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Effect of fertilizer, manure and irrigation on nutrient availability in soil of boro rice field

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Abstract

The experiment was conducted in the farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh to study the effect of various organic manures and inorganic fertilizers with different water management on the nutrient availability of *boro* rice field. BRRI dhan29 was used as the test crop in this experiment. The experiment consists of 2 factors i.e. Irrigation and fertilizer plus manure. Two levels of irrigations (I_1= Continuous flooding and I_2= Saturated Condition) were used with 8 levels of fertilizer plus manure, as T_0: Control, T_1: 100% ($N_{120}P_{25}K_{60}S_{20}Zn_2$) Recommended dose of Fertilizer, T_2: 50% NPKSZn + 5 ton cow-dung ha^{-1}, T_3: 70% NPKSZn + 3 ton cow-dung ha^{-1}, T_4: 50% NPKSZn + 5 ton compost ha^{-1}, T_5: 70% NPKSZn+3 ton compost ha^{-1}, T_6: 50% NPKSZn + 3.5 ton poultry manure ha^{-1} and T_7: 70% NPKSZn+2.1 ton poultry manure ha^{-1}, with 16 treatment combinations and 3 replications. The pore-water samples were collected and analyzed during rice growing period. The higher concentrations of N, P and K were found in the pore water of T_6 (50% NPKSZn + 3.5 ton poultry manure ha^{-1}) and T_7 (70% NPKSZn + 2.1 ton poultry manure ha^{-1}) treatments where higher yield were obtained. The higher N, P, K & S concentrations and uptake were observed in the treatments where fertilizer plus manure were applied. The highest concentrations of grain N (1.31%), P (0.272%), K (0.195%) and S (0.091%) were recorded from T_5, T_3, T_7 and T_2 treatment respectively and lowest from T_0 (Control) treatment.

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Introduction

Rice (*Oryza sativa*) is one of the major crops of the world. Rice is a semi aquatic annual grass plant and is the most important cereal crop in the developing world. Global rice production has tripled in the last five decades from 150 million tons in 1960 to 450 million tons in 2011, due to the rice Green Revolution in Asia (Rejesus et al., 2012). A study showed that most Asian countries won't be able to feed their projected population without irreversibly degrading their land resources, even with high levels of management inputs (Beinroth et al., 2001). 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 cropping system is the most important cropping system in Bangladesh.

Scientists are trying to improve the production systems with the help of combination of organic and inorganic sources of nutrients. The application of different levels of irrigation in *boro* rice affects the yield by affecting nutrient accumulation. More nutrients are leached out from soil when higher levels of irrigation water are added during *boro* rice growing period. Moisture levels affect the organic matter accumulation and

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mineralization. Yang et al. (2004) reported that application of chemical fertilizers with farmyard manure or wheat or rice straw in alternate wetting and drying condition increased N, P, & K uptake by rice plants.

This study was undertaken to: develop a suitable integrated dose of inorganic fertilizers combined with different manures for *boro* rice; evaluate the effects of inorganic and organic fertilizer with different water management on the nutrient concentration of *boro* rice; and investigate the improvement of soil fertility due to the use of organic manure in combination with chemical fertilizers.

This detailed study was under taken with the following objectives:

i. To maintain the soil health by adopting Integrated Nutrient Management system in rice cultivation.
ii. To investigate, the improvement of soil fertility due to the use of organic manure in combination with chemical fertilizers.
iii. To investigate the availability of N, P, K and S in pore water of cropped and un-cropped soil with different fertilizer application.

Material and Methods

The experiment was conducted in the Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.

Experimental site and soil: The experiment was conducted in typical rice growing silt loam soil at the Sher-E-Bangla Agricultural University Farm, Dhaka during the *boro* season of 2012-13.

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).

Planting material: BRRI dhan 29 was used as the test crop in this experiment.

Land preparation: Ploughing was done. Before transplanting each unit of plot was cleaned by removing the weeds, stubbles and crop residues. Finally each plot was prepared by puddling.

Experimental Design: The experiment was laid out in a split plot design (SPD) with three replications (Figure 1 and 2).

