INTEGRATED EFFECTS OF NITROGEN AND SULFUR ALONG WITH POULTRY MANURE ON THE GROWTH, YIELD, AND NUTRIENT CONTENTS OF RICE

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CERTIFICATE

This is to certify that the thesis entitled "INTEGRATED EFFECTS OF NITROGEN AND SULFUR ALONG WITH POULTRY MANURE ON THE GROWTH, YIELD AND NUTRIENT CONTENTS OF RICE" submitted to the DEPARTMENT OF AGRICULTURAL CHEMISTRY, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment [1] of the requirements for the degree of MASTER OF SCIENCE (M.S.) in AGRICULTURAL CHEMISTRY, embodies the results of a piece of bona fide research work carried out by DIPAION SARKER, Registration. No.06-01893, under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma in any other institution.

I further certify that any help or sources of information received during the course of this investigation has duly been acknowledged.

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DEDICATED TO

MY

BELOVED PARENTS

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ABSTRACT

The experiment was conducted in the farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from August to December 2012 to study the effect of various combinations of organic manure and inorganic fertilizer on the growth, yield, chlorophyll and nutrient content of BRRI dhan33. The experiment consists of the following treatments : T_1: 100% Inorganic fertilizer (Recommended dose) + 5 ton poultry manure/ha , T_2: 75 % N of recommended dose + 5 ton poultry manure/ha, T_3: 50 % N of recommended dose + 5 ton poultry manure/ha, T_4: 25 % N of recommended dose + 5 ton poultry manure/ha, T_5: 75 % S of recommended dose + 5 ton poultry manure/ha, T_6: 50 % S of recommended dose + 5 ton poultry manure/ha, T_7: 25 % S of recommended dose + 5 ton poultry manure/ha, T_8: 100% Inorganic fertilizer and T_9: 5 ton poultry manure/ha. With these 9 treatments, the experiment was laid out in a randomized complete block design (RCBD) with three replications. Significant variation was found in growth and yield parameters as well as in chlorophyll content and nutrient content of Aman rice due to the effect of various treatments. For most of the growth parameters (among plant height, leaf length and diameter, leaf number and total tiller per plant), better results were found in 100% Inorganic fertilizer + 5 ton poultry manure/ha which was statistically similar with 75 % of recommended dose of S + 5 ton poultry manure/ha, 75 % of recommended dose of N + 5 ton poultry manure/ha and followed by 50 % of recommended dose of S + 5 ton poultry manure/ha respectively while the lowest results were from 5 ton/ha poultry manure treatment. On the other hand, significantly higher chlorophyll "a", "b" and total chlorophyll content were recorded in 100% Inorganic fertilizer + 5 ton poultry manure/ha and it was closely similar with 75 % of recommended dose of N + 5 ton poultry manure/ha and lowest values were recorded in 5 ton/ha poultry manure treatment. Number of effective tillers plant^{-1}, panicle length, number of rachis plant^{-1}, filled grain plant^{-1} and fresh weight of plant were highest in 100% Inorganic fertilizer + 5 ton poultry manure/ha and it was either statistically similar or closely followed by 75 % of recommended dose of S + 5 ton poultry manure/ha. Significantly higher grain yield (4.18 t ha^{-1}) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) which was statistically similar with T_5 (75 % of recommended dose of S + 5 ton poultry manure/ha) (4.13 t ha^{-1}). Better result was also given by T_2 (75 % of recommended dose of N + 5 ton poultry manure/ha) (4.05 t ha^{-1}). Lowest grain yield (3.67 t ha^{-1}) was found from the treatment using sole poultry manure (T_9 : 5 ton/ha). Similarly, N content in grain and N, K content in straw were also higher in 100% Inorganic fertilizer + 5 ton poultry manure/ha treatment followed by 75 % of recommended dose of N + 5 ton poultry manure/ha compared to other fertilizer treatments. S content in grain and P, S content in straw were higher in 75 % of recommended dose of S + 5 ton poultry manure/ha compared to other fertilizer treatments. Lowest N and S content in grain and N, P, K, S content in straw were found from the treatment using poultry manure only (T_9 : 5 ton/ha).

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LIST OF ABBREVIATIONS

%	=	Percent
@	=	At the rate of
°C	=	Degree Celsius
AEZ	=	Agro Ecological Zone
BARI	=	Bangladesh Agricultural Research Institute
BAU	=	Bangladesh Agricultural University
BBS	=	Bangladesh Bureau of Statistics
cv.	=	Cultivar (s)
DAS	=	Days After Sowing
DMRT	=	Duncan's Multiple Range Test
EC	=	Emulsifiable Concentrate
et al.	=	And Others
FAO	=	Food and Agriculture Organization
g	=	Gram
IRRI	=	International Rice Research Institute
LSD	=	Least Significant Difference
MoP		Muriate of Potash
ppm	=	Parts per million
RCBD	=	Randomized Complete Block Design
SAU	=	Sher-e-Bangla Agricultural University
t/ha	=	Ton per Hectare
Tk./ha	=	Taka per Hectare
TSP	=	Triple Super Phosphate

CHAPTER 1

INTRODUCTION

Rice is intensively cultivated in Bangladesh covering about 80% of arable land. Rice alone constitutes 95% of the food grain production in Bangladesh. Unfortunately, the yield of rice is low considering the other rice growing countries like South Korea and Japan where the average yield is 7.00 and 6.22 t/ha, respectively (FAO, 1999). On the other hand, the demand for increasing rice production is mounting up to feed the ever-increasing population.

A suitable combination of organic and inorganic sources of nutrients is necessary for sustainable agriculture that can ensure food production with high quality. Nambiar (1991) views that integrated use of organic manure and chemical fertilizers would be quite promising not only in providing greater stability in production, but also in maintaining better soil fertility. The long-term research at BARI revealed that the application of cowdung @ 5 t/ha/year improved rice productivity as well as prevented the soil resources from degradation (Bhuiyan, 1994). Poultry manure is another good source of nutrients in soil. Meelu and Singh (1991) showed that 4 t/ha poultry manure along with 60 kg N/ha as urea produce grain yield of crop similar to that with 120 kg N/ha as urea alone.

Soil organic matter improves the physicochemical properties of the soil and ultimately promotes crop production. Evidences from different AEZ of the country have shown a decrease in the content of organic matter by the range of 15 to 30% over the last 20 years

(Miah, 1994). Therefore, it would not be wise to depend only on inherent potentials of soils for higher crop production. More recently, attention is focused on the global environmental problems; utilization of organic wastes, FYM, compost, vermicompost and poultry manures as the most effective measure for the purpose.

The application of different fertilizers and manures influences the physical and chemical properties of soil and enhances the biological activities. It is also positively correlated with soil porosity and enzymatic activity. Organic fertilizer enhances soil porosity by increasing regular and irregular pores and causes a priming effect of native soil organic matter. Applications of both chemical and organic fertilizers need to be applied for the improvement of soil physical properties and supply of essential plant nutrients for higher yield. (Sarvanan *et al*., 1987).

Among macronutrients usually applied as commercial fertilizers, nitrogen has the quickest and most pronounced effect on cereal production. It increased size and number of grains per panicle and protein percentage. It also improves the utilization of phosphorus and potassium to an appreciable extent (Brady, 1999). Inadequate nutrition, especially limitation of nitrogen, is one of the major bottlenecks of rice production in the world where about one third of the total N applied to crop is used for rice (Raun and Johnson, 1991). Rice is very responsive to N fertilization and high yield potential of modern varieties cannot be realized without N supply to the plant during the entire growing season. Nitrogen has quickest and remarkable effect on cereals production (Brady, 1999).

Sulphur, one of the most important nutrients for all plants and animals, is considered as the fourth major nutrient after nitrogen, phosphorous and potassium for agricultural crop production. Sulphur is a structural constituent of organic compounds, some of which are uniquely synthesized by plants, providing human and animals with essential amino acids (methionine and cysteine). It is involved in chlorophyll formation, activation of enzymes and is a part of vitamins biotin and thiamine (B1) (Hegde and Sudhakara Babu, 2007). There are many other sulphur containing compounds in plants which are not essential, but may be involved in defense mechanisms against herbivores, pest and pathogens, or contribute to the special taste and odour of food plants. Sulphur improves oil and protein contents, flour quality for milling and baking, marketability of copra, quality of tobacco and nutritive value of forages, *etc.* Poultry manure is superior to the other farmyard manure as a source of nitrogen supply. All the nitrogen in poultry manure is not in available form initially. Hence soils treated with poultry manure are less susceptible to nitrogen leaching since the vegetables grown utilize nitrate as they are produced (Maynard, 1984).

Considering the above facts, the present research was under taken with the following objectives:

- To examine the combined effects of N and S fertilizers along with poultry manure on the growth, yield and yield contributing characters of rice (cv. BRRI dhan33).
- To evaluate the effect of poultry manure incorporated with nitrogen and sulphur fertilizers on the chlorophyll contents of rice (cv. BRRI dhan33).
- To observe the integrated effects of poultry manure, nitrogen and sulphur fertilizers on the nutrient contents rice (cv. BRRI dhan33).

CHAPTER 2

REVIEW OF LITERATURE

Soil organic manure and inorganic fertilizer is the essential factor for sustainable soil fertility and crop productivity because is the store house of plant nutrients. Sole and combined use of cowdung, poultry manure, compost, and inorganic fertilizer acts as a source of essential plant nutrients. Experimental evidences in the use of cowdung, poultry manure, compost, and nitrogen, phosphorus, potassium and sulphur showed an intimate effect on the yield and yield attributes of rice. Yield and yield contributing characters of rice are considerably influenced by different doses of NPKS fertilizer and cowdung, poultry manure & compost manure and their combined application. Some literature related to the study are reviewed below-

2.1 Effect of chemical fertilizer on the growth and yield of rice

Haq *et al.* (2002) conducted an experiment with twelve treatments combination of N, P, K, S, Zn and Diazinon. They found that all the treatments significantly increased the grain and straw yield of BRRI dhan30 rice over control. 90 kg N + 50 kg P_2O_5 + 40 kg K_2O + 10 kg S + 4 kg Zn ha^{-1} + diazinon gave the highest grain and straw yield.

Amin *et al.* (2004) conducted an experiment to evaluate the effect of increased plant density and fertilizer dose on yield of rice variety IR-6. He found that increased fertilizer dose of NPK increase plant height.

Saha *et al.* (2004) conducted an experiment in 2002-2003 to create and compare a suitable fertilizer recommendation model for lowland rice. Five different fertilizer recommendation models were tested and compared with one check plot. Results showed that the application of different packages estimated by different fertilizer models significantly influenced leaf number, panicle length, panicle numbers, spikelet number per panicle, total grains per panicle, number of filled grain and unfilled grain per panicle. The combination of NPK that gave the highest result (120-13-70-20 kg/ha NPKS).

Asif *et al.* (2000) reported that NPK levels significantly increase the panicle length, number of primary and secondary branches panicle^{-1} when NPK fertilizer applied in 180-90-90 kg ha^{-1} this might be attributed to the adequate supply of NPK.

Sarker *et al.* (2001) obtained the nitrogen responses of a Japonica (Yumelvitachi) and an Indica (Takanari) rice variety with different nitrogen levels viz. 0, 40, 80, and 120 kg N/ha. They observed that application of nitrogen increased grain and straw yields significantly but harvest index was not increased significantly.

Singh and Singh (2002) carried out a field experiment to see the effect of different S levels (0, 20 and 40 kg/ha) on rice cv. Swarna and PR-108 in Varanasi, Utter Pradesh, India. They reported that plant height, leaf length, tillers/m^2, dry matter production, panicle length and grains/panicle were significantly increased with increasing levels of S up to 40 kg/ha.

Rasheed *et al.* (2003) reported that the effect of different NP levels i.e., 0-0, 25-0, 50-25, 75-50, 100-75 and 125-100 kg ha^{-1} on yield and yield attributes of rice Bas-385. Yield attributes (No. of effective tillers per hill, spikelet per panicle, normal kernels per panicle, 1000-grain weight) were improved linearly with increasing NP levels up to 100-75 kg/ha. The NP level of 100-75 kg/ ha resulted in the highest grain yield of 4.53 t/ha with minimum kernel abnormalities (Sterility, abortive kernels and opaque kernels) as against the minimum of 2.356 t/ha in the control (0-0) followed by 25-0 kg NP/ ha with maximum kernel abnormalities.

Singh *et al.* (2003) also reported that crop growth rate and relative growth rate such as total dry matter production was significantly influenced by NPK fertilizers. The tiller number, number of leaves and total dry matter production are closely correlated with yield depending on the rice cultivar which can be greatly enhanced by applying proper nutrient.

Rahman *et al.* (2007) conducted a field experiment using rice (cv. BRRI dhan29) as a test crop and found that application of S had a significant positive effect on tillers/hill, plant height, panicle length and grains/panicle. They also indicated that application of S fertilizer at a recommended rate (20kg S/ha) might be necessary for obtaining higher grain yield as well as straw yield of Boro rice (cv BRRI dhan29).

Ndaeyo *et al.* (2008) conducted an experiment in Nigeria with five rice varieties (WAB340- 8-8-2HI, WAB881-10-37-18-8-2-HI, WAB99-1-1, WAB224-8-HB, WAB189-B-B-B-8-HB) and four rates of NPK (15:15:15) fertilizer (0, 200, 400 and 600kg/ha). The results showed that 600kg/ha NPK (15:15:15) fertilizer rate significantly ($P < 0.05$) increased plant height, number of leaves and tillers per plant in both years. The

400kg/ha rate increased the number of panicles per plant, length of central panicle per plant and the overall grain yields, straw yield over other rates by 4-32% and 2-21% in 2005 and 2006, respectively.

Islam *et al.* (2008) conducted an experiment in 2001-2002, 2002-2003 and 2003-2004 to determine the response and the optimum rate of nutrients (NPK) for Chili- Fallow-T. *aman* cropping pattern. He found that grain yield influenced significantly due to application of different rates of nutrients and 60-19-36 kg/ha NPK maximized the yield of T. *aman* rice varieties in respect of yield and economics.

Maurya and Yadav (1987) studied the effect of N level (0, 50 and 100 kg N/ha) on grain yield and yield parameters using overage seedlings of four transplanted rice varities-Mahsuri, Sarjoo 52, Ratna, and Saket 4 in RCBD with four replication. Experimental plot soil was sandy loam with pH 7.5, EC (1:2) 0.09 mmho/cm, 0.42% organic C, 17.5 kg available P/ha and 135 kg available K/ha. Fifty five day old seedlings were transplanted at 2-3 seedlings/hill at 20 × 10-cm spacing. Each increment of N significantly increased leaf number, panicle number, panicle weight, test weight, plant height and grain yield but average N use efficiency was low, 17.7 kg grain/kg N with 50 kg N/ha and 14.1 kg grain/kg N with 100 kg N/ha. In general, grain yield and yield parameters were adversely affected by planting overage seedlings, which resulted in low grain yields for all varieties. N application was beneficial to grain yield, even with overage seedlings.

