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Effect of N and P on the yield, yield attributes and protein content of aromatic rice (cv. BRRI dhan34)

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Abstract: A field experiment was conducted at the Central Farm of Bangladesh Agricultural University, Mymensingh during the period from July to December, 2009 to observe the effect of N and P fertilization on the yield attributes and yield of aromatic rice cv. BRRI dhan34. The experiment comprised of four levels of N and four levels of P viz. 0, 55, 110, and 165 kg N ha^{-1} (N_0, N_1, N_2 and N_3) and 0, 25, 50 and 75 kg P ha^{-1} (P_0, P_1, P_2 and P_3), respectively. Yield and yield attributes were significantly influenced by the individual application of N and P except plant height and panicle length. The highest values of most the parameters were recorded from the plot fertilized with N_3 and P_2 treatment. Interaction effect of N and P fertilizer showed significant variation on filled grains, total grains, 1000-grain weight, grain and straw yield. The highest values of most of the parameters were obtained from the treatment combination of N_3P_2 except plant height, panicle length, total tillers, straw nitrogen content and straw yield. The overall results suggest that aromatic rice can be grown non calcareous soil fertilized with 110 kg N in combination with 50 kg P ha^{-1} to get higher yield for its large scale production in Bangladesh.

Key words: Nitrogen, phosphorus, aromatic rice, yield, protein.

Introduction

Bangladesh is an agrarian country ranking 4th in both areas and production of rice where agriculture is the single largest sector of her economy. According to BBS (2004) Bangladesh produces 26.19 million tons rice per annum from 10.83 million hectares of lands. But the yield of rice is quite lower (3.43 t ha^{-1}) compared to other rice producing countries of the world such as Australia, Korea, Japan and Spain where per hectare yield are 10.29, 5.99, 5.85 and 7.28 t, respectively. Aromatic rice are generally low yielding but they are considered best in quality and also considered highly valued and cultivation of aromatic rice becoming popular day by day due to its high price and export potential. Nitrogen is the key element which plays a vital role in vegetative growth and development of yield components and yield of rice. An increase in the yield of rice by 70 to 80 percent may be obtained by the proper application of nitrogenous fertilizer. Recently, our farmers apply higher doses of nitrogenous fertilizer and resulting lodging and susceptibility to insect-pest and disease. On the other hand, lower doses of N may drastically reduce the yield. Phosphorus is indispensable for all forms of life because of its genetic role in RNA and function in energy transfer via. ATP. Adequate P nutrition enhances many fundamental process viz. photosynthesis, N-fixation, flowering, fruiting and maturation. But P is widely deficient in Bangladesh soils and the amount of P in the available form is usually very low, seldom exceeds 0.01% of the total P in the soil. Unfortunately, much of such added P is converted to the less available secondary mineral forms, form which it is released very slowly.

A very few sporadic research works have been done on the effect of N and/or P on the yield and yield components of aromatic rice. Considering the above facts, the present piece of study was undertaken to examine the effect of N and P on the yield attributes, yield and protein content of aromatic rice.

