NUTRIENT MANAGEMENT IN MAIZE *(Zea mays* L.) BASED INTERCROPPING SYSTEMS UNDER THE RAINFED CONDITION OF NAGALAND

A

Thesis

Submitted to

NAGALAND UNIVERSITY

for the Degree

of

DOCTOR OF PHILOSOPHY (Agriculture)

in

AGRONOMY

By

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2015

Affectionately

Dedicated

To

Tongti & Sentimen

DECLARATION

I, BEREMJUNGLA, 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 Nagaland University for the degree of Doctor of Philosophy in Agronomy.

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CERTIFICATE

This is to certify that the thesis entitled, 'Nutrient management in maize *(Zea mays* L.) based intercropping systems under the rainfed condition of Nagaland', submitted for fulfilment of the requirements for the award of Doctor of Philosophy (Agriculture) under Nagaland University, Medziphema is a record of bonifide research work carried out by Mrs. Beremjungla, Reg. No. 364/2009 under my guidance and supervision.

The candidate has fulfilled all the requirements under the Ph. D regulations of Nagaland University and the thesis or part of it has not been submitted to any other University for any degree or distinction.

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A B S T R A C T

A field experiment was conducted during *kharif* season of 2008 and 2009 in the experimental farm of School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema Campus, Nagaland to evaluate the nutrient management in maize *(Zea mays* L.) based intercropping systems. The experiment was laid out in 'Split plot design' with two main plot treatments (maize + groundnut-IC_1 and maize + soybean-IC_2) and six sub-plot fertilizer treatments (Control- $F_{1,}$ 100% NPK to maize and intercrop-$F_{2,}$ 100% NPK to maize only – $F_{3,}$ 100% NPK to maize + 50% NPK to intercrop - $F_{4,}$ 50% NPK to maize + 100% NPK to intercrop-F_5, 50% NPK to maize and intercrop - F_6). There were twelve treatment combinations. Between the two intercropping systems tested maize with groundnut (2:2) was found to be the best intercropping system recording better crop growth and yield attributes and higher grain and straw yields. Among the different fertilizer doses, application of NPK at 100% to both the crops was found to be the best fertilizer dose producing the highest crop growth and yield. The interaction of intercropping system involving maize and groundnut along with application of 100% NPK to both the crops was found to record the best crop growth and yield among the different interactions tested. Intercropping of maize with groundnut was found to be most feasible and economical among the two intercropping systems tested whereas, among the different fertilizer doses tested, application of 100% NPK to both the crops was found to be most economically feasible. The interaction of intercropping of maize with groundnut along with application of 100% NPK to both the crops was found to be the most economically viable cultivation practice registering the highest gross return and net return/ha and also recording the higher B:C ratio.

Key words- Maize, groundnut, soybean, intercrop, nutrient management

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LIST OF ABBREVIATIONS

%	Per cent
@	at the rate of
° C	Degree Celsius
a.i	Active Ingredient
BCR	Benefit Cost Ratio
CD	Critical Difference
CEY	Crop Equivalent Yield
CGR	Crop Growth Rate
cm	Centimetre
DAS	Days after Sowing
d. f	Degree of Freedom
EC	Emulsified Concentrate
FAO	Food and Agricultural Organisation
et al	and others
Fig.	Figure
FYM	Farm Yard Manure
g	Gram
HI	Harvest Index
ha	Hectare
ICAR	Indian Council of Agricultural Research
IC	Inter Cropping
i.e.	That is
kg	Kilogram
l	Litre
LAI	Leaf Area Index
LER	Land Equivalent Ratio
m	Metre
Max.	Maximum
Min.	Minimum
ml	Millilitre
mm	Millimetre
MOP	Muriate of Potash

MSS	Mean Sum of Square
NEHR	North East Hill Region
NPK	Nitrogen, Phosphorus and Potassium
NS	Non-Significant
NU	Nagaland University
O.C	Organic Carbon
q	Quintal
RCC	Relative Crowding Coefficient
RDF	Recommended Dose of Fertilizer
RGR	Relative Growth Rate
`	Rupee
SS	Sum of Square
SEd±	Standard Error of Mean Difference
SSP	Single Super Phosphate
SASRD	School of Agricultural Sciences and Rural Development
SPD	Split Plot Design
t	Tonnes
Viz.,	Namely

Acknowledgement

No scientific endeavour is a result of an individual's effort, so comes the time to look back the path during this endeavour and remember the faces and spirit behind the action with a sense of gratitude.

It is my immense pleasure to express my deep sense of gratitude to my Supervisor Dr. T. Gohain, Asst. Professor (Stage-III) Department of Agronomy, Nagaland University (SASRD), Medziphema Campus, for his constant supervision, guidance, constructive criticism and valuable suggestions. In spite of his heavy schedules, he had always managed to make enough time and pay due attention and being so patient and often giving me a push throughout the entire course of investigation.

A special word of gratitude goes to the Committee Members Dr. P.L Singh, Associate Professor Department of agronomy and Dr. Y. K. Sharma, Professor, Department of Agriculture Chemistry and Soil Science. NU: SASRD, Medziphema Campus for their valuable insights and suggestions.

I am grateful to Dr. L. Tonpang Longkumer, Head, Department of Agronomy, the faculty and staff members of the Department of agronomy NU: SASRD, Medziphema Campus for their endless support.

I take this opportunity to express my heart felt gratefulness to Dean, NU: SASRD, Medziphema Campus for providing all necessary facilities for conducting this investigation.

I am extremely thankful to the Government of Nagaland for granting study leave and Directorate of Agriculture, Nagaland for all the official help during the course of study.

I extend my profound gratitude and indebtedness to Dr. A.K Sahu. Asst. Professor Department of Agricultural Economics, NU:

SASRD, Medziphema Campus for his unstinted help in carrying out the statistical analysis.

I would also like to acknowledge my thanks to Mr. Mhombemo Ngullie, Asst. Librarian and staffs for providing all possible library facilities.

My profound gratitude to Mr. Temjenmenba, AVS, Department of Agriculture Extension, NU: SASRD, Medziphema Campus for his untiring support and help.

I owe my special sense of gratitude to Noyingthung Kikon for his profuse help in formatting the entire tables, his ideas and contribution whenever required.

I appreciate the help extended by Mr. Metchiu, Superintend, Dr. Bendangyanger Dy. Director, Lipok Pongener SDAO and Abemo Merry.

My credit for the completion of my thesis goes to my husband Matsung who shouldered all responsibilities of running our family, my parents, in laws, brothers and sisters and my two wonderful children Tongti and Sentimen for their constant prayers, inspiration, patience, understanding and sacrifice with enthusiasm and affections during the entire period of the study to make it all success.

Above all I thank the Almighty God for His guidance and blessings.

Place: *(Beremjungla)*
Date:

CHAPTER-I

INTRODUCTION

Maize (*Zea mays L.*) is the third most important crop world wide following rice and wheat. It is one of the most versatile crops and can be grown in diverse environmental conditions and has diversified uses in human food, animal feed and industrial products. It is referred to as 'miracle crop and also as 'queen of cereals' for its production and values. Maize is rich in carbohydrates and proteins and a fairly good source of iron, phosphorus and vitamin B-complex. It contributes upto15% of world's protein and 19% of calories derived from food crops. It has vast industrial potentialities as well, having around 500 different uses such as- starch, syrup, alcohol, acetic acid, lactic acid, glutamic acid etc which can be prepared from maize. Maize is cultivated both in tropical and temperate regions of the world. The area under cultivation of maize in the world is 139 million hectares with the production of around 863.42 million tones (Anonymous, 2013-14). In India, maize is grown under varied soil and climatic condition from sea level to an altitude of 2500 meters or more. Maize is generally grown during *kharif* in North India, but this crop has grown successfully in winter as well as summer (Patel *et al.*, 1985). The total maize cultivated area in India is 9.09 million hectares with a production of 23.29 million tonnes and the average productivity is 2563 kg per hectare (Anonymous, 2014_a). Productivity of maize in India during *kharif* is low as compared to *rabi* although larger area is covered by the crop during *kharif.*

North Eastern Region of India has a high potential for maize cultivation, but the productivity is low in comparison to the national average. It is the second most important cereal crop of North Eastern Region of India and it occupies around 0.23 million hectares area with a production of 0.37 million tonnes and an average productivity of 1469.88 kg per hectare (Anonymous, 2015) against the national average yield of 2563 kg per ha (Anonymous, 2014_b). Maize is an important cereal crop next to rice in Nagaland and is grown successfully all over the state both in the high and low altitudes. The total area occupied by the cereal crops in Nagaland is 2,64,400 hectares out of which maize cultivation occupies on an area of 68,430 hectares with a total production of 134000 tonnes (Anonymous, 2014_b).

India has the highest area under oilseeds but the lowest productivity 8.6 q/ha. About 85% areas of oilseeds are under rainfed conditions. The cereals and cash crop have occupied the fertile lands while oilseeds and pulses have shifted to marginal and sub-marginal lands with low fertility. Oilseeds are energy rich crops but they are grown under energy-starved conditions. Oilseeds are the most important constituents of Indian diet. The per capita requirement of fat and oils per day is 35 g and half of the requirement is met by other sources. About 18 g per day per capita of oil is essential through oilseeds. The present edible oil available is 4.3 mt against the requirement of 5.5 mt therefore there is net shortage of 1.2 mt. In Nagaland, groundnut and soybean are gaining attention of farmers primarily for its increasing market value. Although rice and maize is considered as a staple food in Nagaland, the price of oilseeds per kg is 3-4 times higher than that of cereal crop. If proper care is taken in oilseeds similar with that of rice and maize cultivation than there will be surplus production as the agro climatic condition is suitable to grow pulses and oilseeds throughout the year.

Technological advancement has opened new prospects for producing more food and other agricultural crops from less land. Intensive cultivation practices have become an order of the day, as a means of feeding the growing population. Due to the use of high yielding varieties, crop production has increased in the last few years and enhanced consumption of chemical fertilizers. Further boost in total agricultural production has come by way of intensified growing of crops vis-à-vis sole cropping. Productivity improvement technologies essentially included the use of non-renewable energy sources nutrient products i.e. chemical fertilizers. The need to increase food production in India arises from population growth and a change in the agricultural system from subsistence to a more intensive production system leaning towards a commercial enterprise. In Nagaland, the low productivity and cropping intensity is due to the use of local cultivars, mono cropping and shifting cultivation with improper management. The process of cultivation in virgin land can no longer be practiced in this generation, therefore for future increase in production of maize and other crops must come largely from higher yield per unit area per unit time.

Growing more than one crop on the same piece of land at a time is an old practice known to Indian farmers. Cereals, pulses, oil-seeds and tuber crops used to be grown together more as a measure of domestic self- sufficiency than as a step to increase cropping intensity and thereby in increasing the productivity of a piece of land. However, experiments on intercropping revealed several advantages. These advantages include diversification of crops, covering of risks due to weather destructions, pest and weed control, greater productivity and revenue per unit area. The purpose of intercropping is not only to grow more than one crop together but also to attain more yields per unit area with optimum economic returns. Intercropping was originally practiced as an insurance against crop failure under rainfed condition. It also limits weed growth, pest and disease infestation, economic use of N fertilizer due to association of legumes (Choudhury, 1979, De and Singh, 1979). Stability of the crop yield can also be achieved in upland through crop substitution and intercropping (Rao *et al.,* 1982). Further if biological complexities and their interaction are carefully integrated in an intercropping system provided appropriate crops are chosen, yield can be increase to maximum (Francis, 1989). Thus, it is clearly justified that intercropping has been recognized as a beneficial system for crop production. It can provide substantial yield advantage as compared to sole cropping (Patel *et al.,* 1987). Superiority of intercropping over sole cropping has been shown in terms of higher and more dependable gross returns per ha. Its potential for greater employment is also revealed. Studies show that intercropping is largely a system of small and unirrigated farms. A significant implication of this finding is that breakthrough in intercropping technology will help poor farmers. Increased research resource allocations to intercropping with thus serve the equity goals better. Researchers cannot and need not generate equally complex new intercropping systems. Instead, they should concentrate on generating a simple system that satisfies key objectives, such as profitability and stability, without completely ignoring the other objectives that underline the traditional intercropping systems. (Jodha, 1981).

Crop production is changing from systems dependent on the natural fertility of the soil to fertilizer dependent system. It is well recognized that applying fertilizers constitute an important component for yield improvement. Increased agricultural productivity usually comes as the result of a combination of several factors such as use of high yielding seed, irrigation, plant protection measures, cultural practices, soil improvement and increased use of fertilizers. Of all these factors, fertilizers seem to be the most important component influencing crop yields. When the nutrient needs of crops cannot be fully met from the soil reserves, these have to be added to the soil through fertilizers and manures. Only a well-nourished crop can yield a good harvest and a marketable surplus. Nutrient management needs many inputs, one of which is the brain. This implies that recommendation should be technically sound, practically feasible and economically attractive.

Among the plant nutrients primary nutrients such as, nitrogen, phosphorus and potassium play a crucial role in deciding the growth and yield. Nitrogen is the most deficient primary nutrient in Indian soils. The response of crops to nitrogen varies widely from place to place, depending upon the fertility level of soil and other environmental conditions. This necessitates the study on the response of crop to different levels of fertilizer. The use of applied nitrogen is only about 30-40 percent (Parthipan, 2000). The nitrogen use can be improved with application of nitrogen coinciding with peak need by the crop. Nitrogen is needed in large amounts for higher outputs. A provision for an adequate supply of nitrogen throughout the growing season is necessary and is one of the important functions of soil management (Jain, 1981). Nitrogen is utilized by the maize plant in the form of nitrates, ammonium salts, nitrates and certain organic forms. A considerable portion of nitrogen is taken up fairly in the form of nitrates. Ammonium nitrogen in the form of ammonium sulphate is also utilized in appreciable quantities (Vietes *et al.,* 1946). Nitrogen uptake continues throughout the growth period and diminishes at maturity. High pH levels favour ammonium absorption and low pH level favours nitrates. Most of the nitrogen is converted into amino acids, amides and chlorophyll and more than half of nitrogen accumulates in grain (Sayre, 1955). Nitrogen increases plant height, number of leaves at tasselling stage, dry weight of cob bearing leaves, length and diameter of cobs, number of grains per cob and test weight (Tiwary *et al.,* 1970).

Phosphorus is known to stimulate early and extensive development of root systems, which enables rapid maize growth and to mature early (Sankaran *et al.*, 2005). Phosphorus is essential for energy transfer in the living cells by means of high energy phosphate bonds of ATP. Therefore phosphorus is of prime importance in the formation and translocation of carbohydrates, fatty acids, glycerides and other essential intermediate compounds. Phosphorus is absorbed by the plants in the form of inorganic salts. After uptake of phosphorus it is directly carried to the living tissues within the plants. Phosphorus is found in the form of phytin, lecithin hexosephosphate, nucleic acid, phosphor protein and as organic form associated mostly with Mg, K, N and Ca (Sayre, 1948). Nearly 75 percent of phosphorus gets translocated into the grain at the time of maturity of which ¾ occurs in the form of phytin.

Maize has high yield potential and response greatly to potassium fertilizer. Therefore, proper management of potassium nutrient is essential to realize maximum potential of the crop because it plays important role in activating various enzymes (Tisdale *et al.*, 1990). Potassium, although it is not known to be a constituent of any essential organic compound in plants, nonetheless it is known to have several important functions in plant metabolism. Potassium is absorbed in large quantities from soluble inorganic sources. Much of potassium remains in the solution of cell sap (Morris and Safre, 1935). Maximum accumulation of potassium takes place at the time of silking and the loss of potassium occurs largely through stems and leaves. Potassium deficient plants exhibits nearly 40 percent increase in protein concentration, while the amount of protein per shoot is much reduced.

With the country and the state marching towards food security and economic independence, the need for balance and judicious utilization of available resources has become one of paramount importance. This context has become all the more important for a developing country like India, where the country is striving towards development, progress and prosperity in all aspects. Thus land use based planning has become all the more essential for productive agriculture (Rathore, 2008). In Nagaland, farmers are still following their age-old indigenous ways of cultivation, they are not aware of the benefits of scientific management of crop plants. The manuring and fertilization practices adopted by the farmers of this state are empirical and not based on systematic field trials. Therefore, the present investigation entitled "**Nutrient management in maize (*Zea mays* L) based intercropping system under the rainfed condition of Nagaland**" has become a matter of prime importance to the region. The study being the premier one in the concerned region, will help the cultivators which can bring about increased level of states contribution towards national income, at the same time bringing prosperity to the poor farmers.

Objectives of the study

1. To find out the most suitable maize- based intercropping system.
2. To find out the most suitable doses of fertilizer for maize-based intercropping system.
3. To find out the economics of maize -based intercropping system
4. To study the productivity of different maize- based intercropping system.

CHAPTER II

REVIEW OF LITERATURE

The practice of intercropping with different crop combination and with different fertilizer treatment has vast area of study and many of the research works have been done in India and abroad in the recent years. The available literatures related to the present investigation have been revealed in this chapter.

2.1 Intercropping: concept, importance and advantage

The crops grown in intercrop are so selected that they differ in their canopy structure, height, root depth, growth habit and durations, so that they can accommodate each other with less competition. The crop may or may not be sown or harvested at one time but the crop must be grown in separate rows (Krantz *et al.*, 1975).

Intercropping is the cultivation of two or more crops simultaneously on the same piece of land with or without a definite row pattern, where crop intensification is in both time and space dimension. (Andrews and Kassam, 1976).

The purpose of intercropping is not only to grow more than one crop but to attain more yields per unit area with superior economic returns. Intercropping was originally practiced as an insurance against crop failure under rainfed conditions. Besides providing insurance against climatic aberration, intercropping ensures better utilization of natural resources like land, water and sunlight (Willey, 1979). It also limits weed growth, pest and disease infestation; protect soil against erosion, highest gross return, economy in the use of nitrogenous fertilizer due to association of legumes (Mandal *et al.,* 1989)

The beneficial aspects of intercropping as analysed by various scientists can be enumerated as i) Increased efficiency in utilization of environmental resources, ii) More efficient utilization of labourers, iii) Reduction in adverse effects of disease, pest and weeds, iv) Insurance against crop failure, v) Protection of soil against erosion, vi) Higher gross return and vii) Economy in the use of nitrogenous fertilizer, due to association of legume with non- legume (Willey, 1979; Choudhury, 1979 ; De and Singh, 1979).

Murthy (1988) reported that even under severe drought condition optimum return can be achieved. Intercropping shows superiority in term of monetary return (Chandrashekar *et al.,* 1983) and was more productive than sole cropping (Patel *et al.,* 1987). Farmers prefers mixed or intercropping because the system provides satisfactory yield even under adverse condition and substantial yield advantage in practice (Singh *et al.,* 1980).

Amashams (2011) reported that intercropping is the practice of growing two or more crops simultaneously on the same field to maximize total production per unit area. The most important advantage of intercropping systems comprised of both tall and short plants in the potential complementarities in sun light utilization for crop production. The advantages of intercropping a cereal with a legume are often limited by the dominance of the cereal, which severely inhibits the legume. A goal of many small farmers using a maize-legume intercropping system is to achieve full production of the peanut crop plus the additional yield of the associated maize crop. Intercropping as a kind of crop diversification is popular now among the small holders.

2.2 Maize based intercropping

Das and Mathur (1980) reported that grain yield of maize significantly increased when intercropped with urd, cowpea and moong as compared to that of maize alone and intercropped with groundnut.

Kalra and Gangwar (1980) conducted a field experiment to study the response of maize to intercropping of legumes and results revealed that the highest net return was obtained from intercropping treatment over maize sole crop.

Akanda and Quayyum (1982) opined that maize yield decreases in intercropping system with groundnut in comparison to sole crop.

Singh and Singh (1984) reported that intercropping of greengram with maize enhance the productivity of maize by 17-21%.

Prsuty *et al.* (1985) reported that maize + groundnut and maize + soybean proved better than sole maize.

Ahlawat and Sharma (1986) reported that the short duration pulses when intercropped with maize gave 3-5 q/ha additional pulse grain without any adverse effect on yield of main crops.

Saxena and Chandel (1986) in a two year study reported that when Ganga-2 maize was intercropped with ‘Bragg’ soybean significantly decreased the leaf area index of soybean by 9 to 51 percent at all the stages, mean net assimilation rate by 24 to 26 percent at 45 to 60 days after sowing. There was significant reduction in dry matter (21-60%), branches (5-31), pods/plant (23-54) and grain yields (65-69%) of soybean. Maize did not affect 1000 grain weight and seed/pod. Reduction in the leaf area index (3-55%) of maize was more at wider spacing and at 30-45 days after sowing. Except at harvest the dry matter of maize decreased by 6-15% and the grain yield by 3-45% with intercropping.

Singh *et al.* (1986) revealed from experiments that maize yield increased by 32, 31 and 16 % with green gram, black gram and soybean respectively as intercrops.

Chui (1988) reported that maize intercropping significantly increased total grain/seed yield and land equivalent ratio.

Thakur and Sharma (1988) reported that intercropping of maize with groundnut did not affect the canopy height of maize, but increased that of groundnut over the sole cropping. Groundnut showed decrease dry matter accumulation under intercropping. Intercropping of groundnut did not affect the seed yield of maize but reduced the kernel yield of groundnut.

Wright *et al.* (1988) reported that soybean is considered as an ideal crop for intercropping with maize owing to its comparative tolerance for shade and drought, efficient light utilization and less competitiveness for soil moisture.

Mandal *et al.* (1990) carried out an experiment during rainy season on a typical upland sandy-loam soil. Results showed that the maize +groundnut intercropping gave maximum combined intercrop yield, followed by maize + green gram. Intercropping stand of maize and groundnut gave significantly highest total return and net return/ha than the other treatments.

Raja and Reddy (1990) revealed that higher productivity per area and unit time could be obtained when maize was intercropped with cowpea over sole crop.

Singh and Bajpai (1991) reported that intercrops of maize with blackgram, greengram and soybean increased the grain yield of maize in both the years and this increase in yield of maize might be due to N availability by decaying nodules of legumes. Among the intercrops, soybean recorded the highest yield giving a maximum net profit of Rs 3, 517/ha, followed by groundnut, blackgram, common millet and greengram.

Venugopal and Shivashankar (1991) conducted a field experiment on the effect of maize crop residue and nitrogen levels on productivity and economics of maize +

soybean under paired row system of planting maize. Intercropping of maize under paired row system of planting was superior to sole cropped maize.

Buragohain and Baruah (1992) reported that maize + cowpea gave LER values more than one for all the mixed stands.

Gangwar and Sharma (1994) reported that the highest reduction in grain yield of maize was noticed under maize + prickly sesbania intercropping system. Maize + greengram recorded green forage yield of 38q/ha and gave 2.9 q/ha of bonus yield of grain in addition to 21.1 q/ha grain yield of maize and resulted in higher net return.

El-Douby *et al.* (1996) conducted a field trial on intercropping of maize and soybean and reported that the maize grain yield and soybean seed yield was highest when grown alone.

Zamar and Giambastiani (1996) in a field trial on intercropping of maize and soybean, results shows that Land equivalent ratio reached 1.09 and 1.11 in the 1st and 2nd year, respectively. In both years, maize grain yields were higher under intercropping than in pure stand whereas grain yields of soybeans were unaffected by an associated maize crop.

Eneji and Oko (1997) conducted a field experiment on maize and groundnut intercropped and reported that crop yield was higher in the sole plots than the intercropped plots, with maize giving higher yields. Intercropping decreased the yield of maize and groundnuts by 25 and 22% respectively. Monetary returns were higher with intercropping than sole cropping.

Jana and Saren (1998) in their field experiment on intercropping of maize and groundnut, results revealed that groundnut dry matter accumulation was significantly higher in sole crops compared with intercropping. In maize, yield and yield attributes were not significantly different between intercrops and sole crops. On the basis of land-equivalent ratio, intercropping gave 82 and 70% more productive yield than sole crop.

Mandimba (1998) conducted a field trial of maize-groundnut intercropping and as monocultures and revealed that Intercropping of maize and groundnut reduced the dry matter and grain/seed yields of both the crops compared with sole cropping, but overall grain/seed yield was significantly higher in the intercropping systems.

Sharma *et al.* (1998) reported that the yield of maize was not influenced significantly by intercrops in different maize-based legume intercropping, however the effect was significant when maize-equivalent yields were studied with sole crop. 1000 grain weight, grain yield and straw yield were influenced significantly by various intercrop treatments.

Singh *et al.* (1998) conducted a field experiment on productivity and nutrient balance of maize + blackgram intercrop and reported that the grain yield of intercropped maize was almost similar (4.04-4.18 to t/ha) with black gram yield of 0.82-0.84 t/ha and maize-equivalent yield of 5.88-5.96 t/ha to its sole crop (4.32 t/ha)

Galal (1999) revealed that, yield of both maize and sunflower crops was highest in pure stands and progressively decreased with decreasing proportion in the intercropping system. Maize was the dominant component in all intercropping systems as indicated by positive values for aggressivity. Land equivalent ratios of the intercropping systems were 0.549-0.767.

Pandey *et al.* (1999) reported the highest total yield, maize equivalent yield, LER value, net return and benefit : cost ratio in paired rows of maize in 2 rows of soybean. The higher yield advantage obtained in maize + soybean intercropping than maize + french bean may be due to better nitrogen fixation and utilization in the former intercropping than in latter.

Saren and Jana (1999) conducted a field trial in intercropping maize and groundnut and reported that the intercropping decreased groundnut yield but not maize yield compared with pure stands.

Parvender *et al.* (2000) conducted an experiment during rainy seasons of 2003 and 2004 to find out the most suitable economically and biologically sustainable maize (*Zea mays* L.)-based intercropping system under rainfed conditions. Intercropping of greengram [*Vigna radiata* (L.) Wilczek] with maize was found to have increased the total productivity by 15.7-44.5% in comparison to sole cropping of maize. Magnitude of reduction in yield of the base crop due to intercropping of greengram was highest (45.7-53.5%) when maize was widely planted at 75/90 cm in 1:2 row ratios against the 27.0-33.1% for maize planted at 50/60 cm in 1:1 row proportion. Paired row planting of maize + greengram intercropping in 1:1 row ratio showed yield reduction to the tune of 18.2%.

Patra *et al.* (2000) In their field experiment on maize based intercropping system reported that Land equivalent ratio, area-time equivalent ratio, monetary value total and relative net returns were greater than unity with all the intercropping systems, indicating advantages in yield, land use efficiency and monetary return/unit time and space over the respective monocultures. Intercropping of maize with legumes was more advantageous than with non-legumes.

Shivay and Singh (2000) conducted a field experiment on maize + urdbean, maize + soybean and maize sole and recorded that maize + urdbean gave the highest LAI at 90 DAS. Plant height and dry matter accumulation were not affected by different cropping systems. Intercropping of maize with urdbean resulted in 22.0 and15.2 % higher grain yields than sole maize. However, yield from the maize + urdbean cropping system was statistically on a par with that of maize + soybean.

Singh *et al.* (2000) conducted a field experiment on maize intercrops. The treatment comprised of sole maize, maize + pea and maize + lentil with 0, 50, 100, 150 and 200 kg N/ha. and revealed that maize grown with legumes accumulated significantly more dry matter and nitrogen than in sole stand. The highest dry matter production was recorded in maize + pea cropping system. Legumes produced less dry matter when intercropped compared with their sole stand.

Singh *et al.* (2000) conducted a field experiment on winter maize intercrops and revealed that the yield attributes length and girth of cob, number and weight of grains per cob, cobs per plant and 1000 grain weight were increased by intercropping legumes. The respective mean maize grain yield were 46.4, 54.3 and 53.5q/ha when maize was grown as a sole and intercropped with pea or lentil.

Gulzar *et al.* (2001) conducted a field experiment on maize and soybean intercropping and results indicated that intercropping significantly reduced plant height of soybean and taller plants were observed in sole cropping system. Days to maturity of soybean increased in intercropping compared to monocropping. Seed yield of soybean was adversely affected by intercropped with maize. Results further indicated that intercropped maize yields were at par with the sole crops in both the intercropping. There was no significant effect on the plant height and days to maturity of maize in intercropping and monocropping. Land equivalent ratio for intercropping system was greater (1.499 and 1.599) than sole crop.

Mathews *et al*. (2001) conducted a field trial on maize and pigeon pea intercropping on short and long duration and evaluated that the yields of both crops in intercropping systems were generally lower than in monocropping systems. The yield reduction in intercropping systems for LD and MD pigeonpea cultivar was in the range 7.4-31.0% while that of maize ranged from 8.7 to 38.6%. In the SD trial, yield reduction was in the range 36.8

Rana *et al.* (2001) conducted an experiment on maize/legume intercropping and reported that the plant height and leaf area index of maize crop in maize+legume intercropping systems were significantly higher compared to pure maize. Grain yield of maize in intercropping was higher compared to sole crop. Intercropping of legume with maize gave 30-40% yield of the corresponding sole crop.

Rahimy *et al.* (2003) reported that land equivalent ratio was highest with intercropping of maize and soybean compared to sole crop.

Morgado and Willey (2003) reported that nitrogen increased the biomass yield of maize and application of 50 kg N/ha in intercropping maize increased maize yield significantly compared with control. The efficiency of intercropping compared to sole cropping was evidenced by the values obtained for land equivalent ratio for biomass, cob and pod yields that increased with increases in nitrogen fertilizer rates.

Polthanee and Trelo-ges (2003) conducted a field experiment to investigate the growth, yield and yield components of maize, groundnut, soybean and mung bean under intercropping and single cropping. Results revealed that the yield and yield components of maize were not affected by intercropping system. In the legume crops, groundnut, soybean and mung bean, intercropping systems reduced the leaf area and top dry weight per plant, compared with single cropping. The grain yield of groundnut, soybean and mung bean was reduced by 28, 39 and 51%, respectively, compared with single cropping. The pod number per plant was the most affected by intercropping among the yield components. However, maize-legume intercropping increased land use efficiency by 48-66% depending on legume species. Maize-groundnut intercropping gave the highest land use efficiency.

Laxminarayana and Munda (2004) revealed that intercropping legumes with cereals was found to be highly productive and profitable inclusion of groundnut as an intercrop with rice and maize not only enhanced crop yields and highest net returns but also had positive effect on soil fertility build up.

Panhwar *et al.* (2004) studied the performance of maize in intercropping system with soybean with different nitrogen level during *kharif* season and results revealed that sole maize recorded greater grain yield/ha .Intercropping of soybean in maize rows did not show any adverse effect on maize plant height, number of leaves, 1000 grain weight as well as grain yield of maize. The results further revealed that sole crop of soybean gave better performance in respect of seed yield ha^{-1} and yield contributing parameters. While seed yield and other yield contributing parameters of soybean were significantly affected in intercrop treatments due to competition with main crop.

Adhikari *et al*. (2005) conducted a field experiment for bio-economical evaluation of maize-groundnut intercropping system and revealed that sole groundnut recorded significantly high maize-equivalent yield (79.28 q/ha), net returns (Rs. 23,238/ha) and benefit : cost ratio (2.38), followed by maize + groundnut in 2:2 ratio (62.26 q/ha, Rs 18,595/ha and 2.32 respectively). The yield of maize did not vary much for intercropping, but the pod yield of groundnut was reduced by 52.2% and 47.7 % by intercropping with maize.

Chalka and Nepalia (2006) conducted a field experiment on maize intercropping with legumes and reported that all intercropping systems produced higher biological yield of crops over sole crops.

Padhi and Panigrah (2006) studied the maize based intercropping system and revealed that intercrop blackgram followed by soybean was found better than groundnut. Maize with soybean and maize with black gram significantly recorded the highest maize-grain equivalent yield of 25.7 and 11.8 q/ha at 1:1 row ratio respectively.

Adeniyan and Ayoola (2007) conducted a field experiments and results indicated that intercropping depressed maize grain yield and cassava fresh tuber yield. The response observed in the yields of maize and cassava under soybean varieties in intercropping systems with maize and cassava was not significant. Soybean plant height at harvest, number of days to 50 percent flowering, number of pods per plant, weight of 100 seeds and seed yield were significantly affected by intercropping systems. The higher values (18.53 g and 0.87 t/ha) were obtained for 2001 compared to that of 2002.

Adu- Gyamfi *et al*. (2007) reported that intercropping maize with legume are able to reduce the amount of nutrients taken from the soil as compared to a maize monocrop. During absence of nitrogen fertilizer, intercropped legumes will fix nitrogen from the atmosphere and not compete with maize for nitrogen resources.

Bharati *et al.* (2007) conducted a field study on winter maize-based intercropping systems and reported that sole maize; maize-potato; maize-rajmah; and maize-toria, resulted maximum maize equivalent yield under maize-potato system (123.48 and 140.07 q/ha), followed by maize-rajmah (83.83 and 82.64 q/ha) and maize-toria (57.73 and 61.86 q/ha).

Bharati, *et al.* (2007) conducted a field experiment on maize-based intercropping systems and reported that intercropping of maize reduced the maize yield but significant reduction was recorded only in french bean and toria intercropping system. All the intercrops with maize recorded significantly higher maize-equivalent yield than sole cropping of maize. Sole cropping of maize recorded the maximum net return per rupee of investment. Among intercropping systems, maize + potato generated the highest net return followed by maize + rajmah.

Channabasavanna *et al.* (2007) conducted a field experiment on maize-based intercropping systems to study the productivity and economics of different intercropping systems in maize The data revealed that among different intercrops, maize + sesame produced the highest maize equivalent yield (8115 kg/ha), net returns (Rs. 15 657/ha) and cost-benefit ratio (2.36). This was followed by maize + soybean.

Marer *et al.* (2007) conducted a field experiment on productivity and economics of maize and pigeonpea intercropping and reported that sole crop of maize and pigeonpea recorded significantly higher grain yield (6337 and 1090 kg/ha respectively) over intercropping systems. Intercropping gave the maximum maize equivalent yield (8076 kg/ha), net returns (Rs. 30492/ha) and B:C ratio (2.75) over sole crops.

Muoneke *et al.* (2007) conducted a field experiments to study the performance of maize/soybean intercropping and results revealed that intercropping reduced the number of soybean pods per plant by 46% in the early season and seed yield by 42 and 46% in the early and late seasons, respectively. Maize plant height and leaf production were not influenced by intercropping. The productivity of the intercropping system indicated yield advantage of 2-63% as depicted by the LER of 1.02-1.63 showing efficient utilization of land resource by growing the crops together and this increased with maize planting density. The total monetary return was higher for the intercrops than the sole crops with the values highest with 53 330 and late (283 069.70) seasons.

Singh and Singh (2007) in a field experiment conducted at Manipur to investigate the effect of intercropping maize with cowpea on fodder yield reported that the plant height, green fodder yield, and dry matter production of maize were significantly higher at intercropping with cowpea than sole crop of maize. All the intercropping were superior in terms of fodder yield values compared to sole crop maize

Alom *et al.* (2008) carried out an experiment in maize + mungbean intercropping systems and reported grain yield of maize was at par with sole and intercropped but mungbean yield as sole crop was significantly higher than intercropped system. Maize equivalent yield (9.61 in 2004 and 10.85 t/ha in 2005), mungbean equivalent yield (5.49 in 2004 and 6.20 t/ha in 2005) and land equivalent ratio (1.51 in 2004 and 1.56 in 2005) were found maximum in intercropping systems than sole cropping.

Amit Yadav *et al.* (2008) reported on maize based intercropping that intercropping gave the highest grain (59.41 q/ha) and maize equivalent yields (74.17). The increased over sole cropping of maize and intercropping in replacement was, respectively, 9 and 90% in grain yield and 36 and 55% in maize equivalent yield.

Kumar *et al.* (2008) conducted a field experiment on maize intercropping and reported that intercropping of maize with urdbean significantly increased the leaf area index, dry matter production, and grain yield maize equivalent over sole crop of maize during both years.

Lingaraju *et al.* (2008) studied on intercropping of maize and pigeonpea and reported that though intercropping resulted in significant reduction in the yield of sole crops, it was better compensated by components crops in terms of total yield and income.

Mudita *et al.* (2008) indicated from his experiment that intercropping maize with soybean was more efficient than sole cropping with regard to Land Equivalent Ratio (LER) and income.

Ojikpong *et al.* (2008) conducted a field experiments on intercropping of maize with sesame and reported that the maize growth and yield were not adversely affected by the intercropping as compared with sole crop. Yield reductions due to intercropping were 28.0, 44.7, 61.1 and 61.0% respectively. Intercropping maize with sesame resulted in high yields from both crops and a high land equivalent ratio of 1.33.

Sangtam *et al.* (2008) conducted a field experiment in Nagaland, during the summer of 2003 to study crop yield and returns in a maize-based intercropping system. Sole crop of maize recorded the highest grain yield. However, maize + ginger and maize + French bean (*Phaseolus vulgaris*) intercropping systems gave the highest returns.

Sharma *et al.* (2008) conducted a field experiment to assess the production potential and economic viability of intercropping of forage sorghum, pearl millet and maize with cowpea, rice bean and cluster bean. Pooled analysis of data revealed that intercropping of sorghum and cowpea recorded the highest total green fodder (557.0 q/ha), dry matter (131.9 q/ha) and crude protein yield (11.76 q/ha) as well as net return (Rs. 21025/ha) and benefit:cost ratio (2.05). It was statistically at par with the combinations involving rice bean and cluster bean with sorghum as well as cowpea and rice bean with pearl millet. Monetary advantage ranged from Rs. 1053/ha with intercropping of maize and cluster bean to Rs. 5899/ha under sorghum+cowpea. Land equivalent ratio and relative crowding coefficient were more than 1 in all intercropping system. Maximum values 1.39 and 6.58 were obtained in sorghum+cowpea intercropping system. Among the component crops, sorghum with cluster bean was more competitive and aggressive than other cereals + legumes combinations. However, maize intercropped with cowpea was found to be most compatible intercropping systems with lower values of aggressivity (0.11) and competition ratio (1.20).

Ummed *et al.* (2008) conducted a field experiment to evaluate the production potential, biological feasibility and economic viability of intercropping of maize with french bean, cowpea, soybean and green gram and reported that the grain yield of sole maize was higher than the intercropping, but the total grain equivalent yield of maize was highest (4.87 t/ha) in maize + french bean (2:2) intercropping system. Intercropping of maize with frenchbean in 2:2 row proportion gave maximum monetary advantage (Rs 6586/ ha), net returns (Rs 16462/ha), income-equivalent ratio (1.38) and benefit: cost ratio (1.96) over other intercropping systems. This treatment accounted for maximum land equivalent ratio (1.36).

Ylmaz *et al.* (2008) in an experiment conducted on maize based intercropping reported that intercropping was superior in terms of yield, land use efficiency and economics as compared to sole crop.

Banik and Sharma (2009) reported that legumes yield was significantly reduced when intercropped with baby corn. However, total productivity in terms of baby corn yield equivalent (7063 kg/ha) was highest under the baby corn-groundnut intercropping system, and land use efficiency was higher under the intercropping system as compared with monocrops of either species. There was a significant increase in atmospheric nitrogen fixation by the legumes for the intercropping system over monocrops. Baby corn facilitated an increase in nodule number and dry weight in legumes under intercropping over monocrops. These findings suggest that intercropping baby corn and legumes, particularly groundnut, can increase total productivity per unit area, improve land use efficiency, and increase atmospheric nitrogen fixing ability.

Eskandari and Ghanbari (2009) conducted a field experiment on intercropping of maize and cowpea, the results showed that intercropping systems had a significant effect on forage dry weight, where dry matter yield was increased by intercropping as compared with maize and cowpea sole crops. It was related with a higher consumption of environmental resources, such as photo synthetically active radiation and soil moisture, by intercropping. Maize forage quality in terms of crude protein was improved by intercropping. It was because of more nitrogen availability for maize in intercropping compared with its sole crop.

Dolijanovic *et al.* (2009) conducted a field study on intercropping of maize and soybean interaction, and reported that comparison with the intercropping production of monocrops production of maize and soybean, with the index LER, the results obtained indicate that there is more intercropping production. The increase of grain yield in the intercropping in relation to monocrops of maize and soya bean was 49%.

Gao Yang *e al.* (2009) conducted a field experiment on effect of monoculture and intercropping. Results showed that there was no significant maize biomass difference between the intercropping and monoculture before 79 days after sowing. After the 79-day period, maize biomass in the intercropping became significantly higher than that of maize monoculture at 0.01 probability level. Soybean biomass of intercropping and monoculture was significantly different. Grain yields for monocultured maize and soybean were more than those for intercropping treatments. However, total yields for intercropping treatments were 6.0 and 320% higher than the yields for monocultured maize and soybean respectively. Incomes from the 2 intercropping systems were 56-6% and 70-74% higher than those from monocultured maize and soybean.

Javanmard *et al.* (2009) showed that intercropping systems had a significant effect on the dry matter yield and also reported that in all intercropping treatments, land equivalent ratios (LER) were well above 1 indicating yield advantages for intercropping.

Katsaruware and Manyanhaire (2009) studied maize+cowpea intercropping and reported that sole cowpea grain yield was significantly higher than grain yield from their respective intercrops.

Parvender *et al.* (2009) conducted an experiment to find out the most suitable economically and biologically sustainable maize-based intercropping system under rainfed conditions. Intercropping of greengram with maize was found to have increased the total productivity by 15.7-44.5% in comparison to sole cropping of maize.

Satyam *et al.* (2009) conducted a field experiment to evaluate the productivity and economics of intercropping of maize with cowpea, soybean and red gram and revealed that maize intercropped with soybean and red gram could fetch better economic returns.

Singh *et al.* (2009) evaluated the yield and economics of winter maize-based intercropping system and result of the experiment showed that biological, grain and stover yields of maize were maximum and significantly higher in sole maize than the intercropping. However, among various maize-based intercropping system, maize + lentil + coriander was found to record significantly higher gross return and net return of Rs 44387/- and Rs 17399/-, respectively, followed by maize + lentil and the lowest gross return and B:C ratio were recorded under sole maize alone.

Suroshe *et al.* (2009) conducted a field experiment during *kharif* season on intercropping of maize with different legumes, to maximize the productivity and economic returns per unit area of maize based intercropping system under various fertility levels. Maize intercropped with cowpea was more compatible and advantageous than other legume intercropping. Various yield attributes of maize were superior under sole cropping, followed by maize + cowpea intercropping system. This combination recorded the highest maize-equivalent yield (52.94 q/ha) with 11.14% increased over sole maize.

Yu Chang Bing *et al.* (2009) reported that intercropping of maize with soybean restricted the growth of maize before anthesis, but benefited its growth and nutrients absorption thereafter. The growth of maize was significantly restricted in intercropping with wheat when the two crops were in the field and was gradually restored to normal after wheat harvest. Land equivalent ratio (LER) of biomass at harvest was >1 when maize was intercropped with faba bean but<1 when it was intercropped with soybean. There was no significant effect in intercropping as compared to sole crop.

Dahmardeh *et al.* (2010) conducted an experiment of intercropping maize and cowpea and results indicate that intercropping can increase nutrient elements of soil compared to sole maize and improve conservation of soil fertility. It also has significant effects on soil fertility and crop yield. LER (land equivalent ratio) values were greater in all intercropping systems which indicated yield advantage of intercropping over sole cropping of maize.

Munirathnam, and Kumar (2010) conducted an experiment to study the productivity and nitrogen use efficiency of maize + soybean intercropping system at different levels of nitrogen. The results revealed that different systems significantly influenced the MGEY (2648 kg/ha) in both the years of study which was comparable with sole maize (2563kg/ha).

Parvender *et al.* (2010) conducted a field experiment to assess the production potential, biological and economic feasibility of intercropping maize with blackgram. Results revealed that intercropping blackgram with maize was found to be beneficial in increasing the total productivity and yield advantage as compared to monocultures of both maize and blackgram.

Tehran (2010) conducted a field experiment on maize and soybean intercropping and results showed that intercropping of maize and soybean gave the highest Land Equivalent Ratio (1.37) and the highest grain yield.

Tripathi *et al.* (2010) conducted a field experiment on maize -based intercropping systems under irrigated conditions and revealed that the values of land equivalent ratio (LER) and area-time equivalent ratio (ATER) with all the intercropping systems were greater indicating advantage in yield, land-use efficiency and monetary return/unit time and space over the respective monocultures. All the intercrops with maize recorded significantly higher maize-equivalent yield than the sole crop.

Solanki *et al.* (2011) conducted a field experiment on maize based intercropping systems. The results indicated that the highest maize grain equivalent yield of 5.381 and 4.948 t/ha was recorded under maize + blackgram (2:2) intercropping during 2007-2008, respectively which was significantly superior over sole maize by 21.1 and 12.4%.

2.3 Nutrient management in maize based-intercropping

Kalra and Gangwar (1980) conducted a field experiment to study the response of maize to intercropping of legumes at different levels of N for total grain yield and monetary return under rainfed condition. Average increased of total grain production ranged from 29.5-92.5 %. Higher net returns were obtained with intercropping treatments over pure cropping of maize. Application of nitrogen at the rate of 80-120 kg/ha increased the total production by 29.0 to 37.5 percent compared with 40 kg/ha. However, application of 80 kg N/ha was economical.

Shrivastsva *et al.* (1983) studied maize intercropped with legumes and found that combined yield of maize + intercrops increased significantly (7.8 to 29.2 q/ha) with the increasing doses of nitrogen upto 120 kg/ha. Maize + black gram gave maximum yield (41.6 q/ha) and gross income (Rs. 4423/ha) at 120 N/ha followed by maize + groundnut.

Bhatt and Damor (1985) conducted a field experiment during *kharif* season on intercrops. Results showed that the grain yield of maize did not differ significantly from each other. This shows that different legume crops had no adverse effect on the yield of maize. However, the highest yield was recorded by maize groundnut (42.4 q/ha) with 100% recommended dose of fertilizer to groundnut which was 21% higher than sole maize (35.0 q/ha). Legumes when intercropped with maize revealed that the maximum grain yield was obtained 100% fertilizer application in all the legumes compared to no fertilizer or supply of 50% fertilizer. Maximum yield was obtained in case of groundnut followed by green gram, while the lowest was in black gram.

Singh *et al.* (1986) carried out a field experiment on intercropping of legumes in maize under different levels of nitrogen and reported that grain yield of individual maize and legume crop was obtained at 20 and 40 Kg N/ha respectively. The combined yield of both the crops increased significantly with the increasing level of nitrogen upto 80 kg N/ha.

Chui (1988) conducted an experiment on maize intercropped with six rates of N from 0 to 130 kg/ha. Results revealed that effects of N fertilizer on maize or bean yield at maturity were not significant although there was a tendency for applied N to increase yield components of beans as a sole crop or in intercrop. Maize grain yield was not significantly affected by treatment Intercropped beans took up more N, P, K, Mg and Ca than sole beans; with the greatest uptake in intercrop. Maize sole crop took up more nutrients than in intercrop. Nutrient concentrations were higher in beans than in maize, and total nutrient uptake was greater in the intercrops than in sole crop maize.

Jeyaraman *et al.* (1988) reported from his experiment that application of additional dose of 25 kg N/ha in simultaneously sown maize + cowpea intercropping system was found at par with staggered sown maize + cowpea intercropping systems. Highest net income was from maize + cowpea sown simultaneously with extra dose of 25 kg N/ha.

Chakor and Kumar (1988) conducted an experiment on maize + soybean intercropping system and revealed that application of 125% of recommended fertilizer dose of maize recorded significantly higher yields of both the crops over other fertilizer treatments closely followed by 100% recommended dose of maize + 100% recommended dose of soybean in the first year but in the second year it was 75% of recommended dose of maize + 100% recommended dose of soybean.

Siame *et al.* (1989) conducted a field trial in intercropping system with different rates of 0, 30, 60, 90 or 120 kg/ha nitrogen fertilizer doses and reported that maize showed a good response to N in the sole crop as well as in intercropping systems. Land equivalent ratios (LERs) were well above 1 for intercropping systems. LERs increased with an increase in the level of N. there was a slight decrease in yield in intercropping maize with no fertilizer. For any level of N used, returns to the cost of N and the overall net returns were greater from intercropping than sole cropping.

Badiyala and Verma (1991) showed from their experiment on integrated nitrogen management in maize + soybean that the maize grain yield increase significant with the increase in nitrogen level from 0 to 120 kg N/ha, whereas there was a consistent and significant reduction in grain yield of soybean with the addition of nitrogen.

Venugopal and Shivashankar (1991) conducted a field experiment on the effect of maize crop residue and nitrogen levels on productivity and economics of maize + soybean under paired row system of planting maize. Nitrogen application increased the number of cobs, grain number and grain weight besides reducing the barrenness, resulting in increased net returns from Rs 3,773 and Rs 2,561 in the control to Rs 10,407 and Rs 8,310 at 80 Kg N; and Rs 13,210 and Rs 13,210 and Rs 14,974 at 160 kg N/ha during the winter and rainy season respectively. The maize grain yield increased from 2,281 and 887 kg/ha in the control to 5,398 and3,948 kg at 80 kg N and 7,026 and 7,363 kg at 160 kg N/ha during both season.

Chowdhury and Rosario (1992) conducted a field experiment on utilization efficiency of applied nitrogen as related to yield advantage in maize and results revealed that applied N at high levels increased the partial LER of maize but this failed to increase LER due to corresponding reductions in partial LER of mungbean. 30 kg N produced the highest LER (1.40). Applied N increased N uptake of maize but decreased that of mungbean. A large reduction in N uptake of intercropped mungbean was observed when they flowered at 33 DAS but maize was affected 2 weeks later at the tasselling stage. Thus, the competition for N was acute when the crops were at the reproductive stage. The LER analysis in terms of N utilization efficiency showed that N absorption efficiency of maize and mungbean was reduced due to intercropping, and mungbean were more affected than maize. Increased in applied N reduced N absorption by mungbean although it increased that by maize. Total N absorption by intercropped maize and mungbean was greater than that of the sole crops combined. The N conversion efficiency, measured as the amount of grain produced per unit of N absorbed, decreased in maize due to intercropping but increased slightly in mungbean. The absorption term contributed more to an increase in LER over unity than the conversion term.

Varshney (1993) reported from his field experiment during the *kharif* season, maize grown alone or intercropped with urd, soybean or cowpeas and given 50 kg N + 30 kg P_2O_5/ha or 2 or 3 times these rates and revealed that grain/seed yields were not significantly increased by NP rates above 50 kg N + 30 kg P_2O_5.

Sharma (1994) conducted a field trial in pure stands or as maize-legume intercrops. Maize was given 50, 75 or 100% of the recommended fertilizer rate of 90 kg N + 45 kg P_2O_5 + 30 kg K_2O/ha, while the legumes were given 0, 50 or 100% of the recommended rate of 15 kg N + 45 kg P_2O_5 .Maize yield increased with increasing fertilizer rate. Legume yields were greatly decreased by intercropping. The maize-equivalent yield was highest in the maize-legume intercrops with the recommended fertilizer rates applied to maize. Legume yields were not significantly affected by fertilizer rates.

Sharma, (1995) conducted field trials during *kharif* seasons on maize-legume intercropping systems under varying nitrogen levels and reported that maize and intercrop yields increased linearly with up to 120 kg N/ha. The increase in maize yield with intercropping compared with sole cropping was greatest at lower levels of N application.

Bhattacharya and Gautam (1996) conducted a field trial in rainy season, maize grown alone or intercropped with soybeans or black gram was given 0, 30 or 60 kg N/ha, sole-cropped maize was given 90 kg N/ha. Maize yield was generally increased by both intercropping and applied N. Maize grain equivalent yield was highest from maize intercropped with black gram and given 60 kg N/ha.

Varughese and Iruthayaraj (1996) conducted a field experiment on maize and soybean intercropped with 94, 125 or 156 kg N/ha (1989) and 62.5, 125, 187.5 or 250 kg N/ha (1990). In the first year maize grain increased with the rate of nitrogen application whereas in the second year it increased with up to 187.5 kg N/ha.

Kushuwaha and Chandel (1997) conducted a field experiment on maize and soybean intercropped with 0, 50, 100 or 150 kg N and reported that the maize-equivalent grain yield increased with up to 50kg N in the intercrop and was higher than that of the sole crop receiving 120 kg N.

Barik, A.K. *et al.* (1998) conducted a field experiment on sorghum and groundnut intercropping system with different levels of nitrogen and indicated the advantage of intercropping over sole cropping from the values of land-equivalent ratio, relative value total and relative net return. Application of the highest dose of N (120) kg/ha) resulted in higher green and dry forage yields of sorghum compared to lower doses. Higher pod yield of groundnut was obtained from an application of 40 Kg N/ha.

Krishna *et al.* (1998) revealed that nitrogen application on fodder maize intercropped with cowpea had significant linear response. At 180 kg/ha green and dry fodder yields of 27.14 and 5.13 tones/ ha were recorded. Higher nitrogen application lowered crude fibre content.

