EFFECT OF DIFFERENT LEVELS OF ORGANIC AND CHEMICAL FERTILIZERS ON THE PERFORMANCE OF TRANSPLANT AMAN RICE VARIETIES

শেরেবাংলা কৃষি বিশ্ববিদ্যালয় গ্রন্থাগার
সংযোজন নং 37147
স্বাক্ষর তাং 31-10-13

By

MD. ABDUR RAZZAK

REGISTRATION NO. 09-03717

A Thesis

Submitted to the Faculty of Agriculture,
Sher-e-Bangla Agricultural University, Dhaka,
in partial fulfilment of the requirements
for the degree of

MASTER OF SCIENCE

IN

AGRONOMY

SEMESTER: January-June, 2011

Approved by:

(Prof. Dr. A. K. M. Ruhul Amin)	**(Prof. Dr. Md. Jafar Ullah)**
Supervisor	**Co-supervisor**

(Prof. Dr. A. K. M. Ruhul Amin)
Chairman
Examination Committee

CERTIFICATE

This is to certify that the thesis entitled, **"EFFECT OF DIFFERENT LEVELS OF ORGANIC AND CHEMICAL FERTILIZERS ON THE PERFORMANCE OF TRANSPLANT AMAN RICE VARIETIES"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in the partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE IN AGRONOMY,** embodies the result of a piece of *bonafide* research work carried out by **MD. ABDUR RAZZAK,** Registration No. **09-03717** 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.

(Prof. Dr. A. K. M. Ruhul Amin)
Supervisor

Dated: June - 2011
Place: Dhaka, Bangladesh

DEDICATED TO

MY

BELOVED PARENTS

ACKNOWLEDGEMENT

Alhamdulillah, all praises are due to the almighty Allah Rabbul Al-Amin for his gracious kindness and infinite mercy in all the endeavors to the author to let him successfully complete the research work and the thesis leading to Master of Science.

The author would like to express his heartfelt gratitude and most sincere appreciations to his supervisor Professor Dr. A.K.M. Ruhul Amin, Chairman, Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka, for his valuable guidance, advice, immense help, encouragement and support throughout the study period. Grateful appreciation is conveyed to Co-supervisor Professor Dr. Md. Jafar Ullah, Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka, for his constant encouragement, cordial suggestions, constructive criticisms and valuable advice to conduct the research as well as prepare the thesis.

The author expresses his deepest respect and boundless gratitude to all the respected teachers of the Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka, for their valuable teaching, sympathetic co-operation and inspirations throughout the course of this study and research work.

The author wishes to extend his special thanks to Raihan Ullah, S. M. Mehedi Hassan, Md. Ziaul Islam, for their help during experimentation. Thanks to all other friends for their support and encouragement to complete this study.

The author appreciates the assistance rendered by the staff members of the Department of Agronomy and Farm Division, Sher-e-Bangla Agricultural University, Dhaka, who have helped him during the period of experimentation.

Finally, the author is deeply indebted to his parents, sisters and other relatives for their moral support, encouragement and love, and prays to reach the author in this position.

The Author

EFFECT OF DIFFERENT LEVELS OF ORGANIC AND CHEMICAL FERTILIZERS ON THE PERFORMANCE OF TRANSPLANT AMAN RICE VARIETIES

ABSTRACT

An experiment was conducted at the Sher-e-Bangla Agricultural University Farm, Dhaka during the period from June-December 2010 to study the effect of variety and integration of organic and chemical fertilizers on the yield and yield-contributing characters of Transplant aman rice varieties. The experimental treatments included (a) two T. aman rice varieties viz., BRRI dhan46 and Nizershail (b) nine levels of organic and chemical fertilizers viz., without fertilizer (control), recommended dose of chemical fertilizers, cowdung, compost, recommended dose of chemical fertilizers + cowdung, recommended dose of chemical fertilizers + compost, ½ of the recommended dose of chemical fertilizers + cowdung, ½ of the recommended dose of chemical fertilizers + compost, ½ of the recommended dose of chemical fertilizers + cowdung + compost. The experiment was laid out in a split plot design with three replications by placing the variety in the main plots and fertilizers in the subplots. Significant effects on total tillers, effective tillers hill^{-1}, panicle length, filled grains panicle^{-1}, 1000-grain weight, grain yield and straw yield were found by the application of fertilizers on the tested varieties. Significantly the highest grain yield was found with BRRI dhan46 using either recommended dose of chemical fertilizers (4.76 t ha^{-1}) or ½ of the recommended dose of chemical fertilizers + cowdung + compost (4.65 t ha^{-1}).

LIST OF CONTENTS

LIST OF CONTENTS (Cont'd)

LIST OF CONTENTS (Cont'd)

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS

AEZ	=	Agro- Ecological Zone
BARC	=	Bangladesh Agricultural Research Council
BBS	=	Bangladesh Bureau of Statistics
WARDA	=	West Africa Rice Development Association
BINA	=	Bangladesh Institute of Nuclear Agriculture
BRRI	=	Bangladesh Rice Research Institute
cm	=	Centimeter
cv.	=	Cultivar
DAT	=	Days after transplanting
DAS	=	Days after sowing
^{0}C	=	Degree Centigrade
DF	=	Degree of freedom
DMRT	=	Duncan's Multiple Range test
EC	=	Emulsifiable Concentrate
et al.	=	and others
etc.	=	Etcetera
FAO	=	Food and Agriculture Organization
g	=	Gram
HI	=	Harvest Index
HYV	=	High yielding variety
hr	=	hour
IFAD	=	International Fund for Agricultural Development
IRRI	=	International Rice Research Institute
kg	=	kilogram
LV	=	Local variety
LSD	=	Least significant difference
m	=	Meter
m^2	=	meter squares
MV	=	Modern variety
mm	=	Millimeter
MP	=	Murates of Potash
viz.	=	namely
N	=	Nitrogen
ns	=	Non significant
%	=	Percent
CV %	=	Percentage of Coefficient of Variance
P	=	Phosphorus
K	=	Potassium
ppm	=	Parts per million
SAU	=	Sher-e- Bangla Agricultural University
S	=	Sulphur
t ha^{-1}	=	Tons per hectare
TSP	=	Triple super phosphate
UNDP	=	United Nations Development Program
USG	=	Urea supergranules
Zn	=	Zinc

165 4/24/13

CHAPTER 1

INTRODUCTION

Bangladesh is an agro-based country, and rice (*Oryza sativa* L.) is our staple food. It is generally considered as a food deficit country, though the rice production has been doubled compared to that of 1970s (Nasiruddin, 1993). This deficit is due to the fact that growth rate of rice production failed to keep pace with increasing population growth rate. The alarming population growth, rapid industrialization and urbanization during the past few decades resulted in remarkable reduction of cultivated land of the county. By the year 2030, population will reach up to 191 million and the demand of cereal has been projected reach 43.8 million tons (Anon. 1993) against the present production of only 19 million tons. Moreover, the yields of MV rice declined during 1970 to 1981 by 3.0% annually for aus, 1.0% for aman and 3.0% for boro and this trend of negative growth also found to continue over the next decade (Roy, 1996). This is particularly alarming for the sustenance of the people of Bangladesh. Among different rice groups of Bangladesh, Transplant aman is the most important that contributed a lot to the total rice yield. As a result, emphasis should be given to increase the aman yield through the adoption of proper management especially judicious application of fertilizers.

In order to break the above yield barriers, sustaining the productivity and obtaining sufficiency in food, the overall management system of crop culture needs to be improved especially through the nutrient management of crops. Proper utilization of different sources of nutrients in the context of crop-soil productivity must be explored for the existence of the people. The sources of nutrients for crops are nutrient reserve of soil, organic and inorganic fertilizers. None of the sources is complete and therefore, no one is sufficient to sustain soil fertility and productivity. Combination of organic and inorganic fertilizers is being stressed now-a-days.

Soil organic matter plays an important role in preserving the fertility and productivity of soil. Organic matter content in Bangladesh soils is gradually declining due to high cropping intensity and which also causes quick decomposition of organic matter. On the other hand, the farmers rarely add sufficient amount of organic manures to the soil against the removal. As a result, natural nutrient reserve in soil is steadily declining which compels the farmer to pay for increased level of chemical fertilizers only to sustain crop yields.

Integration of organic and inorganic fertilizers may facilitate the utilization of nutrients for crop growth and productivity and help replenish the organic matter status in soil. As the organic matter is the key pivot of nutrient availability and maintenance of better physical condition of soil, it is an essential factor for crop productivity and higher yield. It has already been indicated that the intensive cropping and use of chemical fertilizers have trusted tremendous pressure on the soil organic matter and soil nutrients resulting in the decrease of crop production.

But cowdung is scarce and limited in South East Asia including Bangladesh. In such situation, easily prepared compost can be used instead of cowdung. But cowdung or compost is not utilized properly for crop production. Application of cowdung or compost may play an important role in rice cultivation when used alone or in combination with chemical fertilizers.

Enormous efforts are therefore, needed to formulate organic fertilizers, chemical fertilizers and their combination, that will technically effective and feasible, economically viable, socially acceptable and environmentally sound. In view of limited information on the problems mentioned above, a study was therefore, undertaken with the following objectives:

- To observe the effect of chemical fertilizers on the performance of transplant aman rice,

- To examine the effect of organic manures on the performance of transplant aman rice, and

- Finally, to evaluate the combine effect of organic manures and chemical fertilizers on the performance of transplant aman rice.

CHAPTER 2

REVIEW OF LITERATURE

Rice yield and yield contributing characters are considerably influenced by different dose of chemical fertilizers and manures like cowdung and compost and their combined application. Literature reviewed in this regards on transplanted aman (T. aman) rice with different rates of inorganic and organic fertilizers have been presented below:

2.1 Effect of variety on the performance of T. aman rice

Vergara *et al.* (1974) reported about the variable effect of variety on the number of grains panicle^{-1}. Kumbhar and Sonar (1978) reported the variable effect of rice varieties on grain yield.

Choudhury and Ghosh (1978) carried out a number of field trials with 62 line of scented rice cultivars and observed that 1000-grain weight was highly variable that ranged from 9.0 to 23.0 g. But in some varieties, 1000-grain weight was identical in BR3 and BR8 varieties.

Sawant *et al.* (1986) conducted an experiment with the new rice cv. R-73- 1-1, R-711 and the traditional cv. Ratna and reported that the traditional cv. Ratna was the shortest for the new rice cv. R-73-1-1, R-711.

Babiker (1986) carried out an experiment with rice cv. Giza-171 and Giza-180 and observed that, total tillers hill^{-1} was significantly affected by the cultivars. The variable effect of cultivar on total number of tillers hill^{-1} was also observed by Idris and Matin (1990).

Shamsuddin *et al.* (1988) conducted an experiment with 9 different rice varieties and observed that plant height different significantly among the varieties.

Kamal *et al.* (1988) carried out an experiment with BR3, 1R20 and Pajam2 and found that number of grains panicle^{-1} were 107.6, 123.0 and 170.9, respectively for the three varieties.

Rafey *et al.* (1989) conducted an experiment with different rice cultivars and reported that 1000-grain weight differed among the cultivars studied.

Singh and Gangwer (1989) reported from an experiment with four rice cultivar C-14-8, CR-1009, IET-5656 and IET-6314 that grain number panicle^{-1}, 1000-grain weight and biological yield were the highest for C-14-8 among the varieties.

BRRI (1991) reported that the number of effective tillers produced by some transplant *aman* rice ranged from 7 to 14 and it was significantly differed with variety to variety.

Khan (1991) conducted a greenhouse pot experiment with rice cv. BR6 and CSR4 and reported that yield was higher in cv. CSR4 than in BR6. BRRI (1991) also reported that the plant height differed among the varieties.

Hossain *et al.* (1991) reported that the growth characters like plan height total tillers hill^{-1} and number of grains panicle^{-1} differed significantly among BR3, BR11, Pajam and Jaguli varieties in boro season.

Suprihatno and Sutaryo (1992) evaluated the performances of seven IRRI hybrids and 13 Indonesian hybrids using IR 64 and Way-Seputih as check varieties. They concluded that IR 64 was the highest yielding, significantly out yielding then IR 64616H, IR 64610H and IR 62829A/IR 54 which in turn out yielding Way -Seputih.

Chowdhury *et al.* (1993) stated that the cultivar BR23 showed superior performances over Pajam in respect of yield and yield contributing characters viz. number of bearing tiller $hill^{-1}$, length of panicle, 1000-grain weight, grain and straw yields. On the other hand Pajam produced significantly taller plant, higher number of total spikelets $panicle^{-1}$, grains $panicle^{-1}$ and sterile spikelets $panicle^{-1}$.

Ali and Murshid (1993) conducted an experiment during July to December 1999 to determine suitable variety for late transplanted aman rice, cv. BR23, BR11 and Kumragoir. They reported that local Kumragoir statistically out yielded the modern two cultivars of BR23 and BR11.

BINA (1993) evaluated the performance of four varieties IRATOM 24, BR14, BINA 13 and BINA 9. It was found that varieties differed significantly on plant height, panicle length, number of nonbearing tillers, and sterile spikelets $panicle^{-1}$.

BRRI (1994) reported that Tulsimala produced the highest number of spikelets $panicle^{-1}$ and BR 14 produced the lowest number of spikelets $panicle^{-1}$.

BRRI (1995) conducted an experiment to find out the performance of BR4, BR10, BR11, BR22, BR23 and BR25 cultivars including two local Check Challish and Nizersail planted at 20 cm x 20 cm spacing with 2-3 seedlings $hill^{-1}$. The results indicated that BR4, BR10, BR11, Challish and Nigersail produced grain yields of 4.38, 3.12 and 2.70 t ha^{-1}, respectively. Challish cultivar followed earlier than all other varieties. BR 22 and BR23 showed poor performance.

2.2 Effect of inorganic fertilizers on the performance of T. aman rice

2.2.1 Effect of nitrogen on T. aman rice

BRRI (1980) reported that grain and straw yield of BR11 and BR14 increased significantly at its different stations when applied 100 kg N ha^{-1}.

Ayyasamy and Venkatararnan (1983) studied the effect of different levels of nitrogenous fertilizers and reported that the highest paddy yield was obtained with 120 kg N ha^{-1} in the Kharif season.

Kim *et al.* (1983) conducted a field trial on rice cultivar Kiyonishike with 84 kg N ha^{-1} against zero N. They observed that, at most sampling dates, plant height, tiller number, leaf area, dry weight of below ground and ear weight were higher compared to zero N fertilizer treatments.

Thind *et al.* (1983) studied the influence of nitrogen application on rice grain yield and observed that increasing rate of N application increased the yield significantly up to 180 kg N ha^{-1}.

Awan *el al*. (1984) reported that application of nitrogen with different levels on rice increased plant height, panicle length, 1000-grain weight, grain and straw yields significantly. Kumer *el al*. (1986) and Kolhe and Mitra (1985) studied the effect of different levels of nitrogen for T. aman rice and reported that the yield was increased significantly with N application.

Patel *et al.* (1987) observed three years in a trial with the application of 80, 100 120 and 140 kg N ha^{-1} to rice cultivar 1R22 that gave the rice yield of 3.74, 4.23, 4.51 and 4.74 t ha^{-1}, respectively, and 100 kg N ha^{-1} was the optimum economic rate.

BRRI (1988) carried out experiments at its different stations, using 0, 40, 80 and 120 kg N ha^{-1} with BR9, BR11 and RR16 varieties with blanket doses of

P, K and S at the rate of 25, 35 and 16 kg ha^{-1}, respectively. The varieties BR9 and BR16 produced the highest grain yield ranging from 5.5-6.0 t ha^{-1}.

Wagh and Throat (1988) reported that 50+ 30 + 10 + 10 kg N ha^{-1} applied at 8 days after transplanting (DAT), maximum tillering, primordia initiation and flowering gave the highest yield.

Rahman (1992) carried out a field trail with 0, 25, 50, 75 or 100 kg N ha^{-1} on BR11. He obtained the grain yield of 4.8 t ha^{-1} with control treatment and the highest yield (6.7 t ha^{-1}) with 75-100 kg N ha^{-1}.

Mukherjee and Mandal (1995) conducted a field experiment in 1987 to 1988 in West Bengal on rice cv. Ratna was given with 100 kg N ha^{-1} as urea in 2-3 splits in 3 different ratio i.e. 90:10: 0, 70: 20: 10 and 50: 30: 20 at transplanting, tiller initiation and panicle initiation, respectively. They found that grain yields over 20 % higher control plots.

Bandyopadhyay *et al.* (1988) carried out an experiment on flooded rice cv. Pusa Basmati applying 60, 120 or 180 kg N ha^{-1} and found that seed yields increased with N application upto 120 kg ha^{-1}.

Choudhari *el al.* (1998) conducted a field experiments on three rice cultivars in 1993-96 in Maharashtra by applying 25-100 kg N ha^{-1} or no fertilizers or 12 t ha^{-1} FYM and observed that the grain yield (2.9 t ha^{-1}) was highest with 100 kg N ha $^{-1}$. Haryana Basmati, Kasturi and Pusa Basmati produced mean grain yields of 2.46, 2.38 and 2.261 ha^{-1}, respectively.

Behera (1998) conducted a field experiment on scented rice during rainy season of 1993, 1994 and 1995 applying 0, 30, 60, 90 and 120 kg N ha^{-1} and found that the yield increased 12.9, 22.3, 28.5 and 31% over control, respectively. He has observed that HKR 228 gave the higher grain yield and HKR 228 was superior to other cultivars for panicles m^{-2} and gave a higher grain yield and also found that all the growth and yield forming characters increased linearly upto 90 kg N ha^{-1} and there after grain yield increased marginally.

2.2.2 Effect of phosphorus on T. aman rice

Machado *et al.* (1984) grew Bluebelle by sowing in the first 2 weeks of November and treated with 0, 100, 200 or 300 kg P_2O_5 as TSP. They observed that the availability of P increased linearly with application but even at values as low as 1.8 ppm. There was no immediate or residual effect of P on yields.

Saravanan and Kothandaraman (1984) reported the effect of different types of P fertilizers on rice grain yield. Phosphorus was applied at the rate of 26.19, 39.29 or 52.39 kg ha^{-1}. Grain yield increased with increasing P application.

Saggar *et al.* (1986) reported from field trails with rice and wheat alone or in a rotation that the application of 39 kg P increased mean rice yield of 5.2 to 6.2 t ha^{-1} and mean wheat yield from 1.8 to 3.7 t ha^{-1}. They also reported that application of 39 kg P ha^{-1} to both wheat and rice in rotation increased soil available P from 6.8 to 18.4 ppm.

Melgar and Ligier (1986) with 26 fertilizer trails of phosphatic fertilizer in the North of Carrientes Province showed that the rate of 44 kg ha^{-1} P increased rice yields by an average of 400 kg ha^{-1}. Almost 3 times of the average yield increase was obtained on soils containing 3.3 ppm P, but little or no response was obtained on soils containing more than 6-2 ppm.

BRRI (1991) conducted five term field trails to determine the appropriate frequency of P fertilizer application. Soils where P availability was marginal (Olsen P just around 10 ppm), P fertilizer application to every alternate crop of Boro-Fellow- T. aman sequence reported as good as that to each crop. In this case P application increased grain yield significantly by about 0.2 to 1.4 t ha^{-1} over the control. It was suggested that soils with moderate to high available P contents (Olsen P 15 ppm or more) might require even a less frequent P application for optimum rice yield.

