# EFFECT OF NITROGENOUS FERTILIZER AND GREEN MANURE ON TRANSPLANTED AMAN RICE

**BY**

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# *CERTIFICATE*

This is to certify that the thesis entitled, **"EFFECT OF NITROGENOUS FERTILIZER AND GREEN MANURE ON TRANSPLANTED AMAN RICE"** submitted to the Department of Soil Science, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE IN SOIL SCIENCE**, embodies the result of a piece of bona-fide research work carried out by **S.M. MAHMUDUL HASAN,** Registration No.**06-01936,** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

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*The author.*

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# EFFECT OF NITROGENOUS FERTILIZER AND GREEN MANURE ON TRANSPLANTED AMAN RICE

## ABSTRACT

The study was carried out at Sher-e-Bangla Agricultural University (SAU) Farm to know the effect of N fertilizers (Urea) and green manure (Dhaincha) on T. Aman rice (Var. BRRI dhan33) during August to December 2012. The experiment was laid out in a randomized complete block design with nine treatments and three replications. The treatments were $T_1$ (140 kg N-Urea), $T_2$ (120 kg N-Urea+20 kg N-GM), $T_3$ (100 kg N-Urea+40 kg N-GM), $T_4$ (80 kg N-Urea+60 kg N-GM), $T_5$ (60 kg N-Urea+80 kg N-GM), $T_6$ (40 kg N-Urea+100 kg N-GM) and $T_7$ (20 kg N-Urea+120 kg N-GM), $T_8$ (140 kg N-GM),$T_9$ (70 kg N-Urea+70 kg N-GM). The result demonstrated that the yield contributing characters, grain and straw yields were significantly influenced by the added N fertilizers and green manure. Application of 80 kg N as urea and 60 kg N from green manure produced the highest grain yield (5.02 t $ha^{-1}$). In case of straw yield, the treatment $T_5$ (60 kg N-Urea+80 kg N-GM) produced the highest yield (5.54 t $ha^{-1}$). The treatments $T_4$ and $T_5$ resulted in higher nutrient use efficiency along with higher N, P, K and S uptake by the T. Aman rice. The application of nitrogenous fertilizer with green manure influenced the nutrient concentration in rice grain and straw. The higher grain N were observed in $T_1$ (Recommended dose) plot and higher P, K and S concentrations were observed in the treatments with green manure plot. The combined use of N fertilizer and green manure resulted in considerable improvement in soil fertility. The application of N fertilizer along with green manure increased the total N, available P and available S and exchangeable K in post-harvest soils. The overall findings of the study indicate that the use of 80 kg N as urea (173.90 kg/ha) and 40 kg N from green manure (Dhaincha 2.71 t/ha) should be encouraged to replenish the deteriorating soil fertility and increased crop yield of T. Aman rice.

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# CHAPTER I

# INTRODUCTION

Rice (*Oryza sativa* L.) is the most extensively cultivated cereal crop in Bangladesh, which covers about 74% of the total cropped area (BBS, 2011). In respect of area and production of rice, Bangladesh ranks fourth following China, India and Indonesia (FAO, 2008). Rice is the staple food of about 135 million people of Bangladesh. Rice production increased every year from 1971 to 2012, but the annual increases have generally been modest barely keeping pace with the population.

The production of rice in the Aus, Aman and Boro season was 2.63, 12.74 and 18.53 million tons respectively. The largest harvest is Aman after Boro, occurring in November and December and accounting for more than half of annual production. In the year 1971-72, the total rice production in Aman season was 5695 thousand metric ton, which is 12.22% of the total Aman rice production. In the year 2010-11, the total Aman rice production was 12791.50 thousand metric ton which is 79.28% of the total Aman rice production (BBS, 2011). This increase in rice production is due to a lot of research and adoption of various nutrient and management practices.

Nitrogen is the most important and limiting among the nutrients in crop production all over the world. It is essential constituent of protein or chlorophyll, promotes vegetative growth and provides green color to plant. It is the key nutrient which plays a vital role on the yield of rice. Among the plant nutrients, nitrogen is the most important because of its large requirement by crops and unsuitability in soil. Many workers have reported a significant response of rice to nitrogen in different soils of Bangladesh (Eaqub and Matin, 1981, Bhuiya *et al.*, 1989, Islam *et al.* 1990). On the other hand, deficiency of nitrogen also hampers the production of rice.

Growth and yield parameters of rice are largely affected by N application. N (120 kg $ha^{-1}$) significantly increased plant height, (Lawal and Lawal, 2002).

Different rates of nitrogen application significantly increased the number of tiller $m^{-2}$ (Devasenamma, 2001). Highest grain yield was recorded from the application of 80 kg N $ha^{-1}$ (Salam *et al.* 2004). So, understanding the behavior of nitrogen in soil is essential for maximizing crop productivity and profitability on one hand and for reducing the possible negative impact of nitrogen fertilization on the environment on the other hand.

Green undecomposed material used as manure is called green manure. The plants that are grown for green manure is known as green manure crops. The most important green manure crops are sunnhemp, dhaincha, *pillipesara,* clusterbeans etc.

Green manure plays a vital role in the sustainance of soil fertility and crop productivity. The importance of green manure in soil productivity has been recognized from early times. Incorporation of green manure crops into the soil has been shown to increase organic carbon, total nitrogen and crop yields (Gu and Wen, 1980). Researchers in the Bangladesh Rice Research Institute (BRRI) reported increased yield of rice about 50% by green manure (BRRI, 1983 and 1984).

Integrated application of green manure and fertilizers increased the yield of rice and the availability of NPK was noticed in the soil with increasing the nutrient uptake capacity of rice (Tiwari *et al.*, 1980). Grain yield was increased when 40 kg N $ha^{-1}$ was applied along with Sesbania as green manure over that with 80 kg N $ha^{-1}$ without green manure (Akter *et al.*, 1994). Green manure significantly increased the soil fertility status, organic carbon, available soil N, P and K at post harvest soil (Hemalatha *et al.*, 2000).

Rice crop yield largely depends upon the soil conditions (native nutrient status) and also the supply of available nutrients through chemical fertilizers like N, P, K, S and Zn. Most of the farmers of Bangladesh have a tendency to apply more amount of nitrogen to obtain higher yield. Our farmers only use urea as N fertilizer which accounts for about 75% of total fertilizer used in Bangladesh

(Bhuiyan, 1991). This accounts for a huge cost of production throughout the cultivation.

Most of the soils of Bangladesh are deficient in N and consequently the response of modern rice varieties to nitrogen application has always been observed remarkable. Nitrogen use efficiency for rice crop largely ranges from 25% to 35% and seldom exceeds 50% (Singh and Yadav, 1985). Improper use of fertilizer reduces the yield of rice in spite of increasing the yield. Efficient fertilizer management gives not only higher crop yield of crops but it also reduces fertilizer cost (Hossain and Islam, 1986). Integrated application of Dhaincha (Sesbania sp.) and N fertilizer (Urea) can give not only higher yield but can save also N fertilizer cost. Sesbania could save up to120 kg N $ha^{-1}$ (Hesse, 1984).

Nitrogen reserve of Bangladesh soils is very low due to warm climate accompanied by centuries of cultivation on the same piece of land (Portech and Islam, 1984). Loss of nitrogen through $NH_3$ volatilization, denitrification, leaching, surface runoff, chemical fixation or immobilization by microbes is a serious problem in wet and low lands of Bangladesh where the rice field is subjected to alternate submergence and drained conditions. Recently it has become very expensive to apply sufficient amount of nitrogen fertilizer due to its high market price. So, green manure can be a supplement to inorganic N fertilizer.

The present study was therefore undertaken with the following objectives:

i) To study the integrated effect of N fertilizer (Urea) and Green manure (Dhaincha) on the yield and yield attributes of T. Aman rice.
ii) To evaluate the effect of different doses of nitrogen fertilizer and green manure on the yield and yield attributes of T. Aman rice.
iii) To find out the combined requirement of N fertilizer and green manure for maximizing yield of T. Aman rice.

# CHAPTER II

## REVIEW OF LITERATURE

Nitrogen fertilizer has a great impact and effect on the growth, yield and yield components of rice. Green manure also has a positive impact on growth, yield and yield components of rice. This chapter presents a comprehensive review of the works done in many other countries of the world with regard to the effect of N and Green manure and also their use efficiency on rice. The findings of different workers on the use of nitrogen and green manure at different rates and its ultimate effect on the performance of rice have been summarized below:

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### 2.1 Effect of Nitrogen on Rice

#### 2.1.1 Crop characters

##### 2.1.1.1 Plant height

Ravisankar *et al.* (2003) applied different levels of nitrogen in the field and obtained the highest plant height at harvest (106.0 cm).

Lawal and Lawal (2002) carried out experiments during rainy season in Nigeria to evaluate the growth and yield responses of low land rice to varying N rates and placement methods. They reported that plant height responded to N up to 120 kg N $ha^{-1}$.

Ebaid and Ghanem (2000) applied nitrogen fertilizer to the rice crop at the rate of 0, 96 and 144 kg $ha^{-1}$ as urea and found significantly increased plant height with increasing nitrogen level up to 144 kg $ha^{-1}$.

Singh and Jain (2000) conducted a field experiment in the wet season of 1997 in New Delhi, India where 5 improved semi-tall and 2 traditional tall rice cultivars were given 100:50:40 or 200:100:80 kg NPK $ha^{-1}$. In all the cultivars, the high NPK rate significantly increased plant height.

Sahrawat *et al.* (1999) found that nitrogen level significantly affected plant height. Increasing levels of nitrogen increased the plant height significantly up to 120 kg N $ha^{-1}$.

Rajendran and Veeraputhiran (1999) applied 4 different levels of nitrogen and found the highest plant height with 225 kg N $ha^{-1}$.

Kumar and Singh (1995) reported that increasing levels of nitrogen significantly increased the plant height.

Andrade and Amorin Neto (1996) concluded that increasing rates of applied nitrogen increased plant height significantly.

Maske *et al.* (1997) stated that plant height increased significantly with increased N level. A basal N application increased the plant height significantly (Sharma, 1995; Dahatonde, 1992).

Lawal and Lawal (2002) disclosed that N (120 kg $ha^{-1}$) significantly increased plant height.

Rajendran and Veeraputhiran (1999) conducted an experiment during the kharif season of 1996 and 1997 to study the effect of 4 nitrogen levels (0, 75, 150 and 225 kg $ha^{-1}$) and 3 sowing rates in the nursery (10, 20 and 3 g/$m^{-2}$) on hybrid rice ADTRHI. Nitrogen was applied at 3 equal split namely, 7 days after transplanting, active tillering and panicle initiation stages. They found that the highest plant height and straw yield (13.1 t $ha^{-1}$ were observed in hybrids supplied with 225 kg N $ha^{-1}$.

Reddy *et al.* (1990) noticed positive effect of nitrogen on plant height in rice. Taller plants were p roduced by higher amount of nitrogen application.

Plant height decreased significantly with the reduction in the amount of nitrogen top dressings (Bhuiyan and Saleque, 1990).

Idris and Matin (1990) stated that plant height increased up to 120 kg N $ha^{-1}$ compared to the control and thereafter it decreased at 140 kg N $ha^{-1}$. The longest plant was recorded from 80 kg N $ha^{-1}$ and the lowest on from 0 kg N $ha^{-1}$.

#### 2.1.1.2 Number of tillers $hill^{-1}$

Li-Jun Min *et al.* (2003) reported the effects of N, P and K application on the yield and quality of Brazilian rice cv. IAPAR9. The number of tillers, effective ears and dry matter accumulation increased with N application. Rice yield and N, P and K application rates were positively correlated.

Lawal and Lawal (2002), Mendhe et al. (2002) and Singh and Singh (2002) reported that increasing levels of nitrogen significantly increased total tiller/hill.

Ehsanullah *et al.* (2001) determined the nitrogen use efficiency in fine rice (*Oryza sativa* L.) They found that the application of 100 kg N $ha^{-1}$ showed the maximum number of tiller $hill^{-1}$ and 75 kg N $ha^{-1}$ showed minimum tiller $hill^{-1}$.

Munnujan *et al.* (2001) carried out an experiment with 4 levels of N (0, 40, 80 and 160 kg N $ha^{-1}$) applied at three levels to each of the planting density (20, 40 and 80 hills $m^{-2}$). They observed that tillers per plant increased linearly with the increase in N fertilizer levels.

Sahrawat *et al.* (1999) also observed that nitrogen level significantly affected tillering in rice. The number of tiller $hill^{-1}$ increased significantly with increased nitrogen level.

Hari *et al.* (1997) carried out an experiment with rice hybrids PMS 2A/IR 30802 to study the effect of different levels of nitrogen and observed significant increase in productive tillers $hill^{-1}$ with increasing levels of nitrogen from 0 to 150 kg $ha^{-1}$.

Chander and Pandey (1996) found that application of 120 kg N $ha^{-1}$ resulted in significant increase in number of productive tillers $hill^{-1}$ compared to 60 kg N/ha. Thakur (1993a) observed that increasing levels of N increased the productive tillers $m^{-2}$.

#### 2.1.1.3 Panicle length

Sharma and Dadhich (2003) conducted a field expeiiment in Rajshthan, India during the rainy season of 1997 using rice cultivars Mahi Sugandha, Pusa Basmati-1 and Basmati-370 supplied with 0, 40, 80 and 120 kg N $ha^{-1}$ to determine the effects of nitrogen on the yield of the crops. The Pusa Basmati- 1 produced the maximum panicle length (25.1 cm).

