EFFECT OF FERTILIZER AND MANURE APPLICATION ON YIELD AND YIELD COMPONENTS OF RICE AND LEACHING LOSS OF NUTRIENTS THROUGH UNDISTRUBED SOIL COLUMNS

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This is to certify that the thesis entitled, **"EFFECT OF FERTILIZER AND MANURE APPLICATION ON YIELD AND YIELD COMPONENTS OF RICE AND LEACHING LOSS OF NUTRIENTS THROUGH UNDISTRUBED SOIL COLUMNS"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN SOIL**, embodies the result of a piece of *bona fide* research work carried out by **MD. ASHRAFUL ISLAM**, Registration No. **06-02088** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

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TO

MY BELOVED PARENTS

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ABSTRACT

The experiment was conducted in a net house of Soil Science Department at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from July 2011 to April 2012 to study the effect of fertilizer and manure application on yield and yield components of rice and leaching loss of nutrients through undisturbed soil columns. The experiment consists of 2 factors i. e. soils and fertilizer plus manure. Two levels of soils (S_1= SAU Soil and S_2= Sonargaon Soil) with 4 levels of fertilizer plus manure, as T_0: Control, T_1: 100% $N_{120}P_{20}K_{45}S_{20}$ (Recommended dose), T_2: 50% NPKS + 5 ton cowdung/ha, T_3: 50% NPKS + 2.1 ton poultry manure/ha. were imposed during T.Aman and boro rice season. T. Aman (BR11) and Boro rice (BRRI dhan29) were grown in the soil cores and fertilizer and manure treatments were applied to the soils. There were 8 treatment combinations and 3 replications. Results revealed that soil had no significant effect on the yield and yield parameters. The yield contributing characters and yields were significantly affected by fertilizer and manure application. During T.Aman season, the highest effective tillers/core (17.00), plant height (105.57 cm), panicle length (23.70 cm), grain yield (0.046 kg/core) and straw yield (0.053 kg/core) were found from T_1 (RDCF) treatment. The highest 1000 grain wt. (23.70 g) was obtained from T_2 and filled grain/panicle (121.83) from T_3 treatment and the lowest in T_0 treatment. The highest grain yields was found by the application of Recommended dose of chemical fertilizer which was statically similar to T_3 treatment. The combined effects of soil and fertilizer were not significant but the highest grain (0.049 kg/core) and straw yields (0.056 kg/core) were recorded from S_2T_1 (Sonargaon Soil + 100% NPKS) and the lowest (0.010 kg/core) from S_1T_0 (SAU Soil) treatment combination. Leachate samples were collected at 25, 35, 45, 55, 65 and 75 days after transplantation of T. Aman rice and analyzed for N, P, K and S by using standard analytical method. The N concentration in the leachate during varied significantly with different soil, fertilizer treatment and time.

The higher N concentrations were found in the leachate of SAU (S_1) soil compared to Sonargaon soil. Higher leachate K concentrations were found in Sonargaon soil compared to SAU soil. Among the fertilizer treatments, significantly higher concentrations of K were found in the leachate of 100% chemical fertilizer treatment compared to other. Higher S concentrations were found in the leachate of SAU soil compared to Sonargaon soil. The Boro rice grain nutrient concentrations were significantly affected by the application of fertilizer and manure. The highest concentrations of grain N (1.205%), P (0.261%), K (0.296%) were recorded from T_2 and concentration of S (0.125%) was highest from T_1 treatment and lowest from T_0 treatment. The higher nutrient concentrations were recorded in S_1T_3, S_1T_2, S_2T_2, S_2T_1, treatment combination. After harvest of Boro rice, the post-harvest soil samples were collected from the soil cores up to 20 cm depth at 10 cm intervals. Similarly, highest grain and straw yields of boro rice were obtained from T_1 treatment which was statically similar to T_2 and T_3 treatment. The levels of pH and nutrient concentration were increased in the post harvest soils where manure plus inorganic fertilizer were used.

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CHAPTER I

INTRODUCTION

CHAPTER I

INTRODUCTION

The depleted soil fertility is a major constraint to higher crop production in Bangladesh. The increasing land use intensity has resulted in a great exhaustion of nutrients in soils. Rice-rice system is the most important cropping system in Bangladesh. Continuous cultivation of this highly exhaustive cropping sequence in most of the irrigated fertile lands has resulted in the decline of soil physio-chemical condition in general and particularly soil organic matter (SOM) content.

It will, therefore, be necessary to place greater emphasis on strategic research to increase the efficiency of applied nutrients through integration with organic manures, which will help in accomplishing twin objectives of sustaining soil health and ensuring food security and environmental protection.

Application of manure and fertilizer affects the nutrient movement in soil. The available nutrient moves downward with percolated water. The bioavailability, uptake and movement of nutrients in soil are dependent on a number of factors including the source and concentration of the nutrient, soil properties such as clay content, pH and redox conditions, ions and type and amount of organic matter. The mobility of nutrient through percolated water was evaluated by this experiment and the effect of manure and fertilizer on the growth and yield of Boro and T. Aman rice were evaluated. The efficiency of used fertilizers in the rice field is greatly affected by the level of soil moisture during rice growing periods. Organic matter decomposition and nutrients mineralization are greatly affected by the soil moisture level. Anaerobic conditions in paddy soil leads to mobilization of some nutrients and thus affects nutrients bio availability to rice plants.

The transport of N, P, K and S in soil as well as its uptake by plants is governed by the difference of soil and the variation of added fertilizer. Yang et al. (2004) reported that application of chemical fertilizers with farmyard manure increased N,P and K uptake by rice plants and increased 1000 grain weight and grain yield of rice. The mobility of N, P, K and S in soil is still not thoroughly understood. Little work has been done on the fate of applied fertilizer and manure during rice culture through undisturbed soil columns. To increase the efficiency of manure and fertilizer in rice cultivation, it is necessary to identify the suitable level and type of manure and fertilizer. The fate of added fertilizer in the soil column and estimation of nutrient leaching is a new idea of research. Soil is a heterogenous system, it is important to carry out studies to understand the fate of applied fertilizers in soil systems.

OBJECTIVES:

The objectives of the present study were :

i) To determine the movement of N,P,K and S through leaching with different fertilizer management systems.

ii) To determine the distribution of added fertilizer plus manure in different depths of soil column under different fertilizer management with rice culture.

iii) To evaluate the effect of soil, fertilizer and manure on the yield and quality of Boro and T.Aman rice.

iv) To evaluate the fertility of post-harvest soils with variation of soils ,fertilizer and manure treatment.

CHAPTER II
REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

Soil organic manure and inorganic fertilizer are the essential factor for sustainable soil fertility and crop productivity because organic matter is the store house of plant nutrients. Sole and combined use of cow dung, poultry manure and inorganic fertilizer acts as a source of essential plant nutrients. Experimental evidences in the use of cow dung, poultry manure, and nitrogen, phosphorus, potassium and sulphur showed an intimate effect on the yield and yield attributes of rice. Yield and yield contributing characters of rice are considerably influenced by different doses of NPKS fertilizer, cow dung, poultry manure and their combined application. The fate of fertilizer and manure in undisturbed soil column will be affectd by the variation of soils. The movement and concentrations of N,P,K and S in undisturbed soil columns will be influenced with the application of different manure and fertilizer. Some literature related to the "Effect of fertilizer and manure on the N,P,K and S movement and yield of rice in undisturbed soil columns of different soils" are reviewed below-

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

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

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

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

Haq *et al.* (2002) conducted an experiment with twelve treatments combination of N, P, K, S, Zn and Diazinon. They found that all the treatments significantly increased the grain and straw yields of BRRI dhan 30 rice over control. 90 kg N + 50 kg P_2O_5 +

40 kg K_2O + 10 kg S + 4 kg Zn ha^{-1} + diazinon gave the highest grain and straw yields.

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

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

Phaev *et al.* (2003) concluded that freshly applied P increased rice grain yield by 95%. In the first and second crops using residual P fertilizer, yields increased by 62 and 33% relative to the nil-P plot. Cumulative removal of P in four successive rice crops accounted for 30 and 55% of the 16.5 kg/ha in the form of harvested grain and whole plants.

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

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

Saleque *et al.* (2005) found a linear relationship between P uptake and total system productivity which supports the concept that TSP depend to some extent on P availability. Phosphorus application increased rice yield in different seasons where the highest response in P was in Aus and Boro than T. Aman.

Rahman *et al.* (2007) conducted a field experiment using rice (cv. BRRI dhan 29) as a test crop and found that application of S had a significant positive effect on tillers/hill, plant height, panicle length and grains/panicle. They also indicated that application of S fertilizer at a recommended rate (20kg S/ha) might be necessary for obtaining higher grain yield as well as straw yield of Boro rice (cv BRRI dhan 29).

Ndaeyo *et al.* (2008) conducted an experiment in Nigeria with five rice varieties (WAB340-8-8-2HI, WAB881-10-37-18-8-2-HI, WAB99-1-1, WAB224-8-HB, WAB189-B-B-B-8-HB) and four rates of NPK (15:15:15) fertilizer (0, 200, 400 and 600kg/ha). The results showed that 600kg/ha NPK (15:15:15) fertilizer rate significantly ($P < 0.05$) increased plant height, number of leaves and tillers per plant in both years. The 400kg/ha rate increased the number of panicles per plant, length of central panicle per plant and the overall grain yield, straw yield over other rates by 4-32% and 2-21% in 2005 and 2006, respectively.

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

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

2.2.1 Combined effect of chemical fertilizer and cowdung on the growth and yield of rice

Mannan *et al.* (2000) reported that manuring with cowdung up to 10 t/ha in addition to recommended inorganic fertilizers with late N application improved grain and straw yields and quality of transplant aman rice over inorganic fertilizer alone.

Saitoh *et al.* (2001) conducted an experiment to evaluate the effect of organic fertilizers (cowdung and poultry manure) and pesticides on the growth and yield of rice and revealed that the yield of organic manure treated and pesticide free plots were 10% lower than that of chemical fertilizer and pesticide treated plot due to a decreased in the number of panicle. Yearly application of manure increased the total carbon and nitrogen content in soil.

Dao and Cavegelli (2003) reported that animal manure had long been used as an organic source of plant nutrients and organic matter to improve the physical and fertility condition of agricultural lands.

Tripathy *et al.* (2004) found significantly higher seed yield under the residual effects of the blended cowdung and NPK fertilizer compared to the control.

Saleque *et al.* (2004) conducted a field experiment to determine the effect of different doses of chemical fertilizers alone or in combination with cowdung and rice husk ash on yield of lowland rice-rice cropping sequence. Cowdung and ash were applied on dry season rice only and found the application of cowdung and ash increased rice yield by about 1 t/ha per year over that obtained with chemical fertilizer alone, the treatments, which showed positive yield trend, also showed positive total P uptake trend and positive yield trends were attributed to the increasing P supplying power of the soil.

Saleque *et al.* (2004) showed that application of one third of recommended inorganic fertilizers with 5 t cowdung increased the low land rice yield than other treatments and gave yield 8.87t ha^{-1}.

Rahman *et al.* (2009) conducted a field experiment to study the effect of urea N in combination with poultry manure and cowdung in rice and found application of manures and different doses of urea N fertilizer significantly increased the yield components and grain and straw yields.

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

Channbasavana and Biradar (2001) reported that the application of poultry manure @ 3 t/ha gave 26% and 19% higher grain yield than that of the control 1998 and 1999, respectively.

Eneji *et al.* (2001) observed that average across the soils, the level of extractable Fe increased by 5% in chicken manure and 71% in cattle manure; Mn by 61% in chicken manure and 172% in swine manure; and Cu by 327% in chicken manure and 978% in swine manure. Mixing these manures before application reduce the level of extractable trace elements.

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

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

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

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

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

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

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

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

2.3 Movement of N, P, K and S in soil

Savin et al. (2005) carried out a research study to determine just how far flood water moves fertilizer-N into silt-loam soil and to evaluate the short-term distribution of fertilizer-N following incorporation. They concluded that immediate and deeper movement into silt loam soil of urea applied N as compared to ammonium sulphate-applied N,but also raise concerns about the movement of urea-applied N if urea breaks down to ammonium at the soil surface before the flood water can incorporate fertilizer into the soil.

Michael and Nancey (2000) conducted a study to determine the influence of recommended N fertilizer rate and timing on N movement in soil during the growing season. They found that for irrigated wheat in Arizona, most of the N fertilizer recovered in the top 2.4 of soil was in the surface soil, regardless of N fertilizer practices.

Anderson and Magdoff (2005) found that repeated application of organic forms of P could lead to significant leaching of P to ground water.

Jalali and Rowell (2009) concluded that "When applied K was displaced with the distilled water K was retained in the top 10 -12.5 cm depth of soil. In the undisturbed soil cores there is possibility of preferential flow and lack of K sorption. The application of gypsum and $CaCl_2$ in the reclamation of sodic soil would be expected to leach K from soils.

Abimbola et al. (2010) found that P could be lost through leaching especially at high rate of manure application.Irrigation activity enhanced in situ movement of P down the soil profile.

Mingde et al.(2010) conducted that when the high intensity of precipitation and porous soils play an important role in the accumulation of NO_3-N in soil and its subsequent leaching in the soil profile.

2.4. Changes in soil fertility and properties due to integrated use of fertilizers with manure

Nimbiar (1997 b) views that integrated use of organic manure and chemical fertilizers would be quite promising not only in providing greater stability in production, but also in maintaining healthy soil fertility status. Intensive crop production systems have witnessed serious problems associated with loss of soil fertility as a result of excessive soil mining of plant nutrients and consequently reduction in productivity. Application of external source of plant nutrients is a key element in optimal management of soil organic matter, crop residues and manure for ensuring the bio-availability, the cycling and the balance of nutrients in the soil - plant systems.

Mathew and Nair (1997) reported that cattle manure when applied alone or in combination with chemical fertilizer (NPK) increased the organic C content, total N, available P and K in rice soils.

Xu *et al.* (1997) observed that application of organic matter affect soil pH value as well as nutrient level. They also reported that organic carbon, total N and available P_2O_5, K_2O, S and Zn in the soil were higher in the plots where nutrients were applied through organics than the inorganic sources.

Santhi *et al.* (1999) observed that application of 100% NPK plus FYM decreased the bulk density and increased the water holding capacity of soil. The decreased in bulk density in FYM treated plots might be ascribed to better aggregation. The water holding capacity was increased due to the improvement in structural condition of soil that was brought about mainly by the application of FYM in combination with NPK fertilizers.

Hemalatha *et al.* (2000) revealed that green manure significantly increased the soil fertility status, organic carbon, available soil N, P and K at post harvest soil. They also reported that chemical properties like organic matter content CEC, total N, exchangeable K, available P and S were favorably influenced by the application of organic sources of nitrogen and potassium while the organic sources mostly did not show positive effect. Soil pH decreased slightly compared to the initial status.

Aggelides and Londra (2000) conducted that the amendment compost improved all physical properties under consideration in the soils. The improvements were proportional to the compost rate. The results supported the bulk density and penetration resistances were reduced. The reduction was greater in the loamy soil than in the clay soil. Mean weight diameter of the aggregates was reduced in both soils, while aggregate stability was increased.