Nabavi and Mazaheri (1998) conducted a field experiment on maize and soybean intercropped with 0, 100, 200 and 300 kg N/ha and reported that the maize grain and soybean seed yield increased up to 200 kg N. Land equivalent ratio was highest (2.53) with the 25: 75 maize:soybean intercrop given 200 Kg N.

Singh *et al.* (1998) conducted a field experiment on productivity and nutrient balance of maize and blackgram intercropping with 50-100% fertilizer (20 kg N and 17.6 kg P/ha) to blackgram and component crops fertilized separately indicating that 50% fertilizer to blackgram could be saved without any significant reduction in production potential of the system. Total P uptake in maize + blackgram intercropping decreased by 16-18% in maize and 40-50% in blackgram compared with sole cropping. Separate fertilization to both the component crops had an edge over uniform fertilization for gain in soil-available N and K.

Zhan *et al.* (1998) conducted a field trial on intercropped maize and groundnut with 0, 225, 450 or 675 kg N with 750 kg P_2O_5 /ha or 375, 750, 1125 or 1500 kg P_2O_5 with 75 kg N/ha and reported that groundnut yields increased with the increasing rate of N. Maize yield also increased with decreasing rate of irrigation and increased from 1.48t/ha with no N to 1.65t with 450 kg and 1.45t with 675 kg N/ha. And from 1.42t with 375 kg P_2O_5 to 1.52 t with 1125 kg, then decreased to 1.48 t with 1500 kg P_2O_5 /ha.

Saren and Jana (1999) conducted a field trial in intercropping maize and groundnut and reported that the total NPK uptake was higher in intercropping systems than in pure stands.

Arya and Singh (2000) conducted a field experiment to study the different levels of phosphorus and resulted that application of 90 kg P_2O_5 /ha gave significantly higher grain and straw yields, nutrient uptake and protein yield, compared with 60, 30 and 0 P_2O_5 /ha.

Hassan and Baswaid (2000) conducted an experiment to study the effect of N and P application on the growth and yield of maize as mono and intercropping with black gram with four treatments, control, N, P and NP. Results revealed that nitrogen treatment in monoculture led to an increase in length, leaf area ear height. Under intercropping N treatment was superior to the other treatments. N application gave higher yields in intercropping than monoculture.

Moses *et al.* (2000) carried out a field experiment on maize intercropping with legumes at different levels of fertilizers, maize was given 80:40:20 kg NPK/ha and the intercrops were given no fertilizer or 10:25:10 or 20:50:20 kg NPK/ha. Maize yield was highest when intercropped with pigeonpeas, and increased with increasing fertilizer applied to the intercrops.

Palled *et al.* (2000) conducted an investigation on integrated nutrient management in alley cropped maize-groundnut system with *Subabul*. The NPK recommended rate for groundnut and maize was 25:75:37.5 and 150:75:75 kg/ha, respectively and reported that the maize grain yield at the recommended dose of fertilizer alone was at par with that of 75% N with green manure during three years. The pod yield at 50% recommended rate of fertilizer with green manure was at par with that of recommended rate of fertilizer alone.

Shivay and Singh (2000) conducted a field experiment on growth, yield attributes, yields and nitrogen uptake of maize as influenced by cropping systems and nitrogen levels with 4 nitrogen levels of nitrogen rates i.e. 0,40, 80 and 120 kg/ha and reported that the plant height, LAI and dry matter accumulation were significantly increased with increasing N levels. The highest plant height and dry matter accumulation were recorded with 120 kg N /ha. Significant differences were observed due to different nitrogen levels. Increased application of N reduced barrenness compared to control. Increasing N levels had a significant effect on grain yield in both the years. The highest yield was recorded with 120 kg N /ha (36.5 q/ha) and the maximum N uptake was recorded under maize + urd bean which was higher than maize + soybean and sole maize. Significant increases in N uptake with increasing N levels were recorded in both the years.

Singh *et al.* (2000) conducted a field experiment on maize intercrops. The treatment comprised of sole maize, maize + pea and maize + lentil with 0, 50, 100, 150 and 200 kg N/ha and revealed that maize grown with legumes accumulated significantly more dry matter and nitrogen than in sole stand. The highest dry matter production and nitrogen uptake were recorded in maize + pea cropping system. Dry matter production and N content of component crops exhibited an increasing trend with increasing N levels. Total N uptake increased significantly up to 150 kg N/ha in sole maize and up to 100 kg N/ha in intercropping system

Singh *et al.* (2000) conducted an experiment on maize intercrops with 0, 50, 100, 150 and 200 kg N/ha and recorded that maize responded to N application upto 200 kg N/ha in sole stand and upto 150 kg N/ha in intercrops.

Tijani-Eniola *et al.* (2000) from their study on the effects of different N rates on maize and soybean intercrop with 3 N levels (0, 30 and 60 kg/ha) and 3 cropping systems (sole maize, sole soybean and maize/soybean in alternate rows). Plant height and leaf area indices were significantly increased for both maize and soybean from 6 weeks after sowing by the application of N fertilizer. The 30 kg N/ha dosage showed comparable effects with 60 kg N/ha; produced 10% increment in soybean height and 9% increment in maize height compared to control. N fertilizer increased dry matter by 17% at 50% flowering in soybean and by 11% at 50% silking in maize. Grain yield was increased by 32% with the application of 30 kg N/ha in soybean. Highest grain yield (3.25 t/ha) was obtained from treatment with 60 kg N/ha in soybean. These results indicate that 30 kg N/ha is adequate for good performance of soybean. The land equivalent ratio of >1 for the cropping system suggests an advantage in intercropping maize with soybean.

Misra *et al.* (2001) carried out an experiment on winter maize based intercropping system under different fertilizer levels. Maize grown with lentil was more advantageous than rajma and mustard and recorded the highest average maize yield (74.0 q/ha), intercrop yield (11.4 q/ha), maize-equivalent yield (104.3 q/ha), N, P and K uptake (168.9, 23.7 and 158.7 kg/ha, respectively), Application of up to 100% of the recommended fertilizer rate to the intercrop increased maize, lentil and maize-equivalent yields (69.5, 11.1 and 93.5 q/ha, respectively), nitrogen, phosphorus and potassium uptake (159.1, 25.4 and 145.8 kg/ha, respectively) However, gross returns, net returns and benefit:cost ratio of Rs. 47 865/ha, Rs. 30 764/ha and 1.80 respectively increased with the increased up to 50% of the recommended fertilizer rate. Growth and yield components, i.e. plant height, dry matter accumulation, leaf area index, rows per cob, test weight and shelling percentage, showed trends similar to those of yields

Ranbir *et al.* (2001) conducted an experiment on maize/legume intercropping to optimize NPK fertilizer requirements to legume component in maize and results indicated that NPK fertilizer application produced significantly taller plants and higher LAI whereas 1000 grain weight was not affected. The legume yield in intercropping was higher at 100% NPK fertilizer application compared to 50%. 100% and 50% NPK application did not significantly increase maize yield.

Dey (2003) conducted an experiment on effect of phosphorus fertilization on quality parameters of soybean +maize intercropping system and reported that the total removal of P was higher in maize than that of soybean due to high vegetative growth of maize. The highest value of uptake was recorded at 1:2 with 40 kg P/ha.

Quiroz and Marin (2003) in an experiment showed that maize grain yields were 6938 and 7665 kg/ha in untreated and fertilizer-treated monoculture plots, and 7030 and 7507 kg/ha in untreated and fertilizer-treated intercropped plots, respectively The efficiency indexes land equivalent ratio, area-time equivalency ratio and area-harvest equivalency ratio showed the advantages of intercropping in relation to monocultures.

Panhwar *et al.* (2004) studied the performance of maize in intercropping system with soybean with different nitrogen level during *kharif* season and the results indicated that plant height, number of leaves per plant, 1000 grain weight of maize increased with an increase in nitrogen levels. Maximum grain yield of 1692 kg/ ha was recorded from highest dose (120 kg N/ha).

Adhikari *et al.* (2005) conducted a field experiment for bio-economical evaluation of maize - groundnut intercropping system at varying doses of nitrogen (0, 30 and 60 kg/ha) and reported that 30 kg N/ha recorded better performance than 60 kg N/ha. The uptake of NPK was found maximum (300.62kg/ha) by maize + groundnut (2:2) and least was by sole groundnut (132.20 kg/ha).

Khokhar *et al.* (2005) conducted a study during *kharif* season in intercropping of maize and soybean with 5 fertilizer rates (100% recommended dose of N and P to soybean and maize(F1), 60% N of maize +100% P of soybean (F2), 80% N of maize +100% P of soybean (F3), 100% N of maize +100% P of soybean (F4), and 120% N of maize +100% P of soybean (F5); and 2 cropping systems (intercropping and sole cropping). Application of F1 resulted in the significantly highest N, P and K contents in seed and straw, significant increase in yields of soybean seed and maize grain, and significantly highest soybean equivalent yield (24.8 q/ha) among all treatments. Soybean yield declined while maize yield increased with increasing N rates of maize up to 120%. Intercropping reduced the N content of straw, P content of seed, and maize grain yield, but increased the soybean equivalent yield. N content in seed and P content in straw and K content in both seed and straw recorded from both cropping systems remained at par with each other.

Ashok *et al.* (2006) conducted a field experiment during the winter of 2001-02 and 2002-03 to study the response of various winter maize –based intercropping systems to different fertility levels (50, 75 or 100% of the recommended N, P and K rates) on sandy loam soil. Sole maize resulted in the highest yield of maize. The fertilizer level also affected the growth and yield of maize. The highest total productivity of intercropping system was obtained when the recommended fertilizer rates were applied to both maize and intercrop. However, the net return/rupee invested was highest with the application of 75% of the recommended rates of fertilizers to maize and intercrop. The residual contents of organic carbon, and available nitrogen, phosphorus and potassium did not vary among the cropping systems. However, the highest residual contents of organic carbon, and available nitrogen, phosphorus and potassium were observed when the recommended rate of fertilizers was applied to both maize and intercrop.

Chalka and Nepalia (2006) conducted a field experiment nutrient uptake appraisal of maize intercropping with legumes and results revealed maize intercropped with cowpea and soybean produced significantly lower NPK depletion by them. Maize + soybean resulted in higher N uptake while all intercropping systems were at par and resulted in significantly higher P uptake than sole maize. While K uptake by crops was unaffected by intercropping systems.

Meena *et al.* (2006) conducted a field experiment on maize + soybean intercropping with 2:2 ratio sown at 30cm distance with each other. And reported that application of 75% recommended doses of fertilizer (RDF) to maize (90 kgN/ha and 40 kg P/ha) and 50% to soybean (60 kg N/ha and 40 kg P/ha) significantly increased their respective yields, maize-equivalent yield, net returns and benefit cost ratios over 50%RDF in maize and no fertilizer in soybean. Increasing levels of fertility to maize and soybean up to 100% recommended dose increased the total nutrient uptake significantly over 75 and 50% in the both crops in intercropping system.

Padhi and Panigrah (2006) conducted a field experiment on maize-based intercropping system and revealed that intercropping increased available soil N and decreased both P and K content compared to initial available soil NPK content after sole maize. Available soil NPK content varied with the kind of intercrops. However, maize +soybean followed by maize + black gram recorded the highest available soil NPK.

Meena and Singh (2007) conducted an experiment to study the performance of maize + soybean intercropping systems at different nutrient levels and results revealed that increasing levels of fertility of maize and soybean significantly increased in yield and growth parameters, maize equivalent yield upto 75% of recommended 90 kg N and 40 kg P with maize and 50% of 60 kg N and 40 kg P of soybean, respectively.

Quiroz and Marin (2007) conducted an experiment to evaluate the use efficiency of N, P and K in plants of maize and pigeonpea sown as monocrops or intercrops. The results showed a higher absorption of N and K in intercropping corn in comparison with sole crop. In pigeonpea, there was a higher accumulation of N and P in the sole crop plot, and the intercropping was more affected independently of the fertilizer application. The land equivalent ratio (LER) for NPK, based on their absorption and conversion efficiencies, indicated advantages of intercropping over the sole crop regardless of the fertilizer application.

Jiao *et al.* (2008) conducted an experiment to study the effects of N application, N and P absorption in maize-groundnut intercropping system. Results indicated that the yield, N and P absorption of intercropping maize increased significantly; however, the yield and N absorption of intercropping groundnut was reduced in the intercropping system, compared with monocropping maize or groundnut, respectively. The land equivalent ratio for yield (LER) was above 1, and the land use ratio was enhanced by 8-17%, implying obvious intercropping dominance. Compared with zero N application, N fertilizer increased yield of maize and groundnut in the intercropping system by promoting the accumulation and absorption of N and P, enhancing P use efficiency, but the intercropping dominance was weakened with the increase in N fertilizer.

Kumar *et al.* (2008) conducted an experiment to study the influence of integrated N management and intercropping on the growth, yield attributes, yield and N uptake of maize. The treatments consisted of 2 cropping systems: sole maize and maize + urdbean, 3 N levels (40, 80 and 120 kg/ha. Intercropping of maize with urdbean significantly increased the leaf area index, dry matter production, grain yield maize equivalent and N uptake of maize over sole crop of maize during both years. Growth parameters, yield attributes, grain yield, maize grain equivalent yield and total N uptake by maize increased significantly with increasing N rate.

Latha and Prasad (2008) conducted an experiment to determine the productivity of maize and green gram intercropping with different NPK fertilizer levels. Results revealed that yield, equivalent yield, net returns and benefit cost ratio were significantly influenced by intercropping and NPK fertilizer levels. Higher yield was obtained due to the application of 25% extra RDF to maize in intercropping indicating the need for higher fertilizer application of the intercropping to meet the fertilizer demand of both crops. The gross returns, net returns and the benefit cost ratio were significantly higher when paired row planting of maize + green gram was supplied with 125% RDF on clay loam soils.

Li YuYing *et al.* (2008) determined the effects of nitrogen application rates on the productivity, nitrogen uptake and utilization, and soil inorganic nitrogen accumulation in maize intercropping system. The results showed that the correlations between the productivity and soil inorganic nitrogen accumulation and nitrogen fertilizer were significant. When compared to the sole cropping system, intercropping significantly increased the system productivity and nitrogen acquisition by 23 and

33%, respectively. The productivity, nitrogen uptake and utilization efficiency, and soil inorganic nitrogen accumulation of intercropping increased with increased nitrogen application rate, indicating that over abundant nitrogen uptake exited under high nitrogen fertilizer and intercropping. The optimum nitrogen application rate was 186 kg/hm2 considering both ecological and economic benefits. At this rate, intercropping productivity was 1.06x104 kg/hm2, increasing productivity by 14%, saving 38% nitrogen input, and deceasing 75% inorganic nitrogen accumulation, compared with sole cropping system.

Sawargaonkar *et al.* (2008) conducted an experiment to determine the optimum maize-based legume intercropping system and fertilizer treatment. Soybean, black gram and green gram were intercropped with maize, and N, P and K at 75, 100 or 125% of the recommended rates (RDF; 30:60:30, 25:50:0, 25:50:0 and 100:75:75 kg/ha, respectively) were supplied to these plants. The maize-based intercropping systems were more remunerative than sole maize. Maize + black gram and maize + green gram were superior to maize + soybean for grain yield and parameters related to competitive ability. The highest competitive ratio was recorded from maize + soybean intercropping system. The relative crowding coefficients revealed that maize was the dominant species in all intercropping systems. In vertisol, maize + black gram was more advantageous, as reflected by the returns, benefit: cost ratio and competitive parameters. The application of 125 and 100% RDF resulted in higher maize grain equivalent yield and net monetary advantage over 75% RDF. However, 100% RDF registered a higher benefit: cost ratio than 125 and 75% RDF.

Ummed *et al.* (2008) conducted a field experiment to evaluate the production potential, biological feasibility and economic viability of intercropping of maize with french bean, cowpea, soybean and green gram and reported that Intercropping increased available soil N and decreased both soil P and K compared to initial and available soil N, P and K contents after sole maize. Available soil N, P and K contents varied with the kind of intercrops. However, maize + soybean, followed by maize + cowpea system recorded the highest available soil N, P and K among the various intercropping systems.

Anil Kumar and Thakur (2009) conducted an experiment to know the effect of legume intercropping and fertility levels on productivity and nitrogen balance in soil in maize based cropping sequence and results revealed that maize + cowpea (GM) and maize + soybean intercropping system being at par gave 31.9 and 26.9% higher maize yield over maize sole system. Maize responded to 100% fertility level application (5.22 t/ha). Significantly highest system productivity (25.2 kg/ha/day), system profitability (Rs.141.3/ha/day) and B:C ratio (2.74), and uptake were observed in maize + soybean-gobhi sarson system followed maize + cowpea (GM)-gobhi sarson system (22.9 kg/ha/day and Rs.126.1/ha/day). The balance sheet of N showed that there was maximum gain of N in maize + soybean-gobhi sarson sequence followed by maize + cowpea (GM)-gobhi sarson sequence. Application of 50% RDF in *kharif* showed the maximum gain of N in balance sheet, whereas the integrated treatment of 50%NPK+50% organics showed the lowest.

Satyam *et al.* (2009) conducted a field experiment to evaluate the productivity and economics of intercropping of maize with cowpea, soybean and red gram at different N levels (0, 40, 80, 120 kg/ha) under rainfed conditions on alfisols and revealed that though maize responded up to 120 kg N/ha, the maximum yield of soybean and red gram was recorded up to application of 40 and 80 kg N/ha, respectively.

Suroshe *et al.* (2009) conducted an experiment during *kharif* season on intercropping of maize with different legumes maize based intercropping system under various fertility levels and revealed that among the fertility levels, recommended dose of fertilizers (120:60:30 kg NPK/ha) proved more economic than rest of the fertility levels in maize-legume intercropping system.

Ye YouLiang and Li Long (2009) conducted a field experiment on wheat/maize intercropping with three nitrogen rates (0, 225 and 450 kg/ha) and three irrigation levels. The results showed apparent nitrogen utilization rate by plant, nitrogen production rate and the ratio of output to input were the biggest at 225 kg/ha of nitrogen rate.

Yu ChangBing *et al.* (2009) conducted an experiment on maize intercropping with nitrogen (N) at 0 and 225 kg/ha to study the effect of cropping system on the growth of the crops and their nutrient uptake. Compared with sole cropping, intercropping with maize promoted the growth of soybean before anthesis and inhibited its growth and nutrient uptake thereafter. Maize gave higher yield and absorbed more nutrients when intercropped with fababean. Intercropping with soybean benefited its growth and nutrients absorption

Dahmardeh *et al.* (2010) conducted an experiment of intercropping maize and cowpea on yield and soil chemical properties. Measurements of nitrogen, phosphorous, potassium soil and crop yield were carried out to study the effects of intercropping on crop yield in a cowpea-maize intercropping system and found that intercropping increased the amount of nitrogen (N), phosphorous (P) and potassium (K) contents compared to sole crop of maize. The highest amount of N, P and K in soil was obtained at sole cowpea and 100% cowpea+100% maize with no significant difference to 100% cowpea+50% maize. The lowest amount of N, P, and K was obtained at sole maize Results indicate that intercropping can increase nutrient elements of soil compared to sole maize and improve conservation of soil fertility.

Haseeb *et al.* (2010) in their field study on the impact of nitrogen application on the growth and yield of maize sole and in combination with cowpea and results showed that maize intercropped with cowpea and N at 225kg / ha gave higher grain yield of maize and cowpea. The maximum net income and cost benefit ratio was also obtained from maize intercropped with cowpea and N at 225kg/ ha.

Li Hai Gang *et al.* (2010) studied the phosphorus uptake in intercropped and mono-cropped maize in acidic soil and revealed that all plant species increased the pH compared to unplanted control, yield and P uptake were similar in mono-cropping and intercropping, intercropping of maize with legumes did not result in increased maize growth suggesting that the legumes did not increase P availability to maize in the acidic soil.

Munirathnam and Kumar (2010) conducted an experiment to study the productivity and nitrogen use efficiency of maize + soybean intercropping system at different levels of nitrogen. The results revealed application of 100% N produced significantly higher MGEY (2424 kg/ha) than other levels of N fertilization while the lower MGEY (1803 kg/ha) were produced with control. Higher mean net returns were obtained with sole maize (Rs.12504/ha.). Among the N levels, 100% RDN realized an amount of Rs.10888/-ha followed by 75% RDN with net returns of Rs. 9756/-.

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CHAPTER III

MATERIALS AND METHOD

A field experiment entitled "Nutrient management in maize (*Zea mays* L) based intercropping systems under the rainfed condition of Nagaland" was conducted in the experimental farm of School of Agricultural Sciences and Rural Development, Medziphema, Nagaland University. Campus: Medziphema, Nagaland, during the *kharif* season of 2008 and 2009. Details of materials used and procedures followed during the course of investigation are presented in this chapter.

3.1 Site of work

The location of the experimental site is situated at 25° 45' 45" N latitude and 95 ° 53' 04" E longitude at an elevation of 304.8 m above mean sea level.

3.2 Climatic condition of Medziphema

The climatic condition of the experimental site is sub-tropical in nature. The average rainfall varies between 1500 – 2000 mm. Most of the rainfall occurs during May to October. The mean temperature range varies between 15 °C – 35 °C during summer and rarely goes below 8 °C. The meteorological data recorded during the investigation periods are presented in Table-1a and Table-1b and Fig 1a and Fig 1b

3.3 Soil

The soil of the experimental field is sandy loam in texture, deep and well drained. To ascertain the fertility status of the soil, the composite soil samples were collected from different locations of the experimental plot from a depth of 0 to 15 cm with the help of soil auger. The representative samples of the soil were analyzed and the result thus obtained are presented in Table 2

3.4 Experimental details

Design and layout

The details of experiment are given below:

1) Experimental design : Split Plot Design (SPD)

Table 1a. Meteorological data during the period of investigation-2008

Month	Temperature		Relative Humidity (%)	Rainfall (mm)
	Max °C	Min °C		
May	31.66	21.35	50.45	189.30
June	30.70	23.25	67.13	297.90
July	31.15	24.25	63.09	223.80
August	31.5	24.86	67.86	207.60
September	30.35	23.05	66.86	286.60
October	23.38	20.70	64.10	171.30
November	26.79	13.80	47.20	0.00
December	24.50	12.40	50.26	6.50

Source: ICAR, Jharnapani

Table 1b. Meteorological data during the period of investigation -2009

Month	Temperature		Relative Humidity (%)	Rainfall (mm)
	Max °C	Min °C		
May	32.35	23.05	62.73	130.80
June	32.70	24.52	65.59	116.70
July	32.55	25.77	70.39	219.00
August	31.32	25.24	74.79	169.80
September	31.67	24.46	73.10	188.70
October	29.85	21.80	69.79	74.90
November	26.72	15.63	65.52	7.50
December	24.26	10.49	61.32	0.00

Source :ICAR, Jharnapani

2) Main plot treatment : Intercropping system

a) Maize + Groundnut (2:2)

b) Maize + Soybean (2:2)

3) Sub- plot treatment - Fertilizer doses

F_1	- Control
F_2	- 100% NPK to maize and intercrop
F_3	- 100% NPK to maize only
F_4	- 100% NPK to maize + 50% NPK to intercrop
F_5	- 50% NPK to maize + 100% NPK to intercrop
F_6	- 50% NPK to maize and intercrop

4) Replication	: 3
5) No. of treatment combination	: 2 x 6 = 12
6) Total number of plots	: 36
7) Net plot size	: 5 m x 4 m
8) Block border	: 1 m
9) Plot border	: 0.5 m
10) Based crop	: Maize
11) Intercrops	: Groundnut and soybean
12) Varieties	: Maize - Vijay composite Groundnut – JL-24 Soybean – JS- 80-21

3.5 Treatment details

The experiment was carried out with two main plot treatments (cropping system) and six (6) sub-plot treatments (fertilizer). There were twelve (12) treatment combinations. Name and symbol used for different treatments are shown here under.

Main plot treatment (Cropping System)

Maize + Groundnut - IC_1 (2:2)

Maize + Soybean - IC_2 (2:2)

Sub -plot Treatment

Maize + Groundnut (IC_1)

Treatment	**Symbol**
Control	IC_1F_1
100% NPK to both the crop	IC_1F_2
100% NPK to maize only	IC_1F_3
100% NPK to maize + 50% NPK to intercrop	IC_1F_4
50% NPK to maize + 100% NPK to intercrop	IC_1F_5
50% NPK to both the crop	IC_1F_6

Maize + Soybean (IC_2)

Treatment	Symbol
Control	IC_2F_1
100% NPK to both the crop	IC_2F_2
100% NPK to maize only	IC_2F_3
100% NPK to maize + 50% NPK to intercrop	IC_2F_4
50% NPK to maize + 100% NPK to intercrop	IC_2F_5
50% NPK to both the crop	IC_2F_6

3.6 Details of agronomic practices

The various agronomic practices that were carried out during the field experiment are given as follows-

3.6.1 Field preparation

The field was initially ploughed by tractor drawn disc plough followed by two light ploughing by tractor at an interval of one week and subsequently harrowing was done to crush the clods and to uproot and shred the remaining weeds and stubbles. After adequate preparation and levelling of field, plots were laid out as per statistical design as shown in Fig 1. Opening of the furrow was done with the help of furrow opener.

3.6.2 Manures and fertilizers

Recommended dose of fertilizers are given below

- 100% NPK for maize : 80: 60: 40 kg NPK/ha
- 100% NPK for groundnut : 20: 60: 40 kg NPK/ha
- 100% NPK for soybean : 20: 80: 40 kg NPK/ha

Well decomposed FYM was applied in the field @ 10 tonnes per ha before sowing at the time of last ploughing.

Maize seeds were treated with *Azospirillum* and *phosphotika* @20 gm per kg of seeds and groundnut and soybean seeds were treated with *Rhizobium* @20 gm per kg of seeds before sowing.

Different levels of fertilizer i.e. for 100%NPK - 80 kg nitrogen; 60 kg P_2O_5 and 40 kg K_2O / ha and for 50%NPK - 40kg nitrogen; 30 kg P_2O_5 and 20 kg K_2O /ha for maize plants. For 100%NPK - 20 kg nitrogen; 60 kg P_2O_5 and 40 kg K_2O /ha and 50%NPK - 10 kg nitrogen; 30 kg P_2O_5 and 20 kg K_2O/ ha for groundnut plants. For 100%NPK - 20 kg nitrogen; 80 kg P_2O_5 and 40 kg K_2O/ha and for 50%- 10 kg nitrogen; 40 kg P_2O_5 and 20 kg K_2O /ha for soybean. Nitrogen, phosphorus and potassium were applied in the form of urea, single super phosphate (SSP) and muriate of potash (MoP).

Fertilizers were applied in open furrow after harrowing and levelling below the seeds. For maize crop, half of the total quantity of nitrogen and the entire quantity of phosphorus and potassium were applied as basal dose below the seeds and the rest of the nitrogen was applied in two split as side dressing; at knee height stage and at tasselling stage. For groundnut and soybean crop full dose of nitrogen, phosphorus and potassium respectively were applied as basal dose at the time of sowing.

3.6.3 Seed rate and spacing

Recommended seed rate used during the field experiment (2008 and 2009) were given below-

Maize	: 20kg/ha
Groundnut	: 100 kg/ha
Soybean	: 75 kg/ha

Crops were planted in paired rows for all the crops i.e.2:2 row ratio. Spacing for maize crop was 30cm x 30cm and for groundnut and soybean it was 30cm x 15cm.

3.6.4 Sowing of seeds

Seeds were sown at about 5cm deep. Both the based crop and components crops were sown on 12th June in both the year (2008 and 2009). Seeds were sown in open furrows and blanking was done thereafter to cover the seeds.

3.6.5 Aftercare

Thinning was done after one week of germination wherever it was found necessary. Three manual weeding and hoeing were done with the help of hand hoe and kurpi during the entire cropping period. Weeding was always followed by earthing up.

3.6.6 Plant protection measures

Seeds were treated with captan @ 3gm/kg of seeds in order to prevent from seed borne and soil borne disease. Malathion dust 25 E.C @ 25 kg/ha was applied in the whole field just after sowing to protect from ants and termites. Carbofuran 3G @3-4 granules were applied to the leaf whorl of apical shoot to protect the crops against stem borer in maize plants. The infestation of blister beetle and grasshopper in groundnut and soybean plants were effectively controlled by spraying chloropyriphos 20 EC @ 1.5 ml per litre of water.

3.6.7 Harvesting and threshing

3.6.7.1 Maize

In the year 2008, maize was harvested on 11th September and 13th September in 2009. The crop was harvested when it was physiologically matured containing 25-

30% moisture and ears were removed before cutting the stalks. The grains were separated from cobs separately for each plot with the help of maize sheller. Grains were cleaned and sun dried upto 14 % moisture level.

3.6.7.2 Groundnut

Groundnut was harvested on 14th October in 2008 and on 16th October in 2009 respectively. It was harvested when the leaves turn yellow and started shedding. Harvesting was done by using spade and kurpi; the harvested pods were cleaned and dried. The pods weight was taken separately for each plot after cleaning.

3.6.7.3 Soybean

Soybean was harvested on 16th October in 2008 and in 14th October in 2009. The crop was harvested when it was fully matured, leaves turn yellow and pod is hard and dough. Harvesting was done by cutting with sickle. Harvested crops were kept in the threshing floor for 4 days and then it was threshed by beating with sticks. The grain was sun dried upto 10-12 % moisture.

3.7 EXPERIMENTAL OBSERVATION AND SAMPLING TECHNIQUES

3.7.1 Collection of soil samples

For pre sowing, composite soil samples were collected prior to application of manures and fertilizers from the whole experimental field. Different soil samples from each sub plots were collected after harvest for determination of soil pH, organic carbon, available nitrogen (N), available phosphorus (P) and available potassium (K) content.

3.7.2 Determination of chemical characteristics of soil

To determine the nutrient status of the soil, soil samples of experimental field were analysed for pH, organic carbon, available nitrogen (N), available phosphorus (P) and available potassium (K) content.

3.7.2.1 pH (Soil Reaction)

The soil pH was analysed by Potentiometric method. The soil water ratio was of 1:2.5. It was determined by using glass electrode pH meter.

3.7.2.2 Organic carbon (Walkley and Black, 1934))

Organic carbon was determined by titrimetric method. The reagents used were 1N potassium dichromate solution, 0.5N ferrous ammonium sulphate, Concentrated H_2SO_2, Ortho-phosphoric acid and Di-phenyl amine indicator

3.7.2.3 Available Nitrogen (Subbiah and Asija, 1956)

It was determined by alkaline permanganate method. The reagents used were 0.32%KM_nO_4, 2.5% NaOH solution and Methyl red indicator.

3.7.2.4 Available phosphorus (Brays & Kurtz 1945)

The reagents used were Ammonium fluoride, hydrochloric acid, stannous chloride solution and Dickman and Brays reagents. It was determined by using photoelectric colorimeter.

3.7.2.5 Available potassium (Hanway and Haldal, 1952)

Potassium was extracted from the soil with Neutral Ammonium acetate solution and estimated photo metrically**.**

3.8 Determination of nitrogen, phosphorus and potassium in plants

3.8.1 Processing of plant samples

Plants from each plot were cut from the ground base. The plant samples were washed with water to remove soil and dust or any other adhering substance, and then finally washed with distilled water. The plant samples were at first air dried and finally dried in a hot air oven at 60^0-70^0 C for 24 to 36 hours. The oven dried samples was ground in a grinder, fitted with stainless steel blades and pass the samples through a 40-mesh sieve and was used for analysis.

3.8.2 Digestion of plant samples for nitrogen

Half a gram powdered sample was digested with concentrated H_2SO_4 in presence of digestion mixture ($CuSO_4$ + K_2SO_4) till the digest gave clear bluish green colour. The digested sample was further diluted carefully with distill water to known volume. Then a known volume of aliquot was transferred to distillation unit (Micro kjeldahl-apparatus) and liberated ammonia was trapped in boric acid containing mixed indicator. Later, it was titrated against standard H_2SO_4 and the amount of ammonia

Table 2. Physicochemical properties of the experimental field before sowing

Soil parameters	Values		Rating	Method employed
	2008	2009		
pH	5.20	4.72	Acidic	Digital pH meter (single electrode assembly)
Organic carbon (%)	2.0	1.89	High	Rapid titration method
Available N (kg/ha)	250.88	244.15	Low	Alkaline permanganate method
Available P_2O_5 (kg/ha)	34.0	28.6	Medium	Bray's No I method
Available K_2O (kg/ha)	198.32	145.78	Medium	Flame photometric method

liberated was estimated in the form of nitrogen as per the procedure given by Black (1965).

3.8.3 Digestion of plant samples for Phosphorus and Potassium

Half a gram powdered sample was pre-digested with concentrated nitric acid overnight. Further pre-digested sample was treated with di-acid (nitric acid: perchloric acid in the ratio 10:4) mixture and kept on hot plate for digestion till colourless thread like structures was obtained. After complete digestion precipitate was dissolved in 6*N* HCl and transferred to the 100ml volumetric flask through Whatman No. 42 filter paper and finally the volume of the extract was made to 100 ml with double distilled water and preserved for further analysis.

Phosphorus in plant sample was determined by Vanadomolybdophosphoric yellow colour method (Jackson, 1976) by using spectrophotometer at 470 nm.

The potassium content in the digested sample was determined by flame photometer after making appropriate dilution as described by Chapman and Pratt (1961).

3.9 Plant sampling for growth attributes

Five plants each of all the crops were selected randomly from each plot and were tagged. Their growth observations were recorded at 15, 30, 45, 60, 75DAS and at harvest

3.9.1 Plant height (cm)

The plant height was measured from base of the plant to the base of the fully opened top leaf until tassel emergence. Later, the plant height was measured from base of the plant to the collar of flag leaf and expressed in centimetres and mean value was calculated.

3.9.2 Number of leaves per plant

The numbers of green leaves of the five tagged plant leaves per plant were counted and mean value was calculated at different stages as mentioned above.

3.9.3 Number of branches

The numbers of branches were taken for groundnut and soybean crops. Branches from each five tagged plants was counted and the average value was recorded for each plot separately

3.9.4 Leaf area index(LAI):

The LAI was worked out using the formula (Waston, 1947)

$$LAI = \frac{\text{Total leaf area of the plant}}{\text{Ground space occupied}}$$

3.9.5 Crop growth rate (CGR)

It indicates at what rate the crop is growing *i.e.* whether the crop is growing at faster rate or slower rate than normal. It is expresses as a gram of dry matter produced per dat. This formula was worked out by Duncan (1981).

$$CGR = \frac{W_2 - W_1}{A \times (t_2 - t_1)}$$

Where, W_1 and W_2 are dry wt. of plant at time t_1 and t_2 respectively, A- area in m^2

3.9.6 Relative growth rate (RGR):

The RGR was worked out using the formula (Fisher, 1921)

$$RGR = \frac{Log_e W_2 - Log_e W_1}{t_2 - t_1}$$

Where, W_1 and W_2 are dry matter at time t_1 and t_1 respectively. It is expressed as a gram of dry matter produced by a gram of existing dry matter in a day.

3.10 Plant sampling for yield attributes

3.10.1 Maize

3.10.1.1 Number of cobs per plant

The number of cobs from five tagged plants was counted and the average value was recorded for each plot separately

3.10.1.2 Length of cobs per plant(cm)

The length of cob was measured from five tagged plants with the help of linear scale from the bottom to the tip of cob and average value was recorded.

3.10.1.3 Number of seeds per cob

Five cobs were selected at random in every plot and the total number of seeds was counted and thereafter, average number of grains per cob was calculated.

3.10.1.4 Cob weight (g)

The cobs of five sample plants were weighed and their average has been presented as weight of cob.

3.10.1.5 Test weight(g)

From the threshed grains, thousand grains were counted from each plot and their weight was recorded with the help of electronic weighing balance

3.10.1.6 Grain yield (q/ha)

The grain yield was recorded for each plot separately and thereafter the grain yield was converted into q/ha.

3.10.1.7 Stover yield(q/ha)

The plants were cut from the ground base and were allowed for sun dried and then calculated in q/ha.

3.10.1.8 Harvest Index (HI)

The harvest index was worked out using the formula (Nichiporovic,1950)

$$H.I = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

3.10.2 Groundnut and soybean

3.10.2.1 Number of pods per plant

The pods of five tagged plants were counted and their average number has been presented as number of pods per plant.

3.10.2.2 Length of pods (cm)

The length of pods was measured from five tagged plants with the help of linear scale from the bottom to the tip of pod and average value was recorded.

3.10.2.3 Number of seeds per pod

From the five randomly tagged plants the number of seeds per pod were counted and average were recorded.

3.10.2.4 Weight of pods (g)

The pods of five tagged plants were weighed and their average has been presented as weight of pods.

3.10.2.5 Test weight (g)

From the threshed seeds, thousand grains were counted from each plot and their weight was recorded with the help of electronic weighing balance

3.10.2.6 Grain yield (q/ha)

The grain yield of all the plots were collected on treatment basis and the plot yield of each treatment were converted into q/ha.

3.10.2.7 Stover yield (q/ha)

The plants were cut from the ground base and were allowed for sun dried and then calculated in q/ha.

3.10.2.8 Harvest Index (%)

The harvest index was worked out using the formula (Nichiporvich, 1950)

$$H.I \quad \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

3.11 Maize equivalent yield (Crop equivalent yield) CEY

Maize equivalent yield in quintal per hectare was calculated by multiplying the intercrop yield (qt/ha) by maize equivalent factor. Maize equivalent factor was calculated from the ratio of price of unit weight of component crop divided by the price of maize in quintal per hectare.

CEY= (Y_i e_i)

Where, Yi is the yield of *i*th component

e*i* is the equivalent factor of *i*th component or price of the crop

3.12 Land equivalent ratio (LER)

Land equivalent ratio was calculated from the procedures as described by Mead and Willey (1980), LER can be written as –

$$LER = L_A + L_B = \frac{Y_A}{S_A} + \frac{Y_B}{S_B}$$

Where,

L_A and L_B are LERs for the individual crops

Y_A and Y_B is the yield of a and b crop grown as intercrop

S_A and S_B is the yield of a and b crop grown as sole crop

3.13 Relative crowding co-efficient (RCC)

It is used in replacement series of intercropping. It indicates whether a crop, when grown in mixed population, has produced more or less yield than expected. Relative crowding co-efficient was estimated by using the formula:

K_{ab}= Y_{ab}/Y_{aa}-Y_{ab} X Z_{ba}/Z_{ab}

Where,

K_{ab}= RCC of crop *a* intercrop with crop *b*,

Y_{ab}= yield per unit area of crop a intercropped with crop b,

Y_{aa}=Yield per unit of sole crop *a*

Z_{ab} = Proportion of intercropped area initially allocated to crop *a*

Z_{ba}= Proportion of intercropped area initially allocated to crop *b*

RCC > 1 means yield advantage

RCC = 1 no difference

RCC < 1 means yield disadvantage

Sole crop of maize, groundnut and soybean were grown in three different plots along with the experiment but it was not included as the treatments.

3.14 Phenological parameters

3.14.1 Days to 50% flowering

The number of days taken from sowing to 50% tasselling or flowering for all the crops were recorded for each treatment.

3.14.2 Days to maturity

The number of days taken from sowing to harvesting for all the crops was recorded for each treatment.

3.15. Economics

3.15.1. Cost of cultivation (`)

The cost of cultivation was calculated in hectare for each treatment separately as per the item wise cost incurred for different levels of fertilizers.

3.15.2 Gross return (`)

Gross return was calculated for each treatment by multiplying the value of economics procedures and the prevailing market prices of output.

3.15.3 Net return (`)

Net return for each treatment was estimated by subtracting the total cost of cultivation from the gross return. It was estimated by using the following formula

$$Net\ return = Gross\ return - Cost\ of\ cultivation$$

3.15.4 Benefit: cost ratio

Benefit cost ratio of different treatments were estimated by using the formula:

$$Benefit : Cost\ ratio = \frac{Net\ return\ (Rs./ha)}{Cost\ of\ cultivation}$$

3.16 Statistical analysis

The various data recorded during the course of experimental investigation were statistically analyzed by 'Split Plot Design (SPD)' as described by Panse and

Sukhatme (1989). The significance was tested by calculating the critical difference (CD) at 5 percent level, wherever ‘F’ test was found significant.

3.17 Data transformation

3.17.1 Square root transformation

The values for some variables like number of leaves, number of branches, number of seeds, number of pods, number of days to flowering and number of days to maturity are square root transformed.

$\sqrt{x + 0.5}$

3.17.2 Angular transformation

The data in percentage like leaf area index, Harvest index and organic carbon have been angular transformed.

$\sin^{-1}(\sqrt{x/100})$ represented in ^{0} degree.

CHAPTER-IV

EXPERIMENTAL FINDINGS

The experimental findings based on the observations recorded during the year 2008 and 2009 at different stages on growth attributes, yield attributes, Phenological parameters has been critically examined and statistically analyzed and records of different field observations as well as those of laboratory analysis are presented in this chapter with tables. The tables of analysis of variance are given in the appendix section.

4.1 Growth attributes of maize

4.1.1 Plant height (cm)

The data's on plant height of maize during 2008 and 2009 are presented in Table 3a, 3b and 3c.

4.1.1.1 Plant height(cm) at 15 DAS and 30 DAS

From the perusal of the result presented in Table 3a, it was showed that the plant height of maize recorded at 15 DAS and 30 DAS were found non significant effect in intercropping with groundnut and soybean at various recommended doses of fertilizer during both the year (2008-2009).

However, all the different doses of fertilizer showed significant effect on plant height at 15 DAS and 30 DAS. From the pooled data it was recorded that at 15 DAS, 100% RDF to maize alone recorded the maximum plant height (36.28) which was statistically superior to rest of the fertilizer treatments.

At 30 DAS, 100% RDF to maize alone recorded the highest plant height (92.67) which was at par (92.67, 92.15, 90.10 and 90.03) with other fertilizer treatment except control. Control recorded the minimum plant height (77.85) and was significantly inferior to rest of the treatments.

Interaction between intercropping and different recommended dose of fertilizer did not show any differences on plant height at 15 DAS and 30 DAS during both the experimental years.

4.1.1.2 Plant height(cm) at 45 DAS and 60 DAS

It was evident from the data in Table 3b that there was significant difference at 45DAS on plant height between the two intercropping system of maize. From the pooled data it was observed that maize + groundnut recorded the highest plant height (148.12) and the lowest from maize + soybean (140.29), however at 65 DAS the data clearly indicated that there was no significant difference between the two intercropping on plant height.

Statistically, it was found that application of different level of recommended fertilizer dose had a significant effect on plant height at 45 DAS and 60 DAS. At 45 DAS, 100%RDF to maize alone recorded the maximum plant height (148.88) which was at par with 100% RDF to both the crop (148.03) and the minimum was recorded from control (134.37). At 60 DAS, 100% RDF to maize alone recorded the highest plant height (221.92) which was statistically at par with 100% RDF to maize + 50% RDF to intercrop. Control recorded the lowest plant height (181.97) which was significantly inferior to rest of the fertilizer treatments.

Interaction between intercropping and different recommended dose of fertilizer did not show any differences on plant height at 45 DAS and 60 DAS during both the experimental year.

4.1.1.3 Plant height(cm) at 75 DAS and at harvest

The result presented in Table 3c indicated that intercropping system have significant difference on plant height at 75 DAS and at harvest in both the years and reveals that at 75 DAS, maize + soybean intercropping (244.81) was superior to maize + groundnut intercropping (227.69). At harvest, maize + soybean intercropping (250.54) recorded the highest plant height than that of maize + groundnut intercropping (233.01).

Statistically, it was found that application of different level of recommended fertilizer doses has significant effect on plant height at 75 DAS and at harvest. At 75 DAS, results revealed that 100% RDF to maize alone recorded the maximum plant height (248.87) which was at par with100%RDF to maize+50% RDF to intercrop (244.55) and 100% RDF to both the crop (243.82). Control recorded the minimum plant height (207.12) at harvest, 100% RDF to maize alone recorded the maximum plant height (249.48) which was at par with 100%RDF to maize+50% RDF to intercrop (250.67) and 100%RDF to both the crop (249.48). The minimum plant height (212.50) was recorded from control.

Table 3a. Effect of intercropping and fertilizer doses on plant height of maize

Treatments	Plant height of maize (cm)					
	15 DAS			30 DAS		
	2008	2009	Pooled	2008	2009	Pooled
Intercropping (IC)						
IC_1-Maize+Groundnut (2:2)	36.09	33.82	34.96	88.93	88.21	88.57
IC_2-Maize + Soybean (2:2)	35.62	33.38	34.50	91.42	89.16	90.29
SEm±	0.50	0.37	0.31	3.06	1.80	1.77
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Fertilizer doses (F)						
F_1-Control (No NPK)	32.33	30.20	31.27	79.40	76.30	77.85
F_2-100%NPK (both the crop)	36.27	34.50	35.38	90.43	94.90	92.67
F_3-100%NPK (Maize)	37.50	35.07	36.28	97.57	92.00	94.78
F_4-100%(Maize) +50% (Intercrop)	36.40	34.47	35.43	90.47	93.83	92.15
F_5-50% (Maize) + 100% (Intercrop)	35.97	33.87	34.92	90.27	87.93	89.10
F_6-50% NPK (Maize & Intercrop)	36.67	33.50	35.08	92.93	87.13	90.03
SEm±	0.26	0.49	0.28	1.10	1.51	0.93
CD (P=0.05)	0.76	1.44	0.82	3.24	4.45	2.74
Intercropping x fertilizer doses	NS	NS	NS	NS	NS	NS

Table 3b. Effect of intercropping and fertilizer doses on plant height of maize

Treatments	Plant height of maize (cm)					
	45 DAS			60 DAS		
	2008	2009	Pooled	2008	2009	Pooled
Intercropping (IC)						
IC_1-Maize+Groundnut (2:2)	149.48	146.76	148.12	213.34	209.83	211.59
IC_2-Maize + Soybean (2:2)	140.86	139.73	140.29	209.20	206.72	207.96
SEm±	2.25	0.51	1.15	8.53	2.58	4.46
CD (P=0.05)	NS	3.10	6.99	NS	NS	NS
Fertilizer doses (F)						
F_1-Control (No NPK)	135.67	133.07	134.37	182.13	181.80	181.97
F_2-100%NPK (both the crop)	145.50	150.57	148.03	200.43	221.03	210.73
F_3-100%NPK (Maize)	153.30	144.47	148.88	232.60	211.23	221.92
F_4-100%(Maize) +50% (Intercrop)	146.53	146.75	146.64	221.67	217.32	219.49
F_5-50% (Maize) + 100% (Intercrop)	144.77	143.83	144.30	212.37	210.93	211.65
F_6-50% NPK (Maize & Intercrop)	145.23	140.77	143.00	218.43	207.33	212.88
SEm±	1.27	1.29	0.90	4.31	3.77	2.86
CD (P=0.05)	3.74	3.80	2.65	12.71	11.12	8.43
Intercropping x fertilizer doses	NS	NS	NS	NS	NS	NS

Table 3c. Effect of intercropping and fertilizer doses on plant height of maize

Treatments	Plant height of maize (cm)					
	75 DAS			At harvest		
	2008	2009	Pooled	2008	2009	Pooled
Intercropping (IC)						
IC_1-Maize+Groundnut (2:2)	226.43	228.94	227.69	231.00	235.01	233.01
IC_2-Maize + Soybean (2:2)	245.28	244.34	244.81	250.53	250.54	250.54
SEm±	1.08	1.56	0.95	1.50	0.93	0.88
CD (P=0.05)	6.57	9.49	5.78	9.12	5.65	5.35
Fertilizer doses (F)						
F_1-Control (No NPK)	208.60	205.63	207.12	213.77	211.23	212.50
F_2-100%NPK (both the crop)	235.57	252.07	243.82	240.87	258.10	249.48
F_3-100%NPK (Maize)	256.57	241.17	248.87	261.63	248.23	254.93
F_4-100%(Maize) +50% (IC)	241.87	247.23	244.55	247.77	253.57	250.67
F_5-50% (Maize) + 100% (IC)	238.77	237.57	238.17	243.97	243.70	243.83
F_6-50% NPK (Maize & IC)	233.77	236.20	234.98	236.60	241.83	239.22
SEm±	3.69	2.89	2.34	3.37	2.90	2.22
CD (P=0.05)	10.88	8.52	6.90	9.94	8.55	6.54
Intercropping x fertilizer doses	NS	NS	NS	NS	NS	NS

Table4a. Effect of intercropping and fertilizer doses on number of leaves of maize

Treatments	Number of leaves/plant					
	15 DAS			30 DAS		
	2008	2009	Pooled	2008	2009	Pooled
Intercropping (IC)						
IC_1-Maize+Groundnut (2:2)	5.44	3.42	4.38	6.34	7.90	7.10
IC_2-Maize + Soybean (2:2)	5.44	3.18	4.24	6.49	8.33	7.39
SEm±	0.01	0.04	0.02	0.03	0.06	0.03
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Fertilizer doses (F)						
F_1-Control (No NPK)	4.60	3.00	3.76	5.47	7.15	6.28
F_2-100%NPK (both the crop)	6.30	3.68	4.91	7.19	9.19	8.16
F_3-100%NPK (Maize)	5.23	3.28	4.21	6.34	8.16	7.22
F_4-100%(Maize) +50% (Intercrop)	5.50	3.45	4.42	6.59	8.80	7.66
F_5-50% (Maize) + 100% (Intercrop)	5.60	3.28	4.38	6.50	7.91	7.18
F_6-50% NPK (Maize & Intercrop)	5.42	3.12	4.22	6.45	7.58	7.01
SEm±	0.02	0.02	0.02	0.03	0.02	0.02
CD (P=0.05)	0.05	0.05	0.05	0.08	0.05	0.05
Intercropping x fertilizer doses	NS	NS	NS	NS	NS	NS

4.1.2 Number of leaves per plant

4.1.2.1 Number of leaves per plant at 15 DAS and 30 DAS

A critical examination of data presented in Table 4a showed that the number of leaves of maize recorded at 15 DAS and 30 DAS were found non significant in intercropping during both the year (2008 and 2009).

Application of different recommended dose of fertilizer had a significant influence on number of leaves at 15 DAS and 30 DAS in both the year. From the pooled data it was apparent that at 15 DAS, 100%RDF to both the crops recorded the maximum number of leaves (4.91) which was superior to the rest of fertilizer treatment. Control recorded the minimum number of leaves (3.76). At 30 DAS, 100%RDF to both the crops recorded the highest number of leaves (8.16). Control recorded the lowest number of leaves and (6.28) which was statistically less than all the different recommended dose of fertilizer.

Interaction effect on intercropping and fertilizer treatment did not show any significant difference on number of leaves both at 15 DAS and 30 DAS respectively.

4.1.2.2 Number of leaves per plant at 45 DAS and 60 DAS

A perusal of the result in the Table 4b, it was found that intercropping does not show any significant difference on number of leaves at 45 DAS and 60 DAS during both the year.

On further scanning of the treatment for the influence of fertilizer doses on number of leaves, it was evident that all the number of leaves shows significant influence due to different levels of RDF at 45 DAS and 60 DAS. At 45 DAS the maximum number of leaves was recorded from 100%RDF to both the crop (10.82) and the minimum number of leaves was recorded from the control (8.13). At 60 DAS, 100%RDF to both the crop recorded the maximum number of leaves (14.19). The minimum number of leaves was recorded from the control (11.09) which was statistically inferior to the rest of the fertilizer treatments.

Interaction effect on intercropping and fertilizer application on number of leaves did not show any significant difference at 45 DAS and 60DAS.

4.1.2.3 Number of leaves per plant at 75 DAS and at harvest

Observations recorded on number of leaves at 75 DAS and at harvest are presented in Table 4c. The data reveals that number of leaves were found non significant in intercropping during both the year (2008 and 2009).