Sarker *et al.* (2001) conducted a field experiment to evaluate the performance of 3 rice cultivars (IET 12199, IET 10664 and IET 15914) treated with 5 different nitrogen fertilizer levels (0, 40. 80, 120 and 160 kg $ha^{-1}$). IET 12199, treated with 80 kg N $ha^{-1}$ gave the highest value for panicle length (25.77 cm); IET 10664 and IET 15914 also performed well.

Freitas *et al.* (2001) carried out an experiment with three new rice cultivars (IAC- 101, IAC- 102 and IAC- 104) grown under irrigated conditions where N fertilizer was applied as urea (at the rate of 0, 50, 100 and 150 kg $ha^{-1}$) 33% at seedling transplantation and 33% each at 20 and 40 days. They found that panicle length of three cultivars was significantly affected by N treatments.

Azad *et al.* (1995) found that the panicle length increased significantly with the increasing levels of nitrogen from 0 to 75 kg $ha^{-1}$.

#### 2.1.1.4 Number of grains $panicle^{-1}$

Subhendu *et al.* (2003) reported that the effect of N split application during transplanting, tillering and panicle initiation; transplanting, tillering, panicle initiation and 50% flowering; and 10 days after transplanting, panicle initiation and booting on the yield and yield components of rice cultivar BRT-5204, MTU-1010 and IR-64 in Rajendranagar, Hyderabad, India. They found that the application N (120 kg $ha^{-1}$) as urea in equal splits during transplanting, tillering, panicle initiation and 50% flowering resulted in the highest number of grains per panicle (89.8) in MTU- 1010.

Mendhe *et al.* (2002) found that 125 kg N $ha^{-1}$ significantly increased the number of grains per panicle (130.09) in Suraksha compared to 100 kg N $ha^{-1}$.

Tunio *et al.* (2002) conducted a field experiment to evaluate the performance of two scented rice cultivars i.e. Kasturi and Basmati-370 under different nitrogen rates (0, 30, 60, 90, 120 and 150 kg $ha^{-1}$). They found that Basmati-370 produced more filled grains per panicle. The nitrogen rates of 60 and 90 kg $ha^{-1}$proved to be the best among the rates evaluated in terms of filled grains $panicle^{-1}$. The nitrogen level of 125 kg $ha^{-1}$ produced maximum number of grains panicle (Ehsanullah *et al.* 2001).

Thomas and Martin (1999) found that integrated use of green manures and biological fertilizer along with chemical fertilizers has a positive effect on the number of filled grains $panicle^{-1}$.

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### 2.1.1.5 Number of panicles $m^{-2}$

Sharma and Dadhich (2003) conducted an experiment using rice cultivars MahiSugandha, Pusa Basmati-1 and Basmati-370 with N rates of 0, 40, 80 or 120 kg N $ha^{-1}$in Rajasthan, India during the rainy season of 1997 to determine the effects of N on the yield of the crops. They found that Basmati- 1 give highest number of panicles $m^{-2}$ (336) than others. Yield attributes of the crop increased with increasing rates of N.

Tunio *et al.* (2002) found that among the N rates by receiving 60 and 90 kg N/ha Basmati-370 produce maximum panicle $m^{-2}$ among the other rates of nitrogen.

Thomas and Martin (1999) reported that the integrated use of green manures and biological fertilizers along with chemical fertilizers has a positive effect on the number of panicle $m^{-2}$.

### 2.1.1.6 1000-grain weight

Arivazhagan and Ravichandran (2005) conducted a field experiment with rice cv. IR 20 in Annamalainagar, Tamil Nadu, India, during kharif 1997 and rabi

1997-98. There were 6 treatments with 4 different fertilizer schedules (100:50:50, 100:50:75, 150:50:50 and 150:50:75 kg NPK $ha^{-1}$). Application of 150:50:75 kg NPK $ha^{-1}$ resulted in the highest number of panicles per hill (9.06), panicle length (19.6 cm), 1000-grain weight (20.50 g), grain yield (5.06 t $ha^{-1}$) and straw yield (6.10 t $ha^{-1}$). The nutrient uptake in grain and straw increased with the increase in the level of N and K.

Maiti and Pal (2003) reported that the effects of nitrogen fertilizer rate (0, 120 and 140 kg $ha^{-1}$) on the performance of 1 cultivar (IET-4786) and 4 hybrid varieties (Pro Agro 6Y213, Pro Agro 6Y3024, Pro Agro 6111N and Pro Agro 6201) of rice studied in Mohanpur, West Bengal, India. The nitrogen fertilizer was applied during transplanting (50%) and at the tillering and panicle initiation stages (50%). The hybrid varieties had 10.4, 38.9, 9.30 and 32.5% higher number of panicles, number of filled grains per panicle, 1000-grain weight and grain yield respectively than the high-yielding cultivar IET-4786. The hybrid varieties also recorded greater nitrogen (112.59-120.10 kg $ha^{-1}$, phosphorus (112.672-120.179 kg $ha^{-1}$) and potassium (115.748-123.505 kg $ha^{-1}$) uptake than IET-4786 (89.101, 89.261 and 91.9 14 kg $ha^{-1}$, respectively). The application of 140 kg nitrogen $ha^{-1}$ resulted in the highest increase in 1000- grain weight (5.80%) over the control.

Lawal and Lawal (2002) conducted three field experiments during the rainy season of 1996, 1997 and 1998 in Nigeria to evaluate the growth and yield responses of lowland rice to varying N rates and placement methods. The treatment consisted of four N rates (0, 40, 80 and 120 kg $ha^{-1}$ and two fertilizer placement method (deep and surface placement). They found that the nitrogen rate up to 120 kg $ha^{-1}$ has a positive effect on the 1000-grain weight.

Rodriguez *et al.* (2002) carried out an experiment in Araure, Portuguese state (Venezuela) during the rainy season of 1998 to evaluate the response of rice cultivars Fonaiap l and Cimarron at two different rates of nitrogen (150 and 200 kg N $ha^{-1}$). They found that nitrogenous fertilizer supplied @ 150 and 200 kg N $ha^{-1}$ has a positive effect on 1000-grain weight (28.97 g) of both cultivars.

Ehsanullah *et al.* (2001) conducted a field experiment to evaluate the effect of split application of nitrogen at three different stages like sowing, tillering and Panicle emergence @ 125 kg N $ha^{-1}$. They found that the split application of N fertilizer at different growth stages significantly affected the 1000 grain weight and also the grain and straw yields.

Devasenamma *et al.* (2001) conducted a field experiment in Andhra Pradesh, India during the rabi season of 1996-97 to study the performance of rice hybrids (APHR 2, DRRH 1, MGR 1, TNRH 16 and MLR 33358) at various N fertilizer rates (0, 60, 120 and 180 kg N $ha^{-1}$. They found that the TNRH 16 exhibits the highest 1000-grain weight (20.50 g) than others.

Bindra *et al.* (2000) observed that crop transplanted on 7 July gave 2.26% higher 1000-grain weight than those transplanted on 14 July. The higher N response was observed with 30 kg/ha during 7 July transplanting followed by 60 kg $ha^{-1}$.

**2.1.1.7 Grain and straw yields**

Walker *et al.* (2007) conducted an experiment to evaluate the change in Lancaster extractable P, K, Ca, Mg, Na, Zn as well as soil pH and total N on Sharkey soils (very-fine, smecfitic, thermic Chromic Epiaquert). Furthermore, N rate and application timing studies were conducted in the cut areas of these soils for two rice cultivars. Concentrations of total N and Lancaster P declined with soil profile depth on Sharkey clay and Sharkey silty clay soil. Soil pH significantly decreased at one of two locations. Rice grain yields decreased as the percentage of pre-flood (PF) N increased for 'Lemont.' Optimum yields for 'Priscilla' were obtained at 151 to 202 kg N $ha^{-1}$.

Mazumder *et al.* (2005) reported that different levels of nitrogen influenced grain yield, straw yield and biological yield with the application of 100% RD of N (99.82 kg, N $ha^{-1}$) which was statistically followed by other treatments in descending order. The highest grain yield (4.861t $ha^{-1}$) was obtained with 100% RD of N and the lowest one (3.801t $ha^{-1}$) from no application of N.

Mashkar and Thorat (2005) conducted a field experiment during the 1994 kharif season in Konkan, Maharashtra, India, to study the effects of different nitrogen levels (0, 40, 80 and 120 kg N $ha^{-1}$ on the N, P and K uptake and grain yield of scented rice cultivars (Pusa Basmati 1, Kasturi, Incrayani and sugandha). The different levels of N had significant effect in augmenting the uptake of N, P and K nutrients and grains as well as straw yield of rice. Application of 120 kg N/ha recorded significantly higher N, P and K uptake in rice compared to the rest of the N levels. Every increment of 40 kg N $ha^{-1}$ from 0 to 120 kg N $ha^{-1}$ increased the total N uptake by 49.55, 34.30 and 27.17%, total P uptake by 40.33, 27.06 and 20.32% and total K uptake by 32.43, 20.70 and 17.25% respectively.

Hussaini *et al.* (2005) carried out a study to assess the effects of nitrogen (30, 60, 90 and 120 kg N $ha^{-1}$) and phosphorus (20, 40 and 60 kg $P_2O_5$ $hill^{-1}$) on the growth and yield of rice/sorghum inter-crop. Application of nitrogen up to 90 kg $ha^{-1}$ enhanced the growth and yield of rice crop and application of phosphorus 40 kg $P_2O_5$ $ha^{-1}$ resulted in higher growth and yield of rice crops.

Rahman *et al.* (2005) determined the nitrogen level and found that the grain yield of rice increased with increasing nitrogen levels and the highest yield (4.19 t $ha^{-1}$) was attained with 150 kg N $ha^{-1}$ while further increase in nitrogen level decreased the grain yield. It was estimated that the grain yield with 150 kg N $ha^{-1}$ was 35.8, 18.9, 5.0 and 6.0% higher than those obtained with 0, 50, 100 and 200 kg N $ha^{-1}$ respectively.

Al-Gusaibi (2004) conducted pot experiments in greenhouse during the Summer seasons (March-June) of 1999 and 2000, the effects of N (at 0, 50, 100 and 150 kg $ha^{-1}$) on rice cv. Hassawi and found that yield, yield components and nutrient (N and P) uptake increased each successive increment of N. Grain yield increased significantly from 10.5 to 14.3 t $ha^{-1}$.Grain yield was highest with 150 kg N $ha^{-1}$ and was significantly superior to 0 and 50 kg N $ha^{-1}$ treatments in both seasons, but was at par with 100 kg N $ha^{-1}$ treatment in the second season.

Sidhu *et al.* (2004) reported that nitrogen fertilizers substantially increased the mean grain yield of Basmati up to 40 kg N $ha^{-1}$ in the fallow Basmati-wheat sequence while 60 kg N $ha^{-1}$ reduced, Basmati yield. Compared to the treatment $N_0$ the mean grain yield of Basmati was increased by 0.31, 0.40 and 0.23 t $ha^{-1}$at doses of 20, 40 and 60 kg N $ha^{-1}$ respectively.

Singh *et al.* (2004) reported that increasing level of nitrogen significantly increase the yield of Pusa rice hybrid-10. The maximum grain yield (5.87 t $ha^{-1}$ was recorded at the highest level of nitrogen application (180 kg N $ha^{-1}$) and was 4.2, 15.5 and 39.3% higher than in the 120, 60 and 0 kg N $ha^{-1}$ treatments respectively.

Salam *et al.* (2004) conducted an experiment to determine the level of nitrogen with application level (0, 40, 80 and 120 kg $ha^{-1}$) of N. The highest grain yield was recorded from the application of 80 kg N $ha^{-1}$.

Adigbo *et al.* (2003) conducted a field experiment at two locations: University of Agriculture, Abeokuta (UNAAB) and Olowo-Papa (OP) in Ogun state both in Forest-savannah transition zone of Nigeria to investigate the response of three upland rice cultivars (*O. sativa*) to mucuna residue incorporation and Nitrogen (N) fertilizer and the effects of residues incorporation on the soil chemical properties. Fertilizer equivalent of the green manure used was estimated to be 30 kg N $ha^{-1}$ at OP. Grain yield response of the rice varieties to N-fertilizer was linear and curvilinear at OP and UNAAB, respectively. The yields of the two improved varieties (ITA15O and 1TA257) were significantly higher than OFADA variety at both locations. Mucuna residue from the dry season fallow appeared to improve soil chemical properties as well as grain yield.

Jena *et al.* (2003) reported that deep placement of urea super-granules (USG) significantly improved grain and straw yields and nitrogen use efficiency of rice and reduced volatilization loss of ammonia relative to the application of prilled urea.

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Singh *et al.* (2003) conducted a field experiment from 1997-98 to 1999-2000 on Typic Ustochrept soil of Modipurarn, Meerut, Uttar Pradesh, India to study the effect of nitrogen and phosphorus fertilizers on the growth and yield of rice (Oryza sativa). At maturity, rice yield was increased by 5.5 to 10.9%, 9 to 10% and 13.1 to 19.4%, respectively with 120 kg N and 26 kg P $ha^{-1}$compared to 120 kg N alone.

Wopereis *et al.* (2002) stated that rice yields increased significantly as a result of N application on two N dressings (applied of the onset of tillering and at panicle initiation) with a total of approximately 120 kg N $ha^{-1}$ in farmer's field.

Choudhury and Hanif (2002) pointed out that yield of rice significantly increased with application of 120 kg N $ha^{-1}$ over farmers practice (80 kg N $ha^{-1}$).