Panda and Das (1997) conducted the trials were conducted at Regional Reserch Station of the Orissa University of Agriculture and Technology located at Chiplima in Sambalpur.

The effect of different levels of nitrogen on the yield of grain and straw and grain: straw ratio of the straw ratio of the short duration varieties of rice reveal that the yield of grain and straw and grain: straw ratio increased significantly with increasing levels of nitrogen up to 200 kg N/ha, irrespective of seasons and varieties, while no nitrogen (control) gave the minimum. The reasons for the high yields per hectare with increasing levels of nitrogen may be that the higher dressing of nitrogen causes vigorous shoot growth for manufacturing food materials in large quantities and better development of roots for greater uptake of nutrients. Moreover, the number of productive tillers/m2, panicle weight and plant height increased significantly with increasing levels of nitrogen application.

Sadaphal *et al.* (1981) conducted experiment at the Indian agricultural research institute, New Delhi during the kharif seasons of 1978 and 1979. The soil was sandy clay loam having a pH of 7.9. The total N and available P of the soil were 0.11% and 18 kg/ha, respectively. They reported that the differences amongst the three rates of nitrogen application viz., 40, 80 and 120 kg/ha as regards height of plant, number of tillers per hill, number of productive tillers per hill, length of panicle and grain weight per panicle were significant. Grain weight per panicle at 120 kg N/ha was significantly greater than those fertilized at 80 kg N/ha which was in turn greater over 40 kg N/ha. Number of tillers per hill, number of productive tillers per hill and length of panicle under 80 and 120 kg N/ha were at par and were significantly superior to the attributes recorded at 40 kg N/ha. Height 25 of plants at 120 kg N/ha was significantly superior to those recorded at 40 and

80 kg N/ha. The yield of grain increased with increase in the rates of nitrogen applied to the soil.

Ahmed *et al.* (1989) conducted a greenhouse experiment to investigate the effect of nitrogen and residual sulphur on growth and yield of rice. The highest values of plant height and number of tillers per pot were observed with the treatment receiving 120 ppm N with 60 ppm S applied as gypsum at previous monsoon season.

Mandhata Singh *et al.* (1993) observed that the highest plant height of rice (cv. Mahsuri) was recorded with the application of 60 kg of sulphur per ha as elemental sulphur at Varanasi. The plant height was found to be 24.6, 25.2 and 26.1 per cent higher over control treatment at tillering, panicle initiation and at harvesting stages respectively. Application of sulphur through pyrite showed the similar results.

Ram *et al.* (1999) reported that application of sulphur at 90 kg per ha in rice, grown under reclaimed salt affected soil in Kanpur, gave the highest grain and straw yields of 3.95 and 7.26 t per ha, respectively. The yields were 37.63 and 50 per cent higher over control for grain and straw respectively. These doses of sulphur applied through pyrite and gypsum produced significantly higher yield than 30 kg S per ha. Sulphur use efficiency was greater with gypsum than pyrites irrespective of their level of application.

Tiwari *et al.* (1983) conducted a green house experiment to study the effect of sulphur fertilization on rice in 24 soils of district Kanpur, widely varying in their available sulphur contents. In 12 of 24 soils, the increase in grain yield of rice by sulphur application was more than 10 per cent, the highest being 30 per cent. The grain yield increased from 42.8 g per pot to 47.6 g per pot with sulphur application.

Bhuvaneswari *et al.* (2007) conducted a field experiment in wetland farms in Annamalai University to study the effect of farmyard manure (FYM) and four levels of sulphur applied through gypsum on the growth and yield of rice var. ADT 43. Results of the experiment revealed that the yield characters *viz.*, number of panicles per m^2, number of filled grains per panicle, 1000 grain weight, grain and straw yield increased with S levels and highest grain (5750 kg per ha) and straw (7300 kg per ha) yield was noticed with 40 kg S per ha plus FYM at the rate of 12.5 t per ha and decreased thereafter with further increase in sulphur level. The per cent increase over the control was 14.5 and 15.4 for grain and straw yield respectively.

Naw Mar Lar Oo *et al.* (2007) reported that the grain and straw yields of rice grown in a field experiment at IARI, Delhi, increased significantly with increasing S levels. The percentage increase in the grain yield of rice at application of 20, 40 and 60 kg S per ha over control was in the order of 6.5, 7.3 and 8.8 per cent, respectively. Application of 20 kg S per ha increased significantly the biological yield of rice over control but remained statistically on par with 40 kg S per ha. The maximum biological yield of rice (19.17 t per ha) was recorded with 60 kg S per ha and it was significantly superior to rest of the S treatments.

Altaf Hossain *et al.* (1987) reported that application of Zn and S alone or in combination significantly increased the grain yield of 'BR 4' rice under both moist and submerged conditions in Bangladesh. Under the moist condition, an application of Zn by dipping the seedling roots in a 2% ZnO solution was found to be the most effective in increasing the yield. However, under submerged condition, combined application of $ZnSO_4$ and gypsum gave the highest grain yield.

Ahmed *et al.* (1989) conducted a greenhouse experiment to investigate the effect of nitrogen and residual sulphur on growth and yield of rice. The highest values of filled grain per panicle, filled grain percentage, 1000 grain weight, grain yield, straw yield and grain: straw ratio were observed with the treatment receiving 120 ppm N with 60 ppm S applied as gypsum at previous monsoon season.

2.2 Combined effect of chemical fertilizer and poultry manure on the growth and yield of rice

Channbasavana and Biradar (2001) reported that the application of poultry manure @ 3 t ha^{-1} gave 26% and 19% higher grain yield than that of the control 1998 and 1999, respectively. Eneji *et al.* (2001) observed that average across the soils, the level of extractable Fe increased by 5% in chicken manure and 71% in cattle manure; Mn by 61% in chicken manure and 172% in swine manure and Cu by 327% in chicken manure and 978% in swine manure. Mixing these manures before application reduce the level of extractable trace elements.

Singh *et al.* (2001) studied on the effect of poultry manure under irrigated condition with nitrogen in rice-wheat cropping system in an Alfisol of Bilapur, Madhya Pradesh, India. The treatment consisted of poultry manure alone and in combination with nitrogen fertilizer. Root and shoot biomass at different growth stages increased with the application of N and poultry manure alone and combination. Root and shoot biomass was higher in 100% N through poultry manure, followed by 75% N through poultry manure and 25% through urea.

Vanaja and Raju (2002) conducted a field experiment on integrated nutrient management practice in rice crop. Different combinations of chemical fertilizer with poultry manure (PM) 2 t ha^{-1} gave highest grain and straw yield.

Umanah *et al.* (2003) find out the effect of different rates of poultry manure on the growth, yield component and yield of upland rice cv. Faro 43 in Nigeria, during the 1997 and 1998 early crop production seasons. The treatments comprised 0, 10, 20 and 30 t/ha poultry manure. There were significant differences in plant height, internode length, tiller number, panicle number per stand, grain number/panicle, and dry grain yield. There was no significant difference among the treatments for 1000-grain weight.

Channabasavanna (2003) conducted a field experiment to evaluate the efficient utilization of poultry manure with inorganic fertilizers in wetland rice and found that the growth parameters and grain yield increased with each increment of poultry manure application and was maximuma at 3 t poultry manure/ha. Poultry manure at 2 ton /ha recorded significantly higher values for seed yield and its attributes. The study proved the superiority of poultry manure over farmyard manure (FYM). It was evident from the study that one ton of poultry manure was equivalent to 7 ton FYM which produced at per seed yields. Agronomic efficiency of N (AEN) at 75% NPK (112.5:56.3:56.3 kg NPK/ha) was equivalent to 2 t poultry manure/ha. The results showed that an increase in poultry manure and fertilizer increased rice seed yield. The AEN decreased with an increase in the application of poultry manure and NPK fertilizer.

Mahavisha *et al.* (2004) investigated a field study during the kharif season of 2001 in Andra Pradesh, India to investigate the effect of organic fertilizer sources on the growth and yield of rice. The crop growth and yield were higher with 125% recommended fertilizer + poultry manure and 100% RDF + poultry manure compared to the other treatments.

Miah *et al.* (2004) found 5.6-6 t/ha-grain yields with application of 2 t/ha poultry manure plus 120 kg N/ha in Boro season.

Reddy *et al.* (2005) carried out a field experiment on black clay soils in Gangavati, Karnakata, India, to evaluate the performance of poultry manure (PM) as a substitute for NPK in irrigated rice (cv. IR 64). The application of PM at 5 t/ha recorded a significantly higher grain yield (5.25 t/ha) than the control and FYM application at 7.5 t/ha, significantly improved the soil P and K status, and increased the N content of the soil. Poultry manure at 5 t/ha resulted in higher gross returns (30592 Rupees/ha) over other levels of PM and FYM. However, net returns and benefit cost rations were comparable between 5 and 2 t PM/ha, and between 100 and 75% NPK. The application of 2 t PM/ha and 75% NPK. was found economical.

Miah *et al.* (2006) stated that an application of poultry manure with soil test basis (STB), IPNS and AEZ based fertilizer gave higher grain yield compared to other organic materials.

Xu *et al.* (1997) observed that application of half inorganic fertilizer and half organic manure (swine manure) increase nutrient absorption, panicle number, yield of rice & also increased soil organic matter.

The literature review discussed above indicates that organic manure can supply a good amount of plant nutrients and thus can contribute to crop yields. The integrated approach by using the organic and inorganic sources of nutrients helps improve the efficiency of nutrients. Hence, an effort was undertaken to investigate the effects of integrated nutrient management on rice productivity.

CHAPTER 3

MATERIALS AND METHODS

The experiment was conducted in the farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from August to December 2012 to study the effect of various combinations of poultry manure and inorganic fertilizer on the growth, yield, chlorophyll and nutrient content of BRRI dhan33. This chapter includes materials and methods that were used in conducting the experiment. The details are presented below under the following headings–

3.1 Experimental site and soil

The experiment was conducted in typical rice growing silt loam soil at the Sher-e-Bangla Agricultural University Farm, Dhaka during the *Late Aman* season of 2012. The morphological, physical and chemical characteristics of the soil are shown in the Table 3.1 and 3.2.

3.2 Climate

The experimental area was under the sub-tropical climate that is characterized by high temperature, high humidity and heavy rainfall with occasional gusty winds in kharif season (April-September) and less rainfall associated with moderately low temperature during the Rabi season (November-March).

Table 3.1 Morphological characteristics of the experimental field

Morphology	Characteristics
Location	SAU Farm, Dhaka.
Agro-ecological zone	Madhupur Tract (AEZ- 28)
General Soil Type	Deep Red Brown Terrace Soil
Parent material	Madhupur Clay
Topography	Fairly level
Drainage	Well drained
Flood level	Above flood level

(FAO and UNDP, 1988)

Table 3.2 Initial physical and chemical characteristics of the soil

Characteristics	Value
Mechanical fractions:	
% Sand (2.0-0.05 mm)	22.30
% Silt (0.05-0.002 mm)	56.90
% Clay (<0.002 mm)	20.80
Textural class	Silt Loam
pH (1: 2.5 soil- water)	6.1
Organic Matter (%)	1.09
Total N (%)	0.04
Available K (ppm)	15.62
Available P (ppm)	9.88
Available S (ppm)	8.06

3.3 Planting material

BRRI dhan33 was used as the test crop in this experiment. This variety was developed at the Bangladesh Rice Research Institute. It is recommended for *Aman* season. (BRRI, 2004).

3.4 Land preparation

The land was first opened on 1 August, 2012 by a tractor and prepared thoroughly by ploughing and cross ploughing with a power tiller followed by country plough. Laddering helped breaking the clods and leveling the land followed every ploughing. Before transplanting each unit of plot was cleaned by removing the weeds, stubbles and crop residues. Finally each plot was prepared by puddling.

3.5 Experimental design and layout

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Each replication was divided into 9 plots. The total numbers of unit plots were 27. The plot size was 4.0 m x 3.0 m. The distances between plot to plot and replication to replication were 0.5 m and 1 m, respectively. The layout of the experimental plot has been shown in Appendix I.

3.6 Raising of seedlings

Seeds of BRRI dhan33 were collected from BRRI (Bangladesh Rice Research Institute). The seedlings were raised at the wet seed bed in SAU farm. The seeds were sprouted by soaking for 72 hours. The sprouted seeds were sown uniformly in the well-prepared seed bed in last week of June, 2012.

3.7 Treatments

T_1: 100% Inorganic fertilizer (Recommended dose) + 5 ton poultry manure/ha

T_2: 75 % N of the recommended dose + 5 ton poultry manure/ha

T_3: 50 % N of the recommended dose + 5 ton poultry manure/ha

T_4: 25 % N of the recommended dose + 5 ton poultry manure/ha

T_5: 75 % S of the recommended dose + 5 ton poultry manure/ha

T_6: 50 % S of the recommended dose + 5 ton poultry manure/ha

T_7: 25 % S of the recommended dose + 5 ton poultry manure/ha

T_8: 100% Inorganic fertilizer

T_9: 5 ton poultry manure/ha

Table 3.3 Chemical composition of poultry manure used for the experiment.

Organic manure	Nutrients content				
	C (%)	N (%)	P (%)	K (%)	C:N
Poultry manure	29	2.19	1.98	0.81	8

Hasanuzzaman *et al* (2010).

3.8 Fertilizer application

The amounts of N, P, K, S and Zn fertilizers required per plot were calculated as per the treatments. Full amounts of TSP, MP and gypsum were applied as basal dose before transplanting of rice seedlings. Urea were applied in 3 equal splits: one third was applied at basal before transplanting, one third at active tillering stage (30 DAT) and the remaining one third was applied at 5 days before panicle initiation stage (55 DAT) as per treatments. Calculated amount of Zinc sulphate was applied as basal before transplanting as per treatments.

3.9 Organic manure incorporation

Poultry manure was used in this experiment. The rate of manure was 5 ton/ha and was applied before four days of final land preparation.

3.10 Transplanting

Forty day old seedlings of BRRI dhan33 were carefully uprooted from the seedling nursery and transplanted on 10^{th} August, 2012 in well puddled plot. Two seedlings per hill were used following a spacing of 20 cm × 20 cm. After one week of transplanting all plots were checked for any missing hill, which was filled up with extra seedlings whenever required.

3.11 Intercultural operations

The following intercultural operations were done for ensuring the normal growth of the crop.

3. 11.1 Weed control

During plant growth stage hand weedings were done according to needs.

3. 11.2 Irrigation and drainage

Irrigation water was applied keeping a standing water of about 2-3 cm during the whole growing period.

3. 11.3 Plant protection measure

During the growing period some plants were infested by rice stem borer (*Scirpophaga incertulus*) which was successfully controlled by applying Diazinon 60 EC @ 20 mL per 10 Liter of water for spraying. No prominent infestation of insect-pests and diseases were observed in the field.

