Journal of Agroforestry and Environment

Volume 16, Issue 1, 2023

Journal DOI: https://doi.org/10.55706/jae
Journal homepage: www.jagroforenviron.com

Influence of Nitrogen and Phosphorus on the Growth and Yield of Fine Aromatic Rice (cv. Binadhan-13)

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Received: 09/04/2023
Accepted: 13/06/2023
Available online: 15/06/2023

Abstract: Nitrogen and phosphorus are the essential nutrients involved in various physiological processes and affect the grain yield of rice. An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh to find out how nitrogen and phosphorus affect the growth and productivity of fine aromatic rice. The experiment consisted of five levels of nitrogen viz. 0, 25, 50, 75 and 100 kg N ha^{-1} with four levels of phosphorus viz. 0, 15, 30, and 45 kg P_2O_5 ha^{-1}. The experiment was set up using a randomized complete block design with three replications. According to the findings, the level of nitrogen, phosphorus and their interactions had a big impact on the yield and growth of aromatic rice. At harvest, the highest grain yield (4.15 t ha^{-1}) was found in 75 kg N ha^{-1} which was identical with 100 kg N ha^{-1} while the lowest one was found in control (0 kg N ha^{-1}). In case of phosphorus, 30 kg P_2O_5 ha^{-1} produced the maximum grain yield (3.73 t ha^{-1}) compared to other treatments and the lowest grain yield was discovered in control (0 kg P_2O_5 ha^{-1}). In interaction, the highest plant height (150 cm), number of effective tillers $hill^{-1}$ (7.33), panicle length (24.00 cm), grains $panicle^{-1}$ (136.9) and grain yield (4.37 t ha^{-1}) were recorded in 75 kg N ha^{-1} × 45 kg P_2O_5 ha^{-1}. Application of 75 kg N ha^{-1} along with 45 kg P_2O_5 ha^{-1} appears to be a promising combination for growing aromatic fine rice (cv. Binadhan-13).

Keywords: Fine rice; Nutrient; Yield performance.

INTRODUCTION

Rice (*Oryza sativa* L.) is the primary crop for nourishment worldwide and serves as the fundamental food for over half of the global population, i.e., more than 3 billion individuals. The agriculture of Bangladesh is predominantly rice based and its production of milled rice reached 38.78 million tons (BBS, 2022). In the average person's daily diet, rice provides around 75% of the necessary calories and 55% of the necessary protein (Chowdhury and Hassan 2013). In the rice market, aromatic varieties are more expensive than non-aromatic ones. Aromatic rice has a greater chance of luring rice consumers with its flavor and delectability, as well as commanding a higher price, which might enhance the financial status of rice growers in poor nations like Bangladesh (Fatematuz-Zohora *et al.* 2023).

Bangladesh has good prospects for exporting quality rice, which would generate foreign currency (Islam *et al.* 2008; Sarkar *et al.* 2014). Farmers want to plant premium rice because of its aromatic properties even if it yields less than coarse kinds. It is a more appealing option in some locations since it takes less input than coarse rice. The average rice output across the country is rather low (3.04 t ha^{-1}) (Sinha *et al.* 2018). The primary causes of poor yield are a dearth of better cultivars and improper nutrient management. The productivity of crops has been found to be declining due to nutrient mining, soil organic matter depletion, and soil aggregate decrease (Rahman and Yakupitiyage 2006).

The Bangladeshi soils are becoming more and more deficient in nutrients. The productivity of the soil decreases when chemical fertilizers are used excessively and improperly. An essential agricultural practice that can increase the production of fragrant rice of the highest caliber is the application of the proper fertilizers. The most important nutrient is nitrogen, which is a crucial element for rice cultivation not just in Bangladesh but also in other countries that produce rice (Hasan *et al.* 2002). It is crucial to supply enough nitrogen at the initial, intervals of mid-tillering and panicle initiation for improved grain growth (Ahmed *et al.* 2005). Although phosphorus is substantially less easily absorbed by plants than the other two of the three potential main elements (NPK), it nevertheless serves a critical role. However, the essential plant nutrients phosphorus and nitrogen have a significant impact on rice output. In order to produce aromatic rice, many farmers use very low levels of nitrogen and phosphorus, while others use extremely high levels. Both lower and higher levels have an impact on the development and growth of the crop. Low nitrogen levels significantly diminish output, whereas high nitrogen levels promote excessive vegetative growth, which weakens plants, causes lodging, and makes them more vulnerable to insects, pests, and diseases, reducing yield and polluting the environment. Additionally, after a relatively short time after application, phosphorus is in fixation with the soil complex, rendering more than two-thirds inaccessible (Sahrawat *et al.* 2001). So, it is crucial to identify the ideal amounts of nitrogen and phosphorus that will facilitate optimal growth, development, and anticipated harvest of high-quality aromatic aman rice.

