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Nutrient dynamics in paddy soil under rice culture mesocosm studies

M. A. Islam[1], M. A. Khan[2] and M. A. Rouf [3]

[1]Biotechnology Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh- 2202
[2]Department of Soil Science, Sher-e-Bangla Agricultural University, Dhaka-1207
[3]Adaptive Research and Extension Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh- 2202

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Correspondence:
M. A. Khan
(makhan_sau@ymail.com)

Abstract

The objectives of this study were to determine the nutrient losses through the soil columns with the variation of soil and fertilizer. The experiment was conducted in a net house of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during July–November to study the effect of fertilizer and manure on the growth and yield of T. aman rice and leaching loss of nutrients through undisturbed soil columns. The experiment consists of 2 factors i.e. soils and fertilizer plus manure. Two soils (S_1= SAU Soil and S_2= Sonargaon Soil) with 4 levels of fertilization, as F_0: Control, F_1: 100% $N_{120}P_{20}K_{45}S_{20}$ (FRG 2012), F_2: 50% NPKS + 5 t/ha cowdung, F_3: 50% NPKS + 2.1 t/ha poultry manure were used in the experiment. T. Aman (BR11) rice was grown in the soil cores . Altogether, there were 8 treatment combinations and the treatment combinations were replicated 3 times. Twenty four undisturbed soil cores collected in PVC pipes were placed at the bottom of the perforated plastic containers and two holes of each plastic container was connected to a conical flask that was used to collect column leachate. Leachates were collected at 25, 35, 45, 55, 65 and 75 DAT (Days after transplanting) and analyzed for N, P, K and S. The leachate N, P, K and S concentration varied with different soil, fertilizer and time. The higher N and S concentrations were found in the leachate of SAU soil and higher leachate K concentrations were obtained in Sonargaon soil. The higher amounts of N leaching were observed during 45–55 DAT and higher leachate N concentrations were found in F_1 treatment. Higher leachate K concentrations were found in 100% chemical fertilizer treatment and higher leachate K concentrations were found at 35DAT in all fertilizer treatments. The leachate P concentration increased at 35 DAT and then decreased. 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. The highest effective tillers/core (17.0), plant height (105.6 cm), panicle length (23.70 cm), grain yield (0.046 kg/core) and straw yield (0.053 kg/core) of T. Aman rice were found from F_1 (RDCF) treatment. The highest 1000-grain wt. (23.70 g) was obtained from F_2 and filled grain/panicle (121.8) from T_3 treatment and the lowest in F_0 treatment. The highest grain yield was found by the application of recommended dose of chemical fertilizer which was statistically similar to F_3 (50% NPKS + 2.1 ton poultry manure) 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_2F_1 (Sonargaon Soil + 100% NPKS) treatment combination.

Introduction

Rice-rice cropping system is the most important cropping system in Bangladesh covering more than 75% of the total cultivable land. Continuous cultivation of this highly exhaustive cropping sequence in most of the irrigated fertile lands causing decline of soil physio-chemical condition in general and soil organic matter (SOM) depletion in particular. Moreover, increasing land use intensity has accelerated a great nutrient depletion in the soils of Bangladesh. It will, therefore, be necessary to place greater emphasis on strategic research to increase the efficiency of applied nutrients through the integration of organic manures, which will help in accomplishing twin objectives of sustaining soil health and ensuring food security and environmental protection.

Application of manures and fertilizers has tremendous effects on the nutrient dynamics in soil. The available nutrient moves downward with percolated water. The bioavailability and movement of nutrients in soil are dependent on a number of factors including the sources and concentrations of the nutrient, soil properties such as clay content, pH and redox conditions, ions and type and amount of SOM. The efficiency of applied fertilizers in the rice field is greatly affected by the level of soil moisture during rice growing periods. SOM decomposition and nutrients mineralization are also greatly affected by the soil moisture level. Anaerobic condition 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 is governed by the difference of soil and the variation of added fertilizer. Application of chemical fertilizers with farmyard manure increase N,P and K uptake by rice plants and increase 1000 grain weight and grain yield of rice (Yang et al., 2004). The mobility of N, P, K and S in soil is still not thoroughly understood. The preferential flow of K in the undisturbed soil cores due to lack of K sorption (Jalali and Rowell, 2009). Anderson and Magdoff (2005) found that repeated application of organic forms of P could lead to significant leaching of P to ground water.