3.12 Crop harvest

The crop was harvested at full maturity when 80-90% of the grains were turned into straw colored on 14 November, 2012. The crop was cut at the ground level and plot wise crop was bundled separately and brought to the threshing floor. Ten hills of rice plant were selected randomly from the plants for measuring yield contributing characters.

3.13 Data recording on growth and yield parameters

3.13.1 Plant height (cm)

The height of plant was recorded in centimeter (cm) at 30, 60 DAT (Days After Transplanting) and at harvest. Data were recorded as the average of 10 plants selected at random from the inner rows of each plot. The height was measured from the ground level to the tip of the panicle.

3.13.2 Total number of tillers hill^{-1}

The total number of tillers hill^{-1} was counted as the number of panicle bearing hill/plant at 30, 60 DAT and at harvest. Data on total tillers hill^{-1} were counted from 10 selected hills and average value was recorded.

3.13.3 Total number of effective tiller hill^{-1}

The total number of effective and non-effective tiller hill^{-1} was counted as the number of non-panicle bearing plant/hill at 30, 60 DAT and at harvest. Data on effective tiller hill^{-1} were counted from 10 randomly selected hills and average value was recorded.

3.13.4 Leaf number, length and diameter

The number of leaves, their length and diameter were also recorded from the sample plants at 30, 60 DAT and at harvest.

3.13.5 Length of panicle (cm)

The length of panicle was measured with a meter scale from 10 selected plants and the average value was recorded as per plant at 30, 60 DAT and at harvest.

3.13.6 Number of filled grains per panicle

The total numbers of filled grains were calculated from selected 10 plants of a plot on the basis of grain in the spikelet and then average numbers of filled grain per panicle was recorded.

3.13.7 Fresh weight of plant (kg hill^{-1})

The fresh weight of each hill of the sample plants were recorded during harvest.

3.13.8 Grain yield (kg)

Grains obtained from each unit plot were sun-dried and weighed carefully. The dry weight of grains of the respective unit plot yield was converted to t ha^{-1}.

3.13.9 Chlorophyll content at flag leaf stage (mg g^{-1} fresh weight of leaf)

Chlorophyll content was recorded at flag leaf stage. Hundred milligram of rice leaf sample was broken into small pieces and dipped into 80% acetone in twenty five milliliter vial. The vial was made up to the volume with 80% acetone. Then the sample was kept over forty eight hours in a dark place. Finally the absorbance of the filtrate was taken by spectrophotometer at 663 nm and 645 nm, respectively.

Amount of chlorophyll were calculated using the following equations/ formula (Witham, 1986):

Chlorophyll a (mg/g) = [12.7 (OD_{663}) - 2.69 (OD_{645})] V/1000W

Chlorophyll b (mg/g) = [22.9 (OD_{645}) - 4.68 (OD_{663})] V/1000W

Chlorophyll a+b (mg/g) = [20.2(OD_{645}) – 8.02 (OD_{663})] V/1000W

Where,

OD = Optical density regarding of the chlorophyll extract at the specific indicated wavelength (645 and 663nm)

V = Final volume of the 80% acetone chlorophyll extract (ml)

W = Fresh weight in gram of the tissue extracted

3.14 Chemical analysis of plant samples

3.14.1 Collection and preparation of plant samples

Straw samples were collected after threshing for N, P, K, and S analyses and grain samples were collected for N and S analyses. The plant samples were dried in an oven at 70 ^{0}C for 72 hours and then ground by a grinding machine (wiley-mill) to pass through a 20-mesh sieve. The samples were stored in plastic vial for analyses of N, P, K, and S. The grain and straw samples were analyzed for determination of N, P, K, and S concentrations. The methods were as follows:

3.14.2 Digestion of plant samples with sulphuric acid for N determination

For the determination of nitrogen an amount of 0.5 g oven dry, ground sample were taken in a micro kjeldahl flask. 1.1 g catalyst mixture (K_2SO_4: $CuSO_4$. $5H_2O$: Se in the ratio of 100: 10: 1), and 7 mL conc. H_2SO_4 were added. The flasks were heated at 160^0 C and added 2 ml 30% H_2O_2 then heating was continued at 360^0 C until the digests become clear and colorless. After cooling, the content was taken into a 50 mL volumetric flask and the volume was made up to the mark with de-ionized water. A reagent blank was prepared in a similar manner. Nitrogen in the digest was determined by distilling the digest with 10 N NaOH followed by titration of the distillate trapped in H_3BO_3 indicator solution with 0.01N H_2SO_4(Page *et al.,* 1982).

3.14.3 Digestion of plant samples with nitric-perchloric acid for P, K, and S

A sub sample weighing 0.5 g was transferred into a dry, clean 100 ml digestion vessel. Ten ml of di-acid (HNO_3: $HClO_4$ in the ratio 2:1) mixture was added to the flask. After leaving for a while, the flasks were heated at a temperature slowly raised to 200^0C. Heating were stopped when the dense white fumes of $HClO_4$ occurred. The content of the flask were boiled until they were became clean and colorless. After cooling, the content was taken into a 50 ml volumetric flask and the volume was made up to the mark with de-ionized water. P, K and S were determined from this digest by using different standard methods.

3.14.4 Determination of N, P, K and S from plant samples

3.14.4.1 Nitrogen

Nitrogen was determined by micro kjeldahl method (Jackson, 1973).

3.14.4.2 Phosphorus

Plant samples (straw) were digested by di-acid (Nitric acid and Perchloric acid) mixture and P content in the digest was measured by blue color development (Olsen *et al.*, 1954).

Phosphorus in the digest was determined by using 5 mL for straw sample from 50 mL digest by developing blue color with reduction of phosphomolybdate complex and the color intensity were measured colorimetrically at 660 nm wavelength and readings were calibrated with the standard P curve (Page *et al*., 1982).

3.14.4.3 Potassium

One milli-liter of digest sample for the straw were taken and diluted 20 mL volume to make desired concentration so that the flame photometer reading of samples were measured within the range of standard solutions. The concentrations were measured by using standard curves.

3.14.4.4 Sulphur

Sulphur content was determined from the digest of the plant samples (grain and straw). The digested S was determined by developing turbidity by adding acid seed solution (20 ppm S as K_2SO_4 in 6N HCl) and $BaCl_2$ crystals. The intensity of turbidity was measured by spectrophotometer at 420 nm wavelengths (Hunter, 1984).

3.15 Statistical analysis

The data collected on different parameters were statistically analyzed to obtain the level of significance using the MSTAT-C (Russell, 1986) computer package program. Analysis of variance was done following one factors randomized complete block design. The mean differences among the treatments were compared by Duncan's Multiple Range Test (DMRT) test at 5% level of significance.

CHAPTER 4

RESULTS AND DISCUSSION

The results of different growth parameters, chlorophyll contents, yield attributes, yield and nutrient concentrations in the straw and grains of rice are presented this chapter.

4.1 Plant height

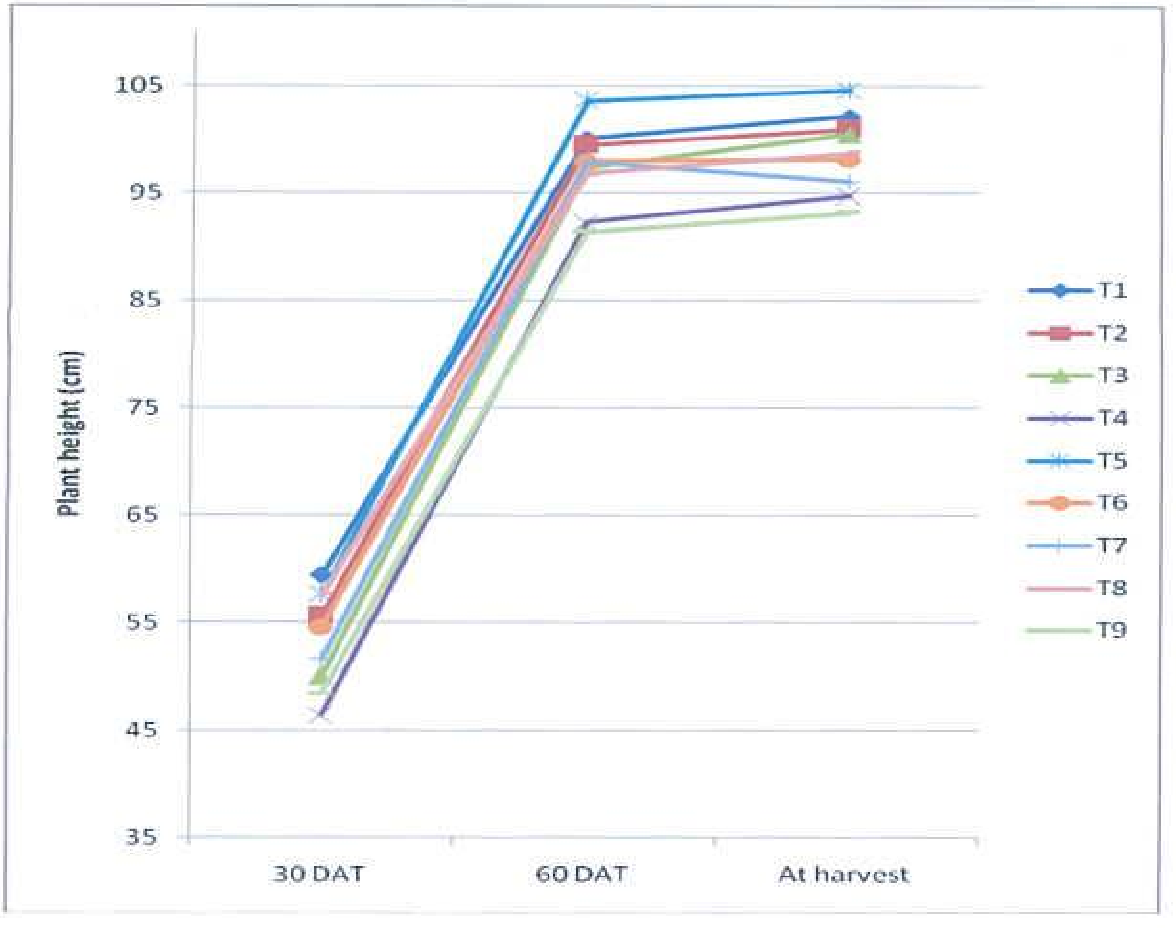
The data on plant height of rice at different growth stages as influenced by organic and inorganic fertilizers are presented in Figure 4.1 and Appendix II.

The plant height at 30 days after transplanting (DAT) differed significantly due to different treatments. Significantly higher plant height (59.4 cm) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) and it was statistically similar with the application of 75 % S of recommended dose+ 5 ton poultry manure/ha (T_5 : 57.6 cm) and T_8 (100% Inorganic fertilizer) (57.6 cm). Lowest plant height at 30 DAT (48.4 cm) was found from the treatment using sole poultry manure (T_9 : 5 ton/ha).

The plant height at 60 days after transplanting (DAT) also differed significantly due to different treatments. Highest plant height (103.6 cm) was recorded in T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) and it was closely followed by T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) (100.1 cm) and T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha) (99.5 cm). Lowest plant height at 60 DAT (91.4 cm) was found from the treatment using sole poultry manure (T_9 : 5 ton/ha).

At harvest, plant height also showed significant variation among the different combinations of organic and inorganic fertilizer. Highest plant height (104.6 cm) was recorded in T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) and it was closely followed by T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) (102.2 cm) and T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha) (101.0 cm). Lowest plant height at harvest (93.2 cm) was found from the treatment using sole poultry manure (T_9 : 5 ton/ha).

It seems from the results that combination of organic and inorganic fertilizers significantly increased the plant height than sole use of inorganic fertilizer and than that of organic manure. Actually organic fertilizers help to increase the organic matter content of soil, thus reducing the bulk density and decreasing compaction. Thus plants get a suitable growing environment which promotes better growth and development. Similar sort of findings were found by many scientists while experimenting with various crops. Amin *et al.* (2004) found that increased fertilizer dose of NPK increase plant height. Rahman *et al.* (2007) found that application of S had a significant positive effect on plant height. Combination of organic and inorganic fertilizers was found better by Umanah *et al.* (2003) in upland rice and Channabasavanna (2003) in wetland rice than only inorganic fertilizers.



T_1: 100% Inorganic fertilizer (Recommended dose) + 5 ton poultry manure/ha, T_2: 75 % N of the recommended dose + 5 ton poultry manure/ha , T_3: 50 % N of the recommended dose + 5 ton poultry manure/ha , T_4: 25 % N of the recommended dose + 5 ton poultry manure/ha , T_5: 75 % S of the recommended dose + 5 ton poultry manure/ha , T_6: 50 % S of the recommended dose + 5 ton poultry manure/ha , T_7: 25 % S of the recommended dose + 5 ton poultry manure/ha, T_8: 100% Inorganic fertilizer , T_9: 5 ton poultry manure/ha

Figure 4.1 : Effect of different combinations of organic and inorganic fertilizer on plant height of BRRI dhan33

4.2 Leaf length

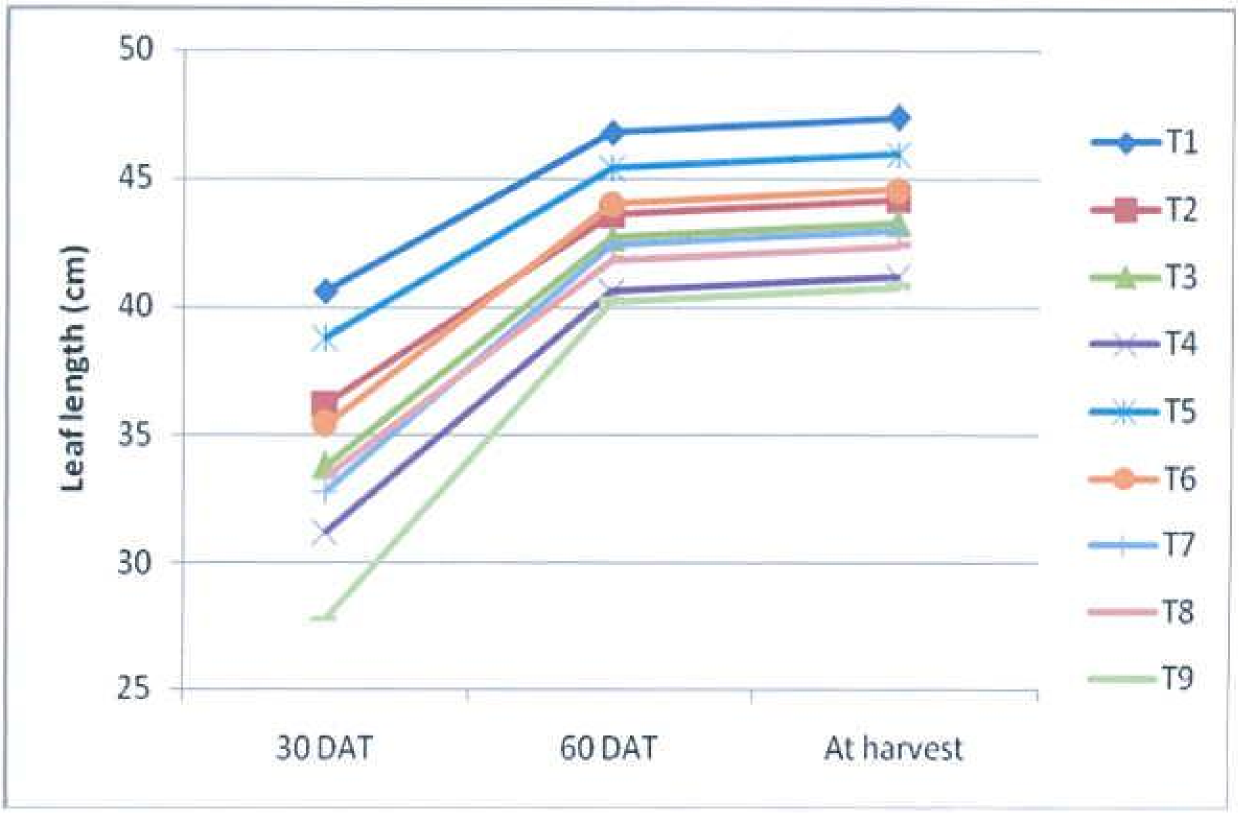
The data on leaf length of rice at different growth stages as influenced by organic and inorganic fertilizers are presented in Figure 4.2 and Appendix III.