MATERIALS AND METHODS

Experimental Site and Experimentation

The study was carried out from July to December 2017 throughout the *Aman* season at the Agronomy Field Laboratory at Bangladesh Agricultural University, Mymensingh (24˚75'N latitude and 90˚50'E longitude). The experimental location experiences a subtropical monsoon environment with high temperatures, high humidity, heavy rainfall, and sporadic gusty winds in the Kharif season, and moderate rainfall and low temperatures in the Rabi season. The floodplain soil in the experimental field was non-calcareous, dark grey, and had an organic matter level of 1.29%. There were five levels of nitrogen (0, 25, 50, 75 and 100 kg N ha^{-1}) and four levels of phosphorus (0, 15, 30 and 45 kg P_2O_5 ha^{-1}) in the experiment. The experiment was conducted as a randomized complete block design (RCBD) and replicated thrice. There were 60 unit plots in all, each measuring 4.0 m × 2.5 m. The blocks were separated by a distance of 1 m and the plots by 75 cm.

Crop Husbandry

The Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh provided the seeds of rice variety Binadhan-13. Using the specific gravity method, the healthy seeds were chosen, and they were then given a 24-hour soak in water. After 72 hours of being taken out of the water, the seeds began sprouting and were considered ready for sowing. The seed bed was prepared using a power tiller, leveled with a ladder, and the sprouted seeds were sown in the nursery bed on July 10, 2017. A motorized tiller was used to prepare the field, which required three plowings, cross-plowing, and laddering. On August 9, 2017, the field was marked according to the experimental specifications, and weeds and stubble were removed from individual plots. Urea and triple superphosphate were applied as per treatments. Other fertilizers viz. Muriate of potash-Gypsum-Zinc sulfate @ 70, 60, and 12 kg ha^{-1}, respectively were thoroughly mixed with the soil during final land preparation. At 15, 30, and 45 days following transplantation, urea was administered in three equal portions. On August 9, 2017, the seedlings were swiftly moved from the nursery bed to the main field without causing any damage to the roots. Three seedlings per hill were transplanted at a rate of three healthy seedlings per hill, with a row distance of 25 cm and a hill distance of 15 cm, respectively. In order to ensure and sustain normal crop growth, intercultural activities were carried out.

Data Collection

Five hills were randomly selected from each unit plot excluding the border rows and central 2.0 m × 2.5 m harvest area, and uprooted to gather data on crop characteristics and yield components. The central 2.0 m × 2.5 m area was then harvested and the crop from each plot was tagged and bundled separately before being brought to the threshing floor. The grains were washed after hand threshing, and they were then sun-dried to a moisture level of 14%. The straw had been adequately dried as well. The grain and straw yields per plot were then measured and converted to t ha^{-1}.

Statistical Analysis

The data collected was organized into a suitable format for statistical analysis. On the acquired data, statistical analysis was done to ascertain the significance of the variance brought on by the experimental treatments. The analysis of variance (ANOVA) technique was used to examine the data acquired, and Duncan's Multiple Range Test (DMRT) was used to evaluate mean differences (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Crop Growth Characters

Effect of Nitrogen and Phosphorus Level on Plant Height

The statistical study showed that amounts of phosphorus and nitrogen had a substantial interaction effect on plant height, as demonstrated in Table 1. Specifically, at 30 days after transplanting (DAT), the tallest plant (84.08 cm) was observed with the combination of 100 kg N ha^{-1} × 30 kg P_2O_5 ha^{-1}, while the lowest plant height (72.42 cm) was

DOI: https://doi.org/10.55706/jae1612

recorded with 25 kg N ha^{-1} × 45 kg P_2O_5 ha^{-1}. Similarly, at 45 DAT, the tallest plant (106 cm) was observed with the application of 100 kg N ha^{-1} × 15 kg P_2O_5 ha^{-1}, whereas the lowest plant height (88.5 cm) was recorded with the combination of 75 kg N ha^{-1} × 45 kg P_2O_5 ha^{-1}.