Little is known 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 know the suitable level and type of manure and fertilizer. The fate of added fertilizer in the soil column and estimation of nutrient leaching will be worthy. The study was undertaken to understand the effect of manure and fertilizer on yield and leaching loss of nutrients through soil columns in rice culture system.

Materials and Methods

An experiment was carried out in a net house of Sher-e-Bangla Agricultural University during the T. Aman season (July to November) to evaluate the nutrient dynamics in undisturbed paddy soil columns with rice culture. The climate of the experimental area is characterized by high temperature, high humidity and medium rainfall with occasional gusty winds during the season. Two soils were collected in poly vinyl choride (PVC) pipes from the SAU farm, Dhaka and Farmers field, Sonargaon, Narayanganj during July, 2011. Twenty four (2 soils x 4 fertilizer application x 3 replication) undisturbed soil cores (25 cm diameter and 40 cm length) were collected in PVC pipes. Initial soil samples were collected from each site and analyzed for physio-chemical properties. The PVC pipes were pushed into the soil by creating pressure inside pipe wall and by adding water in the soil. The soil cores were carried to the net house and were placed in the plastic container. Filter paper (Whatman No. 1), glass wool and a 4-cm layer of acid-washed silica sand (1–2 mm diameter) were placed at the bottom of the plastic container that served as the base for the PVC soil core. Two holes in the plastic base were connected by means of polypropylene tubes and a T tube to a air-tight conical flask to collect leachate (Fig. 1). Two soils (Soil-1: SAU Soil, Soil-2: Sonargaon Soil) and four fertilizer treatments (F_0: Control F_1: ($N_{120}P_{20}K_{45}S_{20}$) (FRG 2012), F_2: 50% NPKS + 5 t/ha cowdung , F_3:50% NPKS + 2.1 t/ha poultry manure) were used for rice cultivation in the PVC cores. The treatment wise required amounts of manures and N, P, K and S fertilizers per core were applied by acre furrow slice based calculation. Full amounts of manure, TSP, MoP and gypsum were applied at final land preparation before transplanting. Urea was applied in 3 equal splits: one third was applied as basal dose 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 soils and manures used have been presented in (Table 1& 2).

BR11 was used as the test crop in this experiment. The experimental design was Complete Randomized Design (CRD) 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. Thirty days old T.Aman seedlings of BR11 were transplanted on the 1st week of July. Two seedlings were used in each hill and one hill/ soil core. Traditional irrigation (2-3 cm continuous flooding) was applied during the growing period of T.Aman rice crop. Intercultural operations and plant protection measures were done to ensure normal growth of the crop. Leachates were collected at 25, 35, 45, 55, 65 and 75 DAT of T. Aman rice and analyzed for N, P, K and S by using standard analytical methods. The crop was harvested at full maturity when 80–90% of the grains were turned into straw color. The crop was cut at ground level. After harvest, the rice yield parameters and yield were recorded.

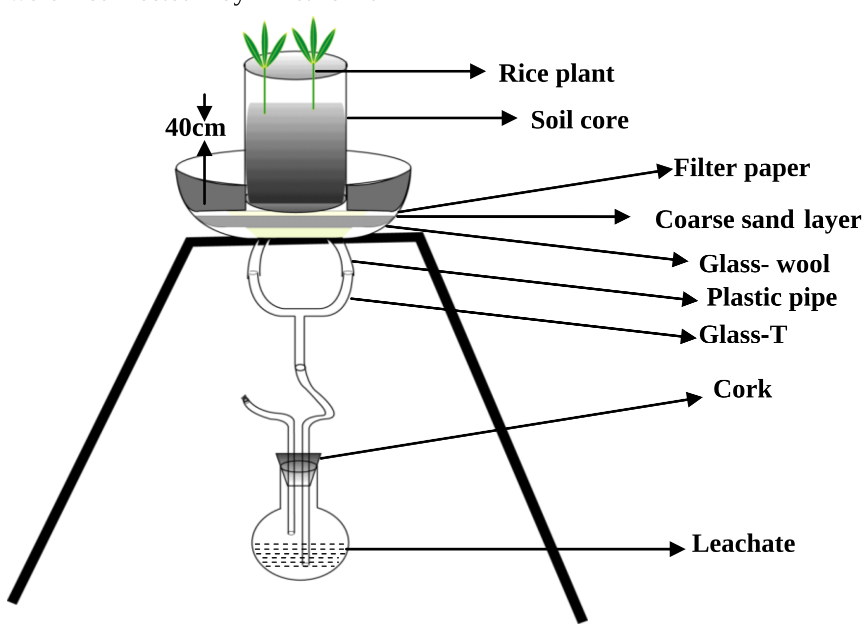


Fig. 1. Leachate collection from undisturbed soil core with fertilizer and manure application in T. Aman rice