Materials and Methods

A field experiment was conducted during *Kharif* season to examine the effect of N and P on yield attributes and yield of aromatic rice in the central farm of Bangladesh Agricultural University, Mymensingh, during the period from July to December, 2009. The soil was silt loam in texture having pH 6.49 with 1.30% organic matter, 0.11% total N, 12.1 mg kg^{-1} available P, 0.06 cmol kg^{-1} exchangeable K. The experiment consisted of N and P 0, 55, 110, and 165 kg N ha^{-1} (N_0, N_1, N_2 and N_3) and 0, 25, 50 and 75 kg P ha^{-1} ^{1} respectively. Soil samples were randomly collected at 0-15 cm depth during the time of land preparation from twenty five spots of the experimental land and composited. The crop under study was aromatic rice (cv.*BRRI dhan34*). This rice genotype was characterized by its scented properties like aroma, size and taste. Nitrogen and P fertilizers were applied as per design and treatments from urea and TSP and all other fertilizers like triple super phosphate, gypsum, borax and muriate of potash were applied according to the fertilizer recommendation guide. All chemical fertilizers and one-third of urea were applied during final land preparation and rest of the urea were applied in two installments. The experiment was laid out in RCBD with three replications. Individual plot size (4 m x 2.5 m) 10 m^2, space between unit plots is 0.5 m and space between replication is 0.5 m. Intercultural operations like weeding, thinning, gap filling, irrigation, pest control were done as and when necessary to ensure normal growth of crop. After collecting plant samples, the crop was harvested and sun dried for 3-4 days and grains were separated from the plants by beating the bundles with bamboo sticks. The seeds were dried in the sun for 2-3 days to 9% moisture level and cleaned. Soil and plant chemical properties were analyzed following the standard methods (Page *et al.,* 1982). Analysis of variance was done with the help of computer package M-STAT developed by Russel (1986) and the mean differences of the treatments were adjudged by LSD test. Total nitrogen was determined by Kjeldahl method (Page *et al.,* 1982). Protein was calculated from percent total nitrogen multiplied by 5.85.

Results and Discussion

Plant height: The plant height of the experimental crop was significantly effected by nitrogen (Table 1).The above results obtained in the study are in conformity with the results of Mohammad *et al*. (2005). The tallest plant (131.3 cm) produced when the crop received with 165 kg N ha^{-1}. The shortest plant (118.9 cm) was found where no nitrogen fertilizer was applied (Table 1). Variation in plant

height was also found to be significant ($p<0.01$) due to P fertilization (Table 2). Crop response to N and P interaction for plant height were presented in Table 3. It can be observed that the interaction of N and P levels ($p<0.01$) showed significant effect on plant height. Numerically, the tallest plant was found when the crop was fertilized with 165 kg N + 75 kg P ha^{-1} and the shortest was found when the crop was fertilized with 0 kg N + 0 kg P ha^{-1}. Kabir (2004) reported that the highest plant height of aromatic rice (*cv. BRRI dhan34*) ranged from 127.27 cm to 137.9 cm due to the application of poultry manure (5.0 t ha^{-1}) with recommended doses of NPKSZn fertilizers.

Table 1. Effect of N on the yield attributes, yield and protein content of aromatic rice cv. BRRI dhan34

Treatments	Plant height (cm)	Panicle length (cm)	Effective tillers $hill^{-1}$	Total tillers $hill^{-1}$	Filled grains $panicle^{-1}$	Unfilled grains $panicle^{-1}$	1000-grain wt. (g)	Grain yield (kg ha^{-1})	Protein content (%)	
									Grain	Straw
N_0	118.9	21.55	12.65	14.30	123.5	19.11	1.10	2017	6.61	2.57
N_1	124.9	22.08	13.26	14.89	130.3	16.82	10.26	2617	7.13	1.40
N_2	127.7	23.80	15.30	16.74	134.0	16.81	11.11	3090	7.49	1.81
N_3	131.3	25.43	14.86	16.34	126.6	19.00	11.00	2938	7.66	1.69
LSD (0.05)	1.63	0.75	0.75	0.77	1.92	1.38	0.34	0.2	0.04	0.04
CV (%)	1.56	3.85	6.42	5.97	2.06	9.22	3.83	4.91	6.59	7.33

Table 2. Effect of P on the yield attributes, yield and protein content of aromatic rice cv. BRRI dhan34

Treatments	Plant height (cm)	Panicle length (cm)	Effective tillers $hill^{-1}$	Total tillers $hill^{-1}$	Filled grains $panicle^{-1}$	Unfilled grains $panicle^{-1}$	1000-grain wt. (g)	Grain yield (kg ha^{-1})	Protein content (%)	
									Grain	Straw
P_0	123.1	22.58	13.15	15.10	121.9	20.11	10.10	2250	6.96	2.87
P_1	125.4	23.08	14.13	15.60	126.7	17.08	10.51	2720	7.19	3.16
P_2	126.0	23.57	14.49	15.73	135.2	16.14	11.15	2990	7.43	3.33
P_3	128.3	23.65	14.29	15.84	130.5	18.41	10.71	2690	7.25	3.01
LSD (0.05)	1.63	0.75	0.75	0.77	2.06	1.38	0.33	0.23	0.04	0.04
CV (%)	1.56	3.85	6.42	5.97	1.92	9.22	3.83	10.51	6.59	7.33