Table 1. Interaction effect of nitrogen and phosphorus level on plant height and number of tillers hill^{-1} of fine aromatic rice at different dates after transplanting (DAT)

Interaction (N × P)	Plant height (cm) at different DAT			Tillers hill^{-1} at different DAT (No.)		
	30	45	60	30	45	60
N_1×P_1	81.83ab	103.75a-c	112.32b-d	10.08a	12.167abc	14.60
N_1×P_2	77.17b	101.33a-e	110.56b-d	8abc	12.167abc	14.23
N_1×P_3	79.08ab	96.92b-g	104.67e-h	8.83a	13.08abc	15.70
N_1×P_4	72.42b	93.08c-g	101.54f-h	6.50b-e	11.25bc	13.70
N_2×P_1	77.17b	89.17e-g	95.32i	4.83e	11.167bc	13.45
N_2×P_2	82.67a	105.17ab	113.89ab	9.83a	14.5ab	17.41
N_2×P_3	80.00ab	101.58a-e	109.87c-e	7.92abc	12.25abc	14.73
N_2×P_4	72.42b	88.833b-g	97.65hi	5.25cde	10.167c	12.27
N_3×P_1	80.17ab	102.08a-d	110.31b-d	7.00a-d	12.83c	15.49
N_3×P_2	77.58b	96.58b-g	105.43d-g	9.50a	14.17abc	17.23
N_3×P_3	82.00ab	90.83d-g	98.98g-i	6.17b-e	14.75ab	17.74
N_3×P_4	80.00ab	94.25b-g	102.43f-h	5.83b-e	13.83abc	16.65
N_4×P_1	83.92a	99.83a-f	108.67c-e	7.33a-d	13.75abc	16.83
N_4×P_2	79.67ab	95.33c-g	106.41d-g	6.67bcd	11.667bc	14.76
N_4×P_3	75.75b	92.58c-g	100.68gh	6.58b-e	14.833ab	17.89
N_4×P_4	75.83b	88.5g	97.59hi	5.083de	12.67abc	15.24
N_5×P_1	82.58a	101.25a-e	109.45c-e	8.33ab	13.08abc	15.70
N_5×P_2	83.58a	106a	115.48a	9.17a	13.417abc	16.19
N_5×P_3	84.08a	98.5b-f	109.43c-e	9.00a	14.333ab	17.24
N_5×P_4	81.92ab	96.42b-g	106.34de-g	6.58b-e	15.75a	18.93
$LSD_{0.05}$	5.29	5.89	3.35	3.17	1.60	2.12
Significance level	**	**	**	*	***	NS
CV (%)	7.70	5.16	5.83	3.42	7.79	6.56

According to the DMRT, mean values in a column with the same letter (s) or no letter do not differ substantially from one another, however mean values in a column with a different letter do.

** = Significant at 1% level of probability, N_1 = 0 kg ha^{-1}, N_2 =25 kg ha^{-1}, N_3 = 50 kg ha^{-1}, N_4 = 75kg ha^{-1}, N_5 = 100 kg ha^{-1} and P_1 = 0 kg ha^{-1}, P_2 =15 kg ha^{-1}, P_3 = 30 kg ha^{-1}, P_4 = 45 kg ha^{-1}

At 60 DAT, the tallest plant (115.48 cm) was observed the interaction of 100 kg N ha^{-1} × 15 kg P_2O_5 ha^{-1}, while the shortest plant (95.32 cm) was observed with 25 kg N ha^{-1} × 0 kg P_2O_5 ha^{-1}. These results are in line with other studies by Bahadur *et al.* (2013) who discovered that nitrogen application boosted rice plant height and Fageria and Baligar (1997) discovered that phosphorus application had a substantial impact on plant height.