The leaf length at 30 days after transplanting (DAT) differed significantly due to different treatments. Significantly higher leaf length (40.6 cm) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) and it was closely followed by T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) (38.8 cm) and 75 % N of recommended dose+ 5 ton poultry manure/ha (T_2 : 36.2 cm). Lowest leaf length at 30 DAT (27.8 cm) was found from the treatment using sole poultry manure (T_9 : 5 ton/ha).

The leaf length at 60 days after transplanting (DAT) also differed significantly due to different treatments. Highest leaf length (46.8 cm) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) and it was closely followed by T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) (45.4 cm) and T_6 (50 % S of recommended dose + 5 ton poultry manure/ha) (44 cm). Lowest leaf length at 60 DAT (40.2 cm) was found from the treatment using 100% recommended dose of poultry manure (T_9 : 5 ton/ha).

At harvest, leaf length also showed significant variation among the different combinations of organic and inorganic fertilizer. Highest leaf length (47.37 cm) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) and it was statistically similar with by T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) (45.97 cm) and T_6 (50 % S of recommended dose + 5 ton poultry manure/ha) (44.57 cm) and T_2 (44.17 cm). Lowest leaf length at harvest (40.77 cm) was found from the treatment using only poultry manure (T_9 : 5 ton/ha).

From the above results it can be presumed that, combination of organic and inorganic fertilizers significantly increased the leaf length than sole use of inorganic fertilizer and than that of organic manure. Similar sort of findings were found by many scientists while experimenting with various crops. Saha *et al.* (2004) found that different fertilizer recommendation models significantly influenced leaf growth. Singh and Singh (2002) found that leaf growth significantly increased with increasing levels of S up to 40 kg/ha.



T_1: 100% Inorganic fertilizer (Recommended dose) + 5 ton poultry manure/ha, T_2: 75 % N of the recommended dose + 5 ton poultry manure/ha , T_3: 50 % N of the recommended dose + 5 ton poultry manure/ha , T_4: 25 % N of the recommended dose + 5 ton poultry manure/ha , T_5: 75 % S of the recommended dose + 5 ton poultry manure/ha , T_6: 50 % S of the recommended dose + 5 ton poultry manure/ha , T_7: 25 % S of the recommended dose + 5 ton poultry manure/ha, T_8: 100% Inorganic fertilizer , T_9: 5 ton poultry manure/ha

Figure 4.2 : Effect of different combinations of organic and inorganic fertilizer on leaf length of BRRI dhan33

4.3 Leaf diameter

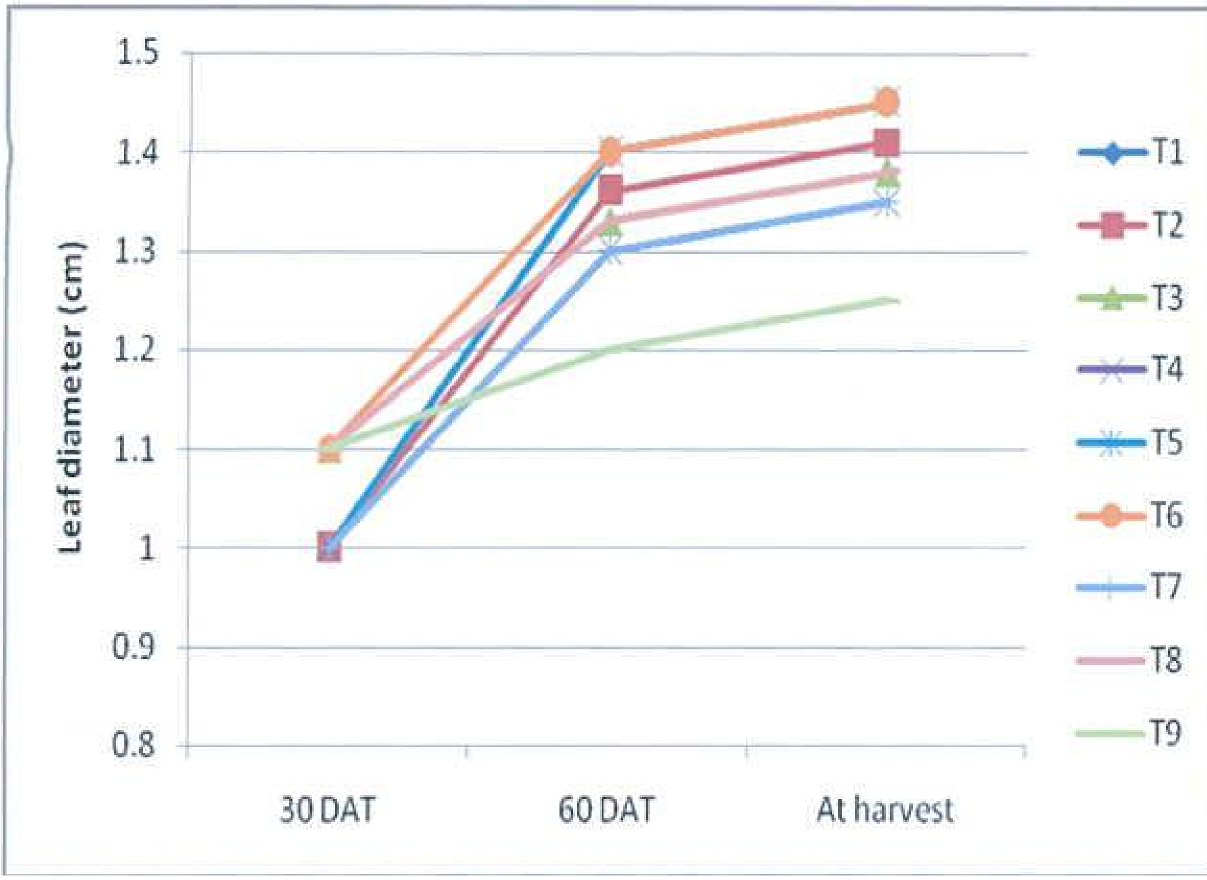
The data on leaf diameter of rice at different growth stages as influenced by organic and inorganic fertilizers are presented in Figure 4.3 and Appendix IV.

The leaf diameter at 30 days after transplanting (DAT) differed insignificantly due to different treatments.

The leaf diameter at 60 days after transplanting (DAT) differed significantly due to different treatments. Highest leaf diameter (1.4 cm) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha), T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) and in T_6 (50 % S of recommended dose + 5 ton poultry manure/ha). Lowest leaf diameter at 60 DAT (1.2 cm) was found from the treatment using 100% recommended dose of poultry manure (T_9 : 5 ton/ha).

At harvest significant variation was found in leaf diameter among the different combinations of organic and inorganic fertilizer. Highest leaf diameter (1.45cm) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha), T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) and in T_6 (50 % S of recommended dose + 5 ton poultry manure/ha). Lowest leaf diameter at harvest (1.25 cm) was found from the treatment using only poultry manure (T_9 : 5 ton/ha).

From the above results it can be presumed that, combination of organic and inorganic fertilizers significantly increased the leaf diameter than sole use of inorganic fertilizer and than that of organic manure. Sadaphal *et al*. (1981) found that increased fertilizer dose of NPK increase all the growth parameters.



T_1: 100% Inorganic fertilizer (Recommended dose) + 5 ton poultry manure/ha, T_2: 75 % N of the recommended dose + 5 ton poultry manure/ha , T_3: 50 % N of the recommended dose + 5 ton poultry manure/ha , T_4: 25 % N of the recommended dose + 5 ton poultry manure/ha , T_5: 75 % S of the recommended dose + 5 ton poultry manure/ha , T_6: 50 % S of the recommended dose + 5 ton poultry manure/ha , T_7: 25 % S of the recommended dose + 5 ton poultry manure/ha, T_8: 100% Inorganic fertilizer , T_9: 5 ton poultry manure/ha

Figure 4.3 : Effect of different combinations of organic and inorganic fertilizer on leaf diameter of BRRI dhan33

From the above results it can be presumed that, combination of organic and inorganic fertilizers significantly increased the leaf diameter than sole use of inorganic fertilizer and than that of organic manure. Similar sort of findings were found by many scientists while experimenting with various crops. Saha *et al.* (2004) found that different fertilizer recommendation models significantly influenced leaf growth. Singh and Singh (2002) found that leaf growth significantly increased with increasing levels of S up to 40 kg/ha.

4.4 Number of leaves

The data on number of leaves plant^{-1} of rice at different growth stages as influenced by organic and inorganic fertilizers are presented in Figure 4.4 and Appendix V.

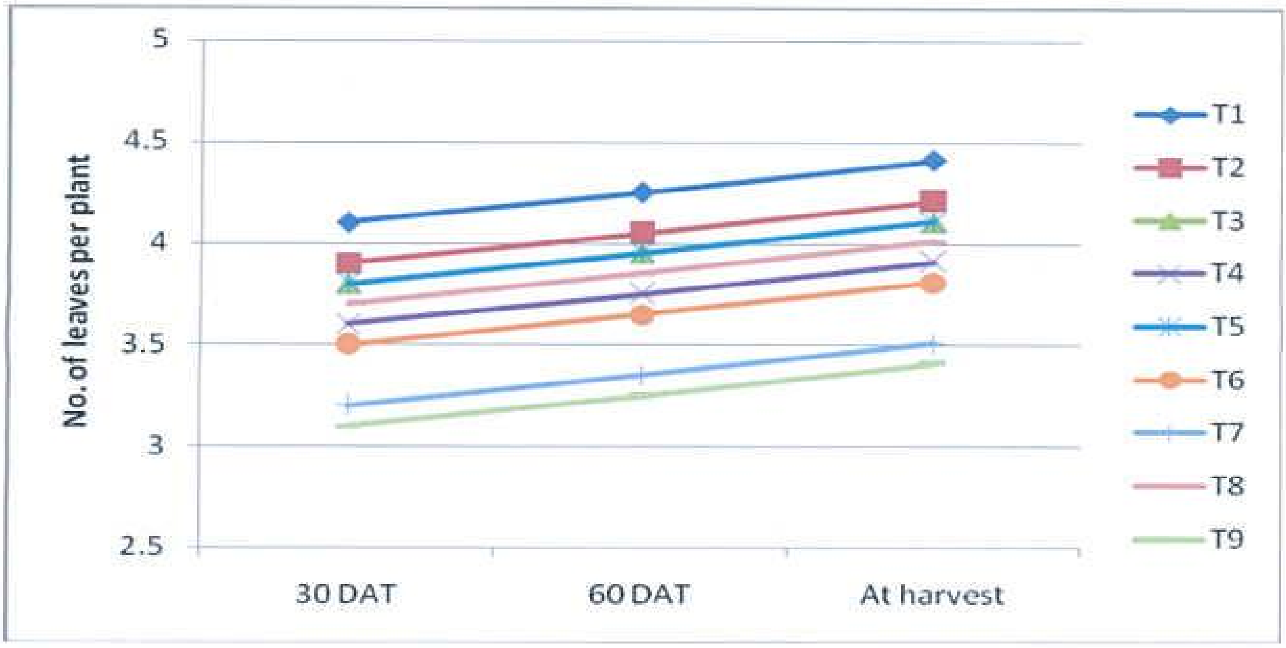
The number of leaves plant^{-1} at 30 days after transplanting (DAT) differed significantly due to different treatments. Significantly higher number of leaves plant^{-1} (4.1) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) which was statistically same with T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha) (3.9) and it was closely followed by T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) and T_3 (50 % N of recommended dose+ 5 ton poultry manure/ha) (3.8). Lowest number of leaves plant^{-1} at 30 DAT (3.1) was found from the treatment using sole poultry manure (T_9 : 5 ton/ha).

The number of leaves plant^{-1} at 60 days after transplanting (DAT) also differed significantly due to different treatments. Highest number of leaves plant^{-1} (4.25) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) which was statistically same with T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha) (4.05) and it was closely followed by T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) and T_3 (50 % N of recommended dose+ 5 ton poultry manure/ha) (3.95).

Lowest number of leaves plant^{-1} at 60 DAT (3.25) was found from the treatment using 100% recommended dose of poultry manure (T_9 : 5 ton/ha).

At harvest, number of leaves plant^{-1} also showed significant variation among the different combinations of organic and inorganic fertilizer. Highest number of leaves plant^{-1} (4.41) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) and it was closely followed by T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha) (4.21), T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) (4.11) and T_3 (50 % N of recommended dose+ 5 ton poultry manure/ha) (4.11). Lowest number of leaves plant^{-1} at harvest (3.41) was found from the treatment using only poultry manure (T_9 : 5 ton/ha).

Combination of organic and inorganic fertilizers significantly increased the number of leaves plant^{-1} than sole use of inorganic fertilizer and than that of organic manure. Similar sort of findings were found by many scientists while experimenting with various crops. Ndaeyo *et al.* (2008) showed that higher NPK (15:15:15) fertilizer rate significantly ($P < 0.05$) increased number of leaves. Maurya and Yadav (1987) studied the effect of N level and showed that each increment of N significantly increased leaf number in rice.