Table 1. 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 (%)	0.69	1.01
Total N (%)	0.062	0.073
Exchangeable K (cmolckg^{-1})	0.12	0.23
Available P (mg kg^{-1})	19.85	12.00
Available S (mg kg^{-1})	14.40	16.00

Table 2. Nutrient levels in cowdung and poultry manure (oven dry basis)

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

Soil and leachate analysis

Soil samples were analyzed for both physical and chemical characteristics viz. texture, pH, total N and available P, K, and S contents. The leachate samples were analyzed for N, P, K and S concentrations. 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 in the Marshall's triangular co-ordinate following the USDA system. Soil pH was determined by glass electrode pH meter (Jackson, 1962). The organic carbon was determined by wet-oxidation method (Walkley and Black, 1935). Total N of soil was determined by the Micro Kjeldahl method. One g of oven dry ground soil sample was taken into a micro Kjeldahl flask to which 1.1 g 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°C and added 2 ml H_2O_2 and then heating at 360°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 N determination (Page *et al*., 1982). Ten ml digest was transferred into the distillation flask, 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 boric acid. By operating switch of the distillation apparatus the distillate was collected and titrated with 0.01N sulphuric acid. Available P was determined from the soil with 0.5 M $NaHCO_3$ solution, pH 8.5 (Olsen *et al*., 1954). Exchangeable K was determined by 1N NH_4OAc (pH 7) extraction method and by using flame photometer and calibrated with a standard curve. Available S was extracted by $CaCl_2$ (0.15%) solution and determined as described by Page *et al*. (1982). The leachates were analyzed for available N, P, K and S by using similar methods. The data obtained for different parameters were statistically analyzed to find the significant difference of different treatments on yield and yield contributing characters of BR11. 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).

Results and Discussion

Leachate N and K concentrations

The N concentration in leachate during T. Aman growing period varied with different soils, fertilizer treatments and time. Higher leachate N concentrations were found during 35 to 45 DAT of rice with different soils and fertilizer treatments. The higher N concentrations were found in the leachates of SAU (S_1) soil compared to Sonargaon soil (S_2). The N leaching increased with time from 25 to 45 days after transplantation of rice may be due to increasing temperature, microbial activity and application of urea in soil. The highest leachate N concentrations (5.08 ppm) was recorded in SAU soil and that of 4.78 ppm was recorded in Sonargaon soil (Table 3). 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 3). The higher K leaching was found in the Sonargaon soil may be due to the presence of higher levels of background available K. Higher K leaching was noticed at 35DAT may be due to the effect of temperature and that date was closer to application of fertilizer.

Table 3. N and K conc. in leachates at different dates of T. Aman rice growing period in two soils

Soil	leachate N (ppm)						leachate K (ppm)					
	25 DAT	35 DAT	45 DAT	55 DAT	65 DAT	75 DAT	25 DAT	35 DAT	45 DAT	55 DAT	65 DAT	75 DAT
S_1	1.87	4.25a	5.08	3.50a	3.84	2.45	0.71a	3.61	1.07b	0.71a	1.81	2.87
S_2	1.81	3.47b	4.78	1.93b	3.03	2.33	1.20b	4.85	1.49a	1.43b	2.5	4.22
SE(±)	NS	0.27	NS	0.43	NS	NS	0.07	**NS**	0.12	0.06	0.49	1.02

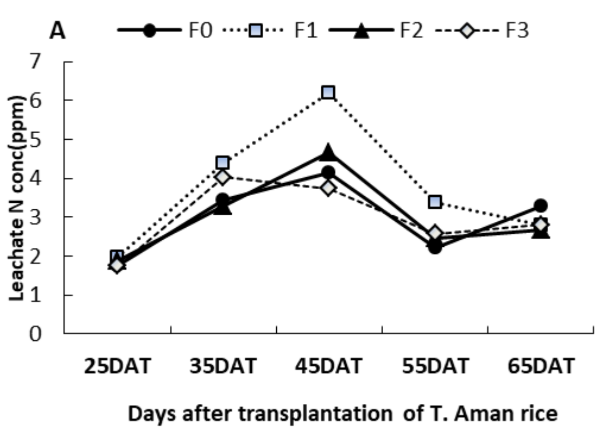
In a column figure(s) with dissimilar letter differ significantly as per DMRT at 5% level of significance.