Panicle length: The effect of N and P showed significant effect on panicle length (Table 1).The longest panicle (25.43 cm) was obtained from N_3 and the shortest (21.55 cm) from control. Among the treatments 75 kg ha^{-1} produced the longest panicle (23.65 cm) and the shortest from the control (Table 2). Experimental crops which were fertilized with P might receive the added plant nutrient and that is why the panicle length was higher compared to control. The results confirms with the findings of Singh *et al*. (1997) who reported that application of P resulted higher panicle length. There was noted that there was significant difference in panicle length of aromatic rice due to N and P interaction. The longest panicle (26.84 cm) was recorded in 165 kg N + 75 kg P ha^{-1} and the shortest was recorded from 0 kg N + 0 kg P ha^{-1} (Table 3).

Total tillers $hill^{-1}$: Different levels of N showed significant effect on the total tillers $hill^{-1}$ (Table 1). The data show that N_2 treatment produced the highest (16.74) and N_0 treatment the lowest (14.30) total tillers $hill^{-1}$. It is revealed from the results that N enhanced the number of total tillers $hill^{-1}$. Islam *et al*. (1996) also reported that number of total tillers $hill^{-1}$ of rice was increased by N application. The effect of P failed to show any significant difference on the number of total tillers $hill^{-1}$ (Table 2). Application of 75 kg P ha^{-1} (P_3) produced the highest total tillers $hill^{-1}$. On the other hand, the lowest total tillers $hill^{-1}$ was found in control treatment. There was significant variation between nitrogen and phosphorus interaction effect on total tillers $hill^{-1}$.The highest number of total tillers was found from the treatment combination N_2P_2 (17.30) treatment and the lowest from the control combination.

Effective tillers $hill^{-1}$: Effective tiller differs significantly due to the different levels of N application. The highest number of effective tiller (15.30) was observed when the crop was fertilized with 110 kg N ha^{-1} and the lowest was attained in control. It can be concluded from the above findings that increase in N levels caused considerable increase in effective tiller (Islam *et al.* 1996). Significant variation in effective tiller $hill^{-1}$ was found ($p<0.01$) due to P application. Crop grown with 50 kg P ha^{-1} produced the highest number of effective tiller $hill^{-1}$ (14.49) which was statistically identical with P_1 and P_3 treatment and control treatment produced the lowest (13.15) (Table 2). There was significant variation ($p<0.01$) between N and P interaction on effective tiller $hill^{-1}$. Table 3 shows that numerically the highest effective tiller was 16.14 which was statistically similar with N_2P_3 and the lowest from control treatments, respectively.

Filled grains $panicle^{-1}$: Variation in filled grains $panicle^{-1}$ was found significant due to N application (Table 1). Nitrogen at 110 kg ha^{-1} gave highest filled grains $panicle^{-1}$

(134.0) and control treatment produced the lowest (123.5). The result shows that higher filled grain is mainly due to N fertilization. The present study is in accordance with the findings of Nair *et al.* (1994) who reported that filled grain of rice increased significantly due to increased levels of N. Data recorded in Table 2 shows that P 50 kg P ha^{-1} significantly enhanced the filled grains panicle^{-1} (135.2) and control treatment produced the lowest (121.9). Control treatment produced the lowest number of filled grains panicle^{-1} indicating that grains development was restricted by a shortage of P (Tisdale *et al.* 1999). The interaction effect of N and P was observed when the plot was fertilized with 110 kg N in combination with 75 Kg P and the lowest value (119.3) from control. From this above findings, it is concluded that both N and P promotes the filled grains panicle^{-1}.

