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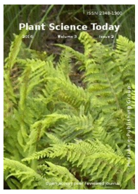

Research Article

Influence of nitrogen and phosphorus on the growth and yield of BRRI dhan57

Mahbubul Haque Imrul,[1] Mst. Afrose Jahan,[1] Mominul Haque Rabin,[2*] Md. Abubakar Siddik,[3] Shahidul Islam,[3] Marjana Yeasmin[4]

[1]Department of Soil Science, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh
[2]Department of Agricultural Chemistry, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh
[3]Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh
[4]Department of Agronomy, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh

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Corresponding Author
Mominul Haque Rabin
✉ robin_94sau@yahoo.com

Abstract

The field experiment was carried out during the period from July to November, 2013 at the research farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh to investigate the influence of nitrogen and phosphorus on the growth and yield of BRRI dhan57. The two factorial experiments were laid out in a Randomized Complete Block Design (RCBD) with three replications. Four levels of nitrogen N_0: 0 kg N ha^{-1}, N_1: 90 kg N ha^{-1}, N_2: 120 kg N ha^{-1}, N_3: 150 kg N ha^{-1} and three levels of phosphorous P_0: 0 kg P_2O_5 ha^{-1}, P_1: 25 kg P_2O_5 ha^{-1} and P_2: 35 kg P_2O_5 ha^{-1} were used in this experiment. Data revealed that at 30 and 60 days after transplanting (DAT) and at the time of harvest the tallest plants were observed in the treatments N_2 (120 kg N ha^{-1}), P_2 (35 kg P ha^{-1}) and treatment combination N_2P_2 (120 kg N and 35 kg P ha^{-1}) whereas, the treatments N_0, P_0 and treatment combination N_0P_0 (without N and P) showed the smallest plant height in each case, respectively. Side by side, N_2, P_2 treatments and N_2P_2 treatment combination gave the maximum effective tillers hill^{-1}, highest length of panicle and the maximum filled grains panicle^{-1}. The highest 1000 grain weight (20.85 g), grain yield (4.95 t ha^{-1}), straw yield (5.39 t ha^{-1}) and biological yield (10.34 t ha^{-1}) were found in the treatment combination N_2P_2 and also found highest in each individual under N_2 and P_2 treatments.

Keywords
Rice; nitrogen; phosphorus; growth; yield

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Introduction

Rice (*Oryza sativa L.*) is one of the leading cereal crops under Poaceae family. Nearly half of the population of the world use rice as their main food. Maximum Asian people entirely live on rice and above 90% of total world rice produced and consumed in Asia (BBS, 2013). It has major role in Bangladesh economy providing significant contribution to the Gross Domestic Product (GDP), employment generation and food availability. Rice is widely cultivated cereal crop in Bangladesh. It fulfills about 75% of the calories and 55% of the protein of our average daily diet (Bhuiyan *et al.*, 2002). In our climatic and edaphic conditions rice grown well throughout the year. BBS (2013) reported that rice offers about 48% of rural employment, two-third of total calorie and one-half of the total protein ingestion of an average person in the country. Nearly 75% of the total cropped area and above 80% of the total irrigated area is covered by rice. Therefore, it plays a key role in

Table 1. Records of meteorological observation (monthly) for the period of experiment (June 2013-November 2013)

Year	Month	Air temperature (^{0}C)		Relative humidity (%)	Total rainfall (mm)
		Maximum	Minimum		
2013	June	32.8	17.4	69.4	2.70
	July	31.75	16.14	71.42	2.39
	August	31.02	15.27	74.41	1.70
	September	31.46	14.82	73.20	2.10
	October	30.18	14.85	67.82	1.40
	November	28.10	6.88	58.18	0.52

the livelihood of the people of Bangladesh. Among the rice growing countries, Bangladesh occupies third position in rice area and fourth position in rice production (BRRI, 2012). But the average yield is relatively low compared to top rice producing countries. The largest part of the total production of rice comes from Aman rice. In Bangladesh about 50.92% of the rice areas covered by T. aman of which modern T. aman varieties covers 60% (BBS, 2005). Nitrogen (N) is the essential plant nutrient which is the promising factor in rice production. It is the limiting nutrient in rice production and when applied as inorganic sources then losses highly (Fillery *et al.* 1984). Effective tillers plant^{-1}, yield and yield parameters are significantly influenced by nitrogen on the rice production. (Jashim *et al.*, 1984, BRRI, 1990). So it is needed to find out the appropriate dose of nitrogen fertilizer for effective management and better yield of rice. For normal growth and development, plant required macronutrients like phosphorus (P). The soil chemical properties greatly influence the phosphorus requirements of plant (Sahrawat *et al.*, 2001). The optimum proportion of nitrogen and phosphorus fertilizer enhances the growth and development of a crop as well as ensured the availability of other essential nutrients for the plant. In the light of the above discussion, the present study was undertaken with the following objective: to select the suitable combination of N and P fertilizers concerning to growth and yield of BRRI dhan57.

Materials and Methods

Experimental site and climate

The experiment was carried out in typical rice growing clay loam soil at the farm of Sher-e-Bangla Agricultural University, Dhaka. The experimental area is located in the sub tropical humid condition with medium rainfall during the *kharif* season (March-September) and scanty rainfall in the *rabi* season (October-February). During the crop growing period, the mean of minimum and maximum temperature, mean relative humidity and total rainfall have been presented in Table 1.

Experimental treatments

The experiment was consisted on four levels of nitrogen N_0: 0 kg N ha^{-1}, N_1: 90 kg N ha^{-1}, N_2: 120 kg N ha^{-1}, N_3: 150 kg N ha^{-1} and three levels of phosphorous P_0: 0 kg P_2O_5 ha^{-1}, P_1: 25 kg P_2O_5 ha^{-1} and P_2: 35 kg P_2O_5 ha^{-1}. There were in total 12 (4×3) treatment combinations such as N_0P_0, N_0P_1, N_0P_2, N_1P_0, N_1P_1, N_1P_2, N_2P_0, N_2P_1, N_2P_2, N_3P_0, N_3P_1 and N_3P_2.

Land preparation

The land was ploughed by power tiller. Laddering helped breaking the clods and leveling the land followed every ploughing. Before transplanting each unit of plot was cleaned by removing the weeds, stubbles and crop residues. Finally each plot was prepared by puddling for seedling transplanting.