Momuat *et al.* (1992) conducted a field experiment using several rate of triple super phosphate (TSP) to evaluate the response of rice crop to TSP application. Using several TSP rates, application of TSP up to 200 kg ha^{-1} did not increase rice yield significantly.

Hassan *et al.* (1993) carried out an experiment to observe the yield response of Basmati 385 rice to 0, 33, 66 and 99 kg P ha^{-1}. All treatments received 125-62-4.2 N, K, Zn ha^{-1}. They observed that yield increased significantly upto 33 kg ha^{-1} for all soil P test values, but significant responses to the next higher dose was observed only when test values were less than or equal to 11 mg P kg^{-1}.

Mahajan *et al.* (1994) conducted that a pot experiment on a clay soil, 3 rice cultivars received 0, 80 and 120 kg P_2O_5 ha^{-1}. Grain yield was the highest with 80 kg P_2O_5.

Subba *el al.* (1995) reported that phosphorus applied at the rate of 50 mg P kg^{-1} soil as SSP increased the grain and straw yields significantly.

2.2.3 Effect of potassium on T. aman rice

Morok and Dhaliwal (1987) reported form a replicated field trails enveloping graded doses of K showed that paddy response to the application of K in soils of low to medium K availability. A dose of 30 kg of K_2O ha^{-1} was optimum that gave unit response of 4.90 kg grain with one K of K_2O dose and also gave a net profit of Rupees 1.88 per Rupee invested on potassium fertilizer.

Uexkull (1984) reported that in traditional rice culture, the negative K balance over a 5 year period was only 169 kg ha^{-1}, under intensive HYV culture it increased to about 1200 kg ha^{-1}.

Purohit *et al.* (1986) conducted two year trials with three varieties of rice and four levels of K_2O (0, 40, 60 and 80 kg ha^{-1}) and observed that grain yield and net profit were the highest with 80 kg K_2O ha^{-1}.

BRRI (1990) studied the potassium response on rice in 18 field trials. The soil had variable levels of available K (exchangeable K 0.11-0.44 mg/100 g). Five K treatment, 0, 30, 60, 90 and 100 kg ha^{-1} were tested at each location with BR1, BR3, BR14 and BR15 rice varieties. The application of 30 kg K ha^{-1} increased grain yield slightly over control at most of the locations where increased K doses did not bring any additional yield.

BRRI (1994) reported that by applying K rate up to 120 kg ha^{-1} that, it failed to increase the straw and grain yield significantly over 30 kg K ha^{-1}.

Saleque *et al.* (1995) reported that a positive yield response in rice was found up to 120 kg K ha^{-1}/.

2.2.4 Effect of sulphur on T. aman rice

Islam *et at.* (1990) reported that sulphur application significantly increased the grain and straw yield of BR2 rice. They have also reported that application of sulphur increased the concentration of S both in grain and straw.

Shamim *et al.* (1991) reported that the grain yield of rice cv BR11 increased 390 kg ha^{-1} due to application of 30 kg ha^{-1}.

Tandon (1991) reported the response of about 40 crops to S under field conditions in India. Among the crops, the application of S to rice increased the grain yield by 752 kg ha^{-1} and on an average paddy yield was found to be increasing by 17% in 27 studies.

Bhuiyan (1992) carried out field trials on crop response to fertilizers and showed that S deficiency in both soils and crops was increased due to the use of S free fertilizers. He further stated that, there was frequently a synergistic effect between N and S fertilizer in rice. Superphosphate elemental S and S bentonite also increased the yield of rice.

Rashid *et al.* (1992) carried out a trial in Pakistan in 1988-91 on rice cv. Basmati-385 by applying different S sources and found that element S produced yield increases of 18, 9.2 and 5.8% when applied at transplanting, or 15 or 30 days after transplanting.

Islam and Hossain (1993) reported that application of 20 kg S ha^{-1} with NPK significantly increased the grain yield of BR11 rice. Tupatkar and Sonar (1995) showed that application of 2.5 t ha^{-1} of pyrite increased grain and straw yields over control.

2.2.5 Effect of zinc on T. aman rice

Babiker (1986) reported that rice cultivars Giza 171 and Giza 180 were grown with 0, 25, 50 and 75 kg $ZnSO_4$ ha^{-1} in nursery and field experiment and found that leaf area, heading date, plant height, tillering capacity, productive tillers, panicle length, number of grains and spikelets $panicle^{-1}$, 1000- grain weight and panicle weight were increased significantly due to application of $ZnSO_4$. It was concluded that 50 kg $ZnSO_4$ ha^{-1} was most effective and economic rate for improving grain yield and its components.

Salam and Subramanian (1988) reported that application of 5.7 kg Zn ha^{-1} increased the grain yield but did not affect the straw yield. It was further reported that application increased Zn uptake by plant.

Hossain *et al.* (1989) reported that the application of zinc in the form $ZnSO_4$ ha^{-1} significantly increased both grain and straw yields as well as different yield components except the number of tillers $hill^{-1}$.

Chhibba *et al.* (1989) conducted field trials on a Zn deficient soil in the Punjab province of India with 0, 5, or 10 kg Zn ha^{-1} as $ZnSO_4$, ZnO and Zn frits on Jaya rice. Rice grain yield increased significantly with Zn application irrespective of rate or source, among sources and the highest rice grain yield was produced by $ZnSO_4$ and frits, ZnO was least effective.

Sarker *et al.* (1989) reported that the effects of Zn application at the rate of 20 kg $ZnSO_4$ ha^{-1} to the soil during seed bed preparation or three foliar sprays of 0.5% $ZnSO_4$ + 0.25 % lime at 10 days intervals after transplanting gave grain yields of 7.2 to 7.4 t ha^{-1} compared with 5.6 t ha^{-1} without Zn. Mostafa (1990) reported from Egypt that the application of $ZnSO_4$, either soil or foliar spray significantly increased the grain yield of rice.

Dixit and Khanda (1994) conducted a field experiment and found that application of ZnSO4 increased the grain yield of rice. Sarkunan *et al.* (1996) conducted a pot experiment under flooded condition and found that Zn application increased the grain yield of rice. Conducted a pot experiment under flooded condition and found that Zn application increased the grain yield of rice.

2.2.6 Effect of inorganic fertilizer combination on the performance of T. aman rice

Miah and Eunus (1978) reported that the application of increased doses of NPK tended to produce increased grain yield. Among the 16 NPK treatment combinations, 111 kg of N and 45 kg each of P_2O_5 and K_2O ha^{-1} came out to be the best for grain yield.

Bhuiya *et al.* (1979) carried out a fertilizer trial in the Bangladesh Agricultural University Farm with 1R8, a high yielding rice variety using three rates of N (0, 113 and 135 kg N ha^{-1}), two rates of P (0 and 45 kg P_2O_5 ha^{-1}) and two rates of K (0 and 45 kg K_2O ha^{-1}). Application of N and P increased both the grain and straw yield. But the effect of N application was more pronounced than the effect noted due to P application. The application of K slightly decreased the grain and straw yield of rice.

Hossain *et al.* (1989) reported that sulphur application significantly increased the grain and straw yield of rice and Zn + NPK applications increased higher grain and straw yield but were not statistically significant over NPK treatment. Sulphur and Zn content in grain and straw increased considerably due to addition to S and Zn respectively. Greatly boosted up to 5% and 82% over control when sulphur was added with N and NPK treatment, respectively.

Chaudhury and Badiuzzaman (1992) found that grain yield increased significantly due to application of K up to 100 kg ha^{-1} and grain and straw yield also increased due to application of 30 kg ha^{-1} S and highest grain yield (5.9 t ha^{-1}) from combined application of 150 kg K_2O and 30 kg S ha^{-1} as well as applying K favourably influenced yield components while S level had no significant variations on plant hight and straw yield.

Sagwal and Kumar (1994) carried out an experiment on Basmati-370 rice in 1990 during rainy season by applying zero fertilizer, 60 kg N, 30 kg P_2O_5, 30 kg K_2O or 25 kg $ZnSO_4$ ha^{-1} as N, NP, NPK or N P K Zn to Basmati-370 and PK and Zn were applied at pudding and N in 2 equal splits 3 and 6 weeks after transplanting. Grain yield ranged from 1.6 t ha^{-1} with no fertilizer to 2.59 t ha^{-1} with NPKZn an financial returns were highest N P K Zn.

Choudhury *et al.* (1994) conducted a field experiment during dry and wet season with cv. BR3 and BR11 and observed that combined application of N, P, K and S from urea, TSP, MP and gypsum gave similar grain yields of 5.6-5.7 t ha^{-1} in the wet season.

Sajjad (1995) conducted field experiment in Papua New Guinea on rice cv. wantok and Tamba applying on fertilizers or 5 fertilizers rates between 60-

30-30 and 140-70-70 kg NPK ha^{-1}, yield on wantok was 4.7 t ha^{-1} in the control treatment and highest (8.8 t ha^{-1}) at the highest NPK rate but yield increase was significant only up to 100-50-50 kg NPK ha^{-1} (8.1 t ha^{-1}). Yield of Tambu was 5.2 t ha^{-1} without fertilizers and 8.8 t ha^{-1} at the highest application rate, which was not significantly different from 7.5 t ha^{-1} with 120-60-60 kg ha^{-1}.

Gogoi and Lalita (1996) conducted an experiment by applying 3 rates of NPK fertilizer (0-0-0, 20-10-10, or 40-20-20 kg ha^{-1} as N-P_2O_5-K_2O) on transplanted rice cv. Mahsuri and Badshabhog under flood condition. Cultivar Mahsuri (4.08 t ha^{-1}) significantly out yielded the traditional Baotshabhog (2.75 t ha^{-1}).

Lal and Roy (1996) carried out an experiment on rice and applying zero NPK, 2 rates between 2 kg N +1kg P_2O_5 + 0.5 kg K_2O and 10 kg N +15 kg P_2O_5 +2.5 kg K_2O/1000 m^2. Grain yield of 3.96 t ha^{-1} was obtained when 2 kg N + 1 kg P_2O_5 + 0.5 kg K_2O. A further increase in the NPK rate did not increase the grain yield significantly.

Fageria and Zimmerman (1996) found that grain yield, dry matter production and yield components increased with increasing fertilizer rates.

2.3 Effect of cowdung on the performance of T. aman rice

Rashid and Siddique (1988) reported that cattle manure at high rates increased grain yields. Kuppuswamy *et al.* (1992) conducted a field trials in 1989 at Anna-malainagan, Tamil Nadu with rice cv. IR-20 were application of 10 t Farmyard manure (FYM) gave grain yields of 7.33 t ha^{-1}.

Rajput and Waris (1992) reported that maximum rice yield was obtained when 100 kg N + farmyard manure was applied at the rate of 10 t ha^{-1}. The grain and straw yields were 34.7 and 52.5 t ha^{-1}, respectively.

Kant and Kumar (1994) reported that the increasing rates of amendments with FYM increased the number of effective tillers $hill^{-1}$ significantly and number of grains $panicle^{-1}$, 1000-grain weight was also increased over the control. At the maximum level of FYM (30 t ha^{-1}, increase of 48% tillers $hill^{-1}$, 14% of grains $panicle^{-1}$ and 4.5% weight of 1000-grains over the control were recorded. They have also reported that higher rate of FYM (30 t ha^{-1}) resulted 22.0% increase in grain yield over the untreated plots.

Gupta (1995) found that the application of pig manure (10 t ha^{-1}) produced The highest grain yield (4.5 t ha^{-1}) followed by poultry manure and FYM which produced yield of 4.10 and 3.90 t ha^{-1} of rice grain, respectively. The increase of rice yield with organic manure was 34 to 55% higher over the control of 5 to 22% higher over NPK fertilizer, it was concluded that application of organic manures like pig manure and FYM are beneficial to rice cultivation in Altisoils.

Bhattacharya *et al*. (1996) carried out an experiment in plastic pots of 5 kg capacity with no hole and filled with 4 kg soil. They have reported that the application of 2.59 kg ha^{-1} of FYM could produce about 2 g pot^{-1} grain as well as straw yield than no FYM treated soil.

2.4 Effect of compost on the performances of T. aman rice

Patel *et al.* (1983) reported that rice yield significantly increased by the granulated composts. Application of 60 kg N as granulated compost ha^{-1} to rice was the most effective in increasing the number of panicles per unit area, fertile spikelets panicle^{-1}, 1000-grain weight and rice yields followed by urea enriched FYM.

Nelidov *et al.* (1986) reported that compost stimulated soil microorganism, increased non-symbiotic N-fixation, neutralized the alkaline reaction of the soil S improved plant nutrient. These results have a significant increase in the productivity of rice.

Sharma *et al.* (1990) reported that wheat straw, rice straw and water hyacinth were applied at 4 rates and on 4 dates before transplanting to rice cv. Ratna. Grain yield increased significantly within organic FYM or with rates upto the equivalent of 15 t ha^{-1}. With wheat straw and rice straw application yield was highest 10 t ha^{-1}. Yield increased significantly when wheat straw and rice straw were applied upto 30 days before transplanting (DBT), but such increases were less pronounced with FYM water hyacinth. The effects of higher rate (10 and 15 t ha^{-1}) were higher with early application of organic materials per 20 and 30 DBT.

Chattopadhyay *et al.* (1992) reported that application of compost with urea gave the highest yields of rice. Plant uptake of N, P, K, Zn, Fe, Mn and Cu and the nutrient status of soil with the different treatments are presented.

Jhilayvathi *et al.* (1995) reported that partially decomposed and fully decomposed coir pit (12.50 t ha^{-1}) incorporated two days before transplanting rice cv. DAT 36 seedlings influenced the rice yield components like panicle length and grain panicle^{-1}, grain yields were 3.82, 3.79 and 375 t ha^{-1} in rice when applied at 30-d, 25-d and 20-d CCP (Composted coir pith), respectively, compared with 3.31 t h^{-1} in unamended controls.

2.5 Effect of fertilizer and manure combinations on performance of T. aman rice

Mian and Eaqub (1976) reported that the application of N, residual P and FYM influenced the yield and yield contributing characters of rice.

Kobayashi *et al.* (1989) conducted an experiment on rice growth with annual application of either 10 or 20 t FYM ha^{-1} or 10 t FYM with 80 kg each of N, P_2O_5 and K_2O. Average unpolished rice yields over the 5 years were 3.66 t ha^{-1} with 10 t FYM ha^{-1}, 3.35 t with 20 t FYM h^{-1} and 5.92 t with FYM+NPK fertilizer. Plant height, number of stems m^{-2} and panicle number all showed similar difference to those shown on yield but the number of grains per ear was highest with 10 t FYM ha^{-1}.

Sharma *et al* (1990) reported that significant increase in grain yield of rice as obtained by the application of recommended rate of nutrient through chemical fertilizer + 8 t FYM ha^{-1}. Ahmed and Rahman (1991) reported that the application of organic matter and chemical fertilizer increased tiller and panicle production and straw and grain yields of rice.

Mandal *et al.* (1990) observed that the application of 0 or 10 t FYM ha^{-1} gave average paddy yields of 1.90 and 2.64 t ha^{-1}, respectively. Applying 40 kg N ha^{-1} or N + P_2O_5 + K_2O at 40 + 2 20, 60 + 40 + 40, 80 + 60 + 60 kg ha^{-1} gave yield of 3.17, 3.90, 3.54 & 4.0 t ha^{-1} without FYM but 3.81, 4.10, 4.54 and 4.58 t ha^{-1} with FYM, respectively. The numbers of panicle m^{-2}, spikelets, panicle, percentage of filled grains and 1000-grain weight increased with increasing NPK rates and FYM application.

Raju *et al.* (1993) observed, in rice field in the rainy season by applying 0, 50, 75 or 100% of the recommended NPK fertilizer rate, 50% of the recommended NPK rate + 7.5 t FYM, 6 t rice straw or 4.48 + sesbanai cannabania ha^{-1}, 75% of the recommended NPK rate + 3.757 FYM, 3 t rice straw or 2.24 + S. cannabania or 60 kg N ha^{-1} as urea, 17.5 kg P as single super phosphate and 33.3 kg K as Muriate of potash. The recommended fertilizer rate gave the highest grain yield of 5.23 t ha^{-1} which was not significantly different from 5. 15 t and 4.47 t with 75% of the recommended rate + 3 t rice straw or 2.24 t ha^{-1} . cannabania, respectively. Application of 60 kg N gave 4.35 t and the control yield was 2.71 t ha^{-1}.

Ghosh *et. al.* (1994) reported that grain yield of rice cv. CR1018 was increased in both of the combinations of organic (10 t ha^{-1} FYM) and inorganic N fertilizer (25 kg N ha^{-1}) as it were compared with an organic fertilizer alone (20 t FYM ha^{-1}).

Mathew *et al.* (1994) conducted a field experiment on rice cv. Jyothi that was given no fertilizers, a recommended rate of NPK fertilizers, manure with 10 t ha^{-1} FYM + 35 kg each of P and K + 35 or 17.5 kg N. They have observed that grain yield was the highest (3.44 t ha^{-1}) with FYM + 35 kg N compared with 3.2 + obtained with the recommended NPK rate.

Roy *et al.* (1996) observed that application of 60 kg N in urea and 60 kg FYM gave the highest rice yield. There was no significant difference in yield when 120 kg N ha^{-1} was app either through urea or ammonium chloride alone, or a combination of the both. The yield and yield component were lower when 120 kg N was applied through FYM and Nitrogen use efficiency was highest when 60 kg N was applied through urea and 60 kg through FYM.

Singh (1995) reported that cattle manure significantly improve rice yield but was less efficient than urea. The combination of cattle manure and urea showed no positive interaction effects. Total N uptake by rice was also significantly higher from urea than manure P and K uptake by rice increased in response to N application from urea and cattle manures.

Delower *et al.* (1996) observed that the effect of organic recycling on wheat-mungbeen-rice (grown during the T. aman season) cropping system. Five treatment were evaluated viz. control, compost, compost + half of NPK, full of NPK and compost. Decomposed straw was applied at 20, 10 & 24 t ha^{-1} for wheat-mungbean-rice respectively. The application of compost alone had a lesser effect on growth and yield of wheat-mungbean and rice, but the application of compost +NPK increased yield. The full NPK +compost treatment increased rice yields by 83-85% compared with the compost.

Jeony *et al.* (1996) observed that rice was given 110 kg N + 120 kg P + 130 kg K ha^{-1} (100% NPK) alone or with 5 t rice straw ha $^{-1}$ or half these NPK rate (50% NPK) alone or 5 t rice straw. 20 t compost + 20 t fermented pig manure, Pig manure + compost, 3 t oil cake or 5 t fermented chicken manure ha^{-1}. Application of organic manure + 50% NPK gave grain yield of 9 to 17% lower than these were obtained with 100% NPK rate. Grain content alkali digestion value and gel consistency were unaffected by treatments. Amylase content of grain was lower in plant given straw, compost or compost + pig manured compared with 100 % NPK treatment. In general, organic fertilizer did not improve rice cooking quality and tests.

Sanzo *et al.* (1997) observed that applications of stander rate of 200 kg N, 80 kg P and 90 kg K ha^{-1} or 15, 30 or 45 t cattle manure ha^{-1} with or without PK, with or without 50% or 100% of the standard rate of application N.