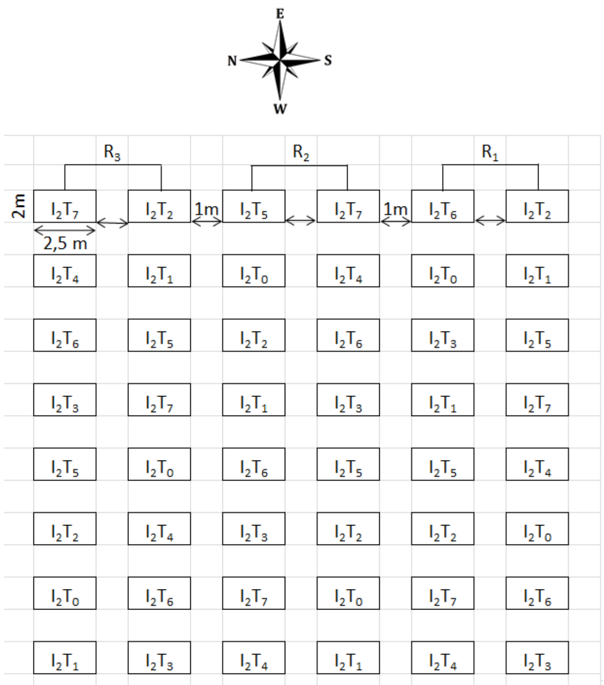

Figure 1. Layout of the experimental Plot of Boro Rice

Figure 2. Main Field

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

Treatments: The experiment consists of 2 factors (i) irrigation and (ii) fertilizer plus manure. Details of factors and their combinations are presented below:

Factor A: 2 Level of ırrigation in the main plot

I_1= Continuous flooding

I_2= Saturated condition

Factor B: 8 Fertilizer, manure treatment in the sub plot

T_0: Control
T_1: 100% ($N_{120}P_{25}K_{60}S_{20}Zn_2$) recommended dose of fertilizer
T_2: 50% NPKSZn + 5 ton cow dung ha^{-1}
T_3: 70% NPKSZn + 3 ton cow dung ha^{-1}
T_4: 50% NPKSZn + 5 ton compost ha^{-1}
T_5: 70% NPKSZn + 3 ton compost ha^{-1}
T_6: 50% NPKSZn + 3.5 ton poultry manure ha^{-1}
T_7: 70% NPKSZn + 2.1 ton poultry manure ha^{-1}

Treatment combination

I_1T_0 = (Continuous flooding + Control)
I_1T_1 = Continuous flooding + 100% ($N_{120}P_{25}K_{60}S_{20}Zn_2$) (Recommended dose)
I_1T_2 = (Continuous flooding + 50% NPKSZn + 5 ton cow dung ha^{-1})
I_1T_3 = (Continuous flooding + 70% NPKSZn + 3 ton cow dung ha^{-1})
I_1T_4 = (Continuous flooding + 50% NPKSZn + 5 ton compost ha^{-1})
I_1T_5 = (Continuous flooding + 70% NPKSZn + 3 ton compost ha^{-1})
I_1T_6 = (Continuous flooding + 50% NPKSZn + 3.5 ton poultry manure ha^{-1})
I_1T_7 = (Continuous flooding + 70% NPKSZn + 2.1 ton poultry manure ha^{-1})
I_2T_0 = (Saturated condition + Control)
I_2T_1 = Saturated condition + 100% ($N_{120}P_{25}K_{60}S_{20}Zn_2$) (Recommended dose)
I_2T_2 = (Saturated condition + 50% NPKSZn + 5 ton cow dung ha^{-1})
I_2T_3 = (Saturated condition + 70% NPKSZn + 3 ton cow dung ha^{-1})
I_2T_4 = (Saturated condition + 50% NPKSZn + 5 ton compost ha^{-1})
I_2T_5 = (Saturated condition + 70% NPKSZn + 3 ton compost ha^{-1})
I_2T_6 = (Saturated condition + 50% NPKSZn + 3.5 ton poultry manure ha^{-1})
I_2T_7 = (Saturated condition + 70% NPKSZn + 2.1 ton poultry manure ha^{-1})

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

Organic manure incorporation: Three different types of organic manure viz. cow-dung, poultry manure and compost were used. The rates of manure as 5&3, 3.5&2.1 and 5&3 tons per ha for cow-dung, poultry manure and compost per plot were calculated as per the treatments, respectively. Cow-dung, compost and poultry manure were applied before four days of final land preparation. Chemical compositions of the manures used have been presented in Table 1.