Table 4b. Effect of intercropping and fertilizer doses on number of leaves of maize

Treatments	Number of leaves/plant					
	45 DAS			60 DAS		
	2008	2009	Pooled	2008	2009	Pooled
Intercropping (IC)						
IC_1-Maize+Groundnut (2:2)	8.82	10.30	9.54	13.37	11.45	12.39
IC_2-Maize + Soybean (2:2)	7.52	11.60	9.45	12.44	12.66	12.55
SEm$\pm$	0.09	0.08	0.06	0.02	0.05	0.03
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Fertilizer doses (F)						
F_1-Control (No NPK)	6.89	9.47	8.13	11.38	10.81	11.09
F_2-100%NPK (both the crop)	9.47	12.27	10.82	15.00	13.40	14.19
F_3-100%NPK (Maize)	8.31	11.29	9.75	12.27	12.22	12.25
F_4-100%(Maize) +50% (Intercrop)	7.84	12.08	9.86	13.26	12.88	13.07
F_5-50% (Maize) + 100% (Intercrop)	8.53	9.30	9.48	12.84	11.81	12.32
F_6-50% NPK (Maize & Intercrop)	7.98	10.18	9.05	12.75	11.25	11.99
SEm$\pm$	0.04	0.03	0.03	0.04	0.02	0.02
CD (P=0.05)	0.11	0.08	0.08	0.11	0.05	0.05
Intercropping x fertilizer doses	NS	NS	NS	NS	NS	NS

Table4c. Effect of intercropping and fertilizer doses on number of leaves of maize

Treatments	Number of leaves/plant					
	75 DAS			At harvest		
	2008	2009	Pooled	2008	2009	Pooled
Intercropping (IC)						
IC_1-Maize+Groundnut (2:2)	8.57	7.93	8.24	7.61	6.97	7.28
IC_2-Maize + Soybean (2:2)	8.21	9.15	8.67	7.25	8.19	7.71
SEm$\pm$	0.02	0.06	0.03	0.02	0.06	0.03
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Fertilizer doses (F)						
F_1-Control (No NPK)	7.73	7.25	7.49	6.99	6.51	6.75
F_2-100%NPK (both the crop)	9.05	9.82	9.44	8.04	8.79	8.41
F_3-100%NPK (Maize)	8.43	8.80	8.61	7.61	7.98	7.79
F_4-100%(Maize) +50% (Intercrop)	8.64	9.31	8.97	7.53	8.22	7.87
F_5-50% (Maize) + 100% (Intercrop)	8.30	8.41	8.36	7.23	7.34	7.28
F_6-50% NPK (Maize & Intercrop)	8.19	7.69	7.94	7.19	6.69	6.94
SEm$\pm$	0.02	0.03	0.02	0.02	0.03	0.02
CD (P=0.05)	0.05	0.08	0.05	0.05	0.08	0.05
Intercropping x fertilizer doses	NS	NS	NS	NS	NS	NS

A critical examination of the data pertaining to the effect of fertilizer doses, the data reveals that all levels of fertilizer doses had significant influence on number of leaves both at 75 DAS and at harvest. At 75 DAS, 100% RDF to both the crop gave the highest number of leaves (9.44) which was statistically superior to rest of the recommended dose of fertilizers. The minimum was observed from the control (7.49). At harvest, the maximum number of leaves was recorded from 100%RDF to both the crop (8.41) and the minimum was recorded from control (6.75).

Interaction effect on intercropping and fertilizer application on number of leaves did not show any significant difference at 75 DAS and at harvest.

4.1.3 Leaf area index (LAI)

4.1.3.1 Leaf area index at 15 DAS and 30 DAS

From the perusal of the result presented in Table 5a, it was evident that the leaf area index in intercropping at 15 DAS was found significant in both the year. From the pool data, maize + soybean recorded the maximum leaf area index (0.28) and the minimum was recorded from maize + groundnut (0.14). At 30 DAS it was found non significant during both the years.

On further scanning of the treatment for the influence of fertilizer doses on leaf area index, it was found that the LAI shows significant influence due to different doses of fertilizer at 15 DAS and 30 DAS. At 15 DAS, the mean pooled data revealed that the maximum leaf area index was recorded from 100% RDF to both the crop (0.24) and was statistically at par with all the treatments except control. Control recorded the minimum LAI (0.15). At 30 DAS, 100% RDF to both the crop gave the maximum LAI (1.25) and was par with all the treatments except control. The lowest LAI was recorded from control (0.88).

Critical examinations of the data pertaining to the interaction effect on intercropping and fertilizer application on LAI at 15 DAS dose not show any significant difference. The data reveals that at 30 DAS, interaction effect has significant influence on LAI. The perusal of the data revealed that maize + groundnut with 100%RDF to maize alone recorded the maximum LAI (1.25). However it was at bar with all the treatments except with the control. The lowest LAI was recorded with maize + groundnut control (0.88) and maize + soybean control (0.88).

4.1.3.2 Leaf area index at 45 DAS and 60 DAS

A perusal of the result in the Table 5b, it was found that intercropping does not show any significant difference on LAI at 45 DAS but at 60 DAS it was found significant where intercropping of maize with soybean was superior (4.59) than intercropping with soybean (4.21) but it was at bar.

On further scanning of the treatment for the influence of fertilizer doses on LAI, it was evident that all leaf area indexes shows significant influence due to different levels of recommended dose of fertilizer. At 45 DAS, the maximum LAI were recorded from 100%RDF to both the crop (2.81) and was at par with 100% RDF to maize alone (2.64). Control recorded the minimum LAI (1.78). At 60 Das, 100% RDF to both the crop gave the highest LAI (5.22) and was statistically at par with 100% RDF to maize +50% RDF to intercrop (4.90). The minimum LAI was recorded from the control (3.24).

Interaction effect on intercropping and fertilizer application on leaf area index did not show any significant difference in the first year at 45 DAS and 60DAS but in the second year there was significant difference both at 45 DAS and 60DAS. Observation taken from the mean pool data at 45 DAS, the maximum LAI was recorded from maize + soybean with 100%RDF both the crop (2.88) which was at par with maize + groundnut with 100% RDF to maize alone (2.77) and maize100% RDF + groundnut 50% RDF (2.76). Maize + soybean control recorded the lowest LAI (1.74) which was statistically at par with maize + groundnut control (1.79). At 60 DAS, the maximum LAI (5.55) was recorded from maize + soybean 100% RDF to both the crop and was at par with maize + soybean with 100% RDF to maize and 50% RDF to intercrop (5.19) and maize + soybean with 100% RDF to maize alone (5.21). The minimum LAI was recorded from maize + soybean control (3.21) and was statistically at par with maize + groundnut control (3.27).

4.1.4 Crop growth rate (CGR)

4.1.4.1 Crop growth rate at 30 DAS and 45 DAS (g/day)

Perusal of the data presented in Table 6a, it was found that intercropping does not show any significant difference on CGR at 30DAS during both years. At 45 DAS it was found significant in the second year where intercropping of maize + groundnut (0.57) which was at par with intercropping of maize and soybean (0.47). The mean pool data on the two

Table5a. Effect of intercropping and fertilizer doses on leaf area index (LAI) of maize

Treatments	Leaf area index					
	15 DAS			30 DAS		
	2008	2009	Pooled	2008	2009	Pooled
Intercropping (IC)						
IC_1-Maize+Groundnut (2:2)	0.16	0.13	0.14	1.13	1.12	1.13
IC_2-Maize + Soybean (2:2)	0.30	0.26	0.28	1.10	1.16	1.30
SEm±	0.04	0.03	0.03	0.22	0.03	0.11
CD (P=0.05)	0.24	0.18	0.18	NS	NS	NS
Fertilizer doses (F)						
F_1-Control (No NPK)	0.16	0.15	0.15	0.87	0.89	0.88
F_2-100%NPK (both the crop)	0.26	0.22	0.24	1.24	1.26	1.25
F_3-100%NPK (Maize)	0.25	0.21	0.23	1.17	1.22	1.19
F_4-100%(Maize) +50% (Intercrop)	0.24	0.22	0.23	1.20	1.26	1.23
F_5-50% (Maize) +100% (Intercrop)	0.22	0.19	0.21	1.14	1.14	1.14
F_6-50% NPK (Maize & Intercrop)	0.21	0.18	0.20	1.10	1.10	1.10
SEm±	0.04	0.04	0.03	0.10	0.02	0.05
CD (P=0.05)	0.11	0.11	0.08	0.29	0.05	0.14
Interactions (IC x F)						
IC_1 x F_1	0.10	0.11	0.10	0.88	0.89	0.88
IC_1 x F_2	0.19	0.15	0.17	1.26	1.22	1.24
IC_1 x F_3	0.17	0.15	0.16	1.26	1.25	1.25
IC_1 x F_4	0.17	0.15	0.16	1.23	1.24	1.23
IC_1 x F_5	0.16	0.14	0.15	1.10	1.10	1.10
IC_1 x F_6	0.15	0.12	0.13	1.08	1.06	1.07
IC_2 x F_1	0.23	0.20	0.21	0.87	0.87	0.88
IC_2 x F_2	0.34	0.30	0.32	1.22	1.26	1.22
IC_2 x F_3	0.34	0.29	0.31	1.09	1.19	1.14
IC_2 x F_4	0.33	0.29	0.31	1.16	1.28	1.22
IC_2 x F_5	0.30	0.26	0.28	1.18	1.17	1.18
IC_2 x F_6	0.29	0.25	0.27	1.12	1.14	1.13
SEm±	0.06	0.06	0.04	0.14	0.03	0.07
CD (P=0.05)	NS	NS	NS	NS	0.08	0.20

Table5b. Effect of intercropping and fertilizer doses on leaf area index (LAI) of maize

Treatments	Leaf area index					
	45 DAS			60 DAS		
	2008	2009	Pooled	2008	2009	Pooled
Intercropping (IC)						
IC_1-Maize+Groundnut (2:2)	2.41	2.37	2.39	4.28	4.13	4.21
IC_2-Maize + Soybean (2:2)	2.38	2.35	2.36	4.67	4.50	4.59
SEm$\pm$	0.25	0.02	0.13	0.12	0.04	0.06
CD (P=0.05)	NS	NS	NS	NS	0.24	0.36
Fertilizer doses (F)						
F_1-Control (No NPK)	1.80	1.76	1.78	3.31	3.17	3.24
F_2-100%NPK (both the crop)	2.83	2.78	2.81	5.36	5.09	5.22
F_3-100%NPK (Maize)	2.72	2.56	2.64	4.81	4.60	4.70
F_4-100%(Maize) +50% (Intercrop)	2.39	2.49	2.44	4.91	4.90	4.90
F_5-50% (Maize) + 100% (Intercrop)	2.43	2.38	2.41	4.45	4.31	4.38
F_6-50% NPK (Maize & Intercrop)	2.26	2.23	2.24	4.16	3.98	4.07
SEm$\pm$	0.17	0.03	0.07	0.22	0.06	0.11
CD (P=0.05)	0.50	0.08	0.20	0.64	0.17	0.32
Interactions (IC x F)						
IC_1 x F_1	1.82	1.79	1.81	3.36	3.18	3.27
IC_1 x F_2	2.73	2.69	2.71	4.97	4.83	4.90
IC_1 x F_3	2.87	2.67	2.77	4.52	4.22	4.37
IC_1 x F_4	2.36	2.41	2.38	4.57	4.66	4.62
IC_1 x F_5	2.40	2.39	2.40	4.29	4.19	4.24
IC_1 x F_6	2.36	2.31	2.33	4.07	3.81	3.94
IC_2 x F_1	1.77	1.74	1.75	3.26	3.15	3.21
IC_2 x F_2	2.95	2.88	2.91	5.76	5.34	5.55
IC_2 x F_3	2.59	2.46	2.52	5.10	4.99	5.04
IC_2 x F_4	2.42	2.58	2.50	5.25	5.14	5.19
IC_2 x F_5	2.47	2.38	2.42	4.61	4.43	4.52
IC_2 x F_6	2.16	2.15	2.16	4.25	4.16	4.20
SEm$\pm$	0.24	0.04	0.12	0.30	0.09	0.16
CD (P=0.05)	NS	0.11	0.35	NS	0.26	0.47

years of experimental on crop growth rate at 45 DAS revealed that intercropping of maize with groundnut (0.58) was highest but was at par with intercropping of maize with soybean (0.46).

On further scanning of the treatment for the influence of fertilizer doses on CGR, it was evident that all CGR shows significant influence at 30DAS and 45 DAS due to different levels of RDF. Pool data at 30 DAS, the maximum CGR was recorded from 100%RDF to maize (0.24) and was at par with 100% RDF to maize +50% RDF to intercrop. Control recorded the lowest CGR (0.18) which was statistically inferior to the rest of the treatments. At 45 DAS, 100%RDF to maize recorded the highest CGR (0.63) and the minimum growth rate was recorded from the control (0.33).

Interaction effect on intercropping and fertilizer application on CGR did not show any significant difference at 30 DAS and 45 DAS in both years.

4.1.4.2 Crop growth rate at 60 DAS and 75 DAS (g/day)

Observation recorded on crop growth rate at 60 DAS and 75 DAS are presented in Table 6b. The data reveals that there was no significant difference during the first year (2008) both at 60 DAS and 75 DAS. Data on CGR obtained from mean pooled data of 2008 and 2009 revealed that, at 60 DAS it was found that the CGR of maize + groundnut intercropping (1.86) were significantly superior but was at par with ,maize + soybean intercropping (1.58). At 75 DAS, maize + groundnut intercropping (0.49) were significantly superior to maize + soybean intercropping (0.23).

Further analysis of the data revealed that all CGR at 60DAS show significant influence due to different levels of RDF. The maximum CGR was recorded from 100% RDF to maize (1.97) which was at par with 100% RDF to both the crop (1.90) and 100% RDF to maize + 50% RDF to intercrop (1.83). The minimum crop growth rate was recorded from the control (1.21). At 75DAS, there was no significant difference on different recommended dose of fertilizer.

During both years, interaction effect on intercropping and fertilizer application on CGR did not show any significant difference at 60 DAS and 75 DAS.

Table 6a. Effect of intercropping and fertilizer doses on crop growth rate (CGR) of maize

Treatments	Crop growth rate (g/day)					
	30 DAS			45 DAS		
	2008	2009	Pooled	2008	2009	Pooled
Intercropping (IC)						
IC_1-Maize+Groundnut (2:2)	0.22	0.22	0.22	0.59	0.57	0.58
IC_2-Maize + Soybean (2:2)	0.22	0.22	0.22	0.46	0.47	0.46
SEm$\pm$	0.00	0.00	0.00	0.05	0.01	0.03
CD (P=0.05)	NS	NS	NS	NS	0.06	0.18
Fertilizer doses (F)						
F_1-Control (No NPK)	0.19	0.18	0.18	0.34	0.32	0.33
F_2-100%NPK (both the crop)	0.21	0.23	0.22	0.50	0.64	0.57
F_3-100%NPK (Maize)	0.25	0.22	0.24	0.70	0.55	0.63
F_4-100%(Maize) +50% (Intercrop)	0.23	0.23	0.23	0.53	0.57	0.55
F_5-50% (Maize) + 100% (Intercrop)	0.23	0.22	0.22	0.57	0.54	0.55
F_6-50% NPK (Maize & Intercrop)	0.23	0.22	0.22	0.53	0.49	0.51
SEm$\pm$	0.01	0.00	0.00	0.03	0.01	0.02
CD (P=0.05)	0.02	0.01	0.01	0.08	0.02	0.05
Intercropping x fertilizer doses	NS	NS	NS	NS	NS	NS

Table 6b. Effect of intercropping and fertilizer doses on crop growth rate (CGR) of maize

Treatments	Crop growth rate (g/day)					
	60 DAS			75 DAS		
	2008	2009	Pooled	2008	2009	Pooled
Intercropping (IC)						
IC_1-Maize+Groundnut (2:2)	1.93	1.78	1.86	0.50	0.47	0.49
IC_2-Maize + Soybean (2:2)	1.56	1.60	1.58	0.24	0.22	0.23
SEm$\pm$	0.12	0.02	0.06	0.06	0.01	0.03
CD (P=0.05)	NS	0.12	0.36	NS	0.06	0.18
Fertilizer doses (F)						
F_1-Control (No NPK)	1.24	1.18	1.21	0.25	0.32	0.29
F_2-100%NPK (both the crop)	1.77	2.02	1.90	0.47	0.39	0.43
F_3-100%NPK (Maize)	2.08	1.85	1.97	0.30	0.31	0.31
F_4-100%(Maize) +50% (Intercrop)	1.83	1.84	1.83	0.41	0.37	0.39
F_5-50% (Maize) + 100% (Intercrop)	1.70	1.62	1.66	0.47	0.35	0.41
F_6-50% NPK (Maize & Intercrop)	1.82	1.62	1.72	0.33	0.31	0.33
SEm$\pm$	0.11	0.03	0.06	0.11	0.03	0.06
CD (P=0.05)	0.32	0.08	0.17	NS	NS	NS
Intercropping x fertilizer doses	NS	NS	NS	NS	NS	NS

4.1.5 Relative growth rate (RGR)

4.1.5.1 Relative growth rate at 30 DAS and 45 DAS (g/g/day)

Observations recorded on RGR at 30 and 45 DAS are presented in Table 7a. The data reveals that, at 30 DAS there was no significant difference on intercropping during both the year. At 45 DAS, maize + groundnut intercropping (0.057) was recorded the maximum RGR which was at par to maize + soybean intercropping (0.05).

Applications of different RDF did not show any significant influence on RGR at 30 DAS during both the experimental year. From the mean pool data at 45 DAS, the highest RGR was recorded from 100%RDF to both the crop which was at par with all the other treatments.

From data, it was clearly indicated that there was no interaction effect on intercropping and fertilizer application on RGR both at 30 DAS and 45 DAS.

4.1.5.2 Relative growth rate at 60 DAS and 75 DAS (g/g/day)

The result pertaining to the influence of intercropping and fertilizer and their interaction on RGR are presented in Table 7b.

It is evident from the data that intercropping does not show any significant difference on RGR at 60 DAS during both the years. At 75 DAS, in the first year there was no significant difference on RGR but was found significant in the second year. From the mean pool data, it clearly indicates that, maize + groundnut intercropping (0.008) was superior over maize + soybean (0.005).

Further examination of the data for the influence of different recommended dose of fertilizer on RGR reveals that different fertilizer doses dose not have any significant influence on RGR at 60 DAS and 75 DAS during both the year.

Experimental result of the mean pooled data of 2008 and 2009 on interaction effect of RGR at 60 DAS and 75 DAS showed that there was no any significance influence of interaction effect between intercropping and fertilizer application at 60 DAS and 75 DAS during both the experimental years.

Table 7a. Effect of intercropping and fertilizer doses on relative growth rate (RGR) of maize

Treatments	Relative growth rate (g/g/day)					
	30 DAS			45 DAS		
	2008	2009	Pooled	2008	2009	Pooled
Intercropping (IC)						
IC_1-Maize+Groundnut (2:2)	0.067	0.155	0.111	0.034	0.080	0.057
IC_2-Maize + Soybean (2:2)	0.068	0.155	0.111	0.030	0.071	0.050
SEm$\pm$	0.0009	0.0008	0.0006	0.0012	0.0005	0.0007
CD (P=0.05)	NS	NS	NS	NS	0.003	0.004
Fertilizer doses (F)						
F_1-Control (No NPK)	0.066	0.155	0.111	0.027	0.062	0.045
F_2-100%NPK (both the crop)	0.066	0.152	0.109	0.032	0.084	0.058
F_3-100%NPK (Maize)	0.068	0.155	0.112	0.036	0.079	0.057
F_4-100%(Maize) +50% (Intercrop)	0.069	0.154	0.111	0.031	0.078	0.055
F_5-50% (Maize) + 100% (Intercrop)	0.069	0.156	0.112	0.033	0.078	0.055
F_6-50% NPK (Maize & Intercrop)	0.068	0.156	0.112	0.032	0.074	0.053
SEm$\pm$	0.001	0.001	0.0007	0.0012	0.001	0.0008
CD (P=0.05)	NS	NS	NS	0.003	0.002	0.002
Intercropping x fertilizer doses	NS	NS	NS	NS	NS	NS

Table 7b. Effect of intercropping and fertilizer doses on relative growth rate (RGR) of maize

Treatments	Relative growth rate (g/g/day)					
	60 DAS			75 DAS		
	2008	2009	Pooled	2008	2009	Pooled
Intercropping (IC)						
IC_1-Maize+Groundnut (2:2)	0.035	0.078	0.056	0.005	0.011	0.008
IC_2-Maize + Soybean (2:2)	0.034	0.079	0.056	0.003	0.006	0.005
SEm$\pm$	0.0023	0.0005	0.0012	0.0006	0.0002	0.0003
CD (P=0.05)	NS	NS	NS	NS	0.001	0.001
Fertilizer doses (F)						
F_1-Control (No NPK)	0.034	0.078	0.057	0.004	0.011	0.007
F_2-100%NPK (both the crop)	0.036	0.079	0.057	0.004	0.008	0.006
F_3-100%NPK (Maize)	0.033	0.080	0.057	0.003	0.007	0.005
F_4-100%(Maize) +50% (Intercrop)	0.035	0.079	0.057	0.004	0.009	0.006
F_5-50% (Maize) +100% (Intercrop)	0.033	0.075	0.054	0.005	0.009	0.007
F_6-50% NPK (Maize & Intercrop)	0.035	0.078	0.057	0.004	0.008	0.006
SEm$\pm$	0.0016	0.001	0.001	0.001	0.0006	0.0006
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Intercropping x fertilizer doses	NS	NS	NS	NS	NS	NS

4.2 Yield attributes of maize

4.2.1 Land equivalent ratio (LER)

Observations recorded on LER are presented in Table 8. The data revealed that there was no significant effect on intercropping during both years (2008 and 2009).

Further examination of the data for the influence of fertilizer doses on LER reveals that different fertilizer doses found significant influence on LER during both the years. From the pool data, it was observed that the maximum LER was recorded from 100%RDF to both the crop (1.45) which was statistically superior among all the fertilizer treatments and the minimum LER was recorded from control (0.75).

A critical examination of the data pertaining to the interaction effect on intercropping and fertilizer application on LER reveals that there was significant difference during both the experimental years. From the pool data it was observed that the highest LER on interaction effect was recorded from maize + soybean with 100%RDF to both the crop (1.47) which was at par with maize + groundnut with 100%RDF (1.44). The minimum was recorded from maize + groundnut at control (0.74) which was statistically at par with maize + soybean control (0.76).

4.2.2 Relative crowding coefficient (RCC)

A perusal of the result in the Table 8, it was found that intercropping did not show any significant difference on RCC at both the year.

On further scanning of the treatment for the influence of fertilizer doses on relative crowding coefficient, it was evident from the pool data that all treatments showed significant influence due to different levels of RDF. The maximum RCC was recorded from 100%RDF to both the crop (7.78) and minimum was recorded from control (0.75).

Interaction effect on intercropping and fertilizer application on relative crowding coefficient did not show any significant difference during both the years.

Table 8. Effect of intercropping and fertilizer doses on land equivalent ratio (LER) and relative crowding coefficient (RCC) of maize

Treatments	Land equivalent ratio			Relative crowding coefficient		
	2008	2009	Pooled	2008	2009	Pooled
Intercropping (IC)						
IC_1-Maize+Groundnut (2:2)	1.13	1.09	1.11	3.99	2.66	3.32
IC_2-Maize + Soybean (2:2)	1.11	1.08	1.09	3.01	1.58	2.30
SEm$\pm$	0.02	0.02	0.01	0.46	1.00	0.55
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Fertilizer doses (F)						
F_1-Control (No NPK)	0.77	0.73	0.75	0.91	0.59	0.75
F_2-100%NPK (both the crop)	1.47	1.44	1.45	9.76	5.80	7.78
F_3-100%NPK (Maize)	1.07	1.04	1.06	2.68	1.62	2.15
F_4-100%(Maize) +50% (Intercrop)	1.27	1.25	1.26	4.51	2.88	3.70
F_5-50% (Maize) + 100% (Intercrop)	1.13	1.08	1.11	1.48	0.94	1.21
F_6-50% NPK (Maize & Intercrop)	0.99	0.97	0.98	1.65	0.89	1.27
SEm$\pm$	0.02	0.01	0.01	0.86	0.73	0.57
CD (P=0.05)	0.05	0.03	0.03	2.54	2.45	1.68
Interactions (IC x F)						
IC_1 x F_1	0.76	0.72	0.74	0.95	0.68	0.82
IC_1 x F_2	1.45	1.43	1.44	12.19	7.93	10.06
IC_1 x F_3	1.01	0.98	1.00	2.32	1.69	2.01
IC_1 x F_4	1.26	1.25	1.25	5.07	3.18	4.12
IC_1 x F_5	1.13	1.09	1.11	1.77	1.26	1.52
IC_1 x F_6	1.03	0.99	1.01	1.65	1.21	1.43
IC_2 x F_1	0.78	0.74	0.76	0.86	0.50	0.68
IC_2 x F_2	1.49	1.44	1.47	7.33	3.68	5.50
IC_2 x F_3	1.14	1.09	1.12	3.04	1.54	2.29
IC_2 x F_4	1.28	1.25	1.26	3.96	2.58	3.27
IC_2 x F_5	1.13	1.07	1.10	1.20	0.62	0.91
IC_2 x F_6	0.95	0.95	0.96	1.66	0.58	1.12
SEm$\pm$	0.02	0.02	0.01	1.22	1.03	0.80
CD (P=0.05)	0.06	0.06	0.03	NS	NS	NS

4.2.3 Length of cobs (cm)

Observation recorded on length of cobs is presented in Table 9. The data reveals that length of cobs were found non significant in intercropping during both the year (2008 and 2009).

A critical examination of the data pertaining to the effect of fertilizer doses, the data reveals that all levels of fertilizer doses had significant influence on length of cobs. From the pool data, the minimum length of cob was observed from the control (15.14) and maximum was recorded from 100%RDF to both the crop (17.96) which was at par with 100%RDF maize alone (17.59).

Interaction effect on intercropping and fertilizer application on length of cobs did not show any significant difference in the first year but was found significant difference in the second year. The maximum was recorded from maize + soybean with 100%RDF to maize (18.36cm) which was at par with maize + soybean with 100%RDF to both the crops (17.84cm). The minimum was recorded from maize + groundnut control (14.85).

4.2.4 Number of seeds per cob

The result presented in Table 9 indicated that during first year there was no significant difference in intercropping system, whereas during second year it shows significant difference in number of seeds per plant. From the mean pool data it was recorded that maize + groundnut intercropping was significantly superior (367.03) over maize + soybean intercropping (343.71).

Statistically, it was found that application of different level of recommended fertilizer doses has significant effect on number of seeds and results revealed that 100%RDF to both the crop recorded maximum number of seeds per plant (406.17). Control recorded the minimum number of seeds per cob (314.21).

Data on the number of seeds in the first year showed that there was no significant effect on intercropping and fertilizer application but found significant difference in the second year. From the pool data it was recorded that maximum number of seeds was recorded from maize + groundnut with 100%RDF to both the crop (413.01). The minimum was recorded from maize + soybean control (299.07).

Table 9. Effect of intercropping and fertilizer doses on length of cobs and number of seeds per cob of maize

Treatments	Length of cob (cm)			Number of seeds per cob		
	2008	2009	Pooled	2008	2009	Pooled
Intercropping (IC)						
IC_1-Maize+Groundnut (2:2)	16.84	16.23	16.54	371.18	362.90	367.03
IC_2-Maize + Soybean (2:2)	17.38	17.04	17.21	348.82	338.61	343.71
SEm$\pm$	0.18	0.16	0.12	0.17	0.03	0.08
CD (P=0.05)	NS	NS	NS	NS	0.18	0.48
Fertilizer doses (F)						
F_1-Control (No NPK)	15.47	14.82	15.14	318.19	310.25	314.21
F_2-100%NPK (both the crop)	17.53	17.65	17.59	409.77	402.59	406.17
F_3-100%NPK (Maize)	18.40	17.52	17.96	370.64	355.65	363.09
F_4-100% (Maize) +50% (Intercrop)	17.13	16.72	16.93	391.66	381.04	386.33
F_5-50% (Maize) + 100% (Intercrop)	18.47	16.96	17.21	339.09	332.27	335.67
F_6-50% NPK (Maize & Intercrop)	16.67	16.16	17.41	334.57	326.46	330.49
SEm$\pm$	0.20	0.16	0.13	0.16	0.11	0.10
CD (P=0.05)	0.59	0.47	0.38	0.47	0.32	0.29
Interactions (IC x F)						
IC_1 x F_1	15.33	14.36	14.85	333.77	325.66	329.72
IC_1 x F_2	17.00	17.45	17.23	416.48	409.56	413.01
IC_1 x F_3	18.00	16.69	17.34	366.34	354.07	360.20
IC_1 x F_4	16.67	16.18	16.42	402.31	394.99	398.62
IC_1 x F_5	17.40	16.74	17.07	356.82	349.83	353.32
IC_1 x F_6	16.67	15.97	16.32	354.71	346.69	350.69
IC_2 x F_1	15.60	15.27	15.43	302.96	295.24	299.07
IC_2 x F_2	18.07	17.84	17.95	403.11	395.63	399.38
IC_2 x F_3	18.80	18.36	18.58	374.97	357.20	366.03
IC_2 x F_4	17.60	17.27	17.43	381.19	367.37	374.23
IC_2 x F_5	17.53	17.18	17.36	321.81	315.17	318.48
IC_2 x F_6	16.67	16.36	16.51	315.02	306.80	310.92
SEm$\pm$	0.29	0.22	0.18	0.23	0.15	0.14
CD (P=0.05)	NS	0.64	0.53	NS	0.44	0.41

4.2.5 Weight of cobs (gm)

Perusal of the data presented in Table 10, it was found that during first year intercropping did not show any significant difference on weight of cobs but in the second year it was found significant. From the pool data it was revealed that intercropping has a significant influence. Maize + groundnut intercropping was superior (124.20) but was at par with intercropping of maize + soybean (121.58).

On further scanning of the treatment for the influence of fertilizer doses on weight of cobs, it was evident that all weight of cobs showed significant influence. The maximum weight of cobs was recorded from 100%RDF to both the crops (138.61) and minimum was recorded from the control (93.97).

Interaction effect on intercropping and fertilizer application on weight of cobs did not show any significant difference in both years.

4.2.6 Test weight (g)

Observations recorded on test weight are presented in Table 10. The data revealed that test weight was found non significant in intercropping during both the experimental year (2008 and 2009).

Statistically, it was found that application of different level of recommended fertilizer doses had significant effect on test weight and results from the pool data it was revealed that 100%RDF to both the crop recorded the maximum test weight (241.42). Whereas the minimum test weight was recorded from control (172.78).

There was no interaction effect on intercropping and fertilizer application during first year. In the second year it showed significant effect. From the pool data it was revealed that the maximum test weight (245.98) was recorded from maize + groundnut with 100% RDF to both the crop which was statistically at par with maize + soybean intercropping with 100 % RDF to both the crop (236.87). Maize+ groundnut control recorded the minimum test weight (166.67) and was at par with maize + soybean control (178.89).

4.2.7 Grain yield of maize (q/ha)

Observation recorded on grain yield is presented in Table 11. The data revealed that grain yield was found non significant in intercropping during both the year (2008 and 2009).

Table 10. Effect of intercropping and fertilizer doses on weight of cobs and test weight of maize

Treatments	Weight of cob (g)			Test weight (g)		
	2008	2009	Pooled	2008	2009	Pooled
Intercropping (IC)						
IC_1-Maize+Groundnut (2:2)	125.54	122.86	124.20	209.63	205.69	207.66
IC_2-Maize + Soybean (2:2)	122.56	120.60	121.58	209.08	205.14	207.11
SEm±	1.22	0.24	0.62	4.15	1.49	2.20
CD (P=0.05)	NS	1.46	3.77	NS	NS	NS
Fertilizer doses (F)						
F_1-Control (No NPK)	95.47	92.46	93.97	175.00	170.56	172.78
F_2-100%NPK (both the crop)	139.69	137.54	138.61	243.18	239.67	241.42
F_3-100%NPK (Maize)	131.21	128.61	129.91	217.61	213.86	215.73
F_4-100%(Maize) +50% (Intercrop)	133.11	131.02	132.07	228.23	224.41	226.32
F_5-50% (Maize) +100% (Intercrop)	123.73	122.11	122.92	197.95	194.42	196.19
F_6-50% NPK (Maize & Intercrop)	121.09	118.63	119.86	194.16	189.57	191.86
SEm±	1.76	0.60	0.93	5.31	1.25	2.73
CD (P=0.05)	5.19	1.77	2.74	15.66	3.68	8.05
Interactions (IC x F)						
IC_1 x F_1	96.17	93.09	94.63	168.83	164.51	166.67
IC_1 x F_2	140.83	137.58	139.21	247.69	244.26	245.98
IC_1 x F_3	130.10	126.99	128.54	212.58	208.72	210.65
IC_1 x F_4	133.77	131.85	132.81	224.55	221.36	222.96
IC_1 x F_5	129.43	127.20	128.31	204.43	201.39	202.91
IC_1 x F_6	122.92	120.44	121.68	199.70	193.88	196.79
IC_2 x F_1	94.77	91.83	93.30	181.16	176.61	178.89
IC_2 x F_2	138.54	137.49	138.02	238.67	235.07	236.87
IC_2 x F_3	132.31	130.23	131.27	222.64	218.99	220.82
IC_2 x F_4	132.45	130.19	131.32	231.90	227.46	229.68
IC_2 x F_5	118.03	117.01	117.52	191.48	187.45	189.46
IC_2 x F_6	119.26	116.82	118.04	188.62	185.26	186.94
SEm±	2.48	0.85	1.31	7.51	1.77	3.86
CD (P=0.05)	NS	NS	NS	NS	5.22	11.38

Further analysis of the data revealed that all grain yield of maize showed significant influence on different recommended doses of fertilizer during both years. In the first year the maximum grain yield was recorded from 100%RDF to both the crops (39.05). The minimum grain yield was recorded from the control (20.64). Observation on the second year data showed that, maximum grain yield was recorded from 100%RDF to both the crops (36.0). The minimum grain yield was recorded from the control (17.79). Further analysis of the mean pool data revealed that 100%RDF to both the crops recorded the highest (37.53) maize grain yield which was statistically superior from the rest of the treatments. In control recorded the lowest maize grain yield (19.22).

A critical examination of the data pertaining to the interaction effect on intercropping and fertilizer application on grain yield reveals that there was significant difference in both the years. Analysis recorded from the mean pool data indicates that, the highest grain yield on interaction effect was recorded from maize + groundnut with 100%RDF to both the crop (38.91). The minimum was recorded from maize + soybean control (17.30) which was statistically at par with maize + groundnut control (19.73).

4.2.8 Stover yield of maize (q/ha)

A critical examination of the data presented in Table 11 showed that stover yield was found no significant effect in intercropping during both the experimental year.

On further examination of the data for the influence of different doses of fertilizer on stover yield, it was observed that all levels of fertilizer had significant influence on stover yield over control. Analysis from the mean pool data, the highest (75.37) stover yield was recorded from 100%RDF to both the crop and the lowest (38.93) by control.

The interaction effect between intercropping and different recommended doses of fertilizer was found significant. From the mean pooled data, the highest (78.09) stover yield was recorded from maize + groundnut with 100%RDF to both the crop and the lowest (38.34) from maize + soybean control which was statistically at par with (39.53) maize + groundnut control.

Table 11. Effect of intercropping and fertilizer doses on grain yield and stover yield of maize

Treatments	Grain yield (q/ha)			Stover yield (q/ha)		
	2008	2009	Pooled	2008	2009	Pooled
Intercropping (IC)						
IC_1-Maize+Groundnut (2:2)	30.43	27.71	29.07	61.37	55.42	58.39
IC_2-Maize + Soybean (2:2)	28.82	25.70	27.26	59.44	51.25	55.34
SEm$\pm$	0.80	0.50	0.47	1.65	1.03	0.97
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Fertilizer doses (F)						
F_1-Control (No NPK)	20.64	17.79	19.22	42.11	35.75	38.93
F_2-100%NPK (both the crop)	39.05	36.00	37.53	79.24	71.50	75.37
F_3-100%NPK (Maize)	31.54	28.68	30.11	64.57	57.32	60.95
F_4-100%(Maize)+50%(Intercrop)	35.33	32.78	34.06	71.58	65.26	68.42
F_5-50% (Maize)+100%(Intercrop)	25.87	22.80	25.33	53.36	45.80	49.58
F_6-50% NPK (Maize & Intercrop)	25.34	22.16	23.75	51.56	44.36	47.96
SEm$\pm$	0.68	0.43	0.40	1.27	0.87	0.77
CD (P=0.05)	2.00	1.27	1.18	3.75	2.56	2.27
Interactions (IC x F)						
IC_1 x F_1	21.18	18.28	19.73	42.34	36.71	39.53
IC_1 x F_2	40.10	37.71	38.91	80.66	75.52	78.09
IC_1 x F_3	30.38	27.87	29.13	62.15	55.69	58.92
IC_1 x F_4	35.79	33.28	34.54	72.02	66.28	69.15
IC_1 x F_5	27.94	24.96	26.45	56.57	50.02	53.30
IC_1 x F_6	27.21	24.15	25.68	54.47	48.29	51.38
IC_2 x F_1	20.10	17.30	18.70	41.89	34.80	38.34
IC_2 x F_2	38.00	34.29	36.15	77.81	67.49	72.65
IC_2 x F_3	32.69	29.49	31.09	66.99	58.96	62.98
IC_2 x F_4	34.87	32.27	33.57	71.15	64.24	67.69
IC_2 x F_5	23.79	20.64	22.22	50.15	41.58	45.86
IC_2 x F_6	23.46	20.18	21.82	48.65	40.42	44.54
SEm$\pm$	0.97	0.60	0.57	1.80	1.23	1.09
CD (P=0.05)	2.86	1.76	1.68	NS	3.62	3.21

4.2.9 Harvest index (%)

Perusal of the data presented in Table 12, it was found that maize based intercropping did not show any significant difference on harvest index during both experimental years.

Application of different recommended dose of fertilizer influenced harvest index significantly with the highest (33.81) from 50%RDF maize + 100% RDF to intercrop. However it was at par with all treatments.

Interaction between different doses of fertilizer treatment and intercropping showed no significant effect during both the years of experimentation.

4.2.10 Maize equivalent yield (q/ha)

The influence of different intercropping treatments at various fertilizer treatments on maize equivalent yield are presented in Table 12. Data in the table indicates that different intercropping had significant difference in both the experimental years. From the mean pool data showed that maize + groundnut intercropping (72.80) was significantly superior to maize + soybean intercropping (51.73).

Further examination of the data for the influence of recommended dose of on maize equivalent yield revealed that different fertilizer doses had significant influence during both the years. From the mean pool data, it was observed that the maximum maize equivalent yield (81.35) was recorded from 100%RDF to both the crop which was significantly superior to the rest of the treatments and minimum was recorded from control (42.51).

Interaction effect on intercropping and fertilizer application on maize equivalent yield had significant difference in both years. Data on maize equivalent yield obtained from mean pooled data of 2008 and 2009 revealed that, the highest maize equivalent yield (94.83) was recorded from maize + groundnut intercropping with 100% RDF to both the crops and the minimum from maize + soybean intercropping control(35.42).

4.3 Phenological parameters

4.3.1 Days to 50 per cent flowering

It was evident from the data presented in Table 13 and revealed that different intercropping system did not show any significant difference during both the experimental years.

Table 12. Effect of intercropping and fertilizer doses on harvest index and maize equivalent yield

Treatments	Harvest index (%)			Maize equivalent yield (q/ha)		
	2008	2009	Pooled	2008	2009	Pooled
Intercropping (IC)						
IC_1-Maize+Groundnut (2:2)	33.15	33.33	33.24	75.80	69.79	72.80
IC_2-Maize + Soybean (2:2)	32.65	33.40	33.00	54.05	49.41	51.73
SEm$\pm$	0.16	0.02	0.08	0.87	0.09	0.44
CD (P=0.05)	NS	NS	NS	5.29	0.54	2.67
Fertilizer doses (F)						
F_1-Control (No NPK)	32.89	33.23	33.05	44.69	40.33	42.51
F_2-100%NPK (both the crop)	33.01	33.49	33.24	84.54	78.16	81.35
F_3-100%NPK (Maize)	32.82	33.35	33.07	59.14	54.02	56.58
F_4-100%(Maize) +50% (Intercrop)	33.05	33.44	33.24	72.42	67.50	69.96
F_5-50% (Maize) + 100% (Intercrop)	32.65	33.24	33.81	68.42	62.77	65.59
F_6-50% NPK (Maize & Intercrop)	32.95	33.31	33.12	60.36	54.83	57.60
SEm$\pm$	0.21	0.21	0.15	0.59	0.92	0.54
CD (P=0.05)	0.61	NS	0.44	1.74	2.71	1.59
Interactions (IC x F)						
IC_1 x F_1	33.34	33.24	33.29	52.08	47.12	49.60
IC_1 x F_2	33.21	33.30	33.26	98.48	91.17	94.83
IC_1 x F_3	32.83	33.35	33.08	65.16	59.45	62.31
IC_1 x F_4	33.20	33.43	33.31	84.47	79.38	81.93
IC_1 x F_5	33.06	33.29	33.17	82.32	75.78	79.05
IC_1 x F_6	33.31	33.34	33.32	72.31	65.85	69.08
IC_2 x F_1	32.42	33.21	32.78	37.30	33.54	35.42
IC_2 x F_2	32.81	33.69	33.23	70.60	65.15	67.88
IC_2 x F_3	32.79	33.34	33.05	53.12	48.59	50.86
IC_2 x F_4	32.89	33.44	33.15	60.37	55.61	57.99
IC_2 x F_5	32.17	33.17	32.64	54.51	49.76	52.14
IC_2 x F_6	32.53	33.30	32.88	48.41	43.81	46.11
SEm$\pm$	0.30	0.29	0.21	0.83	1.30	0.77
CD (P=0.05)	NS	NS	NS	2.44	3.83	2.27

Table 13. Effect of intercropping and fertilizer doses on days to 50% flowering and days to maturity of maize

Treatments	**Days to 50% flowering**			**Days to maturity**		
	2008	**2009**	**Pooled**	**2008**	**2009**	**Pooled**
Intercropping (IC)						
IC_1-Maize+Groundnut (2:2)	62.67	65.21	63.93	90.91	94.52	92.70
IC_2-Maize + Soybean (2:2)	62.70	65.11	63.90	90.86	94.19	92.51
SEm$\pm$	0.03	0.01	0.01	0.01	0.00	0.00
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Fertilizer doses (F)						
F_1-Control (No NPK)	60.03	61.88	60.95	90.66	93.01	91.83
F_2-100%NPK (both the crop)	65.27	68.89	67.07	91.51	96.09	93.78
F_3-100%NPK (Maize)	63.50	66.49	64.98	90.89	94.95	92.91
F_4-100%(Maize) +50% (Intercrop)	64.30	66.30	65.31	91.56	94.13	92.85
F_5-50% (Maize) + 100% (Intercrop)	61.71	63.82	62.75	90.32	94.15	92.22
F_6-50% NPK (Maize & Intercrop)	61.39	63.66	62.51	90.32	93.82	92.06
SEm$\pm$	0.02	0.02	0.02	0.02	0.02	0.01
CD (P=0.05)	0.05	0.05	0.05	NS	NS	NS
Intercropping x fertilizer doses	NS	NS	NS	NS	NS	NS

Statistically, it was found that application of different level of recommended fertilizer doses found significant effect. In general, the number of days required to 50 per cent flowering in maize was 60 to 67 DAS and results revealed that 100%RDF to both the crop recorded the maximum number of days (67.07). While, the lowest number of days required to 50 per cent flowering was recorded from control (60.95) DAS during both years.

There was no interaction effect on intercropping and fertilizer application to 50 per cent flowering in maize during both years.

4.3.2 Days to maturity.

The influence of intercropping system at different fertilizer doses on the number of days needed for maturing in maize are presented in Table 13. Data in the table indicated that intercropping system at various fertilizer doses and interaction effect on fertilizer and intercropping did not show any significant difference during both the experimental years.

4.4 Economics

For the comparison of economic profitability of different treatments at various fertilizer doses and different intercropping, the cost of cultivation, gross return, net return and benefit: cost ratio of different treatments were calculated and presented in Table14 and Table 15.

4.4.1 Cost of cultivation (`)

Observation recorded on cost of cultivation is presented in Table 14. The data reveals that different intercropping has significant difference in both the experimental year. From the mean pool data, it was observed that maize + groundnut intercropping (` 31305) were significantly superior to maize + soybean intercropping (` 28872).

Further analysis of the data reveals that all cost of cultivation of maize shows significant due to different levels of RDF. The maximum cost of cultivation was recorded from 100%RDF to both the crops (` 31941). The minimum cost of cultivation was recorded from the control (` 26975) from the pool data.

A critical examination of the data pertaining to the interaction effect on intercropping and fertilizer application on cost of cultivation revealed that there was significant difference

Table14. Cost of cultivation and gross return.

Treatments	Cost of cultivation (`)			Gross return (`)		
	2008	2009	Pooled	2008	2009	Pooled
Intercropping (IC)						
IC_1-Maize+Groundnut	31551	31059	31305	75803	69791	72797
IC_2-Maize + Soybean	28872	28872	28872	54042	49410	51726
SEm±	0.04	0.07	0.04	870.09	85.02	437.12
CD (P=0.05)	0.34	0.61	0.20	5294	517.33	2659
Fertilizer doses (F)						
F_1-Control (No NPK)	27075	26875	26975	44658	40326	42492
F_2-100%NPK (both the crop)	32078	31803	31941	84540	78163	81351
F_3-100%NPK (Maize)	29783	29508	29646	59140	54020	56580
F_4-100%(Maize) +50% (IC)	31207	30931	31069	72421	67498	69960
F_5-50% (Maize) + 100% (IC)	30999	30774	30887	68415	62770	65592
F_6-50% NPK (Maize & IC)	30127	29902	30014	60361	54828	57595
SEm±	0.59	0.12	0.07	584.53	916.42	543.48
CD (P=0.05)	1.74	0.34	0.20	1724.3	2703	1603.2
Interactions (IC x F)						
IC_1 x F_1	28569	28169	28369	52083	47116	49600
IC_1 x F_2	33297	32747	33022	98483	91173	94828
IC_1 x F_3	31277	30727	31002	65156	59453	62305
IC_1 x F_4	32512	31962	32237	84470	79383	81926
IC_1 x F_5	32218	31768	31993	82316	75776	79046
IC_1 x F_6	31433	30983	31208	72310	65846	69078
IC_2 x F_1	25582	25582	25582	37233	33536	35385
IC_2 x F_2	30860	30860	30860	70596	65153	67875
IC_2 x F_3	28290	28290	28290	53123	48586	50855
IC_2 x F_4	29903	29901	29902	60373	55613	57993
IC_2 x F_5	29781	29781	29781	54513	49763	52138
IC_2 x F_6	28821	28821	28821	48413	43810	46111
SEm±	0.83	0.17	0.10	826.65	1296.0	768.60
CD (P=0.05)	2.44	0.50	0.29	2438.6	3823.2	2267.3

in both the years. Data recorded from the mean pool, the highest cost of cultivation on interaction effect was recorded from maize + groundnut with 100%RDF to both the crop (`33022). The minimum was recorded from maize + soybean control (` 25582).

4.4.2 Gross return(`)

The influence of different intercropping treatments at various fertilizer treatments on gross return per hectare are presented in Table 14. Data in the table indicated that intercropping had significant difference in both the experimental year. The field experiment of 2008 and 2009 and mean pooled analysis of the two year data revealed that maize + groundnut intercropping (` 72797) were significantly superior to maize + soybean intercropping (` 51726).

Further examination of the data for the influence of different recommended dose of fertilizer on cost of cultivation found that different fertilizer doses had significant influence during both the years. From the mean pool data, it was observed that the maximum gross return was recorded from 100%RDF to both the crop (` 81351) and minimum was recorded from control (` 42492).

Interaction effect on intercropping and fertilizer application on gross return found significant difference in both years. Data on gross return obtained from mean pooled data of 2008 and 2009 revealed that, the highest gross return (` 94828) was recorded from maize + groundnut intercropping with 100% RDF to both the crops and the minimum gross return from maize + soybean intercropping control (` 35385).

4.4.3 Net return (`)

Observations recorded on net return are presented in Table 15. Data in the table indicated that intercropping treatments at different recommended dose of fertilizer had a significant variation on net return in both the experimental year (2008 and 2009). It was revealed from the pool data that maize + groundnut intercropping (` 41492) which was significantly superior to maize + soybean intercropping (` 22854).

Further analysis of the data revealed on different recommended dose of fertilizer on net return showed significant influence due to different levels of RDF. Observation recorded from

Table 15. Net return and benefit cost ratio.

Treatments	Net return (`)			B: C Ratio		
	2008	2009	Pooled	2008	2009	Pooled
Intercropping (IC)						
IC_1-Maize+Groundnut (2:2)	44252	38732	41492	2.39	2.23	2.31
IC_2-Maize + Soybean (2:2)	25169	20538	22854	1.86	1.70	1.78
SEm±	870.09	85.02	437.12	0.03	0.003	0.01
CD (P=0.05)	5294.3	517.33	2160.5	0.18	0.01	0.03
Fertilizer doses (F)						
F_1-Control (No NPK)	17582	13451	15517	1.64	1.49	1.57
F_2-100%NPK (both the crop)	52461	46359	49410	2.62	2.45	2.54
F_3-100%NPK (Maize)	29356	24511	26934	1.98	1.83	1.91
F_4-100% (Maize) +50% (IC)	41215	36567	38891	2.31	2.17	2.24
F_5-50% (Maize) + 100% (IC)	37415	31995	34705	2.19	2.03	2.11
F_6-50% NPK (Maize & IC)	30234	24926	27580	1.99	1.82	1.91
SEm±	584.53	916.42	543.48	0.02	0.03	0.02
CD (P=0.05)	1724.3	2703.4	1603.2	0.05	0.08	0.05
Interactions (IC x F)						
IC_1 x F_1	23514	18947	21231	1.82	1.67	1.75
IC_1 x F_2	65186	58426	61806	2.96	2.78	2.87
IC_1 x F_3	33879	28726	31303	2.08	1.93	2.01
IC_1 x F_4	51958	47421	49689	2.60	2.48	2.54
IC_1 x F_5	50098	44008	47053	2.55	2.39	2.47
IC_1 x F_6	40877	34863	37870	2.30	2.13	2.22
IC_2 x F_1	11651	7954	9803	1.46	1.31	1.39
IC_2 x F_2	39736	34293	37015	2.29	2.13	2.21
IC_2 x F_3	24833	20296	22565	1.88	1.72	1.80
IC_2 x F_4	30473	25713	28093	2.02	1.86	1.94
IC_2 x F_5	24732	19982	22357	1.83	1.67	1.75
IC_2 x F_6	19592	14989	17290	1.68	1.52	1.60
SEm±	826.65	1296.0	768.6	0.03	0.04	0.03
CD (P=0.05)	2438.6	3823.2	2267.3	0.08	0.11	0.08

the pool data showed that the maximum net return was recorded from 100%RDF to both the crops (`49410). The minimum net return was recorded from the control (` 15517).

A critical examination of the data pertaining to the interaction effect on intercropping and fertilizer application on net return revealed that there was significant difference in both the experimental years. The highest net return on interaction effect was recorded from maize + groundnut with 100%RDF to both the crop (` 61806). The minimum was recorded from maize + soybean control (` 9803).

4.4.4 Benefit cost ratio (B:C ratio)

It was evident from the data presented in Table 15 that the B:C ratio differed significantly due to different RDF and at various intercropping during both the field experimental year (2008 and 2009). Data revealed from the pool data shows that maize + groundnut intercropping (2.31) was significantly superior to maize + soybean intercropping (1.78).

On further scanning of the treatment for the influence of fertilizer doses on B:C ratio, it was evident that B:C ratio showed significant influence due to different levels of RDF. The maximum B:C ratio was recorded from 100%RDF to both the crop (2.54). The minimum B:C ratio was recorded from the control (1.57).

Interaction effect on intercropping and fertilizer application on B:C ratio shows significant difference in both the years. The maximum B:C ratio was recorded from maize + groundnut with 100%RDF to both the crop (2.87) and minimum was recorded from maize + soybean control (1.39).

4.5 Growth attributes of groundnut

4.5.1 Plant height of groundnut (cm)

Variations on plant height of groundnut due to different fertilizer doses in intercropping were significant at all stages of observation. Data on the mean plant height of groundnut were recorded at 15, 30, 45, 60, 75DAS and at harvest are presented in Table 16a, 16b and 16c.

4.5.1.1 Plant height (cm) at 15 DAS and 30 DAS

It was evident from the data presented in Table 16a revealed that intercropping treatment at different fertilizer levels had significant variation in the plant height of groundnut at 15 and 30 DAS during the experimental year 2008 and 2009.

At 15 DAS (2008), the maximum plant height of groundnut was recorded with 100% RDF to both the crops (18.27 cm) control recorded the lowest plant height (15.93 cm) which was significantly inferior over all the treatments.

The second year data on the plan height at 15 DAS showed that the maximum plant height of groundnut were recorded from 50% RDF to maize + 100% RDF to intercrop (16.07 cm) and 100% RDF to maize (16.07 cm) which was at par with 100% RDF to both the crops (15.08 cm).The minimum plant height of groundnut was recorded with control (13.87 cm).

A further analysis of the mean pooled data of 2008 and 2009 revealed that the maximum plant height of groundnut was recorded from 100% RDF to both the crops (17.03 cm) which was at par with 50% RDF to maize + 100% RDF to intercrop (16.87 cm) The minimum plant height was obtained from control (14.90 cm).