Ayoola and Makinde (2009) concluded that after two years of application and cropping, enriched poultry manure increases soil N, P and K contents by 41.7%, 1.8% and 20.7%, respectively while fortified cowdung increases the nutrients by 25%, 0.33% and 3.4%, respectively, Although both organic manures increased the soil N and P, poultry manure gave higher values while the soil K, Ca and Mg contents were more increased with the cowdung than poultry manure.

The literature review discussed above indicates that organic manure can supply a good amount of plant nutrients and thus can contribute to crop yields. The properties of soils are also influenced by the inclusion of organic manure and crop residues in the soil fertility management system either directly or through residual action. The integrated approach by using the organic and inorganic sources of nutrients helps to improve the efficiency of nutrients. Hence, an effort should be undertaken to investigate the effect of integrated nutrient management and irrigation on subsistance of crop productivity and maintenance of soil fertility in a rice cropping.

CHAPTER III

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

The experiments were carried out during the T.Aman and Boro seasons of 2011-2012 to evaluate the movement of nutrient in undisturbed soil columns with rice culture. The details of the materials and methods employed during the course of this investigation are presented in this chapter.

3.1. Effect of soil and fertilizer on the yield parameters and yield of T.Aman rice

3.1.1. Undisturbed soil core collection

Two different types of undisturbed soil cores were collected from the SAU farm and Narayanganj district during July, 2011.Twenty four (2 soils x 4 fertilizer treatment x 3 replication) undisturbed soil cores (25cm diameter and 40 cm length) were collected in pvc pipes. Initial soil samples were collected from each site at 10 cm intervals of (0-40 cm) pit and analyzed for physio-chemical properties. The soil was taken from a rice cultivated farm with a homogenous soil. The polyvinyle choride (PVC) pipe were pushed to the soil by creating pressure inside pipe wall and by adding water in the soil. The soil cores were transferred to the net house and processed for setting on the plastic container.

3.1.2. Experimental Site

The experiment was conducted in a net house of Soil Science Department at Sher-E-Bangla Agricultural University (SAU), Dhaka during July, 2011 to April, 2012.

3.1.3. Climate

The climate of the experimental area is characterized by high temperature, high humidity and medium rainfall with occasional gusty winds during the *kharif* season (March-September) and a scanty rainfall associated with moderately low temperature in the *rabi* season (October-March). The weather information regarding temperature, rainfall, relative humidity and sunshine hours prevailed at the experimental site during the cropping season July 2011 to April 2012 have been presented in Appendix I.

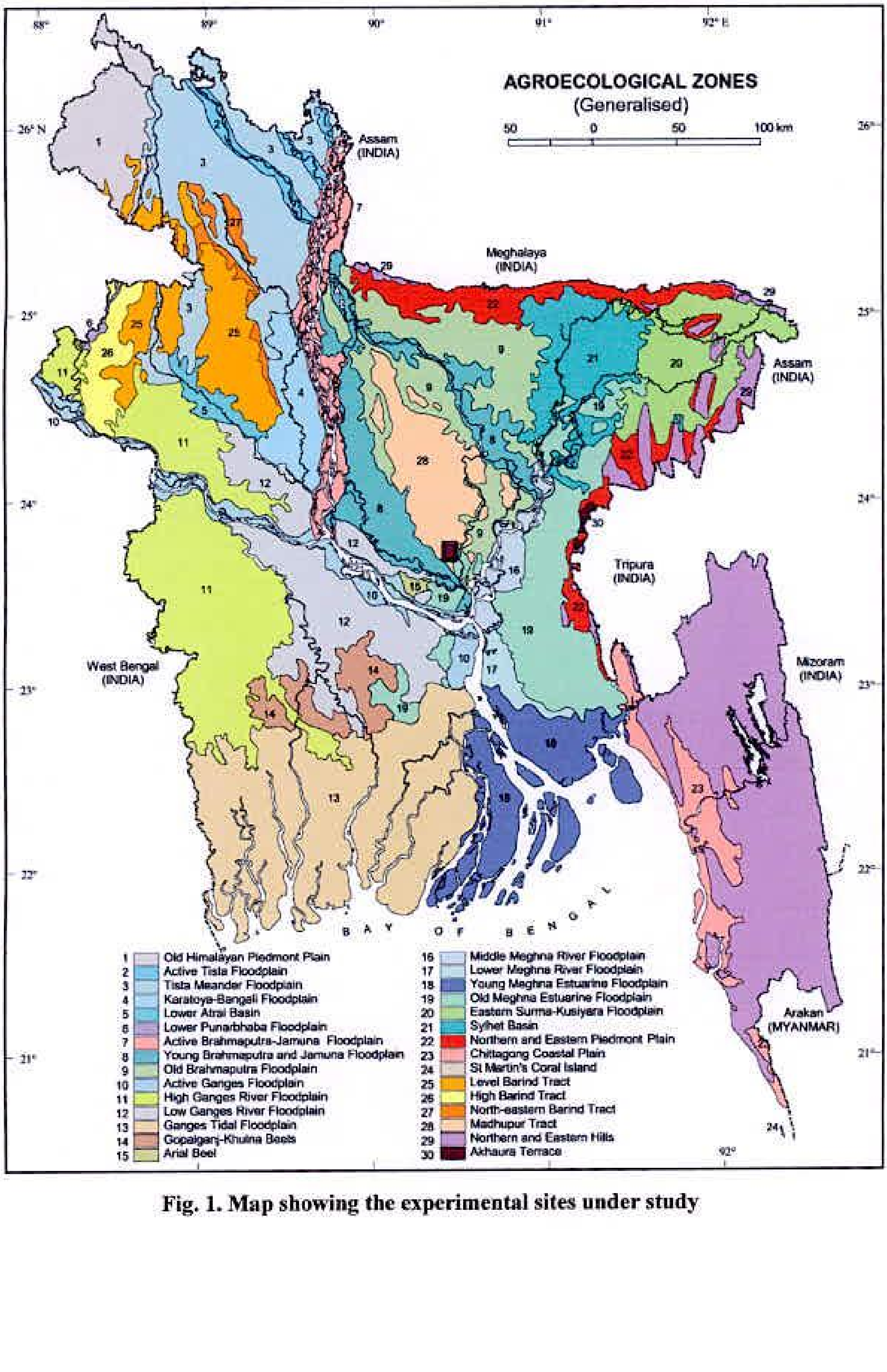

Fig. 1. Map showing the experimental sites under study

3.1.4. Experimental set-up

Whatman filter papers, glass wool and a layer of (2 cm) acid washed silica sand sieved to 1-2 mm were placed at the bottom of the perforated plastic containers where soil cores were placed. Two holes of the plastic container were connected with a conical flask by two plastic pipes via glass T tube (Fig. 2). Two glass tubes were inserted through the cork placed on the neck of the conical flask and grease was used for make it air tight. Then, the long glass tube of the conical flask was connected with the holes of the plastic container by plastic pipe via glass T tube.

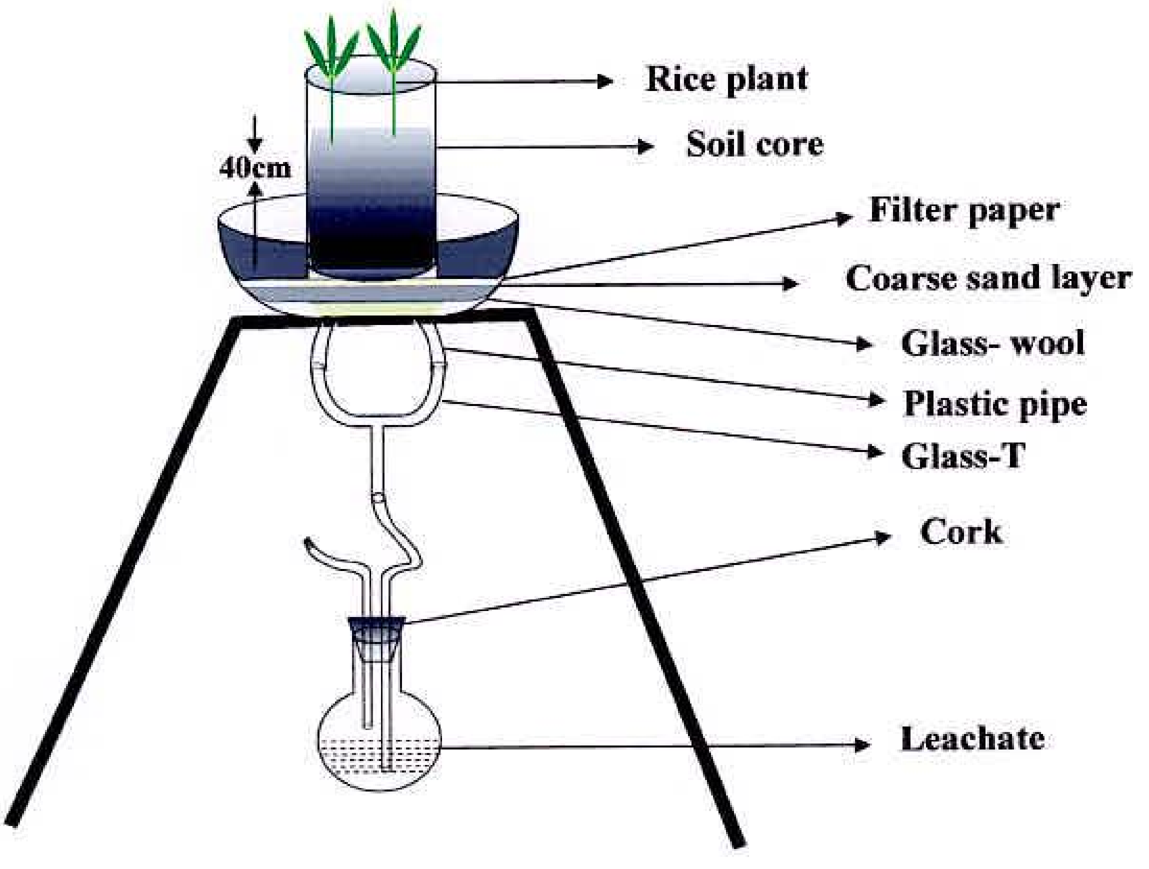

Fig. 2. Leachate collection from undisturbed soil core with fertilizer and manure application in T.Aman rice.

3.1.5. Planting material

BR11 was used as the test crop in this experiment which is recommended for T.Aman season. BRRI dhan29 was used as the test crop in this experiment. It is recommended for *Boro* season. This two variety was developed at the Bangladesh Rice Research Institute (BRRI).

3.1.6. Experimental design and layout

The experimental design was a Randomized complete block design (RCBD) with two factors and three replicates for each treatment. The distance maintained between core to core and row to row were 40 cm and 1m respectively.

R_1	R_2	R_3
S_1T_0	S_1T_0	S_1T_0
S_1T_1	S_1T_1	S_1T_1
S_1T_2	S_1T_2	S_1T_2
S_1T_3	S_1T_3	S_1T_3
S_2T_0	S_2T_0	S_2T_0
S_2T_1	S_2T_1	S_2T_1
S_2T_2	S_2T_2	S_2T_2
S_2T_3	S_2T_3	S_2T_3

Fig. 3 : Layout of the experiment in net house.

3.1.7. Initial soil sampling

Initial soil samples were collected from 40 cm depth at 10 cm intervals from SAU campus, Dhaka and another from Sonargaon, Narayanganj. The composite soil sample were air-dried, crushed and passed through a 2 mm (8 meshes) sieve. After sieving, the soil samples were kept in a plastic container for physical and chemical analysis of the soil.

3.1.8. Treatments

Factor A- soil

Soil-1 (SAU Soil)

Soil-2 (Sonargaon Soil)

Factor B (Fertilizer and manure)

(T_0) Control

(T_1) Recommended dose of fertilizer ($N_{120}P_{20}K_{45}S_{20}$).

(T_2) 50% NPKS + 5 ton cowdung ha^{-1}

(T_3) 50% NPKS + 2.1 ton poultry manure

3.1.9. Fertilizer and Manure application

Fertilizer and manure treatments were applied in the soils of the core during the T.Aman cultivation. The treatment wise required amounts of manures and N, P, K and S fertilizers per core were applied by considering the soil weight of 0-15cm depth. Full amounts of manure, TSP, MP and gypsum were applied at final land preparation before transplanting of rice seedlings. Urea was applied in 3 equal splits: one third was applied at basal before transplanting, one third at active tillering stage (30 DAT) and the remaining one third was applied at 5 days before panicle initiation stage (55 DAT). Chemical compositions of the manures used have been presented in (Table 3.2).

Table 3.1. Chemical compositions of the cowdung and poultry manure (oven dry basis)

Sources of organic manure	Nutrient content			
	N (%)	P (%)	K (%)	S (%)
Cowdung	1.46	0.29	0.74	0.24
Poultry manure	2.2	1.99	0.82	0.29

3.1.10. Seedlings preparation

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

3.1.11. Transplanting

Thirty days old T.Aman seedlings of BR11 were carefully uprooted from the seedling nursery and transplanted on Ist week of July, 2011. Two seedlings for one hill (BR11) were transplanted in the core. After one week of transplanting all soil cores were checked for any missing seedlings, which were filled up with extra seedlings whenever required.

3.1.12. Irrigation management of soil

Traditional irrigation (2-3 cm continuous flooding) was applied on the soils of the core as and when required during the growing period of T.Aman rice crop.

3.1.13. Intercultural operations

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

3.1.14. Weeding

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

3.1.15. Insect and pest control

There was no infestation of diseases in the field but leaf roller (*Chaphalocrosis medinalis*, Pyralidae, Lepidoptera) was observed in the field and used Malathion @ 1.12 L ha^{-1}.

3.1.16. Crop harvest

The T.Aman crop was harvested at full maturity when 80-90% of the grains were turned into straw colored on November, 2011. The crop was cut at the ground level. After harvest, the rice yield parameters and yield were recorded.

3.1.17. Total no. of effective tiller/core

The total number of effective tiller/core was counted as the number of panicle bearing hill/plant. Data on effective tiller/hill were counted from the hill of the core and average value was recorded.

3.1.18. Plant height

The height of plant was recorded in centimeter (cm) at harvesting stage. Data were recorded as the average of all the plants selected at random from the inner rows of each core. The height was measured from the ground level to the tip of the panicle.

3.1.19. Length of panicle

The length of panicle was measured with a meter scale from all the plants of core and the average value was recorded as per plant.

3.1.20. No. of filled grain per panicle

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

3.1.21. Weight of 1000 seeds

One thousand seeds were counted randomly from the total cleaned harvested seeds and then weighed in grams and recorded.

3.1.22. Straw yield

Straw obtained from each core (g/core) were sun-dried and weighed carefully.

3.1.23. Grain yield

Grains obtained from each core (g/core) were sun-dried and weighed carefully.

3.1.24. Soil analysis

Soil samples were analyzed for both physical and chemical characteristics viz. texture, pH, total N and available P, K, and S contents. The soil samples were analyzed by the following standard methods as follows:

3.1.25. Textural class

Mechanical analysis of soil were done by hydrometer method (Bouyoucos, 1926) and the textural class was determined by plotting the values of % sand, % silt and % clay to the Marshall's triangular co-ordinate following the USDA system.

3.1.26. Soil pH

Soil pH was measured with the help of a glass electrode pH meter, the soil water ratio being maintained at 1: 2.5 (Jackson, 1962).