Yield generally increased with increasing rates of manure, with better result in combination with NPK, with 45 t manure there was no significant difference in yield between N rates.

Singh *et al.* (1997) conducted a field trail at Birasa Agricultural University by applying 0, 50, 75 or 100 % of 120 kg N + 50 kg P_2O_5 + 40 kg K_2O ha^{-1} and 10 t FYM ha^{-1} and or 13 kg Cyanobacteria ha^{-1}, they obtained highest rice yield of 4.58 t ha^{-1} with 100% NPK + FYM + Cyanobacteria.

From the reviews cited above it is clear that manuers and fertilizers have positive influence on yield of rice, and combination of them produces better yield in most of the cases.

CHAPTER 3
MATERIALS AND METHODS

The experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka during the period from June to December 2010 to study the effect of different organic, inorganic and their combinations on the performance of transplant aman rice. The details of the materials and methods have been presented below:

3.1 Description of the experimental site

3.1.1 Location

The experiment was carried out in the Sher-e-Bangla Agricultural University farm, Dhaka-1207. The experiment field was located at $90^0 22'$E longitude and $23^0 41'$N latitude at an altitude of 8.6 meters above the sea level. The experimental site was located under the agro-ecological zone of Modhupur Tract, AEZ-28. For better understanding the experimental site is shown in the Map of AEZ of Bangladesh in Appendix I (UNDP and FAO, 1988).

3.1.2 Climate

The experimental area belongs to the sub-tropical climate that is characterized by high temperature, high humidity and heavy rainfall with occasional gusty winds in kharif season (April - September) and less rainfall associated with moderately low temperature during the rabi season (October - March). The average relative humidity, maximum temperature, minimum temperature, total rainfall and sunshine hour of the experiment site varied as 69 - 84%, 26.4°C - 32.1°C, 14.1°C - 26.3°C, 12.8 - 373.1 mm and 3-5.7 hrs respectively (Appendix II).

3.1.3 Soil

The soil of the experimental field belongs to the general soil type of Shallow Red Brown Terrace type under Tejgaon Series. The land was above flood level and sufficient sunshine was available during the experimental period. The physiochemical properties of the soil have been given in Appendix III.

3.2 Variety used

Two transplant *aman* rice cultivars viz., BRRI dhan46 and Nizershail were used as test crops. Their salient features are as stated below.

BRRI dhan46

BRRI dhan46 is generally grown in *aman* season in flood prone areas after flooding. It is photosensitive like BR22, BR23 and Naizersail. This variety was developed through hybridization between BR11, Shornolota and RSC 14766a. This variety matures at 145-150 days of planting. It attains at a plant height of 90 cm. The variety gives an average yield of 5 t ha^{-1}.

Nizershail

Nizershail is a local variety. Its leaves are frequent, erect and deep green in colour. Seedling attained 30 cm within 30 days. This variety gives better yield up to 30 August planting. In early planting, the average grain yield is 3.5 - 4.5 t ha^{-1}. If situation favors, this variety can be transplanted in later than August 30 but yield reduces drastically in late planting (BRRI, 1991 and Miah *et al.*, 1990).

3.3 Experimental Details

3.3.1 Treatments

There are two factors in this experiment. These are as follows:

Factor A. Variety-2

V_1) BRRI dhan46, and

V_2) Nizershail

Factor B. Organic and inorganic fertilizer and their combination - 9

i) T_1 = Without fertilizer (control)

ii) T_2 = Recommended dose of chemical fertilizers

iii) T_3 = Cowdung

iv) T_4 = Compost

v) T_5 = Recommended dose of chemical fertilizers + cowdung

vi) T_6 = Recommended dose of chemical fertilizers + compost,

1165

vii) T_7 = ½ of the recommended dose of chemical fertilizers + cowdung

viii) T_8 = ½ of the recommended dose of chemical fertilizers + compost

ix) T_9 = ½ of the recommended dose of chemical fertilizers + cowdung + compost

Recommended dose of manures and fertilizer has been presented in section 3.5.3.

37147

3.4 Design and layout

The experiment was laid out in a split plot design with three replications. Experimental plot was first divided into three blocks. Each block was then divided into two main plots to accumulate the cultivar at random. Each main plot was then divided into nine subplots where fertilizers and manures and their combination treatments were allocated randomly. Thus the total number of units plots were 54. Layout of the experiment was done keeping inter block and inter plot spacing of 1 m and 0.75 m, respectively. The unit plot size was 4.0 m x 2.5 m.

3.5 Crop cultivation

3.5.1 Seedling raising

Rice seeds BRRI dhan46 was collected from the Bangladesh Rice Research Institute, Joydebpur, Gazipur and Nizersahil was collected from the Bangladesh Agriculture Development Corporation, Dhaka. Seeds were soaked in water for 24 hours and then incubated for 48 hours. Nursery beds for each variety were prepared and sprouted seeds of two rice varieties were sown in the wet nursery bed on 8 July 2010. Proper care was taken to raise the seedlings in the nursery beds. No manuring and fertilization was done, but irrigation was done and weeds were removed from the nursery bed as and when necessary.

3.5.2 Land preparation

The experimental field was first opened on 2 July 2010, by a tractor drawn disc plough. First ploughing was done on 25 July and another one was done on 28 July, 2010. The land was irrigated on 30 July 2010. Later on, the land was puddled thoroughly by ploughing and cross ploughing for four times with a country plough followed by laddering to level the land. Weeds and stubble were removed from the land and thus the land was made ready for transplanting. The field layout was done on 30 July 2010, immediately after land preparation.

3.5.3 Application of fertilizers and manures

Recommended dose of N, P, K and S were 74, 48, 48 and 7.5 kg ha^{-1}, respectively, and that of cowdung or compost 5t ha^{-1} (BRRI 2011). Fertilizer and manure, and their combination was applied in the individual plots as per treatment. Except urea all the chemical fertilizers and cowdung or compost were applied at the time of final land preparation and mixed them thoroughly with soil one day before transplanting. Urea was top dressed in three equal splits. one third of urea was applied at 10 days after transplanting and the remaining two third were applied in two equal splits at 35 and 55 days after transplanting.

3.5.4 The uprooting and transplantation of seedlings

Seedlings were raised separately on nursery bed and 24 days old seedlings were transplanted on 1 August in 2010, by maintaining a space of 15 cm between hills and 25 cm between rows. Necessary gap filling was done at 7 days after transplanting.

3.5.5 Intercultural operations

The crops were kept under constant observations from transplanting to harvesting. Intercultural operations such as weeding, irrigation, pest management and other necessary cultural operations were done for proper growth and development of the crops.

Two weedings were done on 15 and 45 days after transplanting to keep the crops free from weeds. Natural precipitation was not found adequate and therefore, supplementary irrigations were done at 60, 75 and 90 days after transplanting.

The crop was infested with stem borers (*Tryporyza encertulus*) at 80 DAT. This was controlled by spraying Diazinon 60 EC at the rate of 1 L ha^{-1}. Successive two sprays at seven day intervals were required to control them.

3.6 Harvesting, processing and data collection

3.6.1 Growth data

Ten sample plants were selected at random from each plot and tagged them for taking growth data.

3.6.2 Yield contributing characters and yield data

Ten hills from each plot were collected at random prior to harvesting and taken out for studying yield attributes. The crop was harvested plot wise on the basis of their maturity. The crop was harvested when 80% spikelets were matured. First harvesting was done on 15 November, 2010. These plants were taken out with respective tag levels. An area of central $3m^2$ were harvested for measurements of grain and straw yields. The harvested crops were threshed, cleaned, dried, weighed and necessary data were collected on various crop characters. The following data were recorded:

Growth data:

i) Plant height (cm)

ii) Tillers hill^{-1} (no.)

iii) Dry weight hill^{-1} (g)

Yield contributing characters data:

iv) Effective tillers hill^{-1} (no.)

v) Non-effective tillers hill^{-1} (no.)

vi) Panicle length (cm)

vii) Sterile spikelets panicle^{-1} (no.)

viii) Grains panicle^{-1} (no.)

ix) Total spikelets panicle^{-1} (no.)

x) 1000-grain weight (g)

Yield and harvest index data:

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

xii) Straw yield (t ha^{-1})

xiii) Biological yield (t ha^{-1})

xiv) Harvest Index (%).

3.7 Procedures of data collection

3.7.1 Plant height

The height of the plant was taken from the ten preselected hills at the time of 25, 40, 55, 70, 85 DAT and at harvest. Plant height was measured from the ground level to the tip of the leaf of plant. The average height of ten hill, was considered as the height of the plant for each plot. The height was expressed in centimeter (cm).

3.7.2 Tillers $hill^{-1}$

Total number of tillers were counted from the ten preselected hills at the time of 25, 40, 55, 70, 85 DAT and at harvest. The tillers obtained from ten hills were averaged to have tillers $hill^{-1}$.

3.7.3 Dry weight $hill^{-1}$ (g)

Three sample hills uprooted from each plot unbiasly, wash them in water and then dried them in an electric oven maintaining 60^0C for 48 hours. Then the hills were weighed in an electric balance and averaged them to have dry weight $hill^{-1}$.

3.7.4 Effective and non-effective tillers $hill^{-1}$

The number of tillers from the sample ten hills were counted. The tillers having panicles with at least one grain were considered as effective tillers.

On the other hand, tillers having no panicle were regarded as non-effective tillers.

3.7.5 Panicle length (cm)

Panicle length was recorded from the basal nodes of the rachis to apex of each panicle.

3.7.6 Grains and sterile spikelets panicle^{-1}

Number of grains and sterile spikelets were counted from ten randomly selected particle. Presence of any material in the spikelets was considered as grain. On the other hand, the sterile spikelets lacked any food materials inside.

3.7.7 Weight of 1000-grain (g)

One thousand grains were randomly collected from the seed stock obtained from plants of each plot and were dried in an oven and weight them by using an electric balance. The weight was adjusted at 14% moisture content and expressed in grams (g).

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

Plants of central 3m^2 area were harvested and grains were separated from the plant. The grains were cleaned and dried properly in the sun. After drying, the weight of the grain was measured and the weight was converted as t ha^{-1}. The grain weight was adjusted at 14% moisture content and expressed in t ha^{-1}.

3.7.9 Straw yield (t ha^{-1})

Straw from 3 m^2 areas of each plot was weighed after repeated drying and expressed in t ha^{-1}.

3.7.10 Biological yield ($t\ ha^{-1}$)

Grain yield and straw yield were altogether regarded as biological yield and expressed in $t\ ha^{-1}$.

The biological yield was calculated with the following formula:

Biological yield = Grain yield + Straw yield

3.7.11 Harvest Index (%)

Harvest index was calculated from the grain yield and straw yield and expressed in percentage (%) using the following formula:

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

Here, Biological yield = Grain yield + Straw yield

3.8 Collection of initial soil sample

For chemical analysis, soil samples were collected from the experimental filed at a depth of 0 - 15 cm before final land preparation and also after harvest and then they were composited to form a bulk sample. The soil sample was air dried, ground and sieved to remove unwanted materials and kept in ploy bag for laboratory analysis.

3.9 Soil sample analysis

Soil sample were analyzed for both physical and chemical properties form the soil characteristics under the experimental plot were analyzed in the Soil Testing Laboratory, Soil Resources and Development Institute. Khamarbari, Dhaka.

3.10 Statistical analysis

The data were compiled and tabulated in proper form for statistical analysis. Analysis of variance was done following the experimental design with the help of the computer package program MSTATC. The mean differences among the treatments were adjudged by Duncan's New Multiple Range Test (Gomez and Gomez, 1984).

CHAPTER 4

RESULTS AND DISCUSSION

Effect of chemical fertilizers, cowdung, compost and their combination on the growth, yield and yield contributing characters of BRRI dhan46 and local variety Nizershail studied and the results have been presented in Table 1 to 9 and figure 1 to 6 discussed below.

4.1 Plant height (cm)

The effect of variety on plant height was affected at different days after transplanting (Fig. 1). Taller plant (35.95, 72.40, 88.03, 99.59, 107.591 and 110.93 cm at 25, 40, 55, 70, 85 DAT and at harvest, respectively) was produced by Nizershail and the shorter (27.35, 57.21, 74.834, 85.01, 92.07 and 95.38 cm at 25, 40, 55, 70, 85 DAT and at harvest, respectively) was produced by BRRI dhan46. This differences were mostly due to the genetic variation among the varieties. These results were agreed with those of Shamsuddin *et al.* (1988) who have stated that plant height varies among the varieties.

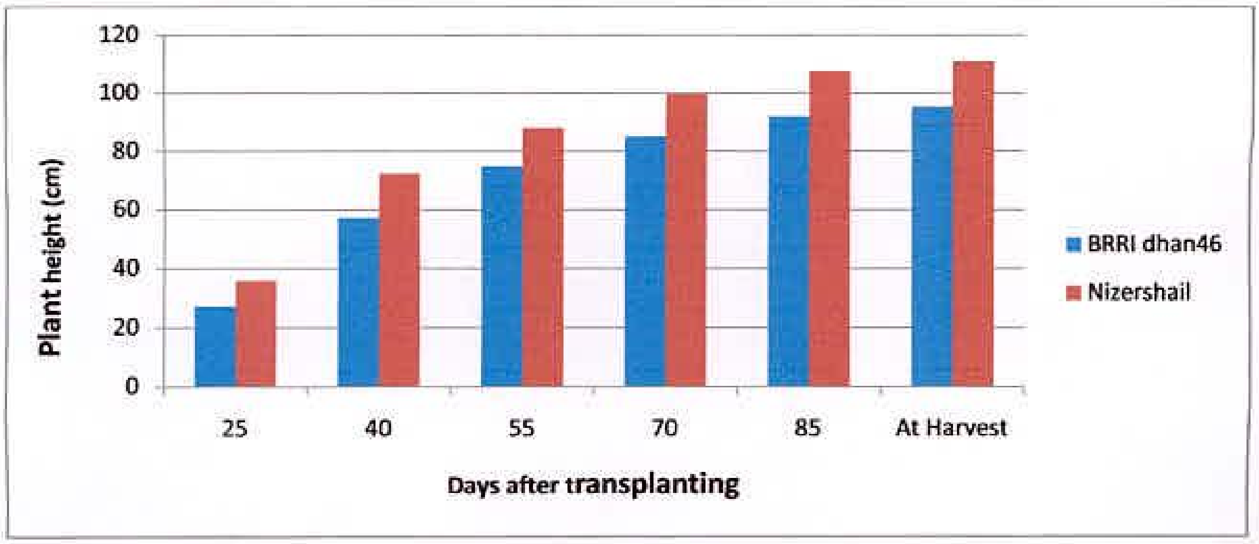


Fig. 1 Effect of variety on plant height at different growth duration of T. aman rice varieties ($S\bar{x}$= 0.36, 0.64, 0.73, 4.94, 6.35 and 6.71 at 25, 40, 55, 70, 85 DAT and at harvest, respectively)

Effect of different fertilizers, manures and their combination treatment on plant height was significantly affected at 5% level of probability (Fig. 2). Plant attained maximum height (34.71, 70.01, 88.52, 98.74, 107.3 and 111.3 cm at 25, 40, 55, 70, 85 DAT and at harvest, respectively) with T_2 treatment (recommended dose of chemical fertilizers) and the shortest plant (28.08, 55.19, 69.28, 80.26, 86.3 and 88.25 cm at 25, 40, 55, 70, 85 DAT and at harvest, respectively) with the control treatment. Therefore, it was clear that the plant height at harvest increased at each level of fertilizers over the control. The results corroborates with the findings of Koboyashi *et al.* (1989) who observed increasing plant height with FYM + fertilizer N applied plots.

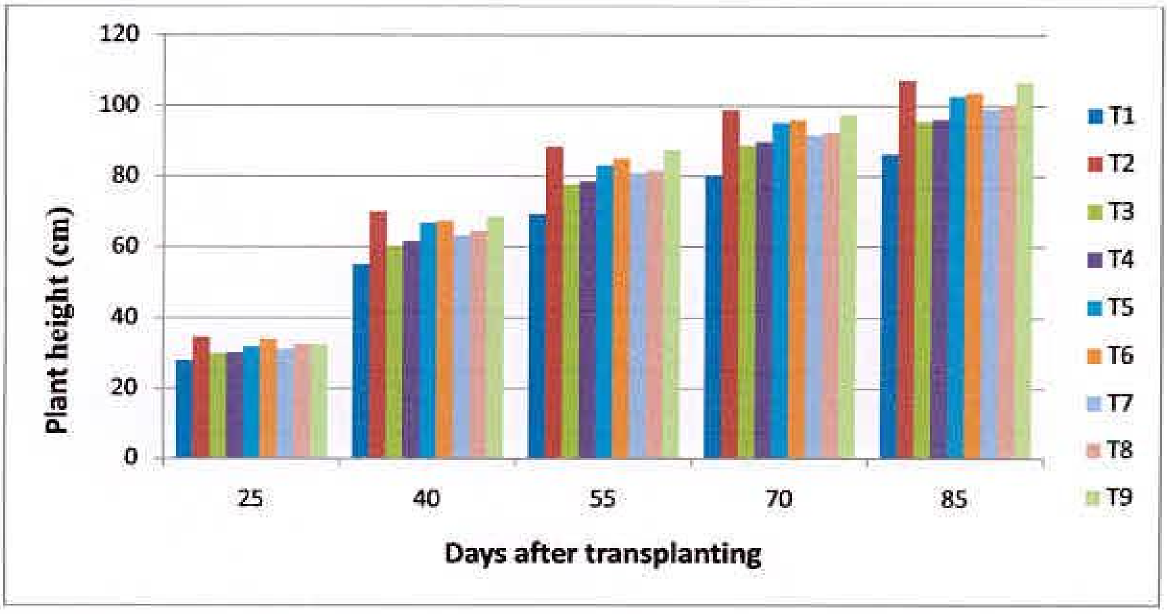


Fig. 2 Effect of fertilizers on plant height at different plant growth duration of T. aman rice varieties ($S\bar{x}$ = 0.6473, 1.7247, 1.7743, 1.83, 2.41 and 2.12 at 25, 40, 55, 70, 85 DAT and at harvest, respectively).

T_1 = Without fertilizer (control),
T_2 = Recommended dose of chemical fertilizers,
T_3 = Cowdung,
T_4 = Compost,
T_5 = Recommended dose of chemical fertilizers + cowdung,
T_6 = Recommended dose of chemical fertilizers + compost,
T_7 = ½ of the recommended dose of chemical fertilizers + cowdung,
T_8 = ½ of the recommended dose of chemical fertilizers + compost ,
T_9 = ½ of the recommended dose of chemical fertilizers + cowdung + compost

Plant height affected significantly by the interaction of variety and fertilizers (Table 1). The tallest plant (40.25, 76.05, 96.07, 106.7, 115.8 and 119.9 cm at 25, 40, 55, 70, 85 DAT and at harvest, respectively) was produced by the treatment combination of V_2T_2 (Nizershail with recommended dose of chemical fertilizers) and the shortest one (15.91 , 45.29, 65.29, 75.92, 81.00, and 83.00 cm at 25, 40, 55, 70, 85 DAT and at harvest, respectively) by V_1T_1 (BRRI dhan46 with control) treatment.