Planting materials, design and plot size

BRRI dhan57 was used as planting material in this experiment. This variety was developed at the Bangladesh Rice Research Institute from the cross between Bashmoti (D) and BR5 in 1998. It is recommended for *Aman* season. The two factorial experiments were laid out in a RCBD design with three replications. The size of the each plot was 3.0 m × 1.5 m. The distances between block to block and plot to plot were 1.0 m and 0.5 m, respectively.

Fertilizer application

Urea, Triple Super Phosphate (TSP), Muriate of Potash (MOP), Gypsum, zinc sulphate and borax were applied as the source of N, P, K, S, Zn and B respectively. Doses of nitrogen and phosphorus were applied as per treatments. During the final land preparation the one third amount of urea and entire amount of TSP, MOP (120 kg ha$^{-1)}$, gypsum (30 kg ha^{-1}), zinc sulphate (2 kg ha^{-1}) and borax (10 kg ha^{-1}) were applied. At the tillering and panicle initiation stages, rest of urea was applied in two equal instalments (BRRI, 2013).

Raising of seedlings

The seedlings of rice were raised wet-bed methods. The seeds were sprouted by soaking for 72 hours. The sprouted seeds were sown uniformly in the well-prepared seed bed. During seedling growing, no fertilizers were used. Proper water and pest management practices were followed whenever required.

Transplanting

The 30 days old nursery seedlings of BRRI dhan57 were uprooted carefully and were kept in soft mud in shade. The seedlings were then transplanted with 20 cm x 20 cm spacing on the well puddled plots. After one week of transplanting, all plots were checked for any missing hill, which was filled up with extra seedlings whenever required.

Statistical analysis

All the collected data on different parameters were statistically analyzed following the analysis of variance (ANOVA) technique using MSTAT-C computer package program and mean differences adjusted by Least Significant Difference (LSD) test at 5% level of significance.

Results and Discussion

Plant height

Plant height of BRRI dhan57 was statistically significant due to different levels of nitrogen at 30 and 60 days after transplanting (DAT) and at harvest (Table 2). At 30 and 60 DAT and harvest, the tallest plant (22.60, 80.81 and 115.66 cm, respectively) were recorded from N_2 (120 kg N ha^{-1}) which were statistically similar (22.47, 80.09 and 112.44 cm, respectively) with N_3 (150 kg N ha^{-1}) whereas the shortest plant (20.98, 61.08 and 82.09 cm, respectively) was found from N_0 or control condition. It was revealed that increased plant height up to a certain level then decreases due to increasing the nitrogen fertilizer. Optimum nitrogen (N) is essential for vegetative growth but excess N may cause excessive vegetative growth, prolong the growth duration and delay crop maturity with reduction in grain yield. BRRI (1992) reported that 120 to 160 kg N ha^{-1} was assumed to be due to excessive vegetative growth follower by lodging after flowering. Andrade and Amorim (1996) observed that increasing level of N increased plant height. Patel and Upadhaya (1993) found that rate of N up to 150 kg ha^{-1} which increased the plant height significantly.

Plant height of BRRI dhan57 varied significantly for different levels of phosphorus at 30 and 60 DAT and harvest (Table 1). At 30 and 60 DAT and harvest, the tallest plant (22.37, 78.12 and 111.64 cm, respectively) were observed from P_2 (35 kg P_2O_5 ha^{-1}) which were statistically identical (22.13, 71.90 and 95.51 cm, respectively) with P_1 (25 kg P_2O_5 ha^{-1}). Whereas the shortest plant (18.85, 59.67 and 80.97 cm, respectively) were observed from P_0 (0 kg P_2O_5 ha^{-1}). It revealed that with the increase of application of phosphorus, plant height showed increasing trend, but after a certain level plant height increases very slowly.

Interaction effect of different levels of nitrogen and phosphorus showed significant variation on plant height of BRRI dhan57 at 30 and 60 DAT and harvest (Table 3). At 30 and 60 DAT and harvest, the tallest plant (28.77, 81.27 and

Table 2. The effect of different levels of nitrogen and phosphorous on plant height of BRRI dhan57

Treatment	Plant height (cm)		
	30 DAT	60 DAT	Harvest
Levels of nitrogen			
N_0	20.98 c	61.08 c	82.09 c
N_1	21.76 b	72.43 b	94.31 b
N_2	22.60 a	80.81 a	115.66 a
N_3	22.47 a	80.09 a	112.44 a
$LSD_{(0.05)}$	0.688	0.285	5.416
Significance level	0.01	0.01	0.01
Levels of phosphorous			
P_0	18.85 b	59.67 c	80.97 c
P_1	22.13 a	71.90 ab	95.51 ab
P_2	22.37 a	78.12 a	111.64 a
$LSD_{(0.05)}$	0.596	0.247	4.690
Significance level	0.01	0.01	0.01
CV(%)	6.15	10.06	6.81

N_0: 0 kg N ha^{-1} (control); N_1: 90 kg N ha^{-1}; N_2: 120 kg N ha^{-1}; N_3: 150 kg N ha^{-1} and P_0: 0 kg P_2O_5 ha^{-1} (control); P_1: 25 kg P_2O_5 ha^{-1}; P_2: 35 kg P_2O_5 ha^{-1}

Table 3. Interaction effect of different levels of nitrogen and phosphorous on plant height of BRRI dhan57

Treatment	Plant height (cm)		
	30 DAT	60 DAT	Harvest
N_0P_0	18.13 f	60.90 e	87.75 i
N_0P_1	22.28 e	65.07 de	98.16 h
N_0P_2	22.12 e	64.77 de	99.93 g
N_1P_0	23.43 de	67.01 cde	102.29 f
N_1P_1	25.28 bcd	70.97 bcd	106.63 d
N_1P_2	25.62 bc	71.94 bcd	104.46 e
N_2P_0	22.26 e	65.62 de	96.99 h
N_2P_1	26.86 b	77.21 ab	114.20 b
N_2P_2	28.77 a	81.27 a	119.05 a
N_3P_0	23.82 cde	70.32 bcd	106.83 d
N_3P_1	26.12 b	76.25 ab	110.18 c
N_3P_2	25.32 bcd	73.57 bc	107.53 d
$LSD_{(0.05)}$	1.913	6.934	1.191
Significance level	0.05	0.05	0.01
CV(%)	5.87	5.98	4.65

N_0: 0 kg N ha^{-1} (control); N_1: 90 kg N ha^{-1}; N_2: 120 kg N ha^{-1}; N_3: 150 kg N ha^{-1}; P_0: 0 kg P_2O_5 ha^{-1} (control); P_1: 25 kg P_2O_5 ha^{-1}; P_2: 35 kg P_2O_5 ha^{-1}

119.05 cm, respectively) were observed from N_2P_2 (120 kg N ha^{-1} and 35 kg P_2O_5 ha^{-1}) whereas, the shortest plant (18.13, 60.90 and 87.75 cm, respectively) were recorded at 30 and 60 DAT and harvest, respectively from N_0P_0 (0 kg N ha^{-1} and 0 kg P_2O_5 ha^{-1}). 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 increase plant height.