At 30 DAS (2008), the maximum plant height of groundnut was recorded 100% RDF to both the crops (42.67 cm) which was statistically at par with 50% RDF to maize + 100% RDF to intercrop (41.20 cm). Control recorded the lowest plant height of groundnut (34.40 cm).

In the second year (2009), at 30 DAS, the maximum plant height was recorded at 100% RDF to both the crops (38.60 cm) which was statistically at par with 50% RDF to maize + 100% RDF to intercrop (37.60 cm) and 50% RDF to maize + 50% RDF to intercrop 36.80 cm) . The lowest plant height of groundnut was recorded with control (32.73 cm).

Result obtained from the mean pooled data of 2008 and 2009 revealed that the maximum plant height (40.63 cm) was recorded from 100% RDF to both the crops which was at par with 50% RDF to maize + 100% RDF to intercrop (39.40 cm) while control recorded the lowest plant height of groundnut (33.57 cm).

4.5.1.2 Plant height(cm) at 45 and 60 DAS

The data pertaining to the influence of intercropping system at various RDF on the plant height of groundnut at 45 and 60 DAS are presented in Table 16b and revealed that

Table 16a. Effect of intercropping and fertilizer doses on plant height of groundnut

Treatments	15 DAS			30 DAS		
	2008	**2009**	**Pooled**	**2008**	**2009**	**Pooled**
F_1-Control (No NPK)	15.93	13.87	14.90	34.40	32.73	33.57
F_2-100%NPK (both the crop)	18.27	15.80	17.03	42.67	38.60	40.63
F_3-100%NPK (Maize)	16.53	16.07	16.30	38.13	35.80	36.97
F_4-100%(Maize) +50% (Intercrop)	17.67	14.53	16.10	39.93	36.53	38.23
F_5-50% (Maize) + 100% (Intercrop)	17.67	16.07	16.87	41.20	37.60	39.40
F_6-50% NPK (Maize & Intercrop)	17.13	14.60	15.87	38.93	36.80	37.87
SEm$\pm$	0.11	0.38	0.20	0.42	0.71	0.41
CD (P=0.05)	0.32	1.12	0.59	1.23	2.09	1.20

Table 16b. Effect of intercropping and fertilizer doses on plant height of groundnut

Treatments	45 DAS			60 DAS		
	2008	**2009**	**Pooled**	**2008**	**2009**	**Pooled**
F_1-Control (No NPK)	61.60	58.87	60.23	83.53	80.00	81.77
F_2-100%NPK (both the crop)	73.40	69.53	71.47	93.60	89.20	91.40
F_3-100%NPK (Maize)	68.07	65.93	67.00	87.47	84.80	86.13
F_4-100%(Maize) +50% (Intercrop)	68.87	67.47	68.17	90.07	85.27	87.67
F_5-50% (Maize) + 100% (Intercrop)	70.13	69.07	69.60	91.73	88.27	90.00
F_6-50% NPK (Maize & Intercrop)	68.73	66.40	67.57	89.67	86.67	88.17
SEm$\pm$	1.12	1.16	0.80	1.23	0.52	0.67
CD (P=0.05)	3.30	3.42	2.35	3.62	1.53	1.97

intercropping system at various fertilizer levels had a significant impact on the plant height of groundnut during both the experimental year (2008 and 2009).

At 45 DAS (2008), the maximum plant height was recorded 100% RDF to both the crops (73.40 cm) which was statistically at par with 50% RDF to maize + 100% RDF to intercrop (70.13 cm). The lowest plant height of groundnut was recorded with control (61.60 cm).

The second year (2009) data on the plant height of groundnut at 45 DAS, showed that 100% RDF to both the crops (69.53 cm) were statistically at par with 50% RDF to maize + 100% RDF to intercrop (69.07 cm) and control recorded the lowest plant height (58.87 cm).

A further analysis of the mean pooled data of 2008 and 2009 field experiment revealed that the maximum plant height was obtained from 100% RDF to both the crops (71.47 cm) which was statistically at par with 50% RDF to maize + 100% RDF to intercrop (69.60cm) while control recorded the minimum plant height of groundnut (60.23 cm).

At 60 DAS (2008), there is significant difference in the plant height of groundnut. 100% RDF to both the crops (93.60 cm) recorded the tallest plant height which was followed by 50% RDF to maize + 100% RDF to intercrop (91.73 cm), followed by 100% RDF to maize + 50% RDF to intercrop (90.07 cm), followed by 50% RDF to maize + 100% RDF to intercrop (89.67 cm). In the control (83.53 cm) recorded the minimum plant height.

The second year data (2009) on the plant height of groundnut at 60 DAS showed that there is a significant variation in the plant height at 60 DAS. The highest plant height was recorded from 100% RDF to both the crops (89.20 cm) which was at par with 50% RDF to maize + 100% RDF to intercrop (88.27 cm) and control recorded the lowest plant height (80.00 cm).

A further analysis of the pooled data of 2008 and 2009 field experiment revealed that, the maximum plant height at 60 DAS was obtained with 100% RDF to both the crops (91.40 cm) which was statistically at par with 50% RDF to maize + 100% RDF to intercrop (90.00 cm) while minimum plant height of groundnut was recorded from control (81.77 cm).

4.5.1.3 Plant height at 75 DAS and at harvest

A critical examination of the data presented in Table 16c revealed that intercropping system at various fertilizer treatments had a significant influence in the plant height of groundnut at 75 and 90 DAS in both the year 2008 and 2009.

At 75 DAS (2008), 100% RDF to both the crops recorded the highest plant height (108.20 cm) which was at par with 50% RDF to maize + 100% RDF to intercrop (105.67 cm) The lowest plant height was obtained control (95.07 cm).

The second year (2009) data on the plant height of groundnut at 75 DAS, revealed that the highest plant height was recorded from 100% RDF to both the crops(104.00 cm) which was at par with100% RDF to maize + 50% RDF to intercrop (102.73 cm), followed by 50% RDF to maize + 100% RDF to intercrop (101.93 cm). Control (92.27 cm) recorded the minimum plant height.

Further analysis of the mean pooled data of 2008 and 2009 field experiment on the plant height of groundnut showed that, maximum plant height (106.10 cm) was recorded from100% RDF to both the crops. The lowest plant height (93.67 cm) was recorded from control.

At harvest DAS (2008), the maximum plant height of groundnut was recorded with 100% RDF to both the crops(110.53 cm) which was at par with 50% RDF to maize + 100% RDF to intercrop (108.80 cm) followed by 100% RDF to maize + 50% RDF to intercrop (107.13 cm). Control (97.40 cm) recorded the minimum plant height.

The data pertaining to the second year (2009) on plant height at harvest revealed that 100% RDF to both the crops recorded the maximum plant height (107.20 cm) of groundnut which was at par with 50% RDF to maize + 100% RDF to intercrop (105.20 cm) followed by 100% RDF to maize + 50% RDF to intercrop (104.93 cm). The lowest plant height (95.30 cm) was obtained from control.

Further analysis of the mean pooled data of 2008 and 2009 on the plant height of groundnut revealed that the maximum plant height (108.87 cm) was obtained from 100% RDF to both the crops which was at par with 50% RDF to maize + 100% RDF to intercrop (107.00 cm) followed by 100% RDF to maize + 50% RDF to intercrop (106.03 cm) whereas control recorded the minimum plant height (96.35 cm) of groundnut.

Table 16c. Effect of intercropping and fertilizer doses on plant height of groundnut

Treatments	75 DAS			At harvest		
	2008	2009	Pooled	2008	2009	Pooled
F_1-Control (No NPK)	95.07	92.27	93.67	97.40	95.30	96.35
F_2-100%NPK (both the crop)	108.20	104.00	106.10	110.53	107.20	108.87
F_3-100%NPK (Maize)	100.73	97.53	99.13	103.53	100.73	102.13
F_4-100%(Maize) +50% (Intercrop)	103.93	102.73	103.33	107.13	104.93	106.03
F_5-50% (Maize) + 100% (Intercrop)	105.67	101.93	103.80	108.80	105.20	107.00
F_6-50% NPK (Maize & Intercrop)	101.67	98.13	99.90	104.73	101.33	103.03
SEm±	1.09	1.17	0.80	1.29	1.23	0.90
CD (P=0.05)	3.21	3.45	2.35	3.80	3.62	2.65

Table 17a. Effect of intercropping and fertilizer doses on number of leaves of groundnut

Treatments	15 DAS			30 DAS		
	2008	2009	Pooled	2008	2009	Pooled
F_1-Control (No NPK)	8.28	6.03	7.11	28.79	21.27	24.89
	(2.96)	(2.56)	(2.76)	(5.41)	(4.67)	(5.04)
F_2-100%NPK (both the crop)	9.85	7.94	8.87	35.93	31.18	33.52
	(3.22)	(2.91)	(3.06)	(6.04)	(5.63)	(5.83)
F_3-100%NPK (Maize)	9.19	6.33	7.70	31.59	23.97	27.66
	(3.11)	(2.61)	(2.86)	(5.67)	(4.95)	(5.31)
F_4-100%(Maize) +50% (Intercrop)	9.21	7.13	8.14	32.72	27.32	29.96
	(3.12)	(2.76)	(2.94)	(5.76)	(5.27)	(5.52)
F_5-50% (Maize) + 100% (Intercrop)	9.17	7.39	8.26	33.87	28.64	31.20
	(3.11)	(2.81)	(2.96)	(5.86)	(5.40)	(5.63)
F_6-50% NPK (Maize & Intercrop)	8.99	6.87	7.89	32.47	25.17	28.71
	(3.08)	(2.71)	(2.90)	(5.74)	(5.07)	(5.40)
SEm±	0.04	0.04	0.03	0.05	0.08	0.05
CD (P=0.05)	0.14	0.13	0.09	0.17	0.31	0.16

* Figures in parenthesis are transformed values

4.5.2 Number of leaves per plant

Variation in the number of leaves of groundnut due to different recommended dose of fertilizer was significant at all stages of observation. Data on the mean number of leaves of groundnut were recorded at 15, 30, 45, 60 and 90 DAS and are presented in Table 17a, 17b and 17c.

4.5.2.1 Number of leaves per plant at 15 DAS and 30 DAS

A critical examination of data presented in Table 17a showed that the number of leaves of groundnut recorded at 15 DAS and 30 DAS were found significant in intercropping during both the year (2008-2009).

At 15 DAS (2008), the maximum number of leaves was recorded from 100% RDF to both the crops (9.85) which were superior to the rest of fertilizer treatment. In control plots recorded the lower number of leaves (9.85).

The second year (2009) data on the number of leaves of groundnut at 15 DAS showed that 100% RDF to both the crops recorded the maximum (7.94) and control recorded the lowest number of leaves (6.03).

A further analysis of the mean pooled data of 2008 and 2009 field experiment revealed that the maximum number of leaves at 15 DAS was obtained from 100% RDF to both the crops (8.87) which were superior to all the treatments while control recorded the minimum number of leaves of groundnut (7.11).

At 30 DAS (2008), 100% RDF to both the crops recorded the maximum number of leaves (35.93) which was significantly superior as compared to RDF. The minimum number of leaves (28.79) was obtained with control.

In second year (2009), 100% RDF to both the crops (31.18) had a significantly more number of leaves over all other treatments. The lowest number of leaves was recorded with control (21.27).

Result obtained from the mean pooled data of 2008 and 2009 experiment revealed that the maximum number of leaves (33.52 cm) was recorded with 100% RDF to both the crops while control recorded the minimum number of leaves (24.89).

4.5.2.2 Number of leaves per plant at 45 DAS and 60 DAS

Perusal of the data presented in Table 17b revealed that at 45 DAS (2008), there was significant difference on number of leaves of groundnut. 50% RDF to maize + 100% RDF to intercrop (57.26) recorded the highest number of leaves. The lowest was recorded from control (46.52).

Observation on the second year (2009) data showed that number of leaves was highest with 100% RDF to both the crops (52.61) while control recorded the lowest number of leaves (38.68).

A further analysis of the mean pooled data of 2008 and 2009 revealed that the maximum number of leaves (54.04) was recorded with 50% RDF to maize + 100% RDF to intercrop which was statistically at par with 100% RDF to both the crops (53.90). The minimum number of leaves was recorded with control (42.51).

At 60 DAS (2008), 100% RDF to both the crops recorded the maximum number of leaves (73.53) which was significantly superior as compared to other treatments. The minimum number of leaves (61.53) was obtained with control.

In second year, 100% RDF to both the crops (69.19) had a significantly more number of leaves over all RDF treatments. The lowest number of leaves was recorded with control (52.13).

Result obtained from the mean pooled data of 2008 and 2009 experiment revealed that the maximum number of leaves (71.34) was recorded with 100% RDF to both the crops while control recorded the minimum number of leaves (56.73).

4.5.2.2 Number of leaves per plant at 75 DAS and at harvest

A perusal of the result in the Table 17c indicated that different RDF had a significant difference on number of leaves at 75 DAS and at harvest in both the years (2008 and 2009).

At 75 DAS (2008), the maximum number of leaves of groundnut was recorded with 100% RDF to both the crops (78.00) while the minimum number of leaves was obtained with control (64.87) which is significantly inferior among all treatments.

Result of the data in 2009 indicated that at 75 DAS, 100% RDF to both the crops recorded the maximum number of leaves of groundnut (73.34). The lowest number of leaves was recorded with control (55.10).

Table 17b. Effect of intercropping and fertilizer doses on number of leaves of groundnut

Treatments	45 DAS			60 DAS		
	2008	**2009**	**Pooled**	**2008**	**2009**	**Pooled**
F_1-Control (No NPK)	46.52 (6.86)	38.68 (6.26)	42.51 (6.56)	61.53 (7.88)	52.13 (7.25)	56.73 (7.57)
F_2-100%NPK (both the crop)	55.20 (7.46)	52.61 (7.29)	53.90 (7.38)	73.53 (8.60)	69.19 (8.35)	71.34 (8.48)
F_3-100%NPK (Maize)	53.28 (7.33)	38.97 (6.28)	45.85 (6.81)	68.04 (8.28)	54.01 (7.38)	60.82 (7.83)
F_4-100%(Maize) +50% (Intercrop)	54.81 (7.44)	44.51 (6.71)	49.53 (7.07)	69.20 (8.35)	57.24 (7.60)	63.08 (7.97)
F_5-50% (Maize) + 100% (Intercrop)	57.26 (7.60)	50.91 (7.17)	54.04 (7.39)	69.86 (8.39)	62.89 (7.96)	66.33 (8.18)
F_6-50% NPK (Maize & Intercrop)	54.43 (7.41)	43.52 (6.64)	48.83 (7.02)	67.86 (8.27)	56.31 (7.54)	61.95 (7.90)
SEm$\pm$	0.14	0.17	0.11	0.07	0.11	0.07
CD (P=0.05)	0.41	0.50	0.30	0.20	0.32	0.20

* Figures in parenthesis are transformed values

Table 17c. Effect of intercropping and fertilizer doses on number of leaves of groundnut

Treatments	75 DAS			At harvest		
	2008	**2009**	**Pooled**	**2008**	**2009**	**Pooled**
F_1-Control (No NPK)	64.87 (8.08)	55.10 (7.46)	59.89 (7.77)	59.93 (7.77)	50.66 (7.15)	55.20 (7.46)
F_2-100%NPK (both the crop)	78.00 (8.86)	73.34 (8.59)	75.65 (8.73)	74.13 (8.64)	68.97 (8.33)	71.52 (8.49)
F_3-100%NPK (Maize)	71.93 (8.51)	58.30 (7.67)	64.94 (8.09)	63.11 (7.98)	49.54 (7.07)	56.12 (7.52)
F_4-100%(Maize) +50% (Intercrop)	73.50 (8.60)	61.02 (7.84)	67.12 (8.22)	67.62 (8.25)	57.23 (7.60)	62.32 (7.93)
F_5-50% (Maize) + 100% (Intercrop)	73.64 (8.61)	66.66 (8.20)	70.11 (8.40)	69.18 (8.35)	62.13 (7.91)	65.61 (8.13)
F_6-50% NPK (Maize & Intercrop)	72.66 (8.55)	60.46 (7.81)	66.42 (8.18)	67.97 (8.27)	55.66 (7.49)	61.66 (7.88)
SEm$\pm$	0.11	0.10	0.07	0.10	0.11	0.07
CD (P=0.05)	0.32	0.29	0.20	0.29	0.32	0.20

* Figures in parenthesis are transformed values

A perusal of the result of the mean pooled data of 2008 and 2009 revealed that, maximum number of leaves (75.65) was recorded with 100% RDF to both the crops while control (59.89) recorded the lowest number of leaves.

In 2008, the maximum number of leaves of groundnut at harvest was recorded with 100% RDF to both the crops (74.13). Control recorded the minimum number of leaves (59.93) of groundnut.

In the second year (2009), the number of leaves at harvest was highest with 100% RDF to both the crops (68.97) while the minimum number of leaves per plant was obtained from control (50.66).

Further analysis of the mean pooled data of 2008 and 2009 revealed that, 100% RDF to both the crops (71.52) had a significantly more number of leaves as compared to the rest of the RDF treatments in an intercropping system. The minimum number of leaves was recorded with control (55.20).

4.5.3 Number of branches of groundnut

4.5.3.1 Number of branches at 15 and 30 DAS

The influence of different fertilizer treatments on number of branches per plant at 15 DAS (2008) are presented in Table 18a. Data on number of branches at 15 DAS indicates that different application of RDF showed variation in the number of branches per plant. The maximum number of branches per plant was obtained from 100% RDF to both the crops (3.33) and the minimum number of branches per plant was obtained from control (2.73).

In the second year (2009), the number of branches at 15DAS was found non significance.

Result obtained from the mean pooled data of 2008 and 2009 experiment revealed that the maximum number of branches (2.52) was recorded with 100% RDF to both the crops which was at par with (2.42) 50% RDF to maize + 100% RDF to intercrop while control recorded the minimum number of branches (2.13).

The data on the number of branches at 30 DAS (2008) showed that the various fertilizer treatment of an intercropping system have a significant variation in the number of branches per plant. The maximum number of branches per plant was obtained from 100% RDF to both the crops (7.52). The minimum number of branches per plant was obtained from control (5.40).

Table 18a. Effect of intercropping and fertilizer doses on number of branches of groundnut

Treatments	15 DAS			30 DAS		
	2008	**2009**	**Pooled**	**2008**	**2009**	**Pooled**
F_1-Control (No NPK)	2.73	1.60	2.13	5.40	4.72	5.06
	(1.80)	(1.45)	(1.62)	(2.43)	(2.29)	(2.36)
F_2-100%NPK (both the crop)	3.33	1.80	2.52	7.52	6.07	6.78
	(1.96)	(1.52)	(1.74)	(2.83)	(2.56)	(2.70)
F_3-100%NPK (Maize)	3.05	1.52	2.23	6.33	4.86	5.57
	(1.88)	(1.42)	(1.65)	(2.61)	(2.32)	(2.46)
F_4-100%(Maize) +50% (Intercrop)	3.19	1.72	2.41	6.59	5.33	5.94
	(1.92)	(1.49)	(1.71)	(2.66)	(2.41)	(2.54)
F_5-50% (Maize) + 100% (Intercrop)	3.20	1.73	2.42	6.90	5.66	6.27
	(1.92)	(1.49)	(1.71)	(2.72)	(2.48)	(2.60)
F_6-50% NPK (Maize & Intercrop)	3.10	1.66	2.33	6.52	5.13	5.81
	(1.90)	(1.47)	(1.68)	(2.65)	(2.37)	(2.51)
SEm$\pm$	0.02	0.06	0.03	0.05	0.04	0.03
CD (P=0.05)	0.05	NS	0.08	0.14	0.11	0.08

* Figures in parenthesis are transformed values

Table 18b: Effect of intercropping and fertilizer doses on number of branches of groundnut

Treatments	45 DAS			60 DAS		
	2008	**2009**	**Pooled**	**2008**	**2009**	**Pooled**
F_1-Control (No NPK)	6.48	5.93	6.20	7.05	6.45	6.75
	(2.64)	(2.54)	(2.59)	(2.75)	(2.64)	(2.69)
F_2-100%NPK (both the crop)	8.17	7.25	7.71	8.71	7.79	8.24
	(2.94)	(2.78)	(2.86)	(3.03)	(2.88)	(2.96)
F_3-100%NPK (Maize)	7.55	5.72	6.60	8.19	6.52	7.33
	(2.84)	(2.49)	(2.67)	(2.95)	(2.65)	(2.80)
F_4-100%(Maize) +50% (Intercrop)	7.62	6.32	6.95	8.25	7.20	7.72
	(2.85)	(2.61)	(2.73)	(2.96)	(2.78)	(2.87)
F_5-50% (Maize) + 100% (Intercrop)	7.80	6.66	7.22	8.63	7.32	7.96
	(2.88)	(2.68)	(2.78)	(3.02)	(2.80)	(2.91)
F_6-50% NPK (Maize & Intercrop)	7.56	5.93	6.72	8.20	6.65	7.41
	(2.84)	(2.54)	(2.69)	(2.95)	(2.67)	(2.81)
SEm$\pm$	0.04	0.05	0.03	0.02	0.04	0.02
CD (P=0.05)	0.11	0.14	0.08	0.05	0.11	0.05

* Figures in parenthesis are transformed values

Result of the data in 2009 indicated that at 30 DAS, 100% RDF to both the crops recorded the maximum number of branches of groundnut (6.07). The lowest number of branches was recorded with control (4.72).

Further analysis of the mean pooled of 2008 and 2009 experimental data indicated that the different RDF an intercropping system has a significant variation on the number of branches per plant. The highest number of branches per plant was obtained from 100% RDF to both the crops (6.78). The lowest number of branches per plant was recorded with control (5.06) of an intercropping system.

4.5.3.2 Number of branches at 45 and 60 DAS

It is evident from the data presented in Table 18b showed that intercropping system at different recommended doses of fertilizer had a significant variation in the number of branches per plant of groundnut at 45 and 60 DAS during both the experimental year 2008 and 2009.

At 45 DAS (2008), the maximum number of branches of groundnut was recorded with 100% RDF to both the crops (8.17) while the minimum number of branches was obtained with control (6.48) which is significantly inferior among all treatments.

Result of the data in 2009 indicated that at 45 DAS, 100% RDF to both the crops recorded the maximum number of branches of groundnut (7.25). The lowest number of branches was recorded with control and 100% RDF to maize + 50% RDF to intercrop (5.93).

A perusal of the result of the mean pooled data of 2008 and 2009 revealed that, maximum number of branches (7.71) was recorded with 100% RDF to both the crops while control (6.20) recorded the lowest number of branches.

At 60 DAS in 2008, the maximum number of branches of groundnut was recorded with 100% RDF to both the crops (8.71). Control recorded the minimum number of branches (7.05) of groundnut.

In the second year (2009), the number of branches at 60DAS was highest with 100% RDF to both the crops (7.79) while the minimum number of branches per plant was obtained from control (6.45) which was at par with 100% RDF to maize alone (6.52).

Further analysis of the mean pooled data of 2008 and 2009 revealed that, 100% RDF to both the crops (8.24) had a significantly more number of branches as compared to the rest of the RDF treatments in an intercropping system. The minimum number of branches was recorded with control (6.75).

4.5.3.3 Number of branches at 75 DAS and at harvest

Observations recorded on number of branches per plant at 75 DAS and at harvest are presented in Table 18c. It was observed from the data that intercropping treatments at different fertilizer doses showed a significant variation on number of branches in both the experimental year (2008 and 2009).

Data revealed that at 75 DAS different application of RDF had variation in the number of branches per plant. The maximum number of branches per plant was obtained from 100% RDF to both the crops (9.39) and the minimum number of branches per plant was obtained from control (7.87).

In the second year (2009), the number of branches at 75DAS was highest with 100% RDF to both the crops (8.56) while the minimum number of branches per plant was obtained from control (7.14) which was at par with 100% RDF to maize alone (7.20).

Result obtained from the mean pooled data of 2008 and 2009 experiment revealed that the maximum number of branches (8.97) was recorded with 100% RDF to both the crops while control recorded the minimum number of branches (7.50).

The data on the number of branches at harvest (2008) showed that the various fertilizer treatment of an intercropping system had a significant variation in the number of branches per plant. The maximum number of branches per plant was obtained from 100% RDF to both the crops (10.02). The minimum number of branches per plant was obtained from control (8.23).

In the second year (2009), the number of branches at harvest was highest with 100% RDF to both the crops (8.95), while the minimum number of branches per plant was obtained from control (7.48).

A critical analysis of the mean pooled data of 2008 and 2009 field experiment showed that at harvest the maximum number of branches per plant was recorded with 100% RDF to both the crops (9.48). Control plot recorded the minimum number of branches per plant (7.85).

Table 18c. Effect of intercropping and fertilizer doses on number of branches of groundnut

Fertilizer	75 DAS			At harvest		
	2008	2009	Pooled	2008	2009	Pooled
F_1-Control (No NPK)	7.87	7.14	7.50	8.23	7.48	7.85
	(2.89)	(2.76)	(2.83)	(2.95)	(2.82)	(2.89)
F_2-100%NPK (both the crop)	9.39	8.56	8.97	10.02	8.95	9.48
	(3.15)	(3.01)	(3.08)	(3.24)	(3.07)	(3.16)
F_3-100%NPK (Maize)	8.56	7.20	7.87	8.90	7.61	8.24
	(3.01)	(2.78)	(2.89)	(3.07)	(2.85)	(2.96)
F_4-100%(Maize) +50% (Intercrop)	8.81	7.77	8.28	9.36	8.17	8.75
	(3.05)	(2.88)	(2.96)	(3.14)	(2.94)	(3.04)
F_5-50% (Maize) + 100% (Intercrop)	9.18	7.87	8.52	9.81	8.24	9.01
	(3.11)	(2.89)	(3.00)	(3.21)	(2.96)	(3.08)
F_6-50% NPK (Maize & Intercrop)	8.68	7.51	8.09	8.96	7.82	8.38
	(3.03)	(2.83)	(2.93)	(3.08)	(2.88)	(2.98)
SEm±	0.03	0.04	0.02	0.02	0.04	0.02
CD (P=0.05)	0.08	0.11	0.05	0.05	0.11	0.05

* Figures in parenthesis are transformed values

Table 19a. Effect of intercropping and fertilizer doses on leaf area index (LAI) of groundnut

Treatments	15 DAS			30 DAS		
	2008	2009	Pooled	2008	2009	Pooled
F_1-Control (No NPK)	0.40	0.40	0.40	3.43	3.44	3.44
	(3.62)	(3.61)	(3.61)	(10.67)	(10.69)	(10.68)
F_2-100%NPK (both the crop)	0.80	0.76	0.78	5.60	5.52	5.56
	(5.14)	(5.00)	(5.07)	(13.68)	(13.58)	(13.63)
F_3-100%NPK (Maize)	0.57	0.61	0.59	4.36	4.30	4.33
	(4.34)	(4.49)	(4.42)	(12.05)	(11.96)	(12.01)
F_4-100%(Maize) +50% (Intercrop)	0.66	0.71	0.68	4.96	4.81	4.88
	(4.65)	(4.82)	(4.73)	(12.86)	(12.66)	(12.76)
F_5-50% (Maize) + 100% (Intercrop)	0.75	0.72	0.73	5.51	5.47	5.49
	(4.95)	(4.87)	(4.91)	(13.57)	(13.53)	(13.55)
F_6-50% NPK (Maize & Intercrop)	0.60	0.60	0.60	4.49	4.30	4.39
	(4.43)	(4.43)	(4.43)	(12.22)	(11.97)	(12.10)
SEm±	0.05	0.08	0.05	0.17	0.12	0.10
CD (P=0.05)	0.14	0.23	0.15	0.50	0.35	0.08

* Figures in parenthesis are transformed values

4.5.4 Leaf area index (LAI) of groundnut

4.5.4.1 Leaf area index (LAI) at 15 and 30 DAS

It is evident from the data presented in Table 19a showed that intercropping system at different recommended doses of fertilizer had a significant variation on LAI per plant of groundnut at 15 and 30 DAS during both the experimental year 2008 and 2009.

In the first year, at 15 DAS, the maximum LAI (0.80) was recorded with 100% RDF to both the crops (9.48) which was at par with (0.75) 50% RDF to maize + 100% RDF to intercrop while control recorded the minimum LAI (0.40). However, it was at par with 100% RDF to maize alone (0.57).

The second year data (2009) revealed that, the maximum LAI (0.76) was obtained with 100% RDF to both the crops which was at par with 50% RDF to maize + 100% RDF to intercrop (0.72) followed by 100% RDF to maize + 50% RDF to intercrop (0.71). The minimum LAI was recorded with control (0.40). However it was at par with 50% RDF to maize + 50% RDF to intercrop (0.60).

A further analysis of the mean pooled data of 2008 and 2009 revealed that LAI was maximum (0.78) with 100% RDF to both the crops which was at par with 50% RDF to maize + 100% RDF to intercrop (0.73) followed by 100% RDF to maize + 50% RDF to intercrop (0.68). The minimum LAI was recorded with control (0.40).

At 30 DAS (2008), the maximum LAI was recorded with 100% RDF to both the crops(5.60) which was at par with 50% RDF to maize + 100% RDF to intercrop (5.51). The minimum LAI was recorded with control (3.43).

In the second year (2009) experimental data showed that, maximum LAI of groundnut was recorded 100% RDF to both the crops (5.52) However, it was statistically comparable with 50% RDF to maize + 100% RDF to intercrop (5.47). In control recorded the minimum LAI (3.44).

Observation on the mean pooled data of 2008 and 2009 revealed that the LAI was maximum with 100% RDF to both the crops(5.56) which was at par with 50% RDF to maize + 100% RDF to intercrop (5.49). The lowest LAI was recorded with control (3.44), which was significantly inferior to rest of the recommended fertilizer treatments.

4.5.4.2 Leaf area index (LAI) at 45 and 60 DAS

From the perusal of the result presented in Table 19b, it was evident that the leaf area index in intercropping of groundnut at 45 DAS was found significant in both the years.

The first year (2008) showed the maximum LAI per plant in groundnut from 50% RDF to maize + 100% RDF to intercrop (13.05) which was at par with (12.18) 100% RDF to both the crops followed by 100% RDF to maize + 50% RDF to intercrop (11.32). In control recorded the minimum LAI per plant (7.69).

In the second year (2009), 50% RDF to maize + 100% RDF to intercrop recorded the highest LAI (12.52). The lowest LAI (7.46) was recorded from the control.

Further analysis of the mean pooled data of 2008 and 2009 experimental results revealed that the maximum LAI per plant (12.78) was obtained from 50% RDF to maize + 100% RDF to intercrop while control recorded the minimum LAI per plant (7.58).

At 60 DAS, 2008 field experiment indicates that the maximum LAI per plant (21.16) was obtained from 100% RDF to both the crop. However, it was statistically at par with 50% RDF to maize + 100% RDF to intercrop (21.15) and control recorded the lowest LAI per plant (14.59).

In the second year (2009) data showed that there was no significant difference on fertilizer doses in intercropping.

Result obtained from the mean pooled data of 2008 and 2009 field experiment revealed that, there was no significant difference among the fertilizer treatment at 60 DAS on LAI.

4.5.5 Crop growth rate (CGR) of groundnut

It is evident from the data presented in Table 20a and 20b that intercropping system at different fertilizer treatments had a significant variation in the crop growth rate per plant of groundnut at all stages during both the experimental year 2008 and 2009.

4.5.5.1 Crop growth rate (CGR) of groundnut at 30 and 45 DAS.

At 30 DAS (2008), the maximum crop growth rate per plant of groundnut (0.18) was obtained 100% RDF to both the crop which was at par with all the other fertilizer treatment (0.15) except control. Control recorded the minimum crop growth rate (0.11).

Table 19b. Effect of intercropping and fertilizer doses on leaf area index (LAI) of groundnut

Treatments	45 DAS			60 DAS		
	2008	2009	Pooled	2008	2009	Pooled
F_1-Control (No NPK)	7.69	7.46	7.58	14.59	13.74	14.16
	(16.10)	(15.85)	(15.97)	(22.44)	(21.75)	(22.10)
F_2-100%NPK (both the crop)	12.18	11.78	11.98	21.16	20.58	20.87
	(20.42)	(20.06)	(20.24)	(27.38)	(26.97)	(27.17)
F_3-100%NPK (Maize)	10.16	9.32	9.73	17.12	16.90	17.01
	(18.58)	(17.76)	(18.17)	(24.43)	(24.26)	(24.35)
F_4-100%(Maize) +50% (Intercrop)	11.32	10.26	10.79	18.34	17.70	18.02
	(19.65)	(18.68)	(19.17)	(25.35)	(24.87)	(25.11)
F_5-50% (Maize) + 100% (Intercrop)	13.05	12.52	12.78	21.15	39.93	30.12
	(21.17)	(20.71)	(20.94)	(27.37)	(39.17)	(33.27)
F_6-50% NPK (Maize & Intercrop)	10.18	9.85	10.02	17.64	17.20	17.42
	(18.60)	(18.28)	(18.44)	(24.82)	(24.49)	(24.66)
SEm$\pm$	0.29	0.19	0.18	0.31	4.98	2.49
CD (P=0.05)	0.85	0.56	0.53	0.91	NS	NS

* Figures in parenthesis are transformed values

Table 20a. Effect of intercropping and fertilizer doses on crop growth rate (CGR) of groundnut

Treatments	Crop growth rate (g/day)					
	30 DAS			45DAS		
	2008	2009	Pooled	2008	2009	Pooled
F_1-Control (No NPK)	0.11	0.11	0.11	0.32	0.25	0.28
F_2-100%NPK (both the crop)	0.18	0.19	0.19	0.54	0.52	0.53
F_3-100%NPK (Maize)	0.15	0.14	0.14	0.39	0.34	0.37
F_4-100%(Maize) +50% (Intercrop)	0.15	0.14	0.15	0.46	0.43	0.44
F_5-50% (Maize) + 100% (Intercrop)	0.15	0.14	0.14	0.46	0.45	0.46
F_6-50% NPK (Maize & Intercrop)	0.15	0.14	0.14	0.45	0.43	0.44
SEm$\pm$	0.01	0.003	0.005	0.034	0.018	0.020
CD (P=0.05)	0.02	0.008	0.01	0.10	0.05	0.05

The crop growth rate at 30 DAS in 2009 revealed that there was significant variation. 100% RDF to both the crop recorded the highest crop growth rate (0.19) which was significantly superior as compared to the rest of the fertilizer treatment in an intercropping system. The lowest crop growth rate was recorded from control (0.14).

Further analysis of the pooled data of two experiments (2008 and 2009) revealed that there is a significant difference on crop growth rate in all the fertilizer treatments. The maximum crop growth rate was recorded from 100% RDF to both the crop (0.19).while control recorded the minimum CGR (0.11).

At 45 DAS (2008), the maximum crop growth rate(0.54) was obtained from 100% RDF to both the crop which was statistically at par with 50% RDF to maize + 100% RDF to intercrop and 100% RDF to maize + 50% RDF to intercrop (0.46) followed by 50% RDF to maize + 50% RDF to intercrop (0.45) of an intercropping system. Control recorded the lowest CGR (0.32) and it was at par with 100% RDF to maize alone (0.39).

In the second year (2009), the CGR at 45 DAS was maximum with 100% RDF to both the crop (0.52) and was at par with 50% RDF to maize + 100% RDF to intercrop (0.45). The minimum CGR was obtained from control (0.25).

A critical analysis of the mean pooled data of 2008 and 2009 field experiment showed that at 45 DAS 100% RDF to both the crop recorded the maximum LAI (0.53) which was at par with 50% RDF to maize + 100% RDF to intercrop (0.46). The lowest LAI was recorded from control (0.28).

4.5.5.2 Crop growth rate (CGR) of groundnut at 60 and75 DAS

It was evident from the data presented in Table 20b showed that intercropping system at different recommended doses of fertilizer had a significant variation on CGR per plant of groundnut at 60 and 75 DAS.

In the first year (2008), at 60 DAS, the CGR was found non significant. However in the second year (2009), it was found significant. The maximum CGR (1.00) was recorded with 100% RDF to both the crops, while control recorded the minimum LAI (0.76). However, it was significantly at par with (0.77) 50% RDF to maize + 50% RDF to intercrop followed by 100% RDF to maize alone (0.78).

A further analysis of the mean pooled data of 2008 and 2009 revealed that CGR was maximum (1.02) with 100% RDF to both the crops. The lowest CGR was from control (0.77)

Table 20b. Effect of intercropping and fertilizer doses on crop growth rate (CGR) of groundnut

Treatments	Crop growth rate (g/day)					
	60 DAS			75 DAS		
	2008	2009	Pooled	2008	2009	Pooled
F_1-Control (No NPK)	0.77	0.76	0.77	0.25	0.28	0.27
F_2-100%NPK (both the crop)	1.04	1.00	1.02	0.31	0.32	0.32
F_3-100%NPK (Maize)	0.78	0.78	0.78	0.49	0.51	0.50
F_4-100%(Maize) +50% (Intercrop)	0.90	0.87	0.88	0.41	0.36	0.39
F_5-50% (Maize) + 100% (Intercrop)	0.91	0.85	0.88	0.45	0.47	0.46
F_6-50% NPK (Maize & Intercrop)	0.80	0.77	0.78	0.47	0.47	0.47
SEm$\pm$	0.084	0.012	0.043	0.07	0.01	0.04
CD (P=0.05)	NS	0.03	0.12	NS	0.02	0.11

Table 21a. Effect of intercropping and fertilizer doses on relative growth rate (RGR) of groundnut

Treatments	Relative growth rate (g/g/day)					
	30 DAS			45 DAS		
	2008	2009	Pooled	2008	2009	Pooled
F_1-Control (No NPK)	0.072	0.081	0.076	0.071	0.063	0.067
F_2-100%NPK (both the crop)	0.082	0.091	0.086	0.076	0.075	0.075
F_3-100%NPK (Maize)	0.080	0.087	0.084	0.070	0.068	0.069
F_4-100%(Maize) +50% (Intercrop)	0.081	0.083	0.082	0.076	0.078	0.077
F_5-50% (Maize) + 100% (Intercrop)	0.074	0.078	0.076	0.075	0.079	0.077
F_6-50% NPK (Maize & Intercrop)	0.080	0.084	0.082	0.076	0.077	0.077
SEm$\pm$	0.003	0.002	0.002	0.004	0.002	0.002
CD (P=0.05)	NS	0.005	0.005	NS	0.005	0.005

which was at par with 100% RDF to maize alone (0.78) and 50% RDF to maize + 50% RDF to intercrop (0.78).

At 75 DAS (2008), the crop growth rate was found non significant. However, the CGR per plant at 75 DAS in the second year (2009) showed that, 100% RDF to both the crop recorded the maximum (0.51). The minimum CGR (0.28) was obtained from control.

Experimental result of the mean pooled data of 2008 and 2009 revealed that the maximum crop growth rate was obtained from100% RDF to maize alone (0.50) and was at par with 50% RDF to maize + 50% RDF to intercrop (0.47) followed by 50% RDF to maize + 100% RDF to intercrop (0.46).Control recorded the lowest CGR (0.27) which was at par with100% RDF to both the crops (0.32) followed by 100% RDF to maize + 50% RDF to intercrop (0.39).

4.5.6 Relative growth rate (RGR) of groundnut

4.5.6.1 Relative growth rate (RGR) of groundnut at 30 and 45 DAS

From the perusal of the result presented in Table 21a, it was found that the RGR at 30 DAS was non significant in the year first year (2008), however in the second year (2009), the RGR was found significant. The highest RGR was recorded from 100% RDF to both the crops (0.091) which was statistically at par with 100% RDF to maize alone (0.087) of intercropping system. The lowest RGR was obtained from 50% RDF to maize + 100% RDF to intercrop (0.078 which was at par with control (0.081).

Experimental result of the mean pooled data of 2008 and 2009 on RGR at 30 DAS showed that, the maximum RGR was obtained from 100%RDF to both the crop (0.086) and was at par with 100%RDF to maize alone (0.084) followed by 100%RDF to maize +50%RDF to intercrop and 50%RDF to maize +50%RDF to intercrop (0.082). Control and 50%RDF to maize +100%RDF to intercrop recorded the minimum RGR (0.076).

At 45DAS, data recorded in the first year (2008) on RGR of groundnut did not show any significant difference. The second year data (2009) on RGR of groundnut at 45 DAS showed that there was significant variation. The highest RGR was recorded from 50% RDF to maize + 100% RDF (0.079) which was at par with 100% RDF to maize + 50% RDF (0.078) followed by 50% RDF to maize + 50% RDF to intercrop (0.077) followed by 100% RDF to both the crops (0.075). Control recorded the lowest RGR (0.063).

A further analysis of the pooled data of 2008 and 2009 field experiment revealed that, the maximum RGR at 45 DAS was obtained from 100% RDF to maize + 50% RDF, 50% RDF to maize + 100% RDF to intercrop and 50% RDF to maize + 50% RDF to intercropping (0.077) which was at par with 100% RDF to both the crops (0.075). Control recorded the lowest RGR (0.067), however it was at par with 100% RDF to maize alone (0.069).

4.5.6.2 Relative growth rate (RGR) of groundnut at 60 and 75 DAS

The data presented on Table 21b on relative growth rate at 60 DAS (2008), showed that application of different RDF does not have any significant variation. In the second year (2009), data showed that the maximum RGR was recorded from control (0.071). 50% RDF to maize + 50% RDF recorded the lowest RGR (0.054) which was at par with all the rest of the treatments except control.

Further analysis of the mean pooled of 2008 and 2009 experimental data indicated that there was no significant variation on RGR at 60 DAS.

At 75 DAS (2008), the RGR was found non significant. However, the RGR in the second year (2009), 50% RDF to maize + 50% RDF to intercrop (0.019) 100% RDF to both the crop recorded the maximum CGR (0.51). The minimum CGR (0.28) was obtained from control.

Experimental result of the mean pooled data of 2008 and 2009 revealed that there was no significance difference on RGR at 75 DAS.

4.6 Yield attributes of groundnut

4.6.1 Relative crowding coefficient (RCC)

A perusal of the result presented in the Table 22 revealed that intercropping system at various fertilizer doses had significant influence in relative crowding coefficient on groundnut during the experimental year, 2008 and 2009.

The first year (2008) experimental indicated that the maximum RCC in groundnut was recorded from100% RDF to both the crops (1.15) and was significantly superior to all the other fertilizer treatments. In control recorded the lowest RCC (0.39).

In the second year (2008), maximum RCC was recorded from100% RDF to both the crops (1.15) which was at par with 50% RDF to maize + 100% RDF to intercrop (1.54). In control recorded the lowest RCC (0.50) and was at par with 100% RDF to maize alone.

Table 21b. Effect of intercropping and fertilizer doses on relative growth rate (RGR) of groundnut

Treatments	Relative growth rate(g/g/day)					
	60 DAS			75 DAS		
	2008	2009	Pooled	2008	2009	Pooled
F_1-Control (No NPK)	0.064	0.071	0.067	0.012	0.014	0.013
F_2-100%NPK (both the crop)	0.055	0.056	0.055	0.010	0.011	0.011
F_3-100%NPK (Maize)	0.056	0.060	0.058	0.020	0.022	0.021
F_4-100%(Maize) +50% (Intercrop)	0.056	0.058	0.057	0.016	0.015	0.015
F_5-50% (Maize) + 100% (Intercrop)	0.057	0.056	0.056	0.016	0.018	0.017
F_6-50% NPK (Maize & Intercrop)	0.052	0.054	0.053	0.019	0.019	0.019
SEm$\pm$	0.005	0.001	0.006	0.003	0.0004	0.002
CD (P=0.05)	NS	0.002	0.017	NS	0.001	0.005

Table 22. Effect of intercropping and fertilizer doses on relative crowding coefficient (RCC) of groundnut

Treatments	Relative crowding coefficient		
	2008	2009	Pooled
F_1-Control (No NPK)	0.39	0.50	0.45
F_2-100%NPK (both the crop)	1.15	1.69	1.42
F_3-100%NPK (Maize)	0.47	0.58	0.53
F_4-100%(Maize) +50% (Intercrop)	0.81	1.19	1.00
F_5-50% (Maize) + 100% (Intercrop)	0.99	1.54	1.27
F_6-50% NPK (Maize & Intercrop)	0.71	0.94	0.83
SEm$\pm$	0.02	0.14	0.07
CD (P=0.05)	0.06	0.41	0.20

Results from the pooled data of 2008 and 2009 revealed that the maximum RCC (1.42) was recorded from 100% RDF to both the crops which was statistically at par with 50% RDF to maize + 100% RDF to intercrop (1.27). RCC was minimum (0.45) and was significantly inferior to the rest of the treatments.

4.6.2 Length of pods (cm)

A critical examination of the data presented on Table 23 revealed that all levels of fertilizer doses had significant influence on length of pods. Experimental data of year 2008 shows that the maximum length of pods (3.41) was observed from 100 %RDF to both the crops and minimum was recorded from control (2.61).

In the second year (2009), 100 %RDF to both the crops was found to be superior with regard to length of pods (3.33) which was also at par with 50% RDF to maize + 100% RDF to intercrop (3.03). Control recorded the lowest length of pods (2.51) and was at par with 100% RDF to maize alone (2.74) followed by 50% RDF to maize + 50% RDF to intercrop (2.78).

Results obtained from the mean pooled data of 2008 and 2009 on length of pods revealed that maximum length of pods was obtained from100% RDF to both the crop (3.37). Control recorded the lowest length of pods (2.56) which was at par with 100% RDF to maize alone.

4.6.3 Number of seeds per pod

A critical examination of the data presented in Table 24 revealed that intercropping system at various fertilizer levels had a significant influence in the number of seeds per pod in groundnut during both the field experimental year, 2008 and 2009.

The first year (2008) experimental data indicated the maximum number of seeds per pod in groundnut (2.13) was recorded from 100 %RDF to both the crops which were significantly higher as compared to the other fertilizer treatment in an intercropping system. Control recorded the minimum number of seeds per pod (1.74).

In the second year (2009), 100 %RDF to both the crops recorded the highest number of seeds per pod (2.11). The lowest number of seeds per pod was obtained from control (1.69) which was significantly inferior over the other fertilizer treatment in an intercropping system.

Table 23. Effect of intercropping and fertilizer doses on length of pods of groundnut

Treatments	Length of pod(cm)		
	2008	2009	Pooled
F_1-Control (No NPK)	2.61	2.51	2.56
F_2-100%NPK (both the crop)	3.41	3.33	3.37
F_3-100%NPK (Maize)	2.87	2.74	2.81
F_4-100%(Maize) +50% (Intercrop)	3.06	2.99	3.02
F_5-50% (Maize) + 100% (Intercrop)	3.13	3.03	3.08
F_6-50% NPK (Maize & Intercrop)	2.88	2.78	2.83
SEm$\pm$	0.06	0.09	0.56
CD (P=0.05)	0.17	0.26	1.65

Table 24: Effect of intercropping and fertilizer doses on number of seeds per pod of groundnut

Treatments	No. of seeds/pod		
	2008	2009	Pooled
F_1-Control (No NPK)	1.74	1.69	1.71
	(1.50)	(1.48)	(1.49)
F_2-100%NPK (both the crop)	2.13	2.11	2.12
	(1.62)	(1.61)	(1.62)
F_3-100%NPK (Maize)	1.81	1.76	1.79
	(1.52)	(1.50)	(1.51)
F_4-100%(Maize) +50% (Intercrop)	1.91	1.79	1.85
	(1.55)	(1.51)	(1.53)
F_5-50% (Maize) + 100% (Intercrop)	2.01	1.87	1.94
	(1.58)	(1.54)	(1.56)
F_6-50% NPK (Maize & Intercrop)	1.86	1.78	1.82
	(1.54)	(1.51)	(1.52)
SEm$\pm$	0.01	0.01	0.01
CD (P=0.05)	0.02	0.02	0.02

* Figures in the parenthesis are transformed values

Further analysis of the mean pooled data of 2008 and 2009 experimental results revealed that the maximum number of seeds per pods (2.12) was obtained from 100 % RDF to both the crops while control recorded the minimum number of seeds per pod (1.71).

4.6.4 Number of pods per plant

A critical examination of the data presented in Table 25 revealed that intercropping system at various fertilizer levels had a significant influence in the number of pods per plant in groundnut during both the field experimental year, 2008 and 2009.

The first year (2008) experimental data showed that the maximum number of pods per plant in groundnut was recorded from 100 % RDF to both the crops (46.87) which were significantly higher as compared to the other RDF in an intercropping system. In control recorded the minimum number of pods per plant (38.18).

In the second year (2009), 100 % RDF to both the crops recorded the highest number of pods per plant (42.54) which superior to other fertilizer levels. The lowest number of pods per plant was obtained from control (32.14) which was significantly inferior over the other fertilizer levels in an intercropping system.

Further analysis of the mean pooled data of 2008 and 2009 experimental results revealed that the maximum number of pods per plant (44.68) was obtained from 100 % RDF to both the crops while control recorded the minimum number of pods per plant (35.10).

4.6.5 Weight of pods per plant of groundnut (g)

Observations recorded on weight of pods per plant are presented in Table 26. The data revealed weight of pods per plant was found significant during both the year (2008 and 2009).

The data pertaining to the weight of pods per plant in the year 2008 revealed that the maximum weight of pods per plant was obtained from 100 % RDF to both the crops (50.78) which was at par with 50% RDF to maize + 100% RDF to intercrop (50.36) followed by 100% RDF to maize + 50% RDF to intercrop (48.91). Control recorded the lowest weight of pods per plant (41.15) and was statistically at par with 100% RDF to maize alone (43.31) followed by 50% RDF to maize + 50% RDF to intercrop (44.98).

In the second year 2009 field experiment revealed that the highest weight of pods per plant was recorded from 100 % RDF to both the crops (45.29) and was at par with 50% RDF

Table 25. Effect of intercropping and fertilizer doses on number of pods per plant of groundnut

Treatments	No. of pods/plant		
	2008	2009	Pooled
F_1-Control (No NPK)	38.18	32.14	35.10
	(6.22)	(5.71)	(5.97)
F_2-100%NPK (both the crop)	46.87	42.54	44.68
	(6.88)	(6.56)	(6.72)
F_3-100%NPK (Maize)	39.30	33.98	36.59
	(6.31)	(5.87)	(6.09)
F_4-100%(Maize) +50% (Intercrop)	40.58	35.55	38.02
	(6.41)	(6.00)	(6.21)
F_5-50% (Maize) + 100% (Intercrop)	44.26	40.78	42.50
	(6.69)	(6.42)	(6.56)
F_6-50% NPK (Maize & Intercrop)	39.77	35.06	37.38
	(6.35)	(5.96)	(6.15)
SEm$\pm$	0.07	0.08	0.05
CD (P=0.05)	0.20	0.23	0.14

* Figures in parenthesis are transformed values

Table 26. Effect of intercropping and fertilizer doses on weight of pod per plant of groundnut

Treatments	Pods weight/plant (g)		
	2008	2009	Pooled
F_1-Control (No NPK)	41.15	34.68	37.92
F_2-100%NPK (both the crop)	50.78	45.29	48.03
F_3-100%NPK (Maize)	43.31	37.33	40.32
F_4-100%(Maize) +50% (Intercrop)	48.91	41.72	45.31
F_5-50% (Maize) + 100% (Intercrop)	50.36	44.13	47.25
F_6-50% NPK (Maize & Intercrop)	44.98	38.88	41.93
SEm$\pm$	1.49	0.82	0.85
CD (P=0.05)	4.39	2.41	2.50

to maize + 100% RDF to intercrop (44.13) followed by 100% RDF to maize + 50% RDF to intercrop (41.72). Control recorded the lowest weight of pods per plant (34.68) and was statistically at par with 100% RDF to maize alone (37.33).

A critical analysis of the mean pooled data of 2008 and 2009 field experiment revealed that the maximum weight of pods per plant was obtained from 100 % RDF to both the crops (48.03) which was statistically at par with 50% RDF to maize + 100% RDF to intercrop (47.25) and control recorded the minimum weight of pods per plant (37.92).

4.6.6 Test weight (g)

It was evident from the data presented in Table 27 that intercropping system at different fertilizer level had a significant influence on the test weight of groundnut during the experiment year of 2008 and 2009.

The data on the test weight of groundnut in the first year (2008) revealed that 100 % RDF to both the crops recorded the maximum test weight (479.32), which was significantly at par with 50% RDF to maize + 100% RDF to intercrop (471.26). The minimum test weight was obtained from control (418.47) and was at par with 100 % RDF to maize alone (428.26) followed by 50% RDF to maize + 50% RDF to intercrop (436.01).

In second year (2009), the data in the table indicated that the maximum test weight of groundnut was obtained from 100 % RDF to both the crops (471.40) while control recorded the lowest test weight (404.19) which was significantly inferior as compared to other fertilizer treatments.

Further analysis of the mean pooled data of 2008 and 2009 showed that the maximum test weight of groundnut was recorded from 100 % RDF to both the crops (475.36) and the minimum 1000 grain weight was recorded from control (411.33).