Table 1. Interaction effect of variety and fertilizers on plant height at different plant growth duration of T. aman rice varieties

Interaction (variety x fertilizers)	Plant height (cm)					
	25 DAT	40 DAT	55 DAT	70 DAT	85 DAT	At harvest
V_1T_1	15.91 j	45.29 i	65.29 g	75.92 g	81.00 f	83.00 g
V_1T_2	32.72 ef	63.98 c-g	80.97 c-e	90.79 c-e	98.75 cde	102.80 c-e
V_1T_3	25.55 i	54.18 h	71.54 fg	82.00 fg	88.10 ef	91.10 fg
V_1T_4	27.17 hi	54.91 h	72.45 fg	82.70 e-g	88.75 ef	91.70 fg
V_1T_5	28.18 hi	60.09 e-h	76.00 ef	88.10 d-f	95.10 de	98.50 d-f
V_1T_6	29.19 gh	60.89 d-h	78.85 d-f	88.78 c-f	96.00 de	99.50 d-f
V_1T_7	28.00 hi	56.10 gh	74.17 ef	83.54 e-g	90.59 ef	94.00 ef
V_1T_8	28.10 hi	57.50 f-h	74.79 ef	84.17 e-g	92.00 ef	95.35 ef
V_1T_9	31.35 fg	61.95 d-h	79.45 d-f	89.08 c-f	98.38 c-e	102.60 c-e
V_2T_1	31.79 e-g	65.08 c-f	73.26 ef	84.61 ef	91.60 ef	93.50 ef
V_2T_2	40.25 a	76.05 a	96.07 a	106.70 a	115.80 a	119.90 a
V_2T_3	33.10 d-f	66.53 b-e	84.05 b-d	95.67 b-d	103.30 b-d	106.00 b-d
V_2T_4	34.29 c-e	68.45 a-d	84.79 b-d	96.90 bc	103.80 b-d	106.80 b-d
V_2T_5	36.79 bc	73.78 ab	90.40 ab	102.50 ab	110.50 ab	114.00 ab
V_2T_6	36.95 bc	74.07 ab	91.25 ab	103.30 ab	111.30 ab	115.00 ab
V_2T_7	35.75 b-d	70.54 a-c	88.05 a-c	99.85 ab	107.80 a-c	111.00 a-c
V_2T_8	36.70 bc	71.69 a-c	88.90 a-c	100.60 ab	108.80 abc	112.70 ab
V_2T_9	37.95 ab	75.45 a	95.50 a	106.20 a	115.50 a	119.50 a
$S\bar{x}$	0.9154	2.436	2.509	2.586	3.402	2.994
CV(%)	7.01	6.52	7.34	7.85	5.90	8.03

V_1T_1 = BRRI dhan46 x without fertilizer (control),
V_1T_2 = BRRI dhan46 x recommended dose of chemical fertilizers,
V_1T_3 = BRRI dhan46 x cowdung,
V_1T_4 = BRRI dhan46 x compost,
V_1T_5 = BRRI dhan46 x (recommended dose of chemical fertilizers + cowdung),
V_1T_6 = BRRI dhan46 x (recommended dose of chemical fertilizers + compost),
V_1T_7 = BRRI dhan46 x (½ of the recommended dose of chemical fertilizers + cowdung),
V_1T_8 = BRRI dhan46 x (½ of the recommended dose of chemical fertilizers + compost),
V_1T_9 = BRRI dhan46 x (½ of the recommended dose of chemical fertilizers + cowdung + compost)
V_2T_1 = Nizershail x without fertilizer (control),
V_2T_2 = Nizershail x recommended dose of chemical fertilizers,
V_2T_3 = Nizershail x cowdung,
V_2T_4 = Nizershail x compost,
V_2T_5 = Nizershail x (recommended dose of chemical fertilizers + cowdung),
V_2T_6 = Nizershail x (recommended dose of chemical fertilizers + compost),
V_2T_7 = Nizershail x (½ of the recommended dose of chemical fertilizers + cowdung),
V_2T_8 = Nizershail x (½ of the recommended dose of chemical fertilizers + compost),
V_2T_9 = Nizershail x (½ of the recommended dose of chemical fertilizers + cowdung + compost)

4.2 Number of total tillers hill^{-1}

Varieties showed different effect for producing total tillers hill $^{-1}$ for all sampling dates (Fig. 3). However, the figure showed that the total tillers hill^{-1} was higher (4.39, 9.36, 17.57, 14.34, 12.72 and 12.499 at 25, 40, 55, 70, 85 DAT and at harvest, respectively) in BRRI dhan46 and that of lower (3.53, 6.058, 10.71, 10.94, 10.212 and 9.892 at 25, 40, 55, 70, 85 DAT and at harvest, respectively) was in Nizershail.

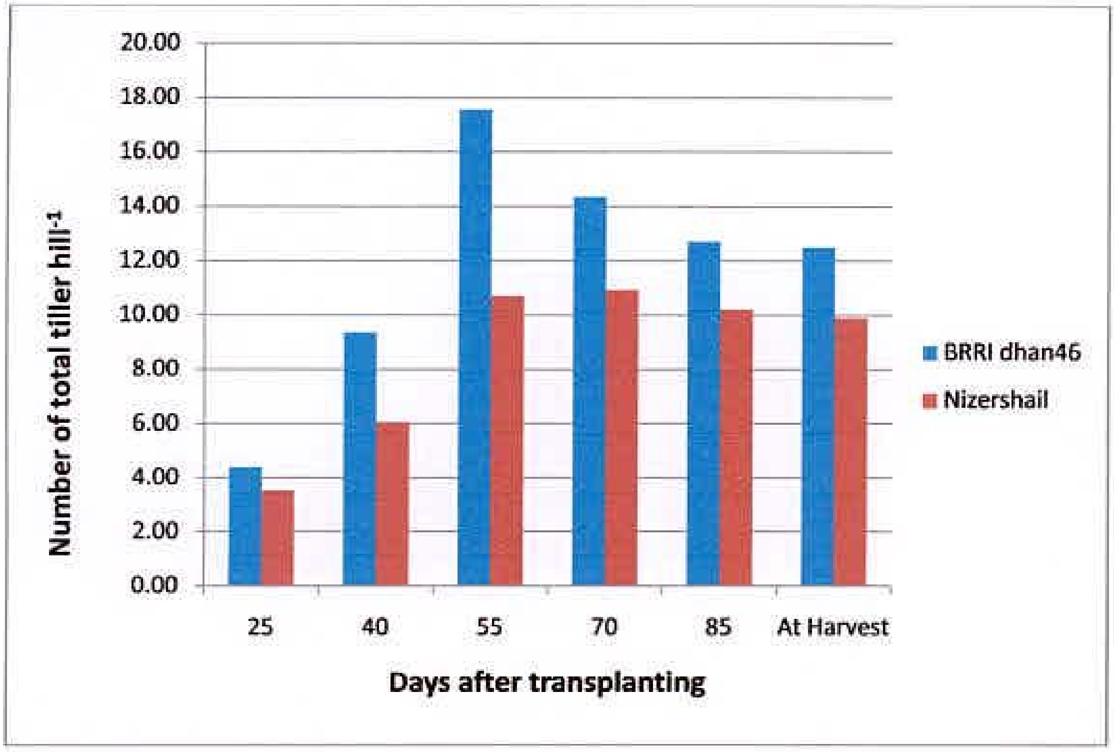


Fig. 3 Effect of variety on total tillers hill^{-1} at different plant growth stage of T. aman rice varieties ($S\bar{x}$ = 0.36, 0.272, 4.39, 2.4, 1.814, 3.0392 at 25, 40, 55, 70, 85 DAT and at harvest, respectively)

Number of total tillers hill^{-1} varied significantly due to fertilizers and manure combination treatments (Fig. 4). In general, fertilizer applied plot increased the number of total tillers hill^{-1} over control (without fertilizer). Maximum number of total tillers hill^{-1} (5.11, 9.86, 15.74, 14.51, 13.39 and 13.32 at 25, 40, 55, 70, 85 DAT and at harvest, respectively) was counted from T_2 treatment (Recommended dose of chemical fertilizers) and the minimum number of total tiller hill^{-1} (30.1,4.60, 10.19, 8.18, 6.90 and 6.50 at 25, 40, 55, 70, 85 DAT and at harvest, respectively) was produced by control treatment (Fig. 4). The progressive improvement in the formation of tillers with different fertilization might be due to increased nutrients uptake which enhanced tillering. Ahmed and Rahrnan (1991) reported that combined application of organic matter and chemical fertilizers increased the tiller of rice plant.

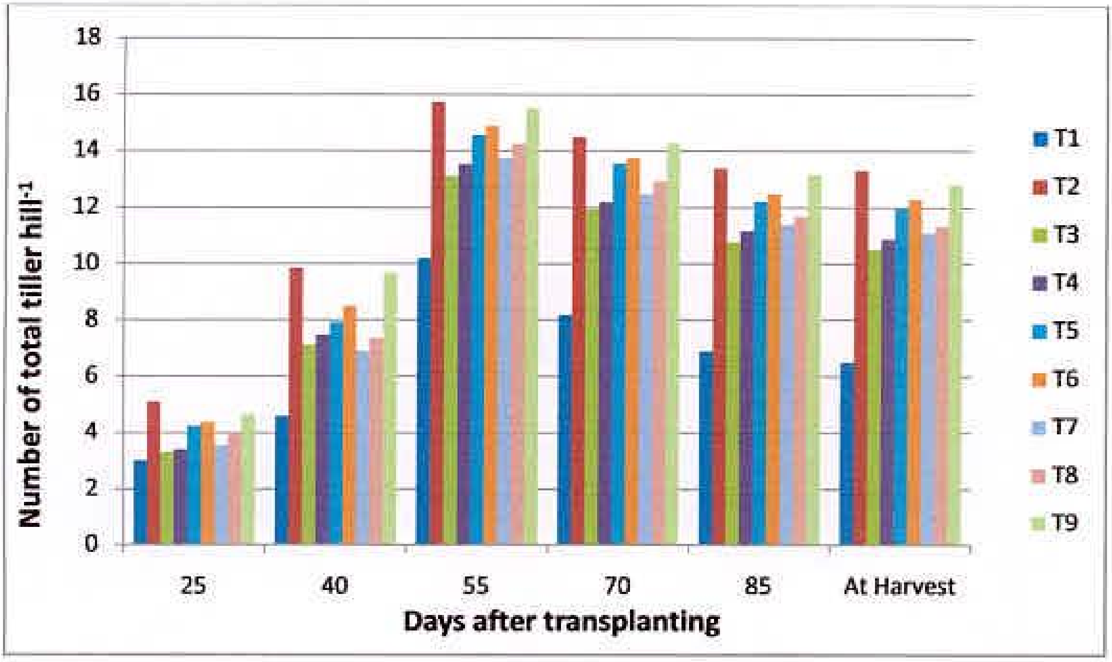


Fig. 4 Effect of organic and inorganic fertilizers on total tillers hill^{-1} at different plant growth duration of T. aman rice varieties ($S\overline{x}$ = 0.10, 0.02, 0.33, 0.13, 0.48, 0.38 at 25, 40, 55, 70, 85 DAT and at harvest, respectively)

T_1 = Without fertilizer (control),
T_2 = Recommended dose of chemical fertilizers ,
T_3 = Cowdung,
T_4 = Compost,
T_5 = Recommended dose of chemical fertilizers + cowdung,
T_6 = Recommended dose of chemical fertilizers + compost,
T_7 = ½ of the recommended dose of chemical fertilizers + cowdung,
T_8 = ½ of the recommended dose of chemical fertilizers + compost,
T_9 = ½ of the recommended dose of chemical fertilizers + cowdung + compost

Variety and fertilizers interacted significantly with each other in respect of number of total tillers hill^{-1} (Table 2). Interaction of V_1T_2 resulted in maximum number of total tillers hill^{-1} (5.59, 12.00, 17.75, 16.29, 14.79 and

14.75 at 25, 40, 55, 70, 85 DAT and at harvest respectively). The lowest Number of total tillers hill^{-1} (3.00, 3.70, 9.00, 6.98, 6.50 and 6.00 at 25, 40, 55, 70, 85 DAT and at harvest, respectively) was produced by the treatment combination of V_2T_1 (Nizershail with control treatment).

Table 2. Interaction effect of variety and fertilizers on total tiller hill^{-1} at different plant growth stage of T. aman rice varieties

Interaction (variety x fertilizers)	Tiller number hill^{-1}					
	25 DAT	40DAT	55 DAT	70 DAT	85 DAT	At harvest
V_1T_1	3.01 h	5.50 h	11.37 g	9.37 de	7.30 g	7.00 i
V_1T_2	5.59 a	12.00 a	17.75 a	16.29 a	14.79 a	14.75 a
V_1T_3	3.21 gh	8.05 ef	15.00 d	13.50 a-d	12.00 b-e	11.80 c-f
V_1T_4	3.51 fg	8.75 de	15.45 cd	13.89 a-d	12.59 a-d	12.20 b-f
V_1T_5	5.01 b-d	9.77 bc	16.65 a-c	15.50 a-c	13.50 ab	13.30 a-c
V_1T_6	5.10 bc	10.00 b	16.89 ab	15.73 a-c	13.85 ab	13.69 ab
V_1T_7	4.00 e	9.03 cd	15.52 cd	14.13 a-d	12.79 a-c	12.50 b-e
V_1T_8	4.79 cd	9.37 b-d	16.00 b-d	14.60 a-d	12.98 a-c	12.70 b-d
V_1T_9	5.30 ab	11.79 a	17.50 a	16.08 ab	14.67 a	14.55 a
V_2T_1	3.00 h	3.70 i	9.00 h	6.98 e	6.50 g	6.00 i
V_2T_2	4.63 d	7.71 fg	13.73 e	12.73 a-d	11.98 b-e	11.90 c-f
V_2T_3	3.40 f-h	5.20 h	11.23 g	10.37 c-e	9.57 f	9.25 h
V_2T_4	3.29 f-h	5.58 h	11.61 fg	10.50 c-e	9.76 ef	9.55 gh
V_2T_5	3.49 fg	6.07 h	12.50 e-g	11.60 a-e	10.93 c-f	10.70 f-h
V_2T_6	3.67 ef	6.97 g	12.88 ef	11.75 a-e	11.10 c-f	10.88 e-h
V_2T_7	3.11 gh	5.76 h	11.98 fg	10.80 b-e	10.00 ef	9.70 gh
V_2T_8	3.20 gh	5.98 h	12.50 e-g	11.25 a-e	10.38 d-f	10.00 gh
V_2T_9	4.00 e	7.55 fg	13.54 e	12.48 a-d	11.69 b-f	11.05 d-g
$S\bar{x}$	0.136	0.304	0.408	1.589	0.680	0.544
CV(%)	5.95	6.84	5.77	9.80	10.28	8.42

V_1T_1 = BRRI dhan46 x without fertilizer (control),
V_1T_2 = BRRI dhan46 x recommended dose of chemical fertilizers,
V_1T_3 = BRRI dhan46 x cowdung,
V_1T_4 = BRRI dhan46 x compost,
V_1T_5 = BRRI dhan46 x (recommended dose of chemical fertilizers + cowdung),
V_1T_6 = BRRI dhan46 x (recommended dose of chemical fertilizers + compost),
V_1T_7 = BRRI dhan46 x (½ of the recommended dose of chemical fertilizers + cowdung),
V_1T_8 = BRRI dhan46 x (½ of the recommended dose of chemical fertilizers + compost),
$V_1 T_9$ = BRRI dhan46 x (½ of the recommended dose of chemical fertilizers + cowdung + compost),
V_2T_1 = Nizershail x without fertilizer (control),
V_2T_2 = Nizershail x recommended dose of chemical fertilizers,
V_2T_3 = Nizershail x cowdung,
V_2T_4 = Nizershail x compost,
V_2T_5 = Nizershail x (recommended dose of chemical fertilizers + cowdung),
V_2T_6 = Nizershail x (recommended dose of chemical fertilizers + compost),
V_2T_7 = Nizershail x (½ of the recommended dose of chemical fertilizers + cowdung),
V_2T_8 = Nizershail x (½ of the recommended dose of chemical fertilizers + compost),
$V_2 T_9$ = Nizershail x (½ of the recommended dose of chemical fertilizers + cowdung + compost)

4.3 Dry weight $hill^{-1}$

Variety had significant effect on dry weight $hill^{-1}$. Dry weight was higher in BRRI dhan46 (9.10, 22.96 and 35.12g at 30, 60 DAT and at harvest, respectively). The lowest dry weight (7.81, 18.199 and 27.96 g at 30, 60 DAT and at harvest, respectively) was produced from the variety Nizershail (Fig. 5)

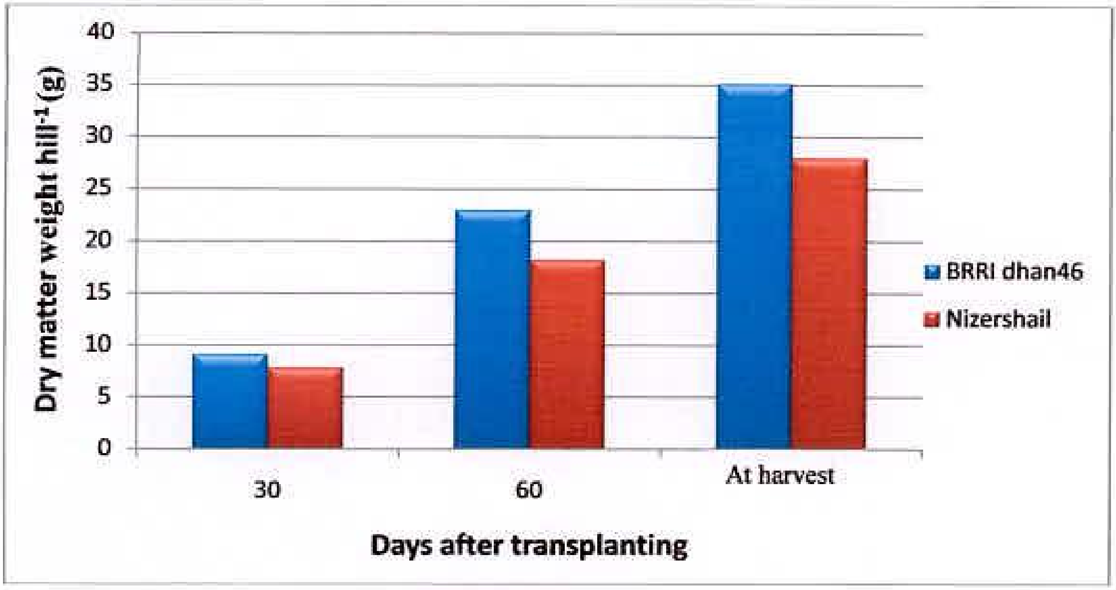


Fig. 5 Effect of variety on dry matter $hill^{-1}$ at different crop growth stage of T. aman rice varieties ($S\bar{x}$ = 0.48, 0.73, 0.73 at 30, 60 DAT and at harvest, respectively)

Fertilizer combination exerted significant effect on dry weight $hill^{-1}$. The highest dry weight (11.77, 24.94 and 38.67 at 30, 60 DAT and at harvest, respectively) was produced from treatment T_2. The lowest dry weight (6.45, 12.1 and 20.24 at 30, 60 DAT and at harvest, respectively) was produced by control treatment (T_1).