Table 1. Chemical compositions of the cow-dung, poultry manure and compost (Oven dry basis)

Sources of organic manure	Nutrient content			
	N (%)	P (%)	K (%)	S (%)
Cow-dung	1.46	0.29	0.74	0.24
Poultry manure	2.20	1.99	0.82	0.29
Compost	1.49	0.28	1.60	0.32

Transplanting: Forty days old seedlings of BRRI dhan29 were carefully uprooted from the seedling nursery and transplanted in 18 January, 2013 in well puddle plot.

Pore water collection: Pore-water samples were collected from inner and outside the cores during boro rice growing period by using rhizon sampler (Rhizon MOM 10 cm length, 2.5 mm OD, Rhizosphere Research Products, Wageningen, and The Netherlands) during the different dates of rice growing periods. The pore-water samples were filtered through Whatman no. 42 filter paper and analyzed for N, P, K and S contents by standard method (Plate 1 and 2).

Plate 1. Rhizon Samples

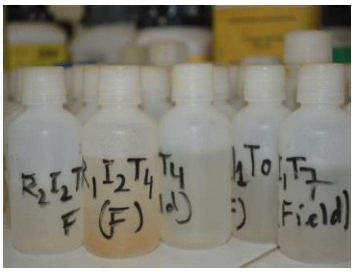

Plate 2. Pore Water Samples

Digestion of plant samples with sulphuric acid for N analysis: For the determination of nitrogen an amount of 0.5 g oven dry, ground sample were taken in a micro Kjeldahl flask. 1.1 g catalyst mixture (K_2SO_4: $CuSO_4$. $5H_2O$: Se in the ratio of 100: 10: 1), and 7 ml conc. H_2SO_4 were added. The flasks were heated at 160^{0}C and added 2 ml 30% H_2O_2 then heating was continued at 360 ^{0}C until the digests become clear and colorless. After cooling, the content was taken into a 50 ml volumetric flask and the volume was made up to the mark with de-ionized water. A reagent blank was prepared in a similar manner. Nitrogen in the digest was 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 (Pequerul et. al. 1993).

Digestion of plant samples with nitric-perchloric acid for P, K and S analysis: 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^{0}C. 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.

Determination of P, K and S from plant samples

Phosphorus: Plant samples (grain and straw) were digested by di-acid (Nitric acid and Perchloric acid) mixture and P content in the digest was measured by blue color development. Phosphorus in the digest was determined by using 1 ml for grain sample and 2 ml for straw sample from 100 ml digest by developing blue color with reduction of phosphomolybdate complex and the color intensity were measured colorimetrical at 660 nm wavelength and readings were calibrated with the standard P curve (Jones, 2001).

Potassium: Ten milli-liters of digest sample for the grain and five ml for the straw 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 (Jones, 2001).

Sulphur: Sulphur content was determined from the digest of the plant samples (grain and straw) as described by Jones (2001). The digested S was determined by developing turbidity by adding acid seed solution (20 ppm S as K_2SO_4 in 6N HCl) and $BaCl_2$ crystals. The intensity of turbidity was measured by spectrophotometer at 420 nm wavelengths (Jones, 2001).

Statistical Analysis

The significance of the difference among the treatment means was estimated by the Duncan's Multiple Range Test (DMRT) at 5% level of probability.

Results

Effect of irrigation on the N and P concentration of pore-water during *boro* rice growing period

The higher levels of pore-water N concentrations were found inside the core where crop was not grown. There was no significant influence of irrigation on the pore-water P concentrations and higher levels of pore-water P were found in the saturated condition of rhizospheric zone of rice plant compared to continuous flooded condition (Table 2).

