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ORIGINALE ARTICLE

Effects of Varied Phosphorus Fertilizer Rates on Yield and Nutrient Uptake of Boro Season Rice (*Oryza sativa L.*) in Bangladesh

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ABSTRACT

Background: The response of boro rice to different phosphorus fertilizer doses is critical for optimizing growth and yield. Understanding the interactions between rice varieties and phosphorus levels can lead to improved agricultural practices and increased productivity. **Objective:** The experiment aimed to evaluate the response of two boro rice varieties to different phosphorus fertilizer doses, focusing on growth and yield parameters. **Methods**: The experiment was conducted from January to June 2022 at the Agronomy Field Laboratory, University of Rajshahi. A Randomized Complete Block Design (RCBD) was used to test two rice varieties (BRRI dhan28 and BRRI dhan58) and three phosphorus levels (P1 = 100 kg ha-1, P2 = 150 kg ha-1, P3 = 200 kg ha-1). **Results:** The study found that BRRI dhan58 (V2) outperformed BRRI dhan28 (V1) in several growth and yield parameters. Specifically, BRRI dhan58 exhibited superior plant height (101.47 cm), a higher number of tillers, and greater chlorophyll content (51.03 SPAD). It also had longer panicle length (23.23 cm), a higher number of grains per panicle (185.66), and greater 1000-grain weight (23.09 g). Additionally, BRRI dhan58 produced a higher grain yield (7.66 t ha-1), straw yield (9.10 t ha-1), and biological yield (16.76 t ha-1), while having fewer non-effective tillers (5.31) and a lower harvest index (45.73%). Regarding phosphorus treatments, the highest dose (P3 = 200 kg ha-1) yielded the best results across various parameters. Plants treated with P3 exhibited the greatest plant height (108.86 cm), the highest total and effective tiller counts, and the highest chlorophyll content (55.37 SPAD). Additionally, P3 treatment resulted in the longest panicle length (24.94 cm), the highest number of grains per panicle (200.70), and the greatest 1000-grain weight (23.18 g). This phosphorus level also produced the highest grain yield (8.26 t ha-1), straw yield (9.81 t ha-1), and biological yield (18.07 t ha-1), although it also resulted in more non-effective tillers (5.58). The interaction of BRRI dhan58 with the highest phosphorus dose (V2P3) produced the best outcomes for nearly all parameters. This combination resulted in the highest grain yield (8.37 t ha-1) and biological yield (18.42 t ha-1), although it also had the highest number of non-effective tillers (6.09).
Keywords: *Phosphorus fertilizer; Chlorophyll content; Single-photon avalanche diode.*

1.INTRODUCTION

Rice (*Oryza sativa* L.) is the most important food for the people of Bangladesh (Zaman, 2000) and it is the staple food for more than two billion people in Asia (Myint *et al*., 2010) and it provides 21% and 15% per capita of dietary energy and protein, respectively (Maclean *et al.,* 2002). The geographical, climatic, and edaphic conditions in Bangladesh are ideal for year-round rice cultivation. However, Bangladesh's national average rice yield (4.2 t ha^{-1}) is very low when compared to other rice-growing countries such as China (6.30 t ha^{-1}), Japan (6.60 t ha^{-1}) and Korea (6.30 t ha^{-1}) (FAO. 2009). Rice production is dependent on soil nutrient availability. Nitrogen, phosphorus and potassium are the three primary nutrient element for rice growth. Deficiency of these elements during crop growth can limits the yield and yield contributing characters of rice. According to changes in seasonal conditions, Bangladesh has three distinct rice growing seasons: Aus, Aman, and Boro. More than half of total production (55.50%) is obtained in the Boro season (December-May), the second largest production in the Aman season (37.90%) occurring in July-November, and the Aus season (6.60%) occurring in April-June (APCAS, 2016). Boro rice is the most important rice crop for Bangladesh due to its high yield and contribution to rice production among the three growing seasons. Phosphorus (P) is an important plant nutrient for all crops and component of nucleic acid, phytin and phospholipids. It is a component of Adenosine Diphosphate (ADP) and Adenosine Tri Phosphate (ATP) and plays an important role in plant energy transformation (Sanker *et al*, 1984). It is essential for cell division, flowering, and fruiting, as well as seed formation, crop maturation, root development, and quality enhancement. Many Indo-Gangetic plain soils, including Bangladesh, have become P deficient (BRRI, 1992). In Bangladesh, depleted soil fertility is a major hindrance to increased crop production. The increasing intensity of land use has resulted in nutrient depletion in soils. Rice yield in P deficient soil was less than 50% of that obtained from soils containing even moderate levels of P (Saleque *et al*. 1998). Much of the P applied to soils as fertilizer become fixed into unavailable forms to plant (Choudhury *et al*. 2007), leading to agronomic and economic inefficiency. Phosphorus fertilizer management is complex as it requires knowledge of the supply of other nutrients to crop, the overall P balance in soil, the effective P supply from indigenous soil resources, fertilizer application, crop P export and recycling, and the processes that govern the availability of P in a particular soil (Doberman *et al*. 1996). The amount of soil P removed by crops needs to be replenished through the application of fertilizer to maintain soil P balance. The crucial fact about P application to agricultural soils is that an under dose will impede crop growth, while an overdose will be wasteful and also pose an environmental threat of eutrophication (Sharpley *et al*. 2001). The research is carried out based on the following objectives To study the effect of phosphorus on growth and yield of BRRI dhan28 and BRRI dhan58. To evaluate the performance of BRRI dhan28 and BRRI dhan58 using various phosphorus fertilizer dosages.