T_1: 100% Inorganic fertilizer (Recommended dose) + 5 ton poultry manure/ha, T_2: 75 % N of the recommended dose + 5 ton poultry manure/ha , T_3: 50 % N of the recommended dose + 5 ton poultry manure/ha , T_4: 25 % N of the recommended dose + 5 ton poultry manure/ha , T_5: 75 % S of the recommended dose + 5 ton poultry manure/ha , T_6: 50 % S of the recommended dose + 5 ton poultry manure/ha , T_7: 25 % S of the recommended dose + 5 ton poultry manure/ha, T_8: 100% Inorganic fertilizer , T_9: 5 ton poultry manure/ha

Figure 4.4 : Effect of different combinations of organic and inorganic fertilizer on number of leaves plant^{-1} of BRRI dhan33

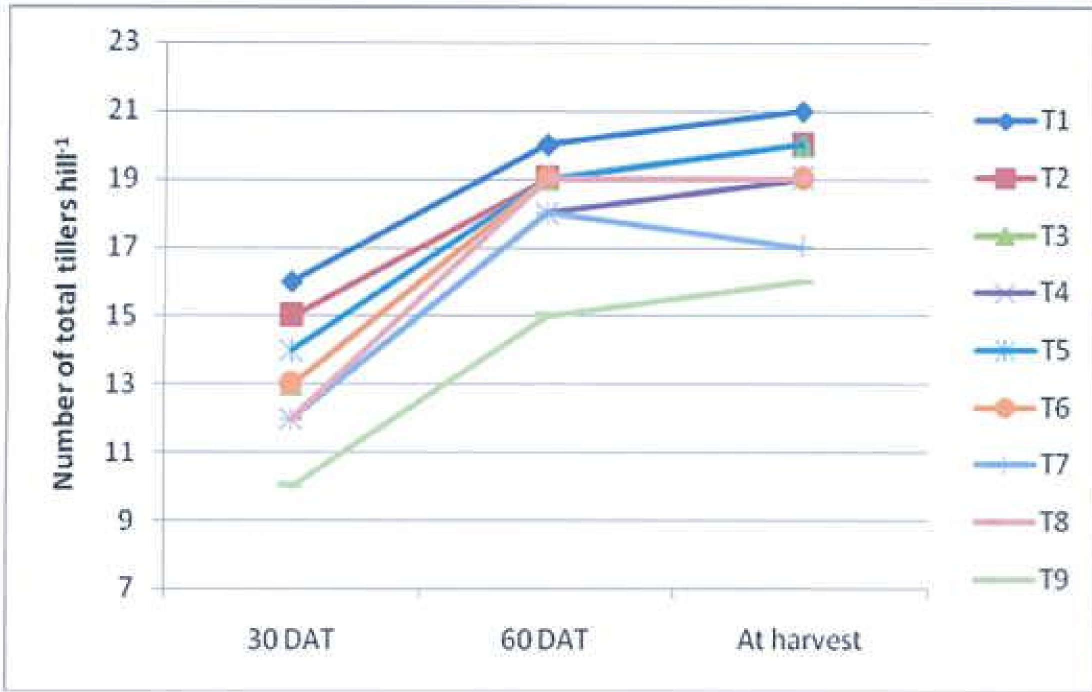
4.5 Number of total tillers

The data on number of total tillers plant^{-1} of rice at different growth stages as influenced by organic and inorganic fertilizers are presented in Figure 4.5 and Appendix VI.

The number of total tillers plant^{-1} at 30 days after transplanting (DAT) differed significantly due to different treatments. Significantly higher number of total tillers plant^{-1} (16) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) which was statistically same with T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha) (15) and it was closely followed by T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) (14). Lowest number of total tillers plant^{-1} at 30 DAT (10) was found from the treatment using sole poultry manure (T_9 : 5 ton/ha).

The number of total tillers plant^{-1} at 60 days after transplanting (DAT) also differed significantly due to different treatments. Highest number of total tillers plant^{-1} (20) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) and it was closely followed by T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha), T_3 (50 % N of recommended dose+ 5 ton poultry manure/ha), T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) and T_6 (50 % S of recommended dose + 5 ton poultry manure/ha) (19). Lowest number of total tillers plant^{-1} at 60 DAT (15) was found from the treatment using 100% recommended dose of poultry manure (T_9 : 5 ton/ha).

At harvest, number of total tillers plant^{-1} also showed significant variation among the different combinations of organic and inorganic fertilizer. Highest number of total tillers plant^{-1} (21) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) and it was closely followed by T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha), T_3 (50 % N of recommended dose+ 5 ton poultry manure/ha) and T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) (20). Lowest number of total tillers plant^{-1} at harvest (16) was found from the treatment using only poultry manure (T_9 : 5 ton/ha).



T_1: 100% Inorganic fertilizer (Recommended dose) + 5 ton poultry manure/ha, T_2: 75 % N of the recommended dose + 5 ton poultry manure/ha , T_3: 50 % N of the recommended dose + 5 ton poultry manure/ha , T_4: 25 % N of the recommended dose + 5 ton poultry manure/ha , T_5: 75 % S of the recommended dose + 5 ton poultry manure/ha , T_6: 50 % S of the recommended dose + 5 ton poultry manure/ha , T_7: 25 % S of the recommended dose + 5 ton poultry manure/ha, T_8: 100% Inorganic fertilizer , T_9: 5 ton poultry manure/ha

Figure 4.5 : Effect of different combinations of organic and inorganic fertilizer on number of total tillers hill^{-1} of BRRI dhan33

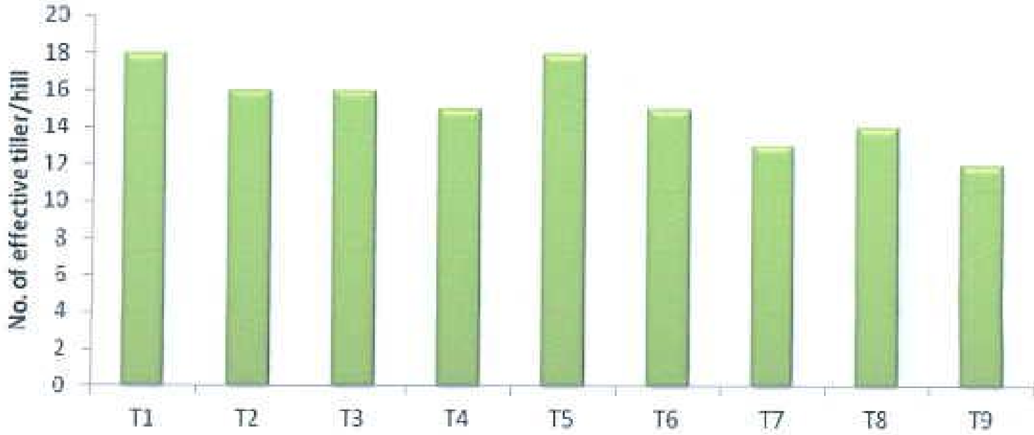
Combination of organic and inorganic fertilizers significantly increased the number of total tillers plant^{-1} than sole use of inorganic fertilizer and than that of organic manure. Similar sort of findings were found by many scientists while experimenting with various crops. Sadaphal *et al.* (1981) found that increased fertilizer dose of NPK increase number of total tillers plant^{-1}. Ahmed *et al.* (1989) found that application of 120 ppm N with 60 ppm S applied as gypsum had a significant positive effect on number of total tillers plant^{-1}.

4.6 Number of effective tillers at harvest

The data on number of effective and non-effective tillers tillers plant^{-1} of rice at harvest as influenced by organic and inorganic fertilizers are presented in Figure 4.6 and Appendix VII.

The number of effective tillers plant^{-1} at harvest differed significantly due to different treatments. Significantly higher number of effective tillers plant^{-1} (18) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) and T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha). Lowest number of effective tillers plant^{-1} at harvest (12) was found from the treatment using sole poultry manure (T_9 : 5 ton/ha).

Combination of organic and inorganic fertilizers significantly increased the number of effective tillers plant^{-1} than sole use of inorganic fertilizer and than that of organic manure. Similar sort of findings were found by many scientists while experimenting with various crops. Amin *et al.* (2004) found that increased fertilizer dose of NPK increase number of total tillers plant^{-1}. Rahman *et al.* (2007) found that application of S had a significant positive effect on number of total and effective tillers plant^{-1}. Combination of organic and inorganic fertilizers was found better for number of effective by Umanah *et al.* (2003) in upland rice and Channabasavanna (2003) in wetland rice than only inorganic fertilizers.



T_1: 100% RDF + PM 5 t ha^{-1}, T_2: 75 % RDN + PM 5 t ha^{-1}, T_3: 50 % RDN + PM 5 t ha^{-1}, T_4: 25 % RDN + PM 5 t ha^{-1}, T_5: 75 % RDS + PM 5 t ha^{-1}, T_6: 50 % RDS + PM 5 t ha^{-1}, T_7: 25 % RDS + PM 5 t ha^{-1}, T_8: 100% RDF, T_9: PM 5 t ha^{-1}

Figure 4.6 : Effect of different combinations of organic and inorganic fertilizer on number of effective tillers plant^{-1} of BRRI dhan33

4.7 Chlorophyll content (mg g^{-1} fresh weight of leaf)

The data on chlorophyll content ("a", "b" and total) of rice at different growth stages as influenced by organic and inorganic fertilizers are presented in Table 4.1 (a, b).

The chlorophyll "a" content at different growth stages (45, 60 and 75 DAT) differed significantly due to different treatments. Significantly higher chlorophyll "a" (2.838, 1.592 and 0.61 mg g^{-1} fresh weight of leaf respectively) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) and it was closely followed by T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha) (2.532, 1.428 and 0.466 mg g^{-1} fresh weight of leaf respectively). Lowest chlorophyll "a" content at different growth stages was found from the treatment using sole poultry manure (T_9 : 5 ton/ha) (2.301, 1.311 and 0.369 mg g^{-1} fresh weight of leaf respectively).The chlorophyll "b" content at different growth stages (45, 60 and 75 DAT) also differed significantly due to different treatments. Significantly higher chlorophyll "b" (2.905, 2.358 and 0.351 mg g^{-1} fresh weight of leaf respectively) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) and it was closely followed by T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha) (2.496, 1.808 and 0.328 mg g^{-1} fresh weight of leaf respectively). Lowest chlorophyll "b" content at different growth stages was found from the treatment using sole poultry manure (T_9 : 5 ton/ha) (1.402, 1.219 and 0.226 mg g^{-1} fresh weight of leaf respectively).

The total chlorophyll content at different growth stages (45, 60 and 75 DAT) also differed significantly due to different treatments. Significantly higher total chlorophyll (5.382, 3.797 and 0.961 mg g^{-1} fresh weight of leaf respectively) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) and it was closely followed by T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha) (5.028, 3.236 and 0.794 mg g^{-1} fresh weight of leaf respectively). Lowest total chlorophyll content at different growth stages was found from the treatment using sole poultry manure (T_9 : 5 ton/ha) (3.703, 2.53 and 0.595 mg g^{-1} fresh weight of leaf respectively). Yuanyuan et al. (2012) found that, with the same fertilization, leaf area index and chlorophyll content values in early paddy rice growth stages were lower, and increased rapidly with the tillers increasing, reaching its maximum value in the heading and flowering stage, then decreased gradually.

Table 4.1 (a): Effect of different combinations of organic and inorganic fertilizer on chlorophyll content ("a" & "b") of BRRI dhan33

Treatments	Chlorophyll a (mg g^{-1} fresh weight of leaf)			Chlorophyll b(mg g^{-1} fresh weight of leaf)		
	45 DAT	60 DAT	75 DAT	45 DAT	60 DAT	75 DAT
T_1	2.838 a	1.592 a	0.61 a	2.905 a	2.358 a	0.351 a
T_2	2.532 b	1.428 b	0.466 bc	2.496 bc	1.808 c	0.328 a-c
T_3	2.458 bc	1.407 bc	0.452 bc	2.48 bc	1.504 d	0.246 a-c
T_4	2.406 b-d	1.383 bc	0.405 c	1.945 d	1.23 e	0.21 c
T_5	2.427 b-d	1.438 b	0.535ab	2.341 c	1.749 c	0.299 a-c
T_6	2.397 b-d	1.381 bc	0.534 ab	1.783 d	1.563 d	0.267 a-c
T_7	2.318 cd	1.374 bc	0.432 bc	1.571 e	1.474 d	0.266 a-c
T_8	2.339 cd	1.378 bc	0.401 c	2.435 bc	1.76 c	0.299 a-c
T_9	2.301 d	1.311 c	0.369 c	1.402 e	1.219 e	0.226 bc
$LSD_{0.05}$	0.1394	0.1061	0.1153	0.1781	0.1394	0.1104
CV %	3.01	2.54	1.987	3.25	1.69	5.13
Significance level	*	**	**	**	**	**

** - Significant at 1% level, * - Significant at 5% level

Table 4.1 (b) : Effect of different combinations of organic and inorganic fertilizer on chlorophyll content (total) of BRRI dhan33

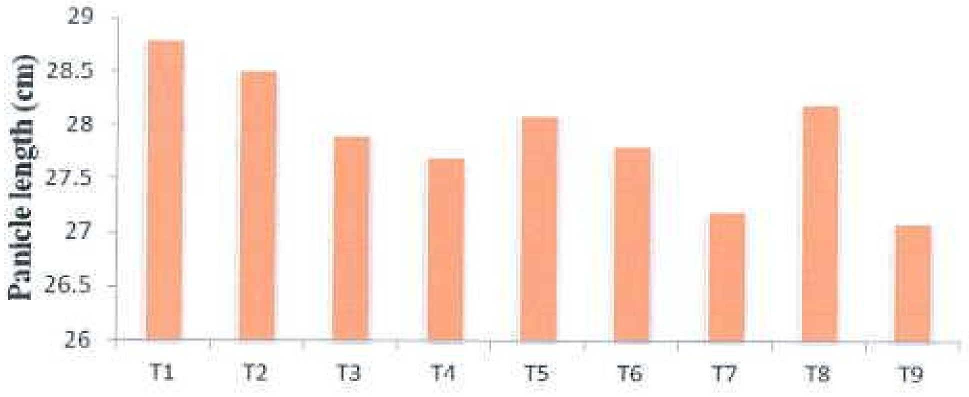
Treatments	Total chlorophyll (mg g^{-1} fresh weight of leaf)		
	45 DAS	60 DAS	75 DAS
T_1	5.382 a	3.797 a	0.961 a
T_2	5.028 b	3.236 b	0.794 a-c
T_3	4.938 bc	2.911 cd	0.698 bc
T_4	4.351 d	2.613 e	0.615 bc
T_5	4.768 c	3.247 b	0.834 ab
T_6	4.18 d	2.944 cd	0.801 a-c
T_7	3.889 e	2.848 d	0.698 bc
T_8	4.774 c	3.138 bc	0.7 bc
T_9	3.703 f	2.53 e	0.595 c
$LSD_{0.05}$	0.1781	0.2285	0.1998
CV %	3.57	2.91	3.39
Significance level	**	**	**

** - Significant at 1% level

4.8 Panicle length

The panicle length differed significantly due to different treatments (Figure 4.7 and Appendix VIII). Significantly higher panicle length (28.8 cm) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) which was statistically similar with T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha) (28.5 cm), T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) (28.1 cm), T_3(27.9 cm), T_4 (27.7 cm) and

T_8 (100% Inorganic fertilizer) (28.2 cm) and. Lowest panicle length (27.1) was found from the treatment using poultry manure only (T_9 : 5 ton/ha).