Effect of Nitrogen and Phosphorus Level on Number of Tillers Hill^{-1}

The interaction effect of nitrogen and phosphorus levels had a considerable impact on the tiller dynamics of fine aromatic rice, as seen in Table 1. At 30 days after transplanting (DAT), the highest number of tillers hill^{-1} (10.08) was observed with the application of 0 kg N ha^{-1} × 0 kg P_2O_5 ha^{-1} while the lowest number of hill^{-1} (4.83) was found in 25 kg N ha^{-1} × 0 kg P_2O_5 ha^{-1}. At 45 DAT and 60 DAT, the maximum number of tillers hill^{-1} (15.75) and (18.93) was observed with the combination of 100 kg N ha^{-1} × 45 kg P_2O_5 ha^{-1}, while the lowest number of tillers hill^{-1} (10.16) and (12.27) was observed with the combination of 25 kg N ha^{-1} × 45 kg P_2O_5 ha^{-1}. This is consistent with the findings of Roy and Paul (2018), who saw an increase in tiller production when nitrogen fertilizer was applied compared to the control, and Alam *et al.* (2009) noted a substantial difference in tiller production when phosphorus fertilizer was applied.

DOI: https://doi.org/10.55706/jae1612

Table 2. Effect of interaction between nitrogen and phosphorous level on the dry matter production of fine aromatic rice at different days after transplanting (DAT)

Interaction (N × P)	Dry matter production (g) at different DAT		
	30	45	60
$N_1 \times P_1$	10.73abcd	20ab	23.56bc
$N_1 \times P_2$	8.8abcd	20.6ab	23.98bc
$N_1 \times P_3$	12.87abc	15.867bc	20.10cde
$N_1 \times P_4$	9.80abcd	13.93c	18.31e
$N_2 \times P_1$	7.33cd	17b	19.34cde
$N_2 \times P_2$	11.27abcd	17.73b	18.97de
$N_2 \times P_3$	11.20abcd	20.93ab	24.54ab
$N_2 \times P_4$	9.33abcd	16.4bc	20.34cd
$N_3 \times P_1$	10.47abcd	15.73bc	18.56de
$N_3 \times P_2$	6.133d	23.87a	27.65a
$N_3 \times P_3$	9.2abcd	19.07ab	22.63bc
$N_3 \times P_4$	10.07abcd	19.53ab	23.21bc
$N_4 \times P_1$	7.87bcd	21.93a	25.32a
$N_4 \times P_2$	7.66bcd	20.52ab	24.43ab
$N_4 \times P_3$	8.87abcd	15.8bc	18.62de
$N_4 \times P_4$	5.93d	15.27bc	18.89de
$N_5 \times P_1$	14.33a	22.87a	26.04a
$N_5 \times P_2$	7.53bcd	19.6ab	23.08bc
$N_5 \times P_3$	13.60ab	18.2bc	21.93cd
$N_5 \times P_4$	9.87abcd	21.3ab	24.66ab
$LSD_{0.05}$	5.63	4.32	3.12
Level of significance	**	**	**
CV (%)	6.98	5.43	6.28

According to the DMRT, mean values in a column with the same letter (s) or no letter do not differ substantially from one another, however mean values in a column with a different letter do.

** = Significant at 1% level of probability, N_1 = 0 kg ha^{-1}, N_2 =25 kg ha^{-1}, N_3 = 50 kg ha^{-1}, N_4 = 75 kg ha^{-1}, N_5 = 100 kg ha^{-1} and P_1 = 0 kg ha^{-1}, P_2 =15 kg ha^{-1}, P_3 = 30 kg ha^{-1}, P_4 = 45 kg ha^{-1}

Effect of Nitrogen and Phosphorus Level on Dry Matter Production

The production of total dry matter was significantly impacted by the interplay of nitrogen and phosphorus, as seen in Table 2. The highest amounts of total dry matter (14.33 g, 22.87 g, and 26.04 g) were found in treatments with 100 kg N ha^{-1} × 0 kg P_2O_5 ha^{-1} at 30, 45, and 60 days after treatment (DAT), respectively. The lowest total dry matter (5.93 g) was observed at 30 DAT in the treatment with 75 kg N ha^{-1}× 45 kg P_2O_5 ha^{-1}. At 45 and 60 DATs, the lowest total dry matter (13.93 g, 18.31 g) production was recorded in the treatment with 0 kg N ha^{-1} × 45 kg P_2O_5 ha^{-1}. Xia *et al.* (2007) reported that increasing the split nitrogen application from the control led to an increase in the buildup of dry matter. Brasil *et al.* (2002) and Paul *et al*. (2021) depicted that soils treated with triple superphosphate produced the higher dry matter.