4.6.7 Groundnut (kernel) yield (q/ha)

The influences of the intercropping system at different recommended dose of fertilizer on the kernel yield of groundnut are presented in Table 28. Data in the table indicated that there was a significant impact on the kernel yield of groundnut during both the field experiment conducted in 2008 and 2009.

Table27. Effect of intercropping and fertilizer doses on test weight of groundnut

Treatments	Test weight (g)		
	2008	2009	Pooled
F_1-Control (No NPK)	418.47	404.19	411.33
F_2-100%NPK (both the crop)	479.32	471.40	475.36
F_3-100%NPK (Maize)	428.26	421.78	425.02
F_4-100%(Maize) +50% (Intercrop)	449.75	441.29	445.52
F_5-50% (Maize) + 100% (Intercrop)	471.26	462.25	466.76
F_6-50% NPK (Maize & Intercrop)	436.01	430.88	433.44
SEm$\pm$	5.63	2.09	3.00
CD (P=0.05)	16.60	6.16	8.84

Table 28. Effect of intercropping and fertilizer doses on kernel yield of groundnut

Treatments	Kernel yield (q/ha)		
	2008	2009	Pooled
F_1-Control (No NPK)	5.15	4.81	4.98
F_2-100%NPK (both the crop)	9.73	8.91	9.32
F_3-100%NPK (Maize)	5.80	5.26	5.53
F_4-100%(Maize) +50% (Intercrop)	8.11	7.68	7.90
F_5-50% (Maize) + 100% (Intercrop)	9.06	8.47	8.77
F_6-50% NPK (Maize & Intercrop)	7.52	6.95	7.23
SEm$\pm$	0.06	0.22	0.11
CD (P=0.05)	0.17	0.64	0.32

A perusal of the data of 2008 field experiment revealed that the kernel yield obtained from 100 % RDF to both the crops (9.73) was significantly higher than that of the other recommended dose of fertilizer treatments. Control recorded the lowest kernel yield (5.15).

The data on the kernel yield in year 2009 indicated that the highest kernel yield was obtained from 100%RDF to both the crop (8.91) and was statistically at par with 50 % RDF to maize + 100% RDF to intercrop (8.47). The lowest kernel yield was obtained with control (4.81) which was significantly inferior as compared to other treatments.

Further analysis of the mean pool data of 2008 and 2009 revealed that the maximum kernel yield was recorded from 100%RDF to both the crop (9.32) which was significantly superior over the rest of the fertilizer treatments in an intercropping.

4.6.8 Stover yield (q/ha)

Observation recorded on stover yield is presented in Table 29. The data revealed that stover yield was found significant in application of different recommended dose of fertilizer during both the year (2008 and 2009).

The first year (2008) experimental data indicated that the maximum stover yield in groundnut was recorded from 100% RDF to both the crops (19.93) which were significantly higher as compared to the other RDF in an intercropping system.

In the second year (2009), 100% RDF to both the crops recorded the highest number stover yield (18.09) which was statistically at par with 50% RDF to maize + 100% RDF to intercrop (17.05). The lowest stover yield was obtained from control (9.68) which was significantly inferior over the other RDF in an intercropping system.

Further analysis of the mean pooled data of 2008 and 2009 experimental results revealed that the maximum haulm yield (19.01) was obtained from 100 % RDF to both the crop while control recorded the minimum haulm yield (10.16).

4.6.9 Harvest Index (%)

The influences of different recommended dose of fertilizer on harvest index of groundnut are presented in Table 30.

The data on harvest index in 2008 indicated that the highest harvest index (32.87) was obtained from 50% RDF to maize + 100% RDF to intercrop. However, it was at par with

Table29. Effect of intercropping and fertilizer doses on stover yield of groundnut

Treatments	Stover yield (q/ha)		
	2008	2009	Pooled
F_1-Control (No NPK)	10.63	9.68	10.16
F_2-100%NPK (both the crop)	19.93	18.09	19.01
F_3-100%NPK (Maize)	13.20	10.63	11.91
F_4-100%(Maize) +50% (Intercrop)	17.43	15.57	16.50
F_5-50% (Maize) + 100% (Intercrop)	18.50	17.05	17.78
F_6-50% NPK (Maize & Intercrop)	15.60	14.09	14.85
SEm±	0.17	0.47	0.25
CD (P=0.05)	0.50	1.38	0.73

Table30. Effect of intercropping and fertilizer doses on harvest index (HI) of groundnut

Treatments	Harvest index (%)		
	2008	2009	Pooled
F_1-Control (No NPK)	32.64	33.20	32.92
F_2-100%NPK (both the crop)	32.81	33.00	32.90
F_3-100%NPK (Maize)	30.53	33.10	31.81
F_4-100%(Maize) +50% (Intercrop)	31.75	33.03	32.39
F_5-50% (Maize) + 100% (Intercrop)	32.87	33.19	33.03
F_6-50% NPK (Maize & Intercrop)	32.53	33.03	32.78
SEm±	0.23	0.17	0.30
CD (P=0.05)	0.68	NS	0.88

100% RDF to both the crop (32.81) followed by control (32.64) followed by 50% RDF to maize + 50% RDF to intercrop (32.53) in an intercropping system. The lowest harvest index was obtained with 100% RDF to maize alone (30.53) which were significantly inferior as compared to other treatments.

A perusal of the data of 2009 field experiment revealed that the harvest index of groundnut was found non significant.

Further analysis of the mean pooled data of 2008 and 2009 field experiment result indicates that the 50% RDF to maize + 100% RDF to intercrop (33.03) were significantly higher than the rest of the fertilizer treatments. The lowest harvest index was obtained from 50% RDF to maize alone (31.81).

4.7 Phenological parameters

4.7.1 Days to 50 per cent flowering

Days to 50% flowering of groundnut are presented in Table 31. The number of days required to 50 per cent flowering in groundnut was found non significant in the first year (2008).

The second year (2009) data on the days to 50 per cent flowering revealed that 50% RDF to maize + 100% RDF to intercrop required 36.65 days to 50 per cent flowering. The lowest number of days needed for 50 per cent flowering in groundnut was recorded from control (32.33days).

The pooled analysis of the two year data (2008 and 2009) showed that days to 50 % flowering of groundnut was found non significant.

4.7.2 Days to maturity

The influence of intercropping system at different fertilizer level on the number of days needed for maturing in groundnut are presented in Table 32 and indicated that there was no significant impact on the number of days to maturity during both the experimental year (2008 and 2009).

Table31. Effect of intercropping and fertilizer doses on 50% flowering of groundnut

Fertilizer	Days to 50% flowering		
	2008	**2009**	**Pooled**
F_1-Control (No NPK)	30.322 (5.55)	32.328 (5.73)	31.317 (5.64)
F_2-100%NPK (both the crop)	33.99 (5.87)	36.33 (6.07)	35.15 (5.97)
F_3-100%NPK (Maize)	30.65 (5.58)	32.67 (5.76)	31.65 (5.67)
F_4-100%(Maize) +50% (Intercrop)	33.32 (5.82)	34.98 (5.96)	34.15 (5.89)
F_5-50% (Maize) + 100% (Intercrop)	33.99 (5.87)	36.65 (6.10)	35.31 (5.98)
F_6-50% NPK (Maize & Intercrop)	32.00 (5.70)	34.32 (5.90)	33.15 (5.80)
SEm$\pm$	0.03	0.04	0.02
CD (P=0.05)	NS	0.11	NS

* Figures in parenthesis are transformed values

Table 32. Effect of intercropping and fertilizer doses on days to maturity of groundnut

Treatments	Days to maturity		
	2008	**2009**	**Pooled**
F_1-Control (No NPK)	123.31 (11.13)	126.65 (11.28)	124.98 (11.20)
F_2-100%NPK (both the crop)	124.02 (11.16)	130.31 (11.44)	127.14 (11.30)
F_3-100%NPK (Maize)	123.31 (11.13)	126.69 (11.28)	124.99 (11.20)
F_4-100%(Maize) +50% (Intercrop)	124.02 (11.16)	128.70 (11.37)	126.35 (11.26)
F_5-50% (Maize) + 100% (Intercrop)	124.02 (11.16)	130.35 (11.44)	127.16 (11.30)
F_6-50% NPK (Maize & Intercrop)	123.64 (11.14)	128.36 (11.35)	125.99 (11.25)
SEm$\pm$	0.01	0.02	0.01
CD (P=0.05)	NS	NS	NS

* Figures in the parenthesis are transformed values

4.8 Growth attributes of soybean (cm)

4.8.1 Plant height of soybean (cm)

The observation on the plant height of soybean as influenced by intercropping treatments at various recommended dose of fertilizer were recorded at an interval of 15, 30, 45, 60, 75 days after sowing (DAS) and at harvest are highlighted in Table 33a, 33b and 33c.

4.8.1.1 Plant height at 15 and 30 DAS (cm)

It was evident from the data presented in Table 33a that intercropping treatment at different recommended dose of fertilizer had a significant variation in the plant height of soybean at 15 and 30 DAS during the experimental year 2008 and 2009.

At 15 DAS (2008), the maximum plant height of soybean was recorded with 100% RDF to both the crop (17.67) which was at par with 50 % RDF to maize + 100% RDF to intercrop (17.20) followed by 100 % RDF to maize + 50% RDF to intercrop (16.80). In control recorded the lowest plant height (15.40) which was significantly inferior over all the treatments.

In the second year at 15 DAS showed that the maximum plant height of soybean from 100% RDF to both the crop (15.87) which was at par with 50 % RDF to maize + 100% RDF to intercrop (15.00). The lowest was recorded from control (12.67).

A further analysis of the mean pooled data of 2008 and 2009 revealed that the maximum plant height of soybean was recorded from 100% RDF to both the crop (16.77) which was at par with 50 % RDF to maize + 100% RDF to intercrop (16.10). The minimum plant height was obtained from control (14.03).

At 30 DAS (2008), the maximum plant height of soybean was recorded from 100% RDF to both the crop (41.40) which was statistically at par with 50 % RDF to maize + 100% RDF to intercrop (38.33). In control recorded the lowest plant height of soybean (31.00).

In the second year (2009), at 30 DAS, the maximum plant height was obtained from 100% RDF both the crop (37.87) which was significantly superior as compared to other fertilizer treatments.

Result obtained from the mean pooled data of 2008 and 2009 field experiment revealed that the maximum plant height (39.63) was recorded from 100% RDF to both the crop while control recorded the lowest plant height of soybean (29.47).

Table 33a. Effect of fertilizer doses on plant height of soybean intercropped with maize

Treatments	Plant height of soybean (cm)					
	15 DAS			30 DAS		
	2008	2009	Pooled	2008	2009	Pooled
F_1-Control (No NPK)	15.40	12.67	14.03	31.00	27.93	29.47
F_2-100%NPK (both the crop)	17.67	15.87	16.77	41.40	37.87	39.63
F_3-100%NPK (Maize)	16.53	14.40	15.47	37.53	33.87	35.70
F_4-100%(Maize) +50% (Intercrop)	16.80	14.47	15.63	38.27	35.20	36.73
F_5-50% (Maize) + 100% (Intercrop)	17.20	15.00	16.10	38.33	36.07	37.20
F_6-50% NPK (Maize & Intercrop)	16.53	14.13	15.33	37.53	34.27	35.90
SEm±	0.26	0.41	0.24	0.84	0.37	0.46
CD (P=0.05)	0.76	1.20	0.70	2.47	1.09	1.35

Table 33b. Effect of fertilizer doses on plant height of soybean intercropped with maize

Treatments	Plant height of soybean (cm)					
	45 DAS			60 DAS		
	2008	2009	Pooled	2008	2009	Pooled
F_1-Control (No NPK)	51.67	48.27	49.97	79.00	75.53	77.27
F_2-100%NPK (both the crop)	73.27	69.27	71.27	99.20	94.13	96.67
F_3-100%NPK (Maize)	62.93	58.80	60.87	88.93	83.00	85.97
F_4-100%(Maize) +50% (Intercrop)	64.33	61.13	62.73	94.13	90.33	92.23
F_5-50% (Maize) + 100% (Intercrop)	67.93	63.47	65.70	95.20	92.67	93.93
F_6-50% NPK (Maize & Intercrop)	64.13	61.00	62.57	92.73	86.53	89.63
SEm±	2.66	0.68	1.37	2.67	0.56	1.37
CD (P=0.05)	7.84	2.00	4.64	7.87	1.65	4.04

Result obtained from the mean pooled data of 2008 and 2009 field experiment revealed that the maximum plant height (39.63) was recorded from 100% RDF to both the crop while control recorded the lowest plant height of groundnut (29.47).

4.8.1.2 Plant height at 45 and 60 DAS

The data pertaining to the influence of intercropping system at various fertilizer level on the plant height of soybean at 45 and 60 DAS are presented in Table 33b revealed that intercropping system at various fertilizer level had a significant impact on the plant height of soybean during both the experimental year (2008 and 2009).

At 45 DAS (2008), the maximum plant height was recorded from 100% RDF to both the crop (73.27) which was statistically at par with 50 % RDF to maize + 100% RDF to intercrop (67.93) followed by 100 % RDF to maize + 50% RDF to intercrop (64.33) . Control recorded the lowest plant height of soybean (51.67).

The second year (2009) data on the plant height of soybean at 45 DAS showed that 100% RDF to both the crop recorded the highest plant height (69.27) of soybean while the lowest was recorded from control (48.27).

A further analysis of the mean pooled data of 2008 and 2009 field experiment revealed that the maximum plant height was obtained from 100% RDF to both the crop (71.27) which was significantly superior to all the other fertilizer level in an intercropping system. However, in control recorded the lowest plant height of soybean (49.97).

At 60 DAS (2008), 100% RDF to both the crop recorded the tallest plant height (99.20) which was at par with 50 % RDF to maize + 100% RDF to intercrop (95.20) followed by 100 % RDF to maize + 50% RDF to intercrop (94.13) followed by 50 % RDF to maize + 50% RDF to intercrop (92.73). However, in control recorded the lowest plant height of soybean (79.00).

The second year data (2009) on the plant height of soybean at 60 DAS showed that there was significant variation in the plant height at 60 DAS. The highest plant height was recorded from 100% RDF to both the crop (94.13) which was statistically at par with 50 % RDF to maize + 100% RDF to intercrop (92.67). In control recorded the lowest plant height of soybean (75.53).

A further analysis of the mean pooled data of 2008 and 2009 field experiment revealed that the maximum plant height at 65 DAS was obtained from 100% RDF to both the crop (96.67) which was at par with 50 % RDF to maize + 100% RDF to intercrop (93.93) followed by 100 % RDF to maize + 50% RDF to intercrop (92.23) while the minimum plant height of soybean was recorded from control (77.27).

4.8.1.3 Plant height at 75DAS and at harvest

A critical examination of the data presented in Table 33c revealed that intercropping system at various fertilizer levels had a significant influence in the plant height of soybean at 75DAS and at harvest in both the year 2008 and 2009.

At 75 DAS (2008), 100% RDF to both the crop (104.13) recorded significantly the higher plant height which was at par with 50 % RDF to maize + 100% RDF to intercrop (100.20) followed by 100 % RDF to maize + 50% RDF to intercrop (99.73) The lowest plant height was obtained from control (86.40). However, it was statistically at par with 100% RDF to maize alone (93.27).

The second year (2009) data on the plant height of soybean at 75 DAS revealed that the highest plant height was recorded from 100% RDF to both the crop (96.27) and was at par with 50 % RDF to maize + 100% RDF to intercrop (95.20) while the minimum plant height was obtained from control (82.33) which was significantly inferior over all the other fertilizer treatments in an intercropping system.

Further analysis of the mean pooled data of 2008 and 2009 field experiment on plant height of soybean showed that, maximum plant height (100.20) was recorded from 100% RDF to both the crop which was statistically at par with 50 % RDF to maize + 100% RDF to intercrop (97.70) followed by 100 % RDF to maize + 50% RDF to intercrop (96.17) while the lowest plant height (82.23) of soybean was recorded from control

At harvest (2008), the maximum plant height of soybean was recorded with 100% RDF to both the crop (106.93) which was significantly at par with 50 % RDF to maize + 100% RDF to intercrop (103.60) followed by 100 % RDF to maize + 50% RDF to intercrop (103.40). Control recorded the minimum plant height (85.93) of soybean.

The data pertaining to the second year (2009) on plant height at harvest revealed that 100% RDF to both the crop recorded the maximum plant height (99.27) of soybean and was significantly at par with 50 % RDF to maize + 100% RDF to intercrop (98.20).

Table 33c. Effect of fertilizer doses on plant height of soybean intercropped with maize

Treatments	Plant height of soybean (cm)					
	75 DAS			At harvest		
	2008	2009	Pooled	2008	2009	Pooled
F_1-Control (No NPK)	86.40	78.27	82.33	85.93	80.13	83.03
F_2-100%NPK (both the crop)	104.13	96.27	100.20	106.93	99.27	103.10
F_3-100%NPK (Maize)	93.27	85.07	89.17	97.07	87.27	92.17
F_4-100%(Maize) +50% (Intercrop)	99.73	92.93	96.33	103.40	95.67	99.53
F_5-50% (Maize) + 100% (Intercrop)	100.20	95.20	97.70	103.60	98.20	100.90
F_6-50% NPK (Maize & Intercrop)	96.60	88.93	92.77	99.80	91.87	95.83
SEm$\pm$	3.43	0.67	1.75	2.63	0.50	1.34
CD (P=0.05)	10.11	1.97	5.16	7.75	1.47	3.95

Table 34a. Effect of fertilizer doses on number of leaves of soybean intercropped with maize

Treatments	No. of leaves/plant of soybean					
	15 DAS			30 DAS		
	2008	2009	Pooled	2008	2009	Pooled
F_1-Control (No NPK)	3.00	2.73	2.86	7.73	6.75	7.23
	(1.87)	(1.80)	(1.83)	(2.87)	(2.69)	(2.78)
F_2-100%NPK (both the crop)	3.73	3.32	3.52	9.53	8.72	9.12
	(2.06)	(1.95)	(2.00)	(3.17)	(3.04)	(3.10)
F_3-100%NPK (Maize)	3.32	2.60	2.95	8.12	7.25	7.68
	(1.96)	(1.76)	(1.86)	(2.94)	(2.78)	(2.86)
F_4-100%(Maize) +50% (Intercrop)	3.39	2.96	3.17	8.66	7.51	8.08
	(1.97)	(1.86)	(1.92)	(3.03)	(2.83)	(2.93)
F_5-50% (Maize) + 100% (Intercrop)	3.59	2.85	3.21	8.92	7.99	8.45
	(2.02)	(1.83)	(1.93)	(3.07)	(2.91)	(2.99)
F_6-50% NPK (Maize & Intercrop)	3.33	2.79	3.05	8.60	0.00	2.97
	(1.96)	(1.81)	(1.88)	(3.02)	(0.71)	(1.86)
SEm$\pm$	0.02	0.03	0.02	0.03	0.04	0.02
CD (P=0.05)	0.05	0.08	0.05	0.08	0.11	0.05

* Figures in parenthesis are transformed values

Further analysis of the mean pooled data of 2008 and 2009 on the plant height of soybean revealed that the maximum plant height (103.10) was obtained from 100% RDF to both the crop which was statistically at par with 50 % RDF to maize + 100% RDF to intercrop (100.90) followed by 100 % RDF to maize + 50% RDF to intercrop (99.53) whereas control of an intercropping system recorded the minimum plant height (83.03) of soybean.

4.8.2 Number of leaves

Variations on the number of leaves of soybean due to intercropping system at different recommended dose of fertilizer were found significant at all stages of observation.

4.8.2.1 Number of leaves at 15 and 30 DAS

Perusal of the data presented in Table 34a revealed that at 15 and 30 DAS, variation on number of leaves of soybean were significant due to different recommended dose of fertilizer treatments during both the year (2008-09).

At 15 DAS (2008), 100% RDF to both the crop recorded the maximum number of leaves (3.73) which was significantly superior to the rest of the treatments. Control recorded the minimum number of leaves (3.00) and was significantly inferior to rest of the treatments.

In 2009, maximum number of leaves (3.32) was recorded from 100% RDF to both the crop which was significantly superior to the rest of the treatments. 100% RDF to maize alone recorded the minimum number of leaves (2.60) and was significantly inferior over all other treatments in an intercropping system.

From the mean pooled data of 2008 and 2009 on number of leaves revealed that the highest number of leaves (3.52) was recorded from 100% RDF to both the crop while the minimum number of leaves of soybean was recorded from control (2.86).

During the first year (2008) at 30 DAS, 100% RDF to both the crop recorded the highest number of leaves (9.53) while the lowest number of leaves (7.73) was recorded with control and was significantly inferior among all the other treatments.

In the second year (2009), maximum number of leaves was recorded from 100% RDF to both the crop (8.72) which significantly superior to all the treatments. However, in control recorded the lowest number of leaves (7.23).

Results from the pooled data of 2008 and 2009 revealed that at 30 DAS, the maximum number of leaves (9.12) was recorded from 100% RDF to both the crop. Minimum number of leaves (7.23) was recorded from control which was statistically inferior to all treatments.

4.8.2.2 Number of leaves at 45 and 60 DAS

It was evident from the data presented in Table 34b that intercropping system at different recommended doses of fertilizer had a significant variation on number of leaves per plant of soybean at 45 and 60 DAS during both the experimental year (2008 and 2009).

During first year (2008), the maximum number of leaves (23.78) was obtained from 100% RDF to both the crop which was significantly superior to the rest of the intercropping treatment at different fertilizer treatments. Minimum number of leaves (15.01) was recorded in control.

While in second year (2009), 100% RDF to both the crop was found to be significantly superior with regard to number of leaves (19.12). Minimum number of leaves (13.64) was recorded from control and was significantly inferior to rest of the treatments.

Results obtained from the mean pooled data of 2008 and 2009 on number of leaves at 45 DAS revealed that maximum number of leaves (21.39) was recorded from 100% RDF to both the crop which was statistically superior to rest of the treatments. Control recorded the minimum number of leaves (14.32) and was significantly inferior to the rest of the treatments.

At 60 DAS (2008), there is significant difference on number of leaves of soybean. 100% RDF to both the crops (28.80) recorded the highest number of leaves. Control (21.00) recorded the minimum number of leaves.

The second year data (2009) on the number of leaves of soybean at 60 DAS showed that there was a significant variation. The highest number of leaves was recorded from 100% RDF to both the crops (24.50) while control recorded the lowest number of leaves (18.45).

A further analysis of the mean pooled data of 2008 and 2009 field experiment revealed that, the maximum number of leaves at 60 DAS was obtained with 100% RDF to both the crops (26.61) while minimum number of leaves of soybean was recorded from control (19.70).

Table 34b. Effect of fertilizer doses on number of leaves of soybean intercropped with maize

Treatments	No. of leaves/plant of soybean					
	45 DAS			60 DAS		
	2008	2009	Pooled	2008	2009	Pooled
F_1-Control (No NPK)	15.01 (3.94)	13.64 (3.76)	14.32 (3.85)	21.00 (4.64)	18.45 (4.35)	19.70 (4.49)
F_2-100%NPK (both the crop)	23.78 (4.93)	19.12 (4.43)	21.39 (4.68)	28.80 (5.41)	24.50 (5.00)	26.61 (5.21)
F_3-100%NPK (Maize)	18.33 (4.34)	16.12 (4.08)	17.21 (4.21)	25.02 (5.05)	21.09 (4.65)	23.01 (4.85)
F_4-100%(Maize) +50% (Intercrop)	20.70 (4.60)	18.05 (4.31)	19.35 (4.46)	25.61 (5.11)	23.74 (4.92)	24.67 (5.02)
F_5-50% (Maize) + 100% (Intercrop)	20.99 (4.64)	18.71 (4.38)	19.83 (4.51)	26.32 (5.18)	23.87 (4.94)	25.08 (5.06)
F_6-50% NPK (Maize & Intercrop)	20.34 (4.57)	16.64 (4.14)	18.44 (4.35)	25.02 (5.05)	22.16 (4.76)	23.57 (4.91)
SEm±	0.10	0.07	0.06	0.12	0.09	0.08
CD (P=0.05)	0.29	0.20	0.17	0.35	0.26	0.23

* Figures in parenthesis are transformed values

Table 34c. Effect of fertilizer doses on number of leaves of soybean intercropped with maize

Treatments	No. of leaves/plant of soybean					
	75 DAS			At harvest		
	2008	2009	Pooled	2008	2009	Pooled
F_1-Control (No NPK)	24.62 (5.01)	23.41 (4.89)	24.01 (4.95)	21.92 (4.73)	20.81 (4.62)	21.36 (4.68)
F_2-100%NPK (both the crop)	35.06 (5.96)	30.19 (5.54)	32.58 (5.75)	32.45 (5.74)	26.75 (5.22)	29.53 (5.48)
F_3-100%NPK (Maize)	29.34 (5.46)	26.44 (5.19)	27.87 (5.33)	26.52 (5.20)	23.25 (4.87)	24.86 (5.04)
F_4-100%(Maize) +50% (Intercrop)	29.71 (5.50)	27.34 (5.28)	28.51 (5.39)	27.41 (5.28)	24.33 (4.98)	25.85 (5.13)
F_5-50% (Maize) + 100% (Intercrop)	31.15 (5.63)	29.06 (5.44)	30.09 (5.53)	29.46 (5.47)	25.14 (5.06)	27.26 (5.27)
F_6-50% NPK (Maize & Intercrop)	29.32 (5.46)	27.10 (5.25)	28.20 (5.36)	26.70 (5.22)	23.15 (4.86)	24.90 (5.04)
SEm±	0.14	0.07	0.08	0.12	0.07	0.07
CD (P=0.05)	0.41	0.20	0.23	0.35	0.20	0.20

* Figures in parenthesis are transformed values

4.8.2.3 Number of leaves at 75 DAS and at harvest

Perusal of the data presented in Table 34c revealed that variation on number of leaves due to different doses of fertilizer were found significant at 75 DAS at harvest.

In the first year (2008) at 75 DAS, the number of leaves (35.06) was recorded from 100% RDF to both the crop and was significantly superior among all other fertilizer treatments. The minimum number of leaves (24.62) was recorded from control.

Further analysis of the second year data (2009) revealed that maximum number of leaves was recorded from 100% RDF to both the crop (30.19). Minimum number of leaves (23.41) was recorded from control and was significantly inferior to all the rest of the fertilizer treatments.

Results obtained from the mean pooled data analysis revealed that maximum number of leaves (32.58) was recorded from 100% RDF to both the crop which was significantly superior to the rest of the treatments. In control recorded the minimum number of leaves (24.01).

At harvest (2008), the maximum number of leaves of soybean was recorded from 100% RDF to both the crops (32.45) which were statistically superior to other fertilizer treatments. In control recorded the lowest number of leaves of soybean (21.92).

The data pertaining to number of leaves in 2009 revealed that highest number of leaves of (26.75) was recorded from 100% RDF to both the crops which were superior as compared to other g treatments. Control recorded the lowest number of leaves (20.81) which were significantly inferior to the rest of the treatment.

Data on number of leaves obtained from mean pooled data of 2008 and 2009 revealed that, the highest number of leaves (29.53) was recorded from 100% RDF to both the crop. Lowest number of leaves (21.36) was recorded from control and was statistically inferior to rest of the treatments.

4.8.3 Number of branches/plant

4.8.3.1. Number of branches at 30 and 45 DAS.

The data pertaining to the number of branches of soybean are presented in Table 35a. Data in the table indicated that intercropping system at different fertilizer doses had a significant impact on the number of branches per plant of soybean at 30 and 45 DAS during both the experimental year (2008 and 2009).

At 30 DAS (2008), the maximum number of branches per plant of soybean (2.59) was obtained from 100% RDF to maize alone which was significantly superior as compared to other fertilizer treatments. 100% RDF to both the crop recorded the minimum number of branches per plant (1.30).

The number of branches per plant at 30 DAS in 2009 revealed that there was significant variation in the number of branches per plant in the all the treatments. 100% RDF to maize alone recorded the highest number of branches per plant (2.46) while 100% RDF to both the crop recorded the minimum number of branches per plant (1.26) which was significantly at par with 100% RDF to maize + 50% RDF to soybean (1.32).

Further analysis of the pooled data of two experiments (2008 and 2009) revealed that there was significant difference in the number of branches per plant in all the treatments. The maximum number of branches per plant was recorded from 100% RDF to maize alone (2.52). The lowest number of branches was recorded with 100% RDF to both the crop.

At 45 DAS (2008), the maximum number of branches per plant was obtained from 100% RDF to both the crop (4.13) while control recorded the minimum number of branches per plant (2.50).

In the second year (2009), the number of branches at 45 DAS was highest with 100% RDF to both the crop (3.86) while the minimum number of branches per plant was obtained from control (1.72).

A critical analysis of the mean pooled data of 2008 and 2009 field experiment showed that at 45 DAS the maximum number of branches per plant was recorded with 100% RDF to both the crop (3.99). Control recorded the minimum number of branches per plant (2.09).

4.8.3.2. Number of branches at 60 and 75 DAS

It is evident from the data presented in Table 35b showed that intercropping system at different recommended dose of fertilizer resulted significant variation in the number of branches per plant of soybean at 60 and 75 DAS during both the experimental year 2008 and 2009.

At 60 DAS (2008), it was observed that the various recommended dose of fertilizer in an intercropping system had a significant variation in the number of branches per plant. The maximum number of branches per plant was obtained from 100% RDF to both the crop (4.61). The minimum number of branches per plant was obtained from control (3.25).

Table 35a. Effect of fertilizer doses on number of branches of soybean intercropped with maize

Treatments	No. of branches/plant of soybean					
	30 DAS			45 DAS		
	2008	**2009**	**Pooled**	**2008**	**2009**	**Pooled**
F_1-Control (No NPK)	1.93 (1.56)	1.85 (1.53)	1.89 (1.55)	2.50 (1.73)	1.72 (1.49)	2.09 (1.61)
F_2-100%NPK (both the crop)	1.30 (1.34)	1.26 (1.33)	1.28 (1.33)	4.13 (2.15)	3.86 (2.09)	3.99 (2.12)
F_3-100%NPK (Maize)	2.59 (1.76)	2.46 (1.72)	2.52 (1.74)	3.20 (1.92)	2.06 (1.60)	2.60 (1.76)
F_4-100%(Maize) +50% (Intercrop)	2.01 (1.58)	1.32 (1.35)	1.65 (1.47)	3.26 (1.94)	2.73 (1.80)	2.99 (1.87)
F_5-50% (Maize) + 100% (Intercrop)	2.14 (1.62)	1.80 (1.52)	1.97 (1.57)	3.39 (1.97)	3.52 (2.01)	3.46 (1.99)
F_6-50% NPK (Maize & Intercrop)\	2.39 (1.70)	2.13 (1.62)	2.26 (1.66)	3.24 (1.93)	2.49 (1.73)	2.85 (1.83)
SEm$\pm$	0.05	0.03	0.03	0.04	0.06	0.03
CD (P=0.05)	0.14	0.08	0.08	0.11	0.17	0.08

* Figures in parenthesis are transformed values

Table 35b. Effect of fertilizer doses on number of branches of soybean intercropped with maize

Treatments	No. of branches/plant of soybean					
	60 DAS			75 DAS		
	2008	**2009**	**Pooled**	**2008**	**2009**	**Pooled**
F_1-Control (No NPK)	3.25 (1.94)	2.93 (1.85)	3.09 (1.89)	3.75 (2.06)	3.52 (2.01)	3.64 (2.03)
F_2-100%NPK (both the crop)	4.61 (2.26)	4.53 (2.24)	4.57 (2.25)	5.01 (2.35)	5.13 (2.37)	5.07 (2.36)
F_3-100%NPK (Maize)	3.69 (2.05)	2.99 (1.87)	3.34 (1.96)	4.37 (2.21)	3.65 (2.04)	4.01 (2.12)
F_4-100%(Maize) +50% (Intercrop)	4.03 (2.13)	3.33 (1.96)	3.67 (2.04)	4.75 (2.29)	4.00 (2.12)	4.37 (2.21)
F_5-50% (Maize) + 100% (Intercrop)	4.07 (2.14)	4.20 (2.17)	4.13 (2.15)	4.99 (2.34)	4.93 (2.33)	4.96 (2.34)
F_6-50% NPK (Maize & Intercrop)	3.77 (2.07)	3.33 (1.96)	3.54 (2.01)	4.27 (2.18)	3.92 (2.10)	4.10 (2.14)
SEm$\pm$	0.03	0.02	0.02	0.04	0.02	0.02
CD (P=0.05)	0.08	0.05	0.05	0.11	0.05	0.05

* Figures in parenthesis are transformed values

Maximum number of branches per plant at 60 DAS in the second year (2009) was recorded from 100% RDF to both the crop (4.53). In control recorded the lowest number of branches per plant (2.93).

Further analysis of the mean pooled of 2008 and 2009 experimental data indicated that the different recommended dose of fertilizer in an intercropping system had a significant variation on the number of branches per plant. The highest number of branches per plant was obtained from 100% RDF to both the crop (4.57). The lowest number of branches per plant was recorded with control (3.09).

The data pertaining to the number of branches per plant at 75 DAS in 2008 revealed that the maximum number of branches per plant was obtained from 100% RDF to both the crop (5.01) which was significantly superior as compared to the rest of the treatments in an intercropping system. The lowest number of branches per plant was recorded from control (3.75).

At 75 DAS in the second year (2009) maximum number of branches per plant was recorded with 100% RDF to both the crop (5.13). While the lowest number of branches per plant (3.52) was obtain from control and which was significantly inferior over all the rest of the treatments in an intercropping system.

A critical analysis of the mean pooled data of 2008 and 2009 field experiment revealed that the maximum number of branches per plant was obtained from 100% RDF to both the crop (5.07). While control ratio recorded the minimum number of branches per plant (3.64).

4.8.3.3. Number of branches at harvest

Perusal of data presented in Table 35c revealed that maize intercropped with soybean at different recommended doses of fertilizer had a significant variation at harvest.

Year 2008 field experiment indicates that the maximum number of branches per plant (5.37) was obtained from 100% RDF to both the crop. Control recorded the lowest number of branches per plant (4.17).

The number of branches per plant at harvest in the second year (2009) showed that, 100% RDF to both the crop recorded the maximum number of branches per plant (5.40). The minimum number of branches per plant (3.99) was obtained from control. However, it was statistically at par with 100% RDF to maize alone (4.05).

Table 35c. Effect of fertilizer doses on number of branches of soybean intercropped with maize

Treatments	No. of branches/plant of soybean		
	At harvest		
	2008	2009	Pooled
F_1-Control (No NPK)	4.17	3.99	4.08
	(2.16)	(2.12)	(2.14)
F_2-100%NPK (both the crop)	5.37	5.40	5.39
	(2.42)	(2.43)	(2.43)
F_3-100%NPK (Maize)	4.73	4.05	4.39
	(2.29)	(2.13)	(2.21)
F_4-100%(Maize) +50% (Intercrop)	4.98	4.47	4.72
	(2.34)	(2.23)	(2.28)
F_5-50% (Maize) + 100% (Intercrop)	5.25	5.21	5.23
	(2.40)	(2.39)	(2.39)
F_6-50% NPK (Maize & Intercrop)	4.62	4.33	4.47
	(2.26)	(2.20)	(2.23)
SEm$\pm$	0.03	0.02	0.02
CD (P=0.05)	0.88	0.05	0.05

* Figures in e parenthesis are transformed values

Table 36a. Effect of fertilizer doses on leaf area index (LAI) of soybean intercropped with maize

Treatments	Leaf area index					
	15 DAS			30 DAS		
	2008	2009	Pooled	2008	2009	Pooled
F_1-Control (No NPK)	0.23	0.19	0.21	1.31	1.04	1.17
	(2.73)	(2.50)	(2.61)	(6.57)	(5.85)	(6.21)
F_2-100%NPK (both the crop)	0.58	0.52	0.55	2.09	1.92	2.01
	(4.38)	(4.14)	(4.26)	(8.31)	(7.97)	(8.14)
F_3-100%NPK (Maize)	0.39	0.34	0.37	1.69	1.55	1.62
	(3.58)	(3.36)	(3.47)	(7.47)	(7.15)	(7.31)
F_4-100%(Maize) +50% (Intercrop)	0.48	0.43	0.45	1.87	1.73	1.80
	(3.96)	(3.74)	(3.85)	(7.85)	(7.56)	(7.71)
F_5-50% (Maize) + 100% (Intercrop)	0.59	0.52	0.55	2.07	1.90	1.99
	(4.39)	(4.14)	(4.26)	(8.28)	(7.92)	(8.10)
F_6-50% NPK (Maize & Intercrop)	0.43	0.36	0.39	1.81	1.64	1.72
	(3.74)	(3.42)	(3.58)	(7.74)	(7.35)	(7.54)
SEm$\pm$	0.57	0.04	0.03	0.10	0.06	0.06
CD (P=0.05)	1.68	0.11	0.08	0.29	0.17	0.17

* Figures in parenthesis are transformed values

A further analysis of the mean pooled data of 2008 and 2009 field experiment showed that 100% RDF to both the crop recorded the maximum number of branches (5.39) per plant. The minimum number of branches per plant was obtained from control (4.08).

4.8.4 Leaf area index (LAI)

4.8.4.1 Leaf area index (LAI) at 15 and 30 DAS

It was evident from the data presented in Table 36a that intercropping treatment at different fertilizer showed a significant variation in leaf area index of soybean at both 15 and 30 DAS during the experimental year (2008 and 2009).

At 15 DAS (2008), the maximum LAI of soybean was recorded with 50% RDF to maize + 100 % RDF to intercrop (0.59) which was at par with 100% RDF to both the crop (0.58). In control recorded the lowest LAI (0.23) which was significantly inferior over all the treatments in an intercropping system.

In second year (2009), 100% RDF to both the crop and 50% RDF to maize + 100 % RDF to intercrop (0.52) had a significantly higher LAI over all treatments in an intercropping system. The lowest LAI was recorded with control (0.19).

A further analysis of the mean pooled data of 2008 and 2009 revealed that LAI was maximum (0.55) with 100% RDF to both the crops and 50% RDF to maize + 100% RDF to intercrop. The minimum LAI was recorded with control (0.21).

At 30 DAS (2008), 100% RDF to both the crops recorded the maximum LAI (2.09) which was statistically at par with 50% RDF to maize + 100% RDF to intercrop (2.07). The minimum LAI (1.31) was obtained with control.

Maximum LAI in the second year (2009) was recorded with 100% RDF to both the crop (1.92) which was at par with 50% RDF to maize + 100 % RDF to intercrop (1.90). Control recorded the lowest LAI (1.04).

Result obtained from the mean pooled data of 2008 and 2009 experiment revealed that the maximum LAI (2.01) was recorded with 100% RDF to both the crop and was statistically at par with 50% RDF to maize + 100 % RDF to intercrop (1.99), while control recorded the minimum LAI (1.17).

4.8.4.2 Leaf area index (LAI) at 45 and 60 DAS

A critical examination of data presented in Table 36b showed that intercropping system at various fertilizer doses had a significant influence in the leaf area index at 45 and 60 DAS in both the year (2008 and 2009).

In the first year (2008), at 45 DAS, the maximum LAI (7.05m) was recorded with 100% RDF to both the crop which was statistically at par with 50% RDF to maize + 100 % RDF to intercrop (7.02). In the control recorded the minimum LAI of soybean (3.71).

The second year data (2009) revealed that, the maximum LAI (6.67) was obtained with 100% RDF to both the crop which was at par with 50% RDF to maize + 100 % RDF to intercrop (6.52).The minimum LAI of soybean was recorded with control (3.25).

A further analysis of the mean pooled data of 2008 and 2009 revealed that LAI was maximum (6.86) with 100% RDF to both the crop which was statistically at par with 50% RDF to maize + 100 % RDF to intercrop (6.77), while minimum LAI was recorded with control (3.25).

At 60 DAS (2008), the maximum LAI was recorded with 100% RDF to both the crop (12.02) which was at par with 50% RDF to maize + 100 % (11.13). Minimum LAI (6.85) was recorded with control.

2009 experimental data shows that the maximum LAI of soybean was recorded with 100% RDF to both the crop (10.69). However, it was statistically comparable with 50% RDF to maize + 100 % RDF to intercrop (10.36). Control recorded the minimum LAI (6.16).

Observation on the mean pooled data of 2008 and 2009 revealed that the LAI was highest with 100% RDF to both the crop (11.34). However, it was significantly at par with 50% RDF to maize + 100 % RDF to intercrop (10.74). The lowest LAI was recorded with control (6.50) which was significantly inferior to rest of the treatments.

4.8.5 Crop growth rate at 30, 45, 60 and 75 DAS (g/day)

The observation on the crop growth rate of soybean as influenced by different fertilizer doses are presented in Table 37a and 37b.

At 30, 45 and 75 DAS, the leaf area index of soybean did not show any significant difference during both the experimental years. However, at 60 DAS in the first year (2008), the highest crop growth rate was recorded with 100% RDF to both the crop (0.255) which was at par with 50% RDF to maize + 100 % RDF to intercrop (0.248) followed by 100%

Table 36b. Effect of fertilizer doses on leaf area index (LAI) of soybean intercropped with maize

Treatments	Leaf area index					
	45 DAS			60 DAS		
	2008	2009	Pooled	2008	2009	Pooled
F_1-Control (No NPK)	3.71	2.81	3.25	6.85	6.16	6.50
	(11.09)	(9.65)	(10.37)	(15.17)	(14.36)	(14.76)
F_2-100%NPK (both the crop)	7.05	6.67	6.86	12.02	10.69	11.34
	(15.39)	(14.96)	(15.17)	(20.27)	(19.07)	(19.67)
F_3-100%NPK (Maize)	4.93	3.82	4.36	9.45	7.83	8.62
	(12.82)	(11.27)	(12.04)	(17.89)	(16.24)	(17.07)
F_4-100%(Maize) +50% (Intercrop)	5.99	4.91	5.44	10.60	9.32	9.95
	(14.16)	(12.80)	(13.48)	(18.99)	(17.76)	(18.38)
F_5-50% (Maize) + 100% (Intercrop)	7.02	6.52	6.77	11.13	10.36	10.74
	(15.36)	(14.78)	(15.07)	(19.48)	(18.77)	(19.12)
F_6-50% NPK (Maize & Intercrop)	5.85	4.64	5.23	9.89	9.40	9.65
	(13.99)	(12.43)	(13.21)	(18.33)	(17.85)	(18.09)
SEm$\pm$	0.28	0.11	0.15	0.69	0.18	0.36
CD (P=0.05)	0.82	0.32	0.44	2.03	0.53	1.06

* Figures in the parenthesis are transformed values

Table 37a. Effect of fertilizer doses on crop growth rate of soybean intercropped with maize

Treatments	Crop growth rate (g/day)					
	30 DAS			45 DAS		
	2008	2009	Pooled	2008	2009	Pooled
F_1-Control (No NPK)	0.048	0.047	0.048	0.103	0.098	0.101
F_2-100%NPK (both the crop)	0.075	0.068	0.072	0.183	0.182	0.182
F_3-100%NPK (Maize)	0.054	0.049	0.051	0.131	0.129	0.130
F_4-100%(Maize) +50% (Intercrop)	0.061	0.053	0.057	0.137	0.135	0.136
F_5-50% (Maize) + 100% (Intercrop)	0.068	0.068	0.068	0.150	0.140	0.145
F_6-50% NPK (Maize & Intercrop)	0.055	0.047	0.051	0.139	0.141	0.140
SEm$\pm$	0.007	0.006	0.004	0.018	0.020	0.109
CD (P=0.05)	N.S	N.S	N.S	N.S	N.S	N.S

Table 37b. Effect of fertilizer doses on crop growth rate of soybean intercropped with maize

Treatments	Crop growth rate (g/ day)					
	60 DAS			75 DAS		
	2008	2009	Pooled	2008	2009	Pooled
F_1-Control (No NPK)	0.160	0.148	0.154	0.208	0.172	0.190
F_2-100%NPK (both the crop)	0.255	0.233	0.244	0.688	0.608	0.648
F_3-100%NPK (Maize)	0.197	0.180	0.188	0.502	0.450	0.476
F_4-100%(Maize) +50% (Intercrop)	0.242	0.233	0.237	0.445	0.379	0.412
F_5-50% (Maize) + 100% (Intercrop)	0.248	0.247	0.247	0.504	0.455	0.480
F_6-50% NPK (Maize & Intercrop)	0.213	0.205	0.209	0.466	0.466	0.466
SEm$\pm$	0.022	0.004	0.106	0.097	0.016	0.049
CD (P=0.05)	0.064	0.011	0.310	NS	NS	NS

Table 38a. Effect of fertilizer doses on relative growth rate of soybean intercropped with maize

Treatments	Relative growth rate (g/g/day)					
	30 DAS			45 DAS		
	2008	2009	Pooled	2008	2009	Pooled
F_1-Control (No NPK)	0.106	0.113	0.110	0.067	0.066	0.067
F_2-100%NPK (both the crop)	0.103	0.104	0.104	0.072	0.075	0.074
F_3-100%NPK (Maize)	0.094	0.097	0.095	0.071	0.074	0.072
F_4-100%(Maize) +50% (Intercrop)	0.099	0.099	0.099	0.066	0.073	0.070
F_5-50% (Maize) + 100% (Intercrop)	0.102	0.105	0.104	0.067	0.065	0.066
F_6-50% NPK (Maize & Intercrop)	0.094	0.090	0.092	0.073	0.078	0.075
SEm$\pm$	0.009	0.007	0.005	0.008	0.006	0.004
CD (P=0.05)	NS	NS	NS	NS	NS	NS

RDF to maize + 50 % RDF to intercrop (0.242) and 50% RDF to maize + 50 % RDF to intercrop (0.213). Control recorded the lowest CGR (0.160) which was significantly inferior over all the treatments.

The second year data on CGR at 60 DAS showed that the maximum CGR of soybean was recorded from 50% RDF to maize + 100 % RDF to intercrop (0.247) followed by 100% RDF to both the crop (0.233) and 100% RDF to maize + 50 % RDF to intercrop (0.233). However, in control recorded the minimum CGR (0.148).

A further analysis of the mean pooled data of 2008 and 2009 at 60 DAS revealed that the maximum CGR of soybean was recorded from 50% RDF to maize + 100 % RDF to intercrop (0.247) followed by 100% RDF to both the crop (0.244) and followed by 100% RDF to maize + 50 % RDF to intercrop (0.237). The minimum CGR was obtained from control (0.154).

4.8.6 Relative growth rate at 30, 45, 60 and 75 DAS (g/g/day)

It was evident from the data presented in Table 38a and 38b that fertilizer treatment does not have any significant variation in the RGR of soybean at 30, 45, 60 and 75 DAS during the experimental year 2008 and 2009.

4.9 Yield attributes of soybean

4.9.1 Relative crowding coefficient (RCC) of soybean

The data pertaining to the influences of intercropping system at various fertilizer levels on relative crowding coefficient are presented in Table 39 and revealed that intercropping system at various fertilizer levels had a significant impact on RCC during both the experimental year (2008 and 2009).

The data on relative crowding coefficient of soybean in the first year (2008) revealed that 100% RDF to both the crop recorded the maximum RCC (1.65), which was significantly superior as compared to treatments. The minimum RCC was obtained from control (0.49).

In second year (2009), the data in the table indicates that the maximum relative crowding coefficient of soybean was obtained from 100% RDF to both the crop (1.71) while control recorded the lowest RCC (0.49) which was significantly inferior as compared to other fertilizer treatments.

Table 38b. Effect of fertilizer doses on relative growth rate of soybean intercropped with maize

Treatments	Relative growth rate (g/g/day)					
	60 DAS			75 DAS		
	2008	2009	Pooled	2008	2009	Pooled
F_1-Control (No NPK)	0.046	0.045	0.045	0.033	0.030	0.031
F_2-100%NPK (both the crop)	0.043	0.042	0.043	0.055	0.053	0.054
F_3-100%NPK (Maize)	0.045	0.044	0.044	0.054	0.053	0.053
F_4-100%(Maize) +50% (Intercrop)	0.051	0.051	0.051	0.045	0.041	0.043
F_5-50% (Maize) + 100% (Intercrop)	0.048	0.049	0.049	0.046	0.045	0.046
F_6-50% NPK (Maize & Intercrop)	0.047	0.046	0.046	0.049	0.051	0.050
SEm$\pm$	0.005	0.005	0.003	0.008	0.007	0.006
CD (P=0.05)	NS	NS	NS	NS	NS	NS

Table 39. Effect fertilizer doses on relative crowding coefficient (RCC) of soybean intercropped with maize

Treatments	Relative crowding coefficient		
	2008	2009	Pooled
F_1-Control (No NPK)	0.49	0.49	0.49
F_2-100%NPK (both the crop)	1.65	1.71	1.68
F_3-100%NPK (Maize)	0.64	0.64	0.64
F_4-100%(Maize) +50% (Intercrop)	0.95	0.91	0.93
F_5-50% (Maize) + 100% (Intercrop)	1.42	1.47	1.45
F_6-50% NPK (Maize & Intercrop)	0.91	0.94	0.92
SEm$\pm$	0.04	0.05	0.03
CD (P=0.05)	0.11	0.14	0.08

Further analysis of the mean pooled data of 2008 and 2009 showed that the maximum relative crowding coefficient of soybean was recorded from 100% RDF to both the crop (1.68) and the minimum RCC was recorded from control (0.49).

4.9.2 Length of pod (cm)

The influences of the intercropping system at different recommended doses of fertilizers on length of pod of groundnut are presented in Table 40. Data in the table indicated that there is a significant impact on the length of pod of soybean during both the field experiment conducted in 2008 and 2009.

During the first year (2008) maximum length of pods per plant in soybean was recorded from 100% RDF to both the crop (3.82) and was significantly at par with 50% RDF to maize + 100 % RDF to intercrop (3.72). In control recorded the minimum length of pods per plant (3.21) which was at par with 100% RDF to maize alone (3.25) followed by 50% RDF to maize + 50 % RDF to intercrop (3.37).

In the second year (2009), 100% RDF to both the crop recorded the longest length of pods per plant (3.78) which was statistically at par with 50% RDF to maize + 100 % RDF to intercrop (3.73). The shortest length of pods per plant was obtained from control (3.20) which was significantly inferior over the other fertilizer treatments in an intercropping system.

Further analysis of the mean pooled data of 2008 and 2009 experimental results revealed that the longest length of pods per plant (3.80) was obtained from 100% RDF to both the crop which was statistically at par with 50% RDF to maize + 100 % RDF to intercrop (3.72). The shortest length of pod per plant (3.21) was recorded from control which was at par with 100% RDF to maize alone (3.23) followed by 50% RDF to maize + 50 % RDF to intercrop (3.37).

4.9.3 Number of pods per plant

Perusal of data presented in Table 41 revealed different recommended dose of fertilizer had a significant effect on number of pods per plant during the experimental year, 2008 and 2009

In the first year (2008) the highest number of pods per plant in soybean was recorded from 100% RDF to both the crop (82.43) which was superior over all the treatments. In control recorded lowest number of pods per plant (56.05).

Table 40. Effect of fertilizer doses on length of pods of soybean intercropped with maize

Treatments	Length of soybean pod (cm)		
	2008	2009	Pooled
F_1-Control (No NPK)	3.21	3.20	3.21
F_2-100%NPK (both the crop)	3.82	3.78	3.80
F_3-100%NPK (Maize)	3.25	3.21	3.23
F_4-100%(Maize) +50% (Intercrop)	3.43	3.40	3.42
F_5-50% (Maize) + 100% (Intercrop)	3.72	3.73	3.72
F_6-50% NPK (Maize & Intercrop)	3.37	3.37	3.37
SEm$\pm$	0.10	0.02	0.05
CD (P=0.05)	0.29	0.06	0.14

Table 41. Effect of fertilizer doses on number of pods per plant of soybean intercropped with maize

Treatments	No. of pods/plant		
	2008	2009	Pooled
F_1-Control (No NPK)	56.05	50.10	53.03
	(7.52)	(7.11)	(7.32)
F_2-100%NPK (both the crop)	82.43	77.82	80.11
	(9.11)	(8.85)	(8.98)
F_3-100%NPK (Maize)	63.50	57.87	60.65
	(8.00)	(7.64)	(7.82)
F_4-100%(Maize) +50% (Intercrop)	68.17	64.89	66.52
	(8.29)	(8.09)	(8.19)
F_5-50% (Maize) + 100% (Intercrop)	74.90	71.13	73.00
	(8.68)	(8.46)	(8.57)
F_6-50% NPK (Maize & Intercrop)	63.66	58.64	61.12
	(8.01)	(7.69)	(7.85)
SEm$\pm$	0.16	0.07	0.09
CD (P=0.05)	0.47	0.20	0.26

*Figures in parenthesis are transformed values

The data pertaining to number of pods per plant in 2009 revealed that number of pods of soybean (77.82) was recorded from 100% RDF to both the crop was significantly superior to rest of the treatments. Control recorded the lowest number of pods per plant (50.10) which were significantly inferior to the rest of the treatment.