3.1.27. Total nitrogen

Total N content of soil were determined followed by the Micro Kjeldahl method. One gram of oven dry ground soil sample was taken into micro kjeldahl flask to which 1.1 gm catalyst mixture (K_2SO_4: $CuSO_4$. $5H_2O$: Se in the ratio of 100: 10: 1), and 7 ml H_2SO_4 were added. The flasks were swirled and heated 160 ^{0}C and added 2 ml H_2O_2 and then heating at 360 ^{0}C was continued until the digest was clear and colorless. After cooling, the content was taken into 50 ml volumetric flask and the volume was made up to the mark with distilled water. A reagent blank was prepared in a similar manner. These digests were used for nitrogen determination (Page *et al.*, 1982).

Then 20 ml digest solution was transferred into the distillation flask, Then 10 ml of H_3BO_3 indicator solution was taken into a 250 ml conical flask which is marked to indicate a volume of 50 ml and placed the flask under the condenser outlet of the distillation apparatus so that the delivery end dipped in the acid. Add sufficient amount of 10N-NaOH solutions in the container connecting with distillation apparatus. Water runs through the condenser of distillation apparatus was checked. Operating switch of the distillation apparatus collected the distillate. The conical flask was removed by washing the delivery outlet of the distillation apparatus with distilled water.

Finally the distillates were titrated with standard 0.01 N H_2SO_4 until the color changes from green to pink.

The amount of N was calculated using the following formula:

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

Where,

T = Sample titration (ml) value of standard H_2SO_4

B = Blank titration (ml) value of standard H_2SO_4

N = Strength of H_2SO_4

S = Sample weight in gram

3.1.28. Available phosphorus

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

3.1.29. Available potassium

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

3.1.30. Available sulphur

Available S content was determined by extracting the soil with $CaCl_2$ (0.15%) solution as described by (Page *et al.* 1982). The extractable S was determined by developing turbidity by adding acid seed solution (20 ppm S as K_2SO_4 in 6N HCl) and $BaCl_2$ crystals. The intensity of turbidity was measured by spectrophotometer at 420 nm wavelengths.

3.2. Effect of soil and fertilizer on the movement of N, P, K and S through undisturbed soil column

3.2.1. Lechate collection methodology

An experiment involving 2 soils and 4 fertilizer treatments were applied in undisturbed soil columns during 2011-2012, with T.Aman and Boro growning season in sequence, to examine the effect of added fertilizer and manure on rice culture.

This experiment was started during T. Aman season of the year 2011. Total 24 (2 soil x 4 fertilizer and manure x 3 replications=24) undisturbed soil cores (25 cm diameter and 40 cm length) were collected in the PVC pipe and placed in the net house. Initial soil samples were collected from 40 cm depth at 10 cm intervals. Twelve undisturbed soil cores were collected from SAU campus and another 12 soil samples from Narayanganj. The soil collection area of SAU is located at 24.75 latitude and 90.50^0E longitude. Whatman filter papers nylon cloth, Glasswool and a layer of acid washed sand sieved to 1-2 cm were placed on the perforated plastic containers. Soil cores were placed on the plastic containers. Two holes of the plastic container were connected with air tight conical flask by two plastic pipes via glass T. tube. Fertilizer and manure treatments were applied in the soils of the core during the T. Aman and Boro season. The treatment were control (T_0), recommended dose of fertilizer (T_1:$N_{120}P_{20}K_{45}S_{20}$), 50% NPKS + 5 ton Cowdung ha^{-1} (T_2), 50% NPKS+2.1 ton poultry manure/ha (T_3).

Table 3.2. Some physicochemical properties of initial soils (0-15cm) of SAU and Sonargaon

Characteristics	SAU Soil	Sonargaon Soil
Textural class	Silt Loam	Silty clay loam
pH	6.4	7.3
Organic C (%)	0.686	1.01
Total N (%)	0.062	0.073
Exchangeable K (cmol kg^{-1})	0.12	0.23
Available P (mg kg^{-1})	19.85	12.00
Available S (mg kg^{-1})	14.40	16.00

3.2.2. Leachate sample collection and analysis

Leachate samples were collected at 25, 35, 45, 55, 65 and 75 days after transplantation of T. Aman rice and analyzed for N, P, K and S by using standard analytical method. The leachate samples were analyzed for N, P, K and S concentrations. The analytical methodology of N,P,K and S have been mentioned in the previous section (3.1).

3.3. Effect of soil and fertilizer on the yield parameter, yield and grain nutrient concentration in Boro rice

3.3.1. Experimental methodology

Boro rice (BRRI dhan29) was grown in the same cores to know the effects of residual and renewal application of fertilizer and manure treatment on the second crop Boro rice during December 2011 to April 2012. After harvest Boro rice (2nd crop), the yield and yield parameters were recorded according to the methods followed in previous crop T.Aman rice. The details methodology of the experiment have been discussed in the previous section (3.1). Same treatment and methodology were applied in the Boro rice cultivation. Fertilizer and irrigation was applied during the growing season but leachate was not collection for analysis. The data of yield and yield parameters were taken the similar way and the grain samples were analyzed for N,P,K and S.

3.3.2. Collection and preparation of plant samples

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

3.3.3. Digestion of plant samples with sulphuric acid for N determination

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

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

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

3.3.5. Determination of Phosphorus

Grain samples were digested by diacid (Nitric acid and Perchloric acid) mixture and P content in the digest was measured by blue color development (Olsen *et al.*, 1954). Phosphorus in the digest was determined by using 1 ml for grain sample from 100 ml digest by developing blue color with reduction of phosphomolybdate complex and the color intensity were measured colorimetrically at 660 nm wavelength and readings were calibrated with the standard P curve (Page *et al.*, 1982).

3.3.6. Determination of Potassium

Five milli-liter of digest sample for the grain were taken and diluted 50 ml volume to make desired concentration so that the flame photometer reading of samples were measured within the range of standard solutions. The concentrations were measured by using standard curves.

3.3.7. Determination of Sulphur

Sulphur content was determined from the digest of grain samples as described by Page *et al.* (1982). The digested S was determined by developing turbidity by adding acid seed solution (20 ppm S as K_2SO_4 in 6N HCl) and $BaCl_2$ crystals. The intensity of turbidity was measured by spectrophotometer at 420 nm wavelength (Hunter, 1984).

3.4. Effect of fertilizer and manure on the change of chemical properties of post harvest soil

After harvest of Boro rice (BRRI dhan29), the post-harvest soil samples were collected from the soil cores upto 20 cm depth at 10 cm intervals. Soil samples of each core were air-dried, crushed and passed through a two mm (10 mesh) sieve. The analytical methodology have been mentioned in the previous section (3.1). The soil samples were kept in plastic container to determine the physical and chemical properties of soil.The soil samples were analyzed for N,P,K,S and pH.

3.5. Statistical analysis

The data obtained for different parameters were statistically analyzed to find out the significant difference of different treatments on yield and yield contributing characters of BR11 and BRRI dhan29. The mean values of all the characters were calculated and analysis of variance was performed by the 'F' (variance ratio) test. The significance of the difference among the treatment means was estimated by the Duncan's Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

The results of different yield attributes, yield of Boro, T.Aman rice, leachate, post harvest soils and grain nutrient concentrations are presented this chapter.

4.1. Effect of soil and fertilizer on the yield parameters and yield of T.Aman rice

4.1.1. Effective tiller of T.Aman rice

4.1.1.1. Effect of soils on the effective tillers/core of T. Aman rice

The effects of soils on the effective tillers/core of rice are presented in (Table 4.1). Results revealed that variation in the number of effective tillers/core of rice was not significantly different in two different soils. Between these two soils, S_1 (SAU Soil) showed the higher (12.42) number of effective tillers/core) and S_2 (Sonargaon Soil) soil showed lower (11.76) number of effective tillers/core.

4.1.1.2. Effects of different doses of fertilizer and manure on the effective tillers/core of T. Aman rice

Different doses of fertilizers showed significant variations in respect of effective tillers/core of rice (Table 4.2). Among the different doses of fertilizers T_1 (RDCF) showed the highest (17.00) number of effective tillers/core. On the contrary, the lowest (6.33) number of effective tillers/core was observed with T_0 where no fertilizer was applied. Nayak *et al.* (2007) reported a significant increase in effective tillers/hill due to application of chemical fertilizer with organic manure. Similar results were also found by Rahman *et al.* (2009) and Reddy *et al.* (2005).

4.1.1.3 Interaction effect of fertilizer and soils on the number of effective tillers/core of T.Aman rice

The combined effect of different doses of fertilizer and soils on the number of effective tillers/core of rice was significant Table 4.3. The highest (18.00) number of effective tillers/core of rice was recorded with the treatment combination S_2T_1 (Sonargaon Soil + RDCF) which was statically similar to S_1T_1 treatment combination. On the other hand, the lowest (6.33) number of effective tillers/core was found in S_1T_0 (SAU Soil + control treatment) and S_2T_0 (Sonargaon Soil + control treatment) treatment combination.

4.1.2. Plant height of T. Aman rice

4.1.2.1. Effect of soils on the plant height of T.Aman rice

The effects of soils on the plant height of rice are presented in Table 4.1. Insignificant variation was observed in the plant height of rice grown in two different soils. Between these two soils, S_2 (Sonargaon Soil) showed the higher (99.95 cm) plant height and S_1 (SAU Soil) Soil showed lower (97.23 cm) plant height

Table 4.1. Effect of soils on the plant height and panicle length of T.Aman rice

Treatments (Soils)	No.effective tillers/core	Plant height (cm)	Panicle length (cm)
S_1 (SAU Soil)	12.42	97.23	22.82
S_2 (Sonargaon Soil)	11.75	99.95	23.13
SE (±)	**NS**	**NS**	**NS**

In a column figure(s) having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

4.1.2.2. Effect of fertilizer and manure on the plant height of T. Aman rice

Rice plants showed significant variation in respect of plant height when fertilizers of different doses were applied (Table 4.2). Among the different fertilizer doses, T_1(RDCF:$N_{120}P_{20}K_{45}S_{20}$) showed the highest (105.57 cm) plant height which was statistically similar to all other treatment except control. On the other hand the lowest (85.33 cm) plant height was observed in T_0 treatment where that received no fertilizer. Plant height was significantly influenced by the application of organic manure and chemical fertilizers reported by Nayak *et al.* (2007). Similar results were also reported by Aga *et al.* (2004), Reddy *et al.* (2005).

Table 4.2 Effect of fertilizer and manure on the plant height and panicle length of T.Aman rice

Treatments	No.effective tillers/core	Plant height (cm)	Panicle length (cm)
T_0	6.33c	85.33b	21.23b
T_1	17.00a	105.57a	23.70a
T_2	14.33b	100.20a	23.38ab
T_3	14.83ab	102.67a	23.60a
SE (±)	**0.552**	**2.15**	**0.50**

In a column figures having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

4.1.2.3 Interaction effects of fertilizer and soils on the plant height of T.Aman rice

Combined application of different doses of fertilizer, manure and soils had significant variation on the plant height of rice (Table 4.3). The lowest (82.33 cm) plant height was observed in the treatment combination S_1T_0 (SAU Soil + No fertilizer). On the other hand, the highest (106.48 cm) plant height was recorded with S_2T_1 (Sonargaon Soil + RDCF) treatment which was statistically similar to S_2T_3, S_2T_2 and S_1T_1 treatment combinations.

Table 4.3. Interaction effect of fertilizer and soils on the plant height and panicle length of T.Aman rice

Treatments	No. of effective tillers/core	Plant height (cm)	Panicle length (cm)
S_1T_0	6.33d	82.33c	21.05
S_1T_1	16.00ab	104.67a	23.62
S_1T_2	14.33bc	99.81ab	22.85
S_3T_3	14.00bc	102.13a	23.76
S_2T_0	6.33d	88.32bc	21.40
S_2T_1	18.00a	106.48a	23.78
S_2T_2	13.00c	100.59ab	23.90
S_2T_3	15.67bc	103.20a	23.44
SE (±)	**0.78**	**3.04**	**NS**
CV (%)	**11.19**	**5.36**	**10.76**

In a column figures having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

4.1.3. Panicle length of T. Aman rice

4.1.3.1. Effect of soils on the panicle length of T.Aman rice

The effects of soils on the panicle length of rice are presented in Table 4.1. Insignificant variation was observed in the panicle length of rice grown in two different soils. Between this two soils, S_2 (Sonargaon soil) showed the higher panicle length (23.13 cm) and S_1 (SAU Soil) soil showed lowest panicle length (22.82 cm).

4.1.3.2. Effects of different doses of fertilizer and manure on the panicle length of T.Aman rice

Rice plants showed significant variation in respect of panicle length when different doses of fertilizer and manures were applied (Table 4.2). Among the different fertilizer doses, T_1 (RDCF: $N_{120}P_{20}K_{45}S_{20}$) showed the higher (23.70 cm) panicle length, which was statistically identical to T_3 (50% RDCF) and T_2 (50% RDCF+ 5 ton cowdung/ha). On the other hand the lowest (21.23 cm) panicle length was observed in the T_0 treatment where no fertilizer was applied. Rahman *et al.* (2009) noted a significant increase in panicle length due to the application of organic manure and chemical fertilizers. Similar results were also reported by Babu *et al.* (2001) and Reddy *et al.* (2005).

4.1.3.3. Interaction effects of fertilizer and soils on the panicle length of T.Aman rice

Combined application of different doses of fertilizer and soils had insignificant variation on the panicle length of rice (Table 4.3). The lowest (21.05 cm) panicle length was observed in the treatment combination S_1T_0 (SAU Soil) + No fertilizer) and the highest (23.90 cm) plant height was recorded in S_2T_2 (Sonargaon Soil + 50% RDCF + 5 ton cowdung/ha) treatments combination.

4.1.4. Number of filled grain per panicle of T.Aman rice

4.1.4.1 Effect of soils on the number of filled grain per panicle of T.Aman rice

The effects of soils on the number of filled grain per panicle of rice are presented in Table 4.4.There was no significant variation on the number of filled grains per panicle of rice grown in two different soils. Between these two soils, S_2 (Sonargaon Soil) showed the higher (107.7) number of filled grain per panicle and S_1 (SAU Soil) soil showed lower (102.3) number of filled grain per panicle.

Table 4.4 Effect of soil on the no. of filled grains/panicle and 1000 grain wt. of rice

Treatments	No. of filled grain/panicle	1000 grain wt. (g)
S_1 (SAU Soil)	102.3	23.45
S_2 (Sonargaon Soil)	107.7	23.60
SE (±)	**NS**	**NS**

In a column figure(s) having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

4.1.4.2. Effect of fertilizer on the number of filled grain per panicle of T.Aman rice

Significant variation was observed in number of filled grains per panicle of rice when different doses of fertilizer were applied (Table 4.5). The highest (121.8) number of filled grain per panicle was recorded in T_3 (50% RDCF + 2.1 ton poultry manure/ha) treatment. The lowest (71.00) number of filled grain per panicle was recorded in T_0 (Control treatment). Similar result was found by Rahman *et al.* (2009).

Table 4.5. Effect of fertilizer on the no. of filled grain/panicle and 1000 grain wt. of T.Aman rice

Treatments	No. of filled grains/panicle	1000 grain wt. (g)
T_0	71.0 b	22.30 b
T_1	114.2 a	23.57 a
T_2	112.8 a	23.70 a
T_3	121.8 a	23.53 a
SE (±)	**4.61**	**0.26**

In a column figure(s) having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT.