Fageria and Baligar (2001) conducted a field experiment where nitrogen levels used were 0, 30, 60, 90, 120, 150, 180 and 210 kg N $ha^{-1}$. They found that nitrogen fertilizer application significantly increased grain yield. Ninety percent of the maximum grain yield (6400 kg $ha^{-1}$) was obtained with the application of 120 kg N $ha^{-1}$ in the first year and in the second and third years 90% of the maximum yields (6345 and 5203 kg $ha^{-1}$ were obtained at 90 and 78 kg N $ha^{-1}$ respectively.

Geethadevi *et al.* (2000) reported that higher grain yield (5950 kg $ha^{-1}$) was recorded from KRH-1 than Rasi (5181 kg $ha^{-1}$) and also found that among the split application treatments nitrogen applied at 60 : 20 : 20 : 20 : 0 recorded significantly higher grain yield (6004 kg $ha^{-1}$) than the recommended practice of 60: 30:30.

Sudhakar *et al.* (2001) carried out an experiment to evaluate the effects of various rice cultivars and nitrogen levels on yield and economics of direct sown semi dry rice during kharif on 1996 and 97. They found that cultivar PMK-1 show the maximum grain and straw yields, net return and B:C ratio. There was a significant increase in grain yield, straw yield, net return and B:C ratio with each increment of nitrogen application up to 125 kg $ha^{-1}$.

Freitas *et al.* (2001) conducted a field experiment to evaluate the response of new rice cultivars (JAC-l0l, IAC-102 and IAC-104) grown under irrigation. The nitrogen fertilizer was applied as urea (0, 50, 100 and 150 kg ha`1) 33% at seedling transplantation and 33% at 20 and 40 days later. They found that cultivars responded significantly to N application and the average yield for three cultivars at higher N rates was more than 8 t $ha^{-1}$. The cultivars IAC- 104 and IAC- 101 presented higher grain yield than IAC -102.

Singh *et al.* (2000) stated that each incremental dose of N gave significantly higher grain and straw yields of rice over its preceding dose. Consequently the crop fertilized with 100 kg N $ha^{-1}$ gave maximum grain yield (2647 kg $ha^{-1}$, Pusa Basmati-1 and Sugandha responded well to 100 kg N $ha^{-1}$ with grain yield of 3180 and 2588 kg $ha^{-1}$ respectively. However, Basmati 370 and BR10 responded only up to 80 and 60 kg N $ha^{-1}$ with grain yield of 2286 and 2168 kg $ha^{-1}$ respectively owing to higher yield attributes.

Chopra and Chopra (2000) reported that seed yield increased linearly up to 120 kg N $ha^{-1}$.

Munnujan *et al.* (2001) treated 4 levels of nitrogen fertilizer (0, 40, 80 and 160 kg $ha^{-1}$) planting density (20, 40 and 80 hill $m^2$) and concluded that the highest grain yield (3.8 t $ha^{-1}$was obtained at 180 kg N $ha^{-1}$ which was similar to yield obtained at 80 kg N $ha^{-1}$ (3.8 t $ha^{-1}$).

Sarker *et al.* (2001) stated that N increased grain yield significantly. N levels significantly affected grain and straw yields.

Rajarathinam and Balasubramaniyan (1999) reported that the higher grain yield of hybrid rice CoRH-2 was produced due to the application of 200 kg N $ha^{-1}$. However, application of 250 kg N $ha^{-1}$ reduced the grain yields significantly.

Rajarathinam and Balasubramaniyan (1999) observed that there was no appreciable change in the yield due to application of higher dose of N above 150 kg $ha^{-1}$.

The influence of two N levels (90 and 150 kg $ha^{-1}$) on the productivity of two hybrids (TNH 1 and TNH 2) was evaluated in comparison with Rasi and Jaya as standard check. The yield response to N application was significant up to 150 kg $ha^{-1}$. The interaction effect among the treatments was not significant. Jaya produced the highest grain yield (5.1 t $ha^{-1}$). The experimental results indicated that the N application (150 kg $ha^{-1}$) was required to achieve higher grain yields in hybrid rice (Singh et al., 1998).

Turkhede *et al.* (1998) conducted an experiment in India with four cultivars and four rates of nitrogen fertilizer and showed that the cultivar Sye-545 gave the highest grain yield (38.29 q $ha^{-1}$) but it was not statistically different from other cultivars. Increasing the nitrogen rate from 75 to 150 kg $ha^{-1}$significantly increased the grain yield.

Singh *et al.* (1998) studied the performance of three hybrids KHR I, ProAgro103 and MGR 1 using Jaya and Rasi as standard checks at four levels of N (0, 60, 120 and 180 kg $ha^{-1}$). They observed that the varieties responded linearly to the applied N levels up to 120 kg $ha^{-1}$ uptake in rice straw treated plot was 45 kg $ha^{-1}$ compared to 36 kg $ha^{-1}$ from without rice straw treated plots.

Cho and Choe (1999) reported that all straw treatments increased yield with the fertilizer N than without N fertilizer.

### 2.2 Effect of Green manure on different yield and yield attributes of Rice

Hossain *et al.* (1987) conducted an experiment in Mymensingh and reported that the plant height of rice was significantly higher in green manure plot. The total and fertile tillers $hill^{-1}$ were not significantly increased by the treatments under the study of incorporation that green manure did not significantly increase the number of florets or grain number $panicle^{-1}$.

Chatterjee *et al.* (1979) reported that green leaf manure of Sesbania and Ipormoea applied before transplanting of rice released more N than farmyard manure and yield of rice was equivalent to that of applied 40 kg N $ha^{-1}$.

Zaman (1983) conducted a field trial and observed that growth and yield parameters of wet land rice were favourably and significantly influenced by sources and rates of organic materials. The effect being dramatic with cow pea followed by dhaincha. When cow pea was applied at the rate of 3.6 t $ha^{-1}$ (dry matter basis) produced grain yield similar to that of recommended fertilizer dose 80 kg N, 60 kg $P_2O_5$ and 40 kg $K_2O$ per hectare. He also reported that nutrient uptake by the crop particularly the micronutrients were remarkably higher with cow pea followed by dhaincha.

Bhuiyan (1984) noticed that green manuring with Sesbania provided higher yield of rice (6.2 t $ha^{-1}$) with less than half N inputs whereas in other areas without green manuring the yields averaged only 4.4 t $ha^{-1}$.

Dreyfus *et al.* (1985) conducted an experiment with *S. rostrata* and found that when rice was transplanted two weeks and immediately after incorporation *S. rostrata* increased grain yield by 3.27 t $ha^{-1}$and 3.36 t $ha^{-1}$ over the control. They suggested that farmers could transplant rice at any time within two weeks of Sesbania incorporation. Similar findings were also reported by Tiwari *et al.* (1980) in India.

Halepyati and Sheelavantar (1988) carried out an experiment in India and found that 55 day old *S. rostrata* when incorporated 1 day before transplanting of rice, Sesbania alone provided higher yield over control. They also found rostrata + N application (50 kg N $ha^{-1}$) gave highest grain and straw yield.

Singh *et al.* (1990) found that without green manure grain (rice) yields were 3.1-3.6 t $ha^{-1}$ whereas 4.5-7.1 t $ha^{-1}$ yields were obtained with green manure.

Becker and Ottow (1991) carried out an experitment and noticed that rice yield was increased up to 54% after growing and incorporation of *S. rostrata*. They also observed that in short day photoperids rice yields averaged 6.5 t/ha with and 2.9 t/ha without incorporation of *S. rostrata* biomass. In long day photoperiods rice yields averaged 5 t/ha with and 3.5 t/ha without green manure.

Aktar *et al.* (1993) carried out an experiment at Begherpara, Jessore, Bangladesh in 1991. Fields were left fallow or 55 day-old *Sesbania rostrata* incorporated into the soil; rice was transplanted and given 60 kg $P_2O_5$ $ha^{-1}$ to the fallow field and 40 kg P to the green manure field with different doses of N. All yield parameters were higher with green manuring except 1000-grain weight.

Aktar *et al.* (1994) reported that grain yield was increased when 40 kg N $ha^{-1}$ was applied along with Sesbania as green manure over that with 80 kg N/ha without green manure. Similarly 30 kg N $ha^{-1}$ along with green manure produced higher yield over that with 60 kg N $ha^{-1}$ and 120 kg N $ha^{-1}$ without green manure. The authors indicated that green manure not only supplied nitrogen but also improved soil condition that enhanced yield even at lower rates of added N.

Bhardwaj *et al.* (1981) compared the efficiency of sunhemp, Sesbania, and Ipomoea as green manures in rice-wheat rotation. When these green manures were added to the soil, the N equivalents were 74.5, 49.9 and 25.3 kg $ha^{-1}$, which were reflected in the rice yields of 4.96, 4.66 and 4.22 t $ha^{-1}$ respectively, compared with 3.40 t $ha^{-1}$without green manure. The authors also reported that rice yields were significantly higher with sunhemp and Sesbania than with no green manure. Ipomoea had a significant effect only on the yield of subsequent wheat crop.

Green manure increase rice yield. Applied green manures such as cowpea, could save up to 75 kg and Sesbania up to 120 kg N $ha^{-1}$ (Hesse, 1984)

Rinaudo *et al.* (1987) stated that 10 t $ha^{-1}$ (dry matter basis) *Sesbania rostrata* accumulated 200 kg N $ha^{-1}$.They assumed that 50% of the accumulated nitrogen in the legumes originate from BNF and GM like *Sesbania rostrata* could provide up to 100 kg N $ha^{-1}$ to subsequent rice crops. Residual fertility in terms of organic carbon and available N, P and K were increased under green manure whereas N fertilizer had no positive impact on soil fertility (Sharma and Mitra, 1989).

Balasubramaniyan *et al.* (1989) conducted an experiment and observed that incorporation of 12 t green manure $ha^{-1}$ a week before transplanting significantly increased paddy yields in 2 to 3 seasons, N rates from 0 to 150 kg $ha^{-1}$ and yield from 3.8-4.6 t $ha^{-1}$and 5.4-7.0 t $ha^{-1}$.

Meelu *et al.* (1994) reported the beneficial effect of incorporation of crop residues in rice wheat cropping system.

Sharanappa and Shivaraj (1995) observed that *Sesbania rostrata* green manure improved the soil organic carbon and available N, P and K contents under a subsequent rice-sunflower sequence.

Sharma and Prasad (1999) conducted field experiments to determine the effect of *Sesbania aculeata/Sesbania rostrata* green manuring and mungbean (*Vigna radiata)* residue incorporation on the productivity and N uptake of a rice wheat cropping system. Green manuring of Sesbania or incorporation of mungbean residue resulted in recycling of 77-113 kg N $ha^{-1}$ and increased productivity of the rice wheat cropping system by 0.5-1.3 t/ ha/year and plant N uptake by 12-35 kg $ha^{-1}$year . The productivity and plant N uptake of the rice wheat cropping system, without nitrogen application to rice after Sesbania green manuring or incorporation / of mungbean residue, were similar to those obtained with 120 kg N $ha^{-1}$ application to rice after no summer crop.

Anand Swarup *et al.* (2000) conducted field experiments in Haryana, India and showed that continuous use of fertilizers N and P significantly enhanced the yield of rice. The maximum yield was obtained with 100% NPK + GM (*Sesbania aculeata*) followed by 150% and 100% NPK +FYM.

Zaman *et al.* (1995 b) reported that the application of Sesbania@ of 5 t $ha^{-1}$ (oven dry basis) once a year, prior to wet season planting, along with 140 kg urea N/ha/yr (80 kg for dry season and 60 kg for wet season) and recommended doses of P, K and S gave a yield of about 11t $ha^{-1}$ yield in a rice- rice cropping pattern on a moderate fertile soils. This practice allowed saving of 150 kg urea/ ha/ yr.

Hundal *et al.* (1992) stated that the contribution of GM to P nutrition of rice showed that fertilizer P addition increased dry matter production and P uptake by GM. Grain yield and P uptake by rice were highest in dhaincha plots followed by sun hemp.

Goswami *et al.* (1988) reported that manuring with *Sesbania aculeata* increased rice yield by 5 t $ha^{-1}$. They found 35.4% recovery of applied N from the rate of 60 kg N $ha^{-1}$ as Sesbania. Green manuring increased rice yield by 100 t/ha/yr in dry season and 0 5 t $ha^{-1}$ in wet season as reported by Balasubramaniyan et al.

Hemalatha *et al.* (2000) revealed that green manure significantly increased the soil fertility status, organic carbon, available soil N, P and K at postharvest soil.

Studies at IRRI showed that the total N, exch. K and available P in soil increased by green manure (IRRI, 1979).

# CHAPTER III

# MATERIALS AND METHOD

This chapter describes materials and methods of the experiment followed in the field and laboratory. This chapter presents a brief description on the location, climate, soil, crop, experimental design, treatments, cultural operation, collection of soil and plant samples and the methods followed for chemical and statistical analysis.

The experiment was carried out at the Sher-e-Bangla Agricultural University Farm, Dhaka, during the period from August to December 2012. The study was conducted to evaluate the effect of nitrogenous fertilizer (Urea) and green manure (Dhaincha) on the yield and quality of BRRI dhan33. The physical and chemical analysis of soil and chemical analysis of straw, grain were done in the Soil Science laboratory of SAU. The materials used and methods followed for the experiment has been described under the following section

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## 3.1 Experimental Site and Soil

The experiment was conducted in typical rice growing silty clay loam soil at the Sher-e-Bangla Agricultural University (SAU) farm, Sher-e-Bangla Nagar, Dhaka, during the T. Aman season of 2012. The morphological, physical and chemical characteristics of the soil are shown in Table 3.1 and 3.2

## 3.2 Climate

The climate of the experimental area is characterized by high temperature, high humidity and medium rainfall with occasional gusty winds during the kharif season (March-September) and a scanty rainfall associated with moderately low temperature in Rabi season (October-February).

