of available nitrogen in soils. *Current Science*. **25**: 259-260.

Subramanian, E., Sathishkumar, A. and Rajesh, P. 2021. Nitrogen and weed management treatments effect on productivity of aerobic rice. *Indian Journal of Weed Science*. **53**(4): 353-357.

Suryakala, P., Murugan, G., Stalin, P., Saravanaperumal, M. and Suseendran, K. 2019. Effect of pre and post emergence herbicides on weed flora and yield of transplanted rice. *Plant Archives*. **19**: 3093-3096.

Suseendran, K., Stalin, P., Kalaiyarasan, C., Jawahar, S., Murugan, G., Kumar, S. R. V. and Arivukkarasu, K. 2020. Studies on integrated nutrient and weed management practices on growth, yield and economics of rice (*Oryza sativa* L.). *Plant Archives*. **20**(1): 1963-1969.

Swain, S., Nanda, S., Kumar, S., Pradhan, M. J., Paramaguru, S., Patra, M. and Paikaray, R. 2023. Effect of fertility levels and weeds management practices on weed dynamics, yield and economics of transplanted rice (*Oryza sativa* L.). *The Pharma Innovation Journal.* **12**(3): 1399-1403.

Tasmin, S., Salam, M. A. and Hossain, M. D. 2019. Effects of integrated weed management practices on the performance of boro rice cultivars. *Archives of Agriculture and Environmental Science*. **4**(3): 273-280.

Tiwari, P., Tiwari, R. K., Tiwari, J. and Yadav, V. 2018. Effect of sowing dates on physiological parameters, productivity and economical gain of different rice varieties under rainfed condition. *International Journal of Current Microbiolology and Applied Science*. **7**(2): 2451-2457.

Tuti, T., Bitok, M., Paton, C., Makone, B., Malla, L. and Muinga N. 2016. Innovating to enhance clinical data management using non-commercial and open-source solutions across a multi-center network supporting inpatient pediatric care and research in Kenya. *Journal of the American Medical Informatics Association*. **23**(1): 184-192.

Tyeb, A., Paul, S. K. and Samad, M. A. 2013. Performance of variety and spacing on the yield and yield contributing characters of transplanted aman rice. *Journal of Agro-Environment science*. **40**(4): 595-597.

Venkatesh, B., Parameswari, Y. S., Madhavi, M. and Ram Prakash, T. 2021. Performance of herbicides and herbicide mixtures on weed control in transplanted rice. *Indian Journal of Weed Science.* **53**(2): 179-181.

Verma, B., Bhan, M., Jha, A. K., Singh, V., Patel, R. and Sahu, M. P. 2023. Weed management in direct-seeded rice through herbicidal mixtures under diverse agro ecosystems. *Agricultural Mechanization in Asia, Africa and Latin America.* **53**(4):7299-7306.

Verma, B., Bhan, M., Jha, A. K., Singh, V., Patel, R., Sahu, M. P. and Kumar, V. 2022. Weed management in direct-seeded rice through herbicidal mixtures under diverse agroecosystems.AMA, *Agricultural Mechanization in Asia, Africa and Latin America*. **53**(4): 7299-7306.

Wahid, W. T., Ali, H., Masud, A. A., Malek, M., Mausam, M. S. 2023. Effect of free-floating plants on weed emergence, growth, and yield of transplanted aman rice varieties. *Innovare Journal of Agricultural Science*. **11**(6): 1-9.

Walkely, A. and Black, T. A. 1934. An estimation of soil organic matter and proposed modification of the chromic acid titration method. Soil Science. **37**: 29-38.

Watson, D. J. 1947. Comparative physiological studies on the growth of field crops. I: Variation in net assimilation rate and leaf area between species and varieties, and within and between years. *Annals of Botany*. **11**(1): 41–76.

Watson, D. J. 1952. The physiological basis for variation in yield. Advances in Agronomy. **4**: 101-145.

Yogananda, S. B., Thimmegowda, P. and Shruthi, G. K. 2017. Weed management effect on growth and yield of wet direct-seeded rice in Cauvery command area of Karnataka. *Indian Journal of Weed Science*. **49**(3): 219-222.

Yogananda, S. B., Thimmegowda, P. and Shruthi, G. K. 2019. Sequential application of pre-and post-emergence herbicides for control of complex weed flora in dry direct-seeded rice under Cauvery command area of Karnataka. *Indian Journal of Weed Science*. **51**(2): 111-115.

Yogananda, S. B., Thimmegowda, P. and Shruthi, G. K. 2021. Weed management in wet (drum)-seeded rice under southern dry zone of Karnataka. Indian Journal of Weed Science. **53**(2): 117-122.

Zaman, F., Devi, S., Islam, M. S., Monira, S. and Gupta, R. 2022. Effect of variety and weed management on the yield performance of Boro rice. *International Journal of Sustainable Crop Production*. **17**(2): 06-15.

Zhang, K., Khan, Z., Liu, J., Luo, T., Zhu, K., Hu, L., Bi, J. and Luo, L. 2022. Germination and growth performance of water-saving and drought resistant rice enhanced by seed treatment with wood vinegar and biochar under dry direct-seeded system. *Agronomy*. **12**(5): 12-23.

Zhang, R. P., Zhou, N. N., Ashen, R. G., Zhou, L., Feng, T. Y., Zhang, K. Y., Liao, X. H., Aer, L. S., Shu, J. C., He, X. W., Gao, F. and Ma, P. 2023.

Effect of Sowing Date on the Growth Characteristics and Yield of Growth-Constrained Direct-Seeding Rice. *Plants*. **12**: 1899.

Zia-Ul-Haq, M., Khaliq, A., Qiang, S., Matloob, A., Hussain, S., Fatima, S. and Aslam, Z. 2019. Weed growth, herbicide efficacy, and rice productivity in dry seeded paddy field under different wheat stubble management methods. *Journal of Integrative Agriculture*. **18**(4): 907- 926.

APPENDICES

APPENDIX-I
Common cost of cultivation

Sl. No	Operations	Qty/ units	Rate ₹	Cost ₹ ha^{-1}
1.	**Field preparation**			
	a. Ploughing	1	1000	1000
	b. Harrowing	1	1000	1000
	c. Bed preparation and sowing	6 man days	400	2400
2.	**Manures and Fertilizer**			
	a. FYM	2.5 t	₹2	5000
	b. Urea	130.2 kg	₹ 320/50 kg bag	833.28
	c. SSP	250 kg	₹ 420/50 kg bag	2100
	d.MOP	66.68 kg	₹ 980/50 kg bag	1306.9
	e. Application of manures and fertilizer	2 man days	400/man/day	800
3.	**Seed**	80 kg	30	2400
4.	**Plant protection**			
	a. Labour charges	12 man days	400/man/day	4800
	b. Insecticide			
	Chloropyriphos	4 litres	550/500ml	4400
	c. Fungicide			
	Carbendazim 50% WP	2 kg	200/100g	4000
5.	**Harvesting, threshing drying and winnowing**	15 man days	400/man/day	6000
			Total	36040.18

APPENDIX-II

Cost of cultivation for different weed management practices

Treatment	Operations	Qty/units	Rate ₹	Cost ₹ ha^{-1}
W_1	-	-	-	-
W_2	a. HW at 15	15 labours	₹400	6000
	b HW at 30	15 labours	₹400	6000
	Total			**12000**
W_3	a. Pretilachlor	1 kg	₹600/ lit	600
	b. HW at 40 DAS	10 labours	₹400	4000
	c. Application of herbicides	2 labours	₹400	800
	Total			**5400**
W_4	a. Pretilachlor	1 kg	₹600/ lit	600
	b. Bispyribac- Na	25 g	₹3500/lit	90
	c. Application of herbicides	2 labours	₹400	800
	Total			**1490**

APPENDIX-III
Schedule of field operations carried out

Sl. No	Operations	Date	
		2021	2022
1.	Ploughing	25.06.2021	3.06.2022
2.	Layout preparation and application of manures	06.07.2021	04.07.2022
3.	Fertilizer application (NPK)	08.07.2021	06.07.2022
4.	Sowing	08.07.2021	06.07.2022
5.	Herbicide application		
	Pretilachlor	08.07.2021	06.07.2022
	Bispyribac sodium	28.072021	26.07.2022
6.	Hand weeding		
	at 15 DAS	23.07.2021	21.07.2022
	at 30 DAS	08.08.2021	06.08.2022
	at 40 DAS	18.08.2021	16.08.2022
7.	Top dressing of N at tillering	27.08.2021	25.08.2022
8.	Harvesting		
	1st	18.11.2021	17.11.2022
	2nd	28.11.2021	26.11.2022
	3rd	30.11.2021	29.11.2022
9.	Threshing	08.12.2021	05.12.2022

APPENDIX-IV

ANOVA for crop growth, yield and quality parameters

1(a) Analysis of variance on plant height (cm) at 30 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.27	0.14	0.01	5.14	NS
Integrated weed management (W)	3	5516.55	1838.85	196.49	4.76	*
Error I	6	56.15	9.36			
Cultivar (C)	3	153.66	51.22	6.53	3.01	*
W x C	9	9.83	1.09	0.14	2.30	NS
Error II	24	188.25	7.84			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.57	0.29	0.02	5.14	NS
Integrated weed management (W)	3	5514.46	1838.15	126.44	4.76	*
Error I	6	87.22	14.54			
Cultivar (C)	3	155.38	51.79	5.34	3.01	*
W x C	9	19.01	2.11	0.22	2.30	NS
Error II	24	232.76	9.70			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	102.27	102.27	63.76	NS
Rep within year	4	6.415	1.604		
Integrated weed management (W)	3	9,941.24	3,313.75	397.11	*
Year x W	3	38.092	12.69	1.52	NS
Error I	12	100.13	8.34		
Cultivar (C)	3	152.23	50.74	9.34	*
Year x C	3	31.82	10.60	1.95	NS
W x C	9	51.82	5.75	1.06	NS
Year x W x C	9	68.93	7.66	1.41	NS
Error II	48	260.62	5.43		

*Significant   NS-Non-significant

1(b) Analysis of variance on plant height (cm) at 60 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.01	0.01	0.00	5.14	NS
Integrated weed management (W)	3	5289.28	1763.09	84.32	4.76	*
Error I	6	125.45	20.91			
Cultivar (C)	3	111.74	37.25	3.09	3.01	*
W x C	9	8.56	0.95	0.08	2.30	NS
Error II	24	289.66	12.07			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.64	0.32	0.02	5.14	NS
Integrated weed management (W)	3	5123.74	1707.91	102.25	4.76	*
Error I	6	100.22	16.70			
Cultivar (C)	3	122.48	40.83	3.27	3.01	*
W x C	9	7.25	0.81	0.06	2.30	NS
Error II	24	299.69	12.49			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	33.228	33.228	188.323	*
Rep within year	4	0.706	0.176		
Integrated weed management (W)	3	10,410.25	3,470.08	184.559	*
Year x W	3	2.737	0.912	0.049	NS
Error I	12	225.625	18.802		
Cultivar (C)	3	232.835	77.612	6.321	*
Year x C	3	1.359	0.453	0.037	NS
W x C	9	13.363	1.485	0.121	NS
Year x W x C	9	2.465	0.274	0.022	NS
Error II	48	589.34	12.278		

*Significant NS-Non-significant

1(c) Analysis of variance on plant height (cm) at 90 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.89	0.44	0.02	5.14	NS
Integrated weed management (W)	3	3671.63	1223.88	60.67	4.76	*
Error I	6	121.04	20.17			
Cultivar (C)	3	197.07	65.69	3.22	3.01	*
W x C	9	19.26	2.14	0.11	2.30	NS
Error II	24	489.02	20.38			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	1.07	0.54	0.02	5.14	NS
Integrated weed management (W)	3	3627.45	1209.15	54.84	4.76	*
Error I	6	132.29	22.05			
Cultivar (C)	3	223.00	74.33	3.04	3.01	*
W x C	9	20.20	2.24	0.09	2.30	NS
Error II	24	585.88	24.41			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	58.99	58.99	116.65	*
Rep within year	4	2.02	0.51		
Integrated weed management (W)	3	7297.08	2432.36	115.25	*
Year x W	3	2.02	0.67	0.03	NS
Error I	12	253.25	21.10		
Cultivar (C)	3	415.96	138.65	6.19	*
Year x C	3	4.13	1.38	0.06	NS
W x C	9	36.01	4.00	0.18	NS
Year x W x C	9	3.42	0.38	0.02	NS
Error II	48	1074.94	22.39		

*Significant   NS-Non-significant

1(d) Analysis of variance on plant height (cm) at harvest as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.58	0.29	0.01	5.14	NS
Integrated weed management (W)	3	3336.10	1112.03	32.98	4.76	*
Error I	6	202.31	33.72			
Cultivar (C)	3	242.89	80.96	3.11	3.01	*
W x C	9	27.24	3.03	0.12	2.30	NS
Error II	24	624.97	26.04			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	2.48	1.24	0.03	5.14	NS
Integrated weed management (W)	3	3279.74	1093.25	25.91	4.76	*
Error I	6	253.13	42.19			
Cultivar (C)	3	232.20	77.40	3.03	3.01	*
W x C	9	27.85	3.09	0.12	2.30	NS
Error II	24	613.67	25.57			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	55.72	55.72	73.37	*
Rep within year	4	3.04	0.76		
Integrated weed management (W)	3	6612.92	2204.31	58.08	*
Year x W	3	2.87	0.96	0.03	NS
Error I	12	455.46	37.96		
Cultivar (C)	3	472.77	157.59	6.11	*
Year x C	3	2.20	0.73	0.03	NS
W x C	9	51.46	5.72	0.22	NS
Year x W x C	9	3.76	0.42	0.02	NS
Error II	48	1238.64	25.81		

*Significant NS-Non-significant

2(a) Analysis of variance on leaf area index (LAI) at 30 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.000	0.000	0.094	5.143	NS
Integrated weed management (W)	3	3.765	1.255	676.387	4.757	*
Error I	6	0.011	0.002			
Cultivar (C)	3	0.024	0.008	4.254	3.009	*
W x C	9	0.008	0.001	0.468	2.300	NS
Error II	24	0.045	0.002			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.001	0.000	0.067	5.143	NS
Integrated weed management (W)	3	3.783	1.261	324.753	4.757	*
Error I	6	0.023	0.004			
Cultivar (C)	3	0.020	0.007	3.399	3.009	*
W x C	9	0.003	0.000	0.196	2.300	NS
Error II	24	0.046	0.002			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.009	0.009	43.66	NS
Rep within year	4	0.001	0		
Integrated weed management (W)	3	7.54	2.51	876.42	*
Year x W	3	0.001	0	0.174	NS
Error I	12	0.034	0.003		
Cultivar (C)	3	0.043	0.014	7.62	*
Year x C	3	0	0	0.021	NS
W x C	9	0.01	0.001	0.59	NS
Year x W x C	9	0.001	0	0.072	NS
Error II	48	0.091	0.002		