Table 3. Interaction effect of N and P on the yield attributes yield and protein content of aromatic rice cv. BRRI dhan34

Treatments	Plant height (cm)	Panicle length (cm)	Effective tillers hill^{-1}	Total tillers hill^{-1}	Filled grains panicle^{-1}	Unfilled grains panicle^{-1}	1000-grain wt. (g)	Grain yield (kg ha^{-1})	Protein content (%)	
									Grain	Straw
N_0P_0	115.8	20.70	11.40	13.87	119.3	22.66	9.90	1820	6.44	2.40
N_0P_1	116.8	21.53	12.66	14.00	121.5	18.66	10.18	2170	6.55	2.52
N_0P_2	118.2	21.87	13.34	14.47	128.6	17.46	10.46	1980	6.79	2.69
N_0P_3	124.7	22.10	13.21	14.85	124.6	17.66	9.87	2100	6.67	2.63
N_1P_0	122.2	21.71	12.25	14.06	123.5	19.40	10.14	2270	6.84	2.57
N_1P_1	125.4	22.06	13.44	15.14	130.7	15.11	10.26	2500	7.20	2.81
N_1P_2	125.5	22.48	13.71	15.27	134.8	14.66	10.51	2950	7.25	2.93
N_1P_3	126.5	22.08	13.64	15.10	132.0	18.10	10.13	2750	7.14	2.81
N_2P_0	124.0	23.36	14.03	15.86	124.8	18.24	9.87	2430	7.08	2.92
N_2P_1	128.3	24.06	15.23	16.64	130.3	16.34	11.24	3110	7.37	3.16
N_2P_2	128.8	24.22	16.14	17.30	144.2	14.00	12.19	3640	7.96	3.45
N_2P_3	129.7	23.56	15.78	17.14	136.7	18.66	11.16	3180	7.66	2.81
N_3P_0	130.5	24.53	14.94	16.62	120.2	20.16	10.51	2500	7.49	3.74
N_3P_1	131.0	24.66	15.20	16.64	124.3	18.20	10.34	3100	7.72	4.15
N_3P_2	131.7	25.71	14.76	15.86	133.2	18.45	11.46	3400	7.84	4.27
N_3P_3	132.2	26.84	14.52	16.26	128.6	19.20	11.69	2750	7.61	4.10
LSD (0.05)	1.56	1.49	1.50	1.54	1.92	2.75	0.67	0.47	0.08	0.08
CV (%)	3.26	3.85	6.42	5.97	4.12	9.22	3.83	10.51	16.52	17.87

Unfilled grains panicle^{-1}: Variation in total grains panicle^{-1} was found to be significant due to N application (Table 1). The highest number of unfilled grains panicle^{-1} (19.11) was obtained from 0 kg N and the lowest (16.81) from N_2 treatment P also significantly enhanced the unfilled grains panicle^{-1} (Table 2). The highest unfilled grains panicle^{-1}(20.11) was found from 0 kg P ha^{-1} and the lowest (16.14) from 75 kg P ha^{-1}. The interaction effect of N and P was significant for unfilled grains panicle^{-1} (Table 3). The highest unfilled grains panicle^{-1} (22.66) was observed with 0 kg N in combination with 0 kg P and the lowest value (14.00) from N_2P_2 treatment. From this above findings, it is concluded that both N and P together decreased number of unfilled grains panicle^{-1}.

1000-grain weight: The weight of 1000-grain was significant at different N levels. The heaviest grain was achieved when the crop provided with 110 kg N ha^{-1} and the lightest grain was recorded in control. The present result indicates that 1000-grain weight was influenced by N. 1000 grain weight of rice was significantly increased by (Chowdhury *et al.*1995). It is found from the Table 2 hat 75 kg Pha^{-1} and control obtained heaviest and lightest grain weight, respectively. From the above findings it is evident that P promotes the 1000-grain weight. Jahiruddin *et al.* (1994) reported that 1000-grain weight of rice was significantly increased by P fertilization. The treatment combination of N and P interaction show significant effect on 1000-grain weight. Data recorded in Table 3 shows that the heaviest grain (12.19) was found by 110 kg N in combination with 75 kg P ha^{-1} and lightest grain (9.90) from control combination. From the present record it is clear that 1000-grain weight was influenced by N and P interaction.