Table: 3.1 Morphological characteristics of the experimental field

| Morphology | Characteristics |
|---|---|
| Locality | SAU farm, Dhaka |
| Agro-ecological zone (FAO and UNDP, 1988) | Madhupur Tract (AEZ 28) |
| General soil type | Deep Red Brown Terrace Soil |
| Parent material | Madhupur Terrace |
| Topography | Fairly level |
| Drainage | Well drained |
| Flood level | Above flood level |

**Table 3.2 Initial physical and chemical characteristics of the soil**

| Characteristics | Value |
|---|---|
| Mechanical fractions: | |
| % Sand (0.2-0.02 mm) | 22.26 |
| % Silt (0.02-0.002 mm) | 56.72 |
| % Clay (<0.002 mm) | 21.02 |
| Textural class | Silty Clay Loam |
| Consistency | Granular and friable when dry. |
| pH(1: 2.5 soil-water) | 6.2 |
| CEC (c mol $kg^{-1}$) | 17.9 |
| Organic C (%) | 0.43 |
| Organic Matter (%) | 0.76 |
| Total N (%) | 0.032 |
| Exchangeable K (c mol $kg^{-1}$) | 0.12 |
| Available P (mg $kg^{-1}$) | 19.85 |
| Available S (mg $kg^{-1}$) | 14.40 |

### 3.3 Planting material

BRRI dhan33, a high yielding, most popular and recent variety of T. Aman rice was used in this experiment as the test crop. Bangladesh Rice Research Institute (BRRI) developed this variety in 1997. Genetic serial number of this variety is BG 850-2 and life cycle ranges from 105-115 days. Heights of mature plants are 100 cm and do not lodge. The average grain yield of this variety generally lies between 5-5.5 t $ha^{-1}$.

### 3.4 Land preparation

The land was first opened on July 25, 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 Raising of seedlings

The seedlings of rice were raised wet-bed methods. Seeds (95% germination) @ 5 kg $ha^{-1}$ were soaked and incubated for 48 hr and sown on a well-prepared seedbed. During seedling growing, no fertilizers were used. Proper water and pest management practices were followed whenever required.

### 3.6 Experimental design and layout

The experiment was laid out in a randomized complete block design (RCBD), where the experimental area was divided into three blocks representing the replications to reduce soil heterogenetic effects. Each block was divided into nine unit plots as treatments with raised bunds around. Thus the total number of unit plot size was 3.5 m x 2.5 m and ailes separated plots from each other. The blocks were separated from one another by one meter drain. Treatments were randomly distributed within the blocks. The layout of the experiment is presented in the Figure 3.1.

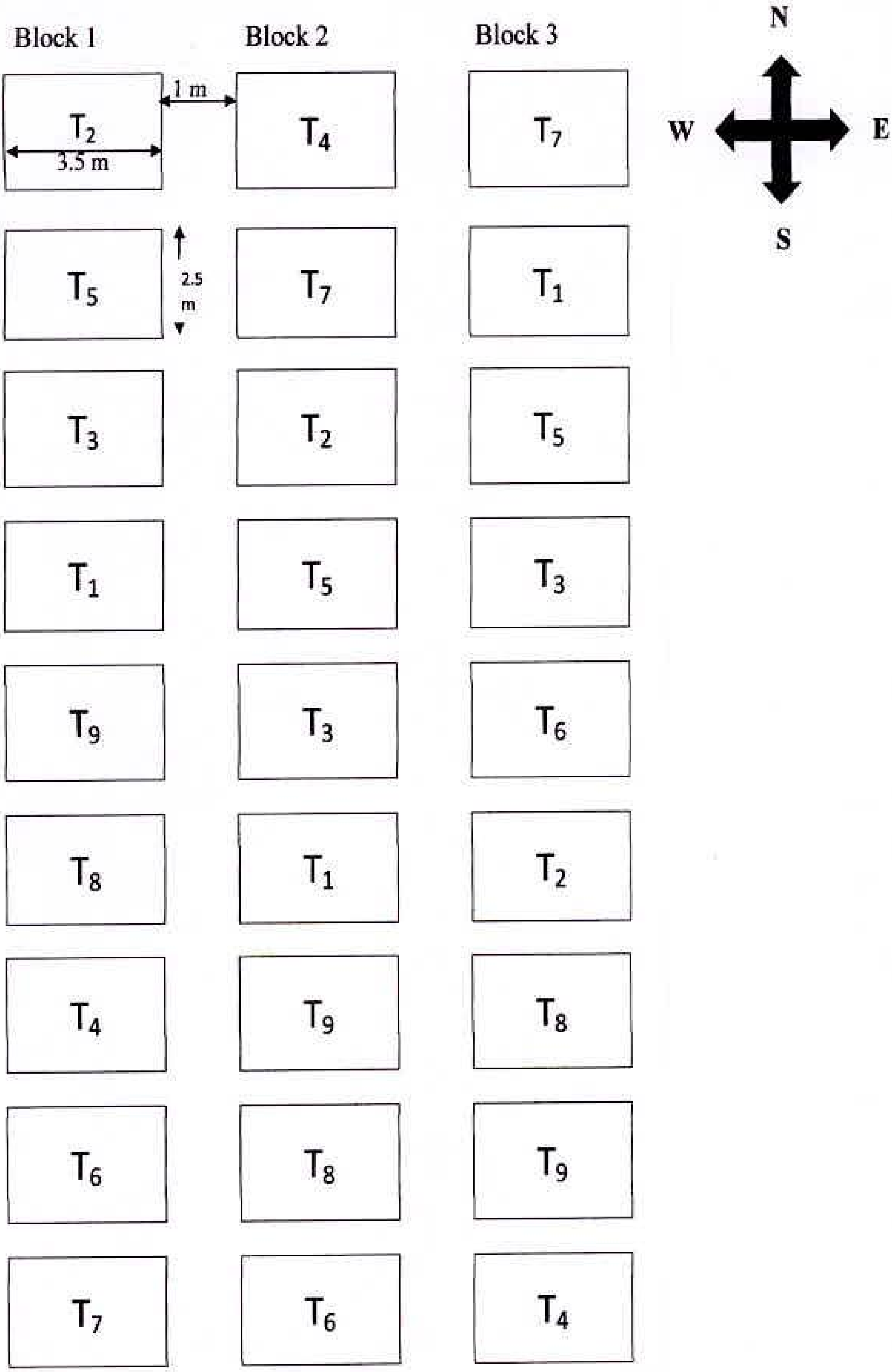


Figure 1. LAYOUT OF THE EXPERIMENT

### 3.7 Initial soil sampling

Before land preparation, initial soil samples at 0-15 cm depth were collected from different spots of the experimental field. The composite soil sample were air-dried, crushed and passed through a 2-mm (8 meshes) sieve. After sieving, the soil samples were kept in a plastic container for physical and chemical analysis of the soil.

### 3.8 Treatment

The fertilizer treatments used in the study was based on BARC fertilizer recommendation guide 2005. Nitrogen and green manure were used in the study. This is a single factor experiment consisting of 9 treatments. The treatments are as follows:

$T_1$ - 140 kg N as Urea (Recommended dose)

$T_2$ - 120 kg N as Urea + 20 kg N as Green manure (GM)

$T_3$ - 100 kg N as Urea + 40 kg N as GM

$T_4$ - 80 kg N as Urea + 60 kg N as GM

$T_5$ - 60 kg N as Urea + 80 kg N as GM

$T_6$ - 40 kg N as Urea + 100 kg N as GM

$T_7$ - 20 kg N as Urea +120 Kg N as GM

$T_8$ - 140 kg N as GM

$T_9$ - 70 kg N as Urea +70 kg N as GM

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### 3.9 Fertilizer application

The amount of N, P, K and S fertilizers required per plot were calculated as per the treatments. 100kg TSP, 70 kg MOP and 60 kg gypsum were applied as basal dose before transplanting of rice seedlings. Necessary amount of Urea was applied in 3 equal splits: one third was applied at after transplanting, one third was applied at active tillering stage (30 DAT) and the remaining one third was applied at 5 days before panicle initiation stage (55 DAT).

The required amount (dose) of urea and dhaincha (dry stem) were calculated from total N coming from urea and green manure and applied according to the following recommendation:

| Treatment | Description | Urea required (kg/ha) | Dhaincha required (t/ha) |
|---|---|---|---|
| $T_1$ | 140 kg N as Urea | 304.34 | 0 |
| $T_2$ | 120 kg N as Urea+ 20 kg N as GM | 260.85 | 0.680 |
| $T_3$ | 100 kg N as Urea+40 kg N as GM | 217.38 | 1.360 |
| $T_4$ | 80 kg N as Urea+60 kg N as GM | 173.90 | 2.030 |
| $T_5$ | 60 kg N as Urea+80 kg N as GM | 130.43 | 2.710 |
| $T_6$ | 40 kg N as Urea+100 kg N as GM | 86.94 | 3.380 |
| $T_7$ | 20 kg N as Urea+120 kg N as GM | 43.47 | 4.060 |
| $T_8$ | 140 kg N as GM | 0 | 4.740 |
| $T_9$ | 70 kg N as Urea+70 kg N as GM | 152.17 | 2.370 |

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### 3.10 Green manure incorporation

Dhaincha was collected from field and dried in sunshine for several days. Then dhaincha was chopped into pieces and incorporated with soil just after plot preparation. The ailes were kept raised so that dhaincha stem cannot move with water. The chemical composition of dhaincha used have been presented in table 3.3.

Table 3.3 Chemical composition of dhaincha (Oven dry basis)

| Sources of organic manure | Nutrient content | | | | | |
|---|---|---|---|---|---|---|
| | C (%) | N (%) | P (%) | K (%) | S (%) | C:N |
| Dhaincha | 46 | 2.95 | 0.26 | 1.56 | 0.24 | 15 |

### 3.11 Transplanting

Thirty five days old seedlings of BRRI dhan33 were carefully uprooted from the seedling nursery and transplanted on 8 August, 2012 in well puddled plot. Two seedlings per hill were used following a spacing of 20 cm x 25 cm. After one week of transplanting all plots were checked for any missing hill, which was filled up with extra seedlings whenever required.

### 3.12 Intercultural operations

Intercultural operations were done to ensure normal growth of the crop. Plant protection measures were followed as and when necessary. The following intercultural operations were done.

### 3.13 Irrigation

Necessary irrigations were provided to the plots from the irrigation channel and when required during the growing period of rice crop.

### 3.14 Weeding

The plots were infested with some common weeds, which were removed by uprooting them from the field three times during the period of the cropping season.

### 3.15 Insect and pest control

There was no infestation of diseases in the field but rice bug was observed in the field during milking stage. Rice bug was controlled by using Malathion @ 1.12 L/ha.

### 3.16 Crop harvest

The crop was harvested at full maturity when 80-90% of the grains were turned into straw colored on 1 December 2012. The crop was cut at the ground level and plot wise crop was bundled separately and brought to the threshing floor.

### 3.17 Yield components

5 representative plant hills from each plot were selected randomly for recording the yield contributing character. After harvest the following yield components were recorded:

1. Plant height (cm)
2. Number of tiller
3. Number of effective tiller $hill^{-1}$
4. Panicle length (cm)
5. Number of grains $panicle^{-1}$
6. Number of filled grains $panicle^{-1}$
7. 1000 grain weight (gm)
8. Grain and straw yield (t $ha^{-1}$)

#### 3.17.1 Plant height

The plant height was measured from the ground level to the top of the panicle. From each plot, plants of 5 hills were measured and averaged.

#### 3.17.2 Panicle length

The measurement of panicle length was taken from basal node of the rachis to the apex of each panicle. Each observation was an average of 5 hills.

#### 3. 17.3 Number of effective tiller $hill^{-1}$

3 hills were taken randomly from each plot and total numbers of effective tillers $hill^{-1}$ were recorded.

#### 3. 17.4 Number of filled grains $panicle^{-1}$

Filled and unfilled grains per panicle were counted and averaged from the panicles of 3 hills.

### 3. 17.5 1000-grain weight

1000 grains were taken from the collected samples plot wise and the weight was recorded in an electrical balance after sun drying.

### 3. 17.6 Grain and straw yields

The harvested crops was threshed, cleaned, dried and weighed carefully. Grain and straw yields were adjusted to 14% moisture content and expressed as t $ha^{-1}$.

### 3.18 Post harvest soil sampling

After harvest of crop, soil samples were collected from each plot at a depth of 0 to 15 cm. Soil sample of each plot were air-dried, crushed and passed through a two mm (10 meshes) sieve. The soil samples were kept in plastic container to determine the physical and chemical properties of soil.

### 3.18.1 Soil analysis

Soil samples were analyzed for both physical and chemical characteristics viz, organic matter, $p^H$, total N and available P, K, and S contents. These results have been shown in the Table 4.6. The soil samples were analyzed by the following standard methods as follows:

### 3.18.2 Organic matter

Organic carbon in soil sample was determined by wet oxidation method of Walkley and Black (1935). The underlying principle was used to oxidize the organic matter with an excess of 1N $K_2Cr_2O_7$ in presence of conc. $H_2SO_4$ and conc. $H_3PO_4$. The excess $K_2Cr_2O_7$ solution was titrated with 1N $FeSO_4$ to obtain the content of organic matter by multiplying the percent organic carbon with 1.73 (Van Bemmelen factor) and the results were expressed in percentage (Page et al. 1982).