4.1.4.3 Interaction effects of fertilizer and soils on the number of filled grain per panicle of T. Aman rice

The combined effect of different doses of fertilizer and soils on the number of filled grains per panicle was insignificant (Table 4.6). The highest (126.00) number of filled grain per panicle of rice was recorded with the treatment combination S_2T_3 (Sonargaon Soil + 50% RDCF + 2.1 ton poultry manure/ha.) treatment. On the other hand, the lowest (71.00) number of filled grain was found in S_1T_0 (SAU Soil + No fertilizer) and S_2T_0 (Sonargaon Soil + No fertilizer) treatment combination.

Table 4.6. Interaction effects of fertilizer and soils on the no. of filled grain/panicle and 1000 grain wt. of T. Aman rice

Treatments	No. of filled grain/panicle	1000 grain wt. (g)
S_1T_0	71.00	22.87
S_1T_1	113.33	23.93
S_1T_2	107.00	23.13
S_1T_3	117.67	23.87
S_2T_0	71.00	23.73
S_2T_1	115.00	23.20
S_2T_2	118.67	24.27
S_2T_3	126.00	23.20
SE (±)	**NS**	**0.35**
CV (%)	**10.76**	**2.56**

In a column figure(s) having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

4.1.5. 1000 grain wt. of T. Aman rice

4.1.5.1 Effect of soils on the 1000 grain wt. of T. Aman rice

Effect of soils on 1000 grain wt. of rice showed insignificant variation when rice was grown in two different soils (Table 4.4). Between these two soils, S_2 (Sonargaon Soil) showed the higher 1000 grain wt. (23.60 g) and S_1 (SAU Soil) soils showed lower 1000 grain wt. (23.45 g).

4.1.5.2 Effect of fertilizer and manure on the 1000 grain wt. T.Aman rice

Rice plants showed significant variation in respect of 1000 grain wt. of rice when fertilizers treatments were applied Table 4.5. Among the different fertilizer doses, T_2 (50% RDCF + 5 ton cowdung/ha) showed the highest 1000 grain wt. (23.70 g) which was statistically identical to T_1 (RDCF). On the other hand, the lowest 1000 grain wt. (22.30 g) was observed in the T_0 treatment where no fertilizer was applied. Yang *et al.* (2004) recorded that 1000-grain weight increased by the application of chemical fertilizer with organic manure. Statistically similar thousand- grain weight was observed in all the treatments except control.

4.1.5.3 Interaction effects of fertilizer and soils on the 1000 grain wt. of T. Aman rice

The combined effect of different doses of fertilizer and soils on the 1000 grain wt. of rice was not significant Table 4.6. The highest 1000 grain wt. of rice (24.27 g) was recorded with the treatment combination S_2T_2 (Sonargaon Soil +50% RDCF + 5 ton cowdung/ha). On the other hand, the lowest 1000 grain wt. (22.87 g) was found in S_1T_0 (SAU Soil + control treatment) treatment combination.

4.1.6. Grain yield of T.Aman rice

4.1.6.1. Effect of soils on the grain yield of T.Aman rice

The effects of soils on the grain yield of rice are presented in Table 4.7. There was no variation of the grain yield of rice grown in two different soils. Between these two soils, S_1 (SAU Soil) and S_2 (Sonargaon Soil) showed the similar grain yield (0.031 Kg/core) .

Table 4.7. Effect of soil on the straw and grain yield of T.Aman rice

Treatments	Straw yield (Kg/core)	Grain yield (Kg/core)
S_1 (SAU Soil)	0.034	0.031
S_2 (l Sonargaon Soi)	0.033	0.031
SE (±)	**NS**	**NS**

In a column figure(s) having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

4.1.6.2. Effects of different doses of fertilizer and manure on the grain yield of T. Aman rice

Different doses of fertilizers showed significant variations in respect of grain yield (Table 4.8).The application of fertilizers and manure had a positive effect on the grain yield of T.Aman rice. Among the different doses of fertilizers, T_1 (RDCF) gave the highest (0.046 Kg/core) grain yield. On the contrary, the lowest (0.010 Kg/core) grain yield was observed in T_0 where no fertilizer was applied. Rahman et al. (2009) reported the grain yield was significantly increased due to application of organic manure and chemical fertilizers. The result is in agreement with the findings of Miah *et al*. (2006), Xu *et al.* (2008) and Miah *et al*. (2004).

Table 4.8. Effect of fertilizer on the straw and grain yield of rice

Treatments	Straw yield (Kg/core)	Grain yield (Kg/core)
T_0	0.011c	0.010c
T_1	0.053a	0.046a
T_2	0.039a	0.038b
T_3	0.045a	0.041ab
SE (±)	**0.003**	**0.50**

In a column figure(s) having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

4.1.6.3. Interaction effect of fertilizer and soils on the grain yield of T.aman rice

The combined effect of different doses of fertilizer and soils on the grain yield of rice was insignificantly different (Table 4.9).The highest (0.049 Kg/core) grain yield of rice was recorded with the treatment combination S_2T_1 (Sonargaon Soil +RDCF). On the other hand, the lowest (0.010 Kg/core) grain yield was found in S_1T_0 (SAU Soil + control treatment) treatment combination. *Lin et al*. (2011) reported that irrigation with organic material application increased yield of rice.

Table 4.9. Interaction effect of fertilizer and soils on the straw and grain yield of T.Aman rice

Treatments	Straw yield (Kg/core)	Grain yield (Kg/core)
S_1T_0	0.010	0.010
S_1T_1	0.050	0.044
S_1T_2	0.035	0.037
S_1T_3	0.041	0.041
S_2T_0	0.012	0.011
S_2T_1	0.056	0.049
S_2T_2	0.029	0.039
S_2T_3	0.036	0.040
SE (±)	**NS**	**NS**
CV (%)	**11.58**	**16.10**

In a column figure(s) having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

4.1.7. Straw yield of T. Aman rice

4.1.7.1. Effect of soil on the straw yield of T.Aman rice

The effects of soil on the straw yield of rice are presented in Table 4.7. Insignificant variation was observed in the straw yield of rice grown in two different soils. Between two soils, S_1 (SAU Soil) showed the higher (0.034 Kg/core) straw yield and S_2 (Sonargaon Soil) soil showed lower (0.033 Kg/core) straw yield.

4.1.7.2 Effects of different doses of fertilizer and manure on the straw yield of T.Aman rice

Significant variation was observed on the straw yield of rice when different doses of fertilizer were applied (Table 4.8).The higher (0.053 Kg/core) yield of straw was recorded in T_1 (RDCF) treatment.The lower (0.011 Kg/core) straw yield was recorded in the T_0 treatment where no fertilizer was applied. Rahman *et al.* (2009) reported that the application of organic manure and chemical fertilizers increased the straw yields of rice. These findings are corroborated with the work of Mannan *et al.* (2000). It is clear that organic manure in combination with inorganic fertilizers increased vegetative growth of plants and thereby increased straw yield of rice.

4.1.7.3 Interaction effect of fertilizer and soil on the straw yield of T. Aman rice rice

The combined effect of different doses of fertilizer and soil on the straw yield of rice was not significant (Table 4.9). The highest (0.056 Kg/core) straw yield of rice was recorded with the treatment combination S_2T_1 (Sonargan Soil + RDCF). On the other hand, the lowest (0.010 Kg/core) straw yield was found in S_1T_0 (SAU Soil + control treatment) treatment combination.

4.2. Effect of soil and fertilizer on the movement of N, P, K and S through undisturbed soil colum

The leachate samples were collected during the T.Aman rice growing period at 25, 35, 45, 55, 65 and 75 days after transplantation. The results of the leachate N,P,K and S concentrations are discussed below :

4.2.1 Leachate N concentration

4.2.1.1. Effect of soils on the leachate of N concentration during T.Aman rice growing period

The N concentration in the leachate during T. Aman growing period varied significantly with different soil, fertilizer treatment and time. Higher leachate N concentrations were found during 35 and 45 DAT of rice with different soils and fertilizer treatments. The higher N concentrations were found in the leachate of SAU (S_1) soil compared to Sonargaon soil. In T.aman season of 2011, the concentration of N in the leachate increased with time from the 25th day after transplantation of rice to 45 DAT may be due to increasing the temperature and microbial activity in soil. The highest leachate N concentrations of 5.08 ppm in SAU soil and 4.78 ppm in Sonargaon soil N were observed at 45 DAT (Table 4.10).The level of N concentration was higher in the leachate at 35 to 65 DAT (1^{st} week of August to mid September) compared to other sampling dates.

Table 4.10. Effect of soils on N conc. in the leachate of different dates of T.Aman rice growing period

Soil	Mean Leachate N concentration in ppm with time					
	25DAT	35DAT	45DAT	55DAT	65DAT	75DAT
S_1(SAU Soil)	1.87	4.25a	5.08	3.50a	3.84	2.45
S_2(Sonargaon Soil)	1.81	3.47b	4.78	1.93b	3.03	2.33
SE(±)	NS	0.27	NS	0.43	NS	NS

In a column figure(s) having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

4.2.1.2 Effect of fertilizers and manure on the leachate of N concentration during T.Aman rice growing period

Among the fertilizer treatments, higher leachate N concentrations were found in the leachate of 100% recommennded dose of chemical fertilizer(T_1-RDCF) and lowest levels of leachate N concentrations was observed in the control treatment (where fertilizer or manure was not added) and two organic and inorganic fertilizer treatments (Table 4.11).

Table 4.11. Effect of fertilizer and manure on N conc. in the leachate of different dates of T.Aman rice growing period

Treatments	Mean Leachate N concentration in ppm with time					
	25DAT	35DAT	45DAT	55DAT	65DAT	75DAT
T_0(Control)	1.75	3.44	4.13	2.22	3.27	2.33
T_1(RDCF)	1.98	4.38	6.18	3.38	2.80	2.22
T_2(50%RDCF + 5 ton cowdung ha^{-1})	1.87	3.27	4.67	2.45	2.68	2.92
T_3(50% RDCF + 2.1 ton poultry manure ha^{-1})	1.75	4.03	3.73	2.57	2.80	2.10
SE(±)	NS	NS	NS	NS	NS	NS

In a column figure(s) having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance

4.2.1.3 Interaction effect of fertilizer, manure and soil on the leachate N concentration during T. Aman rice growing period.

Combined effect of soil and fertilizer had no significant effect on leachate N concentrations of different dates but highest leachate N concentrations was recorded in S_2T_1 (100% recommended dose of chemical fertilizer applied on Sonargaon soil) treatment at 45 DAT and lowest was found in S_1T_0 (No addition of fertilizer in SAU soil) treatment combination at 25 DAT (Table 4.12).

Table 4.12. Effect of fertilizer and manure with different soils on N conc. in the leachate of different dates of T. aman rice growing period

Treatment combination	Mean Leachate N concentration in ppm with time					
	25DAT	35DAT	45DAT	55DAT	65DAT	75DAT
S_1T_0	1.40a	3.62	4.43	2.57	3.27	2.33
S_1T_1	2.33b	5.13	5.60	3.97	1.86	2.80
S_1T_2	2.10b	3.38	5.36	3.03	3.03	2.33
S_1T_3	1.80b	4.55	4.90	3.97	2.80	1.86
S_2T_0	2.10b	3.27	5.83	1.87	3.27	2.33
S_2T_1	1.63ab	3.62	6.77	2.80	3.73	1.63
S_2T_2	1.63ab	3.15	3.97	1.87	2.33	3.50
S_2T_3	2.10b	3.50	2.57	1.17	2.80	2.33
SE(±)	**0.42**	**NS**	**NS**	**NS**	**NS**	**NS**

In a column figure(s) having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

4.2.2. Leachate K concentration

4.2.2.1. Effect of soils on the leachate K concentration during T.Aman rice growing period

Higher leachate K concentrations were found in Sonargaon soil compared to SAU soil. The highest leachate K concentration (4.85 ppm) was found at 35 DAT with Sonargaon soil (Table 4.13).

Table 4.13. Effect of soils on K conc. in the leachate of different dates of T.Aman rice growing period

Soil	Mean Leachate K concentration in ppm with time					
	25DAT	35DAT	45DAT	55DAT	65DAT	75DAT
S_1 (Soil SAU)	0.713a	3.61	1.07b	0.71a	1.81	2.87
S_2 (Soil Sonargaon)	1.20b	4.85	1.49a	1.43b	2.5	4.22
SE(±)	**0.070**	**NS**	**0.124**	**0.06**	**0.49**	**1.02**

In a column figure(s) having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance

4.2.2.2. Effect of fertilizers and manure on the leachate K concentration during T.Aaman rice growing period

Among the fertilizer treatments, significantly higher concentrations of K were found in the leachate of 100% chemical fertilizer treatment compared to control and other two organic plus inorganic fertilizer treatments (Table 4.14). The highest K concentration (5.18 ppm) in the leachate was found at 35 DAT with T_2 treatment and lowest K concentrations were found from the control treatment. Chemical fertilizer was more leachable from the soil solution but where organic and inorganic fertilizers were added to soil then nutrient were adsorbed to organic colloids and formed complex and leaching of K was reduced. The highest concentration of K was found in the leachate of 35 DAT and then almost similar trend was observed. When fertilizer was applied initially more leachable K was present in the leachate firstly, and after 35 days soluble K was fixed on the soil colloidal surface.

Table 4.14. Effect of fertilizer and manure on K conc. in the leachate of different dates of T.Aman rice growing period

Treatments	Mean Leachate K concentration in ppm with time					
	25DAT	35DAT	45DAT	55DAT	65DAT	75DAT
T_0(Control)	0.625b	3.36a	0.59b	0.58c	1.80	1.98
T_1(RDCF)	1.218a	4.24b	1.83a	1.71a	2.06	5.69
T_2(50%RDCF + 5 ton cowdung ha^{-1})	0.938ab	5.18b	1.07ab	1.04b	1.82	4.62
T_3(50% RDCF + 2.1 ton poultry manure ha^{-1})	1.042ab	3.72a	1.31ab	0.94bc	1.95	1.88
SE(±)	0.10	0.46	0.20	0.09	NS	NS

In a column figure(s) having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

4.2.2.3 Interaction effect of fertilizer, manure and soil on the leachate K concentration during T. Aman rice growing period.

Due to combined effect of soil and fertilizer, higher (5.79 ppm) concentrations of K in the leachate were found in the S_2T_2 where 50% recommended dose of chemical fertilizer plus 5 ton compost/ha was applied in Sonargaon soil. Due to combined application of different soil and fertilizer, the leachate concentration significantly influenced and higher leachate K concentration was found in the treatment of S_1T_1 and S_2T_1 in most of time where 100% chemical fertilizer was applied on SAU and Sonargaon soils (Table 4.15).