2.MATERIALS AND METHODS

The experiment was conducted at the Agronomy Field Laboratory, Department of Agronomy and Agricultural Extension, University of Rajshahi, during the period from January 2020 to June 2020 to investigate the influence of different doses of boron and magnesium on growth and yield of boro rice. The materials used and the methods followed during the experimental period are described in this chapter. A brief description of the experimental site, soil, Climate, experimental design, treatments, cultural operations, data collection, and their statistical analysis are narrated under the following heads.

2.1 Location and soil

The study was conducted at the Agronomy Field Laboratory, Department of Agronomy and Agricultural Extension, Rajshahi University, spanning from December 2019 to March 2020. The experimental site featured sandy loam textured soil with a pH level of 7.6.

2.2 Climate

The experimental field was situated within a subtropical climate, distinguished by moderately high temperatures and substantial rainfall throughout the kharif season (November-March). Conversely, during the Rabi season (November to March), the region experienced sparse rainfall coupled with moderately low temperatures.

2.3 Variety and Experimental treatments

BRRI dhan28 and BRRI dhan58 were used in the present experiment. BRRI dhan28 and BRRI dhan58 were collected from Bangladesh rice research institute(BRRI), Regional Station, shyampur, Rajshahi.

2.4 Cultivation techniques

Healthy seeds were soaked for 24 hours, sprouted in darkness, and sown in a prepared seedbed in January 2022. The seedbed was maintained with weeding, irrigation, and pest protection. For transplanting, the field was initially flooded to rot weeds, then ploughed and leveled. The final preparation for transplanting occurred on 26 February 2022, with layout completed on 15 February. NPK fertilizers (urea, TSP, MP) were applied as recommended by BARI during the growth stage. Seedlings were uprooted and transplanted on 26 February using conventional methods. Intercultural operations included gap filling, manual weeding, herbicide application, flood irrigation, and pest control. Infestations by rice stem borers and green leafhoppers were managed with Furadan and Sumithion. Regular observations ensured the plants grew healthily, showing vigorous tiller growth without lodging. Data were collected from three randomly selected hills per plot at 30-day intervals until harvest. The crop was harvested on 1 June at full maturity. Post-harvest, each plot's crop was bundled, tagged, and threshed separately. The grains and straw were sun-dried, adjusted to 14% moisture, and yields were converted to tons per hectare. The field appeared healthy throughout the growing period, with no major disease incidences.

2.5 Collection of experimental data

The data recording procedure involved measuring plant height from three randomly selected plants in each plot at different stages (30, 60, 90, and 120 DAT) and at maturity. Total tillers, including both productive and unproductive, were counted from the same plants. Chlorophyll levels were measured using a SPAD-502 meter. At maturity, yield data were collected by uprooting three hills per plot, excluding border rows, and harvesting the crop from a $1m^2$ area. Yield parameters recorded included plant height, effective and non-effective tillers per hill, panicle length, number of grains per panicle, filled and unfilled grains per panicle, 1000-grain weight, grain yield, straw yield, biological yield, and harvest index. Grain and straw yields were measured, dried, and converted to tons per hectare. Biological yield was calculated by summing grain and straw yields, and the harvest index was determined as the ratio of economic yield to biological yield.