### 3.18.3 Total nitrogen

Total N content of soil were determined followed by the Micro Kjeldahl method. One gram of oven dry ground soil sample was taken into micro kjeldahl flask to which 1.1 gm catalyst mixture ($K_2SO_4$: $CuSO_4$. $5H_2O$: Se in the ratio of 100: 10: 1) and 10 ml $H_2SO_4$ were added. The flasks were swirled and heated (160°C and added 2.5 ml $H_2O_2$ and then heating at 360 °C was continued until the digest become clear and colorless). After cooling, the content was taken into 100 ml volumetric flask and the volume was made up to the mark with distilled water. A reagent blank was prepared in a similar manner. These digests were used for nitrogen determination (Page et al. 1982).

Then 20 ml digest solution was transferred into the distillation flask. Then 10 ml of $H_3BO_3$ indicator solution was taken into a 250 ml conical flask which is marked to indicate a volume of 50 ml and placed the flask under the condenser outlet of the distillation apparatus so that the delivery end dipped in the acid. Sufficient amount of 10N-NaOH solutions was added in the container connecting with distillation apparatus. Water runs through the condenser of distillation apparatus was checked. Operating switch of the distillation apparatus collected the distillate. The conical flask was removed by washing the delivery outlet of the distillation apparatus with distilled water. Finally the distillates were titrated with standard 0.01 N $H_2SO_4$ until the color changes from green to pink. The amount of N was calculated using the following formula:

$$\%N = (T-B) \times N \times 0.014 \times 100/s$$

T = Sample titration (ml) value of standard $H_2SO_4$

B = Blank titration (ml) value of standard $H_2SO_4$

N = Strength of $H_2SO_4$

S = Sample weight in gram

### 3.18.4 Available phosphorus

Available P was extracted from the soil with 0.5 M $NaHCO_3$ solutions, pH 8.5 (Olsen et al., 1954). Phosphorus in the extract was then determined by developing blue color with reduction of phosphomolybdate complex and the color intensity were measured colorimetrically at 660 nm wavelength and readings were calibrated against the standard P curve (Page et al. 1982)

### 3.18.5 Exchangeable potassium

Exchangeable K was determined by 1N $NH_4OAc$ (pH 7) extraction methods and by using flame photometer and calibrated with a standard curve (Page et al 1982).

### 3.18.6 Available sulphur

Available S content was determined by extracting the soil with $CaCl_2$ (0.15%) solution as described by (Page et al. 1982). The extractable 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.

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## 3.19 Chemical analysis of plant samples

### 3.19.1 Collection of plant samples

Grain and straw samples were collected after threshing. The samples were finely ground by using a Wiley-Mill with stainless contact points to pass through a 60-mesh sieve. The samples were stored in plastic vial for analysis of N, P, K and S.

### 3.19.2 Preparation of plant samples

The plant samples were dried in an oven at 65 °C for 72 hours and then ground by a grinding machine. The grain and straw samples were analyzed for determination of N, P, K and S concentrations. The methods were as follows:

### 3.19.3 Digestion of plant samples with sulfuric acid for N

For the determination of nitrogen an amount of 0.2 g oven dry, ground sample was taken in a micro kjeldahl flask. 1.1 gm catalyst mixture ($K_2SO_4$:$CuSO_4.5H_2O$: Se in the ratio of 100: 10: 1) and 5 ml conc. $H_2SO_4$ were added. The flasks were heated at 120 °C and added 2.5 ml 30% $H_2O_2$. Then heating was continued at 180°C until the digests become clear and colorless. After cooling, content was taken into a 100 ml volumetric flask and the volume was made up to the mark with deionized water. A reagent blank was prepared in a similar manner. Nitrogen in the digest was estimated by distilling the digest with 10 N NaOH followed by titration of the distillate trapped in $H_3BO_3$ indicator solution with 0.01N $H_2SO_4$.

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

A sub sample weighing of 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°C. Heating were stopped when the dense white fumes of $HClO_4$ occurred. The content of the flasks were boiled until they become clean and colorless. After cooling, the content was taken into a 100 ml volumetric flask and the volume was made up to the mark with deionized water. P, K and S were determined from this digest.

### 3.19.5 Nutrient uptake

After chemical analysis of straw and grain samples the nutrient contents were calculated and from the value of nutrient contents, nutrient uptake was also calculated by following formula:

Nutrient uptake = Nutrient content (%) x Yield (kg/ha) 100

### 3.20 Statistical analysis

The data for every crop parameters and also for the nutrient concentration and nutrient uptake by the plant (grain and straw) were analyzed statistically by F-test to examine whether the treatment effects were significant or non-significant (Gomez and Gomez, 1984). The mean comparisons of the treatment were evaluated by DMRT (Duncan's Multiple Range Test).

# CHAPTER IV

# RESULTS AND DISCUSSION

An attempt has been made to present a brief and pertinent review of literature in this chapter. A better understanding of the effects of the nutrients supplied from green manure and N fertilizers on rice in our soils will obviously facilitate the development of some agronomic practice for production of crops. While reviewing the earlier work in the world, particularly attention has been paid to the integrated use of green manure with N fertilizers for maintenance of soil fertility, yield, and nutrient uptake and crop productivity in rice based cropping sequence.

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## 4.1 Growth and yield contributing parameters

### 4.1.1 Plant height

The plant height of BRRI dhan33 varied significantly in different treatments due to application of green manure and nitrogenous fertilizers (Table 4.1). It was revealed that all the treatments produced significantly taller plants compared to the treatment $T_8$ (140 kg N-GM). The plant height ranged from 101.1 to 114.0 cm and the highest value (114.0 cm) was noted in the treatment $T_4$ (80 kg N-Urea+60 kg N-GM), which was statistically similar to those found in treatments $T_3$ and $T_7$ respectively. The lowest plant height (101.10 cm) was obtained in the treatment $T_8$ where no N fertilizer was used from inorganic sources. The combined application of N fertilizer with green manure increased the plant height compared to only green manure application. Babu *et al.* observed that the plant height was significantly influenced by the application of organic manure and chemical fertilizers. Rajani Rani *et al.* (2001), Singh *et al.* (1999), Hossain *et al.* (1997) and Sharma and Mitra (1991) also observed similar results.

**Table 4.1 Effect of N fertilizer and green manure on different growth characters of T. Aman rice (BRRI dhan33)**

| Treatments | Plant height (cm) | Number of effective tillers per hill | Number of panicle per hill | Panicle length (cm) |
|---|---|---|---|---|
| $T_1$ | 108.4 b | 15.93 a | 12.53 d | 25.23 ab |
| $T_2$ | 108.5 b | 15.40 ab | 15.50 a | 23.83 cd |
| $T_3$ | 109.4 ab | 14.60 a-c | 13.40 c | 25.01 a-c |
| $T_4$ | 114.0 a | 14.57 a-c | 15.30 a | 25.26 ab |
| $T_5$ | 106.1 b | 13.47 bc | 14.50 b | 25.64 a |
| $T_6$ | 107.3 b | 13.13 bc | 11.50 e | 24.55 a-d |
| $T_7$ | 110.2 ab | 12.80 c | 13.27 cd | 24.01 cd |
| $T_8$ | 101.1 c | 12.20 c | 13.46 c | 23.69 d |
| $T_9$ | 107.4 b | 13.23 bc | 13.00 cd | 24.38 b-d |
| % LSD | 4.747 | 2.155 | 0.772 | 1.095 |
| % CV | 2.97 | 9.68 | 3.38 | 2.26 |

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

$T_1$ - 140 kg N as Urea (Recommended dose)
$T_2$ - 120 Kg N as Urea + 20 kg N as Green manure (GM)
$T_3$ - 100 kg N as Urea + 40 kg N as GM
$T_4$ - 80 kg N as Urea + 60 kg N as GM
$T_5$ - 60 Kg N as Urea + 80 kg N as GM
$T_6$ - 40 kg N as Urea + 100 kg N as GM
$T_7$ - 20 kg N as Urea +120 Kg N as GM
$T_8$ - 140 kg N as GM
$T_9$ - 70 kg N as Urea +70 kg N as GM

### 4.1.2 Number of effective tillers hill$^{-1}$

The number of effective tillers hill$^{-1}$ of BRRI dhan33 significantly varied due to application of green manure and N fertilizer. The number of effective tillers hill$^{-1}$ varied due to different treatments and ranged from 12.20 to 15.93 (Table 4.1). The treatment $T_1$ (140 kg N-Urea) gave the highest number of effective tillers hill$^{-1}$ where only inorganic N fertilizers were applied. The lowest number of effective tillers hill$^{-1}$ (12.20) was observed in the treatment $T_8$ (140 kg N-GM).

Inorganic N fertilizer responded significantly better than organic green manure in increasing the number of effective tillers hill$^{-1}$ of BRRI dhan33. This might be due to inorganic chemical fertilizer becomes readily available to plant than organic source. N is readily available from urea than green manure and hence number of effective tillers hill$^{-1}$ increased. Chander and Pandey (1996) reported a significant increase in effective tillers hill$^{-1}$ due to application of higher doses of nitrogen.

### 4.1.3 Number of panicle hill$^{-1}$

The number of panicle hill$^{-1}$ varied significantly with different treatments (Table 4.1). The number of panicle hill$^{-1}$ ranged from 11.50 to 15.30. The highest number of panicle hill$^{-1}$ (15.30) was observed in treatment $T_4$ (80 kg N-Urea+60 kg N-GM) and the lowest (11.50) was observed in treatment $T_6$ (40 kg N-Urea+100 kg N-GM).

### 4.1.4 Panicle length

The panicle length of BRRI dhan33 varied significantly by different treatments (Table 4.1). The panicle length ranged from 23.69 to 25.64 cm. The highest panicle length of 25.64 cm was observed in the treatment $T_5$ (60 kg N-Urea+80 kg N-GM). The lowest panicle length (23.69 cm) was recorded in the treatment $T_8$ (140 kg N-GM) where all N fertilizer was supplemented by green manure. $T_1$ and $T_3$ treatment also produced highest panicle length. The more increase of panicle length was observed at combined application of green manure with N fertilizer than only green manure application. In case of increased panicle length, BRRI dhan33 responded significantly better with combined application of 40% N fertilizers with green manure. Haque (1999) and Azim (1999) noted a significant increase in panicle length due to the application of organic manure and chemical fertilizers. Babu et al. (2001), Ahmed and Rahman (1991) and Apostol (1989) also reported similar result.

### 4.1.5 Number of total grains panicle$^{-1}$

The number of grains per panicle varied significantly due to different treatments under study that result shows in the table 4.2. The number of grains panicle$^{-1}$ ranged from 179.31 to 129.14. The highest value (179.31) was observed in the treatment $T_4$ (80 kg N-Urea+40 kg N-GM) and the lowest value (129.14) was observed in the treatment $T_8$ (140 kg N-GM). It was observed that the number of grains panicle$^{-1}$ increased with the increase in the amount of green manure to a certain extent. Dhaincha manure applied in combination with N fertilizer increased the number of grains panicle$^{-1}$ of BRRI dhan33 considerably compared to only green manure application. The effect of green manure and N fertilizer on increasing the number of grains panicle$^{-1}$ was more pronounced as compared to only green manure application. This might be due to improvement of soil quality through green manuring with N fertilizer. Grains panicle$^{-1}$ significantly increased due to the application of organic manures and chemical fertilizers (Razzaque, 1996). These results are also in agreement with Hoque (1999) and Azim (1996).

### 4.1.6 Number of filled grain panicle$^{-1}$

The number of filled grain panicle$^{-1}$ varied significantly due to different treatments (Table 4.2). The highest number of filled grain panicle$^{-1}$ (170.3) was recorded in treatment $T_4$ (80 kg N-Urea+40 kg N-GM) and the lowest (113.9) was recorded in treatment $T_8$ (140 kg N-GM).

Table 4.2 Effect of N fertilizer and green manure on different yield characters of T. Aman rice (BRRI dhan33)

| Treatments | Number of grain/total grain per panicle | Number of filled grain per panicle | Number of empty grain per panicle | Thousand grain weight(gm) | Grain yield per hectare (ton) | Straw yield per hectare (ton) |
|---|---|---|---|---|---|---|
| $T_1$ | 158.24 b | 145.7 d | 12.54 c | 23.82 bc | 4.502 cd | 4.815 c |
| $T_2$ | 163.07 b | 150.5 c | 12.57 c | 23.92 bc | 4.507 cd | 4.798 c |
| $T_3$ | 172.73 a | 160.4 b | 12.33 c | 24.33 bc | 4.653 bc | 4.687 c |
| $T_4$ | 179.31 a | 170.3 a | 9.017 e | 26.67 a | 5.050 a | 5.270 ab |
| $T_5$ | 144.49 c | 133.0 e | 11.49 d | 25.00 b | 4.730 b | 5.487 a |
| $T_6$ | 143.71 c | 130.3 e | 13.41 b | 23.67 bc | 4.533 bcd | 5.123 b |
| $T_7$ | 138.52 d | 125.0 f | 13.52 b | 23.39 c | 4.403 d | 4.747 c |
| $T_8$ | 129.14 e | 113.9 h | 15.24 a | 23.33 c | 4.367 d | 4.265 d |
| $T_9$ | 131.61 d | 118.1 g | 13.51 b | 24.33 bc | 4.487 cd | 5.130 b |
| % LSD | 3.462 | 3.238 | 0.7741 | 1.224 | 0.1958 | 0.2448 |
| % CV | 1.31 | 1.41 | 4.03 | 3.44 | 4.62 | 3.96 |

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

$T_1$ - 140 kg N as Urea (Recommended dose)
$T_2$ - 120 Kg N as Urea + 20 kg N as Green manure (GM)
$T_3$ - 100 kg N as Urea + 40 kg N as GM
$T_4$ - 80 kg N as Urea + 60 kg N as GM
$T_5$ - 60 Kg N as Urea + 80 kg N as GM
$T_6$ - 40 kg N as Urea + 100 kg N as GM
$T_7$ - 20 kg N as Urea +120 Kg N as GM
$T_8$ - 140 kg N as GM
$T_9$ - 70 kg N as Urea +70 kg N as GM

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### 4.1.7 Number of empty grain panicle$^{-1}$

The number of empty grain panicle$^{-1}$ varied significantly due to different treatments (Table 4.2). The highest number of empty grain panicle$^{-1}$ (15.24) was observed in the treatment $T_8$ (140 kg N-GM) and the lowest value (9.017) was recorded in treatment $T_4$ (80 kg N-Urea+60 kg N-GM).