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

Number of effective tillers $hill^{-1}$ was significantly influenced by different nitrogen levels (Table 4). N_2 gave the highest (16.60) number of effective tillers $hill^{-1}$ which was statistically similar (16.47) with N_3 whereas N_0 or control condition gave the lowest (12.98) number of effective tillers $hill^{-1}$. BINA (1996) stated that different nitrogen levels significantly influenced the number of effective tillers $hill^{-1}$. Chopra and Chopra (2004) reported that nitrogen had significantly effects on yield attributes of effective tillers $hill^{-1}$ with increasing levels of N up to 120 kg N ha^{-1} in rice.

Phosphorous fertilizer doses significantly varied of number of effective tillers $hill^{-1}$ of BRRI dhan57 (Table 4). The highest effective tillers $hill^{-1}$ (16.37) was recorded in P_2, which was statistically identical (16.13) with P_1 whereas the lowest effective tillers $hill^{-1}$ (13.85) was recorded from P_0 or control condition. Panhawar *et al.* (2011) reported that plant growth and development of root, tillering, early flowering and performs other functions like metabolic activities, particularly in protein synthesis is highly influenced by phosphorus.

Significant interaction effect between nitrogen and phosphorus on number of effective tillers $hill^{-1}$ was observed of BRRI dhan57 (Table 5). N_2P_2 showed the maximum (17.87) effective tillers $hill^{-1}$ while N_0P_0 or control condition showed the minimum (12.27) effective tillers $hill^{-1}$. Chaturvedi (2005) stated that yield is greatly influenced by number of tillers per unit area especially fertile tillers. At harvest tillers m^{-2} of rice is increased significantly due to application of nitrogen fertilizer. Yosef Tabar (2012) observed that 150 kg ha^{-1} nitrogen with 90 kg ha^{-1} phosphorus gave maximum (22.25) fertile tillers. Rasheed *et al.* (2003) reported that the number of effective tillers per hill was increased when NP levels were increased.

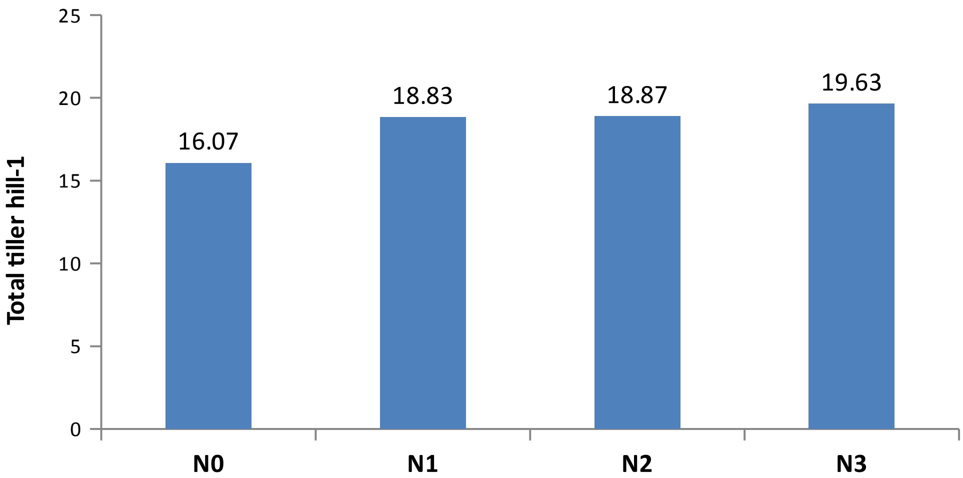
Number of ineffective tillers $hill^{-1}$

Number of ineffective tillers $hill^{-1}$ differed significantly for variation of nitrogen doses (Table 4). The higher number of ineffective tillers $hill^{-1}$ (3.16) was found from N_3 which was statistically

Table 4. Effect of different levels of nitrogen and phosphorous on number of effective & ineffective tillers hill^{-1}, filled grains panicle^{-1} and length of panicle of BRRI dhan57

Treatment	Number of effective tillers hill^{-1}	Length of panicle (cm)	Number of ineffective tillers hill^{-1}	Number of filled grain panicle^{-1}
Levels of nitrogen				
N_0	12.98 c	20.57b	3.09 a	77.09 b
N_1	15.76 b	22.11a	3.07 a	89.31 a
N_2	16.60 a	23.05a	2.27 b	90.66 a
N_3	16.47 a	22.68a	3.16 a	88.44 a
$LSD_{(0.05)}$	0.688	1.133	0.285	5.416
Significance level	0.01	0.01	0.01	0.01
Levels of phosphorous				
P_0	13.85b	19.76b	2.67 b	75.97 b
P_1	16.13 a	22.84a	2.90 ab	90.51 a
P_2	16.37 a	23.70a	3.12 a	92.64 a
$LSD_{(0.05)}$	0.596	0.981	0.247	4.690
Significance level	0.01	0.01	0.01	0.01
CV(%)	6.15	5.49	10.06	6.81

N_0: 0 kg N ha^{-1} (control); N_1: 90 kg N ha^{-1}; N_2: 120 kg N ha^{-1}; N_3: 150 kg N ha^{-1}; P_0: 0 kg P_2O_5 ha^{-1} (control); P_1: 25 kg P_2O_5 ha^{-1}; P_2: 35 kg P_2O_5 ha^{-1}



N_0 – 0 kg ha^{-1} (Control), N_1 –90 kg ha^{-1}, N_2– 120 kg ha^{-1}, N_3– 150 kg ha^{-1}

Figure 1. Effect of nitrogen on the total tiller number hill^{-1}of BRRI dhan57

similar (3.09 and 3.07) with N_0 and N_1, while N_2 gave the lower (2.27) number of ineffective tillers hill^{-1}.