Table 2. Effect of Irrigation on the N and P concentrations of pore-water during *boro* rice growing period

		I_1	I_2
Nitrogen	Pore-water N conc. (ppm) in outside the core at 30 DAT	2.61	2.14
	Pore-water N conc. (ppm) in outside the core at 60 DAT	2.76	3.01
	Pore-water N conc. (ppm) into the core at 30 DAT	4.55	3.66
	Pore-water N conc. (ppm) into the core at 60 DAT	3.10	2.68
Phosphorus	Pore-water P conc. (ppm) in outside the core at 30 DAT	0.16	0.02
	Pore-water P conc. (ppm) in outside the core at 60 DAT	0.32	0.48
	Pore-water P conc. (ppm) into the core at 30 DAT	0.77	1.32
	Pore-water P conc. (ppm) into the core at 60 DAT	0.31	0.25
Potassium	Pore-water K conc. (ppm) In outside the core at 30 DAT	0.75	0.74
	Pore-water K conc. (ppm) in outside the core at 60 DAT	3.47	2.87
	Pore-water K conc. (ppm) inside the core at 30 DAT	2.85	1.48
	Pore-water K conc. (ppm) inside the core at 60 DAT	3.47	2.87
Sulphur	Pore-water S conc. (ppm) In outside the core at 30 DAT	2.60	2.19
	Pore-water S conc. (ppm) in outside the core at 60 DAT	2.86	1.91
	Pore-water S conc. (ppm) inside the core at 30 DAT	3.49	3.45
	Pore-water S conc. (ppm) inside the core at 60 DAT	2.45	2.81

Effects of fertilizer and manure on the pore-water N and P concentrations

The pore-water N, P, K and S concentrations were influenced by the application of different fertilizer treatments. The pore-water N, P, K and S concentrations in the cropped zone (outside the ring) were different from inside the core where root zone was absent. The higher pore-water P concentrations were found into the core and lower in the outside of the cores at 30 DAT and similar pore-water P concentrations were found in the pore-water of inside and outside the core at 60 DAT (Table 3).

Table 3. Effect of fertilizer and manure on the pore-water N concentration of 30 and 60 DAT

Treatments	Pore-water N conc. (ppm) outside the core		Pore-water N conc. (ppm) inside the core		Pore-water P conc. (ppm) outside the core		Pore-water P conc. (ppm) inside the core	
	at 30 DAT	at 60 DAT	at 30 DAT	at 60 DAT	at 30 DAT	at 60 DAT	at 30 DAT	at 60 DAT
T_0	1.50 c	1.56	2.68 b	2.03	0.11 c	0.30 c	0.33 d	0.08 c
T_1	2.65 ab	2.53	5.78 a	3.75	0.15 bc	0.38 abc	1.81 a	0.17 c
T_2	2.78 ab	4.29	3.28 b	3.22	0.15 bc	0.43 ab	0.66 cd	0.17 c
T_3	1.91 bc	2.80	3.85 b	2.35	0.20 a	0.38 abc	1.36 ab	0.40 b
T_4	2.35 abc	2.98	4.08 ab	2.95	0.14 bc	0.34 bc	1.34 ab	0.14 c
T_5	2.43 ab	2.65	4.09 ab	2.64	0.15 bc	0.41 abc	0.65 cd	0.16 c
T_6	2.53 ab	2.80	3.85 b	2.50	0.18 ab	0.50 a	1.14 bc	0.62 a
T_7	2.85 a	3.55	4.27 ab	3.65	0.22 a	0.45 ab	1.12 bc	0.49 b
SE (±)	0.26	0.38	0.49	0.26	0.013	0.04	0.19	0.04

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Combined effects of irrigation and fertilizer on the pore-water N and P concentration

The combined effects of different doses of fertilizer and irrigation on the pore-water N and P concentrations were significantly different (Table 4). The higher pore-water N concentrations were found into the core and outside the core at 30DAT than 60DAT. The higher levels of pore-water P concentrations were found in the pore-water samples of rice cropped area and non-cropped area where I_2T_6, I_2T_7 and I_1T_7 treatment combinations were applied (Table 4).

Table 4. Interaction effect of fertilizer and irrigation on the pore-water N d P concentration