### 4.1.8 1000-grain weight

Table 4.2 shows the effect of green manure and N fertilizers on 1000-grain weight of BRRI dhan33. The 1000-grain weight varied significantly due to different treatments. The 1000-grain weight ranged from 23.33 to 26.67 gm. The highest thousand grain weight of 26.67 gm was obtained in treatment $T_4$ (80 kg N–Urea+60 kg N-GM). The lowest value (23.33) was found in treatment $T_8$ (140 kg N-GM).

Abedin *et al.* (1999) reported that the combined application of organic manure and chemical fertilizers increased the 1000-grain weight of rice. Apostol (1989) observed that application of organic manure and chemical fertilizer increased 1000-grain weight of rice.

### 4.1.9 Grain yield

The grain yield of BRRI dhan33 varied significantly due to application of green manure and N fertilizer (Table 4.2 and figure 2). All the treatments gave significantly higher grain yield over the treatment treated with only green manure. The grain yield ranged from 4.36 ton to 5.05 ton ha$^{-1}$. The highest grain yield (5.05 t ha$^{-1}$) was observed in the treatment $T_4$ (80 kg N-Urea+60 kg N-GM) and the lowest value (4.36 t ha$^{-1}$) was recorded in the treatment $T_8$ (140 kg N-GM). The next highest grain yield (4.730 ton ha$^{-1}$) was observed in the treatment $T_5$ (60 kg N-Urea+80 kg N-GM) which was statistically identical with $T_3$ (100 kg N-Urea+40 kg N-GM). The treatment may be ranked in order of $T_4>T_5>T_3>T_6>T_2>T_1>T_9>T_7>T_8$ in term of grain yields. Inorganic N fertilizer has a significant effect over organic source in increasing grain yield of rice. But a suitable combination of N fertilizer and green manure can increase grain yield over inorganic source. Here, $T_4$ (80 kg N-Urea+60 kg N-GM) gave the best yield.

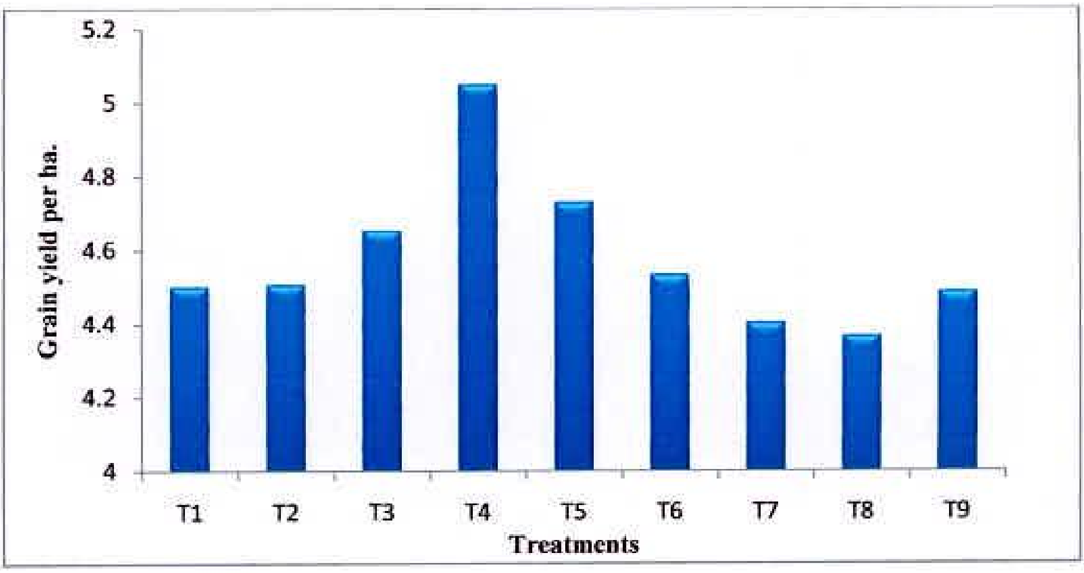


Figure 2. Grain yield of T. Aman rice (cv. BRRI dhan33) as influenced by the combined use of N fertilizer and green manure

$T_1$ - 140 kg N as Urea (Recommended dose)
$T_2$ - 120 Kg N as Urea + 20 kg N as Green manure (GM)
$T_3$ - 100 kg N as Urea + 40 kg N as GM
$T_4$ - 80 kg N as Urea + 60 kg N as GM
$T_5$ - 60 kg N as Urea + 80 kg N as GM
$T_6$ - 40 kg N as Urea + 100 kg N as GM
$T_7$ - 20 kg N as Urea +120 Kg N as GM
$T_8$ - 140 kg N as GM
$T_9$ - 70 kg N as Urea +70 kg N as GM

### 4.1.10 Straw yield

Straw yield of BRRI dhan33 also varied significantly by different treatments under study (Table 4.2 and figure 3). The yields of straw ranged from 5.487 t $ha^{-1}$ to 4.265 t $ha^{-1}$.The highest straw yield (5.487 t $ha^{-1}$) was obtained in the treatment $T_5$ (60 kg N-Urea+80 kg N-GM) and the lowest value (4.265 t $ha^{-1}$)

was noted in the treatment $T_8$ (140 kg N-GM). The next highest straw yield (5.270 t $ha^{-1}$) was observed in the treatment $T_4$, which was statistically comparable with treatments $T_6$ and $T_9$ respectively. The treatments may be ranked in order of $T_5>T_4>T_9>T_6>T_1>T_2>T_7>T_8>T_3$ terms of straw yield. Green manure and N fertilizer exerted comparatively better effect in producing higher straw yields as compared to only green manure. It is clear that green manure in combination with N fertilizers encouraged vegetative growth of plants and thereby increasing straw yield.

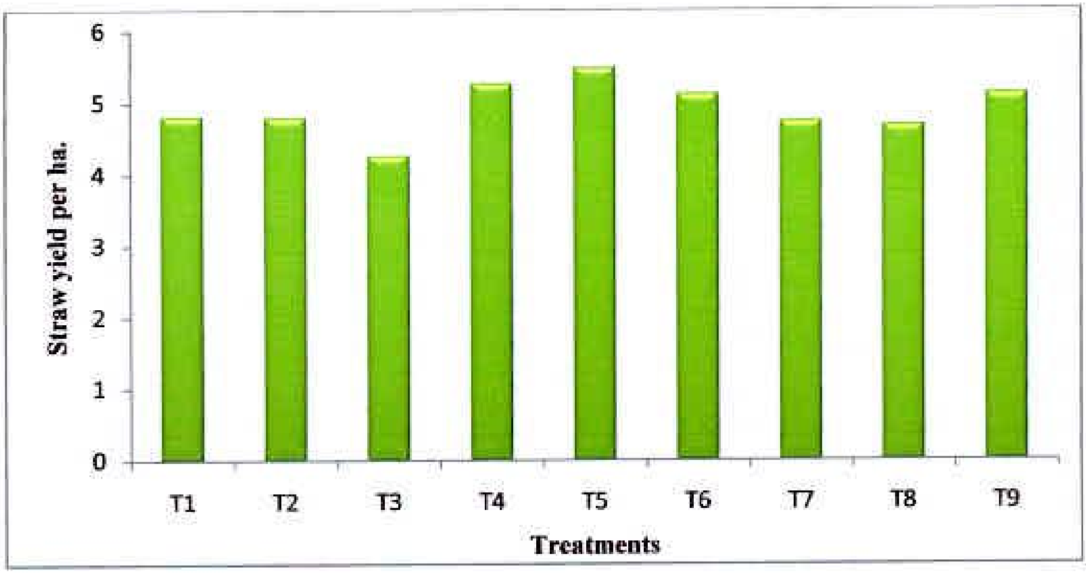


Figure 3. Straw yield of T. Aman rice (cv. BRRI dhan33) as influenced by the combined use of N fertilizer and green manure

$T_1$ - 140 kg N as Urea (Recommended dose)
$T_2$ - 120 Kg N as Urea + 20 kg N as Green manure (GM)
$T_3$ - 100 kg N as Urea + 40 kg N as GM
$T_4$ - 80 kg N as Urea + 60 kg N as GM
$T_5$ - 60 kg N as Urea + 80 kg N as GM
$T_6$ - 40 kg N as Urea + 100 kg N as GM
$T_7$ - 20 kg N as Urea +120 Kg N as GM
$T_8$ - 140 kg N as GM
$T_9$ - 70 kg N as Urea +70 kg N as GM

### 4.2 Nutrient concentration in grain and straw of rice

The grain and straw sample of rice were analyzed for estimating N, P, K and S contents. The results of N, P, K, S of grain and straw have been discussed under the following subsection.

#### 4.2.1 Nitrogen content

The nitrogen content in rice grain varied significantly by different treatments (Table 4.3). The N content in rice grain ranged from 1.58% to 1.78%.The highest N content (1.78%) in rice grain was observed in the treatment $T_1$ (140 kg N-Urea).The next highest N concentration (1.75%) in rice grain was observed in the treatment $T_2$ (120 kg N-Urea+20 kg N-GM) which is statistically similar with treatment $T_3$ (100 kg N-Urea+40 kg N-GM).

The lowest N content (1.58%) in rice grain was observed in the $T_8$ (140 kg N-GM) which is statistically similar with treatment $T_6$ (40 kg N-Urea+100 kg N-GM) and $T_7$ (20 kg N-Urea+120 kg N-GM). Application of chemical N fertilizer increased the nitrogen content of grain markedly than only green manure application.

In rice straw the N content varied significantly due to different treatments (Table 4.3). The N content in rice straw range from 1.21% to 1.49%.The highest N content (1.49%) in rice straw was observed in treatment $T_1$ (140 kg N-Urea) .The lowest N concentration (1.21%) in rice straw was observed in treatment $T_8$ (140 kg N-GM). Application of chemical fertilizer significantly increases the N content in rice straw than green manure.

#### 4.2.2 Phosphorus content

The phosphorus content in rice grain varied significantly due to the different treatments (Table 4.3). Phosphorus content in rice grain ranged from 0.210% to 0.337%. The highest P content (0.337%) in grain was observed in the treatment $T_8$ (140 kg N-GM) and the lowest P concentration (0.210%) was noted in the treatment $T_1$ (140 kg N-Urea). The next highest P content (0.330%) in rice grain was found in the treatment $T_7$ (20 kg N-Urea+120kg N-GM) and $T_3$ (100 kg N-Urea+40 kg N-GM). P content in rice grain increased with the increase in the amount of green manure.

In rice straw the P content varied significantly due to different treatments (Table 4.3). The P content in rice straw ranged from 0.087% to 0.160%. The highest P content (0.16%) in rice straw was recorded in the treatment $T_8$ (140 kg N-GM) and the lowest P concentration (0.087%) was noted in the treatment $T_1$ (140 kg N-Urea). The next highest P content (0.15%) in rice straw was found in the treatment $T_9$ (70 kg N-Urea+70 kg N-GM).

Application of green manure has a pronounced effect in increasing the P content in rice grain and straw as compared to only N fertilizer application.