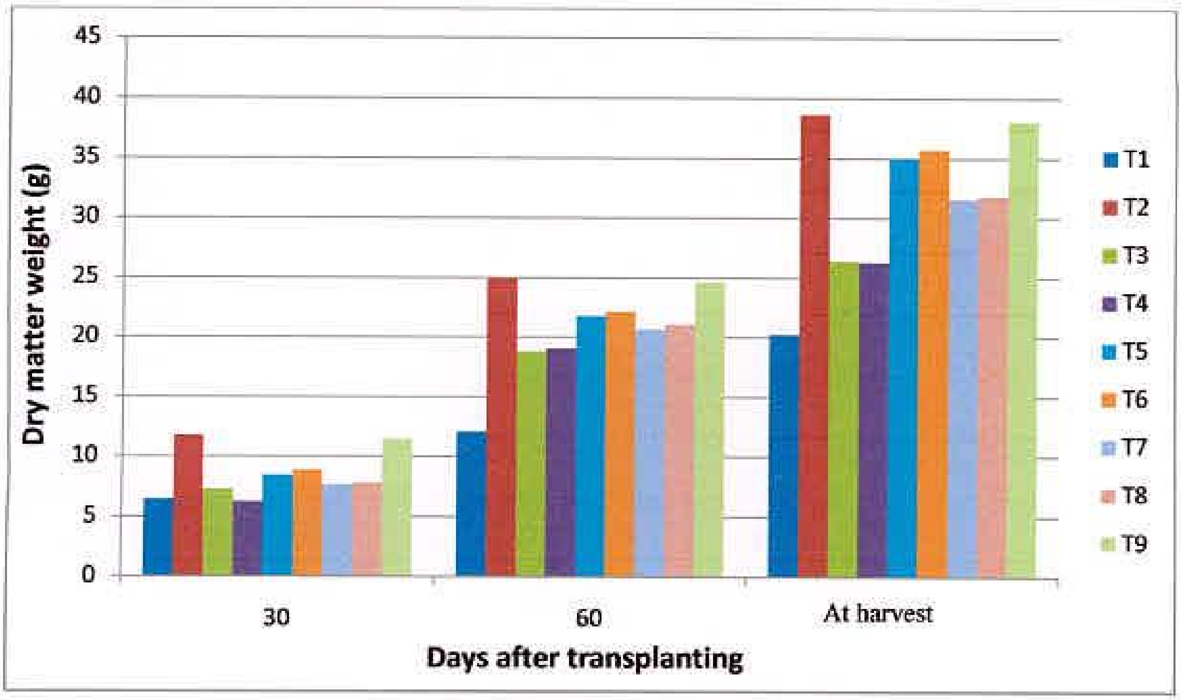


Fig. 6 Effect of fertilizers on dry matter at different crop growth stage of T. aman rice ($S\bar{x}$ = 0.84, 0.19, 0.20 at 30, 60 DAT and at harvest, respectively)

T_1 = Without fertilizer (control),
T_2 = Recommended dose of chemical fertilizers,
T_3 = Cowdung,
T_4 = Compost,
T_5 = Recommended dose of chemical fertilizers + cowdung,
T_6 = Recommended dose of chemical fertilizers + compost,
T_7 = ½ of the recommended dose of chemical fertilizers + cowdung,
T_8 = ½ of the recommended dose of chemical fertilizers + compost,
T_9 = ½ of the recommended dose of chemical fertilizers + cowdung + compost

Interaction effect of variety and fertilizer had significant effect on dry weight hill^{-1}(Table 3). V_1T_2 resulted in maximum number of dry matter weight hill^{-1} (13.36, 27.53 and 43.21 g at 30, 60 DAT and at harvest, respectively). The lowest number of dry matter weight hill^{-1} (5.1, 10.52 and 18.27 at 30, 60 DAT and at harvest, respectively) was produced by the treatment combination of V_2T_1 (Nizershail with control treatment).

Table 3. Interaction effect of variety and fertilizers on dry matter weight at different growth stage of T. aman rice varieties

Interaction (variety x fertilizers)	Dry matter weight (g)		
	30 DAT	60DAT	At harvest
V_1T_1	5.76 ef	13.67 k	22.21 g
V_1T_2	13.36 a	27.53 a	43.21 a
V_1T_3	7.03 d-f	21.08 f	30.35 e
V_1T_4	7.43 d-f	21.34 f	30.05 e
V_1T_5	9.69 a-e	24.25 bc	39.20 b
V_1T_6	9.96 a-d	24.75 b	39.69 b
V_1T_7	8.54 b-f	23.18 d	34.36 c
V_1T_8	8.60 b-f	23.71 cd	34.44 c
V_1T_9	11.54 a-c	27.17 a	42.57 a
V_2T_1	5.10 f	10.52 l	18.27 h
V_2T_2	9.57 a-e	22.35 e	34.14 c
V_2T_3	7.61 c-f	16.52 j	22.47 g
V_2T_4	7.14 d-f	16.77 j	22.55 g
V_2T_5	7.28 d-f	19.29 gh	30.87 e
V_2T_6	7.79 c-f	19.57 g	31.74 d
V_2T_7	6.81 d-f	18.13 i	28.77 f
V_2T_8	7.00 d-f	18.51 hi	29.18 f
V_2T_9	12.00 ab	22.13 e	33.69 c
$S\bar{x}$	1.188	0.272	0.272
CV(%)	8.34	7.29	8.49

V_1T_1 = BRRI dhan46 x without fertilizer (control),
V_1T_2 = BRRI dhan46 x recommended dose of chemical fertilizers,
V_1T_3 = BRRI dhan46 x cowdung,
V_1T_4 = BRRI dhan46 x compost,
V_1T_5 = BRRI dhan46 x (recommended dose of chemical fertilizers + cowdung),
V_1T_6 = BRRI dhan46 x (recommended dose of chemical fertilizers + compost),
V_1T_7 = BRRI dhan46 x (½ of the recommended dose of chemical fertilizers + cowdung),
V_1T_8 = BRRI dhan46 x (½ of the recommended dose of chemical fertilizers + compost),
V_1T_9 = BRRI dhan46 x (½ of the recommended dose of chemical fertilizers + cowdung + compost),
V_2T_1 = Nizershail x without fertilizer (control),
V_2T_2 = Nizershail x recommended dose of chemical fertilizers,
V_2T_3 = Nizershail x cowdung,
V_2T_4 = Nizershail x compost,
V_2T_5 = Nizershail x (recommended dose of chemical fertilizers + cowdung),
V_2T_6 = Nizershail x (recommended dose of chemical fertilizers + compost),
V_2T_7 = Nizershail x (½ of the recommended dose of chemical fertilizers + cowdung),
V_2T_8 = Nizershail x (½ of the recommended dose of chemical fertilizers + compost),
V_2T_9 = Nizershail x (½ of the recommended dose of chemical fertilizers + cowdung + compost)

4.4 Number of effective tillers hill^{-1}

Variety had significant effect on number of effective tillers hill^{-1} (Table 4). Results indicated that the highest number of effective tillers hill^{-1} (10.79) was produced by BRRI dhan46 and lowest one (8.39) was produced by Nizershail. This might be due to the genetic make-up of the variety. These findings corroborated with those of Chowdhury *et al.* (1993) who stated that productive tillers hil1^{-1} varied with variety.

Effect of combined or individual application of different organic and chemical fertilizers on the number of effective tillers hil1^{-1} of T. aman rice varied significantly (Table 5). Treatment T_2 produced the highest number of bearing tillers hill^{-1} (12.32) which was statically similar with $T_{9,}$ T_6 and T_5. The lowest (3.75) was produced by control treatment. From these results, it was observed that number of effective tillers hill^{-1} was increased due to combined fertilization over control. These are an agreement of Kant and Kumar (1994) who have reported that the increasing rate of amendment with FYM increased the number of effective tillers hiil^{-1} significantly.

The effect of interaction between variety and fertilization was found significant in respect of number of effective tillers hill^{-1} (Table 6). Result presented in Table 6 shows that the highest number of effective tillers hill^{-1} (13.75) was found by the treatment combination of V_1T_2 (BRRI dhan46 with recommended dose of chemical fertilizers). The lowest number of effective tillers hill^{-1} (3.5) was produced by the treatment combination of Nizershail with control treatment (V_2T_1) which was statistically similar with V_1T_1.

4.5 Number of non-effective tillers hill^{-1}

The results showed that, there was significant difference for producing non-effective tillers hill^{-1} between the studied varieties (Table 4). The higher number of non-effective tillers hill^{-1} (2.34) were produced by Nizershail and then (1.73) by BRRI dhan46.

Different fertilizer combination treatment exerted significant influence on the production of non-effective tillers hill^{-1} (Table 5). The result showed that, the highest number of non-effective tillers hill^{-1} (3.23) was produced by control treatment and the lowest number of non-effective tillers hill^{-1} (1.38) was produced when the crop was fertilized with recommended dose of chemical fertilizers.

Number of non-effective tillers hill^{-1} was significantly affected by the interaction between variety and fertilizer combination treatment (Table 6). The higher number of non-effective tillers hill^{-1} were observed from the interaction of control treatment with both the varieties (3.2 and 3.25, respectively). On the other hand, the lowest number of non-effective tillers hill^{-1} were recorded from the interaction of recommended dose of chemical fertilizers with both of the varieties (1.00 and 1.05, respectively).

Table 4. Effect of variety on different yield contributing characters of T. aman rice varieties

Variety	Effective tiller hill^{-1} (no.)	Non- effective tiller hill^{-1} (no.)	Panicle length (cm)	Filled grains panicle^{-1} (no.)	Unfilled grains panicle^{-1} (no.)	Weight of 1000-grain (g)
BRRI dhan46 (v_1)	10.79	1.732	25.944	64.886	9.288	21.4
Nizershail (v_2)	8.39	2.342	27.378	56.213	15.563	14.239
$S\bar{x}$	2.22	0.3788	0.0454	2.0412	0.0907	0.1545
CV (%)	9.83	7.35	6.25	7.77	9.28	6.13

Table 5. Effect of fertilizers on different yield contributing characters of T. aman rice varieties

Treatment	Effective tiller hill^{-1} (no.)	Non-effective tiller hill^{-1} (no.)	Panicle length (cm.)	Filled grains panicle^{-1} (no.)	Unfilled grains panicle^{-1} (no.)	Weight of 1000-grain (g)
T_1	3.75 e	3.23 a	16.91 e	40.71 c	20.54 a	8.38 g
T_2	12.32 a	1.38 d	31.60 a	67.31 a	8.20 c	21.17 a
T_3	8.18 d	2.83 ab	23.55 d	57.59 b	13.01 b	16.95 f
T_4	8.98 cd	2.28 bc	23.86 cd	57.62 b	12.44 b	17.33 ef
T_5	10.63 a-c	1.75 cd	29.11 ab	64.13 a	10.41 bc	19.17 b-d
T_6	11.00 ab	1.66 cd	29.65 ab	64.85 a	9.83 bc	19.88 a-c
T_7	9.55 b-d	1.93 cd	26.82 b-d	62.58 ab	11.77 b	18.06 d-f
T_8	9.85 b-d	1.88 cd	27.13 bc	63.15 ab	11.23 bc	18.82 c-e
T_9	12.05 a	1.43 d	31.33 a	67.01 a	8.40 c	20.63 ab
$S\bar{x}$	0.385	0.144	0.680	1.309	0.674	0.463
CV (%)	9.83	7.35	6.25	7.77	9.28	6.13

T_1 = Without fertilizer (control),
T_2 = Recommended dose of chemical fertilizers,
T_3 = Cowdung,
T_4 = Compost,
T_5 = Recommended dose of chemical fertilizers + cowdung,
T_6 = Recommended dose of chemical fertilizers + compost,
T_7 = ½ of the recommended dose of chemical fertilizers + cowdung,
T_8 = ½ of the recommended dose of chemical fertilizers + compost,
T_9 = ½ of the recommended dose of chemical fertilizers + cowdung + compost

Table 6. Interaction effect of variety and fertilizers on different yield contributing characters of T. aman rice varieties

Interaction (variety x fertilizers)	Effective tiller $hill^{-1}$ (no.)	Non-effective tiller $hill^{-1}$ (no.)	Panicle length (cm.)	Filled grains $panicle^{-1}$ (no.)	Unfilled grains $panicle^{-1}$ (no.)	Weight of 1000-grain (g)
V_1T_1	4.00 k	3.20 a	15.50 i	45.57 d	20.50 a	20.10 f
V_1T_2	13.75 a	1.00 h	30.92 ab	73.77 a	5.50 i	25.10 a
V_1T_3	9.00 g-j	2.80 ab	23.02 g	58.40 c	10.04 d-g	20.41 f
V_1T_4	10.20 e-h	2.00 c-f	23.32 g	59.04 c	9.50 e-g	20.60 f
V_1T_5	12.00 b-d	1.30 gh	28.03 b-d	69.26 ab	7.90 f-i	23.08 cd
V_1T_6	12.50 a-c	1.19 gh	28.50 b-d	69.96 ab	7.30 g-i	23.85 bc
V_1T_7	10.95 c-f	1.55 e-h	26.61 d-f	67.05 b	8.80 f-h	21.75 e
V_1T_8	11.20 c-e	1.50 f-h	26.95 d-f	67.50 b	8.25 f-i	22.76 d
V_1T_9	13.50 ab	1.05 h	30.65 ab	73.42 a	5.80 hi	24.55 ab
V_2T_1	3.50 k	3.25 a	18.31 h	34.85 e	20.58 a	12.25 m
V_2T_2	10.90 c-f	1.75 d-g	32.29 a	60.84 c	10.90 d-f	17.25 g
V_2T_3	7.35 j	2.85 ab	24.08 fg	56.20 c	15.98 b	13.50 l
V_2T_4	7.75 ij	2.55 bc	24.41 e-g	56.78 c	15.39 bc	14.06 kl
V_2T_5	9.25 f-i	2.20 b-e	30.19 a-c	59.00 c	12.92 cd	15.25 ij
V_2T_6	9.50 e-i	2.13 c-f	30.79 ab	59.75 c	12.35 c-e	15.90 hi
V_2T_7	8.15 ij	2.30 b-d	27.02 d-f	58.10 c	14.75 bc	14.37 j-l
V_2T_8	8.50 h-j	2.25 b-d	27.31 c-e	58.80 c	14.20 bc	14.87 jk
V_2T_9	10.60 d-g	1.80 d-g	32.00 a	60.60 c	11.00 d-f	16.70 gh
$S\bar{x}$	0.54	0.20	0.96	1.85	0.95	0.32
CV(%)	9.83	7.35	6.25	7.77	9.28	6.13

V_1T_1 = BRRI dhan46 x without fertilizer (control),
V_1T_2 = BRRI dhan46 x recommended dose of chemical fertilizers,
V_1T_3 = BRRI dhan46 x cowdung,
V_1T_4 = BRRI dhan46 x compost,
V_1T_5 = BRRI dhan46 x (recommended dose of chemical fertilizers + cowdung),
V_1T_6 = BRRI dhan46 x (recommended dose of chemical fertilizers + compost),
V_1T_7 = BRRI dhan46 x (½ of the recommended dose of chemical fertilizers + cowdung),
V_1T_8 = BRRI dhan46 x (½ of the recommended dose of chemical fertilizers + compost),
V_1T_9 = BRRI dhan46 x (½ of the recommended dose of chemical fertilizers + cowdung + compost),
V_2T_1 = Nizershail x without fertilizer (control),
V_2T_2 = Nizershail x recommended dose of chemical fertilizers,
V_2T_3 = Nizershail x cowdung,
V_2T_4 = Nizershail x compost,
V_2T_5 = Nizershail x (recommended dose of chemical fertilizers + cowdung),
V_2T_6 = Nizershail x (recommended dose of chemical fertilizers + compost),
V_2T_7 = Nizershail x (½ of the recommended dose of chemical fertilizers + cowdung),
V_2T_8 = Nizershail x (½ of the recommended dose of chemical fertilizers + compost),
V_2T_9 = Nizershail x (½ of the recommended dose of chemical fertilizers + cowdung + compost)

4.6 Panicle length

Panicle length was affected due to variety (Table 4). Among the tested varieties the longest panicle (27.38 cm) was produced by Nizershail and the shortest (24.95 cm) was produced by BRRI dhan46. This may perhaps due to the variation among varieties for their genetic make up.

Panicle length was influenced significantly due to fertilizer treatment (Table 5). The longest panicle (31.60 cm) was obtained by T_2 which was followed by T_9 (31.33 cm) and the shortest panicle (16.91 cm) was recorded from the control treatment. From these results it is observed that panicle length was increased due to different fertilization. Abmed and Rahman (1991) reported that the application of organic matter and chemical fertilizer increased the panicle length and panicle production.

Panicle length varied significantly due to interaction effect of variety and fertilization (Table 6). The longest panicle (32.29 cm) was found in the treatment combination of V_2T_2, which was statistically similar with V_2T_9, V_2T_6, V_2T_5, V_1T_9 and V_1T_2 and the lowest panicle length was (15.5 cm) obtained in V_1T_1 treatment.

4.7 Number of filled grains panicle^{-1}

Variety showed significant influence on the number of filled grains panicle^{-1} (Table 4). The higher number of grains panicle^{-1} (64.886) was observed in BRRI dhan46 and the lower one (56.213) was recorded from Nizershail.

Number of filled grains panicle^{-1} varied significantly due to different fertilizations (Table 5). Among the treatments, T_2 produced the highest number of filled grains panicie^{-1} (67.31) which was statistically similar to T_5, T_6, T_7, T_8, and T_9, and the lowest number of grains panicle^{-1} (40.71) was recorded from control treatment These results showed that, combined application of organic and inorganic fertilizer significantly increased grains panicl^{-1} over control. Similar result was also reported by Main and Eaqub (1976).

Number of grains panicle^{-1} differed significantly due to interaction of variety and fertilization (Table 6). The highest number of filled grains panicle^{-1} (73.77) was produced by V_1T_2 which was statistically similar with V_1T_9 (73.42), V_1T_5 (69.26) and V_1T_6 (69.96), the lowest number of filled grains panicle^{-1} (34.85) was recorded from the interaction of Nizershail with control treatment.

4.8 Number of unfilled grains panicle^{-1}

Number of unfilled grains panicle^{-1} plays a vital role and it is the most traits for yield reduction (Table 4). The table shows that BRRI dhan46 produced the lower number of unfilled grains panicle^{-1} (9.29) and Nizershail produced the higher number of unfilled grains (15.56) panicle^{-1}. Kamal *et al.* (1988) reported variable effect of variety on sterile spikelets panicle^{-1}.

Number of unfilled grains panicle^{-1} was significantly influenced by the different fertilization (Table 5). The Table shows that the highest number of unfilled grains paniele^{-1} (20.54) was produced in the control treatment. The lowest number of unfilled grains panicle^{-1} (8.2) was produced by T_2 treatment which was statistically similar with T_9 treatment.

The effect of interaction between variety and fertilization on number of sterile unfilled grains was highly significant (Table 6). The table shows that the highest number of unfilled grains panicle^{-1} (20.58) was recorded from the treatment combination of Nizershail x control treatment which was statistically similar with V_1T_1 treatment. The lowest number of unfilled grains panicle^{-1} was found in BRRI dhan46 with recommended dose of chemical fertilizers (5.55).