Treatments	Pore-water N conc. (ppm) outside the core		Pore-water N conc. (ppm) inside the core		Pore-water P conc. (ppm) outside the core		Pore-water P conc. (ppm) inside the core	
	at 30 DAT	at 60 DAT	at 30 DAT	at 60 DAT	at 30 DAT	at 60 DAT	at 30 DAT	at 60 DAT
I_1T_0	2.25 bcde	1.42	3.55 abcd	2.10 def	0.11 d	0.22 f	0.20 e	0.07 d
I_1T_1	4.50 a	1.90	6.30 a	4.50 a	0.16 bcd	0.40 bcde	0.25 e	0.20 cd
I_1T_2	2.40 bcd	4.39	4.45 abcd	3.99 ab	0.16 bcd	0.44 bcd	0.59 cde	0.23 cd
I_1T_3	2.80 bcd	2.45	3.50 bcd	2.95 bcde	0.15 cd	0.31 def	0.96 bcde	0.44 b
I_1T_4	1.90 cdef	2.80	5.80 ab	2.45 cdef	0.14 cd	0.28 def	1.21 bcd	0.14 d
I_1T_5	1.55 def	3.20	3.28 cd	3.18 abcd	0.16 bcd	0.32 def	0.82 bcde	0.15 d
I_1T_6	3.10 bc	2.45	4.20 abcd	1.40 f	0.13 d	0.25 ef	0.83 bcde	0.78 a
I_1T_7	2.40 ef	3.45	4.34 abcd	4.20 ab	0.24 a	0.32 def	1.35 bcd	0.49 b
I_2T_0	0.75 f	1.70	2.80 cd	1.95 def	0.11 d	0.37 cdef	0.45 de	0.10 d
I_2T_1	0.80 f	3.15	5.25 abc	3.00 bcde	0.14 cd	0.36 cdef	3.37 a	0.14 d
I_2T_2	3.15 bc	4.20	2.10 d	2.45 cdef	0.13 d	0.42 bcde	0.73 cde	0.12 d
I_2T_3	1.03 ef	3.15	4.20 abcd	1.75 ef	0.25 a	0.45 bcd	1.76 b	0.35 bc
I_2T_4	2.80 bcd	3.15	2.35 d	3.45 abc	0.15 cd	0.40 bcde	1.48 bc	0.14 d
I_2T_5	3.30 ab	2.10	4.90 abc	2.10 def	0.15 cd	0.51 bc	0.47 de	0.18 cd
I_2T_6	1.95 cdef	3.15	3.50 bcd	3.60 abc	0.22 ab	0.75 a	1.44 bc	0.46 b
I_2T_7	3.30 ab	3.65	4.20 abcd	3.10 bcd	0.20 abc	0.57 b	0.88 bcde	0.49 b
SE (±)	0.37	NS	0.49	0.37	0.02	0.04	0.26	0.05

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Effect of irrigation on the K and S concentration of pore-water

The pore-water K and S concentrations were influenced by different irrigation management in the *boro* rice field. The higher levels of pore-water K concentrations were found inside the core where crop was not grown (Table 2).

Effects of fertilizer and manure on the pore-water K and S concentrations

The highest level of available K (4.64 ppm) in cropped area and (5.58 ppm) uncropped area were obtained from T_6 and T_7 (70% NPKSZn + 2.1 ton poultry manure/ha) treatments, respectively. The lowest pore-water K concentrations were found in the control treatment where fertilizer was not used. The similar concentrations of pore-water S were found in the root zone area (outside the core) and without cropped area (inside the core) (Table 5).

Table 5. Effect of fertilizer and manure on the pore-water K concentration of 30 and 60 DAT

Treatments	Pore-water K conc. (ppm) outside the core		Pore-water K conc. (ppm) inside the core		Pore-water S conc. (ppm) outside the core		Pore-water S conc. (ppm) inside the core	
	at 30 DAT	at 60 DAT	at 30 DAT	at 60 DAT	at 30 DAT	at 60 DAT	at 30 DAT	at 60 DAT
T_0	0.33 c	2.16 c	0.54 e	2.48 d	1.47	1.43 c	1.95 d	1.42 c
T_1	0.54 bc	2.45 c	1.69 d	4.89 ab	2.23	2.37 bc	4.19 ab	3.33 a
T_2	1.26 a	3.14 bc	1.75 d	3.78 bc	2.45	2.26 bc	2.51 d	2.40 ab
T_3	0.85 abc	3.72 ab	2.37 c	4.31 bc	2.88	2.77 ab	4.28 a	2.95 ab
T_4	0.68 bc	2.93 bc	2.17 cd	3.62 c	2.69	3.02 ab	3.53 c	2.57 ab
T_5	0.51 bc	3.25 bc	1.76 d	4.10 bc	2.46	2.07 bc	3.48 c	2.27 bc
T_6	0.79 abc	4.64 a	3.15 b	5.53 a	3.03	1.56 c	4.27 a	2.83 ab
T_7	0.98 ab	3.05 bc	3.91 a	5.58 a	1.97	3.58 a	3.57 bc	3.26 a
SE (±)	0.13	0.31	0.15	0.33	NS	0.27	0.19	0.27