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**Table 4.3 Effect of different treatments on N, P, K and S concentration in grain and straw of T. Aman rice (BRRI dhan33)**

Grain nutrient concentration (%)

| Treatments | N | P | S | K |
|---|---|---|---|---|
| $T_1$ | 1.78 a | 0.210 c | 0.095 e | 0.517 e |
| $T_2$ | 1.75 ab | 0.293 ab | 0.097 e | 0.543 e |
| $T_3$ | 1.74 ab | 0.330 a | 0.113 de | 0.570 de |
| $T_4$ | 1.71 b | 0.313 a | 0.124 cd | 0.623 cd |
| $T_5$ | 1.65 c | 0.310 ab | 0.134 bc | 0.660 bc |
| $T_6$ | 1.64 cd | 0.320 a | 0.141 a-c | 0.703 ab |
| $T_7$ | 1.62 cd | 0.330 a | 0.154 ab | 0.737 a |
| $T_8$ | 1.58 d | 0.337 a | 0.156 a | 0.760 a |
| $T_9$ | 1.65 c | 0.250 bc | 0.135 bc | 0.690 a-c |
| % LSD | 0.05474 | 0.05741 | 0.01896 | 0.06476 |
| % CV | 1.02 | 2.99 | 1.79 | 1.47 |

Straw nutrient concentration (%)

| Treatments | N | P | S | K |
|---|---|---|---|---|
| $T_1$ | 1.49 a | 0.087 e | 0.313 b | 1.33 f |
| $T_2$ | 1.41 b | 0.092 e | 0.320 b | 1.37 ef |
| $T_3$ | 1.37 bc | 0.113 d | 0.330 ab | 1.39 e |
| $T_4$ | 1.33 cd | 0.130 b-d | 0.337 ab | 1.45 d |
| $T_5$ | 1.30 de | 0.133 b-d | 0.330 ab | 1.49 cd |
| $T_6$ | 1.26 ef | 0.127 cd | 0.340 ab | 1.52 bc |
| $T_7$ | 1.25 ef | 0.137 bc | 0.360 ab | 1.57 ab |
| $T_8$ | 1.21 f | 0.160 a | 0.390 a | 1.58 a |
| $T_9$ | 1.30 de | 0.150 ab | 0.3433 ab | 1.47 cd |
| % LSD | 0.05474 | 0.02048 | 0.0599 | 0.05474 |
| % CV | 0.95 | 7.84 | 3.05 | 0.95 |

### 4.2.3 Potassium content

The Potassium content in rice grain varied significantly due to different treatments (Table 4.3). Potassium content in rice grain ranged from 0.517% to 0.760%. The highest Potassium content (0.76%) in grain was observed in the treatment $T_8$ (140 kg N-GM) that was significantly higher than the rest of the treatments and the lowest Potassium concentration (0.517%) was noted in the treatment $T_1$ (140 kg N-Urea). The next highest Potassium content in rice grain (0.737%) was found in the treatment $T_7$ (20 kg N-Urea+ 120 kg N-GM) which is statistically similar with treatment $T_6$ (40 kg N-Urea+100 kg N-GM).

In rice straw the Potassium content varied significantly due to different treatments (Table 4.3). The K content in rice straw ranged from 1.58% to 1.33%. The highest K content (1.58%) in rice straw was recorded in the treatment $T_8$ (140 kg N-GM) and the lowest K concentration (1.33%) was noted in the treatment $T_1$ (140 kg N-Urea). The next highest Potassium content (1.57%) in rice straw was found in the treatment $T_7$ (20 kg N-Urea+120 kg N-GM).

The increasing Potassium content in both grain and straw was more pronounced with dhaincha compared to only N fertilizer application. From the results, it was observed that the Potassium content in rice straw was higher than those in grain in all the treatments. Potassium contents both in grain and straw of rice increased due to application of green manure.

### 4.2.4 Sulphur content

The sulphur content in rice grain varied significantly due to the different treatments (Table 4.3). S content in rice grain ranged from 0.095% to 0.156%. The highest S content (0.156%) in grain was observed in the treatment $T_8$ (140 kg N-GM) and the lowest S concentration (0.095%) was noted in the treatment $T_1$ (140 kg N-Urea). The next highest S content (0.154%) in rice grain was found in the treatment $T_7$ (20 kg N-urea+120 kg N-GM) that was statistically identical with $T_6$ (40 Kg N-Urea+100 Kg N-GM).

In rice straw the S content varied significantly due to different treatments (Table 4.3). The S content in rice straw ranged from 0.313% to 0.390%. The highest S content (0.39%) in rice straw was recorded in the treatment $T_8$ (20 kg N-Urea+100 kg N-GM) and the lowest S concentration (0.313%) was noted in the treatment $T_1$ (140 kg N-Urea). The next highest S content in rice straw was found in the treatment $T_7$ (140 kg N-GM).

Sulphur content in straw was slightly higher than that of grain. Green manure and chemical fertilizer influenced greatly in increasing the S content in rice grain compared to only chemical fertilizer application. Azim (1999) and Hoque (1999) reported that application of sulphur from manure and fertilizers increased S content both in grain and straw. Hossain (1996) also reported the similar results.

### 4.3 Nutrient uptake by grain and straw of rice

The uptake of N, P, K and S were calculated from the yield (kg $ha^{-1}$) and nutrient concentration (%) of grain and straw. The results of N, P, K and S uptake by grain and straw of BRRI dhan33 are presented and discussed below:

#### 4.3.1 Nitrogen uptake

Table 4.4 indicate that the results of nitrogen uptake both by rice grain and straw of BRRI dhan33 varied significantly due to application of green manure and N fertilizer. The N uptake by rice grain ranged from 69.26 to 84.72 kg $ha^{-1}$. The highest Nitrogen uptake by grain (84.72 kg $ha^{-1}$) was recorded in the treatment $T_4$ (80 kg N-Urea+60 kg N-GM) which is statistically comparable with treatment $T_3$ (100 kg N-Urea+40kg N-GM) and the lowest N uptake in rice grain (69.26 kg $ha^{-1}$) was observed in the treatment $T_8$ (140 kg N-GM).

The highest N uptake (Table 4.4) by rice straw varied significantly with different treatments. The total nitrogen uptake by rice straw ranged from 51.53 to 66.59 kg $ha^{-1}$. The highest N uptake (66.59 kg $ha^{-1}$) by rice straw was recorded in the treatment $T_4$ (80 kg N-Urea+60 kg N-GM) and the lowest value (51.53 kg $ha^{-1}$)

was observed in the treatment $T_8$ (140 kg N-GM). This result shows that the total N uptake by grain and straw were more influenced due to combined application of dhaincha manure with N fertilizers. Sengar *et al.* (2000) reported that the N uptake by rice grain and straw increased significantly with the combined application of organic manure and chemical fertilizers. Rahman (2001), Duhan *et al.* (2002), Azim (1999) and Hoque (1999) also reported similar results.

### 4.3.2 Phosphorus uptake

Table 4.4 indicate that the results of P uptake both by rice grain and straw of BRRI dhan33 varied significantly due to application of green manure and chemical fertilizers. The P uptake by rice grain ranged from 12.22 to 16.85 kg $ha^{-1}$. The highest phosphorus uptake by grain (16.85 kg $ha^{-1}$) was recorded in the treatment $T_4$ (80 kg N-Urea+60 kg N-GM) and the lowest P uptake by rice grain (12.22 kg $ha^{-1}$) was recorded in the treatment $T_9$ (70 kg N-Urea+70 kg N-GM).

The highest uptake of P by rice straw (7.437 kg $ha^{-1}$) was recorded in the treatment $T_9$ (70 kg N-Urea+70 kg N-GM) and the lowest (4.117 kg $ha^{-1}$) was recorded in the treatment $T_1$ (140 kg N-Urea).

This result shows that the total P uptake by grain and straw were more influenced due to application of green manure with chemical fertilizers. Sengar *et al.* (2000) observed that the highest P uptake by rice grain was recorded with the combined application of organic manure and phosphorous fertilizers. Similar results were also obtained by Gupta *et al.* (1995)

**Table 4.4 N and P uptake by grain and straw of T. Aman rice (cv. BRRI dhan33) as influenced by use of N fertilizer and green manure**

| TREATMENTS | N uptake (kg/ha) | | P uptake (kg/ha) | |
|---|---|---|---|---|
| | Grain | Straw | Grain | Straw |
| $T_1$ | 77.85 bc | 61.29 bc | 13.65 e | 4.117 d |
| $T_2$ | 79.85 b | 64.54 ab | 14.52 c | 4.267 d |
| $T_3$ | 83.56 a | 66.01 a | 15.60 b | 4.327 d |
| $T_4$ | 84.72 a | 66.59 a | 16.85 a | 6.073 c |
| $T_5$ | 79.58 b | 61.36 c | 14.31 d | 7.213 a |
| $T_6$ | 76.23 c | 59.78 c | 14.44 cd | 6.500 bc |
| $T_7$ | 73.10 d | 55.54 d | 12.63 f | 6.243 bc |
| $T_8$ | 69.26 e | 51.53 e | 14.54 c | 6.710 b |
| $T_9$ | 78.96 bc | 61.99 bc | 12.22 g | 7.437 |
| % LSD | 2.797 | 3.012 | 0.1935 | 0.458 |
| % CV | 2.07 | 2.89 | 2.20 | 4.74 |

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

$T_1$ - 140 kg N as Urea (Recommended dose)
$T_2$ - 120 Kg N as Urea + 20 kg N as Green manure (GM)
$T_3$ - 100 kg N as Urea + 40 kg N as GM
$T_4$ - 80 kg N as Urea + 60 kg N as GM
$T_5$ - 60 Kg N as Urea + 80 kg N as GM
$T_6$ - 40 kg N as Urea + 100 kg N as GM
$T_7$ - 20 kg N as Urea +120 Kg N as GM
$T_8$ - 140 kg N as GM
$T_9$ - 70 kg N as Urea +70 kg N as GM

### 4.3.3 Potassium uptake

Table 4.5 indicate that the results of K uptake both by rice grain and straw of BRRI dhan33 varied significantly due to application of green manure and chemical fertilizer. The K uptake by rice grain ranged from 22.20 to 33.08 kg/ha and in straw ranged from 105.5 kg $ha^{-1}$ to 123.10 kg $ha^{-1}$. The highest Potassium uptake by grain (33.08 kg $ha^{-1}$) was recorded in the treatment $T_8$ (140 kg N–GM). The lowest K uptake in rice grain (22.20 kg $ha^{-1}$) was recorded in the treatment $T_1$ (140 kg N-Urea).

The highest K uptake by rice straw (123.10 kg $ha^{-1}$) was recorded in treatment $T_4$ (80 kg N-Urea+60 kg N-GM) the lowest value (105.5 kg $ha^{-1}$) was observed in the treatment $T_2$ (120 kg N-Urea+20 kg N-GM). This result shows that the K uptake by grain and straw were more influenced due to application of green manure in combination with chemical fertilizers. Sengar *et al.* (2000) reported that application of chemical fertilizer and organic manure significantly increased the K uptake by rice. Similar results were also found by Sharma and Mitra (1991), Cassman (1995), Azim (1996) and Hoque (1999).

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### 4.3.4 Sulphur uptake

Table 4.5 indicate that the results of S uptake both by rice grain and straw of BRRI dhan33 varied significantly due to application of green manure and chemical fertilizers. The S uptake by rice grain ranged from 4.103 to 6.570 kg $ha^{-1}$. and in straw ranged from 14.41 to 16.65 kg $ha^{-1}$. The highest S uptake by grain (6.570 kg $ha^{-1}$) was recorded in the treatment $T_7$ (20 kg N-Urea+120 kg N-GM) and the lowest S uptake (4.103 kg $ha^{-1}$) was recorded in the treatment $T_1$ (140 kg N-Urea).

The highest S uptake (16.55 kg $ha^{-1}$) by rice straw was recorded in the treatment $T_1$ (140 kg N-Urea) which is statistically similar with treatment $T_8$ (140 kg N-GM) and lowest (14.41 kg $ha^{-1}$) was recorded in the treatment $T_7$ (20 kg N-Urea+120 kg N-GM).

Table 4.5 K and S uptake by grain and straw of T. Aman rice (cv. BRRI dhan33) as influenced by use of N fertilizer and green manure at different treatments

| TREATMENTS | K uptake (kg/ha) | | S uptake (kg/ha) | |
|---|---|---|---|---|
| | Grain | Straw | Grain | Straw |
| $T_1$ | 22.20 d | 108.0 f | 4.103 d | 16.55 a |
| $T_2$ | 22.92 d | 105.5 g | 4.483 cd | 15.15 cd |
| $T_3$ | 25.85 c | 110.4 e | 5.367 bc | 15.45 c |
| $T_4$ | 30.04 b | 123.1 a | 6.300 ab | 15.94 abc |
| $T_5$ | 30.31 b | 119.2 b | 6.273 ab | 16.39 ab |
| $T_6$ | 31.29 ab | 116.7 c | 6.493 a | 15.57 bc |
| $T_7$ | 31.20 ab | 113.5 d | 6.570 a | 14.41 d |
| $T_8$ | 33.08 a | 112.6 d | 6.553 a | 16.45 ab |
| $T_9$ | 30.25 b | 118.8 b | 5.933 ab | 15.39 c |
| % LSD | 2.384 | 1.223 | 0.9027 | 0.849 |
| % CV | 4.82 | 0.59 | 9.01 | 3.13 |

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

$T_1$ - 140 kg N as Urea (Recommended dose)
$T_2$ - 120 Kg N as Urea + 20 kg N as Green manure (GM)
$T_3$ - 100 kg N as Urea + 40 kg N as GM
$T_4$ - 80 kg N as Urea + 60 kg N as GM
$T_5$ - 60 Kg N as Urea + 80 kg N as GM
$T_6$ - 40 kg N as Urea + 100 kg N as GM
$T_7$ - 20 kg N as Urea +120 Kg N as GM
$T_8$ - 140 kg N as GM
$T_9$ - 70 kg N as Urea +70 kg N as GM

The total S uptake both by rice grain and straw varied significantly with different treatments. This result shows that the total S uptake by grain and straw were more influenced due to application of dhaincha manure with chemical fertilizers, Dhaincha manure provides better effect in increasing the S uptake by BRRI dhan33 as compared to only chemical fertilizer application. Poongotbai et al. (1999) observed that application of sulphur enhanced significantly S uptake by rice. Azim (1999) and Hoque (1999) recorded the higher uptake of S with the application of manure and fertilizers either alone or in combinations. Similar results were also reported by Sengar et al. (2000) and Rahman (2001).