*Significant   NS-Non-significant

2(b) Analysis of variance on leaf area index (LAI) at 60 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.001	0.000	0.058	5.143	NS
Integrated weed management (W)	3	9.482	3.161	592.017	4.757	*
Error I	6	0.032	0.005			
Cultivar (C)	3	0.057	0.019	3.193	3.009	*
W x C	9	0.011	0.001	0.201	2.300	NS
Error II	24	0.142	0.006			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.003	0.002	0.294	5.143	NS
Integrated weed management (W)	3	9.560	3.187	573.895	4.757	*
Error I	6	0.033	0.006			
Cultivar (C)	3	0.053	0.018	3.109	3.009	*
W x C	9	0.006	0.001	0.124	2.300	NS
Error II	24	0.135	0.006			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.014	0.014	14.66	NS
Rep within year	4	0.004	0.001		
Integrated weed management (W)	3	19.04	6.34	1,165.51	*
Year x W	3	0.002	0.001	0.12	NS
Error I	12	0.065	0.005		
Cultivar (C)	3	0.109	0.036	6.29	*
Year x C	3	0	0	0.007	NS
W x C	9	0.015	0.002	0.28	NS
Year x W x C	9	0.002	0	0.04	NS
Error II	48	0.27	0.006		

*Significant NS-Non-significant

2(c) Analysis of variance on leaf area index (LAI) at 90 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.001	0.000	0.090	5.14	NS
Integrated weed management (W)	3	10.07	3.36	956.69	4.75	*
Error I	6	0.021	0.004			
Cultivar (C)	3	0.033	0.011	3.15	3.00	*
W x C	9	0.005	0.001	0.14	2.30	NS
Error II	24	0.084	0.003			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.000	0.000	0.012	5.14	NS
Integrated weed management (W)	3	10.10	3.36	889.53	4.75	*
Error I	6	0.023	0.004			
Cultivar (C)	3	0.032	0.011	3.08	3.00	*
W x C	9	0.004	0.000	0.11	2.30	NS
Error II	24	0.084	0.003			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.004	0.004	21.063	NS
Rep within year	4	0.001	0		
Integrated weed management (W)	3	20.18	6.72	1,844.10	*
Year x W	3	0	0	0.013	NS
Error I	12	0.044	0.004		
Cultivar (C)	3	0.065	0.022	6.24	*
Year x C	3	0	0	0.004	NS
W x C	9	0.008	0.001	0.251	NS
Year x W x C	9	0	0	0.013	NS
Error II	48	0.167	0.003		

*Significant NS-Non-significant

3(a) Analysis of variance on number of plants m^{-2} at 30 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.13	0.06	0.69	5.14	NS
Integrated weed management (W)	3	0.83	0.28	3.08	4.76	NS
Error I	6	0.54	0.09			
Cultivar (C)	3	2.67	0.89	2.91	3.01	NS
W x C	9	0.50	0.06	0.18	2.30	NS
Error II	24	7.33	0.31			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.13	0.06	0.36	5.14	NS
Integrated weed management (W)	3	0.08	0.03	0.16	4.76	NS
Error I	6	1.04	0.17			
Cultivar (C)	3	1.58	0.53	1.69	3.01	NS
W x C	9	0.92	0.10	0.33	2.30	NS
Error II	24	7.50	0.31			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.37	0.37	6	NS
Rep within year	4	0.25	0.06		
Integrated weed management (W)	3	0.70	0.23	1.78	NS
Year x W	3	0.20	0.06	0.52	NS
Error I	12	1.58	0.13		
Cultivar (C)	3	4.12	1.37	4.44	NS
Year x C	3	0.12	0.04	0.13	NS
W x C	9	0.79	0.08	0.28	NS
Year x W x C	9	0.62	0.06	0.22	NS
Error II	48	14.83	0.30		

*Significant NS-Non-significant

3(b) Analysis of variance on number of plants m^{-2} at 60 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.50	0.25	0.75	5.14	NS
Integrated weed management (W)	3	2.25	0.75	2.25	4.76	NS
Error I	6	2.00	0.33			
Cultivar (C)	3	1.08	0.36	1.58	3.01	NS
W x C	9	1.92	0.21	0.93	2.30	NS
Error II	24	5.50	0.23			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.04	0.02	0.06	5.14	NS
Integrated weed management (W)	3	1.23	0.41	1.26	4.76	NS
Error I	6	1.96	0.33			
Cultivar (C)	3	2.23	0.74	2.06	3.01	NS
W x C	9	1.85	0.21	0.57	2.30	NS
Error II	24	8.67	0.36			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.26	0.26	1.92	NS
Rep within year	4	0.54	0.13		
Integrated weed management (W)	3	3.28	1.09	3.31	NS
Year x W	3	0.19	0.06	0.2	NS
Error I	12	3.95	0.33		
Cultivar (C)	3	3.19	1.06	3.61	NS
Year x C	3	0.11	0.03	0.12	NS
W x C	9	1.84	0.20	0.69	NS
Year x W x C	9	1.92	0.21	0.72	NS
Error II	48	14.16	0.29		

*Significant NS-Non-significant

3(c) Analysis of variance on number of plants m^{-2} at harvest as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.50	0.25	0.75	5.14	NS
Integrated weed management (W)	3	2.25	0.75	2.25	4.76	NS
Error I	6	2.00	0.33			
Cultivar (C)	3	1.08	0.36	1.58	3.01	NS
W x C	9	1.92	0.21	0.93	2.30	NS
Error II	24	5.50	0.23			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.04	0.02	0.06	5.14	NS
Integrated weed management (W)	3	1.23	0.41	1.26	4.76	NS
Error I	6	1.96	0.33			
Cultivar (C)	3	2.23	0.74	2.06	3.01	NS
W x C	9	1.85	0.21	0.57	2.30	NS
Error II	24	8.67	0.36			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.26	0.26	1.92	NS
Rep within year	4	0.54	0.13		
Integrated weed management (W)	3	3.28	1.09	3.31	NS
Year x W	3	0.19	0.06	0.2	NS
Error I	12	3.95	0.33		
Cultivar (C)	3	3.19	1.06	3.61	NS
Year x C	3	0.11	0.03	0.12	NS
W x C	9	1.84	0.20	0.69	NS
Year x W x C	9	1.92	0.21	0.72	NS
Error II	48	14.16	0.29		

*Significant NS-Non-significant

4(a) Analysis of variance on dry matter accumulation (g plant^{-1}) at 30 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.00	0.00	0.02	5.14	NS
Integrated weed management (W)	3	4.93	1.64	111.97	4.76	*
Error I	6	0.09	0.01			
Cultivar (C)	3	0.23	0.08	4.78	3.01	*
W x C	9	0.04	0.00	0.26	2.30	NS
Error II	24	0.39	0.02			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.00	0.00	0.06	5.14	NS
Integrated weed management (W)	3	5.35	1.78	64.23	4.76	*
Error I	6	0.17	0.03			
Cultivar (C)	3	0.20	0.07	4.16	3.01	*
W x C	9	0.06	0.01	0.41	2.30	NS
Error II	24	0.38	0.02			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.03	0.03	33.326	NS
Rep within year	4	0.004	0.001		
Integrated weed management (W)	3	10.26	3.42	161.009	*
Year x W	3	0.024	0.008	0.38	NS
Error I	12	0.255	0.021		
Cultivar (C)	3	0.431	0.144	8.917	*
Year x C	3	0.002	0.001	0.036	NS
W x C	9	0.082	0.009	0.564	NS
Year x W x C	9	0.014	0.002	0.099	NS
Error II	48	0.773	0.016		

*Significant NS-Non-significant

4(b) Analysis of variance on dry matter accumulation (g plant^{-1}) at 60 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.03	0.02	0.12	5.14	NS
Integrated weed management (W)	3	40.23	13.41	97.15	4.76	*
Error I	6	0.83	0.14			
Cultivar (C)	3	4.72	1.57	13.95	3.01	*
W x C	9	0.45	0.05	0.45	2.30	NS
Error II	24	2.70	0.11			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.03	0.02	0.10	5.14	NS
Integrated weed management (W)	3	42.20	14.07	87.79	4.76	*
Error I	6	0.96	0.16			
Cultivar (C)	3	4.48	1.49	15.44	3.01	*
W x C	9	0.34	0.04	0.39	2.30	NS
Error II	24	2.32	0.10			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.062	0.062	3.76	NS
Rep within year	4	0.065	0.016		
Integrated weed management (W)	3	82.41	27.47	184.13	*
Year x W	3	0.017	0.006	0.038	NS
Error I	12	1.79	0.14		
Cultivar (C)	3	9.18	3.06	29.25	*
Year x C	3	0.007	0.002	0.023	NS
W x C	9	0.74	0.083	0.78	NS
Year x W x C	9	0.049	0.005	0.052	NS
Error II	48	5.02	0.105		

*Significant NS- Non-significant

4(c) Analysis of variance on dry matter accumulation (g plant^{-1}) at 90 DAS influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.03	0.01	0.02	5.14	NS
Integrated weed management (W)	3	357.37	119.12	190.89	4.76	*
Error I	6	3.74	0.62			
Cultivar (C)	3	71.40	23.80	27.45	3.01	*
W x C	9	7.30	0.81	0.94	2.30	NS
Error II	24	20.81	0.87			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.14	0.07	0.06	5.14	NS
Integrated weed management (W)	3	387.36	129.12	105.60	4.76	*
Error I	6	7.34	1.22			
Cultivar (C)	3	67.99	22.66	36.67	3.01	*
W x C	9	4.79	0.53	0.86	2.30	NS
Error II	24	14.83	0.62			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	1.44	1.44	34.37	NS
Rep within year	4	0.16	0.04		
Integrated weed management (W)	3	744.35	248.11	268.73	*
Year x W	3	0.36	0.12	0.13	NS
Error I	12	11.08	0.92		
Cultivar (C)	3	139.33	46.44	62.55	*
Year x C	3	0.06	0.02	0.027	NS
W x C	9	11.21	1.24	1.67	NS
Year x W x C	9	0.87	0.09	0.13	NS
Error II	48	35.63	0.74		

*Significant NS-Non-significant

5(a) Analysis of variance on crop growth rate (g m^{-2} day^{-1}) at 30-60 DAS influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.07	0.04	0.13	5.14	NS
Integrated weed management (W)	3	47.56	15.85	55.81	4.76	*
Error I	6	1.70	0.28			
Cultivar (C)	3	7.98	2.66	8.86	3.01	*
W x C	9	0.87	0.10	0.32	2.30	NS
Error II	24	7.20	0.30			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.13	0.07	0.18	5.14	NS
Integrated weed management (W)	3	49.77	16.59	43.63	4.76	*
Error I	6	2.28	0.38			
Cultivar (C)	3	7.78	2.59	12.19	3.01	*
W x C	9	0.78	0.09	0.41	2.30	NS
Error II	24	5.11	0.21			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.014	0.014	0.268	NS
Rep within year	4	0.20	0.05		
Integrated weed management (W)	3	97.23	32.41	97.86	*
Year x W	3	0.032	0.011	0.032	NS
Error I	12	3.97	0.33		
Cultivar (C)	3	15.72	5.24	20.48	*
Year x C	3	0.008	0.003	0.011	NS
W x C	9	1.50	0.16	0.65	NS
Year x W x C	9	0.15	0.017	0.06	NS
Error II	48	12.28	0.25		

*Significant NS-Non-significant

5(b) Analysis of variance on crop growth rate (g m^{-2} day^{-1}) at 60-90 DAS influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.00	0.00	0.00	5.14	NS
Integrated weed management (W)	3	440.54	146.85	200.00	4.76	*
Error I	6	4.41	0.73			
Cultivar (C)	3	110.38	36.79	16.21	3.01	*
W x C	9	15.09	1.68	0.74	2.30	NS
Error II	24	54.46	2.27			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.14	0.07	0.02	5.14	NS
Integrated weed management (W)	3	485.23	161.74	56.15	4.76	*
Error I	6	17.28	2.88			
Cultivar (C)	3	104.88	34.96	19.68	3.01	*
W x C	9	10.92	1.21	0.68	2.30	NS
Error II	24	42.63	1.78			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	2.53	2.53	76.86	*
Rep within year	4	0.132	0.033		
Integrated weed management (W)	3	924.94	308.31	170.34	*
Year x W	3	0.63	0.211	0.11	NS
Error I	12	21.72	1.81		
Cultivar (C)	3	215.22	71.74	35.48	*
Year x C	3	0.1	0.03	0.016	NS
W x C	9	24.48	2.72	1.34	NS
Year x W x C	9	1.54	0.17	0.085	NS
Error II	48	97.04	2.02		

*Significant NS-Non-significant

6(a) Analysis of variance on relative growth rate (g g^{-1} day^{-1}) at 30-60 DAS influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.000001	0.000000	0.09	5.14	NS
Integrated weed management (W)	3	0.000019	0.000006	1.67	4.75	NS
Error I	6	0.000022	0.000004			
Cultivar (C)	3	0.000032	0.000011	2.22	3.00	NS
W x C	9	0.000013	0.000001	0.29	2.30	NS
Error II	24	0.000116	0.000005			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.000002	0.000001	0.17	5.143253	NS
Integrated weed management (W)	3	0.000032	0.000011	2.16	4.757063	NS
Error I	6	0.000030	0.000005			
Cultivar (C)	3	0.000034	0.000011	3.93	3.008787	*
W x C	9	0.000016	0.000002	0.63	2.300244	NS
Error II	24	0.000068	0.000003			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0	0	1.76	NS
Rep within year	4	0	0		
Integrated weed management (W)	3	0	0	3.74	NS
Year x W	3	0	0	0.16	NS
Error I	12	0	0		
Cultivar (C)	3	0	0	5.70	*
Year x C	3	0	0	0.01	NS
W x C	9	0	0	0.76	NS
Year x W x C	9	0	0	0.07	NS
Error II	48	0	0		