Crop Characters, Yield and Yield Contributing Characters

Effect of Nitrogen Level on Yield and Yield Contributing Characters

Different nitrogen levels had statistically significant effects on a variety of metrics, including panicle length, number of grains per panicle, grain yield, straw yield, biological yield, and harvest index (Table 3). Plant height, however, was not significantly affected by nitrogen levels. The tallest plants (137.81 cm) were observed with a nitrogen application rate of 75 kg N ha^{-1}, while the shortest plants (131.02 cm) were found in plots with 100 kg N ha^{-1}. The longest panicle (20.91 cm) was observed in plots with 75 kg N ha^{-1}, whereas the shortest panicle (18.74 cm) was observed in plots with 0 kg N ha^{-1}. The highest number of grains panicle^{-1} (115.23) was produced in plots with 75 kg N ha^{-1}, while the lowest number of grains panicle^{-1} (107.08) was produced in plots with 0 kg N ha^{-1}. In terms of grain yield, the highest yield of (4.15 t ha^{-1}) was obtained with an application rate of 75 kg N ha^{-1}, while the lowest yield (3.83 t ha^{-1}) was obtained in plots with 0 kg N ha^{-1} (Figure 1).

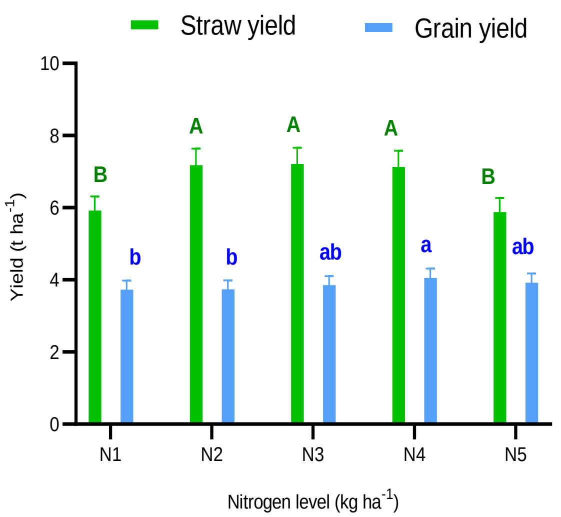

Figure 1. Effect of nitrogen on grain and straw yield (t ha^{-1}) of fine aromatic rice

DOI: https://doi.org/10.55706/jae1612

Table 3. Effect of nitrogen level on crop characters, yield contributing characters and yield of fine aromatic rice

Nitrogen level	Plant height (cm)	Panicle length (cm)	Grains panicle^{-1} (no.)	Biological yield (t ha^{-1})	Harvest index (%)
N_1	132.65cd	18.749b	107.08e	7.248c	24.05ab
N_2	134.04bc	19.514b	109.64d	8.435ab	19.93b
N_3	134.44bc	19.599b	111.43c	8.508a	20.37b
N_4	137.81a	20.911a	115.23a	8.455ab	20.75ab
N_5	131.02d	19.317b	113.99ab	7.347bc	24.79a
$LSD_{0.05}$	2.237	1.305	1.762	0.564	4.24
Significance level	NS	**	**	**	*
CV (%)	6.78	6.62	8.65	5.89	4.45

According to the DMRT, mean values in a column with the same letter (s) or no letter do not differ substantially from one another, however mean values in a column with a different letter do.

** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS = Not significant, N_1 = 0 kg ha^{-1}, N_2 =25 kg ha^{-1}, N_3 = 50 kg ha^{-1}, N_4 = 75kg ha^{-1}, N_5 = 100 kg ha^{-1}

These findings are consistent with previous studies by Masum *et al.* (2008) and Hasanuzzaman *et al.* (2009) who reported that urea fertilizers resulted in higher grain yields compared to other sources. Figure 1 revealed that the highest straw yield (7.31 t ha^{-1}) was obtained with an application rate of 50 kg N ha^{-1}, which was similar to rates of 75 kg N ha^{-1} and 25 kg N ha^{-1} while the lowest straw yield (6.02 t ha^{-1}) was obtained in plots with 0 kg N ha^{-1}. The highest biological yield (8.50 t ha^{-1}) was observed in plots with 50 kg N ha^{-1}, while the lowest yield (7.24 t ha^{-1}) was observed in plots with 0 kg N ha^{-1}. The maximum harvest index of 24.79 % was observed in plots with 100 kg N ha^{-1}, while the lowest harvest index of 19.93% was observed in plots with 25 kg N ha^{-1}.