Number of ineffective tillers hill^{-1} varied significantly for different doses of phosphorous (Table 4). P_2 gave the highest (3.12) number of ineffective tillers hill^{-1} which was statistically identical (2.90) with P_1. In contrast P_0 or control condition gave the lowest (2.67) number of ineffective tillers hill^{-1}.

Interaction effect of nitrogen and phosphorus doses showed significant variation on number of ineffective tillers hill^{-1} of BRRI dhan57 (Table 5). The maximum number of ineffective tillers hill^{-1} (3.73) was observed from N_0P_2, while the minimum number of ineffective tillers hill^{-1} (2.13) was observed from N_2P_2.

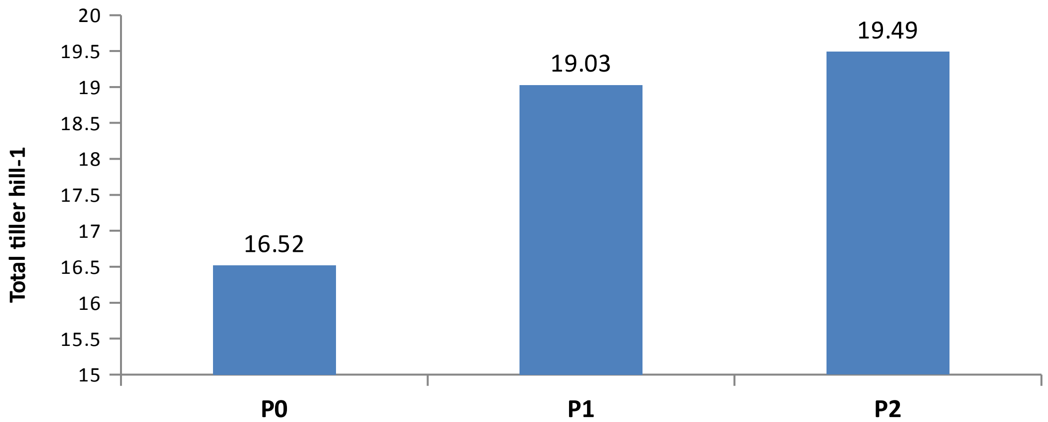
Number of total tillers hill^{-1}

Doses of nitrogen had significant effect on number of total tillers hill^{-1} of BRRI dhan57 (Figure 1). The maximum total tillers hill^{-1} (19.63) was attained from N_3 which were statistically similar (18.87 and 18.83) with N_2 and N_1 and the minimum total

Table 5. Interaction effect of different doses of nitrogen and phosphorous on number of effective & ineffective tillers hill^{-1}, filled grains panicle^{-1} and length of panicle of BRRI dhan57

Treatment	Number of effective tillers hill^{-1}	Length of panicle (cm)	Number of ineffective tillers hill^{-1}	Number of filled grain panicle^{-1}
N_0P_0	12.27 e	17.99 e	2.60 cde	67.83 e
N_0P_1	13.07 de	21.49 cd	2.93 bc	76.03 de
N_0P_2	13.60 cd	22.22 cd	3.73 a	87.40 bc
N_1P_0	14.47 c	21.06 d	2.93 bc	80.63 cd
N_1P_1	16.40 b	21.79 cd	3.27 ab	93.13 ab
N_1P_2	16.40 b	23.48 bc	3.00 bc	94.17 ab
N_2P_0	14.33cd	18.91 e	2.33 de	75.00 de
N_2P_1	17.60 ab	24.64 ab	2.33 de	97.23ab
N_2P_2	17.87 a	25.59 a	2.13 e	99.73 a
N_3P_0	14.33 cd	21.09 d	2.80 bcd	80.43 cd
N_3P_1	17.47 ab	23.45 bc	3.07 bc	93.13 ab
N_3P_2	17.60 ab	23.51 bc	3.60 a	91.77 ab
$LSD_{(0.05)}$	1.191	1.962	0.494	9.381
Significance level	0.05	0.05	0.01	0.05
CV(%)	6.15	5.49	10.06	6.81

N_0: 0 kg N ha^{-1} (control); N_1: 90 kg N ha^{-1}; N_2: 120 kg N ha^{-1}; N_3: 150 kg N ha^{-1}; P_0: 0 kg P_2O_5 ha^{-1} (control); P_1: 25 kg P_2O_5 ha^{-1}; P_2: 35 kg P_2O_5 ha^{-1}



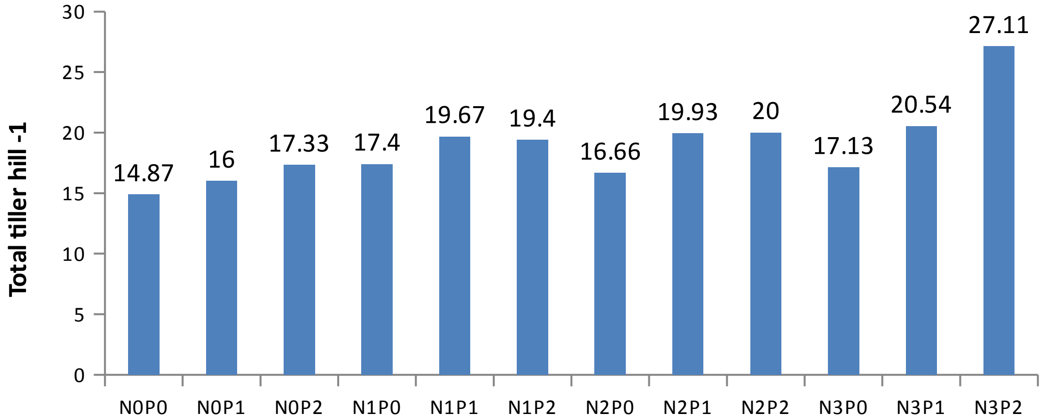
P_0 – 0 kg ha^{-1} (Control), P_1 –25 kg ha^{-1}, P_2– 35 kg ha^{-1}

Figure 2. Effect of phosphorus on the total tiller number hill^{-1}of BRRI dhan57

tillers hill^{-1} (16.07) was observed from N_0 or control condition. Bayan and Kandasamy (2002) reported that tillers hill^{-1} increased with the application of nitrogen fertilizer. Ahmed *et al.* (2005) found that higher N dose produced highest effective tiller hill^{-1} which ultimately leads to achieve higher total tiller per hill. BINA (1996) also stated that the nitrogen doses had significant effect for tillers number hill^{-1}.