*Significant NS-Non-significant

6(b) Analysis of variance on relative growth rate (g g^{-1} day^{-1}) at 60-90 DAS influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.000000	0.000000	0.091	5.14	NS
Integrated weed management (W)	3	0.000043	0.000014	13.75	4.75	*
Error I	6	0.000006	0.000001			
Cultivar (C)	3	0.000044	0.000015	3.08	3.00	*
W x C	9	0.000015	0.000002	0.35	2.30	NS
Error II	24	0.000113	0.000005			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.00	0.00	0.07	5.14	NS
Integrated weed management (W)	3	0.00	0.00	3.15	4.76	NS
Error I	6	0.00	0.00			
Cultivar (C)	3	0.00	0.00	2.71	3.01	NS
W x C	9	0.00	0.00	0.37	2.30	NS
Error II	24	0.00	0.00			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0	0	6.17	NS
Rep within year	4	0	0		
Integrated weed management (W)	3	0	0	9.77	*
Year x W	3	0	0	0.017	NS
Error I	12	0	0		
Cultivar (C)	3	0	0	5.78	*
Year x C	3	0	0	0.01	NS
W x C	9	0	0	0.70	NS
Year x W x C	9	0	0	0.02	NS
Error II	48	0	0		

*Significant NS-Non-significant

7. Analysis of variance on days to 50 % flowering as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.04	0.02	0.06	5.14	NS
Integrated weed management (W)	3	3.56	1.19	3.35	4.76	NS
Error I	6	2.13	0.35			
Cultivar (C)	3	26.90	8.97	19.27	3.01	*
W x C	9	4.19	0.47	1.00	2.30	NS
Error II	24	11.17	0.47			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.04	0.02	0.05	5.14	NS
Integrated weed management (W)	3	4.90	1.63	4.27	4.76	NS
Error I	6	2.29	0.38			
Cultivar (C)	3	19.06	6.35	13.86	3.01	*
W x C	9	3.69	0.41	0.89	2.30	NS
Error II	24	11.00	0.46			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.66	0.66	32	NS
Rep within year	4	0.08	0.02		
Integrated weed management (W)	3	7.45	2.48	6.75	NS
Year x W	3	1	0.33	0.90	NS
Error I	12	4.41	0.36		
Cultivar (C)	3	45.45	15.15	32.81	*
Year x C	3	0.5	0.16	0.36	NS
W x C	9	3.04	0.33	0.73	NS
Year x W x C	9	4.83	0.53	1.16	NS
Error II	48	22.16	0.46		

*Significant NS-Non-significant

8. Analysis of variance on days to 50 % physiological maturity as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.13	0.06	0.20	5.14	NS
Integrated weed management (W)	3	2.50	0.83	2.67	4.76	NS
Error I	6	1.88	0.31			
Cultivar (C)	3	42.17	14.06	72.29	3.01	*
W x C	9	2.67	0.30	1.52	2.30	NS
Error II	24	4.67	0.19			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.00	0.00	0.00	5.14	NS
Integrated weed management (W)	3	0.75	0.25	0.75	4.76	NS
Error I	6	2.00	0.33			
Cultivar (C)	3	34.92	11.64	41.90	3.01	*
W x C	9	4.92	0.55	1.97	2.30	NS
Error II	24	6.67	0.28			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.37	0.37	12	NS
Rep within year	4	0.12	0.03		
Integrated weed management (W)	3	2.79	0.93	2.88	NS
Year x W	3	0.45	0.15	0.47	NS
Error I	12	3.87	0.32		
Cultivar (C)	3	75.37	25.12	106.41	*
Year x C	3	1.70	0.56	2.41	NS
W x C	9	3.79	0.42	1.78	NS
Year x W x C	9	3.79	0.42	1.78	NS
Error II	48	11.33	0.23		

*Significant NS-Non-significant

9. Analysis of variance on days to maturity as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	3.13	1.56	0.53	5.14	NS
Integrated weed management (W)	3	16.23	5.41	1.83	4.76	NS
Error I	6	17.71	2.95			
Cultivar (C)	3	289.73	96.58	38.74	3.01	*
W x C	9	16.19	1.80	0.72	2.30	NS
Error II	24	59.83	2.49			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	4.04	2.02	0.38	5.14	NS
Integrated weed management (W)	3	14.90	4.97	0.92	4.76	NS
Error I	6	32.29	5.38			
Cultivar (C)	3	299.40	99.80	17.31	3.01	*
W x C	9	49.02	5.45	0.94	2.30	NS
Error II	24	138.33	5.76			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	1.04	1.04	0.58	NS
Rep within year	4	7.16	1.79		
Integrated weed management (W)	3	29	9.66	2.32	NS
Year x W	3	2.12	0.70	0.17	NS
Error I	12	50	4.16		
Cultivar (C)	3	580.33	193.44	46.85	*
Year x C	3	8.79	2.93	0.71	NS
W x C	9	49.16	5.46	1.32	NS
Year x W x C	9	16.04	1.78	0.43	NS
Error II	48	198.17	4.12		

*Significant NS-Non-significant

10. Analysis of variance on number of panicles m^{-2} as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	2.04	1.02	0.01	5.14	NS
Integrated weed management (W)	3	26108.25	8702.75	65.30	4.76	*
Error I	6	799.63	133.27			
Cultivar (C)	3	764.08	254.69	3.20	3.01	*
W x C	9	366.25	40.69	0.51	2.30	NS
Error II	24	1909.67	79.57			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.29	0.15	0.00	5.14	NS
Integrated weed management (W)	3	26223.23	8741.08	84.09	4.76	*
Error I	6	623.71	103.95			
Cultivar (C)	3	734.23	244.74	3.03	3.01	*
W x C	9	438.85	48.76	0.60	2.30	NS
Error II	24	1940.67	80.86			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	65.01	65.01	111.44	*
Rep within year	4	2.33	0.58		
Integrated weed management (W)	3	52,328.87	17,442.96	147.06	*
Year x W	3	2.61	0.87	0.007	NS
Error I	12	1,423.33	118.61		
Cultivar (C)	3	1,493.03	497.67	6.20	*
Year x C	3	5.28	1.76	0.02	NS
W x C	9	800.84	88.98	1.10	NS
Year x W x C	9	4.26	0.47	0.00	NS
Error II	48	3,850.33	80.21		

*Significant NS-Non-significant

11. Analysis of variance on length of panicles (cm) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.03	0.02	0.02	5.14	NS
Integrated weed management (W)	3	7.69	2.56	2.57	4.76	NS
Error I	6	5.98	1.00			
Cultivar (C)	3	11.03	3.68	3.89	3.01	*
W x C	9	0.68	0.08	0.08	2.30	NS
Error II	24	22.68	0.95			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.83	0.41	0.36	5.14	NS
Integrated weed management (W)	3	14.33	4.78	4.21	4.76	NS
Error I	6	6.81	1.13			
Cultivar (C)	3	17.29	5.76	3.64	3.01	*
W x C	9	1.11	0.12	0.08	2.30	NS
Error II	24	37.95	1.58			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.799	0.799	3.739	NS
Rep within year	4	0.855	0.214		
Integrated weed management (W)	3	20.841	6.947	6.519	*
Year x W	3	1.179	0.393	0.369	NS
Error I	12	12.789	1.066		
Cultivar (C)	3	27.756	9.252	7.323	*
Year x C	3	0.559	0.186	0.147	NS
W x C	9	0.576	0.064	0.051	NS
Year x W x C	9	1.217	0.135	0.107	NS
Error II	48	60.64	1.263		

*Significant NS-Non-significant

12. Analysis of variance on weight of panicles (g) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.01	0.01	0.63	5.14	NS
Integrated weed management (W)	3	13.87	4.62	479.77	4.76	*
Error I	6	0.06	0.01			
Cultivar (C)	3	0.24	0.08	5.69	3.01	*
W x C	9	0.29	0.03	2.30	2.30	*
Error II	24	0.34	0.01			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.00	0.00	0.01	5.14	NS
Integrated weed management (W)	3	15.01	5.00	411.86	4.76	*
Error I	6	0.07	0.01			
Cultivar (C)	3	0.24	0.08	9.18	3.01	*
W x C	9	0.24	0.03	3.16	2.30	*
Error II	24	0.21	0.01			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.025	0.025	8.013	NS
Rep within year	4	0.012	0.003		
Integrated weed management (W)	3	28.866	9.622	882.751	*
Year x W	3	0.013	0.004	0.391	NS
Error I	12	0.131	0.011		
Cultivar (C)	3	0.476	0.159	14.025	*
Year x C	3	0	0	0.001	NS
W x C	9	0.53	0.059	5.208	*
Year x W x C	9	0.005	0.001	0.049	NS
Error II	48	0.543	0.011		

*Significant NS-Non-significant

13. Analysis of variance on number of grains panicles^{-1} as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.98	0.49	0.01	5.14	NS
Integrated weed management (W)	3	1957.62	652.54	10.56	4.76	*
Error I	6	370.71	61.79			
Cultivar (C)	3	629.84	209.95	3.42	3.01	*
W x C	9	63.11	7.01	0.11	2.30	NS
Error II	24	1471.77	61.32			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	21.39	10.70	0.17	5.14	NS
Integrated weed management (W)	3	2001.95	667.32	10.87	4.76	*
Error I	6	368.21	61.37			
Cultivar (C)	3	765.03	255.01	3.51	3.01	*
W x C	9	81.67	9.07	0.12	2.30	NS
Error II	24	1742.59	72.61			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	61.8	61.8	9.3	NS
Rep within year	4	26.7	6.7		
Integrated weed management (W)	3	4011.9	1337.3	21.5	*
Year x W	3	5.1	1.7	0.0	NS
Error I	12	747.3	62.3		
Cultivar (C)	3	1386.4	462.1	6.8	*
Year x C	3	7.2	2.4	0.0	NS
W x C	9	119.8	13.3	0.2	NS
Year x W x C	9	16.1	1.8	0.0	NS
Error II	48	3260.7	67.9		

*Significant NS-Non-significant

14. Analysis of variance on grain filling percentage as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	8.34	4.17	0.27	5.14	NS
Integrated weed management (W)	3	46.80	15.60	1.02	4.76	NS
Error I	6	91.54	15.26			
Cultivar (C)	3	15.41	5.14	0.45	3.01	NS
W x C	9	77.97	8.66	0.75	2.30	NS
Error II	24	276.64	11.53			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	29.44	14.72	1.17	5.14	NS
Integrated weed management (W)	3	122.13	40.71	3.22	4.76	NS
Error I	6	75.81	12.64			
Cultivar (C)	3	17.67	5.89	0.28	3.01	NS
W x C	9	49.27	5.47	0.26	2.30	NS
Error II	24	503.67	20.99			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	17.41	17.41	1.83	NS
Rep within year	4	37.87	9.47		
Integrated weed management (W)	3	158.02	52.67	3.77	NS
Year x W	3	10.79	3.6	0.25	NS
Error I	12	167.39	13.94		
Cultivar (C)	3	24.81	8.27	0.50	NS
Year x C	3	8.29	2.76	0.17	NS
W x C	9	115.87	12.87	0.79	NS
Year x W x C	9	11.30	1.25	0.07	NS
Error II	48	780.59	16.26		

*Significant NS-Non-significant

15. Analysis of variance on test weight (g) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.60	0.30	0.84	5.14	NS
Integrated weed management (W)	3	1.89	0.63	1.75	4.76	NS
Error I	6	2.16	0.36			
Cultivar (C)	3	5.76	1.92	2.95	3.01	NS
W x C	9	3.00	0.33	0.51	2.30	NS
Error II	24	15.63	0.65			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.10	0.05	0.11	5.14	NS
Integrated weed management (W)	3	0.55	0.18	0.38	4.76	NS
Error I	6	2.90	0.48			
Cultivar (C)	3	3.59	1.20	1.69	3.01	NS
W x C	9	1.83	0.20	0.29	2.30	NS
Error II	24	17.03	0.71			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.32	0.32	1.83	NS
Rep within year	4	0.70	0.17		
Integrated weed management (W)	3	2.18	0.72	1.72	NS
Year x W	3	0.25	0.08	0.20	NS
Error I	12	5.04	0.42		
Cultivar (C)	3	8.65	2.88	4.24	NS
Year x C	3	0.68	0.23	0.33	NS
W x C	9	2.45	0.27	0.40	NS
Year x W x C	9	2.37	0.26	0.38	NS
Error II	48	32.65	0.68		

*Significant NS-Non-significant

16. Analysis of variance on grain yield (kg) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	2943.79	1471.90	0.17	5.14	NS
Integrated weed management (W)	3	4913352.17	1637784.06	188.12	4.76	*
Error I	6	52236.71	8706.12			
Cultivar (C)	3	190522.50	63507.50	11.53	3.01	*
W x C	9	7100.67	788.96	0.14	2.30	NS
Error II	24	132152.83	5506.37			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	1554.04	777.02	0.06	5.14	NS
Integrated weed management (W)	3	4777027.23	1592342.41	128.34	4.76	*
Error I	6	74441.46	12406.91			
Cultivar (C)	3	193298.56	64432.85	11.66	3.01	*
W x C	9	9473.52	1052.61	0.19	2.30	NS
Error II	24	132663.17	5527.63			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	1,658.34	1,658.34	1.475	NS
Rep within year	4	4,497.83	1,124.46		
Integrated weed management (W)	3	9,689,456.87	3,229,819.0	305.955	*
Year x W	3	922.531	307.51	0.029	NS
Error I	12	126,678.17	10,556.51		
Cultivar (C)	3	383,693.03	127,897.68	23.182	*
Year x C	3	128.031	42.677	0.008	NS
W x C	9	16,308.93	1,812.10	0.328	NS
Year x W x C	9	265.26	29.473	0.005	NS
Error II	48	264,816.00	5,517.00		

*Significant NS-Non-significant

17. Analysis of variance on straw yield (kg) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	879.50	439.75	0.01	5.14	NS
Integrated weed management (W)	3	7443846.50	2481282.17	76.08	4.76	*
Error I	6	195687.50	32614.58			
Cultivar (C)	3	364416.17	121472.06	3.97	3.01	*
W x C	9	78937.33	8770.81	0.29	2.30	NS
Error II	24	734677.00	30611.54			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	9421.13	4710.56	0.14	5.14	NS
Integrated weed management (W)	3	7557112.56	2519037.52	76.64	4.76	*
Error I	6	197215.88	32869.31			
Cultivar (C)	3	416971.23	138990.41	3.03	3.01	*
W x C	9	137153.02	15239.22	0.33	2.30	NS
Error II	24	1102479.00	45936.63			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	99,652.59	99,652.59	38.698	NS
Rep within year	4	10,300.63	2,575.16		
Integrated weed management (W)	3	14,986,563	4,995,521	152.573	*
Year x W	3	14,395.62	4,798.54	0.147	NS
Error I	12	392,903.38	32,741.95		
Cultivar (C)	3	778,612.53	259,537.51	6.781	*
Year x C	3	2,774.87	924.955	0.024	NS
W x C	9	194,906.59	21,656.29	0.566	NS
Year x W x C	9	21,183.76	2,353.75	0.061	NS
Error II	48	1,837,156.0	38,274.08		