4.9 Weight of 1000-grain

Varieties differ regarding 1000-grain weight (Table 4). The higher 1000-grain (21.40 g) was recorded from BRRI dhan46 and lower (14.24 g) from Nizershail.

Different levels of fertilizers and manuring showed significant influences on 1000-grain weight (Table 5). The highest 1000-grain weight (21.17 g) was obtained from T_2 treatment. The lowest 1000-grain weight (8.38 g) was obtained from the control treatment.

The effect of interaction between variety and different fertilizers was found significant in respect of 1000-grain weight (Table 6). The maximum 1000-grain weight (25.10 g) was recorded in the interaction of BRRI dhan46 with recommended dose of chemical fertilizers and the lowest one (12.25 g) was recorded in Nizershail x control treatment.

4.10 Grain yield

The varieties exhibited differences in grain yield (Table 7). BRRI dhan46 gave higher grain yield (3.49 t ha^{-1}) and that of lower in Nizershail (2.61 t ha^{-1}). The reasons of this differences might be attributed to the differences in yield contributing characters between the two varieties. Grain yield differences due to varieties were also reported by Suprithatno and Sutaryo (1992) and Kumari *et al.* (1993).

There observed a significant and positive effect due to combination of different fertilizer and manure treatments on grain yield (Table 8). The results indicated that in general, grain yield increased with fertilizers over control. The highest grain yield (4.13 t ha^{-1}) was obtained from the treatment T_2. The lowest grain yield (1.40 t ha^{-1}) was obtained from control treatment.

It can be inferred from the result that grain yield was increased due to fertilizer treatment. But, the combination of recommended chemical fertilizer with cowdung and compost was better to produce higher grain yield. Similar results were obtained by Singhnia and Singh (1986) and Khan *et al.* (1993).

Grain yield was significantly influenced by interaction between variety and combination of different fertilizer and manure treatments (Table 9). However, the highest grain yield 4.76 t ha^{-1} was recorded by the interaction between BRRI dhan46 with recommended dose of chemical fertilizers. The lowest grain yield (1.3 t ha^{-1}) was produced by the interaction of Nizershail with control treatment.

Table 7. Effect of variety on yield and harvest index of T. aman rice varieties

Variety	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
BRRI dhan46 (v_1)	3.499	4.237	7.736	44.389
Nizershail (v_1)	2.614	3.938	6.552	39.52
$S\bar{x}$	0.4141	0.1012	0.5153	2.9366
CV(%)	7.25	8.04	8.41	7.51

Table 8. Effect of fertilizers on yield and harvest index of T. aman rice varieties

Treatment	Grain yield ($t\ ha^{-1}$)		Straw yield ($t\ ha^{-1}$)		Biological yield ($t\ ha^{-1}$)		Harvest index (%)	
T_1	1.40	f	2.74	e	4.14	f	33.90	d
T_2	4.13	a	4.92	a	9.06	a	45.50	a
T_3	2.29	e	3.49	d	5.79	e	39.50	c
T_4	2.35	e	3.50	d	5.85	e	40.00	c
T_5	3.56	c	4.52	ab	8.09	c	43.90	ab
T_6	3.66	bc	4.61	a	8.27	bc	44.10	ab
T_7	3.03	d	4.13	bc	7.16	d	42.40	bc
T_8	3.03	d	3.97	c	7.00	d	43.20	ab
T_9	4.03	ab	4.88	a	8.91	ab	45.00	ab
$S\bar{x}$	0.0905		0.0674		0.1578		0.6	
CV (%)	7.25		8.04		8.41		7.5	

T_1 = Without fertilizer (control),
T_2 = Recommended dose of chemical fertilizers,
T_3 = Cowdung,
T_4 = Compost,
T_5 = Recommended dose of chemical fertilizers + cowdung,
T_6 = Recommended dose of chemical fertilizers + compost,
T_7 = ½ of the recommended dose of chemical fertilizers + cowdung,
T_8 = ½ of the recommended dose of chemical fertilizers + compost,
T_9 = ½ of the recommended dose of chemical fertilizers + cowdung + compost

Table 9. Interaction effect of variety and fertilizers on yield and harvest index of T. aman rice varieties

Interaction (variety x fertilization)	Grain yield ($t\ ha^{-1}$)	Straw yield ($t\ ha^{-1}$)	Biological yield ($t\ ha^{-1}$)	Harvest index (%)
V_1T_1	1.51 h	2.76 i	4.27 j	34.93 fg
V_1T_2	4.76 a	5.11 a	9.87 a	48.32 a
V_1T_3	2.69 f	3.75 g	6.44 h	41.79 cd
V_1T_4	2.77 ef	3.80 fg	6.57 h	42.19 cd
V_1T_5	4.13 b	4.67 bc	8.80 bc	47.02 a
V_1T_6	4.20 b	4.73 a-c	8.93 b	47.12 a
V_1T_7	3.32 cd	4.19 d-f	7.51 ef	44.28 bc
V_1T_8	3.46 c	4.07 e-g	7.53 ef	46.06 ab
V_1T_9	4.65 a	5.05 ab	9.70 a	47.79 a
V_2T_1	1.30 h	2.72 i	4.02 j	32.85 g
V_2T_2	3.51 c	4.74 a-c	8.25 cd	42.68 cd
V_2T_3	1.90 g	3.24 h	5.14 i	37.29 ef
V_2T_4	1.93 g	3.21 h	5.14 i	37.87 e
V_2T_5	3.00 d-f	4.38 c-e	7.38 fg	40.81 d
V_2T_6	3.12 c-e	4.49 cd	7.61 d-f	41.15 d
V_2T_7	2.60 f	3.88 fg	6.82 gh	40.51 d
V_2T_8	2.75 ef	4.07 e-g	6.48 h	40.33 d
V_2T_9	3.42 c	4.71 bc	8.13 c-e	42.20 cd
$S\bar{x}$	0.13	0.13	0.22	0.85
CV(%)	7.25	8.04	8.41	7.51

V_1T_1 = BRRI dhan46 x without fertilizer (control),
V_1T_2 = BRRI dhan46 x recommended dose of chemical fertilizers,
V_1T_3 = BRRI dhan46 x cowdung,
V_1T_4 = BRRI dhan46 x compost,
V_1T_5 = BRRI dhan46 x (recommended dose of chemical fertilizers + cowdung),
V_1T_6 = BRRI dhan46 x (recommended dose of chemical fertilizers + compost),
V_1T_7 = BRRI dhan46 x (½ of the recommended dose of chemical fertilizers + cowdung),
V_1T_8 = BRRI dhan46 x (½ of the recommended dose of chemical fertilizers + compost),
V_1T_9 = BRRI dhan46 x (½ of the recommended dose of chemical fertilizers + compost),
V_2T_1 = Nizershail x without fertilizer (control),
V_2T_2 = Nizershail x recommended dose of chemical fertilizers,
V_2T_3 = Nizershail x cowdung,
V_2T_4 = Nizershail x compost,
V_2T_5 = Nizershail x (recommended dose of chemical fertilizers + cowdung),
V_2T_6 = Nizershail x (recommended dose of chemical fertilizers + compost),
V_2T_7 = Nizershail x (½ of the recommended dose of chemical fertilizers + cowdung),
V_2T_8 = Nizershail x (½ of the recommended dose of chemical fertilizers + compost),
V_2T_9 = Nizershail x (½ of the recommended dose of chemical fertilizers + cowdung + compost)

4.11 Straw yield

Straw yield was influenced significantly by variety (Table 7). From Table 7 it is found that, higher straw yield (4.23 t ha^{-1}) was produced by BRRI dhan46 and lower one (3.93 t ha^{-1}) was produced by Nizershail. The highest number of total tillers $hill^{-1}$ may be resulted in the highest straw yield. These results are in conformity with those obtained by Chowdhury *et al.* (1993) who reported differences in straw yield among varieties.

There was a significant and positive effect due to different fertilizers and manures combinations treatments on straw yield (Table 8). The table indicated that, sraw yield increased due to application of fertilizer and manure combination treatment over control. The highest amount of straw yield (4.92 t ha^{-1}) was found in T_2 treatment. The lowest straw yield (2.74 t ha^{-1}) was obtained from control. Rajput and Warsi (1992) also reported that the application of organic manure and chemical fertilizer increased straw yield of rice.

Straw yield was significantly affected by interaction of variety and combination of fertilizer treatment (Table 9). The table showed that the highest straw yield was recorded from the treatment combination BRRI dhan46 with recommended dose of chemical fertilizers (V_1T_2) which was statistically similar with V_1T_6,V_1T_9 and V_2T_2 combination and the lowest straw yield (2.72 t ha^{-1}) was recorded from Nizershail x control treatment which was statistically similar with V_1T_1 treatment. It can be observed from the result that both the two varieties performed the best due to the combination effect of chemical fertilizer in respect of straw yield.

4.12 Biological Yield

The varietal effect on biological yield was affected significantly (Table 7). Higher biological yield (7.73 t ha^{-1}) was recorded from BRRI dhan46 and lower (6.55 t ha^{-1}) was from Nizershail.

Nine combinations of organic and chemical fertilizers showed significant difference in biological yield (Table 8). The highest biological yield (9.06 t ha^{-1}) was recorded at T_2 treatment. The lowest biological yield (4.14 t ha^{-1}) was found in control treatment.

The interaction between variety and fertilizer treatment exerted significant influence on biological yield (Table 9). Interaction of BRRI dhan46 with recommended dose of chemical fertilizers (V_1T_2) produced the highest (9.87 t ha^{-1}) biological yield which was statistically similar with V_2T_2 (9.70 t ha^{-1}) treatment, The lowest biological yield (4.02 t ha^{-1}) was recorded from the treatment combination Nizershail with control treatment.

4.13 Harvest Index

Harvest index was affected by variety (Table 7). Between the varieties higher harvest index (44.38%) was obtained in BRRI dhan46 and lower harvest index (39.52%) was calculated in Nizershail.

The influence of different combination of fertilizers and manures on harvest index was significant (Table 8). The result showed that, the highest harvest index (45.5%) was recorded at recommended dose of chemical fertilizers and the lowest harvest index (33.90%) was calculated from control treatment.

Interaction of variety with fertilizers influenced significantly on harvest index (Table 9). Results indicated that the highest harvest index 48.32% was recorded in the interaction of BRRI dhan46 x recommended dose of chemical fertilizers. The lowest harvest index 32.85% calculated from the combination of Nizershail with control treatment.

CHAPTER 5

SUMMARY AND CONCLUSION

An experiment was conducted at the Sher-e-Bangla Agricultural University, Field Laboratory during the period from June-December 2010 with a view to study the effect of variety and integration of organic and chemical fertilizer on the yield and yield-contributing characters of transplant T. aman rice. The experimental treatments included (a) two T. aman rice varieties viz. BRRI dhan46 and Nizershail (b) nine levels of organic and chemical fertilizers T_1 = without fertilizer (control), T_2 = recommended dose of chemical fertilizers, T_3 = cowdung, T_4 = compost, T_5 = recommended dose of chemical fertilizers + cowdung, T_6 = recommended dose of chemical fertilizers + compost, T_7 = ½ of the recommended dose of chemical fertilizers + cowdung, T_8 = ½ of the recommended dose of chemical fertilizers + compost, T_9 = ½ of the recommended dose of chemical fertilizers + cowdung + compost. The experiment was laid out in a split plot design with three replications by placing the variety in the main plots and fertilizers in the subplots. The whole amount of organic fertilizer was applied at the one day before transplanting. The entire amount of P, K and Gypsum were applied as basal dose while urea was applied as top dressing in three equal splits at 10 days after transplanting (DAT), 35 DAT and 55 DAT. Seedlings were transplanted on 01 August, 2010 with the two seedlings hill^{-1} at 25 cm spacing between lines and 15 cm spacing between hills. Intercultural operations such as gap filling, weeding, water management and pest management were done as and when necessary. Data were collected on different agronomic characters related to yield attributes and some of important yield components. Data were analyzed using the "Analyses of variance" technique and mean differences were adjudged by DMRT.

Variety had significant influence on almost all the parameter of studied. Taller plant (35.95, 72.40, 88.03, 99.59, 107.591 and 110.93 cm at 25, 40, 55, 70, 85 DAT and at harvest, respectively) was produced by Nizershail and the shorter (27.35, 57.21, 74.834, 85.01, 92.07 and 95.38 cm at 25, 40, 55, 70, 85 DAT and at harvest, respectively) was produced by BRRI dhan46. Total tillers was higher (4.39, 9.36, 17.57, 14.34, 12.72 and 12.499 at 25, 40, 55, 70, 85 DAT and at harvest, respectively) in BRRI dhan46 and the lower number of total tillers hill $^{-1}$ (3.53, 6.058, 10.71, 10.94, 10.212 and 9.892 at 25, 40, 55, 70, 85 DAT and at harvest, respectively) was produced by Nizershail. Dry weight was higher in BRRI dhan46 (9.10, 22.96 and 35.12g at 30, 60 DAT and at harvest, respectively). The lowest dry weight (7.81, 18.199 and 27.96 g at 30, 60 DAT and at harvest, respectively) was produced from treatment by Nizershail. The higher number of effective tillers hill^{-1} (10.79) was produced by BRRI dhan46 and lowers one (8.39) was produced by Nizershail. The higher number of non-effective tillers hill^{-1} (2.34) were produced by Nizershail and then (1.73) by BRRI dhan46. The longer panicle (27.38 cm) was produced by BRRI dhan46 and the shortest (24.95 cm) was produced by Nizershail. The higher number of grains panicle1 (59.886) was observed in BRRI dhan46 and the lower one (51.213) was recorded from Nizershail. The higher number of grains panicle^{-1} (133.96) was observed in BRRI dhan46 and the lower one (80.44) was recorded from Nizershail. BRRI dhan46 produced the lower number of unfilled grains panicle^{-1} (9.29) and Nizershail produced the higher number of unfilled grains (15.56) panicle^{-1}. Higher weight of 1000 grain (21.40 g) was recorded from BRRI dhan46 and lower (14.24) from Nizershail. BRRI dhan46 gave higher grain yield (3.50 t ha^{-1}) then Nizershail (2.61). Higher straw yield (4.23 t ha^{-1}) was produced by BRRI dhan46 and lower one (3.93 t ha^{-1}) was produced by Nizershail. Higher biological yield (7.73 t ha^{-1}) was recorded from BRRI dhan46 and lower one (6.55 t ha^{-1}) was recorded from

Nizershail. Higher harvest index (44.38%) was obtained in BRRI dhan46 and lower harvest index (39.52%) was calculated in Nizershail.

Fertilizer combination had significant influence on almost all the studied parameter of rice. Plant attained highest height (34.71, 70.01, 88.52, 98.74, 107.3 and 111.3 cm at 25, 40, 55, 70, 85 DAT and at harvest, respectively) with recommended dose of chemical fertilizers and the shortest plant (28.08, 55.19, 69.28, 80.26, 86.3 and 88.25 cm at 25, 40, 55, 70, 85 DAT and at harvest, respectively) with the control treatment. Maximum number of total tillers hill^{-1} (5.11, 9.86, 15.74, 14.51, 13.39 and 13.32 at 25, 40, 55, 70, 85 DAT and at harvest, respectively) was counted from recommended dose of chemical fertilizers and the minimum number of total tiller hill^{-1} (30.1, 4.60, 10.19, 8.18, 6.90 and 6.50 at 25, 40, 55, 70, 85 DAT and at harvest, respectively) was produced by control treatment. The highest dry weight (11.77, 24.94 and 38.67 at 30, 60 DAT and at harvest, respectively) was produced from treatment T_2. The lowest dry weight (6.45, 12.1 and 20.24 at 30, 60 DAT and at harvest, respectively) was produced by control treatment (17.83g). Treatment T_2 produced the highest number of bearing tillers hill^{-1} (12.32) and the lowest (3.75) was produced by control treatment. The highest number of non-effective tillers hill^{-1} (3.23) was produced by control treatment and the lowest number of non-effective tillers hill^{-1} (1.38) was produced when the crop was fertilized with recommended dose of chemical fertilizers. The longest panicle (31.60 cm) was obtained by recommended dose of chemical fertilizers. The shortest panicle (16.91 cm) was recorded from the control treatment. T_2 produced the highest number of filled grains panicie^{-1} (62.31) and the lowest number of grains panicle^{-1} (35.71) was recorded from control treatment. The highest number of unfilled grains paniele^{-1} (20.54) was produced in the control treatment. The lowest number of unfilled grains paniele^{-1} (8.20) was produced by T_2. The highest 1000 grain weight (21.17 g) was obtained from T_2 and the lowest (8.37 g) was obtained from the control treatment. The highest grain yield (4.13 t ha^{-1}) was obtained from the treatment T_2. The lowest grain yield (1.40 t ha^{-1}) was obtained from control treatment. The highest amount of straw yield (4.92 t ha^{-1}) was found in T_2 treatment. The lowest straw yield (2.74 t ha^{-1}) was obtained from control. The highest biological yield (9.06 t ha^{-1}) was recorded at T_2 treatment. The lowest biological yield (4.14 t ha^{-1}) was found in control treatment.

The highest harvest index (45.5%) was recorded at recommended dose of chemical fertilizers and the lowest harvest index (33.90%) was calculated from control treatment.

Interaction effect of variety and fertilizer combination treatment had significant influence on almost all the studied parameters. Plant attained maximum height (34.71, 70.01, 88.52, 98.74, 107.3 and 111.3 cm at 25, 40, 55, 70, 85 DAT and at harvest, respectively) with T_2 treatment and the shortest plant (28.08, 55.19, 69.28, 80.26, 86.3 and 88.25 cm at 25, 40, 55, 70, 85 DAT and at harvest, respectively) with the control. V_1T_2 resulted in maximum number of total tillers $hill^{-1}$ (5.59, 12.00, 17.75, 16.29, 14.79 and 14.75 at 25, 40, 55, 70, 85 DAT and at harvest) respectively. The lowest Number of total tillers $hill^{-1}$ (3.00, 3.70, 9.00, 6.98, 6.50 and 6.00 at 25, 40, 55, 70, 85 DAT and at harvest, respectively) was produced by the treatment combination of V_2T_1 (Nizershail with control treatment).
V_1T_2 resulted in maximum number of dry matter weight $hill^{-1}$ (13.36, 27.53 and 43.21 g at 30, 60 DAT and at harvest) respectively. The lowest Number of dry matter weight $hill^{-1}$ (5.1, 10.52 and 18.27 at 30, 60 DAT and at harvest, respectively) was produced by the treatment combination of V_2T_1 (Nizershail with control treatment). The highest number of effective tillers

hill^{-1} (13.75) was found by the treatment combination V_1T_2. The lowest number of effective tillers hill^{-1} (3.5) was produced by the treatment combination of Nizershail with control treatment.