Effect of Phosphorus Level on Yield and Yield Contributing Characters

Plant height, panicle length, number of grains per panicle, grain yield, straw yield, biological yield, and harvest index were all significantly impacted by different phosphorus levels, as demonstrated in Table 4. The tallest plant (144.88 cm), panicle (21.18 cm) and number of grains panicle^{-1} (125.36) was observed in the treatment with 45 kg P_2O_5 ha^{-1}, while the shortest plant (121.25 cm), panicle (18.52 cm) and number of grains panicle^{-1} (97.97) was found in 0 kg P_2O_5 ha^{-1}. Numerically, the highest grain yield (3.73 t ha^{-1}) was obtained with 30 kg P_2O_5 ha^{-1}, whereas the lowest grain yield (3.62 t ha^{-1}) was obtained in 0 kg P_2O_5 ha^{-1}, as shown in Figure 2. Shah (2002) reported similar findings regarding the effect of phosphorus on grain yield. The highest straw yield (9.08 t ha^{-1}) was recorded in the treatment with 30 kg P_2O_5 ha^{-1}, while the lowest straw yield (5.60 t ha^{-1}) was obtained with 0 kg P_2O_5 ha^{-1}, as shown in Figure 2.

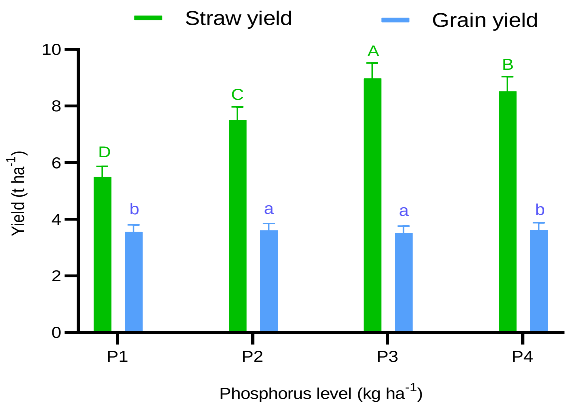

Figure 2. Effect of phosphorus on grain and straw yield (t ha^{-1}) of fine aromatic rice

Alam *et al*. (2009) also reported that the application of 48 kg P_2O_5 ha^{-1} resulted in the highest straw yield. The highest biological yield (9.59 t ha^{-1}) was found in the treatment with 45 kg P_2O_5 ha^{-1}, while the lowest biological yield (6.23 t ha^{-1}) was found in 0 kg P_2O_5 ha^{-1}. The highest harvest index (27.10%) was calculated in the treatment with 45 kg P_2O_5 ha^{-1}, while the lowest harvest index (17.9%) was found in 0 kg P_2O_5 ha^{-1}.

DOI: https://doi.org/10.55706/jae1612

Table 4. Effect of phosphorus level on crop characters, yield contributing characters and yield of fine aromatic rice

Phosphorus level	Plant height (cm)	Panicle length (cm)	Grains panicle^{-1} (no.)	Biological yield (t ha^{-1})	Harvest index (%)
P_1	121.25c	18.5225c	97.97c	6.237c	17.9c
P_2	133.82b	19.0066bc	111.23b	7.88b	21.997b
P_3	136.02b	19.755b	111.343b	8.278b	20.91b
P_4	144.88a	21.188a	125.36a	9.599a	27.104a
LSD0.05	3.967	1.065	3.655	0.885	3.19
Significance level	**	**	**	**	**
CV (%)	6.78	6.62	8.65	5.89	4.45

According to the DMRT, mean values in a column with the same letter (s) or no letter do not differ substantially from one another, however mean values in a column with a different letter do.