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Combined effects of irrigation and fertilizer on the pore-water K and S concentrations

The pore-water K and S concentrations were significantly different due to combined application of different levels of fertilizer and irrigation. The higher pore-water K concentrations were found in the samples of inside the core compared to outside the core (Table 6). The highest pore-water K concentration of outside the core (4.71 ppm) was found in I_2T_6 (Saturated condition + 50% NPKSZn + 3.5 ton poultry manure ha^{-1}) treatment combination. The highest pore-water S concentration of outside the core (4.50 ppm) was found in I_1T_6 (Continuous flooding + 50% NPKSZn + 3.5 ton poultry manure ha^{-1}) treatment combination. The pore-water of 60 DAT of S (Table 6), outside the core (cropped area) was significantly affected by the interaction effects of irrigation and fertilizer and highest concentration of 4.58 ppm was obtained from I_1T_4 (Continuous flooding + 50% NPKSZn + 5 ton compost ha^{-1})treatment which was statistically similar with I_1T_3 and I_1T_7 and I_2T_7 treatments combinations at 30 DAT.

Table 6. Interaction effect of fertilizer and irrigation on the pore-water K and Sconcentration

Treatments	Pore-water K conc. (ppm) outside the core		Pore-water K conc. (ppm) inside the core		Pore-water S conc. (ppm) outside the core		Pore-water S conc. (ppm) inside the core	
	at 30 DAT	at 60 DAT	at 30 DAT	at 60 DAT	at 30 DAT	at 60 DAT	at 30 DAT	at 60 DAT
I_1T_0	0.36 c	1.98 e	0.68 hi	2.09	1.56	1.85 efgh	1.36 i	1.43
I_1T_1	0.64 bc	2.34 de	1.89 cdef	5.00	2.00	2.80 bcdef	2.79 fgh	2.90
I_1T_2	1.86 a	3.83 abcd	2.69 b	4.36	3.02	1.66 efgh	2.84 efgh	2.16
I_1T_3	1.04 bc	4.68 a	2.84 b	4.26	2.44	3.29 abcd	4.33 bc	2.89
I_1T_4	0.34 c	3.09 bcde	2.55 bcd	3.62	1.94	4.58 a	3.76 cde	2.91
I_1T_5	0.34 c	4.15 abc	2.31 bcde	4.36	2.56	2.68 bcdef	3.68 cdef	2.06
I_1T_6	0.64 bc	4.57 ab	4.60 a	6.38	4.50	2.37 bcdefg	4.86 ab	2.47
I_1T_7	0.78 bc	3.09 bcde	5.26 a	6.38	2.75	3.47 ab	4.30 bc	2.71
I_2T_0	0.28 c	2.34 de	0.41 i	2.87	1.38	1.02 gh	2.54 gh	1.41
I_2T_1	0.45 bc	2.55 de	1.49 fg	4.78	2.45	1.94 defgh	5.60 a	3.72
I_2T_2	0.68 bc	2.45 de	0.81 ghi	3.19	1.87	2.86 bcde	2.17 hi	2.64
I_2T_3	0.68 bc	2.77 cde	1.89 cdef	4.36	3.31	2.25 cdefg	4.23 bcd	3.02
I_2T_4	1.01 bc	2.76 cde	1.79 def	3.62	3.44	1.46 fgh	3.29 defg	2.25
I_2T_5	0.68 bc	2.34 de	1.22 fgh	3.83	2.35	1.47 fgh	3.29 defg	2.49
I_2T_6	0.95 bc	4.71 a	1.70 ef	4.68	1.56	0.76 h	3.68 cdef	3.18
I_2T_7	1.19 ab	3.02 bcde	2.57 bc	5.32	1.19	3.50 abc	2.83 efgh	3.81
SE (±)	0.18	0.44	0.21	NS	0.53	0.38	0.27	0.38

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.