Table 4.15. Effect of fertilizer and manure with different soils on K conc. in the leachate of different dates of T. aman rice growing period

Treatment combination	Mean Leachate K concentration in ppm with time					
	25DAT	35DAT	45DAT	55DAT	65DAT	75DAT
S_1T_0	0.625c	3.27	1.19ab	0.33	0.77	1.67
S_1T_1	0.767c	3.80	1.67ab	1.04	1.10	3.75
S_1T_2	0.833bc	4.56	0.71b	0.83	2.82	4.17
S_1T_3	0.625c	2.81	0.71b	0.62	2.56	1.88
S_2T_0	1.042abc	4.33	1.19ab	0.83	2.82	2.29
S_2T_1	1.458ab	4.68	1.43ab	1.04	1.03	5.63
S_2T_2	1.042abc	5.79	1.43ab	2.38	2.82	5.09
S_2T_3	1.458ab	4.62	1.70a	1.25	3.33	1.88
SE(±)	**0.15**	**NS**	**0.25**	**0.13**	**NS**	**NS**

In a column figure(s) having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

4.2.3. Leachate P concentration

4.2.3.1. Effect of soils on the leachate P concentration during T.Aman rice growing period

The P concentrations in the leachate was not significantly different with different soils and treatment. Higher P concentrations were found in the leachate of 35 and 45 DAT and then declined. Almost similar concentration of P was found in the leachate of both the soil (Table 4.16).

Table 4.16. Effect of soils on P conc. in the leachate of different dates of T.Aman rice growing period

Soil	Mean Leachate P concentration in ppm with time					
	25DAT	35DAT	45DAT	55DAT	65DAT	75DAT
S_1(SAU Soil)	0.125	1.359	0.394	0.361	0.156	0.044
S_2(Sonargaon Soil)	0.158	1.216	0.424	0.324	0.110	0.083
SE(±)	**NS**	**NS**	**NS**	**0.43**	**NS**	**NS**

In a column figures having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

4.2.3.2. Effect of fertilizers and manure on the leachate P concentration during T.Aman rice growing period

The fertilizer application did not affect the leachate P concentration significantly. Higher leachate concentrations were found in the T_1, T_2 and T_3 treatments where fertilizer and manure were applied (Table 4.17).

Table 4.17. Effect of fertilizer and manure on P conc. in the leachate of different dates of T.Aman rice growing period

Treatments	Mean Leachate P concentration in ppm with time					
	25DAT	35DAT	45DAT	55DAT	65DAT	75DAT
T_0(Control)	0.175	1.373	0.322	0.331	0.177	0.126
T_1(RDCF)	0.125	1.290	0.436	0.605	0.168	0.047
T_2(50%RDCF + 5 ton cowdung ha^{-1})	0.159	1.300	0.564	0.208	0.100	0.038
T_3(50% RDCF + 2.1 ton poultry manure ha^{-1})	0.104	1.186	0.315	0.227	0.089	0.044
SE(±)	NS	NS	NS	NS	NS	NS

In a column figure(s) having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

4.2.3.3 Interaction effect of fertilizer, manure and soil on the leachate P concentration during of T. Aman rice growing period.

The leachate P concentration was not significantly affected by the interaction effect of fertilizer and soil. The highest (1.698 ppm) leachate P concentration was found at 35 DAT with S_1T_2 treatment combination and the lowest (0.823 ppm) from S_1T_3 treatment combination (Table 4.18).

Table 4.18. Effect of fertilizer and manure with different soils on P conc. in the leachate of different dates of T. aman rice growing period

Treatment combination	Mean Leachate P concentration in ppm with time					
	25DAT	35DAT	45DAT	55DAT	65DAT	75DAT
S_1T_0	0.085	1.193	0.231	0.179	0.032	0.023
S_1T_1	0.096	1.521	0.341	0.545	0.082	0.032
S_1T_2	0.092	1.698	0.611	0.274	0.077	0.038
S_1T_3	0.088	0.823	0.294	0.247	0.145	0.038
S_2T_0	0.105	0.953	0.312	0.183	0.032	0.039
S_2T_1	0.159	1.059	0.530	0.664	0.254	0.057
S_2T_2	0.226	0.902	0.516	0.243	0.122	0.038
S_2T_3	0.121	1.549	0.336	0.206	0.032	0.050
SE(±)	NS	NS	NS	NS	NS	NS

In a column figure(s) having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

4.2.4 Leachate S concentration

4.2.4.1 Effect of soils on the leachate S concentration during T.Aman rice growing period

The leachate S concentrations increased with increasing time upto 75 DAT during the rice growing period in both the soils. Higher S concentrations were found in the leachate of SAU soil compared to Sonargaon soil (Table 4.19).

Table 4.19. Effect of soils on S conc. in the leachate of different dates of T.Aman rice growing period.

Soil	Mean Leachate S concentration in ppm with time					
	25DAT	35DAT	45DAT	55DAT	65DAT	75DAT
S_1(Soil SAU)	3.20	0.386a	4.08	6.89	6.76	7.26
S_2(Soil Sonargaon)	3.35	0.191b	3.85	1.36	6.06	6.21
SE(±)	NS	0.05	NS	0.86	NS	NS

In a column figures having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

4.2.4.2. Effect of fertilizers and manure on the leachate S concentration during T.Aaman rice growing period

Among the fertilizer treatments, higher levels of S concentrations were recorded in the leachate of two combined treatment where cowdung and poultry manure were used with 50% chemical fertilizer (Table 4.20). The highest concentration of 8.74 ppm S was obtained from the T_2 treatment where 50% RDCF and 5 ton cow dung ha^{-1} were applied. The lowest S concentration (0.232 ppm) was obtained from the control treatment.

Table 4.20. Effect of fertilizer and manure on S conc. in the leachate of different dates of T.Aman rice growing period

Treatments	Mean Leachate S concentration in ppm with time					
	25DAT	35DAT	45DAT	55DAT	65DAT	75DAT
T_0(Control)	2.68a	0.232	3.59	2.86	5.31	5.28
T_1(RDCF)	3.05a	0.242	3.87	4.01	6.28	6.73
T_2(50%RDCF + 5 ton cowdung ha^{-1})	3.65b	0.375	3.96	4.09	6.54	8.74
T_3(50% RDCF + 2.1 ton poultry manure ha^{-1})	3.70b	0.303	4.45	5.53	6.51	8.21
SE(±)	**0.29**	**NS**	**NS**	**NS**	**NS**	**NS**

In a column figure(s) having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

4.2.4.3. Interaction effect of fertilizer, manure and soil on the movement S during of T. Aman rice growing period.

The higher leachate S concentrations were found in the combind application of fertilizer and SAU soils. The highest leachate S concentrations were found in the S_1T_3 treatment combination and lowest from S_2T_0 treatment combination (Table 4.21).

Table 4.21. Effect of fertilizer and manure with different soils on S conc. in the leachate of different dates of rice growing period

Treatment combination	Mean Leachate S concentration in ppm with time					
	25DAT	35DAT	45DAT	55DAT	65DAT	75DAT
S_1T_0	2.69	0.232	3.36	4.21	5.79	5.87
S_1T_1	3.10	0.328	4.79	5.91	6.92	7.10
S_1T_2	3.16	0.552	3.60	7.73	5.64	7.98
S_1T_3	3.84	0.431	4.58	9.70	7.66	8.10
S_2T_0	2.67	0.254	3.82	1.51	5.82	2.69
S_2T_1	3.00	0.136	2.95	2.12	5.64	4.36
S_2T_2	4.14	0.198	4.31	0.45	7.44	8.51
S_2T_3	3.57	0.176	4.32	1.36	5.35	7.31
SE(±)	NS	NS	NS	NS	NS	NS

In a column figures having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

4.3. Effect of soil fertilizer and manure on the yield parameter, yield and grain nutrient concentration of Boro rice.

4.3.1. Plant height

4.3.1.1. Effect of soil on the plant height of boro rice

The effects of Soil on the plant height of rice are presented in Table 4.22. Insignificant variation was observed on the plant height of rice with two different soils. Between these two Soil, S_2 (Sonargaon Soil) showed the highest plant height (73.22 cm) and S_1 (SAU Soil) showed lowest plant height (70.27 cm).

Table 4.22. Effect of soil on the plant height and panicle length of boro rice

Soil	Plant height (cm)	Panicle length (cm)
S_1 (SAU Soil)	70.27	21.16
S_2 (Sonargaon Soil)	73.22	21.94
SE (±)	NS	NS

In a column figure(s) having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT at 5% level of significance.

4.3.1.2 Effect of fertilizer and manure on the plant height of rice

Rice plants showed significant variation in respect of plant height when fertilizers of different doses were applied (Table 4.23). Among the different fertilizer doses, T_3 (50% NPKS + 2.1 ton poultry manure) showed the highest plant height (79.95 cm), which was closely followed by T_1 (RDCF), T_2 (50% NPKS + 5 ton cowdung ha^{-1}). On the other hand lowest plant height (64.18 cm) was observed in the T_0 treatment where no fertilizer was applied. Plant height was significantly influenced by the application of organic manure and chemical fertilizers reported by Nayak *et al.* (2007). Similar results also reported by Aga *et al.* (2004) and Reddy *et al.* (2004).

Table 4.23. Effect of fertilizer and manure on the plant height and panicle length of rice

Treatments	Plant height (cm)	Panicle length (cm)
T_0	64.18 c	20.57
T_1	73.73 ab	22.26
T_2	69.12 bc	21.55
T_3	79.95 a	21.84
SE (±)	1.629	NS

In a column figure(s) having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT at 5% level of significance.

4.3.1.3. Interaction effects of fertilizer, manure and soils on the plant height of boro rice

Combined application of different doses of fertilizer and soils had insignificant variation on the plant height of rice (Table 4.24). The lowest plant height (61.52cm) was observed in the treatment combination of S_1T_0 (SAU Soil + No fertilizer). On the other hand, the highest plant height (82.94 cm) was recorded with S_2T_3 (Sonargaon Soil + 50% NPKS + 2.1 ton poultry manure ha^{-1}) treatment combination.

Table 4.24. Effect of soil and fertilizer on the plant height and panicle length of rice

Treatment combination	Plant height (cm)	Panicle length (cm)
S_1T_0	61.52	20.72
S_1T_1	73.48	21.86
S_1T_2	69.12	21.22
S_1T_3	76.96	20.86
S_2T_0	66.84	20.42
S_2T_1	73.97	22.66
S_2T_2	69.13	21.88
S_2T_3	82.94	22.82
SE(±)	NS	NS

In a column figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT at 5% level of significance.

4.3.2. Panicle length

4.3.2.1. Effect of soil on the panicle length of boro rice

The effects of soils on the panicle length of rice are presented in Table 4.22. Insignificant variation was observed on the panicle length of rice with two different soil. Between this two soil, S_2 (Sonargaon Soil) showed the taller panicle (21.94 cm) and S_1 (SAU Soil) showed the shorter panicle (21.16 cm).

4.3.2.2. Effects of different doses of fertilizer and manure on the panicle length of boro rice

Rice plants showed insignificant variation in respect of panicle length when different doses of fertilizer and manures were applied (Table 4.23). Among the different fertilizer doses, T_1 ($N_{120}P_{20}K_{45}S_{20}$) showed the highest panicle length (22.26 cm), which was statistically identical by T_3 (50% NPKS +2.1 ton poultry manure/ha) and T_2 (50% NPKS + 5.0 ton cowdung/ha). On the other hand lowest panicle length (20.57 cm) was observed in T_0 treatment where no fertilizer was applied. Rahman *et al.* (2009) noted a significant increase in panicle length due to the application of organic manure and chemical fertilizers. Babu *et al.* (2001), Reddy *et al.* (2005) also reported similar results.

4.3.2.3. Interaction effects of fertilizer and soil on the panicle length of boro rice

Combined application of different types of soil and fertilizer had insignificant variation on the panicle length of rice (Table 4.24). The lowest panicle length (20.42 cm) was observed in the treatment combination of S_2T_0 (Sonargaon Soil + No fertilizer). On the other hand, the highest plant height (22.82 cm) was recorded with S_2T_3 (Sonargaon Soil + 50% NPKS + 2.1 ton poultry manure/ha) treatment combination.

4.3.3. Number of filled grains per panicle

4.3.3.1. Effect of soil on the number of filled grain per panicle of boro rice

The effects of soil on the number of filled grain per panicle of rice are presented in Table 4.25. Insignificant variation was observed in the number of filled grain per panicle of rice grown in two different Soils. Between these two soils, S_2 (Sonargaon soil) showed the highest number of filled grains per panicle (95.3) and S_1 (SAU Soil) showed lowest number of filled grains per panicle (83.0).

Table 4.25 Effect of soil on the no. of filled grains/panicle and 1000 grain wt. of boro rice

Treatments	No. of Filled grains/panicle	1000 grain wt. (g)
S_1(SAU)	83.0	20.23
S_2(Sonargaon)	95.3	20.52
SE(±)	NS	NS

In a column figure(s) having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT at 5% level of significance.

4.3.3.2 Effect of fertilizer and manure on the number of filled grains per panicle of Boro rice

Significant variation was observed in number of filled grains per panicle of rice when different doses of fertilizer and manure were applied (Table 4.26). The highest number of filled grain per panicle (100.0) was recorded in T_1 ($N_{120}P_{20}K_{45}S_{20}$) treatment. The lowest number of filled grain per panicle (76.0) was recorded in T_0 (Control treatment). Similar result was found by Rahman *et al.* (2009).

Table 4.26. Effect of fertilizer on the no. of filled grains/panicle and 1000 grain wt. of Boro rice

Treatments	No. of Filled grains/panicle	1000 grain wt. (g)
T_0	76.0 b	20.12 b
T_1	100.0 a	20.75 a
T_2	92.0 ab	20.27 ab
T_3	89.0 ab	20.37 ab
SE (±)	4.306	0.116

In a column figure(s) having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT at 5% level of significance.

4.3.3.3. Interaction effects of fertilizer, manure and soil on the number of filled grain per panicle of boro rice

The combined effect of different doses of fertilizer, manure and soil on the number of filled grain per panicle was insignificant (Table 4.27). The highest number of filled grain per panicle of rice (108.00) was recorded with the treatment combination S_2T_2 (Sonargaon Soil + 50% NPKS + 5 ton cowdung/ha) treatment. On the other hand, the lowest number of filled grain (90.00) was found in S_2T_3 (Sonargaon Soil +50% NPKS + 2.1 ton poultry manure/ha) treatment combination.

Table 4.27 Interaction effects of fertilizer and soil on the no. of filled grain/ panicle and 1000 grain wt. of boro rice

Treatment combination	No. of filled grain/panicle	1000 grain wt. (g)
S_1T_0	73.0	20.30 b
S_1T_1	95.0	20.43 ab
S_1T_2	76.0	20.13 b
S_1T_3	88.0	20.07 b
S_2T_0	79.0	19.93 b
S_2T_1	105.0	21.07 a
S_2T_2	108.0	20.40 ab
S_2T_3	90.0	20.67 ab
SE(±)	NS	0.1633

In a column figure(s) having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT at 5% level of significance.

4.3.4. 1000 grain wt. of Boro rice

4.3.4.1. Effect of soil on the 1000 grain wt. of boro rice

The effects of soil on the 1000 grain wt. of rice are presented in Table 4.25. Insignificant variation was observed in the 1000 grain wt. of rice grown in two different soils. Between these two soils, S_2 (Sonargaon soil) showed higher 1000 grain wt. (20.52 g) and S_1 (SAU Soil) showed lower 1000 grain wt. (20.23 g).