The highest N concentrations were found in the leachate of 100% recommended dose of chemical fertilizer (F_1-RDCF) and the lowest concentration was observed in the control treatment (Fig. 2). The higher concentrations of N leaching were observed during 45–55 DAT and highest concentration (6.18 ppm) was found in F_1 treatment at 45DAT. Among the fertilizer treatments, higher concentrations of K were found in the leachate of 100% chemical fertilizer treatment compared to other fertilizer treatments (Fig. 2). The highest K concentration (5.18 ppm) in the leachate was found at 35 DAT with F_2 treatment and lowest K concentrations were found from the control. Chemical fertilizer was more leachable from the soil solution but where organic and inorganic fertilizers were added to soil then nutrients 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.

Combined effect of soil and fertilizer had no significant effect on leachate N concentrations in different dates but highest leachate N concentrations was recorded in S_2F_1 (100% recommended dose of chemical fertilizer applied on Sonargaon soil) treatment at 45 DAT and lowest was found in S_1F_0 (No addition of fertilizer in SAU soil) treatment combination at 25 DAT (Table 4). Due to combined effect of soil and fertilizer, higher (5.79 ppm) concentrations of K in the leachate were found in the S_2F_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 S_1F_1 and S_2F_1 in most of time where 100% chemical fertilizer was applied on SAU and Sonargaon soils (Table 4). Significant amounts of K leaching were found in the leachate samples of different days after transplantation with different soils and fertilizer treatment combinations. This K leaching can be minimized by split application or by adopting proper fertilizer management practices.

Leachate P and S concentration

The P concentrations in the leachate were 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 5). 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 5).



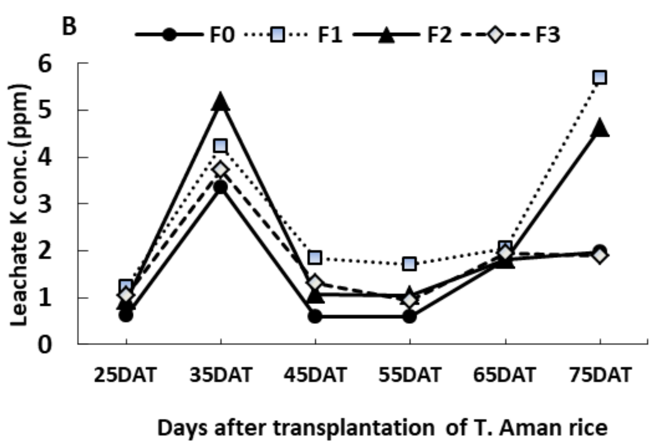


Fig. 2. Effect of fertilizer and manure on N and K conc. in the leachate of different dates of T.Aman rice growing period

Table 4. Effect of fertilizer and manure with different soils on N and K conc. in the leachate of different dates of T. aman rice growing period

Treatment combination	Leachate N (ppm)						Leachate K (ppm)					
	25 DAT	35 DAT	45 DAT	55 DAT	65 DAT	75 DAT	25 DAT	35 DAT	45 DAT	55 DAT	65 DAT	75 DAT
S_1F_0	1.40a	3.62	4.43	2.57	3.27	2.33	0.63c	3.27	1.19ab	0.33	0.77	1.67
S_1F_1	2.33b	5.13	5.60	3.97	1.86	2.80	0.77c	3.80	1.67ab	1.04	1.10	3.75
S_1F_2	2.10b	3.38	5.36	3.03	3.03	2.33	0.83bc	4.56	0.71b	0.83	2.82	4.17
S_1F_3	1.80b	4.55	4.90	3.97	2.80	1.86	0.63c	2.81	0.71b	0.62	2.56	1.88
S_2F_0	2.10b	3.27	5.83	1.87	3.27	2.33	1.04abc	4.33	1.19ab	0.83	2.82	2.29
S_2F_1	1.63ab	3.62	6.77	2.80	3.73	1.63	1.46ab	4.68	1.43ab	1.04	1.03	5.63
S_2F_2	1.63ab	3.15	3.97	1.87	2.33	3.50	1.04abc	5.79	1.43ab	2.38	2.82	5.09
S_2F_3	2.10b	3.50	2.57	1.17	2.80	2.33	1.46ab	4.62	1.70a	1.25	3.33	1.88
SE(±)	**0.42**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.15**	**NS**	**0.25**	**0.13**	**NS**	**NS**