The higher number of non-effective tillers hill^{-1} were observed from the interaction of control treatment with both the varieties (3.2 and 3.25, respectively). On the other hand, the lowest number of non-effective tillers hill^{-1} were recorded from the interaction of recommended dose of chemical fertilizers with both of the varieties (1.00 and 1.05, respectively). The longest panicle (32.29 cm) was found in the treatment combination of V_2T_2, and the lowest panicle length was (15.5 cm) obtained in V_1T_1 treatment. The highest number of filled grains panicle^{-1} (68.77) was produced by V_1T_2 which was statistically similar with V_1T_9 (68.42) and the lowest number of filled grains panicle^{-1} (29.85) was recorded from the interaction of Nizershail with control treatment. The highest number of unfilled grains panicle^{-1} (20.58) was recorded from the treatment combination of Nizershail x control treatment. The lowest number of unfilled grains panicle^{-1} was found in BRRI dhan46 with recommended dose of chemical fertilizers (5.55). Maximum 1000 grain weight (25.10 g) was recorded in the interaction of V_1T_2 and the lowest one (6.25 g) was recorded in the interaction of Nizershail with control treatment. The highest grain yield 4.76 t ha^{-1} was recorded by the interaction between BRRI dhan46 with recommended dose of chemical fertilizers. The lowest grain yield (1.3 t ha^{-1}) was produced by the interaction of Nizershail with control treatment. The highest but identical straw yields (5.11 t ha^{-1}) was recorded from the treatment combination BRRI dhan46 with Recommended dose of chemical fertilizers and the lowest straw yield (2.72 t ha^{-1}) was recorded from Nizershail x control treatment.

Interaction of BRRI dhan46 with recommended dose of chemical fertilizers produced the highest (9.87 t ha^{-1}) biological yield and The lowest biological yield (4.02 t ha^{-1}) was recorded from the treatment combination Nizershail with control treatment. The highest harvest index 48.32% was recorded in the interaction of BRRI dhan46 with recommended dose of chemical fertilizers. The lowest harvest index 32.85% calculated from the combination of Nizershail with control treatment.

From the above study it may be concluded that BRRI dhan46 out yielded the local variety Nizershail by 0.88 t ha^{-1} and recommended dose of chemical fertilizers and half dose of chemical fertilizer + cowdung + compost (T_9) performed best in producing higher level of grain yield as well as other yield contributing characters. However, to reach a specific conclusion and recommendation the same experiment need to be repeated and more research work should be done over different Agro-ecological zones of the country.

REFERENCES

Ahmed, M. and Rahman, S. (1991). Influence of organic matter on the yield and mineral nutrition of modern rice and soil properties. *Bangladesh Rice J.* **2**(1-2): 107-112.

Ali, M. Y. and Murshid, M .G. (1993). Effect of age of seedlings on yield and economic performance of late transplant aman rice. *Bangladesh J. Agril. Sci.* **20**(2): 345-349.

Anonymous, (1993). Report of the first External Review of the Bangladesh Agricultural Research Council, Farm Gate, Dhaka.

Awan, I. U., Ahmed, H.K. and Gandopur, S. U. D. (1984). The effect of different levels of nitrogen application on rice. *Intl. Rice. Res. Newsl.* **8**(6): 26.

Ayyasamy, M. and Venkataraman. (1983). A study on the effect of different levels of nitrogen and slow release urea on rice yield. *Madras Agric. J.* **70**(7): 451-453.

Babiker, F. S. H. (1986). The effect of zinc sulphate levels on rice (*Oryza sativa* L.) growth and productivity. *Alexandria J. Agric. Res*. **31**(2): 480.

Bandyopadhyay, K.K., Sark, M.C. and Uppal, K.S. (1988). Balance in rice as influenced by different sources and levels of nitrogen. *J. Agric. and Biol*. **27**(2): 90-96.

Behera, A.K. (1998). Response of scented rice (*Oryza saliva*). To nitrogen under j transplanted condition. *Indian J. Agron*. **43**(1): 64-67.

Bhattacharya, D., Baruah, T.C. and Barthakur, H.P. (1996). Effect of Benomyl and FYM in redox-potential available iron and manganese of a flooded soil and yield of rice (*Oryza saliva*) to level and time of nitrogen application. *Indian J. Agron.* **37**(4): 681-685.

Bhuiyan, Z.H., Islam, A.K.M.N. and Hoque, M.S. (1979). Yield and protein content of 1R8 rice as influenced by N, P and K fertilizers. *Bangladesh J. Agril. Sci.* **6**(2): 127-130.

Bhuiyan, N.I. (1992). Sulphur fertilization for rice and non-rice crop of Bangladesh Agriculture. In: Int. Sym. On the role of sulphur, magnesium and micronutrients in balanced plant nutrition, sulphur Institute, Washington, USA. pp.81-93.

BINA (1993). Annual Report for 1992-93. Bangladesh Institute of Nuclear Agriculture, P.O. Box. No. 4. Mymensingh. pp. 52-143.

Black, C.A. (1965). Methods of Soils Analysis. Part-I and II, Amer, Soc. Agron. Inc. Pub. Madison, Wisconsin, USA. pp. 1149-1176.

BRRI (1990). Cultural practices. Bangladesh Rice Research Institute, Ann. Rev. 1989. Joydehpur, Gazipur. pp 2-4.

BRRI (1980). Nitrogen response for T. aman varieties. Ann. Inter. Review. Bangladesh Rice Research institute. A14-A15.

BRRI (1988). Annual report for 1987-88. Bangladesh Rice Research institute, Gazipur. pp: 82-310.

BRRI (1991). Annual Report for 1990. Bangladesh Rice Research Institute, Joydebpur, Gazipur. pp. 40-42.

BRRI (1989). Annual Report for 1988. Bangladesh Rice Research Institute, Joydebpur, Gazipur, Bangladesh. BRRI Pub. No. 98, pp. 82, 300.

BRRI (1992). Annual Report for 1991. Bangladesh Rice Research Institute. Joydebpur, Gazipur, Bangladesh. BRRI Pub. No. 108. pp. 57, 166.

BRRI (1995). Adhunic Dhaner Chash (in Bangla), 7th revised Edn. Booklet no, 5, Bangladesh Rice Research Institute, Joydebpur, Gazipur. pp. 3-34.

BRRI (2000). Adhunic Dhaner Chash (in Bangla). Bangladesh Rice Research Institute, Joydebpur, Gazipur. 9th Edn. p. 7.

BRRI (2011). Adhunic Dhaner Chash (in Bangla). Bangladesh Rice Research Institute, Joydebpur, Gazipur. 16th Edn. p. 72.

Chattopadhyay, N., Gupta, M.D., and Gupta, S.K. (1992). Effect of city waste compost and fertilizers on the growth, nutrient uptake and yield of rice. *J. Indian Soc. Soil Sci.* **40**(3):464-468.

Chaudhury, F.A. and Bodiuzzaman, M. (1992). Effect of different levels of potash and sulphur on the growth and yield of Pajam rice. *Bangladesh J. Agril. Sci.* **19**(1): 37-40.

Chhibba, I.M., Nayyar, V.K. and Takkar, P.N. (1989). Direct and residual effect of some Zn carriers in rice-wheat rotations. *J. Indian Soc. Soil Sci.* **37**(3): 585-587.

Choudhari, B.T., Turkhede. A.B., Chore, C.N., Jiotode, D.J. and Thoral, A.W. (1998). Performance of Basmati rice varieties under various levels of nitrogen with organic manure. *J. Soils and Crops*. **8**(1): 4 1-43.

Choudhury, A.T.M.A., Zaman, S.K. and Bhuiyan, N.I. (1994). Evaluation of mixed and complex fertilizers for wet land rice. *Pakistan J. Sci. and Inds. Res.* **37**(9):378-38 1.

Choudhury, D. and Ghosh, A.K. (1978). Evaluation of Agronomic and Physiochemical characteristics of fine and scented rice varieties. *Indian J. Agril. Sci.*, **48**(10): 573-578.

Chowdhurv, M.J.U., Sarker, A.U., Sarker, M.A.R. and Kashem, M.A. (1993). Effect of varity and number of seedlings hill^{-1} on the yield and its components on late transplanted aman rice. *Bangladesh J. Agril. Sci.* **20**(2): 311-316.

Delowera, K., Rahman, H. H., Bhuiyan, A.H., Zaherul, I. and Hossain, A.K.M. (1996). The Wheat-Mungbean-T. aman. Cropping system on red-brown terrace soils. In: Biological nitrogen Faction associated with rice production. Based on selected papers presented in the International Symposium, Dhaka. Bangladesh. 28 November, 2 December 1994.

Dixit, L. and Khanda, C. (1994). Effect of zinc and nitrogen fertilization on yield and yield attributes of summer rice. *Orissa J. Agric. Res*. 7: 1-5.

Fageria, N.K. and Zimerman, F. J. (1996). Response of irrigated rice to fertilizer on lowland soil. Respostade Arroz. Irrigado a adubacao emsolos de varzea. *Pesquisa Agropecuaria Brasileria.* **31**(6): 463-666 [Cited from *Rice Abst.* **20**(3): 221].

Ghosh, B. C., Ghosh, R., Mitra, B.N., Mitra, A. and Jana, M.K. (1994). Influence of organic and inorganic fertilization on the growth and nutrition of rice and fish in a dual culture system. *J. Agril. Sci.* **122**(1): 4 1-45.

Gogoi, A.K. and Lalita, H. (1996). Effect of fertilizer and batachior on weed and yield of transplanted rice (*Oryza sativa*). *Indian J. Agron.* **41**(2): 230-232.

Gomez, K. A. and Gomez, A. A. (1984). Statistical Piocedures for Agricultural Research. 2nd Edn., John Wiley and Sons, New York. p. 680.

Gupta, S.K. (1995). Effect of organic manures on rice yield and nutrient retention in Altisol Soil. *J. Hill. Res.* **8**(2): 169-173.

Haque, S.A. and Biswas, N.R. (1990). Sulphur interaction with plant nutrient in rice. Trons 14th intl. Cong. Soil Sci. Kyoto. Japan. 12-28. August. 1990. IV. 504.

Hassan, G., Chaudhary, E.H., Mian, S.M., Gill, K.H. and Sheikh, A.A. (1993). Yield response of Basmati rice to applied P at different soil P values. *Intl. Rice, Res. Newsl.* **18**(4): 25.

Hossain, A, Islam, R. and Miah, N.A. (1989). Response of rice to sulphur and zinc fertilizer. *Bangladesh Agric. Sci.* **16**(l): 13 1-134.

Hossain, S.M.A., Alam, A.B.M. and Kashem, M.A. (1991). Performance of different varieties of boro rice. In fact searching and Intervention in two FSRDP sites. Activities 1989-90. Farming System Research and Development Programme. Bangladesh Agricultural University, Mymensingh. pp. 19-20 and 150-154.

Hossain, S.M.A., Satter, M., Ahmed, J.U. and Islam, J.U. (1989). Response of rice to different levels of zinc fertilization. *Bangladesh J. Agril. Sci.* **16**(1): 125-127.

Idris, M. and Matin, M.A. (1990). Response of four exotic strains of aman rice of urea. *Bangladesh J. Agril. Sci.* **17**(2): 271-275.

Islam, M.R. and Hossain, A. (1993). Influence of additive nutrients on the yield of BR 11 rice. *Thai. J. Agril. Sci.* 26: 195-199.

Islam, M.R., Hoque, M.S. and Bhuiya, Z.H. (1990). Effect of nitrogen, sulphur fertilization on yield response and nitrogen and sulphur composition of rice. *Bangladesh J. Agric. Sci.* **17**(2): 299-302.

Jackson, M.L. (1962). Soil Chemical Analysis. Prentice Hall. Inc. (Ed. Engle Wood, C.) N. *J., USA. p.* 46.

Jeony, E., Shin, Y. Beom., Young, B., Oh, Yongbee and Shin, Y.S. (1996). Effects of organic mater application on rice growth and grain quality. *J. Agric. Sci., Rice.* **38**(1): 17-26.

Jhilayvathi, T. and Mathan, K.K. (1995). Influence of partially composted coir Pit on the attributes and yield on rice (var. ADT 36. *Modern Agril. J.* **82**(9/10): 528-530.

Kamal, A.M.A. Azam, M. A. and Islam, M.A. (1988). Effect of cultivar and NPK combinations on the yield and yield contributing characters of rice. *Bangladesh J. Agril. Sci.* **15**(1): 105-110.

Kant, S. and Kumar, R. (1994). A comparative study on the effect of four soil amendment on the uptake of Fe, Mn and yield of rice in salt affected soil. *Indian J. Agric. Chem.* **27**(283): 59-70.

Khan, H.R. (1991). Effect of gypsum, zinc and saline water on the yield and nutrient uptake by rice in a coastal saline soil. *Intl. J. Trop. Agric.* **9**(3): 225-233.

Khan, S.K., Mohanty, S.K. and Chalam, A.B. (1993). Integrated management of organic manure and fertilizer nitrogen for rice. *J. Indian Soc. Soil. Sci.* **34**(4): 505-509.

Kim, C.H., Iino, K., Karachi, H. I., Kambayash, M. and Sasattania, T. (1983). Effect of nitrate fertilizer on rice plant growth. *Japanese J. Crop. Sci.* **52**(1): 102-103.

Kohayashi, Y., Abe, S. and Matamoto, K. (1989). Growth and yield of paddy rice under natural cultivation. *Soil and Fert.* 1991. **54**(12): 1931.

Kolhe, C.A. and Mitra, R.A. (1985). Resposne of Joya variety of paddy to N, P, K and S on farmers field in Mysore district. *Mysore J. Agril. Sci.* **24**(1): 29-34.

Kumar, S.R., Reddy, M.R., Reddy, T.M.M. and Reddy, B.B. (1986). Nitrogen management in direct seeded and transplanted rice. *Indian J. Agron.* **31**(1):100-101.

Kumari, L. S., Mahadevappa, M., Vidyachandra, B. and krishnamurthy , R.A. (1993). Performance of experimental rice hybrids in Banglore, Karnataka India. *Intl. Rice Res. Notes*. **18**(1): 16.

Kuppuswamy, G., Jeyahal, A. and Lakshmanan, A.R. (1992). Effect of enriched bio-digested slurry and FYM on growth and yield of rice. *Hort. Sci. Digest (Karnal)*. **15**(2): 104. [Cited from *Soils and Fert.* 1994. **57**(8): 865.

Lal, M. and Roy, R.K. (1996). Effect of nursery seedling density and fertilizer on seedling growth and yield of rice (*Oryza sativa*). *Indian J. Agron.* **41**(4): 642-644.

Machado, M.O., Gornes, A.D. and Pawbtt, E.A. (1984). Response of irrigated rice to application of phosphorus and dolomitic limestone in four successive crops. Flowrianopalis, Brazil: Empresa Catxinerxde prequisa Agro peccearia (1984) 1995-2001. [*Soils and fertilizers Abst.* (1986). **49**(7): 870].

Mahajan, J.P., Singh, R.P. and Dwivedi, A.K. (1994). Utilization of fertilizer phosphorus by some rice varieties as influence by phosphorus fertilization in black soil. *J. Nuclear Agri. Biol.* **23**(4): 242-245.

Mathew, J., Bridgit, T.K. and Joseph, K. (1994). Interaction of organic and inorganic nutrient sources in transplanted low land rice. *J. Crop. Agril.* **32**(2): 166-167. [Cited from *Field Abst.* **19**(1): 31, 1996].

Melgar, R.J. and Ligier, H.D. (1986). Rice response to phosphorus fertilization in Northern Eorrientes. *Ciencia del Suelo* 4119: 38-48.

Miah, M.A.J. and Eunus, M. (1978). Effect of NPK on rice yield. *Bangladesh J. Agril. Sci.* **5**(1): 81.

Miah, N.M., Mian, S.A. and Kamal, N. Q. (1990). Field level performance of the recently recommended T.aman varieties BR 22 and BR 23. In: Proc. Workshop on Experiences with Modern Rice Cultivation in Bangladesh, BRRI, Joydebpur, Gazipur. pp. 21-26.

Mian, M.J.A. and Eaqub, M. (1976). Residual effects of TSP and farm yard manure renewed application of urea on the yield of rice and some chemical properties of soil. *Bangladesh J. Agril. Sci.* **3**(2): 35-42.

Momuat, E.O., Fadhly, A.F., Rauf, M. and Djarnaluddin, S. (1992). Triple super phosphate application on irrigated lowland rice in alluvial soil in south Sulawasi. *Agrikam, Buletin pentation Moros* (Indonesia). **7**(1): 27-33.

Mondal, S.S., Jayaram, D. and Pradhan, B.K.K. (1990). Effect of fertilizer and farmyard manure on the yield and yield components of rice (*Oryza saliva*). *Env. Eco.* **8**(IA): 223-226. [Cited from *Field Crop Abst.* **15**(13: 175.)]

Morok, A.S. and Dhaliwal, G.S. (1987). Response of paddy to potassium in Ferozpur distinct. *Indian Potash J.* **3**(2): 17-20.

Mostafa, M.A. (1990). Response of rice plant to zinc application. *Annals Agric. Sci.* (Special issue). pp.677-685.

Mukherjee. P.K. and Mandal, S.R. (1995). Effect of complete submergence on yield and nitrogen in rice. *Indian J. Agric. Res.* **29**(2): 1-4.

Nasiruddin. M. (1993). Rice production. Ecotype and Research Strategy for Bangladesh Paper presented at BRRI/DAE workshop experiment with modern rice cultivation in Bangladesh. p. 3.

Nelidov, S.N., Vasilera, L.V., and Mishustin, F.N. (1986). Use of crop residues to increase productivity of rice on ameliorated alkaline soils. *Biology Bulletin of Academy of Sciences of the USSR.* **13**(1): 31-43.

Page, L.R., Millar, R.H. and Keeney, D.R. (1989). Methods of' Soils Analysis. Part-11. Amer. Soc. Agron. Inc. Pub. Madison, Wisconsi. USA. pp. 8-10.

Patel, S.R., Shrivastara, S.K., Ram Singh, Chandrawansh, B.R. and Dubey, B.P. (1983). Rice production as influence by different source and time of nitrogen application under low land conditions. *Oryza*. **21**(1): 36-39.

Patel, Z.G., Patel, C.L., Nair, A.G. and Patel, R.B. (1987). Nitrogen management in summer paddy. *Gujarat Agric. Univ. Res.* 1. **12**(2): 3.

Purohit, K.K., Sisdia, RI., Singh, V.K. and Rande, R.C. (1986). Effect of Potash application to rice in northern hill region of chhattisgarh in Madhya Prodesh. *J. Potassium Res.* **2**(1): 36-39.

Rahman, M.A. (1992). Studies on nitrogen economy in transplanted *aman* rice through weed control measures. *Bangladesh J. Sci. Indus. Res.* 2. **27**(1-2): 60-66.

Rajput, A.L. and Warsi, A.S. (1992). Effect of nitrogen and organic manures on rice (*Oryza sativa*) yield and residual effect on wheat (*Triticum aestivuni*) crop. *Indian J. Agron.* **37**(4): 716-720.

Raju, R.A., Reddy, K.A. and Reddy, M.N. (1993). In legraed nutrient management in wet land rice (*Oryza sativa*). *Indian J. Agric. Sci.* **63**(12): 786-789.

Rashid, M., Bajwa, M.I. Hussain, R. Naurnuddi, M. and Rehrnan, F. (1992). Rice response to sulphur in Pakistan. Sulphur in Agric. 16: 3-5.

Rashid , M.A. and Siddique, S.B. (1988). Fertilizer response of deep water rice in Bangladesh. In: Proceeding of the 1987. International deep water Rice Workshop. Manila. Philippine. IRRI. 407-411.

Rafey, A., Khan, P.A. and Srivastava, V.C. (1989). Effect of N on growth, yield and nutrient uptake of upland rice. *Indian J. Agron.* **34**(2): 133-135.