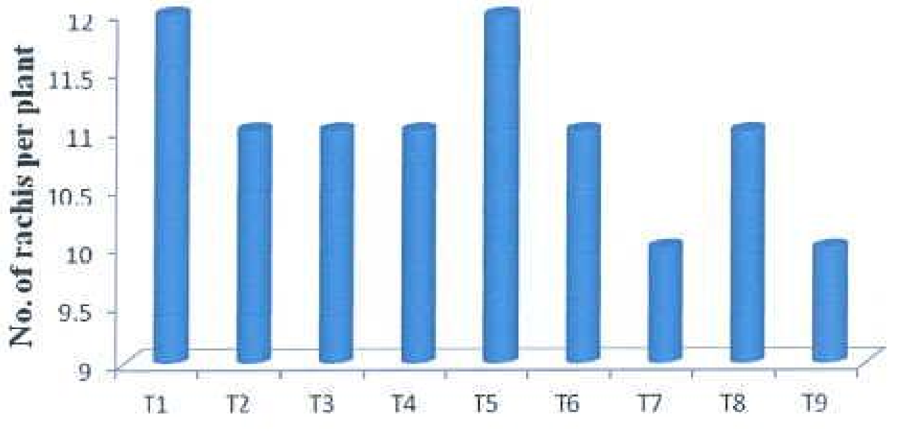
T_1: 100% RDF + PM 5 t ha^{-1}, T_2: 75 % RDN + PM 5 t ha^{-1}, T_3: 50 % RDN + PM 5 t ha^{-1}, T_4: 25 % RDN + PM 5 t ha^{-1}, T_5: 75 % RDS + PM 5 t ha^{-1}, T_6: 50 % RDS + PM 5 t ha^{-1}, T_7: 25 % RDS + PM 5 t ha^{-1}, T_8: 100% RDF, T_9: PM 5 t ha^{-1}

Figure 4.7: Effect of different combinations of organic and inorganic fertilizer on panicle length of BRRI dhan33

Sadaphal *et al*. (1981) showed that length of panicle under 80 and 120 kg N/ha were at par and were significantly superior to the attributes recorded at 40 kg N/ha.

4.9 Number of rachis per plant

The number of rachis plant^{-1} differed significantly due to different combinations of organic and inorganic fertilizer (Figure 4.8 and Appendix VIII). Significantly higher number of rachis plant^{-1} (12) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) and T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha). Lowest number of rachis plant^{-1} (10) was found from the treatment using sole poultry manure (T_9 : 5 ton/ha) and T_7 (25 % S + 5 ton poultry manure/ha).

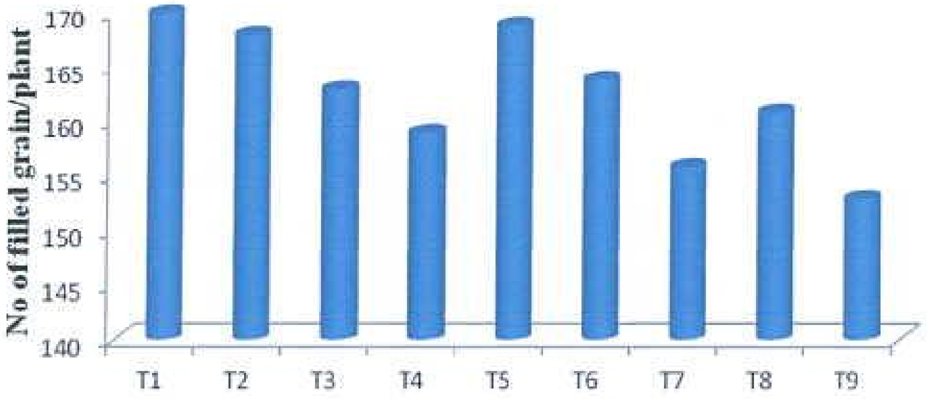


T_1: 100% RDF + PM 5 t ha^{-1}, T_2: 75 % RDN + PM 5 t ha^{-1}, T_3: 50 % RDN + PM 5 t ha^{-1}, T_4: 25 % RDN + PM 5 t ha^{-1}, T_5: 75 % RDS + PM 5 t ha^{-1}, T_6: 50 % RDS + PM 5 t ha^{-1}, T_7: 25 % RDS + PM 5 t ha^{-1} T_8: 100% RDF, T_9: PM 5 t ha^{-1}

Figure 4.8: Effect of different combinations of organic and inorganic fertilizer on number of rachis $plant^{-1}$ of BRRI dhan33

4.10 Number of filled grain per plant

The number of filled grain $plant^{-1}$ differed significantly due to different combinations of organic and inorganic fertilizer (Figure 4.9 and Appendix VIII). Significantly higher number of filled grain $plant^{-1}$ (170) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) and it was closely followed by T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) (169) and T_2 (75% N + 5 ton poultry manure/ha) (168). Lowest number of filled grain $plant^{-1}$ (153) was found from the treatment using sole poultry manure (T_9 : 5 ton/ha).



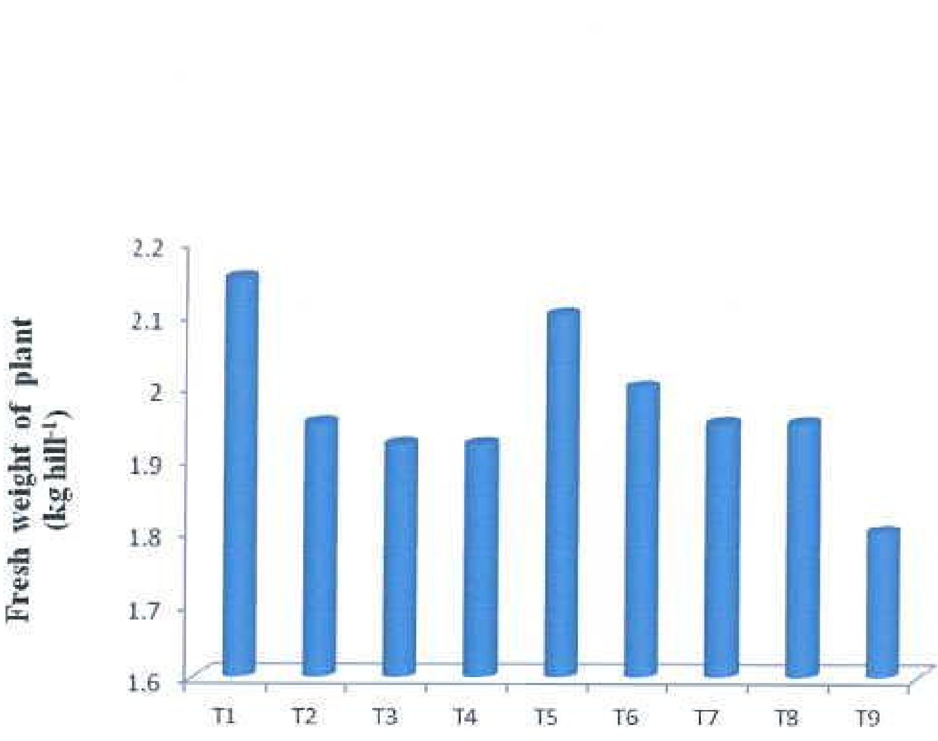
T_1: 100% RDF + PM 5 t ha^{-1}, T_2: 75 % RDN + PM 5 t ha^{-1}, T_3: 50 % RDN + PM 5 t ha^{-1}, T_4: 25 % RDN + PM 5 t ha^{-1}, T_5: 75 % RDS + PM 5 t ha^{-1}, T_6: 50 % RDS + PM 5 t ha^{-1}, T_7: 25 % RDS + PM 5 t ha^{-1}, T_8: 100% RDF, T_9: PM 5 t ha^{-1}

Figure 4.9: Effect of different combinations of organic and inorganic fertilizer on number of filled grain $plant^{-1}$ of BRRI dhan33

Bhuvaneswari *et al.* (2007) found that number of filled grains per panicle increased with S levels and highest grain (5750 kg per ha) and straw (7300 kg per ha) yield was noticed with 40 kg S per ha plus FYM at the rate of 12.5 t per ha and decreased thereafter with further increase in sulphur level.

4.11 Fresh weight of plant (kg $hill^{-1}$)

Fresh weight of plant (kg $hill^{-1}$) differed significantly among the different combinations of organic and inorganic fertilizer (Figure 4.11 and Appendix IX). Significantly higher fresh weight of plant (2.15 kg $hill^{-1}$) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) and it was statistically similar with T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) (2.1 kg $hill^{-1}$). Among the treatments, lowest fresh weight of plant (1.8 kg $hill^{-1}$) was found from the treatment using sole poultry manure (T_9 : 5 ton/ha).

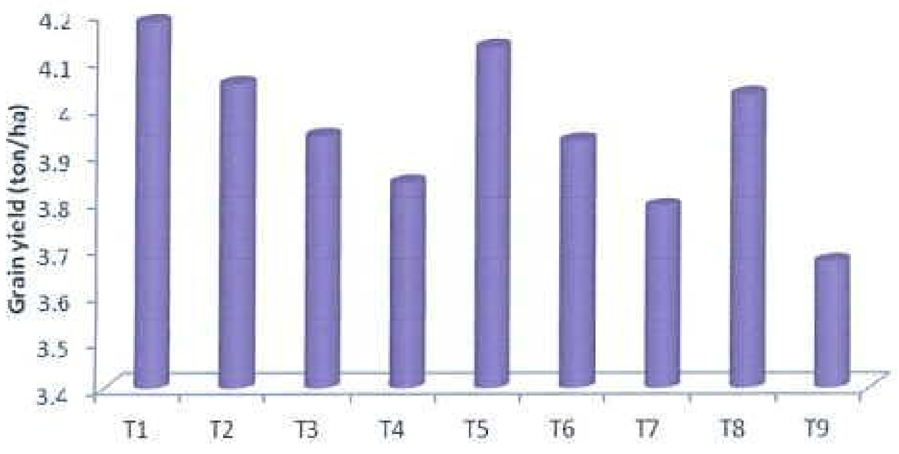


T_1: 100% RDF + PM 5 t ha^{-1}, T_2: 75 % RDN + PM 5 t ha^{-1}, T_3: 50 % RDN + PM 5 t ha^{-1}, T_4: 25 % RDN + PM 5 t ha^{-1}, T_5: 75 % RDS + PM 5 t ha^{-1}, T_6: 50 % RDS + PM 5 t ha^{-1}, T_7: 25 % RDS + PM 5 t ha^{-1}, T_8: 100% RDF, T_9: PM 5 t ha^{-1}

Figure 4.10: Effect of different combinations of organic and inorganic fertilizer on fresh weight of plant of BRRI dhan33

4.12 Grain yield

Grain yield (t ha^{-1}) differed significantly among the different combinations of organic and inorganic fertilizer (Figure 4.12 and Appendix IX). Significantly higher grain yield (4.18 t ha^{-1}) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) which was statistically similar with T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) (4.13 t ha^{-1}). Better result was also given by T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha) (4.05 t ha^{-1}). Lowest grain yield (3.67 t ha^{-1}) was found from the treatment using sole poultry manure (T_9 : 5 ton/ha).



T_1: 100% RDF + PM 5 t ha^{-1}, T_2: 75 % RDN + PM 5 t ha^{-1}, T_3: 50 % RDN + PM 5 t ha^{-1}, T_4: 25 % RDN + PM 5 t ha^{-1}, T_5: 75 % RDS + PM 5 t ha^{-1}, T_6: 50 % RDS + PM 5 t ha^{-1}, T_7: 25 % RDS + PM 5 t ha^{-1}, T_8: 100% RDF, T_9: PM 5 t ha^{-1}

Figure 4.11: Effect of different combinations of organic and inorganic fertilizer on grain yield (t ha^{-1}) of BRRI dhan33

Sarker *et al.* (2001) observed that application of nitrogen increased grain and straw yields significantly. Rahman *et al.* (2007) reported that application of S fertilizer at a recommended rate (20kg S/ha) might be necessary for obtaining higher grain yield as well as straw yield of Boro rice (cv BRRI dhan29). Islam *et al.* (2008) found that grain yield influenced significantly due to application of different rates of nutrients and 60-19-36 kg/ha NPK maximized the yield of T. *aman* rice varieties. Tiwari *et al.* (1983) conducted a green house experiment where they found that grain yield increased from 42.8 g per pot to 47.6 g per pot with sulphur application. Vanaja and Raju (2002) found that combinations of chemical fertilizer with poultry manure (PM) 2 t/ ha gave highest grain and straw yield. Channabasavanna (2003) found that grain yield increased with each increment of poultry manure application and was maximuma at 3 t poultry manure/ha.

4.12 N and S content in grain

4.12.1 N content in grain

N content in grain (%) differed significantly among the different combinations of organic and inorganic fertilizer (Table 4.2). Significantly higher N content in grain (1.28%) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) which was closely followed by T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) (1.25%). Better results were also given by T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha) (1.21%) and T_8 (100% Inorganic fertilizer) (1.19%). Lowest N content in grain (1.10%) was found from the treatment using poultry manure only (T_9 : 5 ton/ha) which was statistically similar with T_7 (25 % S of recommended dose + 5 ton poultry manure/ha) (1.13%). Bari *et al.* (2013) found that nutrient content in grain increased while organic manure combined with inorganic fertilizers.

4.12.2 S content in grain (%)

S content in grain (%) differed significantly among the different combinations of organic and inorganic fertilizer (Table 4.2). Significantly higher S content (0.477%) was recorded in T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) which was closely followed by T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) (0.41%). Better results were also given by T_6 (50 % S of recommended dose + 5 ton poultry manure/ha) which gave 0.372% S in straw. Lowest S content (0.183%) was found from the treatment using poultry manure only (T_9 : 5 ton/ha). Bari *et al.* (2013) found that nutrient content in grain increased while organic manure combined with inorganic fertilizers.

Table 4.2: Effect of different combinations of organic and inorganic fertilizer on N and S content in grain (%) of BRRI dhan33

Treatments	Grain	
	N	S
T_1	1.28 a	0.41 b
T_2	1.21 a-c	0.226 d
T_3	1.15 bc	0.215 d
T_4	1.14 bc	0.198 d
T_5	1.25 ab	0.477 a
T_6	1.16 bc	0.372 bc
T_7	1.13 c	0.268 cd
T_8	1.19 a-c	0.226 d
T_9	1.10 c	0.183 d
$LSD_{0.05}$	0.1075	0.1239
CV %	4.33	4.13
Significance level	*	**

* - Significant at 5 % level, ** - Significant at 1 % level, ns- non-significant

4.13 Nutrient content in straw

4.13.1 N content in straw (%)

N content in straw (%) differed significantly among the different combinations of organic and inorganic fertilizer (Table 4.3). Significantly higher N content (0.351%) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) which was closely followed by T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) (0.334%). Better results were also given by T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha) (0.318%) and T_6 (50 % S of recommended dose + 5 ton poultry manure/ha) (0.309%). Lowest N content (0.286%) was found from the treatment using poultry manure only (T_9 : 5 ton/ha). These results have the conformity with the results of Bari *et al.* (2013).