In a column figure(s) with dissimilar letter differ significantly as per DMRT at 5% level of significance.

Table 5. Effect of soils on P and S conc. in the leachate during T.Aman rice growing period

Soil	Leachate P (ppm)						Leachate S (ppm)					
	25 DAT	35 DAT	45 DAT	55 DAT	65 DAT	75 DAT	25 DAT	35 DAT	45 DAT	55 DAT	65 DAT	75 DAT
S_1	0.125	1.36	0.39	0.36	0.16	0.04	3.20	0.39a	4.08	6.89	6.76	7.26
S_2	0.158	1.22	0.42	0.32	0.11	0.08	3.35	0.19b	3.85	1.36	6.06	6.21
SE(±)	**NS**	**NS**	**NS**	0.43	**NS**	**NS**	NS	0.05	NS	0.86	NS	NS

In a column figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

The fertilizer application did not affect the leachate P concentrations significantly. Higher leachate P concentrations were found in the F_1, F_2 and F_3 treatments where fertilizer and manure were applied (Fig. 3). The leachate P concentration increased at 35 DAT and then decreased. Higher P leaching was noticed at 35DAT may be due to presence of higher orthophosphate in the pore-water initially and decreased solubility for becoming non-labile P with increasing time. The root growth and increase of microbial population may contribute to increase leachate P concentration. 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 (Fig. 3). The highest concentration of 8.74 ppm S was obtained from the F_2 treatment where 50% RDCF and 5 ton cow dung ha^{-1} were applied. The lowest S concentration (0.23 ppm) was obtained from the control treatment.

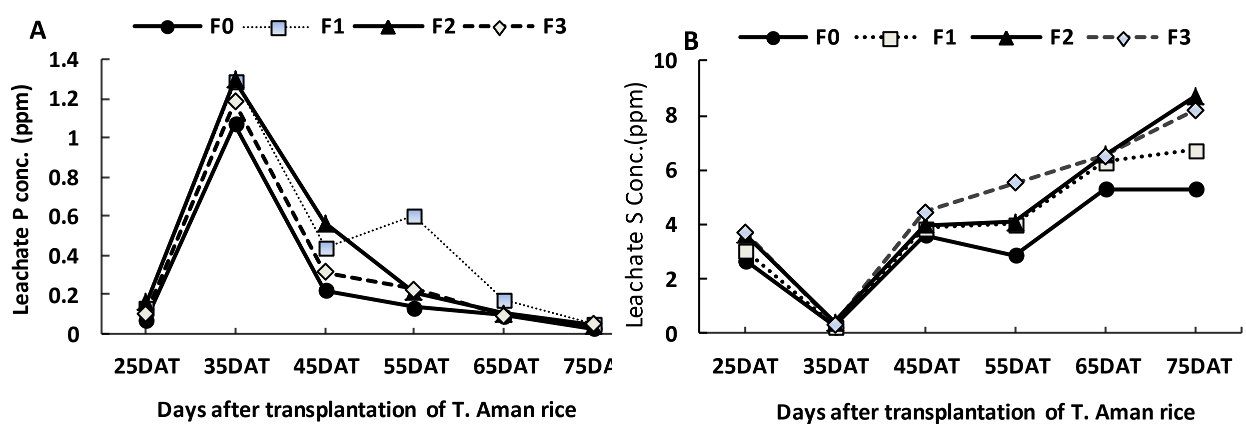


Fig. 3. Effect of fertilizer and manure on P and S conc. in the leachate of different dates of T. Aman rice growing period

The leachate P concentration was not significantly affected by the interaction effect of fertilizer and soil. The highest (1.70 ppm) leachate P concentration was found at 35 DAT with S_1F_2 treatment combination and the lowest (0.82 ppm) from S_1F_3 treatment combination (Table 6). The higher leachate S concentrations were found in the combined application of fertilizer and SAU soils. The highest leachate S concentrations were found in the S_1F_3 treatment combination and lowest from S_2F_0 treatment combination. The presence of higher concentrations of leachate S over the fertilizer treatments and soils during the growing periods indicated higher mobility and solubility of sulphate in soil.