Roy,A., Sing, R.K., Samui, R.C., Dasmahapaa, A.N. (1996). Effect of organic and organic source of N on summer rice for subtrained production in sub- humid sub-trpics. In proceedings, Natural Symposium on sustainable Agriculture in sub-humid zone. March, 3-5.

Saggar, S., Dcv, G. and Meehi, O.P. (1986). Available soil phosphorus in a rice-wheat rotation after extended super phosphorus application. *Intl. Rice Res. Newsl.* **11**(3): 26-27.

Sagwal, O.P. and Kurnar, V. (1994). Effect of balanced use of fertilizers on productivity and profitability of Basmati rice. *Fertilizer Newsl.* **39**(10): 55-57.

Sajjad, M.S. (1995). Influence of different NPK doses on yield and yield components of two standard rice varieties of NPG under lowland field conditions. Papua New Guinea. *J. Agric. Fores and Fisheries*. **38**(2): 124- 126. [*Rice Abst.* 1997. **20**(1): 31].

Salam, A.M. and Subramanian, S. (1988). Influence of nitrogen, zinc and their interaction on the yield and nutrient uptake of IR 20 rice (*Oryza sativa*) in different seasons. *Indian. J. Agril. Sci.* **58**(3): 190-193.

Saleque, M.A., Bhuiyan, N.1. and Saha, P.K. (1995). Potassium requirements in rained lowland rice soils of Bangladesh. **In:** *Intl. Rice Res. Cont*. pp. 279-288.

Sanzo, R., Canizarez, A. and Mantinez, P. (1997). Effect of cattle manure on rice yields and reduction of the rates of nitrogen application to a ferralitic, quartzite, red-yellow leached soil Centre. *Agricola.* **24**(1): 82-84.

Saravanan, A. and Kothandaraman, G.V. (1984). Efficiency of phosphorus fertilizer as determined by IR-20 grain yield. *Intl. Rice Res. Newsl.* **9**(4): 22.

Sarker, B.B., Nath, S.C. and Bhattacharjee. B.K. (1989). Effect of zinc on the yield of transplanted paddy in Tripura. State Agril. Res. Station. **26**(4): 403-404.

Sawant, A. C., Throat, S.T., Khadse, R.R. and Bhosa!e, R. J. (1986). Response of early rice varieties to nitrogen levels and spacing in coastal Maharashtra. *J. Maharashtra Agril. Univ.* **11**(2): 182-184.

Shamim, R., Hossain, S.M.A., Karirn, M.M., Siddique, M.A. and Chowdhury, A.K.M.S.H. (1991). Effect of sulphur and method of Zn application on rice. *Bangladesh J. Agril. Sci.* **18**(1): 11-14.

Shamsuddin, A.M., Islam, M.A. and Hossain, A. (1988). Comparative study on the yield and agronomic characters of nine cultivars of rice. *Bangladesh J. Agril.Sci.* **15**(1): 121-124.

Sharma, A.R., and Mittra, B.N. (1990). Response of rice to rate and time of application of organic materials. *J. Agril. Sci.* **114**(3): 249-252.

Sharma, P.B., Jain, M.P., Lidder, R.S. and Saran, R.N. (1990). Effect of land shading on productivity of different cropping sequences with varying sources of nutrients. *Indian. J. Agril. Sci.* **60**(9): 592-595.

Singh, K.N., Prasad, B., Prasad, A.K.,and Sinha, R.K. (1997). Integrated effects of organic manures biofertilizer and chemical fertilizers in rice wheat sequence. *J. Res. Birsa. Agric. Univ*., **9**(1): 23-24.

Singh, S. and Gangwer, B. (1989). Comparative studies on production potentials in traditional tall and improved rice cultivars. *J. Andaman Sci. Assoc.* **5**(1):81-82.

Singh, Y., Singh, B., Maskinu, M.S. and Meelu, O.P. (1995). Response of wet land rice to nitrogen from cattle manure and urea in a rice-wheat-rotation. *Tropical Agriculture.* **72**(2): 9 1-96.

Singhnia, R.A. and Singh, S. (1986). Effect of manure and nitrogen fertilization on the phosphorus uptake and grain yield of paddy. *Indian. J. Agril. Chem.* **19**(8): 169-172. [Cited from *Field Crop Abst.* **41**(6): 454. 1988].

Subba, R.A, Ganeshamurthy, AN., Sammi, R.K. and Takkar, P.N. (1995). Evaluation of some phospate carriers boron their efficiency in vertic Ustochrept to sustain high productivity of wheat and rice. *J. Indian Soc. Soil. Sci.*, **43**(3): 386-391.

Suprihatno, B. and Sutaryo, .B. (1992). Yield performance of some new rice hybrids in Indonesia. *Intl. Rice Res. Newsl.* **17**(3): 12.

Tandon. H.L.S. (1991). Secondary and Micronutrients in Agriculture. A guide Book-Cum-Directory Crop response and their economics. Fertilizer Development and Consolation Organization. New Delhi. 110. pp. 35-40.

Thind, H.S., Singh, B. and Daol, P.S. (1983). Effect of different levels and methods of nitrogenous fertilizers on the rice grain yield and quality. *Intl. Rice Res. Newsl.* (4): 23.

Tupatkar, P. and Sonar, K.R. (1995). Effect of Pyrite on release of Fe, P and S in a calcarious inceptisol and yield of rice. *J. Indian Soc. Soil. Sci.* **43**(4): 696-698.

Uexkull, V.H.R. (1984). Fertilizer management in wetland soils Potassium paper presented at the IRRI workshop, 26 March-6 April, 1984.

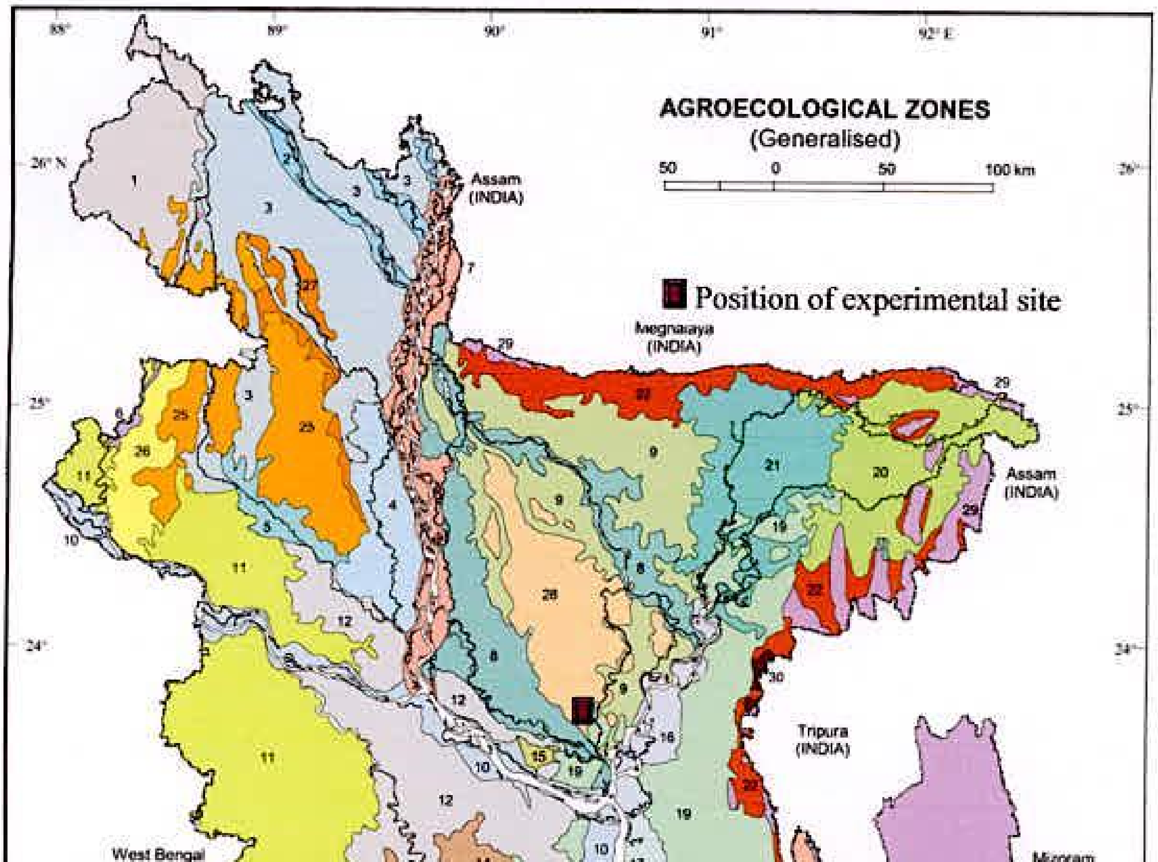
UNDP and FAO. (1988). Land Resources Appraisal of Bangladesh for Agricultural Development, Report No. 2. Agro-ecological Regions of Bangladesh. United Nations Development Programme and Food and Agricultural Organization. BARC, Dhaka. pp. 212-221.

Vergara, B.S., Lilis, R. and Tanaka, A. (1974). Relationship between the length of growing period and yield of rice plants under a limited nitrogen supply. *Soil Sci. Plant. Nutr*. **10**(2): 15-21.

Wagh, R.G. and Throat, S.T. (1988). Response of rice (*Orvza sativa*) variety BR 24 to different times of coastal soils. *J. Indian Soc. Coastal Agril. Res.* **34**(1):33.

APPENDICES

Appendix I. Map showing the experimental site under study



Appendix II. Monthly average relative humidity, air temperature, total rainfall and sunshine hours of Dhaka during *June to December, 2010*

Month	Average RH (%)	Average Temperature (°c)		Total Rainfall (mm)	Average daily Sunshine hours
		Max.	Min.		
June	81	32.1	26.1	340.4	4.7
July	84	31.4	26.2	373.1	3.3
August	80	31.6	26.3	316.5	4.9
September	80	31.6	25.9	300.4	3.0
October	78	31.6	23.8	172.3	5.2
November	77	29.6	19.2	34.4	5.7
December	69	26.4	14.1	12.8	5.5

Source: Bangladesh Meteorology Department (Climate division), Agargaon, Dhaka-1207.

Appendix III. Chemical properties of the initial soil of the experimental site (0-15 cm depth)

Reaction (P^H)	O.M	Total Nitrozen	K	P	S	B	Cu	Fe	Mn	Zn
	%		mlt/100g.soil	ugm/g.soil						
6.7 Nutral	3.29 Medium	0.164 Low	0.40 High	12.5 Low	2.0 Very Low	0.62 High	2.66 Very High	373.1 Very High	72.60 Very High	5.44 Very High

Appendix III. Physical properties of the initial soil of the experimental site (0-15 cm depth)

Soil Texture	Sand	Silk	Clay
	%		
SiL	32	53	15

Source: Soil Resources and Development Institute (SRDI), Khamarbari, Dhaka-1207

Appendix IV. Chemical analysis result of cowdung and compost

Name of manure	Analysis of manure (Result)	Standard value (Bangladesh)
Cowdung	• Colour = Grey • Physical condition =Non-granular form • Odour = Absence of four odour • Organic Carbon = 6.07% • Total Nitrogen (N) = 0.62% • C:N = 9.8:1 • Phosphorus(P) = 0.21% • Potassium (K) = 0.42% • Sulphur (S) = 0.04%	1.Colour = Dark grey to black 2. Physical condition =Non-granular form 3.Odour = Absence of four odour 4.Organic Carbon =10-25% 5. Total Nitrogen (N) = 0.5-4.0% 6. C:N = 20:1 7. Phosphorus (P) = 0.5-1.5% 8. Potassium (K) = 1.0-3.0% 9. Sulphur (S) = 0.1-0.5%
Compost	• Colour = Grey • Physical conditions = Non-granular form • Odour = Absence of four odour • Organic Carbon = 12.93% • Total Nitrogen (N) = 1.02% • C:N = 12.7:1 • Phosphorus(P) = 0.45% • Potassium (K) = 0.57% • Sulphur (S) = 0.172%	• Colour = Grey • Physical condition = Non-granular form • Odour = Absence of four odour • Organic Carbon = 10-25% • Total Nitrogen (N) = 0.5-4.0% • C:N = 20:1 • Phosphorus (P) = 0.5-1.5% • Potassium (K) = 1.0-3.0% • Sulphur (S) = 0.1-0.5%

Source: Soil Resources and Development Institute (SRDI), Khamarbari, Dhaka-1207

Appendix V. Chemical properties of the soil after harvestment of the experimental site

Sample No.	p^H	O.M	Total Nitrozen	K	P	S	Zn	B
				ml/100g.soil				
V_1T_1	5.4 More Acid	1.28 Low	0.010 Very Low	0.20 Medium	16.5 High	12.24 Low	6.4 Very High	0.02
V_1T_2	5.4 More Acid	0.67 Very Low	0.016 Very Low	0.31 High	23.4 Very High	14.35 Low	9.6 Very High	0.07
V_1T_3	5.1 More Acid	0.67 Very Low	0.008 Very Low	0.15 Low	13.8 Optimum	11.05 Low	6.4 Very High	0.49
V_1T_4	5.3 More Acid	0.87 Very Low	0.012 Very Low	0.23 Optimum	19.6 Very High	15.26 Medium	6.2 Very High	0.70
V_1T_5	5.4 More Acid	0.27 Very Low	0.015 Very Low	0.29 Optimum	22.0 Very High	21.04 Low	10.80 Very High	0.30
V_1T_6	5.3 More Acid	1.08 Low	0.016 Very Low	0.32 Optimum	19.3 Very High	14.00 Low	10.00 Very High	0.42
V_1T_7	5.5 More Acid	0.81 Very Low	0.007 Very Low	0.14 Low	16.4 High	15.17 Low	8.2 Very High	0.44
V_1T_8	5.5 More Acid	0.94 Very Low	0.012 Very Low	0.23 Optimum	17.7 High	20.80 Medium	9.0 Very High	0.53
V_1T_9	5.7 Mild Acid	0.87 Very Low	0.013 Very Low	0.26 Optimum	24.1 Very High	10.40 Low	9.0 Very High	0.37
V_2T_1	5.2 More Acid	0.61 Very Low	0.006 Very Low	0.12 Low	15.0 Optimum	13.63 Low	5.4 Very High	0.27
V_2T_2	5.3 More Acid	0.67 Very Low	0.013 Very Low	0.26 Optimum	19.5 Very High	15.38 Low	8.6 Very High	0.57
V_2T_3	5.4 More Acid	0.74 Very Low	0.011 Very Low	0.21 Medium	17.9 High	35.30 Optimum	5.4 Very High	0.57
V_2T_4	5.5 More Acid	0.40 Very Low	0.019 Very Low	0.38 Very High	15.3 High	18.54 Medium	5.2 Very High	0.54
V_2T_5	5.4 More Acid	0.87 Very Low	0.044 Very Low	0.14 Low	20.4 Very High	10.09 Low	9.2 Very High	0.48
V_2T_6	5.7 Mild Acid	0.81 Very Low	0.041 Very Low	0.18 Medium	19.5 Very High	41.16 High	8.0 Very High	0.70
V_2T_7	5.1 More Acid	0.94 Very Low	0.047 Very Low	0.17 Medium	16.0 High	15.10 Low	18.4 Very High	0.01
V_2T_8	5.3 More Acid	0.87 Very Low	0.044 Very Low	0.13 Low	18.8 Very High	10.00 Low	10.0 Very High	0.02
V_2T_9	5.5 More Acid	1.08 Low	0.054 Very Low	0.20 Medium	18.4 High	20.27 Medium	6.0 Very High	0.04

Source: Soil Resources and Development Institute (SRDI), Khamarbari, Dhaka-1207

Appendix VI. Mean square values for plant height of T. aman rice at different days after transplanting (DAT)

Sources of variation	DF	Mean square values at different days after transplanting (cm)					
		25	40	55	70	85	At Harvest
Replication	2	37.27	35.923	86.38	265.37	317.05	362.53
Fertilizer	8	46.92**	315.47**	185.53**	321.20*	296.42**	254.43**
Error (a)	16	9.82	11.95	34.37	100.62	61.38	70.23
Variety	1	1844.51**	2710.23**	5789.58**	11051.04**	1775.38**	1734.0**
variety × Fertilizer	8	9.24	61.99	31.58**	21.09**	13.97**	27.48**
Error (b)	18	6.59	17.69	32.70	45.14	50.81	47.84

**Significant at 1% level

Appendix VII. Mean square values for total tiller number hill^{-1} of T. aman rice at different days after transplanting (DAT)

Sources of variation	DF	Mean square values at different days after transplanting (no.)					
		25	40	55	70	85	At harvest
Replication	2	0.60	14.90	22.56	0.41	3.54	0.17
Fertilizer	4	11.75**	6.94**	12.97**	13.75**	7.33**	12.07**
Error (a)	8	0.46	1.85	2.35	2.68	1.87	1.30
Variety	1	3.33**	23.47**	109.23**	23.73**	24.54**	23.73**
variety × Fertilizer	8	0.31**	4.23**	5.45	0.93**	3.03**	0.82**
Error (b)	20	0.33	1.98	2.58	1.97	3.47	1.76

**Significant at 1% level

Appendix VIII. Mean square values for yield contributing characters of T. aman rice varieties

	DF	Mean square values at different days after transplanting						
		panicle Length (cm.)	Effective Tiller Hill^{-1} (no.)	Non Effective tiller hill^{-1} (no.)	Total Grains Panicle-1 (no.)	Filled Grain panicle^{-1} (no.)	Unfilled Grain panicle^{-1} (no.)	1000 Seed Weight (g)
Replication	2	0.06	0.32	0.006	146.69	193.41	336.80	0.00
Fertilizer	4	8.00**	35.37**	14.10**	2524.60**	3792.41	130.52**	0.01**
Error (a)	8	0.07	0.59	0.03	12.25	14.39	1.80	0.00
Variety	1	36.51**	49.27**	5.99**	31828.17**	38667.13**	332.52**	115.05**
variety × Fertilizer	8	0.28**	2.85	1.15**	85.92**	93.63**	0.27**	0.002**
Error (b)	20	0.06	2.77	0.04	16.78	10.80	4.35	0.00

*Significant at 5% level

**Significant at 1% level

Appendix IX. Mean square values for grain yield, straw yield, biological yield and harvest index of T. aman rice

Sources of variation	Degrees of freedom	Mean square values			
		Grain yield ($t\ ha^{-1}$)	Straw yield ($t\ ha^{-1}$)	Biological yield ($t\ ha^{-1}$)	Harvest index (%)
Replication	2	0.03	0.01	0.07	0.68
Fertilizer	4	3.88**	1.99**	11.38**	52.29**
Error (a)	8	0.002	0.001	0.004	0.08
Variety	1	54.96**	11.89**	117.99**	1242.53**
variety × Fertilizer	8	0.63**	0.16**	1.34**	1.37**
Error (b)	20	0.002	0.001	0.004	0.04

*Significant at 5% level

**Significant at 1% level

শেরেবাংলা কৃষি বিশ্ববিদ্যালয় গ্রন্থাগার
সংযোজন নং 165
স্বাক্ষর ... তাং 4.2.13

Sher-e-Bangla Agricultural University
Library
Accession No 37147
Sign: Date: 31-10-13