4.3.4.2. Effect of fertilizer and manure on the 1000 grain wt. of boro rice

Rice plants showed significant variation in respect of 1000 grain wt. of rice when fertilizers of different doses were applied (Table 4.26). Among the different fertilizer doses, T_1 ($N_{120}P_{20}K_{45}S_{20}$) showed the highest 1000 grain wt. (20.75 g) which was statistically identical by T_3 (50% NPKS + 2.1 ton poultry manure/ha). On the other hand, the lowest 1000 grain wt. (20.12 g) was observed in the T_0 treatment where no fertilizer was applied. Yang *et al.* (2004) also recorded that 1000-grain weight were increased by the application of chemical fertilizer with organic manure. Statistically similar thousand- grain weight was observed in maximum treatments.

4.3.4.3. Interaction effects of fertilizer, manure and soils on the 1000 grain wt. of rice

The combined effect of different doses of fertilizer and soils on the 1000 grain wt. of rice was significant (Table 4.27). The highest 1000 grain wt. of rice (21.07 g) was recorded with the treatment combination S_2T_1 (Sonargaon Soil + $N_{120}P_{20}K_{45}S_{20}$). On the other hand, the lowest 1000 grain wt. (19.93 g) was found in S_2T_0 (Sonargaon Soil + control treatment) treatment combination.

4.3.5. Grain yield

4.3.5.1. Effect of soils on the grain yield of boro rice

The effects of soils on the grain yield of rice are presented in Table 4.28. Insignificant variation was observed in the grain yield of rice grown in two different soils. Between these two soils, S_2 (Sonargaon Soil) showed the higher grain yield (29.67 g/core) and S_1 (SAU Soil) showed lower grain yield (24.58 g/core).

Table 4.28. Effect of soils on the straw yield / core and grain yield/ core of boro rice

Treatments	Straw yield (g / core)	Grain yield (g / core)
S_1(SAU)	28.05	24.58
S_2(Sonargaon)	34.13	29.67
SE(±)	NS	NS

In a column figure(s) having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT at 5% level of significance.

4.3.5.2. Effects of different doses of fertilizer and manure on the grain yield of boro rice

Different doses of fertilizers showed significant variations in respect of grain yield (Table 4.29). The application of fertilizers and manure had a positive effect on the grain yield of boro rice. Among the different doses of fertilizers, T_1 ($N_{120}P_{20}K_{45}S_{20}$) showed the highest grain yield/core (30.67 g/core) which was statistically similar with the T_2 (50% NPKS + 5 ton cowdung/ha) and T_3 (50% NPKS + 2.1 ton poultry manure/ha) treatment. On the contrary, the lowest grain yield/core (20.22 g/core) was observed with T_0 where no fertilizer was applied. Rahman et al. (2009) reported the grain yield was significantly increased due to application of organic manure and chemical fertilizers. This is also in agreement with the findings of Miah *et al.* (2006), Minggang Xu *et al.* (2008) and Miah *et al.* (2004).

Table 4.29. Effect of fertilizer on the straw yield/core and grain yield/core of rice

Treatments	Straw yield (g/core)	Grain yield (g/core)
T_0	24.95	20.22 b
T_1	34.90	30.67 a
T_2	31.80	29.27 ab
T_3	32.72	28.33 ab
SE (±)	NS	2.1260

In a column figure(s) having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT at 5% level of significance.

4.3.5.3. Interaction effect of fertilizer,manure and soils on the grain yield of boro rice

The combined effect of different doses of fertilizer and soils on the grain yield of rice was insignificantly different (Table 4.30). The higher grain yield of rice (34.30 g/core) was recorded with the treatment combination S_2T_2 (Sonargaon Soil + 50% NPKS + 5 ton cowdung /ha). On the other hand, the lower grain yield (19.53 g/core) was found in S_1T_0 (Soils SAU + control treatment) treatment combination. *Lin et al.* (2011) reported that irrigation with organic material application increased yield of rice.

Table 4.30. Interaction effect of fertilizer and soil on the straw yield/core and grain yield /core of boro rice

Treatment combination	Straw yield (g /core)	Grain yield (g /core)
S_1T_0	23.97	19.53
S_1T_1	32.40	28.03
S_1T_2	28.23	24.23
S_1T_3	27.60	26.50
S_2T_0	25.93	20.90
S_2T_1	37.40	33.30
S_2T_2	35.37	34.30
S_2T_3	37.83	30.17
SE(±)	NS	NS

In a column figure(s) having similar letter(s) do not differ insignificantly whereas figures with dissimilar letter(s) differ significantly as per DMRT at 5% level of significance.

4.3.6. Straw yield

4.3.6.1. Effect of soils on the straw yield of boro rice

The effects of soils on the straw yield of rice are presented in Table 4.28. Insignificant variation was observed in the straw yield of rice grown in two different soils. Between these two soils, S_2 (Sonargaon soil) showed the higher straw yield (34.13 g/core) and S_1 (SAU Soil) showed lower straw yield (28.05 g/core).

4.3.6.2. Effects of different doses of fertilizer and manure on the straw yield of boro rice

Inignificant variation was observed on the straw yield/core of rice when different doses of fertilizer were applied (Table 4.29). The highest straw yield (34.90 g/core) was recorded in $T_1(N_{120}P_{20}K_{45}S_{20})$ treatment . The lowest straw yield (24.95 g/core) was recorded in the T_0 treatment where no fertilizer was applied. Rahman *et al.* (2009) reported that the application of organic manure and chemical fertilizers increased the straw yields of rice. These findings are corroborated with the work of Mannan *et al.* (2000).

4.3.6.3. Interaction effect of fertilizer, manure and soils on the straw yield of boro rice

The combined effect of different doses of fertilizer and soils on the straw yield of rice was insignificant Table 4.30. The higher levels straw yield were obtained from the soils of Sonargaon. The higher straw yield of rice (37.83 g/core) was recorded with the treatment combination S_2T_3 (Sonargaon soils +50% NPKS + 2.1 ton poultry manure/ha). On the other hand, the lowest straw yield (23.97 g/core) was found in S_1T_0 (Soils SAU+ control treatment) treatment combination.

4.3.7. N, P, K and S concentration in grain of boro rice

4.3.7.1. Effect of soils on N concentration in boro rice grain

The effects of soils on grain N concentration of rice are presented in Table 4.31. The grain N concentration was not significantly affected by different soils. Similar grain N concentrations were found in SAU and Sonargaon soils.

Table 4.31. Effect of soils on NPKS concentration in boro grain

Treatments	Grain N Concentration (%)			
	N	P	K	S
S_1(SAU)	1.155	0.248	0.269	0.103 a
S_2 (Sonargaon)	1.153	0.242	0.282	0.117 b
SE (±)	NS	NS	NS	0.002

In a column figure(s) having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT at 5% level of significance.

4.3.7.2. Effect of different doses of fertilizer and manure on N concentration in grain of boro rice

Nitrogen concentrations in grain of rice showed statistically insignificant variation due to the application of different doses of fertilizers are presented in Table 4.32. The nitrogen concentration in Boro rice grain increased due to application of fertilizers and manure. The similar levels of grain N concentrations were recorded in all the treatments except control. The highest N concentration in grain (1.205%) was recorded in T_2 (50% NPKS + 5 ton cowdung/ha) which was closely followed (1.183%) by T_3 as 50% NPKS + 2.1 ton poultry manure/ha. On the other hand, the lowest N concentration in grain (1.050%) was found from T_0 as control treatment. A significant increase in N content in rice grain due to the application of organic manure and fertilizers have been reported by investigators (Azim, 1999 and Hoque, 1999).

Table 4.32. Effect of fertilizer and manure on NPKS concentration in grain of boro rice

Treatments	Concentration (%) in grain			
	N	P	K	S
T_0	1.050	0.223	0.231 d	0.095 d
T_1	1.178	0.248	0.286 c	0.125 a
T_2	1.205	0.261	0.296 a	0.105 c
T_3	1.183	0.249	0.291 b	0.115 b
SE (±)	NS	NS	0.0073	0.0041

In a column figure(s) having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT at 5% level of significance.

4.3.7.3. Interaction effect of fertilizer and soils on N concentration in grain of boro rice

The combined effect of different doses of fertilizer and soils on N concentration of rice was insignificant (Table 4.33). The highest N concentration in grain of rice (1.240%) was recorded in the treatment combination S_1T_2 (SAU Soil +50% NPKS + 5 ton cowdung/ha). On the other hand, the lowest N concentration in grain of rice (0.980%) was found in S_1T_0 (SAU Soil + control treatment) treatment combination.

Table 4.33. Combined effects of fertilizer and soils on the NPKS concentration of boro rice grain

Treatments	Grain N Concentration (%)			
	N	P	K	S
S_1T_0	0.980	0.226	0.240	0.086
S_1T_1	1.210	0.258	0.276	0.112
S_1T_2	1.240	0.272	0.283	0.102
S_1T_3	1.190	0.237	0.279	0.112
S_2T_0	1.120	0.220	0.221	0.104
S_2T_1	1.147	0.238	0.296	0.139
S_2T_2	1.170	0.251	0.309	0.108
S_2T_3	1.177	0.261	0.303	0.117
SE (±)	**NS**	**NS**	**NS**	**NS**

In a column figure(s) having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT at 5% level of significance.

4.3.8. P concentration in Boro rice grain

4.3.8.1. Effect of soils on P concentration in grain of boro rice

The effects of soils on P concentration in grain of rice are presented in Table 4.31. Insignificant variation was observed in grain P concentration of Boro rice grown in two different soils. Almost similar P concentrations were obserebed in grain in Sonargaon and SAU soils.

4.3.8.2. Effects of different doses of fertilizer and manure on P concentration in grain of boro rice

Phosphorous concentrations in grain of rice showed statistically insignificant variation due to the application of different doses of fertilizers are presented in Table 4.32.The highest grain P concentration (0.261%) was recorded from T_2 (50% NPKS + 5 ton cowdung/ha) which was closely followed (0.249%) by T_3 as 50% NPKS + 2.1 ton poultry manure/ha. On the other hand, the lowest P concentration in grain (0.223%) was found from T_0 as control treatment. A significant increase in P content in rice straw due to the application of organic manure and fertilizers has been reported by investigators (Azim, 1999 and Hoque, 1999).

4.3.8.3. Interaction effect of fertilizer and soils on P concentration in grain of boro rice

The combined effect of different doses of fertilizer and soils on P concentration in grain of rice was insignificant (Table 4.33). The highest P concentration in grain of rice (0.272%) was recorded with the treatment combination S_1T_2 (Soil SAU +50% NPKS + ton cowdung/ha). On the other hand, the lowest P concentration in grain of rice (0.220%) was found in S_2T_0 (SAU Soil + control treatment) treatment combinations.

4.3.9. K concentration in Boro rice grain

4.3.9.1. Effect of soils on K concentration in grain of boro rice

The effects of soils on K concentration in grain of rice are presented in Table 4.31. Insignificant variation was observed in K concentration in grain of rice grown in two different soils. Between these two soils, S_1 (SAU Soil) showed the higher K concentration in grain of 0.269% and S_2 (Sonargaon Soil) soils showed the lower K concentration of 0.282% in grain.

4.3.9.2. Effect of fertilizer and manure on K concentration in grain of boro rice

Potassium concentrations in grain of rice showed statistically significant variation due to the application of different doses of fertilizers (Table 4.32). The highest K in grain concentration (0.296%) was recorded from T_2 (50% NPKS + 5 ton cowdung/ha) treatment. On the other hand, the lowest K in grain concentration (0.231%) was found from T_0 as control treatment. Singh *et al.* (2001) revealed that potassium content in grain were increased due to combined application of organic manure and chemical fertilizers.

4.3.9.3 Interaction effect of fertilizer and soils on K concentration in grain of boro rice

The combined effect of different doses of fertilizer and soils on K concentration in grain of rice was insignificant (Table 4.33). The highest K concentrations were found in the grain of Sonargaon soils. The higher K concentration in grain of rice (0.309%) was recorded with the treatment combination S_2T_2 (Sonargaon Soil + 50% NPKS + 5 ton cowdung / ha). On the other hand, the lowest K concentration in grain of rice (0.220%) was found in S_2T_0 (SAU Soil + control treatment) treatment combination.

4.3.10. S concentration in Boro rice grain

4.3.10.1. Effect of soils on S concentration of boro rice grain

The effects of soils on S concentration in grain of rice are presented in Table 4.31. Significant variation was observed in grain S concentration of rice grown in two different soils. Between these two soils, S_1 (SAU Soil) showed the higher (0.103%) S concentration in grain and S_2 (Sonargaon Soil) soil showed the lower (0.117%) S concentration in grain.

4.3.10.2. Effects of different doses of fertilizer and manure on S concentration in grain of boro rice

Sulphur concentrations in grain of rice showed statistically significant variation due to the application of different doses of fertilizers are presented in Table 4.32. The highest (0.125%) grain S concentration was recorded from T_1($N_{120}P_{20}K_{45}S_{20}$) which was closely followed (0.115%) by T_3 as 50% NPKS + 2.1 ton poultry manure/ha. On the other hand, the lowest (0.095%) S concentration in grain was found from T_0 as control treatment.

4.3.10.3. Interaction effect of fertilizer and soils on S concentration in grain of boro rice

The combined effect of different doses of fertilizer and soils on S concentration of grain was insignificant (Table 4.33). The highest (0.139%) grain S concentration was recorded in the treatment combination S_2T_1 (Sonargaon Soil + 100% NPKS). On the other hand, the lowest (0.086%) S concentration in grain of rice was found in S_1T_0 (SAU Soil + control treatment) treatment combination.

4.4. Effect of fertilizer and manure on the change of chemical properties of different soils.

After harvest of 2nd crop (Boro rice), the depth wise post harvest soils were collected and analyzed for pH and nutrient concentrations.

4.4.1. Soil pH status of post harvest soil

4.4.1.1. Effect of soil on pH of post harvest soil

There was significant change of pH in post harvest soil with two different soils (Table 4.34). Between two soils, S_2 (Sonargaon Soil) soil showed the higher pH (7.3) and S_1 (SAU Soil) soil showed the lower pH (6.8 in 0-10 cm depth) of post harvest soil. Similaly higher pH (7.6) was found in the 10-20 cm depth of Sonargaon soils and lower pH (7.2) found in SAU of post harvest soil.

Table 4.34. Effect of soil on the pH in post harvest soil

Treatments	Soil pH	
	(0-10) cm depth	(10-20) cm depth
S_1 (SAU)	6.8 b	7.2 a
S_2 (Sonargaon)	7.3 a	7.6 b
SE (±)	**0.042**	**0.015**

In a column figure(s) having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

4.4.1.2. Effect of fertilizer and manure on pH of post harvest soil

The pH of 0-10 cm depth of post harvest soil showed insignificant variation due to the application of different doses of fertilizers (Table 4.35). The highest pH (7.2) of post harvest soil was recorded from T_0 as control treatment. On the other hand, the lowest pH (6.1) of post harvest soil was recorded from T_3 (50% NPKS + 2.1 ton poultry manure/ha). The pH of 10-20 cm depth of post harvest soil was significantly affected by different fertilizer treatments. In the depth of 10-20 cm, the highest pH (7.5) value was found in the T_1 and T_3 treatments and lowest in control treatment.