Table 6. Interaction effect of fertilizer and manure with different soils on P and S conc. in the leachate of different dates during T. aman rice growing period

Treatment combination	Leachate P (ppm)						Leachate S (ppm)					
	25 DAT	35 DAT	45 DAT	55 DAT	65 DAT	75 DAT	25 DAT	35 DAT	45 DAT	55 DAT	65 DAT	75 DAT
S_1F_0	0.08	1.19	0.23	0.18	0.03	0.02	2.69	0.23	3.36	4.21	5.79	5.87
S_1F_1	0.10	1.52	0.34	0.55	0.08	0.03	3.10	0.33	4.79	5.91	6.92	7.10
S_1F_2	0.09	1.70	0.61	0.27	0.08	0.03	3.16	0.55	3.60	7.73	5.64	7.98
S_1F_3	0.09	0.82	0.29	0.25	0.15	0.04	3.84	0.43	4.58	9.70	7.66	8.10
S_2F_0	0.11	0.95	0.31	0.18	0.03	0.04	2.67	0.25	3.82	1.51	5.82	2.69
S_2F_1	0.16	1.06	0.53	0.66	0.25	0.06	3.00	0.14	2.95	2.12	5.64	4.36
S_2F_2	0.23	0.90	0.52	0.24	0.12	0.04	4.14	0.20	4.31	0.45	7.44	8.51
S_2F_3	0.12	1.55	0.34	0.21	0.03	0.05	3.57	0.18	4.32	1.36	5.35	7.31
SE(±)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

In a column figure(s) with dissimilar letter differ significantly as per DMRT at 5% level of significance.

Yield parameters

The effects of soils on the effective tillers/core, plant height, panicle length, filled grains panicle[1], 1000 grain weight, straw and grain yield of rice are presented in Table 7. Results revealed that variation in all the yield parameters and yield of T. aman rice were not significantly different in two different soils. Between these two soils, SAU Soil showed the higher (12.4) number of effective tillers/core, straw yield (0.034 kg/core) and Sonargaon soil showed lower number of effective tillers/core(11.7) and straw yield (0.033 kg/core). Two soils, showed the similar grain yield (0.031 kg/core).

Table 7. Effect of soils on the yield parameters and yield of T. Aman rice

Soils	No. effective tillers/core	Plant height (cm)	Panicle length (cm)	No. of filled grain/panicle	1000- grain wt. (g)	Straw yield (kg/core)	Grain yield (kg/core)
S_1	12.42	97.23	22.82	102.3	23.45	0.034	0.031
S_2	11.75	99.95	23.13	107.7	23.60	0.033	0.031
SE (±)	NS	NS	NS	NS	NS	NS	NS

In a column figure(s) with dissimilar letter differ significantly as per DMRT at 5% level of significance.

Different doses of fertilizers showed significant variations in respect of effective tillers/core, plant height and panicle length of rice (Table 8). Among the different doses of fertilizers F_1 (RDCF) showed the highest (17.0) number of effective tillers/core and plant height (105.5 cm). Similarly increased effective tillers and plant height were also found by Reddy *et al.* (2005). Significant variation was observed in number of filled grains/panicle of rice. The highest (121.8) number of filled grain/panicle was recorded in F_3 (50% RDCF + 2.1 ton poultry manure/ha) treatment and the lowest (71.00) number of filled grain per panicle was recorded in T_0 treatment.

Different doses of fertilizers showed significant variations for grain yield (Table 8). Among the different doses of fertilizer treatments, F_1 (RDCF) gave the highest (0.046 kg/core) grain yield which was statistically similar with F_3 and the lowest (0.010 kg/core) grain yield was observed in F_0 treatment. Similarly higher grain yields in similar treatments were obtained in the findings of Miah *et al*. (2006) and Xu *et al.* (2008).