Doses of phosphorus had significant effect on number of total tillers hill^{-1} of BRRI dhan57 (Figure 2). The maximum number of total tillers hill^{-1} (19.49) was observed from P_2, which were statistically identical (19.03) with P_1 and the minimum number of total tillers hill^{-1} (16.52) was recorded from P_0 or control condition. This result is disagreed with Yosef Tabar (2012) who stated that the phosphorus fertilizer had no significant effect on tiller number. But Alinajoati sisie and Mirshekari (2011) stated that phosphorus is an essential element for tillers development and root growth of wheat.

Interaction effect of nitrogen and phosphorus doses showed significant variation on number of total tillers hill^{-1} of BRRI dhan57 (Figure 3). The highest total tillers hill^{-1} (21.20) was recorded from



N_0: 0 kg N ha^{-1} (control); N_1: 90 kg N ha^{-1}; N_2: 120 kg N ha^{-1}; N_3: 150 kg N ha^{-1}; P_0: 0 kg P_2O_5 ha^{-1} (control); P_1: 25 kg P_2O_5 ha^{-1}; P_2: 35 kg P_2O_5 ha^{-1}

Figure 3. Effect of phosphorus on the total tiller number hill^{-1}of BRRI dhan57

Table 6. Effect of different doses of nitrogen and phosphorous on weight of 1000-grains, grain, straw and biological yield of BRRI dhan57

Treatment	1000 grains weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})
Levels of nitrogen				
N_0	17.31 b	3.15 c	3.56 c	6.71 c
N_1	18.68 a	4.15 b	4.57 b	8.72 b
N_2	19.43 a	4.56 a	4.98 a	9.54 a
N_3	19.33 a	4.47 a	4.96 a	9.43 a
$LSD_{(0.05)}$	0.989	0.243	0.235	0.421
Significance level	0.01	0.01	0.01	0.01
Levels of phosphorous				
P_0	17.50 b	3.81 b	4.22 b	8.03 b
P_1	18.95 a	4.18 a	4.64 a	8.82 a
P_2	19.63 a	4.25 a	4.69 a	8.94 a
$LSD_{(0.05)}$	0.856	0.211	0.204	0.364
Significance level	0.01	0.01	0.01	0.01
CV(%)	6.25	8.11	5.33	5.66

N_0: 0 kg N ha^{-1} (control); N_1: 90 kg N ha^{-1}; N_2: 120 kg N ha^{-1}; N_3: 150 kg N ha^{-1}; P_0: 0 kg P_2O_5 ha^{-1} (control); P_1: 25 kg P_2O_5 ha^{-1}; P_2: 35 kg P_2O_5 ha^{-1}

N_3P_2, while the lowest total tillers hill^{-1} (14.27) was observed from N_0P_0 or control condition. Ndaeyo *et al.* (2008) conducted an experiment where they found that higher rates of NPK resulted higher number of tillers per plant. Yosef Tabar (2012) reported that the interaction effect of nitrogen and phosphorus fertilizer had significant effect on barrier tiller percentage.

Panicle length

Panicle length of BRRI dhan57 was statistically influenced by different doses of nitrogen (Table 4). The longest length of panicle (23.05 cm) was observed from N_2 which was statistically similar (22.11cm and 22.68 cm) with N_1 and N_3, while the shortest length of panicle (20.57 cm) was found from N_0 or control condition. Mondal and Swamy (2003) reported that application of N (120 kg ha^{-1}) as urea in equal splits during transplanting, tillering, panicle initiation and flowering resulted in the highest length of panicle. Ahmed *et al.* (2005) also found that higher N dose produced higher panicle length.

Length of panicle of BRRI dhan57 varied significantly for different levels of phosphorous (Table 4). The longest length of panicle (23.70 cm) was observed from P_2 which was statistically identical (22.84 cm) with P_1, whereas the shortest length of panicle (19.76 cm) was recorded from P_0 or control condition. Das and Sinha (2006) reported that 40 kg P_2O_5 ha^{-1} give the better performance in relation to length of panicle of rice.

The panicle length was varied significantly by different doses of nitrogen and phosphorus of

BRRI dhan57 (Table 5). The longest length of panicle (25.59 cm) was observed from N_2P_2 and the shortest length of panicle (17.99 cm) from N_0P_0 or control condition. Mondal and Swamy (2003) found that application of N (120 kg ha^{-1}) as urea in equal splits during transplanting, tillering, panicle initiation and flowering resulted in the highest length of panicle. Duhan and Singh (2002) reported that 40 kg P_2O_5 ha^{-1} give the better performance in relation to length of panicle of rice.

Number of filled grains panicle^{-1}

Filled grains panicle-^{1} was significantly influenced by doses of nitrogen (Table 4). N_2 gave the maximum (90.66) number of filled grains panicle^{-1} which was statistically similar (89.31 and 88.44) with N_1 and N_3. Whereas the minimum filled grains panicle^{-1} (77.09) was observed in N_0 or control condition. Filled grains panicle^{-1} is one of the most important yields contributing parameter in case of grain crops. Bhuyan *et al.* (2012) observed that bed planting with foliar nitrogen fertilizer produced higher number of grains panicle^{-1}. Rahman *et al.* (2007) conducted an experiment where the results showed that nitrogen level significantly influenced growth and yield components and maximum grains panicle^{-1} was found from 80 kg N/ha.

Number of filled grains panicle^{-1} of BRRI dhan57 varied significantly for different doses of phosphorous (Table 4). The maximum number of filled grains panicle^{-1} (92.64) was observed from P_2, which were statistically identical (90.51) with P_1 whereas the minimum number of filled grains panicle^{-1} (75.97) was observed from P_0 or control condition. Yosef Tabar (2012) stated that the highest total grains panicle^{-1} was recorded for 150 kg/ha phosphorus fertilizer. Yoefi *et al.* (2011) also reported that number of grains panicle^{-1} was significantly influenced by phosphorus fertilizer.