Data on number of pods obtained from mean pooled data of 2008 and 2009 revealed that, the highest number of pods per plant (80.11) was recorded from 100 % RDF to both the crop. Lowest number of pods per plant (53.03) was recorded from control and was statistically inferior to rest of the treatments.

4.9.4 Number of seeds per pod

A critical perusal of the data presented in Table 42 revealed that intercropping system at various recommended dose of fertilizer had a significant influence on the number of seeds per pod in soybean during both the year- 2008 and 2009.

In the first year (2008) maximum number of seeds per pods in soybean was recorded from 100% RDF to both the crop (4.01) which was significantly higher as compared to the other recommended dose of fertilizer in an intercropping system. In control recorded the minimum number of seeds per pod (2.89).

In the second year (2009), 100% RDF to both the crop recorded the highest number of seeds per pod (3.91). The lowest number of seeds per pod was obtained from control (2.75) which was significantly inferior over the other fertilizer treatments in an intercropping system.

Further analysis of the mean pooled data of 2008 and 2009 experimental results revealed that the maximum number of seeds per pod (3.96) was obtained from 100% RDF to both the crop while control recorded the minimum number of seeds per pod (2.82).

4.9.5 Weight of pods per plant (g)

The data pertaining to the influence of intercropping system at various recommended doses of soybean are presented in Table 43 revealed that intercropping system at various fertilizer levels had a significant impact on the weight of pods of soybean during both the experimental year (2008 and 2009).

Table 42. Effect of fertilizer doses on number of seeds per pod of soybean intercropped with maize

Treatments	No. of seeds/pod		
	2008	2009	Pooled
F_1-Control (No NPK)	2.89	2.75	2.82
	(1.84)	(1.80)	(1.82)
F_2-100%NPK (both the crop)	4.01	3.91	3.96
	(2.12)	(2.10)	(2.11)
F_3-100%NPK (Maize)	3.03	2.93	2.98
	(1.88)	(1.85)	(1.87)
F_4-100%(Maize) +50% (Intercrop)	3.42	3.26	3.34
	(1.98)	(1.94)	(1.96)
F_5-50% (Maize) + 100% (Intercrop)	3.85	3.53	3.69
	(2.09)	(2.01)	(2.05)
F_6-50% NPK (Maize & Intercrop)	3.26	3.11	3.19
	(1.94)	(1.90)	(1.92)
SEm$\pm$	0.03	0.01	0.01
CD (P=0.05)	0.08	0.02	0.02

*Figures in parenthesis are transformed values

Table 43. Effect of fertilizer doses on weight of pods per plant of soybean intercropped with maize

Treatments	Weight of pods/plant (g)		
	2008	2009	Pooled
F_1-Control (No NPK)	19.16	18.50	18.83
F_2-100%NPK (both the crop)	29.47	28.37	28.92
F_3-100%NPK (Maize)	22.23	20.75	21.49
F_4-100%(Maize) +50% (Intercrop)	24.44	22.69	23.56
F_5-50% (Maize) + 100% (Intercrop)	27.37	24.26	25.81
F_6-50% NPK (Maize & Intercrop)	23.35	21.55	22.45
SEm$\pm$	0.38	0.47	0.30
CD (P=0.05)	1.12	1.38	0.88

During first year (2008), the highest weight of pods per plant was recorded from 100% RDF to both the crops (29.47) which were significantly superior to all the other RDF in an intercropping system. In control recorded the lowest weight of pods per plant (19.16).

In the second year (2009) maximum weight (28.37) of pod per plant was recorded in 100% RDF to both the crop. Lowest weight of pods per plant was recorded from control (18.50).

A further analysis of the mean pooled data of 2008 and 2009 field experiment revealed that the maximum weight of pods per plant was obtained from 100% RDF to both the crop (28.92) which was statistically superior over all the other RDF, while control recorded the minimum weight of pods per plant (18.83).

4.9.6 Test weight (g)

It was evident from the data presented in Table 44 that intercropping system at different fertilizer doses had a significant influence on the test weight of soybean during the experiment year of 2008 and 2009.

The data on the 1000 grain weight of soybean in the first year (2008) revealed that 100% RDF to both the crop recorded the maximum test weight (145.35 g), which was significantly superior as compared to other fertilizer treatment. The minimum test weight was obtained from control (128.38 g).

In second year (2009), maximum test weight of soybean was obtained from 100% RDF to both the crop (136.71 g) while control recorded the lowest test weight (113.94 g) which was significantly inferior as compared to other fertilizer treatments.

Further analysis of the mean pooled data of 2008 and 2009 showed that the maximum test weight of soybean was recorded from 100% RDF to both the crop (141.03 g) and the minimum test weight was recorded from control (121.16 g).

4.9.7 Seed yield (q/ha)

The influences of the intercropping system at different recommended doses of fertilizer on the seed yield of soybean are presented in Table 45. Data in the table indicated that there was a significant impact on the seed yield of soybean during both the field experiment conducted in 2008 and 2009.

Table 44. Effect of fertilizer doses on test weight of soybean intercropped with maize

Treatments	Test weight of pods (g)		
	2008	**2009**	**Pooled**
F_1-Control (No NPK)	128.38	113.94	121.16
F_2-100%NPK (both the crop)	145.35	136.71	141.03
F_3-100%NPK (Maize)	134.48	126.75	130.62
F_4-100%(Maize) +50% (Intercrop)	136.44	129.02	132.73
F_5-50% (Maize) + 100% (Intercrop)	138.73	131.38	135.06
F_6-50% NPK (Maize & Intercrop)	135.03	129.51	132.27
SEm$\pm$	1.64	1.40	1.08
CD (P=0.05)	4.83	4.13	3.18

Table 45. Effect of fertilizer doses on grain yield of soybean intercropped with maize

Treatments	Grain yield of soybean (q/ha)		
	2008	**2009**	**Pooled**
F_1-Control (No NPK)	5.71	5.41	5.56
F_2-100%NPK (both the crop)	10.87	10.29	10.58
F_3-100%NPK (Maize)	6.81	6.37	6.59
F_4-100%(Maize) +50% (Intercrop)	8.50	7.78	8.14
F_5-50% (Maize) + 100% (Intercrop)	10.24	9.71	9.97
F_6-50% NPK (Maize & Intercrop)	8.32	7.88	8.10
SEm$\pm$	0.11	0.20	0.12
CD (P=0.05)	0.32	0.59	0.35

A perusal of the data of 2008 field experiment revealed that the seed yield obtained in 100 % RDF to both the crops (10.87) was significantly higher than that of the other recommended dose of fertilizer treatments. Control recorded the lowest seed yield of soybean (5.71). The data in the second year 2009 indicated that the highest seed yield was obtained from 100%RDF to both the crop (10.29) which was statistically superior over the rest of the fertilizer treatments. The lowest seed yield was obtained with control (5.41) which was significantly inferior as compared to other treatments.

Further analysis of the mean pool data of 2008 and 2009 revealed that the maximum seed yield was recorded from 100%RDF to both the crop (10.58) which was significantly superior over the rest of the fertilizer treatments in an intercropping. In control recorded the minimum seed yield (5.56).

4.9.8 Stover yield (q/ha)

Observations recorded on stover yield are presented in Table 46. The data revealed that stover yield was found significant in application of different recommended dose of fertilizer during both the experimental year (2008 and 2009).

The first year (2008) experimental data indicated that the maximum stover yield in soybean was recorded from 100% RDF to both the crops (22.87) which were significantly higher as compared to the other RDF in an intercropping system. Control recorded the minimum stover yield (11.73).

In the second year (2009), 100% RDF to both the crops recorded the highest number stover yield (20.97) which was statistically at par with 50% RDF to maize + 100% RDF to intercrop (19.79). The lowest stover yield was obtained from control (11.17) which was significantly inferior over the other RDF in an intercropping system.

Further analysis of the mean pooled data of 2008 and 2009 experimental results revealed that the maximum stover yield (21.92) was obtained from 100 % RDF to both the crop while control recorded the minimum stover yield (11.45).

4.9.9 Harvest Index (%)

The influences of different recommended dose of fertilizer on harvest index of soybean are presented in Table 47.

Table 46. Effect of fertilizer doses on stover yield of soybean intercropped with maize

Treatments	Stover yield of soybean (q/ha)		
	2008	2009	Pooled
F_1-Control (No NPK)	11.73	11.17	11.45
F_2-100%NPK (both the crop)	22.87	20.97	21.92
F_3-100%NPK (Maize)	14.20	12.89	13.54
F_4-100%(Maize) +50% (Intercrop)	17.40	15.83	16.61
F_5-50% (Maize) + 100% (Intercrop)	21.67	19.79	20.73
F_6-50% NPK (Maize & Intercrop)	15.53	16.02	15.78
SEm$\pm$	0.21	0.42	0.24
CD (P=0.05)	0.61	1.23	0.70

Table 47. Effect of fertilizer doses on harvest index of soybean intercropped with maize

Treatments	Harvest index (%)		
	2008	2009	Pooled
F_1-Control (No NPK)	32.74	32.62	32.68
F_2-100%NPK (both the crop)	32.21	32.91	32.56
F_3-100%NPK (Maize)	32.41	33.05	32.73
F_4-100%(Maize) +50% (Intercrop)	32.81	32.95	32.88
F_5-50% (Maize) + 100% (Intercrop)	32.09	32.90	32.49
F_6-50% NPK (Maize & Intercrop)	34.88	32.97	33.92
SEm$\pm$	0.57	0.18	0.30
CD (P=0.05)	1.68	0.53	0.88

Table 48. Effect of fertilizer doses on days to 50% flowering of soybean intercropped with maize

Treatments	Days to 50% flowering		
	2008	2009	Pooled
F_1-Control (No NPK)	49.97	52.06	51.01
F_2-100%NPK (both the crop)	54.00	56.65	55.32
F_3-100%NPK (Maize)	52.00	53.62	52.81
F_4-100%(Maize) +50% (Intercrop)	53.67	56.00	54.83
F_5-50% (Maize) + 100% (Intercrop)	52.33	56.35	54.32
F_6-50% NPK (Maize & Intercrop)	50.66	52.69	51.67
SEm$\pm$	0.10	0.12	0.11
CD (P=0.05)	NS	NS	NS

Table 49. Effect of fertilizer doses on days to maturity of soybean

Treatments	Days to maturity		
	2008	2009	Pooled
F_1-Control (No NPK)	125.33	128.40	126.86
F_2-100%NPK (both the crop)	127.00	132.98	129.97
F_3-100%NPK (Maize)	125.33	128.40	126.86
F_4-100%(Maize) +50% (Intercrop)	126.00	129.92	127.95
F_5-50% (Maize) + 100% (Intercrop)	126.33	133.36	129.83
F_6-50% NPK (Maize & Intercrop)	126.00	129.61	127.80
SEm$\pm$	0.11	0.09	0.10
CD (P=0.05)	NS	NS	NS

4.10 Phenological parameter

4.10.1 Days to 50 per cent flowering

It is evident from the data presented in Table 48 revealed that intercropping system at various fertilizer doses did not show any significant variation in the days to 50% flowering in soybean during both the years of experimentation.

4.10.2 Days to maturity

The influence of intercropping system at different recommended doses of fertilizer on the number of days needed for maturing in soybean are presented in Table 49. No significant impact on the number of days to maturity was recorded during both the experimental years.

4.11 Chemical composition

4.11.1 Chemical composition of maize crop

4.11.1.1 Nitrogen uptake by maize grain (kg/ha)

The data pertaining to the uptake of nitrogen by maize grain affected by different fertilizer doses are summarized in Table 50. The data revealed that there was no significant effect on intercropping during both the years (2008 and 2009).

Further examination of the data for the influence of fertilizer doses on N uptake by maize grain reveals that different fertilizer doses found significant influence on N uptake during both the years. From the pool data, it was observed that the maximum N uptake was recorded from 100%RDF to both the crop (63.70) which was statistically superior among all the fertilizer treatments and the minimum N uptake was recorded from control (26.64).

A critical examination of the data pertaining to the interaction effect on intercropping and fertilizer application on N uptake reveals that there was significant difference during both the experimental years. From the pool data it was observed that the highest N uptake on interaction effect was recorded from maize + groundnut with 100%RDF to both the crop and the minimum was recorded from maize + soybean control.

4.11.1.2 Phosphorus uptake by maize grain (kg/ha)

Observations recorded on phosphorus uptake by maize grain are presented in Table 51. The data revealed that phosphorus uptake was found non significant in intercropping during both the experimental year (2008 and 2009).

Statistically, it was found that application of different level of recommended fertilizer doses had significant effect on phosphorus uptake and results from the pool data it was revealed that 100%RDF to both the crop recorded the maximum phosphorus uptake by grain (20.76). Whereas control recorded the minimum phosphorus uptake by maize grain (6.33).

There was no interaction effect on intercropping and fertilizer application during the first year. In the second year it showed significant effect. From the pool data it was revealed that the maximum phosphorus uptake by maize grain (21.81) was recorded from maize + groundnut with 100% RDF to both the crop. Maize + soybean control recorded the minimum phosphorus uptake by maize grain (5.96).

4.11.1.3 Potassium uptake by maize grain (kg/ha)

Perusal of the data presented in Table 52, it was found that during first year intercropping did not show any significant difference on potassium uptake by maize grain but in the second year it was found significant. From the pool data it was revealed that intercropping has a significant influence on potassium uptake by maize grain. Maize + groundnut intercropping was superior (14.21) over maize + soybean intercropping.

Table 50. Effect of intercropping and fertilizer doses on nitrogen uptake by maize grain

Treatments	N-uptake (kg/ha)		
	2008	2009	Pooled
Intercropping(IC)			
IC_1-Maize+Groundnut (2:2)	47.67	42.85	45.26
IC_2-Maize + Soybean (2:2)	44.59	39.31	41.95
SEm$\pm$	1.55	0.89	0.72
CD (P=0.05)	NS	NS	NS
Fertilizer doses(F)			
F_1-Control (No NPK)	26.64	22.65	24.64
F_2-100%NPK (both the crop)	66.68	60.72	63.70
F_3-100%NPK (Maize)	48.98	43.81	46.40
F_4-100 %(Maize) +50% (Intercrop)	58.43	53.26	55.85
F_5-50% (Maize) + 100% (Intercrop)	39.48	34.60	37.04
F_6-50% NPK (Maize & Intercrop)	36.56	31.43	34.00
SEm$\pm$	0.86	0.55	0.62
CD (P=0.05)	2.53	1.62	2.17
Interactions (IC x F)			
IC_1 x F_1	27.58	23.44	25.51
IC_1 x F_2	68.75	63.82	66.29
IC_1 x F_3	47.61	42.84	45.23
IC_1 x F_4	59.55	54.47	57.01
IC_1 x F_5	43.02	38.10	40.56
IC_1 x F_6	39.48	34.44	36.96
IC_2 x F_1	25.69	21.85	23.77
IC_2 x F_2	64.60	57.61	61.11
IC_2 x F_3	50.35	44.79	47.57
IC_2 x F_4	57.31	52.06	54.68
IC_2 x F_5	35.93	31.11	33.52
IC_2 x F_6	33.64	28.43	31.03
SEm$\pm$	2.27	1.39	0.88
CD (P=0.05)	6.13	4.05	2.26

Table 51. Effect of intercropping and fertilizer doses on phosphorus uptake by maize grain

Treatments	P-uptake (kg/ha)		
	2008	2009	Pooled
Intercropping(IC)			
IC_1-Maize+Groundnut (2:2)	15.04	13.29	14.16
IC_2-Maize + Soybean (2:2)	13.69	11.88	12.78
SEm$\pm$	0.52	0.26	0.23
CD (P=0.05)	NS	NS	NS
Fertilizer doses(F)			
F_1-Control (No NPK)	6.93	5.72	6.33
F_2-100%NPK (both the crop)	21.95	19.57	20.76
F_3-100%NPK (Maize)	15.83	14.07	14.95
F_4-100 %(Maize) +50% (Intercrop)	19.10	17.20	18.15
F_5-50% (Maize) + 100% (Intercrop)	11.46	9.71	10.58
F_6-50% NPK (Maize & Intercrop)	10.93	9.22	10.07
SEm$\pm$	0.31	0.16	0.21
CD (P=0.05)	0.90	0.48	0.62
Interactions (IC x F)			
IC_1 x F_1	7.35	6.03	6.69
IC_1 x F_2	22.88	20.74	21.81
IC_1 x F_3	15.54	13.93	14.73
IC_1 x F_4	19.71	17.85	18.78
IC_1 x F_5	12.66	10.89	11.78
IC_1 x F_6	12.09	10.30	11.19
IC_2 x F_1	6.51	5.42	5.96
IC_2 x F_2	21.03	18.41	19.72
IC_2 x F_3	16.12	14.22	15.17
IC_2 x F_4	18.48	16.55	17.52
IC_2 x F_5	10.25	8.53	9.39
IC_2 x F_6	9.77	8.13	8.95
SEm$\pm$	0.53	0.28	0.30
CD (P=0.05)	NS	0.83	0.85

Table 52. Effect of intercropping and fertilizer doses on potassium uptake by maize grain

Treatments	K-uptake (kg/ha)		
	2008	2009	Pooled
Intercropping(IC)			
IC_1-Maize+Groundnut (2:2)	15.15	13.27	14.21
IC_2-Maize + Soybean (2:2)	14.15	12.08	13.12
SEm$\pm$	0.45	0.21	0.20
CD (P=0.05)	NS	0.83	0.53
Fertilizer doses(F)			
F_1-Control (No NPK)	6.38	5.34	5.86
F_2-100%NPK (both the crop)	22.99	20.65	21.82
F_3-100%NPK (Maize)	16.53	14.57	15.55
F_4-100 %(Maize) +50% (Intercrop)	19.84	17.54	18.69
F_5-50% (Maize) + 100% (Intercrop)	11.72	9.34	10.53
F_6-50% NPK (Maize & Intercrop)	10.45	8.62	9.53
SEm$\pm$	0.28	0.19	0.21
CD (P=0.05)	0.83	0.55	0..60
Interactions (IC x F)			
IC_1 x F_1	6.65	5.54	6.10
IC_1 x F_2	23.81	21.87	22.84
IC_1 x F_3	15.95	14.31	15.13
IC_1 x F_4	20.16	18.08	19.12
IC_1 x F_5	13.03	10.31	11.67
IC_1 x F_6	11.31	9.50	10.40
IC_2 x F_1	6.10	5.13	5.62
IC_2 x F_2	22.17	19.43	20.80
IC_2 x F_3	17.10	14.84	15.97
IC_2 x F_4	19.53	17.00	18.26
IC_2 x F_5	10.40	8.37	9.38
IC_2 x F_6	9.60	7.73	8.66
SEm$\pm$	0.48	0.33	0.29
CD (P=0.05)	1.43	0.96	0.85

On further scanning of the treatment for the influence of fertilizer doses on potassium uptake by maize grain, it was evident that all potassium uptakes by maize grain showed significant influence. The maximum potassium uptake by maize grain was recorded from 100%RDF to both the crops (21.82) and minimum was recorded from the control (5.86).

Interaction effect on intercropping and fertilizer application on potassium uptake by maize grain did not show any significant difference during the first year but in the second year there was significant influence. Data on potassium uptake by maize grain obtained from mean pooled data of 2008 and 2009 revealed that, the highest interaction effect on potassium uptake by maize grain (22.84) was recorded from maize + groundnut intercropping with 100% RDF to both the crop and the minimum from maize + soybean control.

4.11.1.4 Nitrogen uptake by maize stover (kg/ha)

The influence of different intercropping treatments at various fertilizer treatments on nitrogen uptake by maize stover are presented in Table 53. Data in the table indicates that different intercropping does not show any significant difference in both the experimental years.

Further examination of the data for the influence of recommended dose of on nitrogen uptake by maize stover revealed that different fertilizer doses had significant influence during both the years. From the mean pool data, it was observed that the nitrogen uptake by maize stover (63.70) was recorded from 100%RDF to both the crop which was significantly superior to the rest of the treatments and minimum was recorded from control (24.64).

Interaction effect on intercropping and fertilizer application on nitrogen uptake by maize stover had significant difference in both years. Data on nitrogen uptake by maize stover obtained from mean pooled data of 2008 and 2009 revealed that, the highest nitrogen uptake by maize stover (66.29) was recorded from maize + groundnut intercropping with 100% RDF to both the crops and the minimum from maize + soybean intercropping control(23.77).

4.11.1.5 Phosphorus uptake by maize stover (kg/ha)

Perusal of the data presented in Table 54, it was found that maize based intercropping did not show any significant difference on phosphorus uptake by maize stover during both experimental years.

Table 53. Effect of intercropping and fertilizer doses on nitrogen uptake by maize stover

Treatments	N-uptake (kg/ha)		
	2008	2009	Pooled
Intercropping(IC)			
IC_1-Maize+Groundnut (2:2)	48.96	43.11	46.03
IC_2-Maize + Soybean (2:2)	46.84	39.55	43.20
SEm±	1.57	0.89	0.76
CD (P=0.05)	NS	NS	NS
Fertilizer doses(F)			
F_1-Control (No NPK)	26.64	22.65	24.64
F_2-100%NPK (both the crop)	66.68	60.72	63.70
F_3-100%NPK (Maize)	48.98	43.81	46.40
F_4-100 %(Maize) +50% (Intercrop)	58.43	53.26	55.85
F_5-50% (Maize) + 100% (Intercrop)	39.48	34.60	37.04
F_6-50% NPK (Maize & Intercrop)	36.56	31.43	34.00
SEm±	0.86	0.55	0.72
CD (P=0.05)	2.53	1.62	2.04
Interactions (IC x F)			
IC_1 x F_1	27.58	23.44	25.51
IC_1 x F_2	68.75	63.82	66.29
IC_1 x F_3	47.61	42.84	45.23
IC_1 x F_4	59.55	54.47	57.01
IC_1 x F_5	43.02	38.10	40.56
IC_1 x F_6	39.48	34.44	36.96
IC_2 x F_1	25.69	21.85	23.77
IC_2 x F_2	64.60	57.61	61.11
IC_2 x F_3	50.35	44.79	47.57
IC_2 x F_4	57.31	52.06	54.68
IC_2 x F_5	35.93	31.11	33.52
IC_2 x F_6	33.64	28.43	31.03
SEm±	2.27	1.39	1.01
CD (P=0.05)	6.13	4.05	2.29

Table 54. Effect of intercropping and fertilizer doses on phosphorus uptake by maize stover

Treatments	P-uptake (kg/ha)		
	2008	2009	Pooled
Intercropping(IC)			
IC_1-Maize+Groundnut (2:2)	9.72	8.51	9.11
IC_2-Maize + Soybean (2:2)	9.02	7.52	8.27
SEm$\pm$	0.32	0.35	0.19
CD (P=0.05)	NS	NS	N.S
Fertilizer doses(F)			
F_1-Control (No NPK)	5.52	4.35	4.94
F_2-100%NPK (both the crop)	14.00	12.30	13.15
F_3-100%NPK (Maize)	9.80	8.68	9.24
F_4-100 %(Maize) +50% (Intercrop)	11.59	9.66	10.62
F_5-50% (Maize) + 100% (Intercrop)	8.01	6.81	7.41
F_6-50% NPK (Maize & Intercrop)	7.30	6.27	6.79
SEm$\pm$	0.24	0.16	0.18
CD (P=0.05)	0.70	0.45	0.62
Interactions (IC x F)			
IC_1 x F_1	5.54	4.77	5.15
IC_1 x F_2	14.52	13.59	14.05
IC_1 x F_3	9.76	8.71	9.24
IC_1 x F_4	12.02	9.70	10.86
IC_1 x F_5	8.69	7.50	8.09
IC_1 x F_6	7.79	6.76	7.28
IC_2 x F_1	5.50	3.94	4.72
IC_2 x F_2	13.48	11.01	12.25
IC_2 x F_3	9.83	8.65	9.24
IC_2 x F_4	11.15	9.61	10.38
IC_2 x F_5	7.34	6.11	6.72
IC_2 x F_6	6.81	5.79	6.30
SEm$\pm$	0.42	0.27	0.25
CD (P=0.05)	NS	0.79	0.68

Table 55. Effect of intercropping and fertilizer doses on potassium uptake by maize stover

Treatments	K-uptake (kg/ha)		
	2008	2009	Pooled
Intercropping(IC)			
IC_1-Maize+Groundnut (2:2)	94.79	85.24	90.02
IC_2-Maize + Soybean (2:2)	90.22	77.42	83.82
SEm$\pm$	3.10	2.24	1.56
CD (P=0.05)	NS	NS	N.S
Fertilizer doses(F)			
F_1-Control (No NPK)	40.29	33.56	36.93
F_2-100%NPK (both the crop)	136.31	122.79	129.55
F_3-100%NPK (Maize)	103.50	91.62	97.56
F_4-100 %(Maize) +50% (Intercrop)	121.00	109.14	115.07
F_5-50% (Maize) + 100% (Intercrop)	79.90	68.17	74.04
F_6-50% NPK (Maize & Intercrop)	74.03	62.75	68.39
SEm$\pm$	1.49	0.16	1.17
CD (P=0.05)	4.38	0.45	3.41
Interactions (IC x F)			
IC_1 x F_1	40.91	34.88	37.90
IC_1 x F_2	139.57	130.63	135.10
IC_1 x F_3	101.18	89.83	95.50
IC_1 x F_4	122.94	111.77	117.35
IC_1 x F_5	85.28	74.86	80.07
IC_1 x F_6	78.85	69.55	74.20
IC_2 x F_1	39.67	32.23	35.95
IC_2 x F_2	133.05	114.95	124.00
IC_2 x F_3	105.82	93.41	99.62
IC_2 x F_4	119.06	106.51	112.79
IC_2 x F_5	74.52	61.48	68.00
IC_2 x F_6	69.20	55.94	62.57
SEm$\pm$	2.57	2.09	1.65
CD (P=0.05)	NS	6.13	4.85

Application of different recommended dose of fertilizer influenced phosphorus uptake by maize stover significantly with the highest (13.15) from 100%RDF to both the crops. Whereas the minimum (4.94) phosphorus uptake was recorded from control.

Interaction between different doses of fertilizer treatment and intercropping on phosphorus uptake by maize stover did not show any significant difference during the first year but in the second year there was significant influence. Data on phosphorus uptake by maize stover obtained from mean pooled data of 2008 and 2009 revealed that, the highest interaction effect on phosphorus uptake by maize stover (14.05) was recorded from maize + groundnut intercropping with 100% RDF to both the crop and the minimum from maize + soybean control.

4.11.1.6 Potassium uptake by maize stover (kg/ha)

Observations recorded on phosphorus uptake by maize grain are presented in Table 55. The data revealed that potassium uptake by maize stover was found non significant in intercropping during both the experimental year (2008 and 2009).

Statistically, it was found that application of different level of recommended fertilizer doses had significant effect on potassium uptake by maize stover and results from the pool data it was revealed that 100%RDF to both the crop recorded the maximum potassium uptake by maize stover (129.55). Control recorded the minimum (36.93) potassium uptake by maize stover.

There was no interaction effect on intercropping and fertilizer application during the first year. In the second year it showed significant effect. From the pool data it was revealed that the maximum potassium uptake by maize stover (135.10) was recorded from maize + groundnut with 100% RDF to both the crop. Maize + soybean control recorded the minimum potassium uptake by maize stover (35.95).

4.11.1.7 Total nitrogen uptake by maize crop (kg/ha)

A critical examination of the data presented in Table 56 and revealed that intercropping system at various fertilizer levels could not record any significant influence on total nitrogen uptake by maize crop at both the years (2008 and 2009).

It was observed that different level of recommended fertilizer doses recorded significant effect on total nitrogen uptake by maize crop during both the years. From the pooled data it was apparent that 100% RDF to both the crop obtained the highest nitrogen uptake (129.49) and the lowest from control (48.22).

Interaction effect on intercropping and fertilizer application was found non significant effect in the first year. During second year, the maximum nitrogen uptake was however, recorded from maize + groundnut with 100%RDF to both the crop (129.78). The minimum was recorded from maize + soybean control (42.38) which was at par with maize + groundnut control (45.70).

From the pooled data it was found that maize + groundnut with 100%RDF to both the crop recorded the highest total nitrogen uptake (135.16). Maize + soybean control recorded the lowest total nitrogen uptake (46.57) which was at par with maize + groundnut control (49.86).

4.11.1.8 Total phosphorus uptake by maize crop (kg/ha)

Perusal of the data presented in Table 57 and found that intercropping system at different recommended dose of fertilizer levels did not show any significant influence on total phosphorus uptake by maize crop during both the experimental year (2008 and 2009).

Statistically it was found that application of different levels of recommended dose of fertilizer had conspicuous influence on phosphorus uptake in both the year From the mean pooled data of 2008 and 2009 on total phosphorus uptake by maize crop revealed that the highest total phosphorus uptake of (33.92) was recorded from 100% RDF to both the crop. The minimum total phosphorus uptake was recorded from control (11.26).

Interaction effect on intercropping and fertilizer application did not show any significant difference in the first year. But in the second year, it was found that there was significant difference on intercropping and different recommended dose of fertilizer. From the mean pooled data, it was observed that the highest total phosphorus uptake (35.86) was recorded from maize + groundnut intercropping with 100% RDF. The lowest (10.68) total phosphorus uptake was recorded from maize + soybean control which was at par with maize + groundnut control (11.84).

Table 56. Effect of intercropping and fertilizer doses on total nitrogen uptake by maize

Treatments	Total N-uptake (kg/ha)		
	2008	2009	Pooled
Intercropping(IC)			
IC_1-Maize+Groundnut (2:2)	96.63	85.96	91.29
IC_2-Maize + Soybean (2:2)	91.43	78.86	85.15
SEm$\pm$	3.10	1.84	1.47
CD (P=0.05)	NS	NS	NS
Fertilizer doses(F)			
F_1-Control (No NPK)	52.40	44.04	48.22
F_2-100%NPK (both the crop)	136.16	122.82	129.49
F_3-100%NPK (Maize)	103.57	90.38	96.97
F_4-100 %(Maize) +50% (Intercrop)	118.01	105.92	111.96
F_5-50% (Maize) + 100% (Intercrop)	80.41	68.51	74.46
F_6-50% NPK (Maize & Intercrop)	73.62	62.79	68.21
SEm$\pm$	1.68	1.16	1.25
CD (P=0.05)	4.95	3.43	3.57
Interactions (IC x F)			
IC_1 x F_1	54.03	45.70	49.86
IC_1 x F_2	140.54	129.78	135.16
IC_1 x F_3	100.53	88.49	94.51
IC_1 x F_4	119.63	108.00	113.82
IC_1 x F_5	86.27	75.10	80.69
IC_1 x F_6	78.76	68.70	73.73
IC_2 x F_1	50.76	42.38	46.57
IC_2 x F_2	131.78	115.87	123.82
IC_2 x F_3	106.61	92.27	99.44
IC_2 x F_4	116.39	103.84	110.11
IC_2 x F_5	74.56	61.91	68.23
IC_2 x F_6	68.48	56.89	62.68
SEm$\pm$	4.50	2.91	1.77
CD (P=0.05)	NS	7.72	3.26

Table 57. Effect of intercropping and fertilizer doses on total phosphorus uptake by maize

Treatments	Total P-uptake (kg/ha)		
	2008	2009	Pooled
Intercropping(IC)			
IC_1-Maize+Groundnut (2:2)	24.76	21.79	23.28
IC_2-Maize + Soybean (2:2)	22.71	19.39	21.05
SEm±	0.83	0.60	0.42
CD (P=0.05)	NS	NS	N.S
Fertilizer doses(F)			
F_1-Control (No NPK)	12.45	10.07	11.26
F_2-100%NPK (both the crop)	35.96	31.88	33.92
F_3-100%NPK (Maize)	25.63	22.75	24.19
F_4-100 %(Maize) +50% (Intercrop)	30.68	26.86	28.77
F_5-50% (Maize) + 100% (Intercrop)	19.47	16.52	17.99
F_6-50% NPK (Maize & Intercrop)	18.23	15.49	16.86
SEm±	0.48	0.29	0.34
CD (P=0.05)	1.40	0.86	1.17
Interactions (IC x F)			
IC_1 x F_1	12.89	10.79	11.84
IC_1 x F_2	37.40	34.33	35.86
IC_1 x F_3	25.30	22.64	23.97
IC_1 x F_4	31.73	27.55	29.64
IC_1 x F_5	21.35	18.40	19.87
IC_1 x F_6	19.88	17.06	18.47
IC_2 x F_1	12.01	9.35	10.68
IC_2 x F_2	34.51	29.42	31.97
IC_2 x F_3	25.95	22.87	24.41
IC_2 x F_4	29.64	26.16	27.90
IC_2 x F_5	17.59	14.64	16.11
IC_2 x F_6	16.58	13.92	15.25
SEm±	0.83	0.51	0.48
CD (P=0.05)	NS	1.49	1.64

Table 58. Effect of intercropping and fertilizer doses on total potassium uptake by maize

Treatments	K-uptake (kg/ha)		
	2008	2009	Pooled
Intercropping(IC)			
IC_1-Maize+Groundnut (2:2)	109.94	98.52	104.23
IC_2-Maize + Soybean (2:2)	104.37	89.50	96.94
SEm$\pm$	3.55	2.45	1.76
CD (P=0.05)	NS	NS	N.S
Fertilizer doses(F)			
F_1-Control (No NPK)	46.67	38.89	42.78
F_2-100%NPK (both the crop)	159.30	143.44	151.37
F_3-100%NPK (Maize)	120.03	106.19	113.11
F_4-100 %(Maize) +50% (Intercrop)	140.84	126.68	133.76
F_5-50% (Maize) + 100% (Intercrop)	91.62	77.51	84.56
F_6-50% NPK (Maize & Intercrop)	84.48	71.36	77.92
SEm$\pm$	1.67	1.36	1.32
CD (P=0.05)	4.93	4.02	3.90
Interactions (IC x F)			
IC_1 x F_1	47.56	40.42	43.99
IC_1 x F_2	163.38	152.49	157.94
IC_1 x F_3	117.13	104.13	110.63
IC_1 x F_4	143.09	129.85	136.47
IC_1 x F_5	98.31	85.17	91.74
IC_1 x F_6	90.16	79.05	84.61
IC_2 x F_1	45.78	37.36	41.57
IC_2 x F_2	155.22	134.38	144.80
IC_2 x F_3	122.93	108.25	115.59
IC_2 x F_4	138.59	123.51	131.05
IC_2 x F_5	84.92	69.85	77.39
IC_2 x F_6	78.79	63.67	71.23
SEm$\pm$	2.90	2.36	1.87
CD (P=0.05)	8.55	6.96	5.51

4.11.1.9 Total potassium uptake by maize crop (kg/ha)

A critical examination of the data presented in Table 58 revealed that intercropping system at different recommended dose of fertilizer did not show any significant influence on total potassium uptake by maize crop during both the year (2008 and 2009).

Different level of recommended fertilizer dose recorded significant effect on total potassium uptake by maize plant during both the years test weight. From the pooled data it was observed that 100% RDF to both the crop obtained the highest total potassium uptake (151.37) and the lowest from control (42.78).

Further analysis of the data on interaction effect between intercropping and different recommended dose of fertilizer from the pooled data it was apparent that maize + groundnut with 100%RDF to both the crop recorded the highest total potassium uptake (157.94). Maize + soybean control recorded the lowest total potassium uptake (41.57) which was at par with maize + groundnut control (43.99).

4.11.2 Chemical composition of groundnut crop

4.11.2.1 Nitrogen uptake by groundnut kernel (kg/ha)

A critical examination of the data presented on Table 59 revealed that all levels of fertilizer doses had significant influence on nitrogen uptake by groundnut kernel. Experimental data of year 2008 shows that the maximum nitrogen uptake by groundnut kernel (28.35) was observed from 100 %RDF to both the crops and minimum was recorded from control (13.41).

In the second year (2009), 100 %RDF to both the crops was found to be superior with regard to nitrogen uptake by groundnut kernel (25.90). Control recorded the minimum nitrogen uptake by groundnut kernel (12.45) and was at par with 100% RDF to maize alone (14.11).

Results obtained from the mean pooled data of 2008 and 2009 on nitrogen uptake by groundnut kernel revealed that maximum uptake was obtained from100% RDF to both the crop (27.12) and the lowest nitrogen uptake by groundnut kernel (12.93) was obtained from control which was at par with 100% RDF to maize alone.

4.11.2.2 Phosphorus uptake by groundnut kernel (kg/ha)

Observations recorded on phosphorus uptake by groundnut kernel are presented in Table 60. The data revealed that phosphorus uptake by groundnut kernel was found significant during both the experimental year (2008 and 2009).

The data pertaining to the phosphorus uptake by groundnut kernel in the year 2008 revealed that the maximum phosphorus uptake by groundnut kernel was obtained from 100 % RDF to both the crops (3.60) and the minimum was recorded from control (1.68).

In the second year 2009 field experiment revealed that the highest phosphorus uptake by groundnut kernel was recorded from 100 % RDF to both the crops (3.33) and was at par with 50% RDF to maize + 100% RDF to intercrop (3.05). Control recorded the lowest phosphorus uptake by groundnut kernel (1.49) and was statistically at par with 100% RDF to maize alone (1.79).

A critical analysis of the mean pooled data of 2008 and 2009 field experiment revealed that the maximum phosphorus uptake by groundnut kernel was obtained from 100 % RDF to both the crops (3.47) and control recorded the minimum phosphorus uptake by groundnut kernel (1.59).

4.11.2.3 Potassium uptake by groundnut kernel (kg/ha)

A critical examination of the data presented in Table 61 revealed that intercropping system at various fertilizer levels had a significant influence potassium uptake by groundnut kernel during both the field experimental year (2008 and 2009).

The first year (2008) experimental data indicated the maximum potassium uptake by groundnut kernel (13.23) was recorded from 100 %RDF to both the crops which were significantly higher as compared to the other fertilizer treatment in an intercropping system. Control recorded the minimum potassium uptake by groundnut kernel (6.44).

In the second year (2009), 100 %RDF to both the crops recorded the highest potassium uptake by groundnut kernel (11.95). The lowest potassium uptake by groundnut kernel was obtained from control (5.93) which was statistically at par with 100% RDF to maize alone (6.65).

Further analysis of the mean pooled data of 2008 and 2009 experimental results revealed that the maximum potassium uptake by groundnut kernel (12.59) was obtained from

Table 59. Effect of fertilizer doses on nitrogen uptake by groundnut kernel

Treatments	Nitrogen uptake (kg/ha)		
	2008	2009	Pooled
F_1-Control (No NPK)	13.41	12.45	12.93
F_2-100%NPK (both the crop)	28.35	25.90	27.12
F_3-100%NPK (Maize)	15.59	14.11	14.85
F_4-100% (Maize) +50% (Intercrop)	22.55	21.28	21.92
F_5-50% (Maize) + 100% (Intercrop)	25.65	23.80	24.72
F_6-50% NPK (Maize & Intercrop)	20.29	18.62	19.46
SEm$\pm$	0.16	0.61	0.31
CD(P=0.05)	0.51	1.92	0.92

Table 60. Effect of fertilizer doses on phosphorus uptake by groundnut kernel

Treatments	Phosphorus uptake (kg/ha)		
	2008	2009	Pooled
F_1-Control (No NPK)	1.68	1.49	1.59
F_2-100%NPK (both the crop)	3.60	3.33	3.47
F_3-100%NPK (Maize)	1.95	1.79	1.87
F_4-100%(Maize) +50% (Intercrop)	2.81	2.64	2.73
F_5-50% (Maize) + 100% (Intercrop)	3.23	3.05	3.14
F_6-50% NPK (Maize & Intercrop)	2.61	2.34	2.47
SEm$\pm$	0.04	0.10	0.05
CD(P=0.05)	0.12	0.31	0.13

Table 61. Effect of fertilizer doses on potassium uptake by groundnut kernel

Treatments	Potassium uptake (kg/ha)		
	2008	**2009**	**Pooled**
F_1-Control (No NPK)	6.44	5.93	6.18
F_2-100%NPK (both the crop)	13.23	11.95	12.59
F_3-100%NPK (Maize)	7.42	6.65	7.04
F_4-100%(Maize) +50% (Intercrop)	10.55	10.01	10.28
F_5-50% (Maize) + 100% (Intercrop)	12.18	11.24	11.71
F_6-50% NPK (Maize & Intercrop)	10.00	9.01	9.50
SEm$\pm$	0.08	0.30	0.15
CD(P=0.05)	0.24	0.88	0.43

Table 62. Effect of fertilizer doses on nitrogen uptake by groundnut stover

Treatments	Nitrogen uptake (kg/ha)		
	2008	**2009**	**Pooled**
F_1-Control (No NPK)	11.34	10.29	10.82
F_2-100%NPK (both the crop)	29.90	26.97	28.43
F_3-100%NPK (Maize)	14.95	11.94	13.45
F_4-100%(Maize) +50% (Intercrop)	23.01	20.18	21.60
F_5-50% (Maize) + 100% (Intercrop)	27.50	25.07	26.28
F_6-50% NPK (Maize & Intercrop)	22.62	20.24	21.43
SEm$\pm$	0.20	0.72	0.37
CD(P=0.05)	0.58	2.26	1.08

100 % RDF to both the crops while control recorded the minimum potassium uptake by groundnut kernel (6.18) which was inferior over all the other treatments.

4.11.2.4 Nitrogen uptake by stover (kg/ha)

It was evident from the data presented in Table 62 that intercropping system at different fertilizer level had a significant influence nitrogen uptake by stover of groundnut during the experiment year of 2008 and 2009.

The data on the nitrogen uptake by stover in the first year (2008) revealed that 100 % RDF to both the crops recorded the maximum nitrogen uptake by stover (29.90) and the minimum nitrogen uptake by stover was obtained from control (11.34) which was significantly inferior as compared to other fertilizer treatments.

In second year (2009), the data in the table indicated that the maximum nitrogen uptake by stover was obtained from 100 % RDF to both the crops (26.97) and was at par with 50% RDF to maize+100% RDF to intercrop, while control recorded the lowest nitrogen uptake by stover (10.29) and was at par with 100 % RDF to maize alone (11.94).

Further analysis of the mean pooled data of 2008 and 2009 showed that the maximum nitrogen uptake by stover was recorded from 100 % RDF to both the crops (28.43) and the minimum was recorded from control (10.82) which was significantly inferior as compared to other fertilizer treatments.

4.11.2.5 Phosphorus uptake by stover (kg/ha)

A critical examination of the data presented in Table 63 revealed that intercropping system at various fertilizer levels had a significant influence on phosphorus uptake by groundnut stover during both the field experimental year (2008 and 2009).

During first year (2008) experimental data showed that the phosphorus uptake by groundnut stover was recorded from 100 % RDF to both the crops (3.46) which were significantly higher as compared to the other RDF in an intercropping system. Control recorded the minimum phosphorus uptake by haulm (1.35).

In the second year (2009), 100 % RDF to both the crops recorded the highest phosphorus uptake by groundnut stover (3.14) which was superior to other fertilizer levels. The lowest phosphorus uptake by groundnut stover was obtained from control (1.29) which was significantly inferior over the other fertilizer levels in an intercropping system.

Table 63. Effect of fertilizer doses on phosphorus uptake by groundnut stover

Treatments	Phosphorus uptake (kg/ha)		
	2008	**2009**	**Pooled**
F_1-Control (No NPK)	1.35	1.29	1.32
F_2-100%NPK (both the crop)	3.46	3.14	3.30
F_3-100%NPK (Maize)	1.94	1.56	1.75
F_4-100%(Maize) +50% (Intercrop)	2.85	2.59	2.72
F_5-50% (Maize) + 100% (Intercrop)	3.15	2.85	3.00
F_6-50% NPK (Maize & Intercrop)	2.39	2.17	2.28
SEm$\pm$	0.05	0.13	0.36
CD(P=0.05)	0.16	0.42	1.08

Table 64. Effect of fertilizer doses on potassium uptake by groundnut stover

Treatments	Potassium uptake (kg/ha)		
	2008	**2009**	**Pooled**
F_1-Control (No NPK)	45.26	40.91	43.09
F_2-100%NPK (both the crop)	105.85	93.07	99.46
F_3-100%NPK (Maize)	56.72	45.27	50.99
F_4-100%(Maize) +50% (Intercrop)	77.86	74.26	76.06
F_5-50% (Maize) + 100% (Intercrop)	92.19	82.13	87.16
F_6-50% NPK (Maize & Intercrop)	67.96	61.12	64.54
SEm$\pm$	0.71	2.37	1.24
CD(P=0.05)	2.21	7.07	3.66

Further analysis of the mean pooled data of 2008 and 2009 experimental results revealed that the maximum phosphorus uptake by haulm (3.30) was obtained from 100 % RDF to both the crops while control recorded the minimum phosphorus uptake by haulm (1.32).

4.11.2.6 Potassium uptake by groundnut stover (kg/ha)

The influences of the intercropping system at different recommended dose of fertilizer on potassium uptake by haulm are presented in Table 64. Data in the table indicated that there was a significant impact on the potassium uptake by haulm during both the field experiment conducted in 2008 and 2009. A perusal of the data of 2008 field experiment revealed that the potassium uptake by haulm obtained from 100 % RDF to both the crops (105.85) was significantly higher than that of the other recommended dose of fertilizer treatments. Control recorded the lowest potassium uptake by stover (45.26).

The data on potassium uptake by haulm in year 2009 indicated that the highest potassium uptake by haulm was obtained from 100%RDF to both the crop (93.07). The lowest potassium uptake by haulm was obtained from control (40.91) which was statistically at par with 100 % RDF to maize alone (45.27).

Further analysis of the mean pool data of 2008 and 2009 revealed that the maximum potassium uptake by haulm was recorded from 100%RDF to both the crop (99.46) which was significantly superior over the rest of the fertilizer treatments in an intercropping. Control recorded the minimum potassium uptake by haulm (43.09) and was significantly inferior as compared to other treatments.

4.11.2.7 Total nitrogen uptake by groundnut (kg/ha)

The data pertaining to the influences of intercropping system at various recommended doses of groundnut are presented in Table 65 revealed that intercropping system at various fertilizer levels had significant impact on total nitrogen uptake by groundnut during both the experimental year (2008 and 2009).

During first year (2008), the highest total nitrogen uptake by groundnut was recorded from 100% RDF to both the crops (58.24) and was at par with 50% RDF to maize+100% RDF to intercrop (48.86), while control recorded the lowest total nitrogen uptake (24.75).

The second year (2009) data on total nitrogen uptake showed that 100% RDF to both the crop recorded the highest (52.86) uptake. The lowest nitrogen uptake was recorded from control (22.75) and was at par with 100 % RDF to maize alone (26.05).

A further analysis of the mean pooled data of 2008 and 2009 field experiment revealed that the maximum nitrogen uptake was obtained from 100% RDF to both the crop (55.55) which was statistically superior over all the other RDF, while control recorded the minimum total nitrogen uptake (23.75) which was significantly inferior to rest of the fertilizer treatments.

4.11.2.8 Total phosphorus uptake by groundnut (kg/ha)

It was evident from the data presented in Table 66 that intercropping system at different fertilizer doses had a significant influence on the total phosphorus uptake in groundnut during the experiment year of 2008 and 2009.

The data on the total phosphorus uptake in groundnut in the first year (2008) revealed that 100% RDF to both the crop recorded the maximum total phosphorus uptake (7.06), which was significantly superior as compared to other fertilizer treatment. The minimum phosphorus uptake was obtained from control (3.03).

In second year (2009), it was observed that the maximum total phosphorus uptake was obtained from 100% RDF to both the crop (6.47) while control recorded the lowest total phosphorus uptake (2.78) which was significantly inferior as compared to other fertilizer treatments.

Further analysis of the mean pooled data of 2008 and 2009 showed that the maximum phosphorus uptake was recorded from 100% RDF to both the crop (6.76) which was significantly superior to other fertilizer treatment and the minimum total phosphorus uptake was recorded from control (2.91).

Table 65. Effect of fertilizer doses on total nitrogen uptake by groundnut

Treatments	Nitrogen uptake (kg/ha)		
	2008	2009	Pooled
F_1-Control (No NPK)	24.75	22.75	23.75
F_2-100%NPK (both the crop)	58.24	52.86	55.55
F_3-100%NPK (Maize)	30.54	26.05	28.30
F_4-100% (Maize) +50% (Intercrop)	45.56	41.46	43.51
F_5-50% (Maize) + 100% (Intercrop)	53.15	48.86	51.01
F_6-50% NPK (Maize & Intercrop)	42.91	38.86	40.88
SEm$\pm$	0.30	1.32	0.68
CD(P=0.05)	0.93	4.16	1.98

Table 66. Effect of fertilizer doses on total phosphorus uptake by groundnut

Treatments	Phosphorus uptake (kg/ha)		
	2008	2009	Pooled
F_1-Control (No NPK)	3.03	2.78	2.91
F_2-100%NPK (both the crop)	7.06	6.47	6.76
F_3-100%NPK (Maize)	3.89	3.35	3.62
F_4-100%(Maize) +50% (Intercrop)	5.66	5.23	5.44
F_5-50% (Maize) + 100% (Intercrop)	6.38	5.90	6.14
F_6-50% NPK (Maize & Intercrop)	5.00	4.50	4.75
SEm$\pm$	0.08	0.22	0.41
CD(P=0.05)	0.25	0.70	1.19

4.11.2.9 Total potassium uptake by groundnut (kg/ha)

A critical examination of the data presented in Table 67 revealed that intercropping system at various fertilizer levels had a significant influence on total potassium uptake in groundnut during both the experimental years (2008 and 2009).

The first year (2008) experimental data indicates that the maximum total potassium uptake in groundnut was recorded from 100 % RDF to both the crops (119.08) which were significantly higher as compared to the other RDF in an intercropping system. Control recorded the minimum total uptake of potassium (51.07).

In the second year (2009), 100 % RDF to both the crops recorded the highest total potassium uptake (105.01) in groundnut which was superior to other fertilizer levels. The lowest total potassium uptake was obtained from control (46.84) which was significantly inferior over the other fertilizer levels in an intercropping system.

Further analysis of the mean pooled data of 2008 and 2009 experimental results revealed that the maximum potassium uptake (112.05) was obtained from 100 % RDF to both the crops while control recorded the minimum potassium uptake (49.27).

4.11.3 Chemical composition of soybean crop

4.11.3.1 Nitrogen uptake by soybean seeds (kg/ha)

Observation recorded on nitrogen uptake by soybean seeds is presented in Table 68. The data revealed that nitrogen uptake by soybean seeds was found significant in application of different recommended dose of fertilizer during both the year (2008 and 2009).

The first year (2008) experimental data indicated that the maximum nitrogen uptake by soybean seeds was recorded from 100% RDF to both the crops (72.15) which were significantly higher as compared to the other RDF in an intercropping system. Control recorded the minimum nitrogen uptake by soybean seeds (17.47).

In the second year (2009), 100% RDF to both the crops recorded the highest nitrogen uptake by soybean seeds (68.02). The lowest nitrogen uptake by soybean seeds was obtained from control (18.04) which was significantly inferior over the other RDF in an intercropping system.

Further analysis of the mean pooled data of 2008 and 2009 experimental results revealed that the maximum nitrogen uptake by soybean seeds (70.09) was obtained from 100

Table 67. Effect of fertilizer doses on total potassium uptake by groundnut

Treatments	Phosphorus uptake (kg/ha)		
	2008	2009	Pooled
F_1-Control (No NPK)	51.70	46.84	49.27
F_2-100%NPK (both the crop)	119.08	105.01	112.05
F_3-100%NPK (Maize)	64.13	51.93	58.03
F_4-100%(Maize) +50% (Intercrop)	88.41	84.27	86.34
F_5-50% (Maize) + 100% (Intercrop)	104.37	93.37	98.87
F_6-50% NPK (Maize & Intercrop)	77.95	70.13	74.04
SEm$\pm$	0.74	2.66	1.38
CD(P=0.05)	2.33	8.38	4.08

Table 68. Effect of fertilizer doses on nitrogen uptake by soybean seeds

Treatments	Nitrogen uptake (kg/ha)		
	2008	2009	Pooled
F_1-Control (No NPK)	17.47	18.04	17.75
F_2-100%NPK (both the crop)	72.15	68.02	70.09
F_3-100%NPK (Maize)	31.48	29.22	30.35
F_4-100% (Maize) +50% (Intercrop)	46.86	42.79	44.82
F_5-50% (Maize) + 100% (Intercrop)	65.87	62.61	64.24
F_6-50% NPK (Maize & Intercrop)	49.37	46.55	47.96
SEm$\pm$	0.40	1.48	0.77
CD(P=0.05)	1.21	4.61	2.22

% RDF to both the crop while control recorded the minimum nitrogen uptake by soybean seeds (17.75).