Table 4.35. Effect of fertilizer and manure on the pH in post harvest soil

Treatments	Soil pH	
	(0-10) cm depth	(10-20) cm depth
T_0	7.2	7.2 c
T_1	6.9	7.5 a
T_2	7.1	7.4 b
T_3	6.1	7.5 a
SE (±)	**NS**	**0.021**

In a column figure(s) having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

4.4.1.3. Interaction effect of fertilizer and soils on pH of post harvest soil

The higher pH values were found in the Sonargaon soil compared to SAU soil. The combined effect of different doses of fertilizer and soil on pH of 0-10 cm depth of post harvest soil was insignificant (Table 4.36). The highest pH (7.5) of post harvest soil was recorded with the treatment combination S_2T_0 (Sonargaon Soil + Control treatment) treatment. On the other hand, the lowest pH (6.7) of post harvest soil was recorded with the treatment combination S_1T_1 (SAU Soil + RDCF) treatment.The pH of 10-20 cm depth of post harvest soil was significantly affected by combined effects of soils and fertilizers. In the depth of 10-20 cm, the highest pH (7.7) was recorded in S_2T_1 and S_2T_2 treatment combination.

Table 4.36. Combined effects of fertilizer and soils on the pH in post harvest soil

Treatments	Soil pH	
	(0-10) cm depth	(10-20) cm depth
S_1T_0	6.9	6.9 c
S_1T_1	6.7	7.4 b
S_1T_2	6.8	7.1 c
S_1T_3	6.8	7.3 b
S_2T_0	7.5	7.4 b
S_2T_1	7.2	7.7 a
S_2T_2	7.4	7.7 a
S_2T_3	7.2	7.6 a
SE (±)	**NS**	**0.030**

In a column figure(s) having similar letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT at 5% level of significanced.

4.4.2. Total N status of post harvest soil

4.4.2.1. Effect of soils on the N content in post harvest soil

The effects of soils on the total N content of post harvest soil are presented in Table 4.37. Total nitrogen concentration in post harvest soil showed statistically significant differences with two different soils. Between these two soils, S_1 (SAU Soil) showed the higher total N concentrations (0.08% in 0-10 cm depth soil) compared to Sonargaon Soil (0.07%). In 10-20 cm depth, almost similar N concentrations was found in the post harvest soils of SAU and Sonargaon.

Table 4.37. Effect of soil on the NPKS concentration in post harvest soil

Treatments	Total N (%)		Available P (ppm)		Available K (ppm)		Available S (ppm)	
	(0-10)cm depth	(10-20)cm depth	(0-10)cm depth	(10-20)cm depth	(0-10)cm depth	(10-20)cm depth	(0-10)cm depth	(10-20)cm depth
S_1(SAU Soil)	0.08a	0.07	26.77a	22.63a	17.79a	17.37a	19.82b	18.79b
S_2 (Sonargaon Soil)	0.07b	0.07	18.52b	15.02b	12.13b	12.29b	29.36a	24.42a
SE (±)	0.001	NS	1.438	0.751	0.833	0.712	0.790	0.796

In a column figure(s) having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT at 5% level of significance.

4.4.2.2. Effect of fertilizer and manure on the N content in post harvest soil

The total N content of post harvest soil was significantly influenced by fertilizer and manure application. Almost similar N-concentration was found in the depth of 0-10 cm and 10-20 cm soil depths (Table 4.38). The level of total N in post harvest soil increased due to combined application of fertilizer and manure.The highest (0.09 % in 0-10 cm and 0.08 % in 10-20 cm depth) total N concentrations was found in the post harvest soils where T_2 (50% NPKS + 5 ton cowdung/ha) treatment was applied during T.Aman and Boro season. On the other hand, the lower (0.06%) total nitrogen concentrations in post harvest soil was obtained from T_0 as control treatment. Avoola & Makinde (2009) found that application of chemical fertilizer with organic manure increase N content in post harvest soil. Similar result also found by Reddy *et al.* (2005)

Table 4.38. Effect of fertilizer and manure on nutrient concentration of the NPKS in post harvest soil

Treatments	Total N (%)		Available P (ppm)		Available K (ppm)		Available S (ppm)	
	(0-10) cm	(10-20) cm	(0-10) cm	(10-20) cm	(0-10) cm	(10-20) cm	(0-10) cm	(10-20) cm
T_0	0.06d	0.06c	14.92b	13.87c	9.75b	10.58c	13.43c	13.88c
T_1	0.07c	0.07b	24.66a	16.74bc	16.25a	13.92bc	25.78 b	20.94b
T_2	0.09a	0.08a	27.19a	23.56a	14.58ab	16.33ab	25.37 b	25.05ab
T_3	0.08b	0.07b	23.87ab	21.15ab	19.25a	18.50a	33.78a	26.54a
SE (±)	**0.002**	**0.001**	**2.034**	**1.067**	**1.178**	**1.007**	**1.117**	**1.126**

In a column figure(s)(having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT at 5% level of significance.

4.4.2.3. Combined effect of fertilizer and soils on the total N content in post harvest soil

The combined effect of different doses of fertilizer and soils on the N content in post harvest soil of rice core was significantly different (Table 4.39). In the depth of (0-10) cm, the highest (0.097 %) total N concentration of post harvest soil was found in S_1T_2 (SAU Soil + 50% NPKS + 5 ton cowdung/ha) treatment combination and lowest (0.060 %) was obtained from S_1T_0 (SAU Soil + control treatment) treatment combination. Similarly,The highest (0.077 %) level of total N concentration in the depth of (10-20) cm was obtained in S_1T_2 (SAU Soil +50% NPKS + 5 ton cowdung/ha) and S_2T_2 (Sonargaon Soil + 50% NPKS + 5 ton cowdung/ha) treatment combination and lowest concentration was found in both the soils with control treatment.

Table 4.39. Combined effect of fertilizer and soil on the NPKS content in post harvest soil

Treatments	Total N (%)		Available P (ppm)		Available K (ppm)		Available S (ppm)	
	(0-10) cm	(10-20) cm	(0-10) cm	(10-20 cm	(0-10) cm	(10-20) cm	(0-10cm	(10-20) cm
S_1T_0	0.060e	0.070b	19.58	17.04	9.50c	11.67	11.56e	12.69e
S_1T_1	0.077b	0.070b	29.55	20.43	20.00ab	16.67	22.92d	19.79cde
S_1T_2	0.097a	0.077a	28.52	26.37	16.67bc	20.83	14.58e	19.48cde
S_1T_3	0.077b	0.077a	29.53	26.70	25.00a	20.33	30.21bc	23.19bc
S_2T_0	0.070c	0.060c	10.25	10.70	10.00c	9.50	15.29e	15.06dc
S_2T_1	0.067d	0.077a	19.78	13.05	12.50bc	11.17	28.65cd	22.08cd
S_2T_2	0.077b	0.077a	25.85	20.74	12.50bc	11.83	36.15ab	30.63a
S_2T_3	0.077b	0.070b	18.21	15.60	13.50bc	16.67	37.35a	29.90ab
SE (±)	**0.002**	**0.002**	**NS**	**NS**	**1.666**	**1.424**	**1.579**	**1.592**

In a column figure(s) having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT at 5% level of significance.

4.4.3. Available phosphorus concentration in post harvest soil

4.4.3.1. Effect of soils on the P content in post harvest soil

The effects of soils on the P content of post harvest soil are presented in Table 4.37. Available phosphorus concentration in post harvest soil showed statistically significant variations with two different soils. In the depth of (0-10) cm, the highest (26.77 ppm) concentration of available phosphorus was found in S_1 (SAU Soil) soil compared to S_2 (Sonargaon Soil) soil. Similarly, the highest (22.63 ppm) levels of available P concentration was found in S_1 (SAU Soil) soil of 10-20 cm depth.

4.4.3.2. Effect of fertilizer and manure on the P content in post harvest soil

Available phosphorus in post harvest soil showed statistically significant differences due to the application of different manure and inorganic fertilizer during rice growing period (Table 4.38). The level of available P in post harvest soil increased due to combined application of fertilizer and manure. The higher levels of available P (27.19

ppm in 0-10 cm soil and 23.56 ppm in 10-20 cm soil) were recorded in the T_2 (50% NPKS + 5 ton cowdung/ha) treatment. On the other hand, the lower phosphorus levels were (14.92 ppm in 0-10 cm and 13.87 ppm in 10-20 cm) were obtained from T_0 control treatment. Avoola and Makinde (2009) found that application of chemical fertilizer with organic manure increase P content in post harvest soil. Similar result also found by Reddy *et al.* (2005).

4.4.3.3. Combined effect of fertilizer and soils on the P content in post harvest soil

The combined effect of different doses of fertilizer and soils on the available phosphorus in post harvest soil of rice core was insignificant (Table 4.39). In the depth of (0-10) cm, highest (29.55 ppm) level of available P concentration was recorded from S_1T_1(SAU Soil + $N_{120}P_{20}K_{45}S_{20}$) treatment combination and the lowest (10.25 ppm) was found from S_2T_0 (Sonargaon Soil + No fertilizer) treatment combination. Similarly, in the depth of (10-20) cm, the highest (26.70 ppm) phosphorus concentration was found in the treatment combination S_1T_3 (SAU Soil + 50% NPKS + 2.1 ton poultry manure/ha) and similar result was found from S_1T_2 (SAU Soil + 50% NPKS + 5 ton cowdung/ha) treatment combination where fertilizer and manure were applied and the lower (10.70 ppm) was obtained from S_2T_0 (Soil Sonargaon + control treatment) .

4.4.4. Available potassium concentration in post harvest soil

4.4.4.1. Effect of soils on the K content in post harvest soil

The effects of soils on the available K of post harvest soil are presented in Table 4.37. Available potassium in post harvest soil showed statistically significant variations with two different soils.The higher levels of available K was found in the soils of SAU (17.79 ppm in 0-10 cm and 17.37 ppm in 10-20 cm) compared to Sonargaon soil. In each soil, the similar values of available K were found in the 0-10 and 10-20 cm depth soil.

4.4.4.2. Effect of fertilizer and manure on the K content in post harvest soil

Available potassium in post harvest soil showed statistically significant differences due to the application of different organic manure and inorganic fertilizer in rice (Table 4.38). The level of available K in post harvest soil increased due to combined application of fertilizer and manure. The post harvest soil of T_3 (50% NPKS + 2.1 ton poultry manure/ha) treatment gave the highest K concentration in the post harvest soils (19.25 ppm in 0-10 cm and 18.50 ppm in 10-20 cm). On the other hand, the lowest available potassium (9.75 ppm in 0-10 cm and 10.58 ppm in 10-20 cm) was obtained from control treatment. Avoola & Makinde (2009) found that application of chemical fertilizer with organic manure increase K content in post harvest soil. Similar result also found by Reddy *et al.* (2005).

4.4.4.3. Combined effect of fertilizer and soils on the K content in post harvest soil

The combined effect of different doses of fertilizer and soils on the available K in post harvest soil of rice core was significant (Table 4.39). In the depth of 0-10 cm, the highest available potassium concentration (25.00 ppm) was obtained from S_1T_3 (SAU Soil + 2.1 ton poultry manure/ha) treatment combinations and lowest (9.50 ppm) from S_1T_0 (SAU Soil + No fertilizer) treatment combination. Similarly in the depth of (10-20) cm, the higher (20.83 ppm) available potassium was obtained from S_1T_2 (SAU Soil + 50% NPKS + 5 ton cowdung/ha) and the lowest (11.17 ppm) available K concentration was found from S_2T_0 (Sonargaon Soil + No fertilizer) treatment combination.

4.4.5. Available sulphur concentration in post harvest soil

4.4.5.1 Effect of soils on the S content in post harvest soil

The effects of soils on the S content of post harvest soil are presented in Table 4.37. Available sulphur in post harvest soil showed statistically significant variations with two different soils. In the depth of (0-10) cm, the highest (29.36 ppm) concentration of available sulphur was found in S_2 (Sonargaon Soil) soil compared to S_1 (SAU Soil) soil. Similarly in the depth of (10-20) cm, the highest (24.42 ppm) level of available S concentration was found in S_2 (Sonargaon Soil) soil.

4.4.5.2. Effect of fertilizer on the S content in post harvest soil

Available sulphur in post harvest soil showed statistically significant differences due to the application of different organic manure and inorganic fertilizer in rice. The level of available S in post harvest soil increased due to combined application of fertilizer and manure. The post harvest soil of T_3 (50% NPKS + 2.1 ton poultry manure/ha) treatment gave the highest S concentration in the soils of 33.78 ppm in 0-10 cm soil and 26.53 ppm in 10-20 cm soil. On the other hand, the lowest available sulphur (13.43 ppm in 0-10 cm soil and 13.88 ppm in 10-20 cm soil) was obtained from T_0 as control treatment (Table 4.38).

4.4.5.3. Combined effect of fertilizer and soils on the S content in post harvest soil

The combined effect of different doses of fertilizer and soils on the available S in post harvest soil of rice core was significant (Table 4.39). In the depth of (0-10) cm, the highest available sulphur concentration (37.35 ppm) was obtained from S_2T_3 (Sonargaon Soil + 2.1 ton poultry manure/ha) treatment combinations and lowest (11.56 ppm) from S_1T_0 (SAU Soil + No fertilizer) treatment combination. Similarly in the depth of (10-20) cm, the higher (30.63 ppm) available sulphur was obtained from S_2T_2 (Sonargaon Soil + 50% NPKS + 5 ton cowdung/ha) and the lowest (12.69 ppm) available S concentration was found in S_1T_0 (SAU Soil + No fertilizer) treatment combination.

CHAPTER V
SUMMARY AND CONCLUSION

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted in a net house of Soil Science Department of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from July, 2011 to April, 2012 to study the effect of fertilizer and manure application on yield and yield components of rice and leaching loss of nutrients through undisturbed soil columns. The BR11 and BRRI dhan29 were used for T.Aman and Boro rice as the test crop in this experiment. The experiment consists of 2 factors i. e. soils and fertilizer plus manure. Two soils (S_1 = SAU Soil and S_2 = Sonargaon Soil) were used with 4 levels of fertilizer plus manure, as T_0: Control, T_1: 100% $N_{120}P_{20}K_{45}S_{20}$ (Recommended dose), T_2: 50% NPKS + 5 ton cowdung/ha, T_3: 50% NPKS + 2.1 ton poultry manure/ha. There were 8 treatment combination as S_1T_0 (SAU Soil + Control), S_1T_1 (SAU Soil + 100% $N_{120}P_{20}K_{45}S_{20}$ (Recommended dose), S_1T_2 (SAU Soil + 50% NPKS + 5 ton cowdung/ha), S_1T_3 (SAU Soil + 50% NPKS + 2.1 ton poultry manure/ha), S_2T_0 (Sonargaon Soil + Control), S_2T_1 (Sonargaon Soil + 100% $N_{120}P_{20}K_{45}S_{20}$), S_2T_2 (Sonargaon Soil + 50% NPKS + 5 ton cowdung/ha), S_2T_3 (Sonargaon Soil + 50% NPKS + 2.1 ton poultry manure/ha) and 3 replications.