Number of filled grains panicle^{-1} was significantly varied by doses of nitrogen and phosphorus (Table 5). N_2P_2 showed the maximum (99.73) filled grains panicle^{-1} whereas N_0P_0 or control gave the minimum (67.83) filled grains panicle^{-1}. Filed grains panicle^{-1} was most important yield contributing parameter in which was affected the yield of rice (Fallah, 2012). Yosef Tabar (2012) found that maximum fertile spikelet was observed for 150 kg ha^{-1} nitrogen with 60kg ha^{-1} phosphorus fertilizer.

1000 grains weight

1000 grains weight showed significant variation due to different doses of nitrogen (Table 6). N_2 gave the maximum (19.43 g) 1000 grains weight which was statistically similar (19.33 g and 18.68 g) with N_3 and N_1. While N_0 or control condition gave the minimum (17.31 g) weight of 1000-grains. This result agreed with Mondal and Swamy (2003) who reported that 120 kg N ha^{-1} applied as urea in equal splits during transplanting, tillering, panicle initiation and flowering resulted in the highest 1000-grain weight.

1000 grains weight of BRRI dhan57 varied significantly for doses of phosphorous (Table 6). The maximum 1000 grains weight (19.63 g) was recorded from P_2, which were statistically identical (18.95 g) with P_1, while the minimum 1000 grains weight (17.50 g) was found from P_0 or control condition. Yosef Tabar (2012) stated that 90kg ha^{-1} phosphorus fertilizer gave the maximum 1000 grains weight.

1000 grains weight was significantly influenced by different doses of nitrogen and phosphorus (Table 7). N_2P_2 combination performed better 1000 grains weight (20.85 g) and N_0P_0 or control condition gave the lowest (16.75 g) 1000 grains weight. Yosef Tabar (2012) found that the highest 1000 grains weight with 150 kg ha^{-1} nitrogen with 90 kg ha^{-1}.

Grain yield

Statistically significant variation was recorded for grain yield ha-^{1} of BRRI dhan57 due to different levels of nitrogen (Table 6). N_2 gave the maximum grain yield (4.56 t ha^{-1}) which was statistically similar (4.47 t ha^{-1}) with N_3 and closely followed (4.15 t ha^{-1}) by N_1, whereas N_0 gave the minimum (3.15 t ha^{-1}) grain yield. Dwibvedi (1997) noticed that grain yield, straw yield as well as harvest index with 60 kg N ha^{-1} was influenced by different doses of nitrogen. Adhikary and Rhaman (1996) found that the maximum yield was obtained from 100 kg N ha^{-1} (4.52 t ha^{-1}) and followed by 120 kg N ha^{-1} (4.46 t ha^{-1}) and 80 kg N ha^{-1} (4.40 t ha^{-1}).

Grain yield ha^{-1} of BRRI dhan57 varied significantly for different levels of phosphorous (Table 6). The highest grain yield (4.25 t ha^{-1}) was recorded from P_2, which was statistically similar (4.18 t ha^{-1}) with P_1 and the lowest grain yield (3.81 t ha^{-1}) was observed from P_0 or control condition. Islam *et al*. (2010a) reported that grain yield was significantly increased by 10 kg ha^{-1} P but it is not differ by the application of 20 and 30 kg P ha^{-1}. Grain yield was significantly affected by phosphorus fertilizer (Yosefi *et al.,* 2011). Panhawar *et al.* (2011) stated that increase upland rice yield by applying of phosphorus fertilizer. Li *et al.* (2010) reported that P fertilizer application is one of the most essential for crop yield.

Grain yield ha^{-1} of BRRI dhan57 varied significantly for different levels of nitrogen and phosphorous (Table 7). The maximum grain yield (4.95 t ha^{-1}) was observed from N_2P_2, whereas the minimum grain yield (3.07 t ha^{-1}) was recorded from N_0P_0 under ‘control conditions’. Islam *et al.* (2008) reported that grain yield influenced significantly due to different rates of nutrients application and 60-19-36 kg/ha NPK maximized the yield of T. *aman* rice.

Table 7. Interaction effect of different doses of nitrogen and phosphorous on weight of 1000-grains, grain, straw and biological yield of BRRI dhan57

Treatment	1000 grains weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})
N_0P_0	16.75 e	3.07 e	3.43 e	6.50 f
N_0P_1	17.15 e	3.14 e	3.63 e	6.76 f
N_0P_2	18.07 cde	3.23 e	3.63 e	6.86 f
N_1P_0	17.95 de	3.96 cd	4.36 cd	8.31 de
N_1P_1	18.43 b-e	4.21 bcd	4.61 bcd	8.82 cde
N_1P_2	19.65 a-d	4.28 bcd	4.74 bc	9.03 cd
N_2P_0	17.13 e	3.86 d	4.22 d	8.08 e
N_2P_1	20.32 ab	4.87 a	5.33 a	10.20 ab
N_2P_2	20.85 a	4.95 a	5.39 a	10.34 a
N_3P_0	18.15 cde	4.37 bc	4.87 b	9.24 c
N_3P_1	19.88 abc	4.51 ab	5.00 ab	9.52 bc
N_3P_2	19.95 abc	4.52 ab	5.01 ab	9.53 bc
$LSD_{(0.05)}$	1.713	0.422	0.408	0.728
Significance level	0.05	0.05	0.01	0.01
CV(%)	6.25	8.11	5.33	5.66

N_0: 0 kg N ha^{-1} (control); N_1: 90 kg N ha^{-1}; N_2: 120 kg N ha^{-1}; N_3: 150 kg N ha^{-1}; P_0: 0 kg P_2O_5 ha^{-1} (control); P_1: 25 kg P_2O_5 ha^{-1}; P_2: 35 kg P_2O_5 ha^{-1}

Straw yield

Statistically significant variation was recorded for straw yield ha-^{1} of BRRI dhan57 due to different doses of nitrogen (Table 6). The highest straw yield (4.98 t ha^{-1}) was observed from N_2 which was statistically similar (4.96 t ha^{-1}) to N_3 and closely followed (4.57 t ha^{-1}) by N_1, whereas the lowest straw yield (3.56 t ha^{-1}) was recorded from N_0 or control. Mondal and Swamy (2003) reported that N (120 kg ha^{-1}) applied as urea in equal splits during transplanting, tillering, panicle initiation and flowering resulted in the highest straw yield. Islam *et al.* (2008b) found that straw yield significantly influenced by nitrogen levels. This result are in an agreement with the findings of Dhane *et al.* (1989) who reported that straw yield increases with increasing nitrogen level.