4.11.3.2 Phosphorus uptake by soybean seeds (kg/ha)

The influences of the intercropping system at different recommended dose of fertilizer on phosphorus uptake by soybean seeds are presented in Table 69. Data in the table indicated that there was a significant impact on the phosphorus uptake by soybean seeds during both the field experiment conducted in 2008 and 2009.

A perusal of the data of 2008 field experiment revealed that the phosphorus uptake by soybean seeds obtained from 100 % RDF to both the crops (6.30) was significantly higher than that of the other recommended dose of fertilizer treatments. Control recorded the lowest phosphorus uptake by soybean seeds (2.28).

The data on phosphorus uptake by soybean seeds in year 2009 indicated that the highest phosphorus uptake by soybean seeds was obtained from 100%RDF to both the crop (5.75). The lowest phosphorus uptake by soybean seeds was obtained from control (1.98).

Further analysis of the mean pool data of 2008 and 2009 revealed that the maximum phosphorus uptake by soybean seeds was recorded from 100%RDF to both the crop (6.03) which was significantly superior over the rest of the fertilizer treatments in an intercropping. Control recorded the minimum phosphorus uptake by soybean seeds (2.13) and was significantly inferior as compared to other treatments.

4.11.3.3 Potassium uptake by soybean seeds (kg/ha)

The data pertaining to the influences of intercropping system at various recommended doses of fertilizer are presented in Table 70 revealed that intercropping system at various fertilizer levels had significant impact on potassium uptake by soybean seeds during both the experimental year (2008 and 2009).

During first year (2008), the highest potassium uptake by soybean seeds was recorded from 100% RDF to both the crops (5.98) and was at par with 50% RDF to maize+100% RDF to intercrop (5.67), while control recorded the lowest potassium uptake by soybean seeds (2.94).

The second year (2009) data on potassium uptake by soybean seeds showed that 100% RDF to both the crop recorded the highest (5.45) uptake and was at par with 50% RDF to

Table 69. Effect of fertilizer doses on phosphorus uptake by soybean seeds

Treatments	Phosphorus uptake (kg/ha)		
	2008	2009	Pooled
F_1-Control (No NPK)	2.28	1.98	2.13
F_2-100%NPK (both the crop)	6.30	5.75	6.03
F_3-100%NPK (Maize)	3.18	2.88	3.03
F_4-100%(Maize) +50% (Intercrop)	4.42	3.99	4.21
F_5-50% (Maize) + 100% (Intercrop)	5.70	5.24	5.47
F_6-50% NPK (Maize & Intercrop)	4.19	3.78	3.98
SEm$\pm$	0.07	0.11	0.06
CD(P=0.05)	0.19	0.30	0.17

Table 70. Effect of fertilizer doses on potassium uptake by soybean seeds

Treatments	Potassium uptake (kg/ha)		
	2008	2009	Pooled
F_1-Control (No NPK)	2.94	2.47	2.70
F_2-100%NPK (both the crop)	5.98	5.45	5.71
F_3-100%NPK (Maize)	3.40	3.12	3.26
F_4-100%(Maize) +50% (Intercrop)	3.91	3.73	3.82
F_5-50% (Maize) + 100% (Intercrop)	5.67	5.11	5.39
F_6-50% NPK (Maize & Intercrop)	3.69	3.31	3.50
SEm$\pm$	0.14	0.12	0.09
CD(P=0.05)	0.45	0.37	0.26

Maize +100% RDF to intercrop (5.11), The lowest potassium uptake by seeds was recorded from control (2.47).

A further analysis of the mean pooled data of 2008 and 2009 field experiment revealed that the maximum potassium uptake by soybean seeds was obtained from 100% RDF to both the crop (5.71) which was statistically superior over all the other RDF, while control recorded the minimum potassium uptake by soybean seeds (2.70) which was significantly inferior to rest of the fertilizer treatments.

4.11.3.4 Nitrogen uptake by soybean stover (kg/ha)

Observations recorded on nitrogen uptake by soybean stover are presented in Table 71. The data revealed that nitrogen uptake by soybean stover was found significant in application of different recommended dose of fertilizer during both the experimental year (2008 and 2009).

The first year (2008) experimental data indicated that the maximum nitrogen uptake by soybean stover was recorded from 100% RDF to both the crops 51.45) which were significantly higher as compared to the other RDF in an intercropping system. Control recorded the minimum nitrogen uptake by soybean stover (9.80).

In the second year (2009), 100% RDF to both the crops recorded the highest nitrogen uptake by soybean stover (46.26). The lowest nitrogen uptake by soybean stover was obtained from control (9.94) which was significantly inferior over the other RDF in an intercropping system.

Further analysis of the mean pooled data of 2008 and 2009 experimental results revealed that the maximum nitrogen uptake by soybean stover (48.86) was obtained from 100 % RDF to both the crop while control recorded the minimum nitrogen uptake by soybean stover (9.87).

4.11.3.5 Phosphorus uptake by soybean stover (kg/ha)

A critical examination of the data presented in Table 72 revealed that intercropping system at various fertilizer levels had a significant influence phosphorus uptake by soybean stover during both the experimental years (2008 and 2009).

The first year (2008) experimental data indicates that the maximum phosphorus uptake by soybean stover was recorded from 100 % RDF to both the crops (7.09) which were

Table 71. Effect of fertilizer doses on nitrogen uptake by soybean stover

Treatments	Nitrogen uptake (kg/ha)		
	2008	2009	Pooled
F_1-Control (No NPK)	9.80	9.94	9.87
F_2-100%NPK (both the crop)	51.45	46.26	48.86
F_3-100%NPK (Maize)	18.74	16.39	17.57
F_4-100%(Maize) +50% (Intercrop)	37.53	33.86	35.69
F_5-50% (Maize) + 100% (Intercrop)	47.16	43.32	45.24
F_6-50% NPK (Maize & Intercrop)	33.45	34.60	34.02
SEm$\pm$	0.65	0.94	0.57
CD(P=0.05)	2.04	1.59	1.68

Table 72. Effect of fertilizer doses on phosphorus uptake by soybean stover

Treatments	Phosphorus uptake (kg/ha)		
	2008	2009	Pooled
F_1-Control (No NPK)	2.46	2.27	2.37
F_2-100%NPK (both the crop)	7.09	6.65	6.87
F_3-100%NPK (Maize)	3.88	3.34	3.61
F_4-100%(Maize) +50% (Intercrop)	5.10	4.17	4.64
F_5-50% (Maize) + 100% (Intercrop)	6.43	5.41	5.92
F_6-50% NPK (Maize & Intercrop)	4.04	4.06	4.05
SEm$\pm$	0.11	0.17	0.1
CD(P=0.05)	0.35	0.52	0.29

significantly higher as compared to the other RDF in an intercropping system. Control recorded the minimum phosphorus uptake by soybean stover (2.46).

In the second year (2009), 100 % RDF to both the crops recorded the highest phosphorus uptake by soybean stover (6.65) which was superior to other fertilizer levels. The lowest phosphorus uptake by soybean stover was obtained from control (2.27) which was significantly inferior over the other fertilizer levels in an intercropping system.

Further analysis of the mean pooled data of 2008 and 2009 experimental results revealed that the maximum phosphorus uptake by soybean stover (6.87) was obtained from 100 % RDF to both the crops while control recorded the minimum phosphorus uptake by soybean stover (2.37).

4.11.3.6 Potassium uptake by soybean stover (kg/ha)

The data pertaining to the influences of intercropping system at various recommended doses of fertilizer on potassium uptake by soybean stover are presented in Table 73 and revealed that intercropping system at various fertilizer levels had significant impact on potassium uptake by soybean stover during both the experimental year (2008 and 2009).

During first year (2008), the highest potassium uptake by soybean stover was recorded from 100% RDF to both the crops (105.48), while control recorded the lowest potassium uptake by soybean stover (35.79).

The second year (2009) data on potassium uptake by soybean stover showed that 100% RDF to both the crop recorded the highest (96.49) uptake. The lowest potassium uptake by stover was recorded from control (34.04).

A further analysis of the mean pooled data of 2008 and 2009 field experiment revealed that the maximum potassium uptake by soybean stover was obtained from 100% RDF to both the crop (100.98) which was statistically superior over all the other RDF, while control recorded the minimum potassium uptake by soybean stover (34.91) which was significantly inferior to rest of the fertilizer treatments.

4.11.7 Total nitrogen uptake by soybean (kg/ha)

A perusal of the result in the Table 74 revealed that intercropping system at various fertilizers had significantly influence on total nitrogen uptake on soybean during the experimental year (2008 and 2009).

Table 73. Effect of fertilizer doses on potassium uptake by soybean stover

Treatments	Potassium uptake (kg/ha)		
	2008	2009	Pooled
F_1-Control (No NPK)	35.79	34.04	34.91
F_2-100%NPK (both the crop)	105.48	96.49	100.98
F_3-100%NPK (Maize)	47.85	42.94	45.40
F_4-100%(Maize) +50% (Intercrop)	73.31	66.52	69.91
F_5-50% (Maize) + 100% (Intercrop)	97.71	89.87	93.79
F_6-50% NPK (Maize & Intercrop)	68.86	67.18	68.02
SEm$\pm$	0.95	1.98	1.1
CD(P=0.05)	2.97	5.25	3.28

Table 74. Effect of fertilizer doses on total nitrogen uptake by soybean

Treatments	Nitrogen uptake (kg/ha)		
	2008	2009	Pooled
F_1-Control (No NPK)	27.27	27.98	27.63
F_2-100%NPK (both the crop)	123.60	114.28	118.94
F_3-100%NPK (Maize)	50.23	45.61	47.92
F_4-100% (Maize) +50% (Intercrop)	84.39	76.65	80.52
F_5-50% (Maize) + 100% (Intercrop)	113.04	105.94	109.49
F_6-50% NPK (Maize & Intercrop)	82.82	81.14	81.98
SEm$\pm$	0.67	2.33	1.22
CD(P=0.05)	2.11	6.96	3.71

The first year (2008) experimental data indicated that the highest total nitrogen uptake in soybean was recorded from100% RDF to both the crops (123.60) and was significantly superior to all the other fertilizer treatments. Control recorded the lowest total nitrogen uptake (27.27).

In the second year (2008), maximum total nitrogen uptake was recorded from100% RDF to both the crops (114.28) while control recorded the lowest nitrogen uptake (27.98).

Results obtained from the pooled data of 2008 and 2009 revealed that the maximum nitrogen uptake (118.94) was recorded from 100% RDF to both the crops which was significantly superior to all the other fertilizer treatments. Control recorded the minimum total nitrogen uptake (27.63) and was significantly inferior to the rest of the treatments.

4.11.8 Total phosphorus uptake by soybean (kg/ha)

A critical examination of the data presented on Table 75 revealed that all levels of fertilizer doses had significant influence on phosphorus uptake during both the experimental year (2008 and 2009).

Experimental data of year 2008 shows that the maximum total phosphorus uptake (13.39) was observed from 100 %RDF to both the crops and minimum was recorded from control (4.74).

In the second year (2009), 100 %RDF to both the crops was found to be superior with regard to total phosphorus uptake (12.40). The lowest total phosphorus uptake was recorded from control (4.25).

Results obtained from the mean pooled data of 2008 and 2009 on total phosphorus uptake revealed that maximum uptake was obtained from100% RDF to both the crop (12.90). The lowest total phosphorus uptake (4.50) was recorded from control which was significantly inferior to the rest of the fertilizer treatments.

4.11.9 Total potassium uptake by soybean (kg/ha)

A critical examination of the data presented in Table 76 revealed that intercropping system at various fertilizer levels had a significant influence on total potassium uptake in soybean during both the field experimental year (2008 and 2009).

The first year (2008) experimental data indicated that highest total potassium uptake in soybean was recorded from 100 %RDF to both the crops (111.46) which was significantly

Table 75. Effect of fertilizer doses on total phosphorus uptake by soybean

Treatments	Phosphorus uptake (kg/ha)		
	2008	2009	Pooled
F_1-Control (No NPK)	4.74	4.25	4.50
F_2-100%NPK (both the crop)	13.39	12.40	12.90
F_3-100%NPK (Maize)	7.06	6.22	6.64
F_4-100%(Maize) +50% (Intercrop)	9.52	8.16	8.84
F_5-50% (Maize) + 100% (Intercrop)	12.13	10.65	11.39
F_6-50% NPK (Maize & Intercrop)	8.22	7.84	8.03
SEm$\pm$	0.11	0.26	0.14
CD(P=0.05)	0.33	0.80	0.41

Table 76. Effect of fertilizer doses on total potassium uptake by soybean

Treatments	Phosphorus uptake (kg/ha)		
	2008	2009	Pooled
F_1-Control (No NPK)	38.73	36.50	37.62
F_2-100%NPK (both the crop)	111.46	101.94	106.70
F_3-100%NPK (Maize)	51.26	46.05	48.66
F_4-100%(Maize) +50% (Intercrop)	77.22	70.25	73.73
F_5-50% (Maize) + 100% (Intercrop)	103.38	94.98	99.18
F_6-50% NPK (Maize & Intercrop)	72.55	70.50	71.52
SEm$\pm$	1.01	2.07	1.16
CD(P=0.05)	3.07	6.55	3.38

superior as compared to the other fertilizer treatment in an intercropping system. Control recorded the lowest total potassium uptake (38.73).

In the second year (2009), 100 %RDF to both the crops recorded the highest total potassium uptake (101.94). The lowest total potassium uptake was obtained from control (36.50) which was significantly inferior over the other fertilizer treatment in an intercropping system.

Further analysis of the mean pooled data of 2008 and 2009 experimental results revealed that the maximum total potassium uptake (106.70) was obtained from 100 %RDF to both the crops while control recorded the minimum total potassium uptake (37.62).

4.12. Physicochemical properties of soil after harvest

4.12.1. pH (Soil reaction)

A perusal of the result in the Table 77 revealed that intercropping system at various fertilizers could not show any significant difference in soil reaction during both the experimental years (2008 and 2009).

Further analysis of the data also indicated that there was no significant difference on different recommended dose of fertilizer on soil reaction during both experimental years.

At both the years soil reaction also did not show any interaction effect of intercropping with fertilizer treatments.

4.12.2 Organic carbon (%)

A critical examination of the data presented in Table 78, revealed that intercropping system at various fertilizer levels did not show any significant influence on organic carbon during both the field experimental year (2008 and 2009).

Further analysis of the experimental results revealed that there was no significant effect on organic carbon percentage on different recommended doses of fertilizer at both the experimental years.

Further analysis of the data also showed that there was no interaction effect on intercropping and different recommended dose of fertilizer.

Table 77. Soil pH as influenced by intercropping and fertilizer doses after harvest

Treatments	Soil pH		
	2008	2009	Pooled
Intercropping(IC)			
IC_1-Maize+Groundnut (2:2)	4.74	4.77	4.75
IC_2-Maize + Soybean (2:2)	4.73	4.80	4.76
SEm±	0.04	0.04	0.03
CD (P=0.05)	NS	NS	NS
Fertilizer doses(F)			
F_1-Control (No NPK)	4.72	4.81	4.76
F_2-100%NPK (both the crop)	4.74	4.91	4.82
F_3-100%NPK (Maize)	4.72	4.73	4.72
F_4-100%(Maize) +50% (Intercrop)	4.75	4.77	4.76
F_5-50% (Maize) + 100% (Intercrop)	4.74	4.78	4.76
F_6-50% NPK (Maize & Intercrop)	4.73	4.73	4.73
SEm±	0.05	0.07	0.04
CD (P=0.05)	NS	NS	NS
Intercropping x fertilizer doses	NS	NS	NS

Table 78. Soil organic carbon (%) as influenced by intercropping and fertilizer doses after harvest

Treatments	Organic carbon (%)		
	2008	2009	Pooled
Intercropping(IC)			
IC_1-Maize+Groundnut (2:2)	1.95	1.89	1.92
IC_2-Maize + Soybean (2:2)	1.93	1.90	1.91
SEm±	0.002	0.002	0.002
CD (P=0.05)	NS	NS	N.S
Fertilizer doses(F)			
F_1-Control (No NPK)	1.93	1.89	1.91
F_2-100%NPK (both the crop)	1.95	1.91	1.93
F_3-100%NPK (Maize)	1.95	1.90	1.92
F_4-100%(Maize) +50% (Intercrop)	1.95	1.90	1.92
F_5-50% (Maize) + 100% (Intercrop)	1.94	1.91	1.92
F_6-50% NPK (Maize & Intercrop)	1.93	1.90	1.91
SEm±	0.005	0.005	0.004
CD (P=0.05)	NS	NS	NS
Intercropping x fertilizer doses	NS	NS	NS

4.12.3 Available nitrogen content in soil (kg/ha)

A critical examination of the data presented in Table 79 revealed that intercropping system at various fertilizer levels did not show any significant influence on available nitrogen content in soil after harvest during both the experimental year (2008 and 2009).

It was found that application of different level of recommended fertilizer doses had significant effect on available nitrogen content in soil after harvest during both the year. At first year the highest (365.98) available nitrogen content in soil was obtained from 100% RDF to both the crop which was at par with 100%RDF to maize +50%RDF to intercrop (346.65). In control recorded the minimum available nitrogen content in soil after harvest (233.93). In the second year results revealed that 100%RDF to both the crop recorded maximum available nitrogen content in soil (338.08) which was statistically at par with 100%RDF to maize +50%RDF to intercrop (318.28). In control recorded lowest available nitrogen content in soil (209.48). From the pooled data it was apparent that 100% RDF to both the crop obtained the highest available nitrogen content in soil after harvest (352.03) and the lowest from control (221.71).

Further analysis of the data revealed that there was no significant interaction effect on intercropping and fertilizer application on available nitrogen content in soil after harvest during both the experimental years (2008 and 2009).

4.12.4 Available phosphorus content in soil (kg/ha)

Perusal of the data presented in Table 80, it was observed that intercropping system at different recommended dose of fertilizer levels did not show any significant influence on available phosphorus content in soil during both the year (2008 and 2009).

It was found that application of different levels of recommended dose of fertilizer had conspicuous influence on available phosphorus content in soil during both the years. In the first year, 100% RDF to both the crops recorded maximum available phosphorus content in soil after harvest (51.44). In control recorded the minimum phosphorus content in soil (24.82). During second year 100% RDF to both the crop recorded the highest available phosphorus content in soil (44.50) while control recorded the lowest phosphorus content in soil (19.75). From the mean pooled data of 2008 and 2009 on phosphorus content in soil revealed that the highest phosphorus content in soil (47.97) was recorded from 100% RDF to both the crop which was statistically superior from the rest of the recommended dose of fertilizer. The minimum available phosphorus content in soil was recorded from control (22.28).

Table 79. Available nitrogen content of soil as influenced by intercropping and fertilizer doses after harvest

Treatments	Nitrogen (kg/ha)		
	2008	2009	Pooled
Intercropping(IC)			
IC_1-Maize+Groundnut (2:2)	311.99	289.09	300.54
IC_2-Maize + Soybean (2:2)	307.88	286.21	297.05
SEm±	9.78	5.36	5.58
CD (P=0.05)	NS	NS	NS
Fertilizer doses(F)			
F_1-Control (No NPK)	233.93	209.48	221.71
F_2-100% NPK (both the crop)	365.98	388.08	352.03
F_3-100% NPK (Maize)	313.28	293.73	303.51
F_4-100% (Maize) +50% (Intercrop)	346.65	318.28	332.47
F_5-50% (Maize) + 100% (Intercrop)	300.52	284.55	292.53
F_6-50% NPK (Maize & Intercrop)	299.27	281.77	290.52
SEm±	8.48	6.72	5.41
CD (P=0.05)	25.01	19.82	15.95
Intercropping x fertilizer doses	NS	NS	NS

Table 80. Available phosphorus content of soil as influenced by intercropping and fertilizer doses after harvest

Treatments	Phosphorus (kg/ha)		
	2008	2009	Pooled
Intercropping(IC)			
IC_1-Maize+Groundnut (2:2)	40.19	34.31	37.25
IC_2-Maize + Soybean (2:2)	37.02	31.16	34.09
SEm±	1.49	1.45	1.04
CD (P=0.05)	NS	NS	NS

Fertilizer doses(F)			
F_1-Control (No NPK)	24.82	19.75	22.28
F_2-100%NPK (both the crop)	51.44	44.50	47.97
F_3-100%NPK (Maize)	41.68	35.97	38.82
F_4-100%(Maize) +50% (Intercrop)	46.04	39.81	42.92
F_5-50% (Maize) + 100% (Intercrop)	34.16	28.70	31.43
F_6-50% NPK (Maize & Intercrop)	33.52	27.70	30.61
SEm$\pm$	1.32	1.28	0.92
CD (P=0.05)	3.89	3.77	2.71
Intercropping x fertilizer doses	NS	NS	NS

Table 81. Available potassium content of soil as influenced by intercropping and fertilizer doses after harvest

Treatments	Potassium (kg/ha)		
	2008	2009	Pooled
Intercropping(IC)			
IC_1-Maize+Groundnut (2:2)	189.78	171.27	180.53
IC_2-Maize + Soybean (2:2)	184.72	162.08	173.40
SEm±	2.60	0.95	1.38
CD (P=0.05)	NS	5.78	8.39
Fertilizer doses(F)			
F_1-Control (No NPK)	138.85	119.60	129.22
F_2-100%NPK (both the crop)	235.78	212.31	224.04
F_3-100%NPK (Maize)	188.19	166.40	177.30
F_4-100%(Maize) +50% (Intercrop)	209.67	191.42	200.54
F_5-50% (Maize) + 100% (Intercrop)	195.92	173.86	184.89
F_6-50% NPK (Maize & Intercrop)	155.11	136.48	145.79
SEm±	8.84	7.98	5.95
CD (P=0.05)	26.08	23.54	17.55
Intercropping x fertilizer doses	NS	NS	NS

Further analysis of the data revealed that interaction effect on intercropping and fertilizer application did not show any significant difference in both the years on available phosphorus content in soil.

4.12.5 Available potassium content in soil (kg/ha)

A critical examination of the data presented in Table 81 revealed that intercropping system at different recommended dose of fertilizer did not show any significant influence on available potassium content in soil during the first year. However, it was found significant in the second year. During second year maize + groundnut recorded the highest potassium content in soil (171.27). Maize + soybean recorded the lowest potassium content in soil (162.08). From the mean pooled data of 2008 and 2009 on potassium content in soil revealed that the highest potassium content in soil after harvest (180.53) was recorded from maize + groundnut. In maize + soybean recorded the lowest available potassium content in soil (173.40).

It was found that application of different level of recommended fertilizer dose had a significant effect on available potassium content in soil during both the year. At first year the highest (235.78) potassium content in soil was obtained from 100% RDF to both the crop which was at par with (209.67) 100% RDF to maize and 50% RDF to intercrop. In control recorded the lowest available potassium content (138.85). In the second year results revealed that 100%RDF to both the crop recorded maximum available potassium contains in soil (212.31) and was at par with 100% RDF to maize + 50% RDF to intercrop. Control recorded the minimum available potassium contain in soil 119.60). From the pooled data it was apparent that 100% RDF to both the crop obtained the highest available potassium contain (224.04) in soil after harvest and was statistically superior from rest of the recommended dose of fertilizer and the lowest was recorded from control (129.22).

No significant interaction effect between intercropping and different recommended dose of fertilizer was recorded during both the experimental years.

CHAPTER- V

DISCUSSION

Nutrient management in maize (*Zea mays*) based intercropping system is an important aspect in NEH region particularly Nagaland because of the poor growth pattern and low productivity which makes the food insecurity most grievous in the face of sharply growing population. Under the circumstances, it is the prime need of the day to push the crop production up through proper nutrient management mainly by judicious use of plant nutrients with advanced technology is a pre requisite to achieve higher crop production. An investigation has been made to explain and discuss the possible reasons of variation exhibited by these different recommended doses of fertilizer in an intercropping to derive valid conclusion for practical applicability.

5.1 Effect of intercropping system at different recommended dose of fertilizer on growth attributes of maize

Adoption of different recommended dose of fertilizer in an intercropping favourably affected plant height, the growth of maize plants showed a non- significant in an intercropping up to 60 DAS, significantly taller plants were observed at 75 and 90 DAS. During both the year (2008 and 2009) maize + soybean intercropping recorded the maximum plant height of maize. These findings may be due to higher nitrogen fixation by the soybean crops, efficient light utilization and less competitiveness for soil moisture. The results of this experiment were in line with the findings of Wright *et al*. (1988) who also reported that soybean is an ideal crop for intercropping with maize owing to its comparative tolerance for shade, drought, efficient light utilization and less competitiveness for soil moisture. Maize plant height increased maximum at the later stages only. These findings may be due to the time taking in the process of absorption of nutrients by plants. The result of the finding is also agreement with the findings of Tijani-Eniola *et al.* (2000) who reported that plant height of maize increase from 6 weeks after sowing by the application of N fertilizer.

Different recommended dose of fertilizer treatments had a significant variation on plant height of maize at all the stages. In both the initial and subsequent year of experiment, 100% RDF to maize alone recorded the tallest plant height which was at par with the other fertilizer treatments except control. This finding might be due to full utilization of available resources.

In the present study, it was recorded that there was no significant variation in an intercropping on number of leaves of maize at all stages. The present finding was in agreement with Muoneke *et al.* (2007) who also reported that leaf production was not influenced by intercropping.

The number of leaves of maize differs significantly with different recommended dose of fertilizer. During both the experimental years (2008 and 2009) 100 % RDF to both the crops recorded the maximum number of leaves per plant at all the stages, this might be due to either direct or indirect involvement of fertilizers in major plant process such as photosynthesis, respiration, enzyme activation and metabolism of carbohydrates.

Intercropping of maize + soybean was found superior over maize + groundnut intercropping on leaf area index at 15 and 60 DAS. At 15 DAS the LAI of maize was found superior when intercropped with soybean, these findings might be due to slow growth of soybean at early stages. At 60 DAS the LAI of maize was again found superior when intercroped with soybean. The reason might be due to the decaying of nodules.

The fertilizer treatments in an intercropping had a significant variation on leaf area index at all the stages during both the initial and subsequent year of field experiment. In both the year, 100% RDF to both the crop gave the highest LAI and control recorded the lowest LAI. The findings of the present investigation was in conformity with the findings of Misra *et al.* (2001) who reported that application of up to 100% of the recommended fertilizer rate to intercrop increase leaf area index. These findings were similar to the findings of Ranbir *et al.*(2001) who reported that NPK fertilizer application produced significantly higher LAI. This finding were also similar to the findings of Meena and Singh (2007) who also

reported that increasing levels of fertility of maize and intercrop significantly increased the growth parameters.

In the present study, it was recorded that there was significant variation in the interaction effect on intercropping and fertilizer application on leaf area index at 30, 45 and 60 DAS.The maximum leaf area index at 30 DAS on interaction was found from maize + groundnut with 100% RDF to maize alone and was at par with all the other treatments except control. At 45 and 60 DAS maximum LAI was observed from maize + soybean with 100% RDF to both the crop and minimum was recorded from maize + soybean control which was at par with maize + groundnut control.

Data on the crop growth rate showed that at 45, 60 and 75 DAS, there was significant variation on intercropping and found that intercropping of maize + groundnut was superior over maize + soybean but was at par. It may be attributed due to the reason that groundnut plants are shorter than soybean, therefore efficient light utilization in maize + groundnut intercropping.

From the result of the present investigation (2008 and 2009) it was found that application of different recommended dose of fertilizer differed significantly on crop growth rate up to 60 DAS. At 30, 45 and 60 DAS the maximum CGR was recorded from 100% RDF to maize alone and the lowest from control.

It was evident from the data that the different intercropping showed significant variation on relative growth rate at 45 and 75 DAS. During both the stages maize + groundnut intercropping was superior over maize + soybean intercropping but was at par at 45 DAS. This might be due to biological feasibility of the component crop in intercropping system which enhances better resource use efficiency in intercropping.

5.2 Effect of intercropping system at different recommended dose of fertilizer on land equivalent ratio of maize

In the present study, it was recorded that in both the intercropping, land equivalent ratios were above 1 indicating yield advantage for intercropping but there was no significant variation between maize + groundnut intercropping and maize + soybean intercropping. This finding was in conformity with the Javanmard *et al.* (2009) and Siame *et al.* (1989), who also reported that the LER were well above 1 in an intercropping and indicates yield advantage for an intercropping.

Application of different recommended dose of fertilizer influenced land equivalent ratio significantly with the highest (1.45) obtained from 100% RDF to both the crop and showed a good response to RDF application. Minimum LER was obtained from control.

The result confirmed the findings of Siame *et al.* (1989), who reported that LER increased with an increase level of fertilizer application.

In the present study, it was recorded that there was significant variation in the interaction effect on intercropping and fertilizer application on land equivalent ratio. The highest LER on interaction was found from maize + soybean with 100% RDF to both the crop and was at par with maize + groundnut. Minimum was observed from maize + groundnut control which was at par with maize + soybean control. It may be attributed due to the reason that with the soybean intercropping it fixes more nitrogen to the maize plants. This result confirms the finding of Chowdhury and Rosario (1992) who reported that applied nitrogen at high levels increases the partial LER of maize.

5.3 Effect of intercropping system at different recommended dose of fertilizer on relative crowding coefficient of maize

After critical examination of the findings, it was observed that the relative crowding coefficient was significantly influenced by various recommended dose of fertilizer on maize plant. The maximum RCC was recorded from 100%RDF to both the crop and minimum was recorded from control. These findings might be due to the response of fertilizer application.

5.4 Effect of intercropping system at different recommended dose of fertilizer on yield attributes of maize

Application of different recommended dose of fertilizer favorably affected length of cobs, significantly longer cobs were observed from the application of 100% RDF to both the crop and the minimum was observed from no fertilizer. These findings might be due to the application of higher doses of fertilizers

There was significant variation on interaction effect on intercropping and fertilizer application on length of cobs in the second year. From the two years data it was found that maximum was recorded from maize + soybean with 100%RDF to maize alone which was at par with maize + soybean with 100%RDF to both the crop and minimum was recorded from maize + groundnut control. This revealed that maize intercropped with soybean benefited its nutrient absorption and had a profound effect on length of cops.

Intercropping treatments differ significantly on number of seeds per cob. From the mean pool data it was recorded that maize + groundnut intercropping was significantly superior over maize + soybean intercropping.

It was found that application of different level of recommended fertilizer doses had significant effect on number of seeds and results revealed that 100%RDF to both the crop recorded maximum number of seeds per plant and control recorded the minimum number of seeds per cob. This result of the finding was in conformity with the findings of Khokhar *et al.* (2005), who also reported that application of 100% RDF of N and P increased grain yield of maize significantly.

There was no interaction effect on intercropping and fertilizer application on number of seeds per pod in the first year but in the second year it differed significantly. Results from the two year data, the maximum number of seeds per cob was obtain from maize + groundnut with 100%RDF to both the crop. The minimum was recorded from maize + soybean control. This result may be due to maximum utilization of fertilizers.

Application of different recommended dose of fertilizer had a significant impact on test weight of maize. 100 % RDF to both the crop recorded the highest test weight whereas control recorded the least test weight of maize. The result of this finding was in line with the findings of Panhwar *et al.* (2004) who also reported that test weight of maize increased with an increase in nitrogen levels in an intercropping. But result of this finding was not in agreement with the findings of Ranbir *et al.* (2001) who reported that test weight of maize was not affected by NPK fertilizer application in an intercropping.

In the present study, it was recorded that there was interaction effect on intercropping and fertilizer application on 1000 grain weight of maize. The maximum test weight was recorded from maize + groundnut with 100% RDF to both the crop which was statistically at par with maize + soybean intercropping with 100 % RDF to both the crop) maize+ groundnut control recorded the minimum 1000 grain weight and was at par with maize + soybean control.

In the present study, it was recorded that there was no significant variation in an intercropping on grain yield. The present finding is in agreement with Bhatt and Damor (1985) who reported that grain yield of maize did not differ significantly from each other in an intercropping. Similar findings were also reported by Sharma *et al* (1998) and Polthanee and Trelo-ges (2003) who reported that yield of maize was not influenced significantly by intercrops in different maize-based legume intercropping. This shows that different legume crops had no adverse effect on the yield of maize.

The fertilizer treatments in an intercropping had a significant variation on grain yield during both the initial and subsequent year of field experiment. From the two years data, 100% RDF to both the crop gave the highest grain yield and control recorded the lowest grain yield. The result of this finding is in agreement with the findings of Sharma (1994) who reported that maize yield increased with the increasing rate of fertilizer. Similar result was obtained by Khokhar *et al.* (2001) who reported that application of 100% RDF of N and P to both the crop produced significantly higher grain yield, Latha and Prasad (2008) who reported that higher grain yield of maize was obtained due to application of 25 % extra RDF to maize in intercropping indicating the need for higher fertilizer application of the intercropping to meet the fertilizer demand of both crops.

There was significant variation on interaction effect on intercropping and fertilizer application on grain yield of maize. From the two years data it was found that maximum grain yield was recorded from maize + groundnut with 100%RDF to both the crop and minimum was recorded from maize + soybean control which was statistically at par with maize + groundnut control.

The various application of recommended dose of fertilizer had a significant influence on stover yield of maize. The highest stover yield was recorded from 100%RDF to both the crop and the lowest by control.

There was interaction effect between intercropping and different recommended doses of fertilizer on stover yield. Results from the two year data, the highest stover yield was obtain from maize + groundnut with 100%RDF to both the crop. The lowest from maize + soybean control which was statistically at par with maize + groundnut control. This result may be due to maximum utilization of fertilizers.

After critical examination of the findings, it was observed that the harvest index was significantly influenced by the application of different recommended dose of fertilizer. The highest harvest index was from 100%RDF to both the crops. However it was at par with all treatments.

5.5 Effect of intercropping system at different recommended dose of fertilizer on maize grain equivalent yield

Between the different intercropping system, maize + groundnut recorded the highest maize grain equivalent yield of 72.80 q/ha, which indicated the superiority over maize + soybean intercropping. This finding confirmed the findings of Latha and Prasad (2008) who reported that maize equivalent yield were significantly influenced by intercropping.

The maize grain equivalent yield differed significantly due to different recommended dose of fertilizer. In general, the data showed that 100 % RDF to both the crop had a significantly higher equivalent yield while the lowest was with control. This finding was in conformity with Sawargaonkar *et al.* (2008) who reported that application of 125 and 100% RDF gave significantly higher MGEY. Similar results were also obtained by Munirathnam and Kumar (2010) who reported that application of 100% N produced significantly higher MGEY than other levels of N fertilization while the lower MGEY were produced with control.

There was an interaction effect on intercropping and fertilizer application on maize grain equivalent yield. In general, the data showed that all the different recommended dose of fertilizer in an intercropping system had a significantly higher maize grain equivalent yield the highest maize grain equivalent yield was recorded from maize + groundnut intercropping with 100% RDF to both the crops and the minimum from maize + soybean intercropping control.

5.6 Effect of intercropping system at different recommended dose of fertilizer on 50 % flowering of maize plants

Data on the days to 50% flowering of 2008 and 2009 on maize plants showed significant variation and observed that control starts flowering earlier than the other recommended dose of fertilizer. 100% RDF to both the crop requires maximum number of days for flowering. These findings may be attributed to the low nutrient in plants which resulted in the reduced number of days to flowering and vice-versa in case of 100% RDF to both the crop.

5.7 Effect of intercropping system at different recommended dose of fertilizer on days to maturity of maize plants

In the present study, it was recorded that there was no significant variation in an intercropping and on different recommended dose of fertilizer and there was no interaction effect on days to maturity of maize. The present finding is in agreement with Gulzar *et al* (2001) who reported that there was no significant effect on days to maturity of maize in an intercropping.

5.8 Economic

5.8.1 Cost of cultivation

In an intercropping system, there was a significant difference on the cost of cultivation during both the year. The highest cost of cultivation was incurred from maize + groundnut intercropping (31305.17) which was significantly superior to maize + soybean intercropping (28872.72). The higher cost of cultivation in maize + groundnut intercropping may be obviously due to the fact that adoption of higher seed rate and higher cost of groundnut and more labour required which influenced the higher cost of cultivation.

Different recommended dose of fertilizer differed significantly on the cost of cultivation. Among the different RDF, the maximum cost of cultivation was recorded from 100%RDF to both the crops (31941.00) while minimum cost of cultivation was recorded from the control (26975.50). The higher cost of cultivation in 100%RDF to both the crops in an intercropping may be obviously due to the fact that adoption higher cost of fertilizer which influenced the higher cost of cultivation.

In the present study, it was recorded that there was interaction effect on intercropping and fertilizer application on cost of cultivation. The highest cost of cultivation on interaction effect was recorded from maize + groundnut with 100%RDF to both the crop (33022.00) and minimum was recorded from maize + soybean control (25582.00). Result of higher cost of cultivation per hectare might be due to higher cost of fertilizer, higher cost of groundnut kernel and more labour required.

5.8.2 Gross return

There was a significant variation in the gross return per hectare due to different intercropping during both the experimental year (2008 and 2009). In general, maize +

groundnut intercropping has the maximum gross return per hectare while the lowest gross return per hectare was from maize + soybean.

The gross return differed significantly due to different recommended dose of fertilizer. In general, the data showed that 100 % RDF to both the crop had a significantly higher gross return while the lowest was recorded with control. The higher gross return in 100% RDF to both the crop may be due to higher yield.

There was significant variation on interaction effect on intercropping and fertilizer application on gross return. From the two years data it was found that highest gross return was recorded from maize + groundnut with 100%RDF to both the crop and minimum was recorded from maize + soybean control. This finding may be obviously due to the fact that higher yield and higher market price of groundnut.

5.8.3 Net return

Between the different intercropping system, maize + groundnut recorded the highest net return (41492.33), which indicates the superiority over maize + soybean intercropping. This finding confirmed the findings of Mandal *et al* (1990) who reported that intercropping of maize and groundnut gave significantly highest net return than the other intercropping.

The net return differed significantly due to different recommended dose of fertilizer. In general, the data showed that 100 % RDF to both the crop had a significantly higher while the lowest was recorded with control. This finding was in conformity with Sawargaonkar *et al.* (2008) who reported that application of 125 and 100% RDF gave significantly higher MGEY. Similar results were also obtained by Munirathnam and Kumar (2010) who reported that application of 100% fertilizer produced significantly higher MGEY than other levels of fertilization while the lower MGEY were produced with control.

There was an interaction effect on intercropping and fertilizer application on net return. In general, the data showed that all the different recommended dose of fertilizer in an intercropping has a significant impact on net return. The highest was recorded from maize + groundnut intercropping with 100% RDF to both the crops and the minimum from maize + soybean intercropping control.

5.8.4 Benefit: cost ratio

There was a significant variation in the benefit: cost ratio due to different intercropping during both the experimental year (2008 and 2009) The maximum benefit cost ratio was recorded in maize + groundnut intercropping while the minimum benefit: cost ratio was recorded in maize + soybean intercropping.

Different recommended dose of fertilizer differed significantly on benefit: cost ratio. Among the different RDF, 100%RDF to both the crops recorded the highest benefit: cost ratio while control recorded the lowest benefit: cost ratio. This finding confirmed the findings of Sawargaonkar *et al.* (2008) who reported that application 100% RDF registered a higher benefit: cost ratio.

In the present study, it was recorded that there was interaction effect on intercropping and fertilizer application on benefit: cost ratio. The highest benefit: cost ratio on interaction effect was recorded from Maize + groundnut with 100% RDF to both the crop and the lowest was recorded from Maize + soybean control.

5.9 Effect of intercropping system at different recommended dose of fertilizer on growth attributes of groundnut.

Adoption of different recommended dose of fertilizer in an intercropping favorably affected plant height, plant height of groundnut increased with the increase in the days after sowing i.e. 15, 30,45,60,75 and 90 DAS. During the first and subsequent year of experiment, it was observed that 100% RDF to both the crop recorded the tallest plant height which was statistically at par with 50% RDF to maize + 100% RDF to intercrop whereas the shortest plant height was recorded with control at all stages of crop growth. The rate of increased in plant height in all the stages was more at higher doses of NPK. These findings may be due to better nutritional environment for plant growth as a result of improvement in root growth, cell multiplication, elongation and cell expression in plants.

Different recommended dose of fertilizer treatments had a significant variation on number of leaves and number of branches of groundnut at all the stages. In both the initial and subsequent year of experiment, 100% RDF to both the crop recorded the maximum number of leaves and number of branches while control recorded the minimum number of leaves and branches of groundnut. This might be due to full utilization of available nutrients.

Different recommended dose of fertilizer in an intercropping had a significant variation on crop growth rate at all the stages of groundnut during both the initial and subsequent year of field experiment. At 30, 45 and 60 DAS, 100% RDF to both the crop gave the maximum CGR while control recorded the lowest CGR. At 75 DAS the maximum CGR was obtained from 100% RDF to maize alone which was at par with 50% RDF to maize + 50 %RDF to intercrop and 50 % RDF to maize + 100 % RDF to intercrop while minimum CGR was recorded from control

In the present study, it was recorded that there was significant variation on relative growth rate in different recommended dose of fertilizer application at 30, 45 and 60 DAS. The maximum RGR was found from 100 % RDF to both the crop which was at par with the other fertilizer treatments except control. In control recorded the minimum RGR

5.10 Effect of intercropping system at different recommended dose of fertilizer on yield attributes of groundnut

There was significant variation on the length of pods of groundnut by the application of different recommended dose of fertilizer. The longest length of pods in groundnut was obtained from100% RDF to both the crop while the shortest from control which was at par with 100% RDF to maize alone. The longest length of pods in groundnut from100% RDF to both the crop may be attributed due to higher dose of NPK fertilizer to the plants

Adoption of different recommended dose of fertilizer in an intercropping had a significant influence in the number of seeds per pod in groundnut during both the field experimental year. The maximum number of seeds per pods was obtained from 100 % RDF to both the crops while control recorded the minimum number of seeds per pod. The reason for maximum number of seeds might be due to higher nutrient supply to the plants due to maximum application of NPK to the soil.

The different recommended dose of fertilizer had a significant impact on number of pods per plant during both the experimental year (2008 and 2009). The highest number of pods per plant in groundnut was recorded from 100 % RDF to both the crops which were superior to other fertilizer treatments. The lowest number of pods per plant was obtained from control which was significantly inferior over the other fertilizer levels in an intercropping system. The highest number of pods per plant in 100 % RDF to both the crops may be attributed due to higher dry matter accumulation.

There was significant variation by the application of different recommended dose of fertilizer on the 1000 seed weight of groundnut. 100 % RDF to both the crops recorded the highest seed weight whereas control recorded the least 1000 seed weight of groundnut.

In the present study, it was recorded that there was significant variation on kernel and stover yield of groundnut by different recommended dose of fertilizer application. The maximum kernel and stover yield was obtained from 100 % RDF to both the crop which indicated the superiority over the rest of the treatments, while control recorded the minimum kernel and stover yield. This result of the finding is in conformity with the findings of Ranbir *et al* (2001) who reported that the legume yield in intercropping was higher at 100% NPK fertilizer application as compared to 50% NPK fertilizer application. Similar results were also obtained by Ashok *et al* (2006) who reported that the highest yield was obtained when the recommended fertilizer rates were applied both maize and intercrop.

Different recommended dose of fertilizer had a significant impact on harvest index during both the year. The highest harvest index of groundnut was obtained from50% RDF to maize + 100% RDF to intercrop while the lowest harvest index was obtained from 50% RDF to maize alone.

Data on the relative crowding coefficient found significant variation on different recommended dose of fertilizer that the maximum RCC was recorded from 100% RDF to both the crops which was statistically at par with 50% RDF to maize + 100% RDF to intercrop and the lowest RCC was from control which was significantly inferior to the rest of the treatments. The maximum RCC from 100% RDF to both the crops might be due to full utilization of the nutrients by the plants.

5.11 Effect of intercropping system at different recommended dose of fertilizer on growth attributes of soybean

Application of different recommended dose of fertilizer had a significant effect on plant height of soybean. Plant height increased with the increase in days after sowing i.e.

15, 30, 45, 60, 75 and at harvest. During the first and subsequent year of experiment, it was observed that 100% RDF to both the crop recorded the tallest plant height which was at par with 50 % RDF to maize + 100% RDF to intercrop while the shortest plant height was obtained from control at all stages of crop growth. This reveals that different RDF had a profound effect on plant height. This result of the finding is in conformity with the findings of Meena and Singh (2007) who reported that increasing levels of fertility of maize and soybean significantly increased the growth parameters.

Number of leaves per plant increased with the increasing levels of NPK over the control at all the stages of crop growth. 100% RDF to both the crop recorded the maximum number of leaves while control recorded the minimum number of leaves of soybean at all stages of crop growth. The result of these findings was in conformity with the findings of Meena and Singh (2007) who also reported that increasing levels of fertility of maize and soybean significantly increased the growth parameters.

There were significant variations on the number of branches at all stages of crop growth. At 30, 45, 60, 75 and 90 DAS the number of branches in soybean was significantly higher in 100% RDF to both the crop which shows the superiority among the other fertilizer treatments. The lowest number of branches was recorded from control. This result of the finding is in conformity with the findings of Meena and Singh (2007) who reported that increasing levels of fertility of maize and soybean significantly increased the growth parameters.

Adoption of different recommended dose of fertilizer in an intercropping had a significant influence on leaf area index of soybean at all stages of crop growth. The maximum LAI was recorded from 100% RDF to both the crop which was statistically at par with 50% RDF to maize + 100 % RDF to intercrop while control recorded the minimum LAI which was significantly inferior over all the treatments in an intercropping system. This finding might be attributed due to full utilization of available nutrients and is with the conformity of the findings of Meena and Singh (2007) who reported that increasing levels of fertility of maize and soybean significantly increased the growth parameters.

5.12 Effect of intercropping system at different recommended dose of fertilizer on yield attributes of soybean

There were significant variations in different recommended dose of fertilizer on number of pods per plant. The maximum number of pods per plant was recorded from 100 % RDF to both the crop. Lowest number of pods per plant was recorded from control and was statistically inferior to rest of the treatments. The reason for the maximum number of pods in 100% RDF may be due to full utilization of available nutrients.

The different recommended dose of fertilizer had a significant impact on 1000 seed weight of soybean. 100% RDF to both the crop recorded the maximum 1000 seed weight whereas control recorded the least 1000 seed weight. The reason for maximum 1000 seed weight might be due to higher nutrient supply to the plants due to maximum application of NPK to soil.

The intercropping system at different recommended doses of fertilizer had a significant impact on the seed yield of soybean during both the field experimental year (2008 and 2009). The maximum seed yield was recorded from 100% RDF to both the crop which was significantly superior over the rest of the fertilizer treatments in an intercropping. In control recorded the minimum seed yield. In general, the result of this finding was not in agreement with the findings of Sharma (1994) who also reported that legume yields were greatly decreased by intercropping and were not significantly affected by fertilizer rates. However the result of this finding was in line with Nabavi and Mazaheri (1998) who reported that soybean yield increased upto 200kg N. The result of this finding was in agreement with the findings of Ranbir *et al.* (2001) who reported that legume yields in intercropping was higher at 100% NPK fertilizer application compared to 50 %. Similar findings were obtained by Khokhar *et al.* (2005) who reported that 100% recommended dose of N and P to both maize and soybean increased the yield of soybean significantly. Similar findings were also obtained by Meena and Singh (2007) who reported that increasing levels of fertility of maize and soybean significantly increased the yield of both maize and soybean.

In the present study, it was recorded that there was significant variation on stover yield of soybean by different recommended dose of fertilizer application. The maximum stover yield (21.92) was obtained from 100 % RDF to both the crop while control recorded the minimum stover yield (11.45). The reason for maximum stover yield might be due to higher nutrient supply to the plants due to maximum application of NPK fertilizer to the soil.

Different recommended dose of fertilizer had a significant impact on harvest index during both the year. The highest harvest index of soybean was obtained from 50% RDF to maize + 50% RDF to intercrop while the lowest harvest index was obtained from 50% RDF to maize + 100 % RDF to intercrop.

5.13 Nutrient (NPK) uptake (kg/ha) by maize plants

The total uptake of nitrogen (N) significantly increased with the increasing levels of NPK over the control in both the years. 100% RDF to both the crop obtained the highest nitrogen uptake and the lowest from control. The results of these findings were in agreement with the findings of Misra *et a* (2001) who reported that application of up to 100 % of the recommended fertilizer rate to the intercrop increased nitrogen, phosphorus and potassium uptake. Kumar *et al* (2008) reported that total N uptake by maize increased significantly with the increasing N rate. Interaction between intercropping and different levels of recommended dose of fertilizer has significant influence on total N uptake. The highest nitrogen uptake was obtained from maize + groundnut with 100% RDF to both the crops which were at par with maize + soybean with 100%RDF to both the crops. maize + soybean control recorded the lowest nitrogen uptake which was at par with maize + groundnut control.

The total phosphorus uptake by grain and straw were significantly influenced by different levels of recommended dose of fertilizer during both the years. The highest phosphorus uptake was obtained from 100% RDF to both the crop while the minimum phosphorus uptake was recorded from control. Similar results was also reported by Misra *et al* (2001) that application of up to 100 % of the recommended fertilizer rate to the intercrop increased phosphorus uptake by maize. There was an interaction effect between intercropping and different levels of recommended dose of fertilizer on total P uptake. The highest P uptake was obtained from maize + groundnut with 100% RDF to both the crops which were at par with maize + soybean with 100% RDF to both the crop. In maize + soybean control recorded the lowest P uptake which was at par with maize + groundnut control.

Adoption of different recommended dose of fertilizer in an intercropping had a significant influence on total potassium uptake by grain and straw during both the experimental year. The highest K uptake was obtained from 100 % RDF to both the crops while control recorded the lowest total K uptake. The result of these findings are in agreement with the findings of Misra *et al* (2001) who reported that application of up to 100 % of the recommended fertilizer rate to the intercrop increased nitrogen, phosphorus and potassium uptake. Interaction between intercropping and different recommended dose of fertilizer had positive influence on K uptake by grain and stover. In maize + groundnut intercropping with 100% RDF to both the crops recorded the highest potassium uptake which was at par to maize + soybean intercropping with 100% RDF to both the crops. Maize + soybean in control recorded the lowest potassium uptake which was statistically at par with maize + groundnut control.

5.14 Nutrient (NPK) uptake (kg/ha) by groundnut plants

Total nitrogen uptake by groundnut grains and stover showed significant influence due to application of different recommended dose of fertilizer in an intercropping. Maximum total N uptake was obtained from 100% RDF to both the crop which was statistically superior over all the other RDF, while control recorded the minimum total nitrogen uptake which was significantly inferior to rest of the fertilizer treatments.

Total phosphorus uptake by groundnut grains and stover were significantly influenced by different recommended dose of fertilizer in an intercropping. The highest phosphorus uptake was obtained from 100% RDF to both the crop while the minimum phosphorus uptake was recorded from control

The total phosphorus uptake showed significant influenced due to application of different levels of recommended dose of fertilizer during both the years. The highest phosphorus uptake was obtained from 100% RDF to both the crop while the minimum phosphorus uptake was recorded from control.

5.15 Nutrient (NPK) uptake (kg/ha) by soybean plants

Adoption of different recommended dose of fertilizer in an intercropping had a significant influence on total nitrogen uptake by soybean during both the experimental year. The maximum nitrogen uptake was obtained from 100 % RDF to both the crops while control recorded the minimum nitrogen uptake.

The total phosphorus uptake by grain and straw were significantly influenced by different levels of recommended dose of fertilizer during both the years. The highest phosphorus uptake was obtained from 100% RDF to both the crop while the minimum phosphorus uptake was recorded from control.

Total potassium uptake by soybean grains and stover showed significant influence due to application of different recommended dose of fertilizer in an intercropping. Maximum total K uptake was obtained from 100% RDF to both the crop which was statistically superior over all the other RDF, while control recorded the minimum total K uptake which was significantly inferior to rest of the fertilizer treatments.

5.16 Soil pH

Intercropping system at various recommended dose of fertilizer does not have any significant influence in soil reaction during both the experimental year (2008 and 2009).

Further analysis of the data also indicates that there was no significant difference on different recommended dose of fertilizer on soil reaction during both experimental years.

At both the years soil reaction also does not show any interaction effect of intercropping with fertilizer treatments.

5.17 Organic carbon (%)

Intercropping system at various fertilizer levels did not show any significant influence on organic carbon during both the field experimental year (2008 and 2009). The result of these findings were in conformity with the findings of Ashok *et al.* (2006) who also reported that organic carbon did not vary among the cropping system.

Further analysis of the experimental results revealed that there was no significant effect on organic carbon percentage on different recommended doses of fertilizer at both the experimental years. The result of this finding is not with the agreement of Ashok *et al.* (2006) who reported that the highest organic carbon content were observed when the recommended rate of fertilizers was applied to both maize and intercrop.