*Significant NS-Non-significant

18. Analysis of variance on biological yield (kg) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	6665.04	3332.52	0.08	5.14	NS
Integrated weed management (W)	3	24283948.16	8094649.38	183.99	4.76	*
Error I	6	263967.95	43994.66			
Cultivar (C)	3	1069523.16	356507.72	7.61	3.01	*
W x C	9	116060.66	12895.63	0.28	2.30	NS
Error II	24	1123623.66	46817.65			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	3818.16	1909.083	0.07	5.14	NS
Integrated weed management (W)	3	24122876.16	8040958.72	281.48	4.76	*
Error I	6	171400.33	28566.72			
Cultivar (C)	3	1173158.83	391052.94	7.17	3.01	*
W x C	9	177034.66	19670.51	0.36	2.30	NS
Error II	24	1309791.50	54574.64			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	127,021.50	127,021.50	48.467	NS
Rep within year	4	10,483.21	2,620.80		
Integrated weed management (W)	3	48,390,632.92	16,130,211.0	444.595	*
Year x W	3	16,191.42	5,397.14	0.149	NS
Error I	12	435,368.29	36,280.69		
Cultivar (C)	3	2,239,139.08	746,379.69	14.723	*
Year x C	3	3,542.92	1,180.97	0.023	NS
W x C	9	270,295.17	30,032.80	0.592	NS
Year x W x C	9	22,800.17	2,533.35	0.05	NS
Error II	48	2,433,415.17	50,696.15		

*Significant NS-Non-significant

19. Analysis of variance on harvest index (%) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.16	0.08	0.03	5.14	NS
Integrated weed management (W)	3	256.24	85.41	28.60	4.76	*
Error I	6	17.92	2.99			
Cultivar (C)	3	8.96	2.99	2.21	3.01	NS
W x C	9	2.20	0.24	0.18	2.30	NS
Error II	24	32.47	1.35			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	2.52	1.26	0.24	5.14	NS
Integrated weed management (W)	3	247.70	82.57	15.85	4.76	*
Error I	6	31.26	5.21			
Cultivar (C)	3	7.30	2.43	0.95	3.01	NS
W x C	9	4.22	0.47	0.18	2.30	NS
Error II	24	61.53	2.56			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	1.304	1.304	1.946	NS
Rep within year	4	2.681	0.67		
Integrated weed management (W)	3	503.418	167.806	40.891	*
Year x W	3	0.507	0.169	0.041	NS
Error I	12	49.245	4.104		
Cultivar (C)	3	16.187	5.396	2.755	NS
Year x C	3	0.087	0.029	0.015	NS
W x C	9	5.576	0.62	0.316	NS
Year x W x C	9	0.864	0.096	0.049	NS
Error II	48	94.017	1.959		

*Significant   NS-Non-significant

20. Analysis of variance on milling percentage (%) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	1.29	0.65	0.74	5.14	NS
Integrated weed management (W)	3	9.22	3.07	3.53	4.76	NS
Error I	6	5.23	0.87			
Cultivar (C)	3	26.32	8.77	6.78	3.01	*
W x C	9	5.79	0.64	0.50	2.30	NS
Error II	24	31.05	1.29			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.00	0.00	0.00	5.14	NS
Integrated weed management (W)	3	8.63	2.88	4.06	4.76	NS
Error I	6	4.25	0.71			
Cultivar (C)	3	13.12	4.37	3.84	3.01	*
W x C	9	0.86	0.10	0.08	2.30	NS
Error II	24	27.33	1.14			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	1.54	1.54	4.67	NS
Rep within year	4	1.32	0.33		
Integrated weed management (W)	3	17.06	5.68	7.22	*
Year x W	3	0.79	0.26	0.33	NS
Error I	12	9.44	0.78		
Cultivar (C)	3	38.249	12.75	10.48	*
Year x C	3	1.19	0.39	0.32	NS
W x C	9	3.95	0.43	0.36	NS
Year x W x C	9	2.69	0.29	0.24	NS
Error II	48	58.38	1.21		

*Significant   NS-Non-significant

21. Analysis of variance on hulling percentage (%) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.05	0.02	0.04	5.14	NS
Integrated weed management (W)	3	5.12	1.71	2.97	4.76	NS
Error I	6	3.45	0.57			
Cultivar (C)	3	17.57	5.86	5.37	3.01	*
W x C	9	7.53	0.84	0.77	2.30	NS
Error II	24	26.17	1.09			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.96	0.48	0.27	5.14	NS
Integrated weed management (W)	3	1.39	0.46	0.26	4.76	NS
Error I	6	10.57	1.76			
Cultivar (C)	3	16.62	5.54	3.40	3.01	*
W x C	9	7.02	0.78	0.48	2.30	NS
Error II	24	39.13	1.63			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.36	0.36	1.38	NS
Rep within year	4	1.06	0.26		
Integrated weed management (W)	3	5.77	1.92	1.65	NS
Year x W	3	0.74	0.24	0.21	NS
Error I	12	13.94	1.16		
Cultivar (C)	3	34.01	11.33	8.33	*
Year x C	3	0.16	0.05	0.04	NS
W x C	9	10.34	1.15	0.84	NS
Year x W x C	9	4.19	0.46	0.34	NS
Error II	48	65.32	1.36		

*Significant   NS-Non-significant

22. Analysis of variance on head rice recovery (%) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.52	0.26	0.08	5.14	NS
Integrated weed management (W)	3	19.15	6.38	2.00	4.76	NS
Error I	6	19.17	3.20			
Cultivar (C)	3	33.89	11.30	3.98	3.01	*
W x C	9	4.71	0.52	0.18	2.30	NS
Error II	24	68.11	2.84			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	2.60	1.30	0.60	5.14	NS
Integrated weed management (W)	3	20.24	6.75	3.13	4.76	NS
Error I	6	12.94	2.16			
Cultivar (C)	3	47.31	15.77	8.85	3.01	*
W x C	9	5.12	0.57	0.32	2.30	NS
Error II	24	42.77	1.78			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.66	0.66	0.84	NS
Rep within year	4	3.13	0.78		
Integrated weed management (W)	3	39.35	13.11	4.90	NS
Year x W	3	0.04	0.01	0.005	NS
Error I	12	32.08	2.67		
Cultivar (C)	3	80.48	26.82	11.61	*
Year x C	3	0.72	0.24	0.10	NS
W x C	9	6.40	0.71	0.30	NS
Year x W x C	9	3.40	0.37	0.16	NS
Error II	48	110.88	2.31		

*Significant NS-Non-significant

23. Analysis of variance on protein content (%) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.19	0.09	0.89	5.14	NS
Integrated weed management (W)	3	8.28	2.76	26.51	4.76	*
Error I	6	0.62	0.10			
Cultivar (C)	3	0.23	0.08	0.63	3.01	NS
W x C	9	1.13	0.13	1.01	2.30	NS
Error II	24	2.97	0.12			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.08	0.04	0.29	5.14	NS
Integrated weed management (W)	3	11.04	3.68	27.72	4.76	*
Error I	6	0.80	0.13			
Cultivar (C)	3	0.60	0.20	2.17	3.01	NS
W x C	9	0.61	0.07	0.73	2.30	NS
Error II	24	2.22	0.09			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.36	0.36	5.51	NS
Rep within year	4	0.26	0.06		
Integrated weed management (W)	3	19.15	6.38	54.00	*
Year x W	3	0.13	0.04	0.38	NS
Error I	12	1.41	0.11		
Cultivar (C)	3	0.63	0.21	1.95	NS
Year x C	3	0.20	0.06	0.63	NS
W x C	9	0.97	0.10	1	NS
Year x W x C	9	0.76	0.08	0.78	NS
Error II	48	5.18	0.10		

*Significant   NS-Non-significant

APPENDIX- V

ANOVA for weed parameters

1(a) Analysis of variance on population of grasses (no. m^{-2}) at 20 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.78	0.39	0.51	5.14	NS
Integrated weed management (W)	3	101.23	33.74	43.57	4.76	*
Error I	6	4.65	0.77			
Cultivar (C)	3	50.93	16.98	20.87	3.01	*
W x C	9	3.78	0.42	0.52	2.30	NS
Error II	24	19.52	0.81			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.60	0.30	0.47	5.14	NS
Integrated weed management (W)	3	117.94	39.31	61.57	4.76	*
Error I	6	3.83	0.64			
Cultivar (C)	3	42.97	14.32	16.12	3.01	*
W x C	9	1.97	0.22	0.25	2.30	NS
Error II	24	21.33	0.89			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.02	0.028	0.29	NS
Rep within year	4	0.38	0.095		
Integrated weed management (W)	3	218.51	72.83	92.08	*
Year x W	3	1.561	0.52	0.65	NS
Error I	12	9.49	0.79		
Cultivar (C)	3	93.58	31.19	37.29	*
Year x C	3	1.10	0.36	0.43	NS
W x C	9	3.99	0.44	0.53	NS
Year x W x C	9	1.214	0.13	0.16	NS
Error II	48	40.15	0.83		

*Significant   NS-Non-significant

1(b) Analysis of variance on population of grasses (no. m^{-2}) at 40 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.20	0.10	0.09	5.14	NS
Integrated weed management (W)	3	209.17	69.72	63.37	4.76	*
Error I	6	6.60	1.10			
Cultivar (C)	3	65.25	21.75	12.57	3.01	*
W x C	9	8.22	0.91	0.53	2.30	NS
Error II	24	41.53	1.73			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	1.78	0.89	1.15	5.14	NS
Integrated weed management (W)	3	186.55	62.18	80.74	4.76	*
Error I	6	4.62	0.77			
Cultivar (C)	3	58.21	19.40	19.30	3.01	*
W x C	9	9.19	1.02	1.02	2.30	NS
Error II	24	24.13	1.01			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.511	0.51	0.75	NS
Rep within year	4	2.707	0.67		
Integrated weed management (W)	3	390.19	130.06	186.72	*
Year x W	3	0.14	0.047	0.06	NS
Error I	12	8.35	0.69		
Cultivar (C)	3	119.2	39.73	31.49	*
Year x C	3	0.10	0.03	0.02	NS
W x C	9	13.39	1.48	1.17	NS
Year x W x C	9	2.34	0.26	0.20	NS
Error II	48	60.56	1.26		

*Significant NS-Non-significant

1(c) Analysis of variance on population of grasses (no. m^{-2}) at 60 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	1.35	0.67	0.53	5.14	NS
Integrated weed management (W)	3	294.11	98.04	76.76	4.76	*
Error I	6	7.66	1.28			
Cultivar (C)	3	113.07	37.69	18.47	3.01	*
W x C	9	22.40	2.49	1.22	2.30	NS
Error II	24	48.97	2.04			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	2.54	1.27	0.30	5.14	NS
Integrated weed management (W)	3	287.78	95.93	22.85	4.76	*
Error I	6	25.18	4.20			
Cultivar (C)	3	91.60	30.53	15.77	3.01	*
W x C	9	28.35	3.15	1.63	2.30	NS
Error II	24	46.45	1.94			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.18	0.18	0.19	NS
Rep within year	4	3.70	0.92		
Integrated weed management (W)	3	580.812	193.60	84.02	*
Year x W	3	0.65	0.21	0.09	NS
Error I	12	27.64	2.30		
Cultivar (C)	3	198.76	66.25	33.63	*
Year x C	3	5.97	1.99	1.01	NS
W x C	9	32.86	3.65	1.85	NS
Year x W x C	9	17.3	1.92	0.97	NS
Error II	48	94.56	1.97		

*Significant NS-Non-significant

2(a) Analysis of variance on population of sedge (no. m^{-2}) at 20 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.47	0.24	0.47	5.14	NS
Integrated weed management (W)	3	47.42	15.81	31.44	4.76	*
Error I	6	3.02	0.50			
Cultivar (C)	3	25.67	8.56	10.85	3.01	*
W x C	9	2.80	0.31	0.39	2.30	NS
Error II	24	18.92	0.79			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.96	0.48	2.34	5.14	NS
Integrated weed management (W)	3	57.90	19.30	94.29	4.76	*
Error I	6	1.23	0.20			
Cultivar (C)	3	28.05	9.35	15.09	3.01	*
W x C	9	2.99	0.33	0.54	2.30	NS
Error II	24	14.87	0.62			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.54	0.54	1.52	NS
Rep within year	4	1.43	0.35		
Integrated weed management (W)	3	104.83	34.94	99.10	*
Year x W	3	0.34	0.11	0.32	NS
Error I	12	4.23	0.35		
Cultivar (C)	3	53.31	17.77	25.31	*
Year x C	3	0.35	0.12	0.17	NS
W x C	9	4.48	0.49	0.71	NS
Year x W x C	9	1.27	0.14	0.20	NS
Error II	48	33.70	0.70		

*Significant NS-Non-significant

2(b) Analysis of variance on population of sedge (no. m^{-2}) at 40 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.03	0.01	0.13	5.14	NS
Integrated weed management (W)	3	69.18	23.06	200.52	4.76	*
Error I	6	0.69	0.12			
Cultivar (C)	3	18.91	6.30	15.35	3.01	*
W x C	9	1.68	0.19	0.45	2.30	NS
Error II	24	9.85	0.41			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.08	0.04	0.12	5.14	NS
Integrated weed management (W)	3	64.12	21.37	69.33	4.76	*
Error I	6	1.85	0.31			
Cultivar (C)	3	10.70	3.57	7.99	3.01	*
W x C	9	0.91	0.10	0.23	2.30	NS
Error II	24	10.72	0.45			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.24	0.24	8.98	NS
Rep within year	4	0.11	0.02		
Integrated weed management (W)	3	133.18	44.39	210.21	*
Year x W	3	0.10	0.03	0.15	NS
Error I	12	2.53	0.21		
Cultivar (C)	3	28.89	9.63	22.47	*
Year x C	3	0.68	0.22	0.53	NS
W x C	9	2.31	0.25	0.60	NS
Year x W x C	9	0.27	0.03	0.07	NS
Error II	48	20.57	0.42		