4.13.2 P content in straw (%)

P content in straw (%) differed insignificantly among the different combinations of organic and inorganic fertilizer (Table 4.3). Though higher P content (0.213%) was recorded in T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) which was closely followed by T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) (0.195%). Lowest P content (0.146%) was found from the treatment using poultry manure only (T_9 : 5 ton/ha). These results agree with the results of Bari *et al.* (2013).

4.13.3 K content in straw (%)

K content in straw (%) differed significantly among the different combinations of organic and inorganic fertilizer (Table 4.3). Significantly higher K content (1.8 %) was recorded in T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha) which was closely followed by T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) (1.63%). Better results were also given by T_3 (50 % N of recommended dose+ 5 ton poultry manure/ha) and T_6 (50 % S of recommended dose + 5 ton poultry manure/ha) both of which gave 1.47% K in straw.

Lowest K content (1.15%) was found from the treatment using poultry manure only (T_9 : 5 ton/ha). These results have the conformity with the results of Bari *et al.* (2013).

4.13.4 S content in straw (%)

S content in straw (%) differed significantly among the different combinations of organic and inorganic fertilizer (Table 4.3). Significantly higher S content in straw (0.293%) was recorded in T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) which was statistically same with T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) (0.285%). Better results were also given by T_6 (50 % S of recommended dose + 5 ton poultry manure/ha) which gave 0.231% S in straw. Lowest S content in straw (0.149%) was found from the treatment using poultry manure only (T_9 : 5 ton/ha). These results have the conformity with the results of Bari *et al.* (2013).

Table 4.3: Effect of different combinations of organic and inorganic fertilizer on N, P, K and S content in straw (%) of BRRI dhan33

Treatments	Straw			
	N	P	K	S
T_1	0.351 a	0.195	1.31 de	0.285 a
T_2	0.318 a-c	0.192	1.8 a	0.221 b
T_3	0.302 bc	0.157	1.47 c	0.181 c-e
T_4	0.29 c	0.149	1.19 ef	0.156 de
T_5	0.334 ab	0.213	1.63 b	0.293 a
T_6	0.309 bc	0.186	1.47 c	0.231 b
T_7	0.3 bc	0.151	1.29 de	0.193 b-d
T_8	0.305 bc	0.192	1.34 d	0.209 bc
T_9	0.286 c	0.146	1.15 f	0.149 e
$LSD_{0.05}$	0.03662	0.1061	0.1153	0.03662
CV %	2.56	3.11	6.51	1.27
Significance level	*	ns	**	**

* - Significant at 5 % level, ** - Significant at 1 % level, ns- non-significant

CHAPTER 5

SUMMARY AND CONCLUSION

The experiment was conducted in the Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from August to December 2012 to study the effect of various combinations of organic manure and inorganic fertilizer on the growth, yield, chlorophyll and nutrient content of Aman rice. BRRI dhan33 was used as the test crop in this experiment. The experiment consists of the following treatments : T_1: 100% Inorganic fertilizer (Recommended dose) + 5 ton poultry manure/ha , T_2: 75 % N of recommended dose+ 5 ton poultry manure/ha, T_3: 50 % N of recommended dose+ 5 ton poultry manure/ha, T_4: 25 % N of recommended dose+ 5 ton poultry manure/ha, T_5: 75 % S of recommended dose+ 5 ton poultry manure/ha, T_6: 50 % S of recommended dose+ 5 ton poultry manure/ha, T_7: 25 % S of recommended dose+ 5 ton poultry manure/ha, T_8: 100% Inorganic fertilizer and T_9: 5 ton poultry manure/ha. The soil of the experimental field initially had a pH of 6.9, organic carbon 1.05%, total N 0.08%, available P 12.78 ppm, exchangeable K 43.29 ppm, available S 23.74 ppm, available B 0.36 ppm. The experiment was designed with 9 treatments, laid out in a randomized complete block design (RCBD) with three replications. Each plot size was 2 m x 2 m.

The seeds were sown in 10 March 2012. Forty days old seedlings of BRRI dhan33 were carefully uprooted from the seedling nursery and transplanted on 21st August, 2012 in well puddled plot. All recommended cultural practices were followed to grow the crop.

Frequent samplings were done at 30 and 60 days after transplanting (DAS) and at harvest for counting plant height, number of leaves/plant, number of branches/plant. The crop was harvested at maturity on 27 December, 2012. Grain yields were recorded at 14% moisture content. The seed samples were chemically analyzed for N and S content and straw samples were chemically analyzed for N, P, K, and S content. All the data were statistically analyzed by MSTAT-C programme and the differences between treatments means were adjudged by Duncan's Multiple Range Test (DMRT).

Significant variation was found in growth and yield parameters as well as in chlorophyll content and nutrient content of Aman rice due to the various combinations of organic and inorganic fertilizers. At 30 DAT, significantly higher plant height was recorded in T_1 and it was statistically similar with the application of 75 % S of recommended dose+ 5 ton poultry manure/ha (T_5). At 60 and at harvest, highest plant heights were recorded in T_5 and it was statistically similar with T_1. At all the growth stages, leaf length was highest at T_1 and it was closely followed by T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) and T_6 (50 % S of recommended dose+ 5 ton poultry manure/ha). The leaf diameter at 30 days after transplanting (DAT) differed insignificantly due to different treatments. Highest leaf diameter (1.4 cm) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha), T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) and in T_6 (50 % S of recommended dose+ 5 ton poultry manure/ha) at 60 and at harvest. Significantly higher number of leaves plant^{-1} was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) which was statistically similar with T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha) (3.9) and it was closely followed by T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) and T_3 (50 % N of recommended dose+ 5 ton poultry manure/ha) at 30 and 60 DAT. At harvest, number of leaves plant^{-1} was recorded highest in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) and it was statistically similar with T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha), T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) and T_3 (50 % N of recommended dose+ 5 ton poultry manure/ha). At 30 DAT, among the various treatments, the highest number of total tillers plant^{-1} was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) which was statistically similar with T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha) and it was closely followed by T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha). At 60 and at harvest, similar trend was observed. All the above growth parameters gave lowest result at T_9 (5 ton poultry manure/ha).

Significantly higher number of effective tillers plant^{-1} was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) and T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha). Lowest number of effective tillers plant^{-1} at harvest (12) was found from the treatment using sole poultry manure (T_9 : 5 ton/ha). Highest number of non-effective tillers plant^{-1} (5) was recorded in T_8 (100 % inorganic fertilizer) and it was followed by T_2, T_3, T_4, T_6 and T_9 as all of these gave 4 non-effective tillers plant^{-1}. Lowest number of non-effective tillers plant^{-1} at harvest (2) was found from the treatment using T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha).

Significantly higher chlorophyll "a", "b" and total chlorophyll content (2.838, 1.592 and 0.61 mg g^{-1} fresh weight of leaf respectively) were recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) and it was closely followed by T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha) and T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) at 45, 60 and 75 DAT. On the other hand, lowest chlorophyll "a", "b" and total chlorophyll content at different growth stages was found from the treatment using sole poultry manure (T_9 : 5 ton/ha).

Higher panicle length was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) which was statistically same with T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha) and was closely followed by T_8 (100% Inorganic fertilizer) and T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha). Significantly higher number of rachis $plant^{-1}$ (12) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) and T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha). Significantly higher number of filled grain $plant^{-1}$ was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) and it was closely followed by T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) and T_2 (75% N + 5 ton poultry manure/ha) and lower number of unfilled grain $plant^{-1}$ was recorded in T_9. Higher fresh weight of plant (2.15 kg $hill^{-1}$) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) and it was statistically similar with T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) (2.1 kg $hill^{-1}$). All the above yield attributing parameters showed lowest result at sole poultry manure (T_9 : 5 ton/ha) except number of unfilled grain plant$^-$

$^{-1}$. Significantly higher grain yield (4.18 t ha^{-1}) was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) which was statistically similar with T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) (4.13 t ha^{-1}). Better result was also given by T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha) (4.05 t ha^{-1}). Lowest grain yield (3.67 t ha^{-1}) was found from the treatment using sole poultry manure (T_9 : 5 ton/ha).

N, P, K and S contents of rice straw were differed significantly due to the different combinations of organic and inorganic fertilizer doses. Significantly higher N and K content was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) which was closely followed by T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha). Better results were also given by T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha) and T_6 (50 % S of recommended dose+ 5 ton poultry manure/ha). P content in straw (%) differed insignificantly among the different combinations of organic and inorganic fertilizer though higher P content was recorded in T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) which was closely followed by T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha). Significantly higher S content was recorded in T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) which was statistically same with T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha). Better results were also given by T_6 (50 % S of recommended dose+ 5 ton poultry manure/ha). Lowest N, P, K and S contents of rice straw were found from the treatment using poultry manure only (T_9 : 5 ton/ha). Significantly higher N content in grain was recorded in T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha) which was closely followed by T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha). Better results were also given by T_2 (75 % N of recommended dose+ 5 ton poultry manure/ha) and T_6 (50 % S of recommended dose+ 5 ton poultry manure/ha). Lowest N content in grain (1.10%) was found from the treatment using poultry manure only (T_9 : 5 ton/ha) which was statistically similar with T_7 (25 % S of recommended dose+ 5 ton poultry manure/ha) (1.13%). Significantly higher S content in grain was recorded in T_5 (75 % S of recommended dose+ 5 ton poultry manure/ha) which was closely followed by T_1 (100% Inorganic fertilizer + 5 ton poultry manure/ha). Better results were also given by T_6 (50 % S of recommended dose+ 5 ton poultry manure/ha). Lowest S content in grain (0.149%) was found from the treatment using poultry manure only (T_9 : 5 ton/ha).

From the above results it can be concluded that combination of organic manure and inorganic fertilizer is more productive compare to sole use of organic manure and inorganic fertilizers.

It is true that sustainable production of crops cannot be maintained by using only chemical fertilizers and similarly it is also not possible to obtain higher crop yield by using organic manure alone. So use of organic manure in integration with inorganic fertilizers is very important in improving soil fertility and crop productivity. By combining the both, we may be able to reduce the doses of inorganic fertilizers. It is evident from the results that, in case of BRRI dhan33, 5 ton/ha poultry manure +75% S gave statistically similar growth, yield contributing characters, yield and nutrient content with 100% Inorganic fertilizer + 5 ton poultry manure/ha. So, if we use 5 ton/ha poultry manure +75% S, it will allow us to lessen 25% inorganic sulfur fertilizer at least.

Suggestion for future research:

1. Studies with different doses of poultry manure or other organic manure should be performed.
2. Research works may be initiated on the long term effects of organics and their residual effect on succeeding crop.
3. Other improved cultivars may be tested under such fertilizer combinations.

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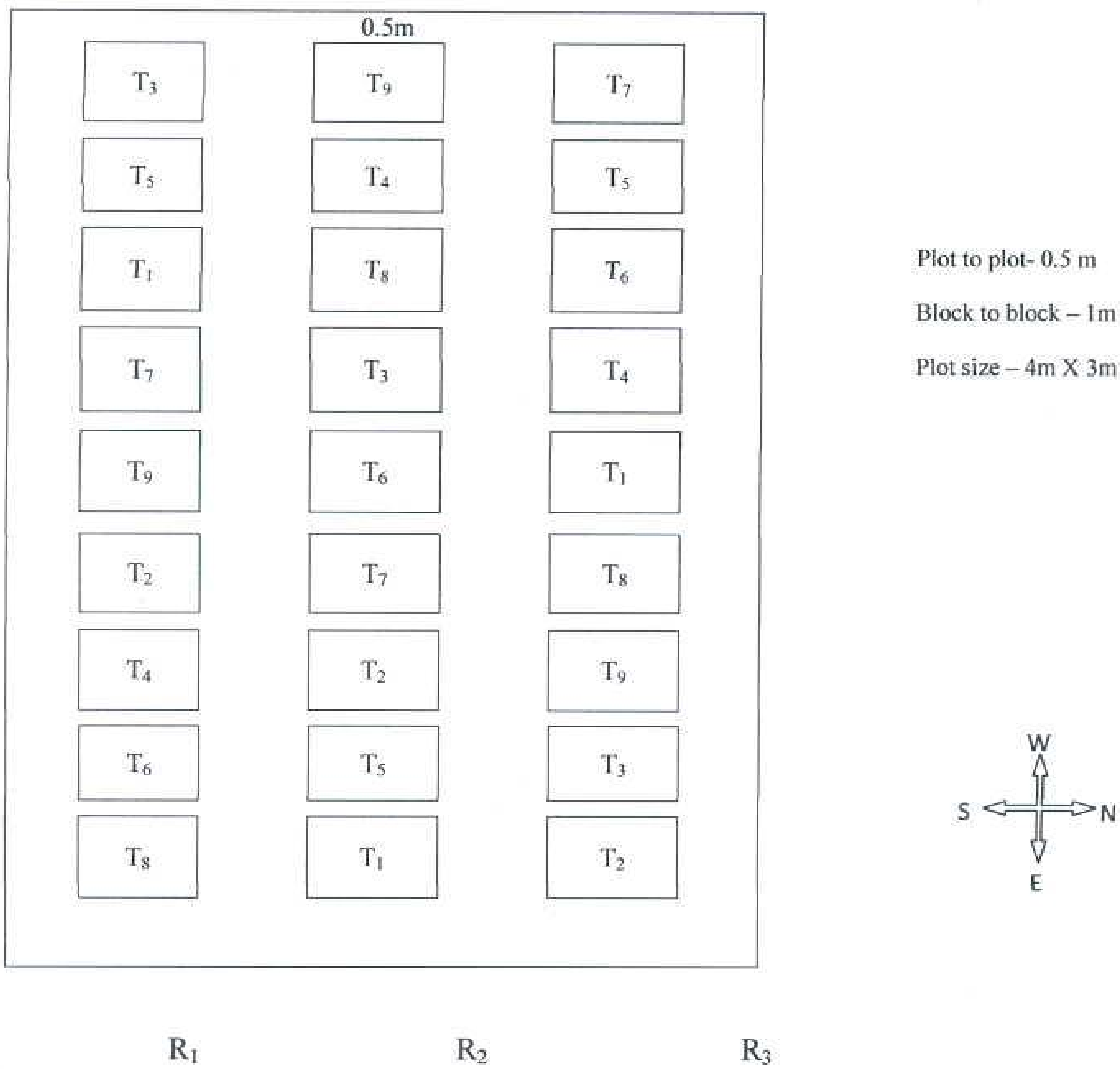
APPENDICES