Discussion

The experiment was conducted in the Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. BRRI dhan 29 was used as the test crop in this experiment. The nutrient concentration in BRRI dhan29 rice plant was significantly affected by application of irrigation. The higher levels of grain N, K and S concentrations were recorded from I_1 (Continuous flooding) and P concentrations were recorded from I_2 (Saturated condition) treatment. The highest concentrations of grain N (1.31%), P (0.272%), K (0.195%), S (0.091%) were recorded from T_5 (70% NPKSZn + 3 ton compost ha^{-1}), T_3 (70% NPKSZn + 3 ton cow-dung ha^{-1}), T_1 (100% Recommended dose of Fertilizer), T_2 (50% NPKSZn + 5 ton cow-dung ha^{-1}), T_4 (50% NPKSZn + 5 ton compost ha^{-1}), T_7 (70% NPKSZn + 2.1 ton poultry manure ha^{-1}) and T_2 (50% NPKSZn + 5 ton cow-dung ha^{-1}) treatment combination respectively which is supported the result of Golabi et. al. (2007). The highest concentrations of straw N (0.730%), P (0.057%), were recorded from T_2 (50% NPKSZn + 5 ton cow-dung ha^{-1}) treatment, K (1.63%) were recorded from T_3 (70% NPKSZn + 3 ton cow-dung ha^{-1}) and S (0.052%) were recorded from T_6 (50% NPKSZn + 3.5 ton poultry manure ha^{-1}) treatment as same as Palm et. al. (1997). The combined effect of fertilizer and manure significantly influenced the grain and straw N, P, K and S concentrations and higher levels grain nutrient concentrations were observed in the treatments where fertilizer plus manure more used.

Conclusion

The N, P, K and S concentrations were studied in the pore-water and the concentrations of N, P, K and S varied with the irrigation, fertilizer, cropped, without cropped areas and time in this experiment. The higher concentration of pore water N, P and K were found in the T_6 (50% NPKS + 3.5 ton poultry manure ha^{-1}) and T_7 (70% NPKSZn + 2.1 ton poultry manure per hectare) treatments where poultry manure and inorganic fertilizer were used. There was a good correlation between yield Vs Pore-water nutrient concentration and Pore-water nutrient Vs grain nutrient accumulation.

References

Beinroth, F.H., Eswaran, H., Reich, P.F., 2001. Land quality and food security in Asia. In: Response to land degradation. Bridges, E.M., Hannam, I.D. Penning de Vries, F.W.T., Scherr, S.J., Sombatpanit, S. (Eds.). Science Publishers, Enfield, USA, pp. 83-97.

Golabi, M.H., Denney, M.J., Iyekar, C., 2007. Value of composted organic wastes as an alternative to synthetic fertilizers for soil quality improvement and increased yield. *Compost Science and Utilization* 15(4): 267-271.

Jones, Jr.J.B., 2001. Laboratory guide for conducting soil tests and plant analysis. CRC Press, New York, USA. 363p.

Palm, C.A., Myers, R.J., Nandwa, S.M., 1997. Combined use of organic and inorganic nutrient sources for soil fertility maintenance and replenishment. In: Replenishing soil fertility in Africa. Buresh, R.J., Sanchez, P.A., Calhoun, F. (Eds.). Soil Science Society of America, Special Publication 51., Wisconsin, Madison, USA. pp.193-217.

Pequerul, A., Pérez, C., Madero, P., Val, J., Monge, E., 1993. A rapid wet digestion method for plant analysis. In: Optimization of Plant Nutrition. Fragoso, M.A.C., van Beusichem, M.L. Houwers , A. (Eds.). Developments in Plant and Soil Sciences, vol 53. Springer, pp. 3-6.

Rejesus, R.M., Mutuc, M.E.M., Yasar, M., Lapitan, A.V., Palis, F.G., Chi, T.T.N., 2012. Sending Vietnamese rice farmers back to school: further evidence on the impacts of farmer field schools. *Canadian Journal of Agricultural Economics* 60(3): 407-426.

Sahrawat, K.L., 1980. A rapid nondigestion method for determination of potassium in plant tissue. *Communications in Soil Science and Plant Analysis* 11(7): 753-757.

Yang, C., Yang, L., Yang, Y., Ouyang, Z., 2004. Rice root growth and nutrient uptake as influenced by organic manure in continuously and alternately flooded paddy soils. *Agricultural Water Management* 70(1): 67-81.