*Significant NS-Non-significant

2(c) Analysis of variance on population of sedge (no. m^{-2}) at 60 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.07	0.04	0.40	5.14	NS
Integrated weed management (W)	3	118.39	39.46	437.37	4.76	*
Error I	6	0.54	0.09			
Cultivar (C)	3	13.75	4.58	7.68	3.01	*
W x C	9	5.27	0.59	0.98	2.30	NS
Error II	24	14.33	0.60			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.45	0.23	1.41	5.14	NS
Integrated weed management (W)	3	127.39	42.46	265.33	4.76	*
Error I	6	0.96	0.16			
Cultivar (C)	3	16.90	5.63	13.03	3.01	*
W x C	9	2.30	0.26	0.59	2.30	NS
Error II	24	10.38	0.43			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.68	0.68	5.29	NS
Rep within year	4	0.51	0.12		
Integrated weed management (W)	3	245.54	81.84	656.71	*
Year x W	3	0.13	0.04	0.36	NS
Error I	12	1.49	0.12		
Cultivar (C)	3	30.50	10.16	19.76	*
Year x C	3	0.12	0.04	0.08	NS
W x C	9	5.96	0.66	1.28	NS
Year x W x C	9	1.61	0.17	0.34	NS
Error II	48	24.7	0.51		

*Significant   NS-Non-significant

3(a) Analysis of variance on population of broad leaved weeds (no. m^{-2}) at 20 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.12	0.06	0.32	5.14	NS
Integrated weed management (W)	3	50.81	16.94	89.72	4.76	*
Error I	6	1.13	0.19			
Cultivar (C)	3	57.42	19.14	77.00	3.01	*
W x C	9	2.28	0.25	1.02	2.30	NS
Error II	24	5.97	0.25			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.34	0.17	0.45	5.14	NS
Integrated weed management (W)	3	66.09	22.03	58.50	4.76	*
Error I	6	2.26	0.38			
Cultivar (C)	3	66.81	22.27	54.29	3.01	*
W x C	9	8.97	1.00	2.43	2.30	*
Error II	24	9.85	0.41			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	2.78	2.78	24.41	NS
Rep within year	4	0.45	0.11		
Integrated weed management (W)	3	116.30	38.76	137.14	*
Year x W	3	0.59	0.19	0.70	NS
Error I	12	3.39	0.28		
Cultivar (C)	3	123.30	41.10	124.77	*
Year x C	3	0.90	0.30	0.91	NS
W x C	9	8.85	0.98	2.98	NS
Year x W x C	9	2.39	0.26	0.80	NS
Error II	48	15.81	0.32		

*Significant   NS-Non-significant

3(b) Analysis of variance on population of broad leaved weeds (no. m^{-2}) at 40 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.07	0.03	0.07	5.14	NS
Integrated weed management (W)	3	98.30	32.77	62.50	4.76	*
Error I	6	3.15	0.52			
Cultivar (C)	3	61.12	20.37	62.22	3.01	*
W x C	9	4.51	0.50	1.53	2.30	NS
Error II	24	7.86	0.33			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.09	0.04	0.15	5.14	NS
Integrated weed management (W)	3	98.99	33.00	114.38	4.76	*
Error I	6	1.73	0.29			
Cultivar (C)	3	61.53	20.51	39.76	3.01	*
W x C	9	1.55	0.17	0.33	2.30	NS
Error II	24	12.38	0.52			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	1.16	1.16	29.89	*
Rep within year	4	0.15	0.03		
Integrated weed management (W)	3	197.25	65.75	161.77	*
Year x W	3	0.007	0.002	0.006	NS
Error I	12	4.87	0.40		
Cultivar (C)	3	122.59	40.86	96.935	*
Year x C	3	0.04	0.01	0.03	NS
W x C	9	4.11	0.45	1.08	*
Year x W x C	9	1.94	0.21	0.51	NS
Error II	48	20.23	0.42		

*Significant NS-Non-significant

3(c) Analysis of variance on population of broad leaved weeds (no. m^{-2}) at 60 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.32	0.16	0.74	5.14	NS
Integrated weed management (W)	3	121.70	40.57	184.03	4.76	*
Error I	6	1.32	0.22			
Cultivar (C)	3	50.31	16.77	77.01	3.01	*
W x C	9	4.18	0.46	2.13	2.30	NS
Error II	24	5.23	0.22			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.20	0.10	0.79	5.14	NS
Integrated weed management (W)	3	116.80	38.93	311.62	4.76	*
Error I	6	0.75	0.12			
Cultivar (C)	3	55.68	18.56	60.96	3.01	*
W x C	9	2.09	0.23	0.76	2.30	NS
Error II	24	7.31	0.30			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	1.33	1.33	10.25	*
Rep within year	4	0.52	0.13		
Integrated weed management (W)	3	238.39	79.46	459.37	*
Year x W	3	0.09	0.03	0.17	NS
Error I	12	2.07	0.17		
Cultivar (C)	3	105.79	35.26	135.04	*
Year x C	3	0.18	0.06	0.23	NS
W x C	9	5.40	0.6	2.29	NS
Year x W x C	9	0.87	0.09	0.37	NS
Error II	48	12.53	0.26		

*Significant NS-Non-significant

4(a) Analysis of variance on population of total weed population (no. m^{-2}) at 20 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.10	0.05	0.08	5.14	NS
Integrated weed management (W)	3	197.93	65.98	106.30	4.76	*
Error I	6	3.72	0.62			
Cultivar (C)	3	133.73	44.58	85.29	3.01	*
W x C	9	5.59	0.62	1.19	2.30	NS
Error II	24	12.54	0.52			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.86	0.43	1.57	5.14	NS
Integrated weed management (W)	3	232.95	77.65	283.90	4.76	*
Error I	6	1.64	0.27			
Cultivar (C)	3	127.15	42.38	60.58	3.01	*
W x C	9	6.56	0.73	1.04	2.30	NS
Error II	24	16.79	0.70			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	3.637	3.637	15.104	*
Rep within year	4	0.963	0.241		
Integrated weed management (W)	3	430.053	143.351	321.282	*
Year x W	3	0.867	0.289	0.648	NS
Error I	12	5.354	0.446		
Cultivar (C)	3	260.516	86.839	142.367	*
Year x C	3	0.365	0.122	0.199	NS
W x C	9	10.181	1.131	1.855	NS
Year x W x C	9	1.979	0.22	0.36	NS
Error II	48	29.278	0.61		

*Significant NS-Non-significant

4(b) Analysis of variance on population of broad leaved weeds (no. m^{-2}) at 40 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.09	0.04	0.07	5.14	NS
Integrated weed management (W)	3	370.87	123.62	207.12	4.76	*
Error I	6	3.58	0.60			
Cultivar (C)	3	137.94	45.98	52.53	3.01	*
W x C	9	8.89	0.99	1.13	2.30	NS
Error II	24	21.01	0.88			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.86	0.43	0.72	5.14	NS
Integrated weed management (W)	3	346.82	115.61	192.14	4.76	*
Error I	6	3.61	0.60			
Cultivar (C)	3	123.32	41.11	56.90	3.01	*
W x C	9	6.79	0.75	1.04	2.30	NS
Error II	24	17.34	0.72			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	2.036	2.036	8.5	*
Rep within year	4	0.958	0.24		
Integrated weed management (W)	3	717.533	239.178	398.91	*
Year x W	3	0.207	0.069	0.115	NS
Error I	12	7.195	0.6		
Cultivar (C)	3	260.811	86.937	108.82	*
Year x C	3	0.734	0.245	0.306	NS
W x C	9	13.566	1.507	1.887	NS
Year x W x C	9	2.137	0.237	0.297	NS
Error II	48	38.347	0.799		

*Significant NS-Non-significant

4(c) Analysis of variance on population of broad leaved weeds (no. m^{-2}) at 60 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.29	0.14	0.28	5.14	NS
Integrated weed management (W)	3	510.63	170.21	331.38	4.76	Significant
Error I	6	3.08	0.51			
Cultivar (C)	3	159.45	53.15	64.39	3.01	Significant
W x C	9	6.57	0.73	0.88	2.30	NS
Error II	24	19.81	0.83			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	1.11	0.56	0.34	5.14	NS
Integrated weed management (W)	3	532.79	177.60	109.19	4.76	Significant
Error I	6	9.76	1.63			
Cultivar (C)	3	153.51	51.17	60.02	3.01	Significant
W x C	9	9.28	1.03	1.21	2.30	NS
Error II	24	20.46	0.85			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	4.073	4.073	11.586	*
Rep within year	4	1.406	0.352		
Integrated weed management (W)	3	1,042.52	347.505	324.379	*
Year x W	3	0.685	0.228	0.213	NS
Error I	12	12.856	1.071		
Cultivar (C)	3	311.106	103.702	123.762	*
Year x C	3	1.848	0.616	0.735	NS
W x C	9	8.667	0.963	1.149	NS
Year x W x C	9	7.186	0.798	0.953	NS
Error II	48	40.22	0.838		

*Significant NS-Non-significant

5(a) Analysis of variance on dry weight of grasses (g m^{-2}) at 20 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.03	0.02	0.04	5.14	NS
Integrated weed management (W)	3	29.21	9.74	27.49	4.76	*
Error I	6	2.13	0.35			
Cultivar (C)	3	16.80	5.60	16.12	3.01	*
W x C	9	1.35	0.15	0.43	2.30	NS
Error II	24	8.34	0.35			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.15	0.08	0.24	5.14	NS
Integrated weed management (W)	3	30.99	10.33	33.19	4.76	*
Error I	6	1.87	0.31			
Cultivar (C)	3	11.46	3.82	10.60	3.01	*
W x C	9	1.58	0.18	0.49	2.30	NS
Error II	24	8.65	0.36			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.02	0.02	0.96	NS
Rep within year	4	0.08	0.02		
Integrated weed management (W)	3	60.17	20.05	59.71	*
Year x W	3	0.14	0.04	0.14	NS
Error I	12	4.03	0.33		
Cultivar (C)	3	28.01	9.33	26.58	*
Year x C	3	0.77	0.25	0.73	NS
W x C	9	1.35	0.15	0.42	NS
Year x W x C	9	1.17	0.13	0.37	NS
Error II	48	16.86	0.35		

*Significant NS-Non-significant

5(b) Analysis of variance on dry weight of grasses (g m^{-2}) at 40 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.45	0.22	0.37	5.14	NS
Integrated weed management (W)	3	44.72	14.91	24.93	4.76	*
Error I	6	3.59	0.60			
Cultivar (C)	3	18.64	6.21	7.23	3.01	*
W x C	9	1.00	0.11	0.13	2.30	NS
Error II	24	20.63	0.86			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.98	0.49	2.09	5.14	NS
Integrated weed management (W)	3	47.55	15.85	67.81	4.76	*
Error I	6	1.40	0.23			
Cultivar (C)	3	24.58	8.19	25.52	3.01	*
W x C	9	4.57	0.51	1.58	2.30	NS
Error II	24	7.70	0.32			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.01	0.01	0.04	NS
Rep within year	4	1.204	0.30		
Integrated weed management (W)	3	90.72	30.24	79.42	*
Year x W	3	0.21	0.07	0.18	NS
Error I	12	4.56	0.38		
Cultivar (C)	3	42.09	14.03	25.93	*
Year x C	3	1.37	0.46	0.84	NS
W x C	9	3.29	0.36	0.67	NS
Year x W x C	9	1.12	0.12	0.23	NS
Error II	48	25.97	0.54		

*Significant NS-Non-significant

5(c) Analysis of variance on dry weight of grasses (g m^{-2}) at 60 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	1.25	0.62	0.49	5.14	NS
Integrated weed management (W)	3	619.98	206.66	161.59	4.76	*
Error I	6	7.67	1.28			
Cultivar (C)	3	120.51	40.17	24.04	3.01	*
W x C	9	13.43	1.49	0.89	2.30	NS
Error II	24	40.10	1.67			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	1.11	0.56	0.34	5.14	NS
Integrated weed management (W)	3	532.79	177.60	109.19	4.76	*
Error I	6	9.76	1.63			
Cultivar (C)	3	153.51	51.17	60.02	3.01	*
W x C	9	9.28	1.03	1.21	2.30	NS
Error II	24	20.46	0.85			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.27	0.27	0.38	NS
Rep within year	4	2.91	0.72		
Integrated weed management (W)	3	1,234.71	411.57	175.9	*
Year x W	3	0.091	0.03	0.01	NS
Error I	12	28.07	2.34		
Cultivar (C)	3	184.29	61.43	37.21	*
Year x C	3	1.02	0.34	0.20	NS
W x C	9	18.927	2.10	1.27	NS
Year x W x C	9	15.99	1.77	1.07	NS
Error II	48	79.22	1.65		

*Significant NS-Non-significant

6(a) Analysis of variance on dry weight of sedges (g m^{-2}) at 20 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.05	0.03	0.76	5.14	NS
Integrated weed management (W)	3	4.47	1.49	45.17	4.76	*
Error I	6	0.20	0.03			
Cultivar (C)	3	2.43	0.81	10.03	3.01	*
W x C	9	0.31	0.03	0.43	2.30	NS
Error II	24	1.94	0.08			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.15	0.08	3.22	5.14	NS
Integrated weed management (W)	3	4.59	1.53	65.60	4.76	Significant
Error I	6	0.14	0.02			
Cultivar (C)	3	2.27	0.76	12.43	3.01	Significant
W x C	9	0.23	0.03	0.42	2.30	NS
Error II	24	1.46	0.06			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.006	0.006	0.38	NS
Rep within year	4	0.06	0.01		
Integrated weed management (W)	3	8.98	2.99	46.49	*
Year x W	3	0.011	0.004	0.05	NS
Error I	12	0.77	0.06		
Cultivar (C)	3	4.64	1.54	23.20	*
Year x C	3	0.009	0.003	0.04	NS
W x C	9	0.46	0.05	0.77	NS
Year x W x C	9	0.12	0.01	0.21	NS
Error II	48	3.20	0.06		

*Significant NS-Non-significant

6(b) Analysis of variance on dry weight of sedges (g m^{-2}) at 40 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.06	0.03	0.28	5.14	NS
Integrated weed management (W)	3	74.75	24.92	224.93	4.76	*
Error I	6	0.66	0.11			
Cultivar (C)	3	15.28	5.09	13.53	3.01	*
W x C	9	1.08	0.12	0.32	2.30	NS
Error II	24	9.04	0.38			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.11	0.06	0.15	5.14	NS
Integrated weed management (W)	3	65.97	21.99	61.02	4.76	*
Error I	6	2.16	0.36			
Cultivar (C)	3	8.49	2.83	5.80	3.01	*
W x C	9	0.87	0.10	0.20	2.30	NS
Error II	24	11.71	0.49			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.05	0.05	0.55	NS
Rep within year	4	0.35	0.08		
Integrated weed management (W)	3	140.48	46.82	211.37	*
Year x W	3	0.30	0.10	0.46	NS
Error I	12	2.65	0.22		
Cultivar (C)	3	23.24	7.75	17.90	*
Year x C	3	0.25	0.08	0.19	NS
W x C	9	1.67	0.186	0.42	NS
Year x W x C	9	0.54	0.06	0.14	NS
Error II	48	20.77	0.43		