Table 8. Effect of fertilizer and manure on the yield and yield parameters of T. Aman rice

Treatments	No. effective tillers/core	Plant height (cm)	Panicle length (cm)	No. of filled grains/panicle	1000 grain wt. (g)	Straw yield (kg/core)	Grain yield (kg/core)
F_0	6.3c	85.3b	21.2b	71.0 b	22.30 b	0.011c	0.010c
F_1	17.0a	105.6a	23.7a	114.2 a	23.57 a	0.053a	0.046a
F_2	14.3b	100.2a	23.4ab	112.8 a	23.70 a	0.039a	0.038b
F_3	14.8ab	102.7a	23.6a	121.8 a	23.53 a	0.045a	0.041ab
SE (±)	0.55	2.15	0.50	4.61	0.26	0.003	0.50

In a column figures with dissimilar letter differ significantly as per DMRT at 5% level of significance.

Significant variation was observed in the straw yield of rice when different doses of fertilizer were applied (Table 8). The highest straw yield (0.053 kg/core) was recorded in F_1 (RDCF) treatment which was statistically similar with the F_2 and F_3 treatments and lowest (0.011 kg/core) straw yield was recorded in the F_0 treatment.

The combined effect of different doses of fertilizer and soils on the number of effective tillers/core and plant height of rice were significantly different (Table 9). The higher number of effective tillers/core (18.0) and plant height (106.48 cm) of rice were recorded with the treatment combination S_2F_1 (Sonargaon Soil + RDCF) which was statically similar to S_1F_1 S_2F_3, S_2F_2 treatment combination. The lowest (6.33) number of effective tillers/core and plant height was found in S_1F_0 (SAU Soil + control treatment) treatment combination.

Combined application of different doses of fertilizer and soils had insignificant variation on the panicle length, number of filled grain/panicle, straw and grain yield of rice (Table 9). The highest (126.0) number of filled grain per panicle of rice was recorded with the treatment combination S_2F_3 (Sonargaon Soil + 50% RDCF + 2.1 ton poultry manure/ha.) and the lowest (71.00) number of filled grain was found in S_1F_0 (SAU Soil + No fertilizer) and S_2F_0 (Sonargaon Soil + No fertilizer) treatment combination. The highest 1000 grain wt. of rice (24.3 g) was recorded with the treatment combination S_2F_2 (Sonargaon Soil +50% RDCF + 5 ton cowdung/ha) and the lowest 1000-grain wt. (22.87 g) was found in S_1F_0 (SAU Soil + control treatment) treatment combination. The higher (0.049 kg/core) grain yield and straw yield (0.056 kg/core) of rice were recorded with the treatment combination S_2F_1 (Sonargaon Soil +RDCF) and the lower grain yield (0.010 kg/core) and straw yield were found in S_1F_0 (SAU Soil + control treatment) treatment combination.

Table 9. Interaction effect of fertilizer and soils on the yield parameters and yield of T. Aman rice

Treatments	No. of effective tillers/core	Plant height (cm)	Panicle length (cm)	No. of filled grain/panicle	1000 grain wt. (g)	Straw yield (kg/core)	Grain yield (kg/core)
S_1F_0	6.3d	82.3c	21.1	71.0	22.87	0.010	0.010
S_1F_1	16.0ab	104.7a	23.6	113.3	23.93	0.050	0.044
S_1F_2	14.3bc	99.8ab	22.9	107.0	23.13	0.035	0.037
S_1F_3	14.0bc	102.1a	23.8	117.7	23.87	0.041	0.041
S_2F_0	6.3d	88.3bc	21.4	71.0	23.73	0.012	0.011
S_2F_1	18.0a	106.5a	23.8	115.0	23.20	0.056	0.049
S_2F_2	13.0c	100.6ab	23.9	118.7	24.27	0.029	0.039
S_2F_3	15.7bc	103.2a	23.4	126.0	23.20	0.036	0.040
SE (±)	0.78	3.04	NS	NS	0.35	NS	NS

In a column figure(s) with dissimilar letter differ significantly as per DMRT at 5% level of significance.

Conclusion

Higher N and K leaching were obtained in the undisturbed column where chemical fertilizers were used for T. aman rice cultivation. Applications of organic plus inorganic fertilizer are recommended for reducing N and K leaching and increasing T. Aman rice yield. Higher P and K leaching were observed during 30 to 40 DAT, so K and P fertilizer may be applied in split for reducing leaching loss through the soil column and increasing utilization in rice growth and yield.

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