Appendix 1: Layout of the experiment



Appendix II: Effect of different combinations of organic and inorganic fertilizer on plant height of BRRI dhan33

Treatments	Plant height (cm)		
	30 DAT	60 DAT	At harvest
T_1	59.4 a	100.1 ab	102.2 ab
T_2	55.6 b	99.5 ab	101.0 a-c
T_3	50.0 cd	97.4 a-d	100.5 bc
T_4	46.4 e	92.3 cd	94.7 cd
T_5	57.6 a	103.6 a	104.6 a
T_6	54.6 b	98.0 a-c	98.2 b-d
T_7	51.6 c	97.95 a-c	96.1 cd
T_8	57.6 a	96.9 b-d	98.8 b-d
T_9	48.4 d	91.4 d	93.2 d
$LSD_{0.05}$	1.895	5.661	6.358
CV %	4.56	2.37	6.89
Significance level	**	**	**

* - Significant at 5 % level, ** - Significant at 1 % level, ns- non-significant

Appendix III: Effect of different combinations of organic and inorganic fertilizer on leaf length of BRRI dhan33

Treatments	Leaf length (cm)		
	30 DAT	60 DAT	At harvest
T_1	40.6 a	46.8 a	47.37 a
T_2	36.2 a-c	43.6 a-c	44.17 a-c
T_3	33.8 a-c	42.7 a-c	43.27 bc
T_4	31.2 bc	40.6 bc	41.17 c
T_5	38.8 ab	45.4 ab	45.97 ab
T_6	35.4 a-c	44 a-c	44.57 a-c
T_7	32.8 a-c	42.4 a-c	42.97 bc
T_8	33.4 a-c	41.8 bc	42.37 bc
T_9	27.8 c	40.2 c	40.77 c
$LSD_{0.05}$	7.698	4.513	3.662
CV %	3.85	2.39	5.156
Significance level	**	**	**

* - Significant at 5 % level, ** - Significant at 1 % level, ns- non-significant

Appendix IV: Effect of different combinations of organic and inorganic fertilizer on leaf diameter of BRRI dhan33

Treatments	Leaf diameter (cm)		
	30 DAT	60 DAT	At harvest
T_1	1.0	1.4 a	1.45 a
T_2	1.0	1.36 ab	1.41 ab
T_3	1.1	1.33 ab	1.38 ab
T_4	1.0	1.3 ab	1.35 ab
T_5	1.0	1.4 a	1.45 a
T_6	1.1	1.4 a	1.45 a
T_7	1.0	1.3 ab	1.35 ab
T_8	1.1	1.33 ab	1.38 ab
T_9	1.1	1.2 b	1.25 b
$LSD_{0.05}$	1.781	0.1781	0.1394
CV %	5.98	5.67	4.25
Significance level	ns	*	*

* - Significant at 5 % level, ** - Significant at 1 % level, ns- non-significant

Appendix V: Effect of different combinations of organic and inorganic fertilizer on number of leaves plant^{-1} of BRRI dhan33

Treatments	No. of leaves per plant		
	30 DAT	60 DAT	At harvest
T_1	4.1 a	4.25 a	4.41 a
T_2	3.9 a	4.05 a	4.21 ab
T_3	3.8 ab	3.95 ab	4.11 ab
T_4	3.6 a-c	3.75 a-c	3.91 bc
T_5	3.8 ab	3.95 ab	4.11 ab
T_6	3.5 a-c	3.65 a-c	3.81 b-d
T_7	3.2 bc	3.35 bc	3.51 cd
T_8	3.7 a-c	3.85 a-c	4.01 ab
T_9	3.1 c	3.25 c	3.41 d
$LSD_{0.05}$	0.566	0.5994	0.4467
CV %	2.11	7.09	5.32
Significance level	*	**	**

* - Significant at 5 % level, ** - Significant at 1 % level, ns- non-significant

Appendix VI: Effect of different combinations of organic and inorganic fertilizer on number of total tillers hill^{-1} of BRRI dhan33

Treatments	No of Tiller		
	30 DAT	60 DAT	At harvest
T_1	16 a	20 a	21 a
T_2	15 a	19 ab	20 ab
T_3	13 ab	19 ab	20 ab
T_4	12 ab	18 ab	19 a-c
T_5	14 ab	19 ab	20 ab
T_6	13 ab	19 ab	19 a-c
T_7	12 ab	18 ab	17 bc
T_8	12 ab	19 ab	19 a-c
T_9	10 b	15 b	16 c
$LSD_{0.05}$	3.983	4.467	3.371
CV %	5.17	3.09	7.18
Significance level	**	**	**

* - Significant at 5 % level, ** - Significant at 1 % level, ns- non-significant

Appendix VII: Effect of different combinations of organic and inorganic fertilizer on number of effective tillers plant^{-1} of BRRI dhan33

Treatments	No. of effective tiller
T_1	18 a
T_2	16 b
T_3	16 b
T_4	15 c
T_5	18 a
T_6	15 c
T_7	13 e
T_8	14 d
T_9	12 f
$LSD_{0.05}$	0.5660
CV %	5.17
Significance level	**

* - Significant at 5 % level, ** - Significant at 1 % level, ns- non-significant

Appendix VIII: Effect of different combinations of organic and inorganic fertilizer on panicle length, number of rachis plant^{-1}, number of filled grain plant^{-1} of BRRI dhan33

Treatments	Panicle length	No of rachis per plant	No of filled grain/plant
T_1	28.8 a	12 a	170 a
T_2	28.5 a	11 b	168 ab
T_3	27.9 ab	11 b	163 cd
T_4	27.7 ab	11 b	159 de
T_5	28.1 ab	12 a	169 ab
T_6	27.8 ab	11 b	164 bc
T_7	27.2 b	10 c	156 ef
T_8	28.2 ab	11 b	161 cd
T_9	27.1 b	10 c	153 f
$LSD_{0.05}$	1.158	0.3717	4.513
CV %	1.94	5.59	6.21
Significance level	*	*	**

* - Significant at 5 % level, ** - Significant at 1 % level, ns- non-significant

Appendix IX: Effect of different combinations of organic and inorganic fertilizer on fresh weight of plant and grain yield of BRRI dhan33

Treatments	Fresh weight of plant kg hill^{-1}	Yield (ton/ha)
T_1	2.15 a	4.18 a
T_2	1.95 cd	4.05 bc
T_3	1.92 de	3.94 cd
T_4	1.92 de	3.84 de
T_5	2.1 ab	4.13 a
T_6	2 bc	3.93 cd
T_7	1.95 cd	3.79 e
T_8	1.95 cd	4.03 bc
T_9	1.8 e	3.67 f
$LSD_{0.05}$	0.1153	0.1158
CV %	6.10	3.91
Significance level	*	**

* - Significant at 5 % level, ** - Significant at 1 % level, ns- non-significant

Appendix X : ANOVA

A N A L Y S I S   O F   V A R I A N C E   T A B L E (Plant height at 30 DAT ; Appendix ii)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	515.388	57.265	64.0000	0.0000
-3	Error	18	0.000	0.000		
	Total	29	515.388			

A N A L Y S I S   O F   V A R I A N C E   T A B L E (Plant height at 60 DAT; Appendix ii)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	351.528	39.059	742.0000	0.0000
-3	Error	18	0.000	0.000		
	Total	29	351.528			

A N A L Y S I S   O F   V A R I A N C E   T A B L E (Plant height at harvest; Appendix ii)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	-0.000	-0.000	-9.0000	
2	Factor A	9	434.952	48.328	48.0000	0.0000
-3	Error	18	0.000	0.000		
	Total	29	434.952			

A N A L Y S I S   O F   V A R I A N C E   T A B L E (Leaf length at 30 DAT; Appendix iii)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	420.288	46.699	31.0000	0.0000
-3	Error	18	0.000	0.000		
	Total	29	420.288			

A N A L Y S I S   O F   V A R I A N C E   T A B L E(Leaf length at 60 DAT; Appendix iii)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	111.627	12.403	41.0000	0.0000
-3	Error	18	0.000	0.000		
	Total	29	111.627			

A N A L Y S I S   O F   V A R I A N C E   T A B L E(Leaf length at harvest; Appendix iii)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	111.627	12.403	35.0000	0.0000
-3	Error	18	0.000	0.000		
	Total	29	111.627			

A N A L Y S I S   O F   V A R I A N C E   T A B L E (Leaf diameter at 30 DAT; Appendix iv)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	0.072	0.008	5.0000	3.20
-3	Error	18	0.000	0.000		
	Total	29	0.072			

A N A L Y S I S   O F   V A R I A N C E   T A B L E(Leaf diameter at 60 DAT; Appendix iv)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	-0.000	-0.000	0.0000	
2	Factor A	9	0.117	0.013	0.0000	0.00410
-3	Error	18	0.000	0.000		
	Total	29	0.117			

A N A L Y S I S   O F   V A R I A N C E   T A B L E (Leaf diameter at harvest;   Appendix iv)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	-0.000	-0.000	-4.5000	
2	Factor A	9	0.117	0.013	45.0000	0.00380
-3	Error	18	0.000	0.000		
	Total	29	0.117			

A N A L Y S I S   O F   V A R I A N C E   T A B L E (No of leaf at 30 DAT; Appendix v)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	2.712	0.301	40.0000	0.00430
-3	Error	18	0.000	0.000		
	Total	29	2.712			

A N A L Y S I S   O F   V A R I A N C E   T A B L E (No of leaf at 60 DAT; Appendix v)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	2.712	0.301	36.0200	0.0000
-3	Error	18	0.000	0.000		
	Total	29	2.712			

A N A L Y S I S   O F   V A R I A N C E   T A B L E (No of leaf at harvest; Appendix v)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	2.712	0.301	52.0000	0.0000
-3	Error	18	0.000	0.000		
	Total	29	2.712			

A N A L Y S I S   O F   V A R I A N C E   T A B L E (Chlorophyll a at 60 DAT ;Table 4.1(a))

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	-0.000	-0.000	-4.5000	
2	Factor A	9	0.146	0.016	88.0000	0.0000
-3	Error	18	0.000	0.000		
	Total	29	0.146			

A N A L Y S I S   O F   V A R I A N C E   T A B L E (Chlorophyll a at 75 DAT; Table 4.1(a))

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	0.148	0.016	6.0000	0.0000
-3	Error	18	0.000	0.000		
	Total	29	0.148			

A N A L Y S I S   O F   V A R I A N C E   T A B L E (Chlorophyll b at 45 DAT; Table 4.1(a))

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	6.381	0.709	10.1000	0.0000
-3	Error	18	-0.000	-0.000		
	Total	29	6.381			

A N A L Y S I S   O F   V A R I A N C E   T A B L E (Chlorophyll b at 60 DAT; Table 4.1(a))

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	3.300	0.367	60.0000	0.0000
-3	Error	18	0.000	0.000		
	Total	29	3.300			

A N A L Y S I S   O F   V A R I A N C E   T A B L E (Chlorophyll b at 75 DAT; Table 4.1(a))

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	0.061	0.007	9.0000	0.0000
-3	Error	18	0.000	0.000		
	Total	29	0.061			

A N A L Y S I S   O F   V A R I A N C E   T A B L E (Total chlorophyll at 45 DAT; Table 4.1(b))

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	9.226	1.025	11.0000	0.0000
-3	Error	18	0.000	0.000		
	Total	29	9.226			

A N A L Y S I S   O F   V A R I A N C E   T A B L E (Total chlorophyll at 60 DAT; Table 4.1(b))

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	4.357	0.484	7.0000	0.0000
-3	Error	18	0.000	0.000		
	Total	29	4.357			

A N A L Y S I S   O F   V A R I A N C E   T A B L E (Total chlorophyll at 75 DAT; Table 4.1(b))

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	0.336	0.037	5.5000	0.0000
-3	Error	18	0.000	0.000		
	Total	29	0.336			

A N A L Y S I S O F V A R I A N C E T A B L E (N content in straw ;Table 4.3)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	-0.000	-0.000	-4.5000	
2	Factor A	9	1.060	0.118	37.0000	0.00459
-3	Error	18	0.000	0.000		
	Total	29	1.060			

A N A L Y S I S O F V A R I A N C E T A B L E (P content in straw ;Table 4.3)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	0.015	0.002	66.0000	1.0310
-3	Error	18	0.000	0.000		
	Total	29	0.015			

A N A L Y S I S O F V A R I A N C E T A B L E (K content in straw; Table 4.3)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	-9.0000	
2	Factor A	9	1.060	0.118	466.0000	0.0000
-3	Error	18	-0.000	-0.000		
	Total	29	1.060			

A N A L Y S I S O F V A R I A N C E T A B L E (S content in straw; Table 4.3)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	1.209	0.134	17.0000	0.0000
-3	Error	18	-0.000	-0.000		
	Total	29	1.209			

A N A L Y S I S   O F   V A R I A N C E   T A B L E (N content in Grain ;Table 4.2)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	0.082	0.009	1.0090	0.00378
-3	Error	18	0.000	0.000		
	Total	29	0.082			

A N A L Y S I S   O F   V A R I A N C E   T A B L E (S content in Grain; Table 4.2)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	-0.000	-0.000	-9.0000	
2	Factor A	9	0.058	0.006	12.0000	0.0000
-3	Error	18	0.000	0.000		
	Total	29	0.058			

A N A L Y S I S   O F   V A R I A N C E   T A B L E (No. of effective tiller; Appendix vii)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	32.700	3.633	6.0000	0.0000
-3	Error	18	0.000	0.000		
	Total	29	32.700			

A N A L Y S I S   O F   V A R I A N C E   T A B L E (Panicle Length; Appendix viii)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	8.667	0.963	18.0000	0.00376
-3	Error	18	0.000	0.000		
	Total	29	8.667			

A N A L Y S I S O F V A R I A N C E T A B L E (No. of rachis/plant; Appendix viii)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	18.000	2.000	21.0000	0.00419
-3	Error	18	0.000	0.000		
	Total	29	18.000			

A N A L Y S I S O F V A R I A N C E T A B L E (No. of filled grain/plant; Appendix viii)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	826.800	91.867	32.0000	0.0000
-3	Error	18	0.000	0.000		
	Total	29	826.800			

A N A L Y S I S O F V A R I A N C E T A B L E (Fresh weight of plant Kg/hill; Appendix ix)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	-0.000	-0.000	-9.0000	
2	Factor A	9	0.495	0.055	6.0100	0.00429
-3	Error	18	0.000	0.000		
	Total	29	0.495			

A N A L Y S I S O F V A R I A N C E T A B L E (Yield tha^{-1} ; Appendix ix)

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.0000	
2	Factor A	9	0.738	0.082	64.0000	0.00054
-3	Error	18	0.000	0.000		
	Total	29	0.738			