*Significant   NS-Non-significant

6(c) Analysis of variance on dry weight of sedges (g m^{-2}) at 60 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.03	0.01	0.32	5.14	NS
Integrated weed management (W)	3	64.22	21.41	463.54	4.76	*
Error I	6	0.28	0.05			
Cultivar (C)	3	6.09	2.03	7.90	3.01	*
W x C	9	1.64	0.18	0.71	2.30	NS
Error II	24	6.16	0.26			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.23	0.11	1.11	5.14	NS
Integrated weed management (W)	3	73.99	24.66	240.84	4.76	*
Error I	6	0.61	0.10			
Cultivar (C)	3	6.68	2.23	12.32	3.01	*
W x C	9	0.92	0.10	0.56	2.30	NS
Error II	24	4.34	0.18			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.02	0.02	0.40	NS
Rep within year	4	0.23	0.06		
Integrated weed management (W)	3	137.48	45.83	627.90	*
Year x W	3	0.11	0.03	0.53	NS
Error I	12	0.87	0.073		
Cultivar (C)	3	12.65	4.21	22.085	*
Year x C	3	0.11	0.03	0.197	NS
W x C	9	1.75	0.19	1.02	NS
Year x W x C	9	0.69	0.07	0.40	NS
Error II	48	9.16	0.19		

*Significant NS-Non-significant

7(a) Analysis of variance on broad leaved weeds (g m^{-2}) at 20 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.06	0.03	1.25	5.14	NS
Integrated weed management (W)	3	7.28	2.43	103.48	4.76	*
Error I	6	0.14	0.02			
Cultivar (C)	3	7.29	2.43	34.47	3.01	*
W x C	9	0.39	0.04	0.62	2.30	NS
Error II	24	1.69	0.07			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.05	0.02	0.51	5.14	NS
Integrated weed management (W)	3	8.94	2.98	65.22	4.76	*
Error I	6	0.27	0.05			
Cultivar (C)	3	8.31	2.77	49.61	3.01	*
W x C	9	0.44	0.05	0.87	2.30	NS
Error II	24	1.34	0.06			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.01	0.01	1.62	NS
Rep within year	4	0.04	0.01		
Integrated weed management (W)	3	16.167	5.38	111.56	*
Year x W	3	0.01	0.006	0.12	NS
Error I	12	0.58	0.04		
Cultivar (C)	3	15.35	5.11	85.27	*
Year x C	3	0.03	0.01	0.17	NS
W x C	9	0.75	0.08	1.39	NS
Year x W x C	9	0.09	0.01	0.16	NS
Error II	48	2.88	0.06		

*Significant   NS-Non-significant

7(b) Analysis of variance on broad leaved weeds (g m^{-2}) at 40 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.06	0.03	0.09	5.14	NS
Integrated weed management (W)	3	78.35	26.12	75.45	4.76	*
Error I	6	2.08	0.35			
Cultivar (C)	3	37.36	12.45	55.92	3.01	*
W x C	9	3.44	0.38	1.72	2.30	NS
Error II	24	5.35	0.22			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.25	0.12	0.62	5.14	NS
Integrated weed management (W)	3	83.67	27.89	139.81	4.76	*
Error I	6	1.20	0.20			
Cultivar (C)	3	44.40	14.80	45.21	3.01	*
W x C	9	1.03	0.11	0.35	2.30	NS
Error II	24	7.86	0.33			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.14	0.14	4.10	NS
Rep within year	4	0.14	0.03		
Integrated weed management (W)	3	161.76	53.92	233.27	*
Year x W	3	0.41	0.13	0.60	NS
Error I	12	2.77	0.23		
Cultivar (C)	3	81.43	27.14	126.08	*
Year x C	3	0.47	0.15	0.73	NS
W x C	9	2.12	0.23	1.09	NS
Year x W x C	9	1.21	0.13	0.62	NS
Error II	48	10.33	0.21		

*Significant NS-Non-significant

7(c) Analysis of variance on broad leaved weeds (g m^{-2}) at 60 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.46	0.23	0.68	5.14	NS
Integrated weed management (W)	3	133.52	44.51	132.70	4.76	*
Error I	6	2.01	0.34			
Cultivar (C)	3	36.38	12.13	41.30	3.01	*
W x C	9	3.19	0.35	1.21	2.30	NS
Error II	24	7.05	0.29			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.53	0.27	0.70	5.14	NS
Integrated weed management (W)	3	128.78	42.93	112.21	4.76	*
Error I	6	2.30	0.38			
Cultivar (C)	3	39.46	13.15	33.97	3.01	*
W x C	9	2.43	0.27	0.70	2.30	NS
Error II	24	9.29	0.39			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.42	0.42	8.41	*
Rep within year	4	0.20	0.05		
Integrated weed management (W)	3	261.90	87.30	305.41	*
Year x W	3	0.57	0.19	0.67	NS
Error I	12	3.43	0.28		
Cultivar (C)	3	76.19	25.39	97.79	*
Year x C	3	0.36	0.12	0.46	NS
W x C	9	3.57	0.39	1.52	NS
Year x W x C	9	1.53	0.17	0.65	NS
Error II	48	12.46	0.26		

*Significant NS-Non-significant

8(a) Analysis of variance on total dry weight (g m^{-2}) at 20 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.00	0.00	0.00	5.14	NS
Integrated weed management (W)	3	42.82	14.27	45.10	4.76	*
Error I	6	1.90	0.32			
Cultivar (C)	3	27.57	9.19	33.57	3.01	*
W x C	9	1.54	0.17	0.63	2.30	NS
Error II	24	6.57	0.27			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.10	0.05	0.24	5.14	NS
Integrated weed management (W)	3	46.18	15.39	76.01	4.76	*
Error I	6	1.22	0.20			
Cultivar (C)	3	21.55	7.18	23.48	3.01	*
W x C	9	1.70	0.19	0.62	2.30	NS
Error II	24	7.34	0.31			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.26	0.26	10.61	*
Rep within year	4	0.1	0.025		
Integrated weed management (W)	3	88.92	29.64	113.93	*
Year x W	3	0.05	0.01	0.06	NS
Error I	12	3.12	0.26		
Cultivar (C)	3	48.92	16.30	56.28	*
Year x C	3	0.19	0.06	0.22	NS
W x C	9	1.98	0.22	0.76	NS
Year x W x C	9	1.25	0.13	0.48	NS
Error II	48	13.90	0.29		

*Significant   NS-Non-significant

7(b) Analysis of variance on total dry weight (g m^{-2}) at 40 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.14	0.07	0.16	5.14	NS
Integrated weed management (W)	3	187.82	62.61	136.44	4.76	*
Error I	6	2.75	0.46			
Cultivar (C)	3	66.01	22.00	45.41	3.01	*
W x C	9	2.49	0.28	0.57	2.30	NS
Error II	24	11.63	0.48			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.55	0.27	0.73	5.14	NS
Integrated weed management (W)	3	186.94	62.31	166.51	4.76	*
Error I	6	2.25	0.37			
Cultivar (C)	3	70.88	23.63	61.70	3.01	*
W x C	9	2.67	0.30	0.77	2.30	NS
Error II	24	9.19	0.38			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.68	0.68	4.00	NS
Rep within year	4	0.68	0.17		
Integrated weed management (W)	3	374.65	124.88	300.08	*
Year x W	3	0.08	0.02	0.06	NS
Error I	12	4.99	0.41		
Cultivar (C)	3	136.65	45.55	105.26	*
Year x C	3	0.25	0.08	0.19	NS
W x C	9	3.76	0.41	0.96	NS
Year x W x C	9	1.42	0.15	0.36	NS
Error II	48	20.77	0.43		

*Significant NS-Non-significant

7(c) Analysis of variance on total dry weight (g m^{-2}) at 60 DAS as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.06	0.03	0.05	5.14	NS
Integrated weed management (W)	3	721.82	240.61	366.51	4.76	*
Error I	6	3.94	0.66			
Cultivar (C)	3	137.77	45.92	78.18	3.01	*
W x C	9	4.53	0.50	0.86	2.30	NS
Error II	24	14.10	0.59			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	1.07	0.53	0.41	5.14	NS
Integrated weed management (W)	3	750.06	250.02	193.26	4.76	*
Error I	6	7.76	1.29			
Cultivar (C)	3	104.99	35.00	45.25	3.01	*
W x C	9	8.74	0.97	1.25	2.30	NS
Error II	24	18.56	0.77			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.98	0.98	3.48	NS
Rep within year	4	1.12	0.28		
Integrated weed management (W)	3	1,471.04	490.34	504.49	*
Year x W	3	0.78	0.26	0.26	NS
Error I	12	11.66	0.97		
Cultivar (C)	3	240.59	80.19	117.93	*
Year x C	3	2.13	0.71	1.04	NS
W x C	9	4.86	0.54	0.79	NS
Year x W x C	9	8.44	0.93	1.38	NS
Error II	48	32.64	0.68		

*Significant NS-Non-significant

APPENDIX- VI
ANOVA for soil parameters

1. Analysis of variance on soil pH as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.00	0.00	0.05	5.14	NS
Integrated weed management (W)	3	0.04	0.01	0.25	4.76	NS
Error I	6	0.29	0.05			
Cultivar (C)	3	0.06	0.02	0.55	3.01	NS
W x C	9	0.11	0.01	0.31	2.30	NS
Error II	24	0.93	0.04			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.01	0.01	0.14	5.14	NS
Integrated weed management (W)	3	0.02	0.01	0.14	4.76	NS
Error I	6	0.27	0.05			
Cultivar (C)	3	0.02	0.01	0.70	3.01	NS
W x C	9	0.16	0.02	1.54	2.30	NS
Error II	24	0.28	0.01			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.18	0.18	42.13	*
Rep within year	4	0.01	0.004		
Integrated weed management (W)	3	0.002	0.001	0.014	NS
Year x W	3	0.05	0.01	0.37	NS
Error I	12	0.56	0.04		
Cultivar (C)	3	0.02	0.008	0.31	NS
Year x C	3	0.06	0.02	0.86	NS
W x C	9	0.16	0.018	0.73	NS
Year x W x C	9	0.10	0.012	0.45	NS
Error II	48	1.20	0.02		

*Significant NS-Non significant

2. Analysis of variance on organic carbon (%) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.00	0.00	0.03	5.14	NS
Integrated weed management (W)	3	0.02	0.01	0.34	4.76	NS
Error I	6	0.14	0.02			
Cultivar (C)	3	0.04	0.01	0.68	3.01	NS
W x C	9	0.22	0.02	1.34	2.30	NS
Error II	24	0.43	0.02			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.01	0.00	1.79	5.14	NS
Integrated weed management (W)	3	0.03	0.01	4.75	4.76	NS
Error I	6	0.01	0.00			
Cultivar (C)	3	0.01	0.00	0.48	3.01	NS
W x C	9	0.09	0.01	1.66	2.30	NS
Error II	24	0.14	0.01			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.007	0.007	3.18	NS
Rep within year	4	0.008	0.002		
Integrated weed management (W)	3	0.05	0.017	1.35	NS
Year x W	3	0.002	0.001	0.04	NS
Error I	12	0.14	0.012		
Cultivar (C)	3	0.01	0.003	0.28	NS
Year x C	3	0.03	0.012	0.98	NS
W x C	9	0.21	0.024	2.05	NS
Year x W x C	9	0.08	0.009	0.78	NS
Error II	48	0.56	0.012		

*Significant NS-Non-significant

3. Analysis of variance on soil EC (dsm^{-1}) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.00	0.00	0.05	5.14	NS
Integrated weed management (W)	3	0.04	0.01	0.25	4.76	NS
Error I	6	0.29	0.05			
Cultivar (C)	3	0.06	0.02	0.55	3.01	NS
W x C	9	0.11	0.01	0.31	2.30	NS
Error II	24	0.93	0.04			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.01	0.01	0.14	5.14	NS
Integrated weed management (W)	3	0.02	0.01	0.14	4.76	NS
Error I	6	0.27	0.05			
Cultivar (C)	3	0.02	0.01	0.70	3.01	NS
W x C	9	0.16	0.02	1.54	2.30	NS
Error II	24	0.28	0.01			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.001	0.001	24.81	*
Rep within year	4	0	0		
Integrated weed management (W)	3	0.026	0.009	3.76	*
Year x W	3	0	0	0.03	NS
Error I	12	0.028	0.002		
Cultivar (C)	3	0.003	0.001	0.48	NS
Year x C	3	0.003	0.001	0.47	NS
W x C	9	0.008	0.001	0.44	NS
Year x W x C	9	0.016	0.002	0.84	NS
Error II	48	0.101	0.002		

*Significant   NS-Non-significant

4. Analysis of variance on available nitrogen (kg ha^{-1}) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	1.09	0.55	0.00	5.14	NS
Integrated weed management (W)	3	563.34	187.78	0.74	4.76	NS
Error I	6	1520.78	253.46			
Cultivar (C)	3	695.56	231.85	1.10	3.01	NS
W x C	9	3264.44	362.72	1.73	2.30	NS
Error II	24	5040.37	210.02			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	1.37	0.69	0.00	5.14	NS
Integrated weed management (W)	3	594.71	198.24	0.47	4.76	NS
Error I	6	2546.76	424.46			
Cultivar (C)	3	422.94	140.98	0.83	3.01	NS
W x C	9	2888.91	320.99	1.89	2.30	NS
Error II	24	4079.17	169.97			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1.0	43.2	43.2	55.2	*
Rep within year	4.0	3.1	0.8		
Integrated weed management (W)	3.0	1134.3	378.1	1.1	NS
Year x W	3.0	23.1	7.7	0.0	NS
Error I	12.0	4067.1	338.9		
Cultivar (C)	3.0	626.4	208.8	1.1	NS
Year x C	3.0	491.4	163.8	0.9	NS
W x C	9.0	3796.3	421.8	2.2	NS
Year x W x C	9.0	2357.6	262.0	1.4	NS
Error II	48.0	9120.9	190.0		