The yield parameters were not significantly affected with the difference of soil. The number of effective tillers, plant height, panicle length and filled grains panicle^{-1} were significantly influenced by fertilizer and manure treatment in T. aman rice. The higher values of plant height, panicle length and filled grains panicle^{-1} were found in the Sonargaon soil than SAU soil. The single effect of fertilizer and manure significantly influenced the effective tiller core^{-1}, plant height, panicle length and number of filled grain panicle^{-1} of T.Aman rice. The highest number of effective tiller core^{-1}, plant height and panicle length were recorded in T_1(RDCF: Recommended dose of chemical fertilizer) treatment which was statistically similar to T_2 (50% RDCF + 5 ton cowdung ha^{-1}) and T_3 (50% RDCF + 2.1 ton poultry manure ha^{-1}) treatments and lowest was found from T_0 treatment. The maximum number of filled grains panicle^{-1} was obtained from T_3(50% RDCF + 2.1 ton poultry manure ha^{-1}) treatment where 50% RDCF and 2.1 ton ha^{-1} poultry manure were applied and lowest number of filled grains panicle^{-1} was found in T_0 treatment where fertilizer or manure was not applied. Due to combined application of different soil and fertilizer, the highest number of effective tillers and plant height was found in the treatment of S_2T_1 where RDCF was applied in Sonargaon soil which was statistically similar to S_1T_1 and S_2T_3 treatments. The highest panicle length (23.90 cm) was found in the treatment combination S_2T_2 (50% RDCF + 5 ton cowdung ha^{-1} applied in Sonargaon soil) and highest filled grains $panicle^{-1}$ was found in the S_2T_3 treatment where 50% RDCF plus 2.1 ton poultry manure ha^{-1} was used in Sonargaon soil.

The 1000 seed weight, straw and grain yield were not significantly affected due to the difference of soil. Among the fertilizer treatments, the highest straw yield (0.053 kg $core^{-1}$) was found in T_1 treatment (100% recommended dose of chemical fertilizer) which was statistically similar to T_2 (50% RDCF + 5 ton cowdung ha^{-1}) and T_3 (50% RDCF plus 2.1 ton ha^{-1} poultry manure) treatments. Similarly, the highest grain yield (0.046 kg $core^{-1}$) was recorded in T_1 treatment which was statistically similar to T_2 (50%RDCF + 5 ton cowdung ha^{-1}) and T_3 (50% RDCF + 2.1 ton poultry manure ha^{-1}) treatments. The lowest grain yield was recorded in T_0 treatment where fertilizer was not applied. Due to combined effect of different soils and fertilizer treatment, the highest grain yield was obtained from S_2T_1 (RDCF applied on Sonargaon soil) treatment which was almost similar to S_1T_1, S_1T_3, S_2T_2 and S_2T_3 treatment combinations.

The N concentration in the leachate of T. Aman growing period varied significantly with different soil, fertilizer treatment and time. The higher N concentrations were found in the leachate of SAU (S_1) soil compared to Sonargaon soil. In T.aman season of 2011, the concentration of N in the leachate increased with time from the 25^{th} day after transplantation to 45 DAT of T.Aman rice may be due to increasing the temperature and microbial activity in soil. The highest leachate N concentration of (5.08 ppm in SAU and 4.78 ppm in Sonargaon soil) was observed at 45 DAT.The level of N concentration was higher in the leachate at 35 to 65 DAT (1^{st} week of August to mid September). Among the fertilizer treatments, higher leachate N concentrations were found in the leachate of 100% recommennded dose of chemical fertilizer(T_1-RDCF) and lower levels of leachate N concentrations were observed in the control treatment(where fertilizer or manure was not added) and two organic plus inorganic fertilizer treatments. Combined effect of soil and fertilizer had no significant effect on leachate N concentrations but highest leachate N concentrations were recorded in S_2T_1 (100% recommended dose of chemical fertilizer applied on Sonargaon soil) treatment at 45 DAT and lowest was found in S_1T_0 (No addition of fertilizer in SAU soil) treatment combination at 25 DAT.

Higher leachate K concentrations were found in Sonargaon soil compared to SAU soil. Among the fertilizer treatments, higher concentrations of K were found in the leachate of 100% chemical fertilizer treatment compared to other treatments. Chemical fertilizer was more leachable from the solution but where organic plus inorganic fertilizers were added to soil then nutrient were adsorbed to organic colloids and formed complex and leaching was reduced. The highest concentration of K was found in the leachate of 35 DAT and then almost similar trend was observed. When fertilizer was applied initially more leachable K was present in the soil solution, and after 35 days soluble K was fixed on the soil colloidal surface. Due to combined effect of soil and fertilizer, highest concentration of K in the leachate was found in the S_2T_1 where 100% recommended dose of chemical fertilizer was applied in Sonargaon soil. Due to combined application of different soil and fertilizer, the leachate concentration significantly influenced and higher leachate K concentrations were found in the treatment of S_1T_1 and S_2T_1 where 100% chemical fertilizer was applied on SAU and Sonargaon soils.

Almost similar concentration of P was found in the leachate of both the soil. Highest Leachate P concentration was observed at 35 DAT and then declined upto 75DAT. In all soils and fertilizer treatments, the leachate P concentrations were low may be due to less mobility of this nutrient. There was no significant P concentration difference among the soils and fertilizer treatments.

Higher S concentrations were found in the leachate of SAU soil compared to Sonargaon soil. The leachate S concentrations increased with increasing time upto 75 DAT during the rice growing period in both the soils. In the leachate samples of different dates, the lowest leachate S concentration was obtained in control treatment where S was not added as a fertilizer or manure. Among the fertilizer treatments, higher levels of S concentrations were recorded in the leachate of two combined treatment where cowdung and poultry manure were used with 50% chemical fertilizer. The highest concentration of 8.74 ppm S was obtained from the T_2 treatment where 50% RDCF and 5 ton cowdung ha^{-1} were applied. The lowest S concentration (0.232 ppm) was obtained from the control treatment. Due to combined application of soil and fertilizer, lowest level of sulpher in the leachate was found in S_2T_0 treatment where fertilizer was not added on Sonargaon soil.

During Boro season, the highest plant height, panicle length, number of filled grain, 1000 grain wt. straw yield and grain yield were observed in Sonargaon soil. Yield contributing characters and yields were significantly affected by fertilizer and manure. The higher values of yield parameters and yields were recorded in the treatments where fertilizer plus manure were used. The higher plant height (79.95 cm), panicle length (22.26 cm), 1000 grain wt. (20.75 g), grain yield (29.67 g/core) and straw yield (34.13 g/core) and no. of filled grain (100.00) were found from T_1 and T_3 treatments. On the other hand, lowest values were obtained from T_0 treatment. The plant height, panicle length, grain yield, and straw yield and no. of filled grain were not significantly influenced by combined application of manure and fertilizer but 1000 grain wt. was significantly influenced. The higher values of plant height (82.94 cm), panicle length (22.82 cm), 1000 grain wt. (21.07 g), grain yield (34.30 g/core) and straw yield (37.83 g/core) and no. of filled grain (108.00) were recorded from S_2T_1, S_2T_2, S_2T_3 treatment combination. The lower values of plant height (61.52 cm), panicle length (20.42 cm), 1000 grain wt. (19.93 g), grain yield (19.53 g/core) and straw yield (23.97 g/core) and no. of filled grain (73.00) were observed from S_1T_0 and S_2T_0 treatment combination.

Nutrient concentration in grain was significantly affected by application of fertilizer and manure. The grain concentration of N, P, K and S recorded in S_1 and S_2 soils were almost same. The higher grain concentrations of N (1.205%), P (0.261%), K (0.296%) and S (0.125%) were recorded from T_2 and T_1 treatment and lowest value was observed in T_0 treatment. The pH, and levels of N, P, K and S of post harvest soil were significantly affected by soil and fertilizer. The nutrient concentrations in post harvest soils were higher in the fertilizer treatments those received manure plus inorganic fertilizers. There was significant change of pH in post harvest soil in two different soils (Table 4.34). In the depth of 0-10 cm and 10-20 cm soil, the highest pH (7.3 & 7.6) values were found in Sonargaon soil compared to SAU soil. The pH of 0-10 cm depth of post harvest soil showed insignificant variation due to the application of different doses of fertilizers (Table 4.35). The highest pH (7.2) was recorded in T_0 treatment. The lowest pH (6.1) was recorded in T_3 treatment. The pH of 10-20 cm depth of post harvest soil was significantly affected by different fertilizer treatments. In the depth of 10-20 cm, the highest pH (7.5) value was found in the T_1 and T_3 treatments and lowest in control treatment. The combined effect of different doses of fertilizer and soil on pH of 0-10 cm depth of post harvest soil was insignificant.The highest pH (7.5) of post harvest soil was recorded in the S_2T_0 treatment combination. The lowest pH (6.7) was recorded in the S_1T_1 treatment combination. The pH of 10-

20 cm depth of post harvest soil was significantly affected by combined effects of soils and fertilizers. In the depth of 10-20 cm, the highest pH (7.7) was recorded in S_2T_1 and S_2T_2 treatment combination. Total nitrogen concentration in post harvest soil showed statistically significant differences in two different soils. S_1 (SAU Soil) showed the higher total N concentrations (0.08% in 0-10 cm depth soil) compared to Sonargaon Soil (0.07%). In 10-20 cm depth, almost similar N concentrations was found in the post harvest soils of SAU and Sonargaon. The total N content of post harvest soil was significantly influenced by fertilizer and manure application. The highest (0.09 % in 0-10 cm and 0.08 % in 10-20 cm depth) total N concentrations was found in the post harvest soils in T_2 treatment. On the other hand, the lower (0.06%) total N concentrations in post harvest soil was obtained from T_0 as control treatment. The combined effect of different doses of fertilizer and soils on the N content in post harvest soil of rice core was significantly different. In the depth of (0-10) cm, the highest (0.097 %) total N concentration of post harvest soil was found in S_1T_2 treatment combination and lowest (0.060 %) was obtained from S_1T_0 treatment combination. Similarly the highest (0.077 %) level of total N concentrations in the depth of (10-20) cm was obtained in S_1T_2 and S_2T_2 treatment combinations and lowest concentration was found in both the soils with control treatment. Available phosphorus concentration in post harvest soil showed statistically significant variations with two different soils. In the depth of (0-10) cm, the highest (26.77 ppm) concentration of available phosphorus was found in S_1 (SAU Soil) soil compared to S_2 (Sonargaon Soil). Similarly, the highest (22.63 ppm) levels of available P concentration was found in S_1 (SAU Soil) soil of 10-20 cm depth. Available phosphorus in post harvest soil showed statistically significant differences due to the application of different manure and inorganic fertilizer during rice growing period. The higher levels of available P (27.19 ppm in 0-10 cm soil and 23.56 ppm in 10-20 cm soil) were recorded in the T_2 treatment. On the other hand, the lower phosphorus levels were (14.92 ppm in 0-10 cm) and (13.87 ppm in 10-20 cm) were obtained from T_0 control treatment. The combined effect of different doses of fertilizer and soils on the available phosphorus in post harvest soil of rice core was insignificant. In the depth of (0-10) cm, highest (29.55 ppm) level of available P concentration was recorded from S_1T_1treatment combination and the lowest (10.25 ppm) was found from S_2T_0 treatment combination. Similarly, in the depth of (10-20) cm, the highest (26.70 ppm) phosphorus concentration was found in the treatment combination S_1T_3. The

lowest (10.70 ppm) was obtained from S_2T_0. Available K in post harvest soil showed statistically significant variations in two different soils.The higher levels of available K was found in the soils of SAU (17.79 ppm in 0-10 cm and 17.37 ppm in 10-20 cm) compared to Sonargaon soil. Available K in post harvest soil showed statistically significant differences due to the application of different organic manure and inorganic fertilizer. The post harvest soil of T_3 treatment gave the highest K concentration in the post harvest soils (19.25 ppm in 0-10 cm and 18.50 ppm in 10-20 cm). On the other hand, the lowest available K (9.75 ppm in 0-10 cm and 10.58 ppm in 10-20 cm) was obtained from control treatment. The combined effect of different doses of fertilizer and soils on the K content in post harvest soil of rice core was significant. In the depth of 0-10 cm, the highest available potassium concentration (25.00 ppm) was obtained from S_1T_3 treatment combinations and lowest (9.50 ppm) from S_1T_0 treatment combination. Similarly in the depth of (10-20) cm, the higher (20.83 ppm) available potassium was obtained from S_1T_2 and the lowest (9.50 ppm) available K concentration was found from S_2T_0 treatment combination. Available S in post harvest soil showed statistically significant variations in two different soils. In the depth of (0-10) cm, the highest (29.36 ppm) concentration of available sulphur was found in S_2 (Sonargaon Soil) soil compared to S_1 (SAU Soil) soil. Similarly in the depth of (10-20) cm, the highest (24.42 ppm) level of available S concentration was found in S_2 (Sonargaon Soil). Available sulphur in post harvest soil showed statistically significant differences due to the application of different organic manure and inorganic fertilizer in rice. The level of available S in post harvest soil increased due to combined application of fertilizer and manure. The post harvest soil of T_3 treatment gave the highest S concentration in the soils of (33.78 ppm in 0-10 cm soil and 26.53 ppm in 10-20 cm soil). On the other hand, the lowest available sulphur (13.43 ppm in 0-10 cm soil and 13.88 ppm in 10-20 cm soil) was obtained from T_0 as control treatment. The combined effect of different doses of fertilizer and soils on the S content in post harvest soil of rice core was significant. In the depth of (0-10) cm, the highest available sulphur concentration (37.35 ppm) was obtained from S_2T_3 treatment combinations and lowest (11.56 ppm) from S_1T_0 treatment combination. Similarly in the depth of (10-20) cm, the higher (30.63 ppm) available sulphur was obtained from S_2T_2 and the lowest (12.69 ppm) available S concentration was found in S_1T_0treatment combination.

From the above discussion it can be concluded that soil had no significant effect on yield and yield contributing characters. Application of 50% NPKS + 2.1 ton poultry manure/ha is most favorable for improving yield and yield contributing characters in T.Aman (BR11) and Boro rice (BRRI dhan29). The leaching of nutrient was higher in chemical fertilizer treatment (T_1) compared to combined application of fertilizer and manure.The nutrient level of post harvest soil was increased in the treatments where organic plus inorganic fertilizer were observed.

Before recommend the findings of the present study, the following recommendations and suggestions may be made:

1. Such study is needed by using the soils of different agro-ecological zones (AEZ) of Bangladesh.
2. Another combination of NPKS and others organic manures with different fertilizer management may be included for further study.

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APPENDIX

APPENDIX

Appendix I. Monthly record of air temperature, rainfall, relative humidity, soil temperature and Sunshine of the experimental site during the period from July 2011 to April 2012

Year	Month	*Air temperature (°c)		*Relative humidity (%)	*Rain fall (mm) (total)	*Sunshine (hr)
		Maximum	Minimum			
2011	July	37.1	21.1	74.9	77	6.3
	August	35.6	16.9	77.3	270	5.9
	September	33.5	18.5	78.1	210	5.6
	October	36.2	17.5	74.9	320	5.9
	November	31.	15.6	67.3	0.00	5.8
	December	25.5	15.2	68	13.6	5.7
2012	January	24.8	14.2	66	6.6	5.8
	February	27.7	16.1	67	27.8	5.5
	March	33.5	21.9	65	64.7	5.6
	April	49.5	27.5	69	165.9	4.8

* Monthly average,

Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka – 1212.

Plate 1. Experiment in net house of T. Aman

Plate 2. Experiment in net house of Boro season.