Further analysis of the data also shows that there was no interaction effect on intercropping and different recommended dose of fertilizer.

5.18 Available nitrogen content in soil (kg/ha)

In an intercropping system, there was no significant difference on available nitrogen content during both the experimental year (2008 and 2009). The result of these findings was in agreement with the findings of Ashok *et al.* (2006) who reported that available nitrogen did not vary among the cropping system.

Different recommended dose of fertilizer differed significantly on available nitrogen. Among the different RDF, the highest nitrogen content in soil after harvest was recorded from 100% RDF to both the crops while lowest nitrogen content in soil was recorded from the control. The findings of the present investigation was in conformity with the findings of Ashok *et al.* (2006) who reported that the highest nitrogen content were observed when the recommended rate of fertilizers was applied to both maize and intercrop.

In the present study, it was recorded that there was no interaction effect on intercropping and fertilizer application available nitrogen content in soil after harvest during both the experimental year.

5.19 Available phosphorus content in soil (kg/ha)

In the present study, it was recorded that there was no significant variation in an intercropping on phosphorus content in soil after harvest. The present finding was in agreement with Ashok *et al.* (2006) who reported that phosphorus content in soil did not differ significantly from each other in an intercropping.

The different recommended dose of fertilizer in an intercropping had a significant variation on phosphorus content in soil after harvest during both the initial and subsequent year of field experiment, 100% RDF to both the crop gave the highest phosphorus content in soil after harvest and control recorded the lowest phosphorus content in soil after harvest. The result of this finding was in agreement with the findings of Ashok *et al.* (2006) who reported that available phosphorus content in soil after harvest increased with the increasing rate of fertilizer.

There was no interaction effect on intercropping and fertilizer application on phosphorus content in soil.

5.20 Available potassium content in soil (kg/ha)

In the first year, it was recorded that there was no any significant variation in an intercropping on potassium content in soil. The present finding was in agreement with Ashok *et al.* (2006) who reported that potassium content in soil did not differ significantly from each other in an intercropping. However, it was found significant in the second year. During second year maize + groundnut intercropping was found superior over maize + soybean intercropping. From the mean pool data intercropping treatments differ significantly on potassium content in soil after harvest and was recorded that maize + groundnut intercropping was significantly superior over maize + soybean intercropping.

It was found that application of different level of recommended fertilizer doses had significant effect on potassium content in soil and results revealed that 100% RDF to both the crop recorded highest potassium content in soil after harvest and control recorded the lowest potassium content. This result of the finding was in conformity with the findings of Ashok *et al.* (2006) who reported that available phosphorus content in soil after harvest increased with the increasing rate of fertilizer.

There was no interaction effect on intercropping and fertilizer application on potassium content in soil during both the experimental years.

CHAPTER – VI

SUMMARY AND CONCLUSION

The present studies on 'Nutrient management in maize *(Zea mays* L.) based intercropping systems under the rainfed condition of Nagaland' was conducted at the experimental farm of School of Agricultural Sciences and Rural Development, Nagaland University, Campus- Medziphema, Nagaland during the *kharif* season of 2008 and 2009 to evaluate the effect of different recommended dose of fertilizer on growth, yield and economic of different maize based intercropping system. The experiment was laid out in split plot design consisting of twelve treatment combinations and the treatments were replicated three times.

The prominent results of the present investigation are summarized below:

The growth of maize plants showed a non- significant in an intercropping up to 60 DAS. At 70 and 90 DAS, maize + soybean were significantly superior over maize + groundnut intercropping. However, among the different recommended dose of fertilizer in an intercropping, application of NPK in different doses influenced the plant height at all the stages over control. 100% RDF to maize alone showed the tallest plant height and at par in all the fertilizer application except with the control. Intercropping and fertilizer interaction effect was found non-significant.

Application of different recommended dose of fertilizer influenced the number of maize leaves per plant at all the stages over control. 100 % RDF to both the crops recorded the maximum number of leaves per plant at all the stages. Intercropping and fertilizer interaction was non-significant on number of leaves

LAI had marked significant effect with intercropping on maize plant at 15 and 60 DAS. Maize + soybean intercropping was found superior over maize + groundnut intercropping. At 30, 45, 70 DAS and at maturity it failed to reach significant level. Application of 100% RDF to both the crop recorded the highest LAI while control recorded the lowest LAI at all stages of observation. Interaction between intercropping and fertilizer show significant effect at all stages of crop growth.

Crop growth rate (CGR) of maize plant at 45, 60 and 75 DAS had a significant variation between intercropping and found that intercropping of maize + groundnut was superior over maize + soybean but shows at par relation. Different recommended dose of fertilizer significantly influenced the CGR at 30, 45 and 60 DAS. The maximum CGR at all stages was recorded from 100% RDF to maize alone and the lowest from control. Intercropping and fertilizer interaction was non-significant on CGR at all stages.

At 45 and 75 DAS maize + groundnut intercropping was significantly superior over maize + soybean intercropping but shows at par relation in terms of RGR of maize plant. Interaction between intercropping and fertilizer show non significant at all stages

In both the intercropping, land equivalent ratios were above 1, indicating yield advantages for intercropping but was found non significant. Application of different recommended dose of fertilizer influenced land equivalent ratio significantly with the highest obtained from 100% RDF to both the crop and shows a good response to RDF application. Minimum LER was obtained from control. Interaction between intercropping and fertilizer was found significant.

Relative crowding coefficient on maize plant has conspicuous effect with different levels of recommended dose of fertilizer, 100% RDF to both the crops gave the maximum RCC and minimum by control.

Length of cobs significantly increased with application of different recommended dose of fertilizer. 100% RDF to both the crop obtained the longest length of cobs and the shortest from control. Interaction between intercropping and fertilizer shows significant effect.

Intercropping treatments has significant effect on number of seeds per cob. Maize + groundnut intercropping was superior over maize + soybean intercropping. Increasing rate of different level of recommended fertilizer doses has significant effect on number of maize seeds. 100% RDF to both the crop gave the maximum number of maize seeds per plant and control recorded the minimum number of seeds per cob. There was interaction effect on intercropping and fertilizer application.

Application of different levels of recommended dose of fertilizer significantly increased the 1000 grain weight of maize. 100 % RDF to both the crop shows the highest 1000 grain weight whereas control gave the least 1000 grain weight of maize. There was interaction effect on intercropping and fertilizer application on 1000 grain weight of maize

Different levels of recommended dose of fertilizer significantly increased grain yield and stover yield of maize with the increasing level over the control. 100% RDF to both the crop gave the highest grain and stover yield and control recorded the lowest yield. There was significant effect on interaction between intercropping and fertilizer application on grain and stover yield of maize.

Harvest index of maize was significantly influenced by the application of different recommended dose of fertilizer. 100% RDF to both the crops gave highest harvest index. However, there was at par relation with all the treatments.

Days to 50% flowering on maize plants showed significant variation. Control starts flowering earlier than the other RDF. 100% RDF to both the crop requires maximum number of days for flowering. Interaction effect was found non significant.

There was no significant variation on intercropping and on different recommended dose of fertilizer. Their interaction effect was also failed to reach the significant level on days to maturity of maize.

Between the different intercropping system, maize + groundnut shows the highest maize grain equivalent yield over maize + soybean intercropping. Increasing rate of different level of recommended fertilizer doses has significant effect on Maize grain equivalent yield. MGEY was highest with 100 % RDF to both the crop while the lowest was from control. Interaction effect had significant effect on intercropping and fertilizer application on MGEY.

The maximum values of economic indices viz., cost of cultivation, gross return net return and benefit: cost ratio, maize + groundnut intercropping exhibits superiority over maize + soybean intercropping. Different recommended dose of fertilizer shows significantly on all the economic indices. 100% RDF to both the crops gave the maximum while minimum was from control. There was interaction effect on intercropping and fertilizer application on cost of cultivation, gross return net return and benefit: cost ratio.

Different recommended dose of fertilizer in an intercropping significantly influenced the plant height of groundnut at all observations. The tallest plant height was recorded from 100% RDF to both the crop. At par relation was shown with 50% RDF to maize + 100% RDF to intercrop. The shortest plant height was recorded with control at all the stages.

Number of leaves and number of branches of groundnut had marked significant effect with different recommended dose of fertilizer at all the stages. 100% RDF to both the crop recorded the maximum number of leaves and number of branches while control recorded the minimum number of leaves and branches. The number of leaves decreased between 75 DAS and at harvest.

Application of different recommended dose of fertilizer in an intercropping had conspicuous effect on CGR and RGR over the control. Different recommended dose of fertilizer showed positive response on RGR over control, but failed to reach the significant level at 75 DAS.

RCC has conspicuous effect with different recommended dose of fertilizer. At par relation was recorded between 100% RDF to both the crops and 50% RDF to maize + 100% RDF to intercrop.

Length of pods, number of seeds per pod, number of pods per plant and 1000 grain weight were increased with different RDF over the control. The highest was obtained from100% RDF to both the crop

100% RDF to both the crop gave the highest seed and stover yield of groundnut. Application of different recommended dose of fertilizer increased the seed and stover yield over control

Different recommended dose of fertilizer showed positive response on harvest index. 50% RDF to maize + 100% RDF to intercrop show the highest harvest index of groundnut

Days to 50% flowering and maturity of groundnut failed to reach significant level, but showed positive influence. Control requires the minimum number of days to flowering and maturity.

Different recommended dose of fertilizer influenced the plant height of soybean at all the observations over control. 100% RDF to both the crop obtained tallest plant height and shows at par relation with 50 % RDF to maize + 100% RDF to intercrop.

Number of leaves, number of branches and LAI of soybean had significant influence due to different recommended dose of fertilizer over control. 100% RDF to both the crop obtained the maximum number of leaves, number of branches and LAI at all the stages of crop growth.

Different recommended doses of fertilizer showed positive response on CGR over control at all the observations but failed to reach the significant level at 30, 45 and 75 DAS, however, at 60 DAS the highest CGR of soybean was obtained by 50% RDF to maize + 100 % RDF to intercrop and was at par relation with 100% RDF to both the crop and 100% RDF to maize + 50 % RDF to intercrop.

Application of 100% RDF to both the crops shows the maximum RCC. All the different recommended doses of fertilizer increased the RCC over control.

Length of pods per plant of soybean increased with the application of different recommended doses of fertilizer over control. The longest length of pods per plant was obtained from 100% RDF to both the crop and shows at par relation with 50% RDF to maize + 100 % RDF to intercrop.

Number of seeds per pod, number of pods per plant and 1000 seed weight of soybean significantly increased with the application of different recommended doses of fertilizers over control. 100 % RDF to both the crops was superior to other fertilizer treatments.

100%RDF to both the crop showed the best result in terms of seed yield and stover yield of groundnut than the other recommended doses of fertilizer. All the different recommended doses of fertilizer increased the yield over control.

Different recommended dose of fertilizer shows significant impact on harvest index during both the year. The highest harvest index of soybean was obtained from 50% RDF to maize + 50% RDF to intercrop while the lowest harvest index was obtained from 50% RDF to maize + 100 % RDF to intercrop.

Days to 50% flowering and maturity of soybean increased with the recommended dose of fertilizer over control but found non-significant.

The total nitrogen, phosphorus and potassium (NPK) uptake by maize grain and straw was significantly increased with the application of 100% RDF to both the crop. It might be due to maize respondent significantly to NPK levels. Interaction between intercropping and different levels of recommended dose of fertilizer has significant influence on total NPK uptake. The highest interaction effect was obtained by maize + groundnut with 100% RDF to both the crops and was at par relation with maize +

soybean with 100% RDF to both the crops. Maize + soybean control recorded the lowest nitrogen uptake which was at par with maize + groundnut control.

Total nitrogen, phosphorus and potassium (NPK) uptake by groundnut grains and stover showed significant influence with the application of different recommended dose of fertilizer in an intercropping. Maximum total N, P and K uptake was obtained from 100% RDF to both the crop. Control recorded the minimum total N, P and K uptake.

Total nitrogen, phosphorus and potassium (NPK) uptake by soybean grains and stover show positive response with the adoption of different recommended dose of fertilizer in an intercropping. It has been observed that 100 %RDF to both the crops recorded the maximum N, P and K uptake.

Intercropping system at various recommended dose of fertilizer does not have any significant influence in soil reaction and organic carbon. The data also indicated that there was no significant difference on different recommended dose of fertilizer on soil reaction and organic carbon during both experimental years. Interaction effect was also found non significant.

There was no significant difference on available nitrogen and available phosphorus content in soil after harvest in an intercropping. However, available potassium content in soil has conspicuous effect in an intercropping after harvest.

Different recommended dose of fertilizer differed significantly on available nitrogen, phosphorus and potassium content in soil after harvest. The highest N, P and K content in soil after harvest was recorded with 100% RDF to both the crops, while lowest was recorded with the control. There was no interaction effect on intercropping and fertilizer application on N, P and K content in soil.

CONCLUSIONS

1. Maize + groundnut intercropping system found to be most suitable than maize + soybean intercropping. This system recorded highest grain yield (29.07q/ha) and highest equivalent yield (72.80 q/ha).
2. Among the different doses of fertilizer applied to maize +groundnut intercropping system, F_2-100% NPK to both the crop found to be most suitable as it recorded maximum production (37 q/ha maize and 9.32 q/ha kernel yield of groundnut) under the rainfed condition of Nagaland.

3. Maize + groundnut intercropping recorded maximum B: C ratio (2.31) compared to maize + soybean (1.78). Among the different fertilizer doses, 100% RDF to both the crop (F_2) recorded maximum B: C ratio (2.54). Interaction of cropping system (maize + groundnut) and fertilizer doses (F_2) 100% RDF to both the crop recorded highest B: C ratio of 2.87.

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APPENDIX-I

Common cost of cultivation for maize

Sl.No.	Items	No. of units	Rate (`/unit)	Total cost (`/ha)
1.	Field preparation:			
	a) Primary tillage	1	1000.00	1000.00
	b) Harrowing	2	1000.00	2000.00
	c) Seed bed preparation	15 labours	100.00	1500.00
2.	Seeds	10 kg	15.00	150.00
3.	Sowing of seeds	7 labours	100.00	700.00
4.	FYM	10 tons	300.00	3000.00
5.	Biofertilizer	500 gm	25.00	50.00
6.	Plant protection			
	a) Malathion dust 25 E.C	25 kg	60.00	1500.00
	b) Captan	60 gm	45.00	45.00
	c) Furatan granules	20 kg	65.00	1300.00
	d) Application of chemicals	10 labours	100.00	1000.00
7.	Weeding	15 labours	100.00	2500.00
8.	Harvesting	10 labours	100.00	1000.00
9.	Threshing & cleaning	15 labours	100.00	1500.00
10.	Drying & bagging	7	100.00	700.00
			Total	17945.00

APPENDIX-II

Additional cost of cultivation for maize

Sl.No.	Items	No. of units	Rate (`/unit)	Total cost (`/ha)
1.	100%NPK fertilizer			
	a) Urea	87 kg	7.50	652.00
	b) SSP	187.5 kg	5.60	1050.00
	c) MOP	33.5 kg	10.60	355.00
	d) Application of manures and fertilizers	6 labours	100.00	600.00
			Total	2657.00
2.	50% NPK fertilizer			
	a) Urea	43.5 kg	7.50	326.00
	b) SSP	93.75 kg	5.60	525.00
	c) MOP	16.75 kg	10.60	178.00
	d) Application of manures and fertilizers	6 labours	100.00	600.00
			Total	1629.00

APPENDIX-III

Cost of cultivation for groundnut

Sl.No.	Items	No. of units	Rate (`/unit)	Total cost (`/ha)
1.	Seeds	100kg	65.00	6500.00
2.	Sowing of seeds	12 labours	100.00	1200.00
3.	Biofertilizer	500 gm	25.00	50.00
4.	Application of manures & fertilizers	8 labours	100.00	800.00
5.	Plant protection:			
	a) Captan	60 gm	45.00	45.00
	b) Chloropyriphos	10 nos (100 ml)	35.00	350.00
	c) Application of chemicals	6 labours	100.00	600.00
6	Weeding	24	100.00	2400.00
7	Harvesting	18	100.00	1800.00
8	Threshing & cleaning	10	100.00	1000.00
9	Drying & bagging	6	100.00	600.00
			Total	15345.00

APPENDIX-IV

Additional cost of cultivation for groundnut

Sl.No.	Items	No. of units	Rate (`/unit)	Total cost (`/ha)
1.	100%NPK fertilizer			
	e) Urea	22 kg	7.50	165.00
	f) SSP	187.5 kg	5.60	1050.00
	g) MOP	33.5 kg	10.60	355.00
			Total	1570.00
2.	50% NPK fertilizer			
	e) Urea	11 kg	7.50	83.00
	f) SSP	98 kg	5.60	549.00
	g) MOP	17 kg	10.60	180.00
			Total	812.00

APPENDIX-V

Cost of cultivation for soybean

Sl.No.	Items	No. of units	Rate (`/unit)	Total cost (`/ha)
1.	Seeds	37.50 kg	35.00	3113.00
2.	Sowing of seeds	14 labours	100.00	1400.00
3.	Biofertilizer	500 gm	25.00	50.00
4.	Application of manures & fertilizers	8 labours	100.00	800.00
5.	Plant protection:			
	a) Captan	60 gm	45.00	45.00
	b) Chloropyriphos	10 nos (100 ml)	35.00	350.00
	c) Application of chemicals	6 labours	100.00	600.00
6	Weeding	24	100.00	2400.00
7	Harvesting	11	100.00	1800.00
8	Threshing & cleaning	12	100.00	1000.00
9	Drying & bagging	8	100.00	600.00
			Total	12158.00

APPENDIX-VI

Additional cost of cultivation for soybean

Sl.No.	Items	No. of units	Rate (`/unit)	Total cost (`/ha)
1.	100%NPK fertilizer			
	h) Urea	22 kg	7.50	165.00
	i) SSP	165 kg	5.60	924.00
	j) MOP	33.5 kg	10.60	355.00
			Total	1444.00
2.	50% NPK fertilizer			
	a) Urea	11 kg	7.50	83.00
	b) SSP	82.5 kg	5.60	462.00
	c) MOP	17 kg	10.60	180.00
			Total	725.00

APPENDIX-VII

Analysis of variance on pooled data for plant height of maize

Source of variation	d.f	Plant height (cm)					
		15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	Harvest
Year	1	91.57	40.20	66.70	161.70	11.20	72.80
Replication	4	0.21	34.45	19.69	98.48	625.93	621.98
Intercropping(IC)	1	3.73	53.04	1102.15*	237.25	5277.07*	5533.52*
Year x IC	1	0.002	10.73	11.44	4.75	53.38	72.00
Error (a)	4	3.54	113.61	47.64	714.97	32.44	27.95
Fertilizer doses(RDF)	5	37.17*	434.65*	337.76*	2470.15*	2734.44*	2830.63*
Year x RDF	5	0.74	58.51	65.45	58.77	330.38	311.87
IC x RDF	5	1.93	7.32	18.59	60.03	152.58	177.44
Year x IC x RDF	5	0.21	2.00	4.83	23.12	24.82	38.53
Error (b)	40	0.93	10.45	9.81	98.23	65.97	59.21

DAS = Days after sowing.* = Significant at 5% probability level

APPENDIX-VIII

Analysis of variance on pooled data for number of leaves of maize

Source of variation	d.f	Number of leaves/plant					
		15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	Harvest
Year	1	4.283	1.687	3.494	0.251	0.010	0.011
Replication	4	0.008	0.023	0.110	0.069	0.052	0.051
Intercropping(IC)	1	0.019	0.046	0.004	0.009	0.092	0.105
Year x IC	1	0.018	0.009	0.773	0.401	0.309	0.346
Error (a)	4	0.015	0.040	0.125	0.031	0.041	0.040
Fertilizer doses(RDF)	5	0.087*	0.156*	0.243*	0.252*	0.166*	0.148*
Year x RDF	5	0.013	0.012	0.044	0.022	0.026	0.029
IC x RDF	5	0.006	0.001	0.007	0.008	0.008	0.009
Year x IC x RDF	5	0.004	0.004	0.009	0.000	0.001	0.001
Error (b)	40	0.003	0.003	0.008	0.007	0.003	0.004

DAS = Days after sowing. * = Significant at 5% probability level

APPENDIX-IX

Analysis of variance on pooled data for leaf area index (LAI) of maize

Source of variation	d.f	Leaf area index			
		15 DAS	30 DAS	45 DAS	60 DAS
Year	1	0.625	0.057	0.087	0.884
Replication	4	0.194	1.530	0.365	0.677
Intercropping(IC)	1	13.773*	0.002	0.036	5.046*
Year x IC	1	0.022	0.123	0.005	0.000
Error (a)	4	0.022	0.449	0.576	0.137
Fertilizer doses(RDF)	5	0.504*	1.722*	5.699*	12.219*
Year x RDF	5	0.009	0.013	0.071	0.041
IC x RDF	5	0.007	0.107*	0.287*	0.444*
Year x IC x RDF	5	0.009	0.015	0.012	0.052
Error (b)	40	0.010	0.031	0.089	0.151

DAS = Days after sowing.* = Significant at 5% probability level

APPENDIX-X

Analysis of variance on pooled data for crop growth rate of maize

Source of variation	d.f	Crop growth rate (g/day)			
		30 DAS	45 DAS	60 DAS	75 DAS
Year	1	0.001	0002	0.049	0.016
Replication	4	0.0002	0.015	0.022	0.008
Intercropping(IC)	1	0.000	0.236*	1.420*	1.204*
Year x IC	1	0.000	0.006	0.152	0.000
Error (a)	4	0.0002	0.022	0.122	0.032
Fertilizer doses(RDF)	5	0.004*	0.127*	0.884*	0.043*
Year x RDF	5	0.001	0.028	0.087	0.014
IC x RDF	5	0.0002	0.004	0.015	0.022
Year x IC x RDF	5	0.0000	0.009	0.017	0.003
Error (b)	40	0.0001	0.003	0.040	0.041

DAS = Days after sowing.* = Significant at 5% probability level

APPENDIX-XI

Analysis of variance on pooled data for relative growth rate of maize

Source of variation	d.f	Relative growth rate (g/g/day)			
		30 DAS	45 DAS	60 DAS	75 DAS
Year	1	0.136	0.035	0.035	0.000
Replication	4	0.000	0.000	0.000	0.000
Intercropping(IC)	1	0.000	0.001*	0.000	0.000*
Year x IC	1	0.000	0.000	0.000	0.000
Error (a)	4	0.000	0.000	0.000	0.000
Fertilizer doses(RDF)	5	0.000	0.0002*	0.000	0.000
Year x RDF	5	0.000	0.000	0.000	0.000
IC x RDF	5	0.000	0.000	0.000	0.000
Year x IC x RDF	5	0.000	0.000	0.000	0.000
Error (b)	40	0.000	0.000	0.00002	0.000

DAS = Days after sowing.* = Significant at 5% probability level

APPENDIX-XII

Analysis of variance on pooled data for yield attributes of maize

Source of variation	d.f	Land equivalent ratio	Relative crowding coefficient	Length of cobs (cm)	Number of seeds per cob	Weight of cob (g)
Year	1	0.020	34.26	4.03	1.08	97.11
Replication	4	0.007	11.00	1.46	1.82	112.53
Intercropping (IC)	1	0.006	19.04	8.15	6.88*	123.45*
Year x IC	1	0.000	0.03	0.35	0.01	2.28
Error (a)	4	0.005	10.88	0.51	0.25	13.96
Fertilizer doses (RDF)	5	0.686*	84.24*	12.06*	10.50*	2943.11*
Year x RDF	5	0.000	5.42	0.32	0.01	0.68
IC x RDF	5	0.010*	9.42	0.49*	0.64*	60.84
Year x IC x RDF	5	0.001	0.26	0.21	0.004	0.67
Error (b)	40	0.001	3.84	0.19	0.11	10.35

* = Significant at 5% probability level

APPENDIX-XIII

Analysis of variance on pooled data for yield and yield attributes of maize

Source of variation	d.f	Test weight (g)	Grain yield (q/ha)	Stover yield (q/ha)	Harvest index (%)	Maize equivalent yield (q/ha)
Year	1	279.425	154.001	900.294	8.48	510.82
Replication	4	145.155	35.212	139.657	0.64	124.94
Intercropping(IC)	1	5.401	59.151	167.384	0.86	7987.63*
Year x IC	1	0.000	0.720	22.624	1.24	8.43
Error (a)	4	174.765	8.004	34.052	0.23	6.85
Fertilizer doses(RDF)	5	7561.891*	576.934*	2271.790*	0.74*	2109.61*
Year x RDF	5	0.632	0.146	1.076	0.32	1.42
IC x RDF	5	394.005*	15.913*	57.477*	0.18	132.29*
Year x IC x RDF	5	1.303	0.203	1.638	0.19	0.27
Error (b)	40	89.249	1.954	7.148	0.26	3.54

* = Significant at 5% probability level

APPENDIX-XIV

Analysis of variance on pooled data for Phenological attributes of maize

Source of variation	d.f	Days to 50% flowering	Days to maturity
Year	1	0.426	0.585
Replication	4	0.020	0.003
Intercropping (IC)	1	0.000	0.002
Year x IC	1	0.000	0.001
Error (a)	4	0.007	0.000
Fertilizer doses (RDF)	5	0.233*	0.017
Year x RDF	5	0.005	0.006
IC x RDF	5	0.007	0.002
Year x IC x RDF	5	0.004	0.001
Error (b)	40	0.003	0.002

* = Significant at 5% probability level

APPENDIX-XV

Analysis of variance on pooled data for economics

Source of variation	d.f	Cost of cultivation (`)	Gross return (`)	Net return (`)	Benefit cost ratio
Year	1	1089780	509762450	463753512	0.443
Replication	4	0.056	124841869	124841869	0.138
Intercropping(IC)	1	106502147*	7991851022*	6252937137*	5.051*
Year x IC	1	1085846	8569800	3551112	0.000
Error (a)	4	0.056	6878536	6878536	0.007
Fertilizer doses(RDF)	5	3517831*	2111198292*	1619158712*	1.326*
Year x RDF	5	3360	1465086	1411399	0.001
IC x RDF	5	202333*	132018712*	142249691*	0.117*
Year x IC x RDF	5	3266	270370	295432	0.000
Error (b)	40	0.056	3544499	3544499	0.004

* = Significant at 5% probability level

APPENDIX-XVI

Analysis of variance on pooled data for plant height of groundnut

Source of variation	d.f	Plant height (cm)					
		15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	Harvest
Year	1	37.61	73.96	45.78	119.53	87.11	75.98
Error (a)	4	1.67	13.59	6.72	24.26	12.70	17.63
Fertilizer doses(RDF)	5	3.54*	35.27*	88.19*	68.002*	117.31*	119.64*
Year x RDF	5	1.28	1.35	1.49	0.99	1.65	0.62
Error (b)	20	0.23	1.02	3.87	2.65	3.84	4.74

DAS = Days after sowing.* = Significant at 5% probability level

APPENDIX-XVII

Analysis of variance on pooled data for number of leaves of groundnut

Source of variation	d.f	Number of leaves					
		15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	Harvest
Year	1	1.254	3.068	3.522	3.386	3.355	3.422
Error (a)	4	0.023	0.145	0.533	0.099	0.068	0.086
Fertilizer doses(RDF)	5	0.061*	0.450*	0.622*	0.582*	0.609*	0.879*
Year x RDF	5	0.008	0.032	0.137	0.083	0.075	0.073
Error (b)	20	0.004	0.014	0.072	0.026	0.032	0.031

DAS = Days after sowing.* = Significant at 5% probability level

APPENDIX-XVIII

Analysis of variance on pooled data for number of branches of groundnut

Source of variation	d.f	Number of branches/plant					
		15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	Harvest
Year	1	1.609	0.543	0.465	0.391	0.301	0.334
Error (a)	4	0.026	0.013	0.013	0.009	0.011	0.007
Fertilizer doses(RDF)	5	0.010*	0.081*	0.054*	0.052*	0.045*	0.057*
Year x RDF	5	0.002	0.004	0.011	0.008	0.003	0.003
Error (b)	20	0.007	0.006	0.007	0.003	0.003	0.003

DAS = Days after sowing.* = Significant at 5% probability level

APPENDIX-XIX

Analysis of variance on pooled data for leaf area index of groundnut

Source of variation	d.f	Leaf area index(LAI)			
		15 DAS	30 DAS	45 DAS	60DAS
Year	1	0.001	0.116	2.507	23.652
Error (a)	4	0.103	0.097	2.090	33.969
Fertilizer doses(RDF)	5	1.604*	7.393*	18.366*	89.730
Year x RDF	5	0.024	0.015	0.133	37.319
Error (b)	20	0.012	0.062	0.184	37.333

DAS = Days after sowing. * = Significant at 5% probability level

APPENDIX-XX

Analysis of variance on pooled data for crop growth rate (CGR) of groundnut

Source of variation	d.f	Crop growth rate(g/day)			
		30 DAS	45 DAS	60 DAS	75DAS
Year	1	0.000	0.010	0.006	0.000
Error (a)	4	0.002	0.007	0.041	0.001
Fertilizer doses(RDF)	5	0.003*	0.044*	0.057*	0.051*
Year x RDF	5	0.000	0.001	0.001	0.001
Error (b)	20	0.0001	0.002	0.011	0.008

DAS = Days after sowing. * = Significant at 5% probability level

APPENDIX-XXI

Analysis of variance on pooled data for relative growth rate (RGR) of groundnut

Source of variation	d.f	Relative growth rate(g/g/day)			
		30 DAS	45 DAS	60 DAS	75DAS
Year	1	0.0000	0.0000	0.0000	0.0000
Error (a)	4	0.0002	0.0002	0.0002	0.0000
Fertilizer doses(RDF)	5	0.0002*	0.0002*	0.0002*	0.0000*
Year x RDF	5	0.0000	0.0000	0.0000	0.0000
Error (b)	20	0.00005	0.00005	0.00005	0.0000

DAS = Days after sowing.* = Significant at 5% probability level

APPENDIX-XXII

Analysis of variance on pooled data for yield attributes of groundnut

Source of variation	d.f	Relative crowding coefficient	Length of pods (cm)	Number of seeds per pod	Number of pods/plant (g)	Weight of pods/plant (g)
Year	1	0.928	0.082	0.006	1.346	350.563
Error (a)	4	0.208	0.109	0.002	0.249	42.034
Fertilizer doses(RDF)	5	0.917*	0.464*	0.013*	0.511*	97.930*
Year x RDF	5	0.059	0.001	0.0002	0.011	0.481
Error (b)	20	0.028	0.013	0.0003	0.017	4.325

* = Significant at 5% probability level

APPENDIX-XXIII

Analysis of variance on pooled data for yield and yield attributes of maize

Source of variation	d.f	Test weight (g)	Kernel yield (q/ha)	Stover yield (q/ha)	Harvest index (%)
Year	1	657.58	2.70	25.94	11.50
Error (a)	4	688.87	0.85	3.70	0.53
Fertilizer doses(RDF)	5	3642.36	18.13	70.88	1.87
Year x RDF	5	14.84*	0.04*	0.44*	1.89*
Error (b)	20	54.15	0.07	0.37	0.12

* = Significant at 5% probability level

APPENDIX-XXIV

Analysis of variance on pooled data for Phenological attributes of maize

Source of variation	d.f	Days to 50% flowering	Days to maturity
Year	1	0.315	0.405
Error (a)	4	0.014	0.002
Fertilizer doses(RDF)	5	0.645	0.011
Year x RDF	5	0.005	0.005
Error (b)	20	0.071	0.001

* = Significant at 5% probability level

APPENDIX-XXV

Analysis of variance on pooled data for plant height of soybean

Source of variation	d.f	Plant height (cm)					
		15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	Harvest
Year	1	46.24	88.98	124.69	182.25	476.69	491.36
Error (a)	4	1.43	8.68	42.83	72.21	87.09	107.75
Fertilizer doses(RDF)	5	4.97*	69.18*	295.56*	288.43*	256.23*	323.30*
Year x RDF	5	0.14	0.36	0.45	3.07	2.49	3.83
Error (b)	20	0.35	1.25	11.29	11.18	18.27	10.77

DAS = Days after sowing. * = Significant at 5% probability level

APPENDIX-XXVI

Analysis of variance on pooled data for number of leaves of soybean

Source of variation	d.f	Number of leaves/plant					
		15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	Harvest
Year	1	0.163	2.428	0.912	0.828	0.511	1.027
Error (a)	4	0.017	0.039	0.205	0.107	0.100	0.130
Fertilizer doses(RDF)	5	0.022*	1.216*	0.499*	0.356*	0.416*	0.433*
Year x RDF	5	0.004	1.151	0.021	0.012	0.015	0.026
Error (b)	20	0.002	0.003	0.023	0.034	0.039	0.030

DAS = Days after sowing. * = Significant at 5% probability level

APPENDIX-XXVII

Analysis of variance on pooled data for number of branches of soybean

Source of variation	d.f	Number of branches/plant				
		30 DAS	45 DAS	60 DAS	75 DAS	Harvest
Year	1	0.088	0.221	0.073	0.054	0.035
Error (a)	4	0.019	0.064	0.021	0.012	0.014
Fertilizer doses(RDF)	5	0.124*	0.189*	0.103*	0.098*	0.074*
Year x RDF	5	0.009	0.025	0.011	0.010	0.006
Error (b)	20	0.006	0.007	0.002	0.003	0.002

DAS = Days after sowing. * = Significant at 5% probability level

APPENDIX-XXVIII

Analysis of variance on pooled data for leaf area index of soybean

Source of variation	d.f	Leaf area index(LAI)			
		15 DAS	30 DAS	45 DAS	60DAS
Year	1	0.555	1.460	11.972	9.252
Error (a)	4	0.096	0.335	1.562	3.596
Fertilizer doses(RDF)	5	2.278*	3.016*	20.152*	18.486*
Year x RDF	5	0.003	0.037	0.390	0.270

Error (b)	20	0.007	0.020	0.133	0.758

DAS = Days after sowing. * = Significant at 5% probability level

APPENDIX-XXIX

Analysis of variance on pooled data for crop growth rate (CGR) of soybean

Source of variation	d.f	Crop growth rate(g/day)			
		30 DAS	45 DAS	60 DAS	75DAS
Year	1	0.0000	0.0000	0.001	0.020
Error (a)	4	0.0005	0.0002	0.001	0.014
Fertilizer doses(RDF)	5	0.001	0.004	0.008*	0.132
Year x RDF	5	0.0000	0.0000	0.000	0.001
Error (b)	20	0.0005	0.0004	0.001	0.014

DAS = Days after sowing. * = Significant at 5% probability level

APPENDIX-XXX

Analysis of variance on pooled data for relative growth rate (RGR) of soybean

Source of variation	d.f	Relative growth rate(g/g/day)			
		30 DAS	45 DAS	60 DAS	75DAS
Year	1	0.0000	0.0000	0.000	0.000
Error (a)	4	0.00005	0.0002	0.000	0.000
Fertilizer doses(RDF)	5	0.0002	0.0000	0.000	0.000
Year x RDF	5	0.0000	0.0000	0.000	0.000
Error (b)	20	0.0001	0.0001	0.000	0.000

DAS = Days after sowing. * = Significant at 5% probability level

APPENDIX-XXXI

Analysis of variance on pooled data for yield attributes of soybean

Source of variation	d.f	Relative crowding coefficient	Length of pods (cm)	Number of seeds per pod	Number of pods/plant (g)	Weight of pods/plant (g)
Year	1	0.004	0.003	0.015	0.777	24.536
Error (a)	4	0.034	0.010	0.010	0.323	7.792
Fertilizer doses(RDF)	5	1.265	0.372	0.072	2.106	74.003
Year x RDF	5	0.002	0.001	0.001	0.010	1.043

Error (b)	20	0.006	0.015	0.001	0.045	0.547

* = Significant at 5% probability level

APPENDIX-XXXII

Analysis of variance on pooled data for yield and yield attributes of soybean

Source of variation	d.f	Test weight (g)	Kernel yield (q/ha)	Stover yield (q/ha)	Harvest index (%)
Year	1	653.314	2.270	11.334	0.023
Error (a)	4	31.953	1.527	6.458	0.727
Fertilizer doses(RDF)	5	252.811	22.025	98.172	2.811
Year x RDF	5	14.173	0.031	1.294	2.658
Error (b)	20	6.972	0.081	0.337	0.532

* = Significant at 5% probability level

APPENDIX-XXXIII

Analysis of variance on pooled data for Phenological attributes of soybean

Source of variation	d.f	Days to 50% flowering	Days to maturity
Year	1	0.248	0.344
Error (a)	4	0.004	0.002
Fertilizer doses(RDF)	5	0.085	0.022
Year x RDF	5	0.005	0.008
Error (b)	20	0.004	0.001

* = Significant at 5% probability level

APPENDIX-XXXIV

Analysis of variance for nutrient uptake (Maize)

Source of variation	d.f	N uptake (kg/ha)			P uptake (kg/ha)			K uptake (kg/ha)		
		Grain	Stover	Total	Grain	Stover	Total	Grain	Stover	Total
Year	1	458.38	777.36	2430.20	57.26	33.14	177.62	70.23	2244.45	3109.18
Replication	4	89.48	103.90	386.13	9.12	3.01	22.44	8.72	385.14	507.02
Intercropping (IC)	1	197.24	144.89	680.60	34.26	12.91	88.90	21.50*	691.39	956.59
Year x IC	1	0.98	9.36	16.39	0.02	0.37	0.56	0.15	47.97	053.56
Error (a)	4	19.10	20.67	78.15	2.00	1.35	6.31	1.46	87.91	111.55
Fertilizer doses (RDF)	5	2535.14*	2926.05*	10880.07*	355.67*	103.91*	840.52*	439.62*	13755.78*	19074.96*
Year x RDF	5	1.21	5.22	10.17	0.42	0.40	1.32	0.77	15.85	23.16
IC x RDF	5	35.76*	33.67*	136.56*	3.60*	1.34*	8.76*	4.15*	129.10*	179.07*
Year x IC x RDF	5	0.56	0.66	2.31	0.05	0.46	0.64	0.22	7.11	8.31
Error (b)	40	4.66	6.18	18.78	0.53	037	1.40	0.51	16.48	20.98

* = Significant at 5% probability level

APPENDIX-XXXV

Analysis of variance for nutrient uptake (Groundnut)

Source of variation	d.f	N uptake (kg/ha)			P uptake (kg/ha)			K uptake (kg/ha)		
		Kernel	Stover	Total	Kernel	Stover	Total	Kernel	Stover	Total
Year	1	23.45	53.46	147.78	0.389	2478.71	2417.19	6.29	601.88	731.61
Error (a)	4	6.19	6.45	25.12	0.123	5.79	7.57	1.60	80.73	104.65
Fertilizer doses (RDF)	5	184.03*	290.15*	930.95*	3.131*	85.06*	120.57*	38.49*	2776.73*	3462.42*
Year x RDF	5	0.39	0.79	1.87	0.004	54.07	53.59	0.132	21.81	24.64
Error (b)	20	0.59	0.83	2.75	0.018	0.77	09.9	0.137	9.19	11.43

* = Significant at 5% probability level

APPENDIX-XXXVI

Analysis of variance for nutrient uptake (Soybean)

Source of variation	d.f	N uptake (kg/ha)			P uptake (kg/ha)			K uptake (kg/ha)		
		Grain	Stover	Total	Grain	Stover	Total	Grain	Stover	Total
Year	1	63.97	47.26	221.11	1.49	2.42	7.71	1.44	255.53	295.61
Error (a)	4	41.97	17.78	111.52	0.24	0.48	1.40	0.30	103.34	114.41
Fertilizer doses (RDF)	5	2353.08*	1410.16*	7358.67*	12.75*	15.81*	56.69*	8.81*	4030.04*	4401.99*
Year x RDF	5	4.55	9.13	22.32	0.015	0.24	0.29	0.03	14.46	14.73
Error (b)	20	3.52	1.94	8.86	0.022	006	0.11	0.05	7.24	8.00

* = Significant at 5% probability level

APPENDIX-XXXVII

Analysis of variance for physicochemical properties of soil after harvest

Source of variation	d.f	pH	Organic carbon (%)	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
Year	1	0.050	0.003	8941.85	620.34	7618.09
Replication	4	0.007	0.0000	2856.506	16.34	780.89
Intercropping (IC)	1	0.002	0.001	219.731	180.18	914.56*
Year x IC	1	0.007	0.0000	6.83	0.002	76.32
Error (a)	4	0.030	0.0000	1119.59	38.759	68.96
Fertilizer doses (RDF)	5	0.015	0.0000	24097.60*	1048.19*	14606.85*
Year x RDF	5	0.014	0.0000	86.09	1.27	13.78
IC x RDF	5	0.001	0.0000	398.60	40.87	537.98
Year x IC x RDF	5	0.008	0.0000	50.89	00.55	32.29
Error (b)	40	0.022	0.00007	351.28	10.10	425.39

* = Significant at 5% probability level

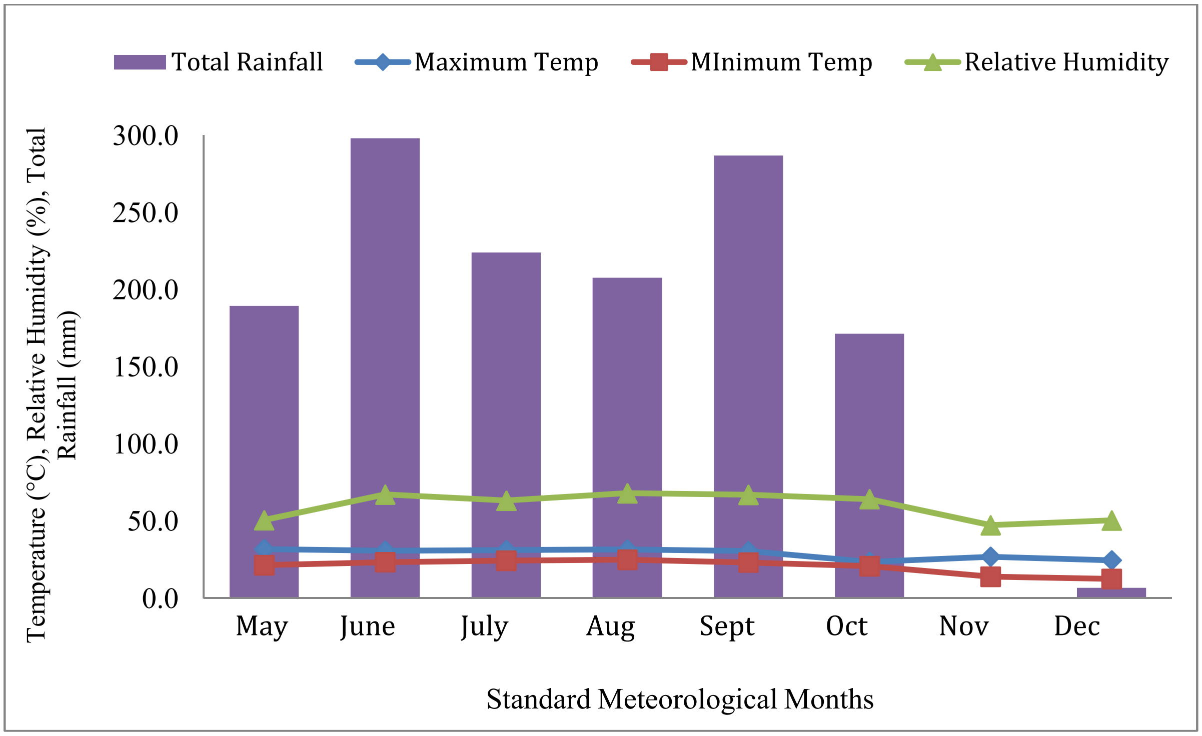


Fig. 1a. Meteorological data during the period of investigation-2008

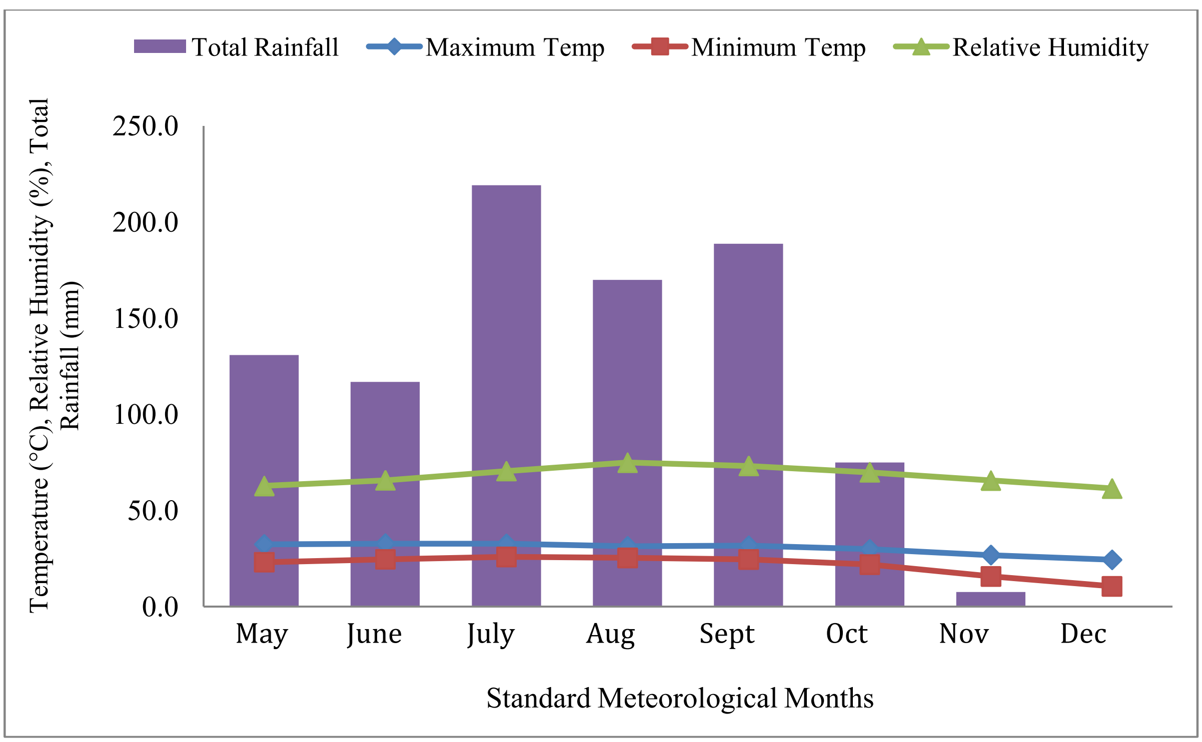


Fig. 1b. Meteorological data during the period of investigation-2009

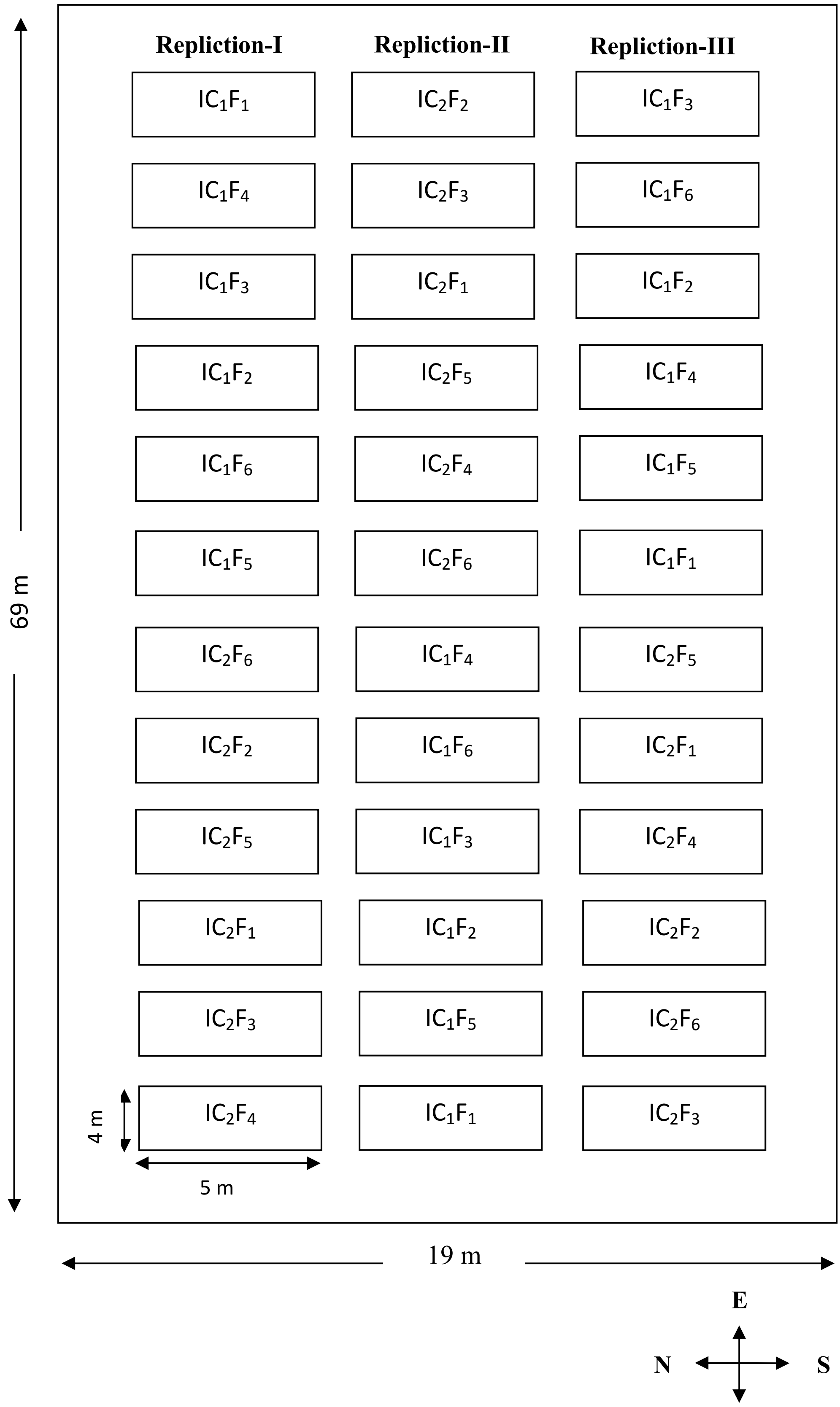


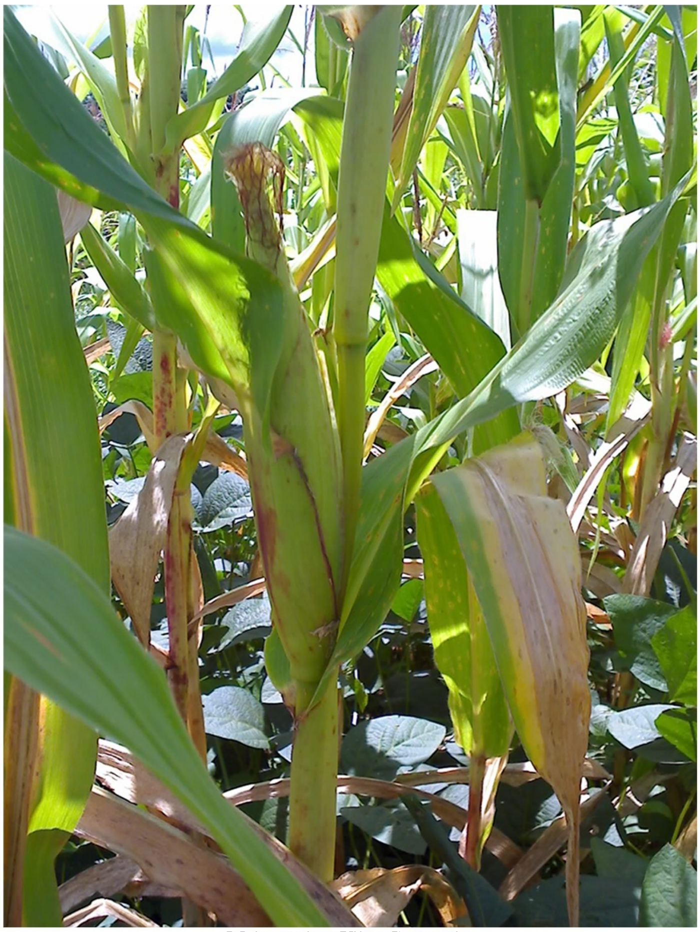
Fig.2. Layout of the experimental field

Plate 1. General view of the experimental field

Maize + Groundnut (IC_1)

Maize + Soybean (IC_2)

Plate 2. Different types of intercropping



Maize variety Vijay Composite

Groundnut variety JL-24

Soybean variety JS 80-21

Plate 3. Crop varieties used in intercropping

Maize: Vijay Composite

Groundnut: JL-24

Soybean JS-80-21

Plate 4. Harvested crops