*Significant NS-Non-significant

5. Analysis of variance on available phosphorous (kg ha^{-1}) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.41	0.20	0.10	5.14	NS
Integrated weed management (W)	3	7.41	2.47	1.27	4.76	NS
Error I	6	11.67	1.95			
Cultivar (C)	3	17.48	5.83	2.90	3.01	NS
W x C	9	9.44	1.05	0.52	2.30	NS
Error II	24	48.26	2.01			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	1.37	0.69	0.00	5.14	NS
Integrated weed management (W)	3	594.71	198.24	0.47	4.76	NS
Error I	6	2546.76	424.46			
Cultivar (C)	3	422.94	140.98	0.83	3.01	NS
W x C	9	2888.91	320.99	1.89	2.30	NS
Error II	24	4079.17	169.97			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	2.6	2.6	16.14	*
Rep within year	4	0.64	0.16		
Integrated weed management (W)	3	9.02	3.00	1.94	NS
Year x W	3	0.84	0.28	0.18	NS
Error I	12	18.52	1.54		
Cultivar (C)	3	11.21	3.73	1.68	NS
Year x C	3	6.60	2.20	0.99	NS
W x C	9	4.79	0.53	0.24	NS
Year x W x C	9	8.17	0.90	0.41	NS
Error II	48	106.49	2.21		

*Significant NS-Non-significant

6. Analysis of variance on available potassium (kg ha^{-1}) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	30.59	15.29	0.09	5.14	NS
Integrated weed management (W)	3	384.76	128.25	0.77	4.76	NS
Error I	6	997.32	166.22			
Cultivar (C)	3	21.23	7.08	0.06	3.01	NS
W x C	9	1282.56	142.51	1.20	2.30	NS
Error II	24	2848.96	118.71			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	592.93	296.46	5.06	5.14	NS
Integrated weed management (W)	3	653.46	217.82	3.71	4.76	NS
Error I	6	351.85	58.64			
Cultivar (C)	3	64.82	21.61	0.20	3.01	NS
W x C	9	498.53	55.39	0.50	2.30	NS
Error II	24	2655.29	110.64			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	170.6	170.6	1.1	NS
Rep within year	4	623.3	155.8		
Integrated weed management (W)	3	739.4	246.5	2.2	NS
Year x W	3	299.1	99.7	0.9	NS
Error I	12	1349.3	112.4		
Cultivar (C)	3	33.2	11.1	0.1	NS
Year x C	3	52.7	17.6	0.2	NS
W x C	9	754.8	83.9	0.7	NS
Year x W x C	9	1026.5	114.1	1.0	NS
Error II	48	5504.6	114.7		

*Significant NS-Non-significant

APPENDIX-VII

ANOVA for plant analysis

1. Analysis of variance on nitrogen content (%) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.003	0.002	0.62	5.14	NS
Integrated weed management (W)	3	0.466	0.155	56.11	4.75	*
Error I	6	0.017	0.003			
Cultivar (C)	3	0.006	0.002	0.73	3.00	NS
W x C	9	0.026	0.003	1.02	2.30	NS
Error II	24	0.067	0.003			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.004	0.002	0.414	5.14	NS
Integrated weed management (W)	3	0.415	0.138	31.50	4.75	*
Error I	6	0.026	0.004			
Cultivar (C)	3	0.013	0.004	2.40	3.00	NS
W x C	9	0.022	0.002	1.36	2.30	NS
Error II	24	0.042	0.002			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.004	0.004	2.11	NS
Rep within year	4	0.007	0.002		
Integrated weed management (W)	3	0.88	0.293	82	*
Year x W	3	0.001	0	0.07	NS
Error I	12	0.043	0.004		
Cultivar (C)	3	0.018	0.006	2.61	NS
Year x C	3	0.001	0	0.15	NS
W x C	9	0.024	0.003	1.15	NS
Year x W x C	9	0.024	0.003	1.15	NS
Error II	48	0.109	0.002		

*Significant NS-Non-significant

2. Analysis of variance on phosphorous content (%) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.003	0.002	0.62	5.14	NS
Integrated weed management (W)	3	0.466	0.155	56.11	4.75	*
Error I	6	0.017	0.003			
Cultivar (C)	3	0.006	0.002	0.73	3.00	NS
W x C	9	0.026	0.003	1.02	2.30	NS
Error II	24	0.067	0.003			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.004	0.002	0.41	5.14	NS
Integrated weed management (W)	3	0.415	0.138	31.50	4.75	*
Error I	6	0.026	0.004			
Cultivar (C)	3	0.013	0.004	2.40	3.00	NS
W x C	9	0.022	0.002	1.36	2.30	NS
Error II	24	0.042	0.002			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0	0	-0.028	*
Rep within year	4	0	0		
Integrated weed management (W)	3	0.63	0.21	810.08	*
Year x W	3	0.002	0.001	2.69	NS
Error I	12	0.003	0		
Cultivar (C)	3	0.017	0.006	40.83	*
Year x C	3	0	0	0.09	NS
W x C	9	0.001	0	0.79	NS
Year x W x C	9	0.001	0	0.43	NS
Error II	48	0.007	0		

*Significant NS-Non-significant

3. Analysis of variance on potassium content (%) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.00	0.00	0.68	5.14	NS
Integrated weed management (W)	3	6.36	2.12	770.39	4.76	*
Error I	6	0.02	0.00			
Cultivar (C)	3	0.04	0.01	9.81	3.01	*
W x C	9	0.01	0.00	0.41	2.30	NS
Error II	24	0.03	0.00			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.00	0.00	0.84	5.14	NS
Integrated weed management (W)	3	6.39	2.13	944.48	4.76	*
Error I	6	0.01	0.00			
Cultivar (C)	3	0.04	0.01	8.28	3.01	*
W x C	9	0.00	0.00	0.18	2.30	NS
Error II	24	0.03	0.00			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0	0	0.051	NS
Rep within year	4	0.008	0.002		
Integrated weed management (W)	3	12.75	4.25	1,697.15	*
Year x W	3	0	0	0.03	NS
Error I	12	0.03	0.003		
Cultivar (C)	3	0.075	0.025	17.401	*
Year x C	3	0.003	0.001	0.684	NS
W x C	9	0.006	0.001	0.46	NS
Year x W x C	9	0.002	0	0.129	NS
Error II	48	0.069	0.001		

*Significant   NS-Non-significant

4. Analysis of variance on nitrogen depletion (kg ha^{-1}) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.29	0.15	0.03	5.14	NS
Integrated weed management (W)	3	4674.34	1558.11	368.16	4.76	*
Error I	6	25.39	4.23			
Cultivar (C)	3	436.31	145.44	39.63	3.01	*
W x C	9	89.34	9.93	2.70	2.30	*
Error II	24	88.08	3.67			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	1.30	0.65	0.04	5.14	NS
Integrated weed management (W)	3	4810.62	1603.54	104.77	4.76	*
Error I	6	91.84	15.31			
Cultivar (C)	3	396.85	132.28	17.63	3.01	*
W x C	9	227.56	25.28	3.37	2.30	*
Error II	24	180.05	7.50			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.148	0.148	0.371	NS
Rep within year	4	1.596	0.399		
Integrated weed management (W)	3	9,484.34	3,161.45	323.528	*
Year x W	3	1.133	0.378	0.039	NS
Error I	12	117.261	9.772		
Cultivar (C)	3	817.506	272.502	48.768	*
Year x C	3	15.714	5.238	0.937	NS
W x C	9	243.158	27.018	4.835	*
Year x W x C	9	73.65	8.183	1.465	NS
Error II	48	268.21	5.588		

*Significant NS-Non-significant

5. Analysis of variance on phosphorous depletion (kg ha^{-1}) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.88	0.44	0.57	5.14	NS
Integrated weed management (W)	3	2400.48	800.16	1028.52	4.76	*
Error I	6	4.67	0.78			
Cultivar (C)	3	183.55	61.18	98.93	3.01	*
W x C	9	56.86	6.32	10.22	2.30	*
Error II	24	14.84	0.62			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	1.68	0.84	0.36	5.14	NS
Integrated weed management (W)	3	2528.53	842.84	360.05	4.76	*
Error I	6	14.05	2.34			
Cultivar (C)	3	157.40	52.47	22.32	3.01	*
W x C	9	101.37	11.26	4.79	2.30	*
Error II	24	56.42	2.35			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.26	0.26	0.41	NS
Rep within year	4	2.54	0.63		
Integrated weed management (W)	3	4,928.67	1,642.89	1,051.66	*
Year x W	3	1.10	0.36	0.23	NS
Error I	12	18.74	1.56		
Cultivar (C)	3	335.93	111.97	75.39	*
Year x C	3	5.17	1.72	1.16	NS
W x C	9	141.16	15.68	10.56	*
Year x W x C	9	17.06	1.89	1.27	NS
Error II	48	71.29	1.48		

*Significant NS-Non-significant

6. Analysis of variance on potassium depletion (kg ha^{-1}) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	14.74	7.37	0.92	5.14	NS
Integrated weed management (W)	3	17797.59	5932.53	743.54	4.76	*
Error I	6	47.87	7.98			
Cultivar (C)	3	1456.21	485.40	98.85	3.01	*
W x C	9	432.48	48.05	9.79	2.30	*
Error II	24	117.85	4.91			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	4.07	2.03	0.07	5.14	NS
Integrated weed management (W)	3	17843.75	5947.92	218.66	4.76	*
Error I	6	163.21	27.20			
Cultivar (C)	3	1222.15	407.38	26.33	3.01	*
W x C	9	734.45	81.61	5.27	2.30	*
Error II	24	371.37	15.47			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	3.77	3.77	0.80	NS
Rep within year	4	18.76	4.69		
Integrated weed management (W)	3	35,640.38	11,880.13	675.39	*
Year x W	3	1.12	0.37	0.02	NS
Error I	12	211.07	17.59		
Cultivar (C)	3	2,658.03	886.00	86.94	*
Year x C	3	20.27	6.75	0.66	NS
W x C	9	1,067.37	118.59	11.63	*
Year x W x C	9	99.73	11.08	1.08	NS
Error II	48	489.14	10.19		

*Significant NS-Non-significant

7. Analysis of variance on nitrogen content in grain (%) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.005	0.002	0.88	5.14	NS
Integrated weed management (W)	3	0.212	0.071	26.51	4.75	*
Error I	6	0.016	0.003			
Cultivar (C)	3	0.006	0.002	0.62	3.00	NS
W x C	9	0.029	0.003	1.01	2.30	NS
Error II	24	0.076	0.003			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.002	0.001	0.28	5.14	NS
Integrated weed management (W)	3	0.283	0.094	27.71	4.75	*
Error I	6	0.020	0.003			
Cultivar (C)	3	0.015	0.005	2.17	3.00	NS
W x C	9	0.016	0.002	0.73	2.30	NS
Error II	24	0.057	0.002			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.009	0.009	5.56	NS
Rep within year	4	0.007	0.002		
Integrated weed management (W)	3	0.491	0.164	53.89	*
Year x W	3	0.003	0.001	0.37	NS
Error I	12	0.036	0.003		
Cultivar (C)	3	0.016	0.005	1.94	NS
Year x C	3	0.005	0.002	0.63	NS
W x C	9	0.025	0.003	0.99	NS
Year x W x C	9	0.02	0.002	0.78	NS
Error II	48	0.133	0.003		

*Significant NS-Non-significant

8. Analysis of variance on nitrogen content in straw (%) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.000	0.000	0.06	5.14	NS
Integrated weed management (W)	3	0.093	0.031	7.85	4.76	*
Error I	6	0.024	0.004			
Cultivar (C)	3	0.127	0.042	28.58	3.01	*
W x C	9	0.030	0.003	2.27	2.30	NS
Error II	24	0.036	0.001			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.007	0.004	0.92	5.14	NS
Integrated weed management (W)	3	0.078	0.026	6.73	4.76	*
Error I	6	0.023	0.004			
Cultivar (C)	3	0.130	0.043	19.37	3.01	*
W x C	9	0.017	0.002	0.84	2.30	NS
Error II	24	0.054	0.002			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.005	0.005	2.836	NS
Rep within year	4	0.008	0.002		
Integrated weed management (W)	3	0.171	0.057	14.505	*
Year x W	3	0.001	0	0.086	NS
Error I	12	0.047	0.004		
Cultivar (C)	3	0.257	0.086	45.988	*
Year x C	3	0	0	0.085	NS
W x C	9	0.043	0.005	2.543	NS
Year x W x C	9	0.005	0.001	0.27	NS
Error II	48	0.09	0.002		

*Significant   NS-Non-significant

9. Analysis of variance on phosphorous content in grain (%) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.000	0.000	0.68	5.14	NS
Integrated weed management (W)	3	0.004	0.001	16.65	4.76	*
Error I	6	0.000	0.000			
Cultivar (C)	3	0.003	0.001	6.53	3.01	*
W x C	9	0.000	0.000	0.25	2.30	NS
Error II	24	0.004	0.000			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.000	0.000	0.59	5.14	NS
Integrated weed management (W)	3	0.004	0.001	15.80	4.76	*
Error I	6	0.000	0.000			
Cultivar (C)	3	0.005	0.002	9.87	3.01	*
W x C	9	0.001	0.000	0.65	2.30	NS
Error II	24	0.004	0.000			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.001	0.001	13.38	*
Rep within year	4	0	0		
Integrated weed management (W)	3	0.007	0.002	32.09	*
Year x W	3	0	0	0.47	NS
Error I	12	0.001	0		
Cultivar (C)	3	0.008	0.003	16.139	*
Year x C	3	0	0	0.25	NS
W x C	9	0.001	0	0.66	NS
Year x W x C	9	0	0	0.22	NS
Error II	48	0.008	0		

*Significant NS-Non-significant

10. Analysis of variance on phosphorous content in straw (%) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.002	0.001	0.97	5.14	NS
Integrated weed management (W)	3	0.002	0.001	0.60	4.76	NS
Error I	6	0.005	0.001			
Cultivar (C)	3	0.000	0.000	0.26	3.01	NS
W x C	9	0.001	0.000	0.19	2.30	NS
Error II	24	0.013	0.001			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.001	0.001	2.70	5.14	NS
Integrated weed management (W)	3	0.003	0.001	3.97	4.76	NS
Error I	6	0.001	0.000			
Cultivar (C)	3	0.001	0.000	0.62	3.01	NS
W x C	9	0.002	0.000	0.47	2.30	NS
Error II	24	0.010	0.000			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0	0	0.12	NS
Rep within year	4	0.003	0.001		
Integrated weed management (W)	3	0.004	0.001	2.435	NS
Year x W	3	0	0	0.10	NS
Error I	12	0.006	0.001		
Cultivar (C)	3	0.001	0	0.45	NS
Year x C	3	0.001	0	0.38	NS
W x C	9	0.002	0	0.39	NS
Year x W x C	9	0.001	0	0.23	NS
Error II	48	0.023	0		