Straw yield ha^{-1} of BRRI dhan57 varied significantly for different levels of phosphorous (Table 6). P_2 gave the (4.69 t ha^{-1}) highest straw yield which was statistically similar (4.64 t ha^{-1}) with P_1 whereas P_0 or control gave the lowest (4.22 t ha^{-1}) straw yield. Gebrekidan and Seyoum (2006) reported that harvest index of rice was significantly increased by the application of 13.2kg P ha^{-1}, accordingly harvest index of the rice crop was negatively and significantly correlated with straw yield.

Statistically significant variation was recorded for straw yield ha^{-1} of BRRI dhan57 due to different doses of nitrogen and phosphorous (Table 7). The maximum straw yield (5.39 t ha^{-1}) was obtained from N_2P_2, whereas the minimum straw yield (3.43 t ha^{-1}) was recorded from N_0P_0 or control. Yosef Tabar (2013) stated that 150 kg N ha^{-1} with 90 kg P ha^{-1} gave the maximum straw yield.

Biological yield

Statistically significant variation was recorded for biological yield ha^{-1} of BRRI dhan57 due to different doses of nitrogen (Table 6). N_2 gave the highest biological yield (9.54 t ha^{-1}) which was statistically similar (9.43 t ha^{-1}) to N_3 and closely followed (8.72 t ha^{-1}) by N_1 while N_0 gave the lowest (6.71 t ha^{-1}) biological yield. Vegetative growth was influenced due to the higher dose of urea and for the reason the grain and straw yield was also increased with the increased dose of nitrogenous fertilizer. Singh and Lallu (2005) stated that each increment dose of N significantly increased grain and straw yields (biological yield) over its preceding dose.

Biological yield ha^{-1} of BRRI dhan57 varied significantly for different levels of phosphorous (Table 6). The highest biological yield (8.94 t ha^{-1})

was recorded from P_2, which were statistically identical (8.82 t ha^{-1}) with P_1, while the lowest biological yield (8.03 t ha^{-1}) was found from P_0 or control. Uddin *et al.* (2014) found that maximum biological yield of BRRI dhan57 obtained from 40 kg P ha^{-1}. Yosef Tabar (2013) also stated that 90 kg P ha^{-1} gave the highest biological yield.

Biological yield ha^{-1} of BRRI dhan57 varied significantly for different levels of nitrogen and phosphorous (Table 7). The highest biological yield (10.34 t ha^{-1}) was observed from N_2P_2, whereas the lowest biological yield (6.50 t ha^{-1}) from N_0P_0 or control condition. Yosef Tabar (2013) reported that 150 kg N ha^{-1} with 90 kg P ha^{-1} gave the maximum biological yield.

Conclusion

Different doses of nitrogen and phosphorus varied significantly for growth and yield of BRRI dhan57. Maximum of yield contributing parameter were in application 120 kg ha^{-1} nitrogen fertilizer, also with application 35 kg ha^{-1} phosphorus fertilizer. It was revealed that application of 120 kg N ha^{-1} along with 35 kg P_2O_5 ha^{-1} has more potential in regarding to yield and yield contributing characters of BRRI dhan57.

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References

Adhikary, R. C., and H. Rahman. 1996. Effect of different doses of nitrogen on the yield of BR 11 variety of rice. In: *Variety, Fertilizer and Weedicide Trial of some Field crops*. Rural Development Academy, Bogra, 15-20.

Ahmed, M., M. Islam, and S. K. Paul, 2005. Effect of nitrogen on yield and other plant characters of Local T. Aman Rice, Var. Jatai. *Res J Agric Biol Sci* 1(2): 158-161.

Ahsan, K. 1996. Effect of rate of N fertilizer on growth and yield of japonica and japonica indica hybrid of rice. *Bangladesh Rice J* 7(1&2): 17-21.

Alinajati Sisie, S. and B. Mirshekari, 2011. Effect of phosphorus fertilization and seed bio fertilization on harvest index and phoshorus use efficiency of wheat cultivars. *Journal of Food, Agriculutral & Environment* l9(2): 388-397.

Amin, M., M. A. Khan, E. A. Khan, and M. Ramzan. 2004. Effect of increased plant density and fertilizer dose on the yield of rice variety Ir-6. *J Res Sci* 15(1): 09-16.

Bayan, H. C. and O. S. Kandasamy, 2002. Effect of weed control methods application of nitrogen on weed and crop in direct seeded puddle rice. *Res Hisar* 24 (2): 200-272.

BBS (Bangladesh Bureau of Statistics). 2005. *The statistical Yearbook of Bangladesh.* Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Govt. of the People's Republic of Bangladesh.

BBS (Bangladesh Bureau of Statistics). 2013. Statistical Yearbook of Bangladesh Statistics Division, Ministry of Planning, Govt. of the People's Republic of Bangladesh, pp. 189-258.

Bhuiya, M. S. U., S. M. A. Hossain, and S. K. G. Kabir. 2002. Nitrogen fertilization in rice cv. BR10 after green manuring. *Bangladesh J Agril Sci* 16(1): 89-92.

Bhuyan, M. H. M., Mst. R. Ferdousi, and M. T. Iqbal, 2012. Foliar spray of nitrogen fertilizer on raised bed increases yield of transplanted aman rice over conventional method. *International Scholarly Research Network*, ID 184953.

BINA (Bangladesh Institute of Nuclear Agriculture). 1996. *Annul Report for 1993-94*. BINA. P.O. Box No. 4, Mymensingh: 175.

BRRI (Bangladesh Rice Research Institute). 1990. Nitrogen response of promising variety. *Annual Rep. Bangladesh Rice Res. Inst*., Joydebpur, Gazipur, pp: 95.

BRRI (Bangladesh Rice Research Institute). 2012. *Annual Report for 2011.* Bangladesh Rice Res. Inst. Joydebpur, Gazipur, Bangladesh, pp. 9-13.