** = Significant at 1% level of probability, P_1 = 0 kg ha^{-1}, P_2 =15 kg ha^{-1}, P_3 = 30 kg ha^{-1}, P_4 = 45kg ha^{-1}

Interaction Effects of Nitrogen and Phosphorus Level on Yield and Yield Contributing Characters

Plant height, panicle length, number of grains in panicle^{-1}, grain yield, straw yield, biological yield, and harvest index were all significantly impacted by the interplay between nitrogen and phosphorus (Table 5 & Figure 3). The tallest plant (150 cm), effective tillers hill^{-1} (7.33) was obtained from the application of 75 kg N ha^{-1}× 45 kg P_2O_5 ha^{-1}, while the shortest plant (117.83 cm) was found in the treatment with 75 kg N ha^{-1}× 0 kg P_2O_5 ha^{-1}. The longest panicle (24.00 cm) was recorded in 75 kg N ha^{-1} × 45 kg P_2O_5 ha^{-1}, while the shortest panicle (18.29 cm) was found with 0 kg N ha^{-1}× 0 kg P_2O_5 ha^{-1}. The highest number of grains panicle^{-1} (136.9) was produced in the treatment 75 kg N ha^{-1} × 45 kg P_2O_5 ha^{-1}, while the lowest number of grains panicle^{-1} (92.33) was produced in the treatment with 0 kg N ha^{-1} × 0 kg P_2O_5 ha^{-1}. The highest grain yield (4.37 t ha^{-1}) was obtained in the treatment with 75 kg N ha^{-1} × 45 kg P_2O_5 ha^{-1}, while the lowest grain yield (2.49 t ha^{-1}) was obtained in the treatment with 0 kg N ha^{-1}× 0 kg ha^{-1}. The highest straw yield (10.43 t ha^{-1}) and biological yield (10.09 t ha^{-1}) was obtained in the treatment with 25 kg N ha^{-1}× 45 kg P_2O_5 ha^{-1}, while the lowest straw yield (4.13 t ha^{-1}) and biological yield (5.08 t ha^{-1}) was obtained in the treatment with 0 kg N ha^{-1} × 0 kg P_2O_5 ha^{-1}.

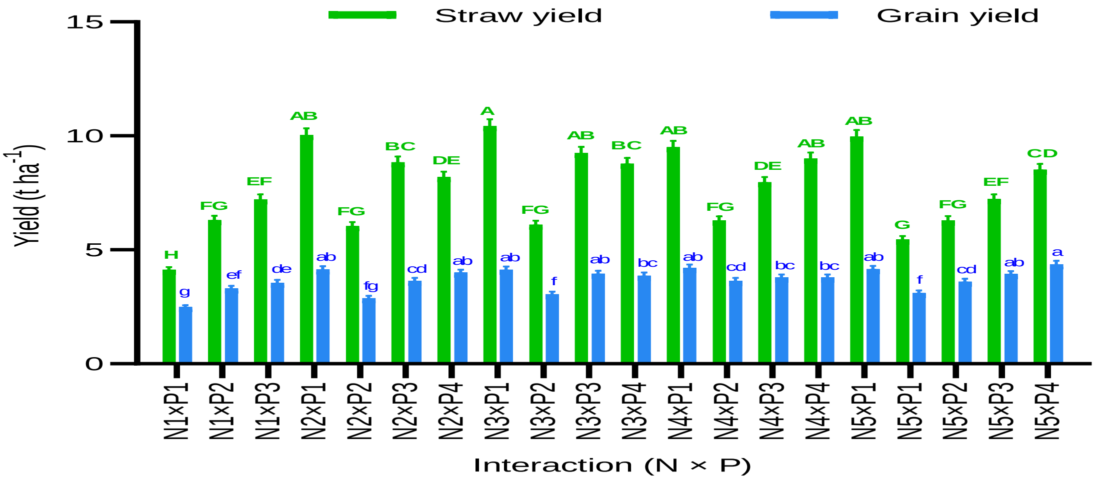

Figure 3. Effect of interaction between nitrogen and phosphorus on grain and straw yield (t ha^{-1}) of fine aromatic rice

DOI: https://doi.org/10.55706/jae1612

Table 5. Interaction effects of nitrogen and phosphorus level on crop characters, yield contributing characters and yield of fine aromatic rice