*Significant NS-Non-significant

11. Analysis of variance on potassium content in grain (%) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.000	0.000	0.04	5.14	NS
Integrated weed management (W)	3	0.005	0.002	31.61	4.76	*
Error I	6	0.000	0.000			
Cultivar (C)	3	0.001	0.000	2.05	3.01	NS
W x C	9	0.001	0.000	0.25	2.30	NS
Error II	24	0.006	0.000			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.000	0.000	0.15	5.14	NS
Integrated weed management (W)	3	0.006	0.002	33.25	4.76	*
Error I	6	0.000	0.000			
Cultivar (C)	3	0.001	0.000	2.64	3.01	NS
W x C	9	0.001	0.000	0.54	2.30	NS
Error II	24	0.004	0.000			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0	0	6.963	NS
Rep within year	4	0	0		
Integrated weed management (W)	3	0.011	0.004	64.603	*
Year x W	3	0	0	0.033	NS
Error I	12	0.001	0		
Cultivar (C)	3	0.003	0.001	4.57	*
Year x C	3	0	0	0.009	NS
W x C	9	0.001	0	0.534	NS
Year x W x C	9	0	0	0.204	NS
Error II	48	0.009	0		

*Significant NS-Non-significant

12. Analysis of variance on potassium content in straw (%) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.000	0.000	0.09	5.14	NS
Integrated weed management (W)	3	0.004	0.001	12.06	4.76	*
Error I	6	0.001	0.000			
Cultivar (C)	3	0.000	0.000	0.07	3.01	NS
W x C	9	0.002	0.000	0.89	2.30	NS
Error II	24	0.005	0.000			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.000	0.000	0.12	5.14	NS
Integrated weed management (W)	3	0.004	0.001	23.60	4.76	*
Error I	6	0.000	0.000			
Cultivar (C)	3	0.001	0.000	1.60	3.01	NS
W x C	9	0.000	0.000	0.30	2.30	NS
Error II	24	0.003	0.000			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0	0	-24.86	*
Rep within year	4	0	0		
Integrated weed management (W)	3	0.007	0.002	30.54	*
Year x W	3	0	0	0.03	NS
Error I	12	0.001	0		
Cultivar (C)	3	0	0	0.59	NS
Year x C	3	0	0	0.65	NS
W x C	9	0.001	0	0.62	NS
Year x W x C	9	0.001	0	0.73	NS
Error II	48	0.008	0		

*Significant NS-Non-significant

13. Analysis of variance on nitrogen uptake in grain (kg ha^{-1}) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.05	0.02	0.00	5.14	NS
Integrated weed management (W)	3	1779.86	593.29	122.76	4.76	*
Error I	6	29.00	4.83			
Cultivar (C)	3	49.03	16.34	9.09	3.01	*
W x C	9	7.97	0.89	0.49	2.30	NS
Error II	24	43.16	1.80			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.84	0.42	0.14	5.14	NS
Integrated weed management (W)	3	1869.57	623.19	204.10	4.76	*
Error I	6	18.32	3.05			
Cultivar (C)	3	68.34	22.78	11.96	3.01	*
W x C	9	3.53	0.39	0.21	2.30	NS
Error II	24	45.70	1.90			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	5.027	5.027	22.59	*
Rep within year	4	0.89	0.223		
Integrated weed management (W)	3	3,649.10	1,216.37	308.396	*
Year x W	3	0.663	0.221	0.056	NS
Error I	12	47.33	3.944		
Cultivar (C)	3	116.072	38.691	20.929	*
Year x C	3	1.162	0.387	0.209	NS
W x C	9	8.195	0.911	0.493	NS
Year x W x C	9	3.349	0.372	0.201	NS
Error II	48	88.738	1.849		

*Significant NS-Non-significant

14. Analysis of variance on nitrogen uptake in straw (kg ha^{-1}) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.32	0.16	0.03	5.14	NS
Integrated weed management (W)	3	986.38	328.79	52.26	4.76	*
Error I	6	37.75	6.29			
Cultivar (C)	3	271.60	90.53	23.61	3.01	*
W x C	9	32.74	3.64	0.95	2.30	NS
Error II	24	92.05	3.84			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	6.42	3.21	0.35	5.14	NS
Integrated weed management (W)	3	980.88	326.96	35.76	4.76	*
Error I	6	54.86	9.14			
Cultivar (C)	3	302.35	100.78	23.19	3.01	*
W x C	9	27.27	3.03	0.70	2.30	NS
Error II	24	104.31	4.35			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	24.301	24.301	14.452	*
Rep within year	4	6.726	1.681		
Integrated weed management (W)	3	1,965.27	655.09	84.869	*
Year x W	3	2.149	0.716	0.093	NS
Error I	12	92.626	7.719		
Cultivar (C)	3	573.666	191.222	46.743	*
Year x C	3	0.544	0.181	0.044	NS
W x C	9	52.979	5.887	1.439	NS
Year x W x C	9	6.992	0.777	0.19	NS
Error II	48	196.36	4.091		

*Significant NS-Non-significant

15. Analysis of variance on total nitrogen uptake (kg ha^{-1}) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	1.92	0.96	0.01	5.14	NS
Integrated weed management (W)	3	23772.81	7924.27	120.18	4.76	*
Error I	6	395.64	65.94			
Cultivar (C)	3	1682.99	561.00	22.22	3.01	*
W x C	9	152.77	16.97	0.67	2.30	NS
Error II	24	605.99	25.25			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	22.87	11.43	0.18	5.14	NS
Integrated weed management (W)	3	25180.24	8393.41	131.46	4.76	*
Error I	6	383.09	63.85			
Cultivar (C)	3	2221.01	740.34	23.30	3.01	*
W x C	9	186.03	20.67	0.65	2.30	NS
Error II	24	762.50	31.77			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	302.3	302.3	48.7	*
Rep within year	4	24.8	6.2		
Integrated weed management (W)	3	48933.2	16311.1	251.4	*
Year x W	3	16.9	5.6	0.1	NS
Error I	12	778.6	64.9		
Cultivar (C)	3	3879.4	1293.1	45.4	*
Year x C	3	24.6	8.2	0.3	NS
W x C	9	254.7	28.3	1.0	NS
Year x W x C	9	84.0	9.3	0.3	NS
Error II	48	1368.4	28.5		

*Significant NS-Non-significant

16. Analysis of variance on phosphorous uptake in grain (kg ha^{-1}) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.05	0.02	0.10	5.14	NS
Integrated weed management (W)	3	113.91	37.97	158.18	4.76	*
Error I	6	1.44	0.24			
Cultivar (C)	3	7.72	2.57	21.06	3.01	*
W x C	9	0.17	0.02	0.15	2.30	NS
Error II	24	2.93	0.12			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.06	0.03	0.10	5.14	NS
Integrated weed management (W)	3	115.45	38.48	134.02	4.76	*
Error I	6	1.72	0.29			
Cultivar (C)	3	9.11	3.04	24.88	3.01	*
W x C	9	0.14	0.02	0.12	2.30	NS
Error II	24	2.93	0.12			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.33	0.33	13.11	*
Rep within year	4	0.10	0.02		
Integrated weed management (W)	3	229.18	76.39	288.34	*
Year x W	3	0.04	0.01	0.05	NS
Error I	12	3.17	0.26		
Cultivar (C)	3	16.84	5.61	45.85	*
Year x C	3	0.03	0.01	0.08	NS
W x C	9	0.26	0.02	0.23	NS
Year x W x C	9	0.04	0.005	0.04	NS
Error II	48	5.87	0.12		

*Significant NS-Non-significant

17. Analysis of variance on phosphorous uptake in straw (kg ha^{-1}) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	1.74	0.87	1.48	5.14	NS
Integrated weed management (W)	3	30.65	10.22	17.30	4.76	*
Error I	6	3.54	0.59			
Cultivar (C)	3	1.04	0.35	0.45	3.01	NS
W x C	9	1.04	0.12	0.15	2.30	NS
Error II	24	18.63	0.78			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.90	0.45	1.56	5.14	NS
Integrated weed management (W)	3	34.73	11.58	39.87	4.76	*
Error I	6	1.74	0.29			
Cultivar (C)	3	4.05	1.35	2.98	3.01	NS
W x C	9	2.45	0.27	0.60	2.30	NS
Error II	24	10.88	0.45			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.67	0.67	1.02	NS
Rep within year	4	2.64	0.66		
Integrated weed management (W)	3	65.06	21.69	49.23	*
Year x W	3	0.23	0.07	0.17	NS
Error I	12	5.28	0.44		
Cultivar (C)	3	4.20	1.40	2.27	NS
Year x C	3	0.9	0.3	0.48	NS
W x C	9	2.18	0.24	0.39	NS
Year x W x C	9	1.305	0.14	0.23	NS
Error II	48	29.53	0.61		

*Significant NS-Non-significant

18. Analysis of variance on total phosphorous uptake (kg ha^{-1}) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	1.87	0.93	0.36	5.14	NS
Integrated weed management (W)	3	1202.09	400.70	155.11	4.76	*
Error I	6	15.50	2.58			
Cultivar (C)	3	61.16	20.39	4.86	3.01	*
W x C	9	10.10	1.12	0.27	2.30	NS
Error II	24	100.73	4.20			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	1.29	0.65	0.24	5.14	NS
Integrated weed management (W)	3	1228.83	409.61	154.65	4.76	*
Error I	6	15.89	2.65			
Cultivar (C)	3	131.66	43.89	13.65	3.01	*
W x C	9	12.06	1.34	0.42	2.30	NS
Error II	24	77.15	3.21			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	10.07	10.07	12.87	*
Rep within year	4	3.13	0.78		
Integrated weed management (W)	3	2,429.62	809.87	309.76	*
Year x W	3	1.32	0.44	0.16	NS
Error I	12	31.37	2.61		
Cultivar (C)	3	184.54	61.51	16.6	*
Year x C	3	8.28	2.76	0.74	NS
W x C	9	14.80	1.64	0.44	NS
Year x W x C	9	7.35	0.81	0.22	NS
Error II	48	177.87	3.70		

*Significant   NS-Non-significant

19. Analysis of variance on potassium uptake in grain (kg ha^{-1}) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.08	0.04	0.37	5.14	NS
Integrated weed management (W)	3	67.25	22.42	212.01	4.76	*
Error I	6	0.63	0.11			
Cultivar (C)	3	3.93	1.31	10.75	3.01	*
W x C	9	0.21	0.02	0.19	2.30	NS
Error II	24	2.93	0.12			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.00	0.00	0.01	5.14	NS
Integrated weed management (W)	3	66.48	22.16	115.81	4.76	*
Error I	6	1.15	0.19			
Cultivar (C)	3	3.67	1.22	13.34	3.01	*
W x C	9	0.25	0.03	0.31	2.30	NS
Error II	24	2.20	0.09			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	0.073	0.073	3.585	NS
Rep within year	4	0.081	0.02		
Integrated weed management (W)	3	133.589	44.53	300.436	*
Year x W	3	0.009	0.003	0.019	NS
Error I	12	1.779	0.148		
Cultivar (C)	3	7.603	2.534	23.741	*
Year x C	3	0.005	0.002	0.015	NS
W x C	9	0.326	0.036	0.339	NS
Year x W x C	9	0.136	0.015	0.141	NS
Error II	48	5.124	0.107		

*Significant NS-Non-significant

20. Analysis of variance on potassium uptake in straw (kg ha^{-1}) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.23	0.12	0.02	5.14	NS
Integrated weed management (W)	3	1254.43	418.14	79.01	4.76	*
Error I	6	31.75	5.29			
Cultivar (C)	3	55.74	18.58	3.30	3.01	*
W x C	9	10.30	1.14	0.20	2.30	NS
Error II	24	135.02	5.63			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.71	0.35	0.09	5.14	NS
Integrated weed management (W)	3	1282.91	427.64	106.76	4.76	*
Error I	6	24.03	4.01			
Cultivar (C)	3	71.55	23.85	3.04	3.01	*
W x C	9	19.96	2.22	0.28	2.30	NS
Error II	24	188.53	7.86			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	18.545	18.545	2.341	NS
Rep within year	3	2,534.84	844.946	106.661	*
Integrated weed management (W)	3	2.659	0.886	0.112	NS
Year x W	3	126.16	42.053	5.309	NS
Error I	3	1.047	0.349	0.044	
Cultivar (C)	9	28.321	3.147	0.397	*
Year x C	9	1.966	0.218	0.028	NS
W x C	48	380.25	7.922		
Year x W x C	1	18.545	18.545	2.341	NS
Error II	3	2,534.84	844.946	106.661	

*Significant NS-Non-significant

21. Analysis of variance on total potassium uptake (kg ha^{-1}) as influenced by integrated weed management and cultivar

ANOVA for first year 2021						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	1.59	0.80	0.07	5.14	NS
Integrated weed management (W)	3	6828.20	2276.07	209.66	4.76	*
Error I	6	65.14	10.86			
Cultivar (C)	3	317.91	105.97	7.42	3.01	*
W x C	9	22.75	2.53	0.18	2.30	NS
Error II	24	342.99	14.29			

ANOVA for first year 2022						
Source of Variance	**df**	**SS**	**MSS**	**F Cal**	**F Tab at 5%**	**S/ NS**
Replications	2	0.41	0.21	0.04	5.14	NS
Integrated weed management (W)	3	6825.84	2275.28	391.15	4.76	*
Error I	6	34.90	5.82			
Cultivar (C)	3	394.88	131.63	8.09	3.01	*
W x C	9	38.02	4.22	0.26	2.30	NS
Error II	24	390.72	16.28			

ANOVA Pooled					
Source of Variance	**df**	**SS**	**MSS**	**F-Cal**	**S/NS**
Year	1	38.722	38.722	70.878	*
Rep within year	4	2.185	0.546		
Integrated weed management (W)	3	13,649.62	4,549.87	547.032	*
Year x W	3	3.669	1.223	0.147	NS
Error I	12	99.809	8.317		
Cultivar (C)	3	709.494	236.498	15.468	*
Year x C	3	3.488	1.163	0.076	NS
W x C	9	54.597	6.066	0.397	NS
Year x W x C	9	6.192	0.688	0.045	NS
Error II	48	733.91	15.29		

*Significant NS-Non-significant