## 4.4 Post harvest soil analysis

### 4.4.1 Organic matter content

Table 4.6 reveals that the organic matter content of the post harvest soils ranged from 0.747% to 0.760%. It was observed that application of green manure has no significant effect on increasing the organic matter content of post harvest soils as compared to the initial soil. The addition of biomass causes slight change in organic matter content of the postharvest soil. The highest value of organic matter content in soil (0.760%) was observed in the treatment $T_6$ and the lowest value was obtained in the treatment $T_7$ (0.747%) which is statistically comparable with all other treatments.

### 4.4.2 Total Nitrogen

The total N contents of the post-harvest soils varied considerably by different treatments (Table 4.6). The total N content of the post-harvest soils ranged from 0.029 to 0.054%. The highest value (0.054%) was observed in the treatment $T_8$ (140 kg N-GM) and lowest value (.029%) was found in the treatment $T_1$ (140 kg N-Urea). The result indicates that application of green manure exerted an increasing effect on the total N content of the post harvest soils. Ravankar et al. (1999) reported that the application of green manure increased the total N content in soil. Several workers reported that green manure had a positive influenced on total and available N content of soil. Similar reports were also observed by Hemalatha et al. (2000) and Prasad and Kerketta (1991).

### 4.4.3 Available Phosphorous

Available phosphorous contents of the post-harvest soils varied considerably by the application of green manure and chemical fertilizers (Table 4.6). Available phosphorous content in soil ranged from 16.11 to 20.49 ppm. The highest P content (20.49 ppm) were recorded in the treatment $T_8$ (140 kg N-GM) and the lowest P content (16.11 ppm) was observed in the treatment $T_1$ (140 kg N-GM). Studies at IRRI showed that the available P in soil increased by green manuring.

### 4.4.4 Exchangeable Potassium

Exchangeable potassium content of the post-harvest soils varied considerably due to the application of green manure and chemical fertilizers (Table 4.6). The exchangeable K content in post-harvest soils ranged from 0.104 to 0.162 m eq per 100g. The highest value (0.162 m eq per 100g) of exchangeable K was noted in the treatment $T_8$ (140 kg N-GM) and the lowest value (0.104 m eq per 100g) was observed in the treatment $T_1$ (140 kg N-Urea). Results in table 4.6 also indicate that exchangeable K content was higher in soils treated with green manure than treated with only chemical fertilizers. Hemalatha *et al.* (2000) also reported similar results.

### 4.4.5 Available Sulphur

Available Sulphur content of the post-harvest soil also varied considerably due to different treatments (Table 4.6).The available sulphur content of the post-harvest soils ranged from 18.35 to 24.25 ppm. The highest available S content (24.25 ppm) was observed in the treatment $T_6$ (40 kg N-Urea+100 kg N-GM) and lowest value (18.35 ppm) was observed in the treatment $T_1$ (140 kg N-Urea). The S content of the post-harvest soils was higher in soils treated with green manure compared to the soils treated with only chemical fertilizers.

Zaman *et al.* (2000) reported that chemical properties like organic matter content, CEC, total N, exchangeable K, available P and S were favorably influenced by the application of organic sources of nitrogen and potassium while the inorganic sources mostly did not show the positive effect.

**Table 4.6 Effect of integrated use of N fertilizer and green manure on the post-harvest soils**

| Treatments | N (%) | P (mg/kg) | S (mg/kg) | K (m eq/100g) | OM (%) |
|---|---|---|---|---|---|
| $T_1$ | 0.029 e | 16.11 g | 18.35 e | 0.104 g | 0.753 |
| $T_2$ | 0.036 d | 16.48 fg | 19.01 e | 0.114 f | 0.759 |
| $T_3$ | 0.042 c | 16.96 ef | 20.56 d | 0.126 e | 0.759 |
| $T_4$ | 0.047 bc | 17.43 de | 21.57 cd | 0.134 d | 0.755 |
| $T_5$ | 0.051 ab | 18.16 cd | 22.78 abc | 0.143 c | 0.756 |
| $T_6$ | 0.051 ab | 18.62 bc | 24.25 a | 0.148 bc | 0.760 |
| $T_7$ | 0.053 a | 19.10 b | 23.69 ab | 0.152 b | 0.747 |
| $T_8$ | 0.054 a | 20.49 a | 22.12 c | 0.162 a | 0.761 |
| $T_9$ | 0.050 ab | 18.05 cd | 22.55 bc | 0.143 c | 0.758 |
| % LSD | 0.005741 | 0.7988 | 1.401 | 0.005741 | NS |
| % CV | 2.17 | 2.57 | 3.74 | 1.01 | 1.30 |

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

$T_1$ - 140 kg N as Urea (Recommended dose)
$T_2$ - 120 Kg N as Urea + 20 kg N as Green manure (GM)
$T_3$ - 100 kg N as Urea + 40 kg N as GM
$T_4$ - 80 kg N as Urea + 60 kg N as GM
$T_5$ - 60 kg N as Urea + 80 kg N as GM
$T_6$ - 40 kg N as Urea + 100 kg N as GM
$T_7$ - 20 kg N as Urea +120 Kg N as GM
$T_8$ - 140 kg N as GM
$T_9$ - 70 kg N as Urea +70 kg N as GM

# CHAPTER V

## SUMMARY AND CONCLUSION

The study was conducted at the Sher-e-Bangla Agricultural University Farm, Dhaka during the Aman season (August-Decmber) of 2012 to evaluate the effect of Nitrogenous fertilizer and green manure in T. Aman rice (cv. BRRI Dhan 33). The soil belongs to the Tejgaon soil series under the AEZ of Madhupur Tract (AEZ - 28). The soil texture was silty clay loam having $p^H$ 6.2, 0.032% total N, 19.9 ppm available P, 0.12 m eq per l00g exchangeable K, 14.4 ppm available S, 0.76% organic matter and CEC 17.9 m eq per 100 g soil. The experiment was designed with 9 treatments and laid out in Randomized Complete Block Design (RCBD) with three replications. The unit plot size was 3.5m x 2.5m and the total numbers of plot were 27. The treatments were $T_1$ (Recommended dose,140 kg N-Urea), $T_2$ (120 kg N-Urea+20 kg N-GM), $T_3$ (100 kg N-Urea+40 kg N-GM), $T_4$ (80 kg N-Urea+60 kg N-GM), $T_5$ (60 kg N-Urea+80 kg N-GM), $T_6$ (40 kg N-Urea+100 kg N-GM) and $T_7$ (20 kg N-Urea+120 kg N-GM),$T_8$ (140 kg N-GM),$T_9$ (70 kg N-Urea+70 kg N-GM). Dhaincha were applied into the plots four days before transplanting of rice seedling. Nitrogen, Phosphorus, Potassium and Sulphur were applied in different rates from Urea, TSP, MP and Gypsum respectively. The seedlings of 35 days old were transplanted in the experimental plots on August 8, 2012. The intercultural operations were done as required. The crop was harvested on December 1, 2012 at full maturity. Three hills were selected randomly from each plot to record the yield contributing characters. The grain and straw yields were recorded plot wise and expressed on 14% moisture basis. Grain and straw samples were analyzed for N, P, K and S contents. The post-harvest soil samples were also analyzed to see the soil $p^H$, organic matter, total N, available P, exchangeable K and available S contents. The data were analyzed statistically by F-test to examine whether the treatment effects were significant and the mean comparisons of the treatments were evaluated by DMRT at p 5 <%.

The study revealed that all the yield contributing characters of BRRI dhan33 were significantly influenced by the integrated use of N fertilizers and green manure. The yield parameters were recorded highest in treatments viz. plant height ($T_4$), number of effective tillers hill$^{-1}$ ($T_1$), number of panicle hill$^{-1}$ ($T_4$), panicle length ($T_5$) ,number of grains panicle$^{-1}$ ($T_4$), 1000-grain weight ($T_4$) respectively and the lowest was found in treatments viz. plant height ($T_8$), number of effective tillers per hill$^{-1}$($T_8$), number of panicle hill$^{-1}$($T_6$), panicle length ($T_8$), number of grains panicle$^{-1}$ ($T_8$), 1000 grain weight ($T_8$) respectively. The grain and straw yields varied significantly due to the different treatments. The highest grain yield (5.05 ton ha$^{-1}$) and straw (5.487 ton ha$^{-1}$) yields were obtained from the treatment $T_4$ (80 kg N-Urea+ 60 kg N-GM) and $T_5$ (60 kg N-Urea+80 kg N-GM) respectively. The lowest grain yield (4.387 ton ha$^{-1}$) and straw yields (4.265 ton ha$^{-1}$) were observed in the treatment $T_8$ (140 kg N-GM) and $T_3$ (100 kg N-Urea+40 kg N-GM) respectively. The grain yields due to different treatments ranked in order of $T_4>T_5>T_3>T_6>T_2>T_1>T_9>T_7>T_8$ respectively. The straw yields ranked in order of $T_5>T_4>T_9>T_6>T_1>T_2>T_7>T_8>T_3$.

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The highest N content in grain (1.78%) and straw (1.49%) were recorded in treatment $T_1$ (140 kg N-Urea) and the lowest N content in grain (1.58%) and straw (1.21%) were found in the treatment $T_8$ (140 kg N-GM) respectively. The highest P content in grain (0.337%) and straw (0.160%) were observed in the treatment $T_8$ (140 kg N-GM) and the lowest P contents in grain (0.21%) and straw (0.087%) were found in the treatment $T_1$ (140 kg N-Urea). Potassium content in grain and straw also significantly varied due to different treatments. The highest K contents in grain (0.76%) and straw (1.58%) were obtained in the treatment $T_8$ (140 kg N-GM) respectively. The lowest K contents in grain (0.517%) and straw (1.33%) were found in the treatment $T_1$ (140 kg N-Urea). It was found that K content in straw was higher than that in grain.

Green manure performed better in increasing the K content both in grain and straw as compared to chemical fertilizers. Sulphur content both in rice grain and straw differed significantly by different treatments. The highest S contents in grain (0.156%) and straw (0.39%) were obtained in the treatment $T_8$ (140 kg N-GM) and the lowest S contents in grain (0.0947%) and straw (0.313%) were found in the treatment $T_1$ (140 kg N-Urea).

Nitrogen, Phosphorus, Potassium and Sulphur uptake by rice (BRRI dhan33) grain and straw were also affected significantly due to the various treatments. The highest total N uptake by grain (84.72 kg $ha^{-1}$) and straw (66.59 kg $ha^{-1}$) were found in the treatment $T_4$ (80 kg N-Urea+60 kg N-GM) and the lowest value of N uptake in grain (69.26 kg $ha^{-1}$) and straw (51.53 kg $ha^{-1}$) were observed in the treatment $T_8$ (140 kg N-GM). The highest total P uptake by grain (16.85 kg $ha^{-1}$) and straw (7.437 kg $ha^{-1}$) were found in the treatment $T_4$ (80 kg N-Urea+60 kg N-GM ) and $T_9$ (70 kg N- Urea+70 kg N- GM) respectively. The lowest value of P uptake in grain (12.22 kg $ha^{-1}$) and straw (4.117 kg $ha^{-1}$) were found in the treatment $T_9$ (70 kg N-Urea+70 kg N-GM) and treatment $T_1$ (140 kg N-Urea). Potassium and Sulphur uptake by BRRI dhan33 was affected significantly due to the application of green manure and N fertilizer. The highest total K uptake by grain (33.08 kg $ha^{-1}$) and straw (123.10 kg $ha^{-1}$) were found in the treatment $T_8$ (140 kg N-GM) and $T_4$ (80 kg N-Urea+60 kg N-GM) respectively. The lowest value of K uptake in grain (22.20 kg $ha^{-1}$) and straw (105.5 kg $ha^{-1}$) were recorded in the treatment $T_1$ (140 kg N-Urea) and $T_2$ (120 kg N-Urea+20 kg N-GM) respectively. The highest total S uptake by grain (6.57 kg $ha^{-1}$) and straw (16.55 kg $ha^{-1}$) were found in the treatment $T_7$ (20 kg N-Urea+120 kg N-GM) and $T_1$(140 kg N-Urea) respectively. The lowest value of S uptake by grain (4.103 kg $ha^{-1}$) and straw (14.41 kg $ha^{-1}$) were recorded in the treatment $T_1$ (140 kg N-Urea) and $T_7$ (20 kg N-Urea+120 kg N-GM).

Application of green manure and N fertilizers resulted in considerable influence on the properties of the post-harvest soils. Green manure increased the total N, available P, exchangeable K and available S in the post-harvest soils. But there was a little change of organic matter due to addition of green manure.

From the present study it may be concluded that BRRI dhan33 responded better to the nutrient supplied from the green manure with N fertilizers in producing better grain and straw yields. The study clearly demonstrates that the benefit of using dhaincha as green manure can reduce the amount and cost of N fertilizers as well as addition of P, K, S from green manure can give good economic yield particularly when the N fertilizer were applied with green manure. The higher nutrient concentrations were observed in grain and straw when N fertilizers were applied in combination with green manure. The study also shows that only green manure application cannot give satisfactory higher yield compared to combined application of N fertilizer and green manure.

BRRI dhan33 can be cultivated profitably in the Tejgaon silty clay loam soil by using combined application of 80 kg N fertilizer as urea (173.90 kg/ha) and 60 kg N as green manure (Dhaincha 2.71 t/ha). The overall findings of this study indicate that the combined use of N fertilizer and green manure in T. Aman rice should be encouraged for maintaining higher rice yield, quality and soil fertility. Such study is needed in different AEZ of the country for regional adaptability and better performance.

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