Grain yield: Grain yield showed a significant variation for different N levels (Fig 1). Among the treatment 110 kg N ha^{-1} produced the highest grain yield (3090 kg ha^{-1}) and the lowest (2020 kg ha^{-1}) from the control. Higher grain yield in N_2 might have resulted from the cumulative favourable effect of the number of effective tillers hill^{-1}, filled grains panicle^{-1} and 1000-grain weight and also helps plant metabolism which produced higher yield (Tiwari *et al.,* 1997). The result obtained in this regard is in accordance with the findings of Chowdhury *et al*. (1995) who reported that N increased the grain yield in rice. Phosphorus showed a significant variation on grain yield. Grain yield was the highest (2990 kg ha^{-1}) when the crop received 75 kg P ha $^{-1}$ and the lowest (2250 kg ha^{-1}) was found from control. Present results are consistent with that of Wankhade (1996) who reported that grain yield increased significantly with each increment of P. The highest (3640 kg ha^{-1}) was recorded in 110 kg N in combination with 75 kg P ha^{-1} and the lowest (1820 kg ha^{-}

^{1}) from control. The second highest yield (3040 kg ha^{-1}) was found with the combination of 165 kg N and 75 kg P ha^{-1}. It is clear from the above trial that N in conjunction with P produces high yield. Similar opinion was on put forward by Ahmed and Hossain (1997) reported that N in combination of P produced higher grain yield.

Straw yield: Different levels of N on straw yield were also showed the same trend as did the grain yield (Fig. 1). The production of higher straw yield (5220 kg ha^{-1}) in110 kg N ha^{-1} might be due to the fact that P tends primarily to encourage above ground vegetative growth compared to control (4360 kg ha^{-1}). The findings for these characters agree with the result obtained by Singh *et al*. (1997) who observed that straw yields of mustard increased with increase in P rates. Fig. 2 showed that straw yield was significantly influenced by N application. The highest and lowest straw yields were obtained from N. The highest straw yield (5800 kg ha^{-1}) was recorded in 165 kg N in combination with 75 kg P ha^{-1} and the lowest (4190 kg ha^{-1}) was found from N_0P_0 (control). It is clear from the above trial that N in conjunction with P produces high straw yield. From the discussion, it is clear that 165 kg N in combination with 75 kg P ha^{-1} had the best performance for straw yield.

Grain protein content: Effect of N on grain protein was statistically significant (Table 1). It was found that N application increased the protein content in grain. The highest protein content (7.66%) was obtained from N_3 and N_2 and the lowest (6.61%) from control. The effect of P on protein content in grain was significant (Table 2). The protein content in rice grain was highest (7.43%) at P_2 treatment and was lowest (6.69%) in control treatment. The data revealed that the interaction effect of N and P was statistically significant (Table 3). The combined application of N and P increased the protein content in an irregular pattern. The highest protein content (7.84%) was achieved by 110 kg N + 55 kg P ha^{-1} and the lowest (6.44%) was in control combination.

Straw protein content: Nitrogen treatment shows significant effect on protein content of straw. The highest protein content (2.57%) was obtained from N_0 and lowest (1.40%) from control. Effect of N on protein content in straw was significant. Among the treatments, the highest protein content (3.33%) was observed due to the application of P at the rate of 55 kg ha^{-1} and the lowest (2.87%) was in control treatment (Table 2). The treatment combination of N and P had significant variation on protein content of the straw of rice. The highest protein content (4.27%) was achieved by 110 kg N in combination with 55 kg P ha^{-1} and the lowest (2.40%) was found from control combination (Table 3).

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