Interaction (N × P)	Plant height (cm)	Effective tillers hill^{-1} (No.)	Length of panicle (cm)	Grains panicle^{-1} (no.)	Biological yield (t ha^{-1})	Harvest index (%)
$N_1 \times P_1$	121.917hi	4.25j	18.29h	92.33k	5.08j	34.75a
$N_1 \times P_2$	131.667fg	5.2hi	18.72fgh	107.5hi	6.80ghi	24.72bcd
$N_1 \times P_3$	134.25def	5.5gh	18.72fgh	111.2efgh	7.32fgh	19.9cde
$N_1 \times P_4$	142.75b	6ef	19.27fgh	117.33cde	9.79ab	16.83e
$N_2 \times P_1$	121.17hi	4.9i	18.49gh	96.73jk	6.50hi	24.64bcd
$N_2 \times P_2$	132.5efg	5.75fg	19.04fgh	107.93ghi	8.94bcd	19.78cde
$N_2 \times P_3$	134.67def	6ef	19.53efg	115cdefg	8.23cdef	19.11de
$N_2 \times P_4$	147.83a	6.2cde	21.00bc	118.9cd	10.09a	16.2e
$N_3 \times P_1$	122.17hi	5.2hi	18.42h	99.77j	6.65hi	25.7bc
$N_3 \times P_2$	137cd	6.083def	19.67def	115.3cdef	9.20abc	18.63de
$N_3 \times P_3$	136.5cde	6ef	19.64def	109.61fgh	8.90bcd	19.99cde
$N_3 \times P_4$	142.08b	6.4bcd	20.67bcd	121.03bc	9.29ab	17.16e
$N_4 \times P_1$	117.83i	5.5gh	18.70fgh	99.65j	6.87ghi	25.76bc
$N_4 \times P_2$	140.75bc	6.5bc	19.28fgh	117.03cde	8.13def	20.52cde
$N_4 \times P_3$	142.66b	6.7b	21.67b	107.35hi	9.14abcd	20.08cde
$N_4 \times P_4$	150a	7.333a	24.00a	136.9a	9.69ab	16.63e
$N_5 \times P_1$	123.17h	5.5gh	18.71fgh	101.35ij	6.08ij	28.63b
$N_5 \times P_2$	129.17g	6.25cde	19.00fgh	113.68defgh	6.72hi	23.84bcd
$N_5 \times P_3$	132fg	6.2cde	19.23fgh	113.6defgh	7.82efg	25.45bc
$N_5 \times P_4$	139.75bc	6.41bcd	20.33cde	127.33b	8.77bcde	21.23cde
$LSD_{0.05}$	2.684	0.30	0.64	4.35	1.14	3.69
Level of sig.	**	***	***	***	***	***
CV (%)	3.61	4.29	4.29	2.97	6.88	3.67

According to the DMRT, mean values in a column with the same letter (s) or no letter do not differ substantially from one another, however mean values in a column with a different letter do.

*** = Significant at 1% level of probability, ** = Significant at 1% level of probability, NS = Not significant, N_1 = 0 kg ha^{-1}, N_2 =25 kg ha^{-1}, N_3 = 50 kg ha^{-1}, N_4 = 75kg ha^{-1}, N_5 = 100 kg ha^{-1} and P_1 = 0 kg ha^{-1}, P_2 =15 kg ha^{-1}, P_3 = 30 kg ha^{-1}, P_4 = 45kg ha^{-1}

The highest harvest index (34.75%) was observed in the treatment with 0 kg N ha^{-1} × 0 kg P_2O_5 ha^{-1}, while the lowest one (16.2%) was observed in the treatment with 25 kg N ha^{-1} × 45 kg P_2O_5 ha^{-1}. Similar results were reported elsewhere (Amin *et al.* 2004; Saha *et al.* 2004; Hasanuzzaman *et al.* 2010).

CONCLUSION

Based on the foregoing discourse, it can be inferred that the utilization of nitrogen and phosphorus is imperative in augmenting the production of high-quality aromatic aman rice. The most substantial crop yield (4.37 t ha^{-1}) was obtained from a combination of 75 kg N ha^{-1} and 45 kg P_2O_5 ha^{-1}. Consequently, the findings indicate that a combination of 75 kg N ha^{-1} and 45 kg P_2O_5 ha^{-1} is indispensable in achieving elevated growth and yield for Binadhan-13. Therefor, aromatic fine rice (cv. Binadhan-13) can be fertilized with 75 kg N ha^{-1} × 45 kg P_2O_5 ha^{-1} in terms of higher yield.

Conflict of Interest

There are no conflicts of interest declared by the authors.

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