BRRI (Bangladesh Rice Research Institute). 2013. Adhunik Dhaner Chash. Joydebpur, Dhaka. p. 19.

Chaturvedi, I. 2005. Effect of nitrogen fertilizers on growth, yield and quality of hybrid rice (*oryza sativa* L.). *Journal of Central European Agriculture* 6(4): 611-618.

Chopra, N. K. and N. Chopra, 2004. Seed yield and quality of "Pusa 44" rice (*Oryza sativa*) as influenced by nitrogen fertilizer and raw spacing. *Indian J Agril Sci* 74(3): 144-146.

Dhane, S. S., R. R. Khadse, V. H. Patil, and N. K. Sauant, 1989. Effect of deep placed USG with limited green manure on transplanted rice yield. *Intl Rice Res Newsl* 14(4): 31.

Duhan, B. S. and M. Singh. 2002. Effect of green manuring and nitrogen on the yield and nutrient uptake of micronutrient by rice. *J Indian Soc Soil Sci* 50(2): 178-180.

Dwivedi, D. K. 1997. Response of scanted rice (*Oryza sativa)* genotypes to nitrogen under mid-land situation. *Indian J Agron* 42 (1): 74-76.

Fallah, A. 2012. Interactive effects of nitrogen and irrigation methods on the growth and yield of rice in amol area. *Int J Agri* 3(4):111-113.

Fillery, I. R. P., J. R. Simpson, and S. K. De Datta. 1984. Influence of field environment and fertilizer management on ammonia loss from flooded rice. *J Soil Sci Soc Amer* 48: 914-920. doi: 10.2136/sssaj1984.03615995004800040043x

Gebrekidan, H. and M. Seyoum, 2006. Effect of mineral N and P fertilizers on yield and yield components of flooded lowland rice on vertisols of fogera plain, Ethiopia. *J Agri Rural Devel Trop Subtrop* 107(2):161-176.

Gomez, K. A. and A. A. Gomez, 1984. *Statistical procedures for Agricultural Research*. Jhon Wiley and Sons, New York.

Islam, M. R., P. K. Saha, M. J. Zaman, and S. K. Uddin. 2010. Phosphorus fertilization in inbred and hybrid rice. *J Biol Sci* 19(2): 181-187.

Islam, M. S., M. A. Hossain, M. A. H. Chowdhury, and M. A. Hannan, 2008b. Effect of nitrogen and transplanting date on yield and yield components of aromatic rice. *J Bangladesh Agril Univ* **6**(2):291-296.

Islam, M. S., M. I. A. Howlader, S. Rafiquzzaman, H. M. K. Bashar, and M. H. Al-Mamun, 2008a. Yield response of chili and T. aman rice to NPK fertilizers in ganges tidal floodplain. *J Soil Nature* **2**(1): 07-13.

Jashim, C., U. Ahmed, and K. U. Ahmed. 1984. Response of rice varieties to applied N in saline soils. *Int Rice Res Newsl* 9(5): 22.

Li, J., J. Gao, Y. Ma, 2010. Phosphorus accumulation in soil in rice-rice cropping systems with chemical fertilizer application: modeling and validation. *World congress of soil science, soil solutions for a changing world*. 224-227.

M. H. Uddin, K. M. Rahman, M. Z. Rahman, Z. Alam, and M. A. Salam, 2014. Effect of phosphorus and sulphur on yield of BRRI dhan57. *J Environ Sci & Natural Resources* 7(1): 7 – 11

Mondal, S. S. and S. N. Swamy, 2003. Effect of time of N application on yield and yield attributes of rice (*Oryza sativa*) cultivars. *Env Ecol* 21(2): 411-413.

Ndaeyo, N. U., K. U. Iboko, G. I. Harry, and S. O. Edem, 2008. Growth and yield performances of some upland rice (*oryza sativa* l.) Cultivars as influenced by varied rates of NPK (15:15:15) fertilizer on an ultisol. *J Trop Agric Food Env Ext* 7(3): 249 – 255.

Page, A. L., R. H. Miller, and D. R. Keeney, 1982. *Methods of analysis part 2, Chemical and Microbiological Properties*, Second Edition American Society of Agronomy, Inc., Soil Science Society of American Inc. Madson, Wisconsin, USA. pp. 403-430.

Panhawar, Q. A. and R. Othman, 2011. Effect of phosphatic fertilizer on root colonization of aerobic rice by phosphate-solubilizing bacteria. *International conference on food engineering and biotechnology. IPCBEE* (9):145-149.

Patel, P. K. and P. N. Upadhyay, 1993. Response of wheat (*Triticum aestivum*) to irrigation under varying levels of nitrogen and phosphorus. *Indian J Agron* 38(1): 113-115.

Rahman, M. H., M. M. Khatun, M. A. A. Mamun, M. Z. Islam, and M. R. Islam, 2007. Effect of number of seedling hill^{-1} and nitrogen level on growth and yield of BRRI dhan32. *J Soil Nature* 1(2):01-07.

Rasheed, M., M. Asif, and A. Ghafoor, 2003. Yield and yield attributes of fine rice BAS-385 as affected by different NP levels on farmer's field. *Pak J Agric Sci* 40: 1-2.

Sahrawat, K. L., M. P. Jones, S. Diatta, and A. Adam, 2001. Response of upland rice to fertilizer phosphorus and its residual value in an ultisol. *Communication in Soil Sci and Plant Analysis* 32(15-16): 2457-2468. doi: 10.1081/CSS-120000384

Singh, S. N. and Lallu. 2005. Influence of different levels of nitrogen on its uptake and productive efficiency of paddy varieties. *Indian J Plant Physiol* 10(1): 94-96.

Yosef Tabar, S. 2012. Effect of nitrogen and phosphorus fertilizer on growth and yield of rice (*Oryza sativa* L). *Intl J Agron Plant Prod* 3(12): 579-584.

Yosef Tabar, S. 2013. Effect of nitrogen and phosphorus fertilizer on spikelet structure and yield in rice (O*ryza sativa* L). *Intl J Agri Crop Sci.* 5 (11): 1204-1208.

Yosefi, K. H., M. Galavi, M. Ramrodi, S. R. Mousavi, 2011. Effect of bio-phosphate and chemical phosphorus fertilizer accompanied with micronutrient foliar application a growth, yield and yield component of maize (single cross704). *Australian J Crop Sci* 175-180.