2.6 Statistical analysis

The collected data underwent analysis utilizing the "STATVIEW" statistical package. Mean differences were evaluated employing Duncan's multiple-range test.

3. RESULTS

3.1 Plant height (cm)

There are no significant differences in plant height was observed between the two rice varieties at 30, 60, 90 and 120 days after transplanting (DAT) and BRRI dhan 58(V_2) produced comparatively taller plants than BRRI dhan 28 (V_1) (**Table 1**).At 30 DAT, the tallest plant (21.74 cm) was observed in V_2 and the shortest plant (21.16 cm) was observed in V_1. At 60 DAT, the highest plant height (43.04 cm) was observed in V_2 and the lowest plant height (40.43 cm) was noticed in V_1. Simmilarly at 90 and 120 DAT, the maximum plant heights (91.75 cm and 101.47 cm) were observed in V_2 and the minimum plant heights (88.22 cm and 97.17 cm) were found in V_1. It was found that Inorganic phosphorus fertilizer increased the plant height of rice. Similar results were found by Reddy *et al.* (2005)**.** A noticeable effect on the plant height of rice was observed for different phosphorus fertilization at all observations (30, 60, 90 and 120 DAT) (**Table 1**). At 30 DAT, the highest plant height (23.49 cm) was found in P_3due to the application of 200 kg P_2O_5 ha^{-1} and the lowest plant height (18.57 cm) was observed in P_1 due to the application of 100 kg P_2O_5 ha^{-1}. At 60 DAT, the maximum plant height (46.70 cm) was observed in P_3 and the minimum plant height (35.13 cm) was recorded at P_1. At 90 DAT, the tallest plant (99.22 cm) was recorded from P_3 which was statistically simillar with P_2 and the shortest plant (77.98 cm)was recorded in P_1. Finally, at 120 days after transplanting, the maximum plant height (108.86 cm) was obtained from P_3 which is statistically significant with P_1(85.73 cm). The above findings are in good alignments with the results of Karmakar (2016) Significant differences in plant height were observed due to interaction between rice varieties and different phosphorus fertilization at all observations **(Table 1)**. At 30 DAT, the highest value for plant height (23.63 cm) was found in combination of V_2 with P_3 which is statistically similar with V_1P_2, V_1P_3, V_2P_2 and lowest value for plant height was found in the combined effect of V_1 with P_1. Similarly, at 60, 90 and 120 DAT, the highest plant found in the combination of V_2P_3 (47.73, 101.27 and 110.66 cm, respectively) and the lowest corresponding values were observed in V_1P_1 (33.21, 75.87 and 82.46 cm, respectively).

3.2 Total number of tiller hill^{-1}

There were non-significant variation case of total number of tillers per hill of the varieties were observed **(Table 1)**. The maximum number of tiller hill^{-1} (19.64) was noticed in BRRI dhan58 and the minimum no of tiller hill^{-1} (18.94) was found in BRRI dhan28. Significant differences were observed due to phophorus fertilization on total no of tillers hill^{-1} of rice **(Table 1)**. The highest number of tillers hill^{-1} (21.16) was found in P_3 which is reduced significantly by 21.12% in P_1. Interaction effects of rice varieties and different doses of phosphorus application showed significant values in case of total no of tillers hill^{-1} which is presented in **Table 1**. Interaction of V_2 with P_3 exhibit highest no of tillers hill^{-1}(21.42) and lowest no of tillers hill^{-1}(16.03) was found in V_1P_1. This result is supported by Islam *et al.* (2011).

3.3 Chlorophyll Content (ChN_{SPAD})

Leaf chlorophyll content of rice varieties were measured on 30 and 60 DAT and presented in **Table 1**. There were no significant differences within the rice varieties at all observations (30 and 60 DAT). At 30 DAT, maximum chlorophyll content (48.47) was found in V_2 and minimum value (45.63) for chlorophyll content was observed in V_1. At 60 DAT, chlorophyll content was highest (51.03) in V_2 and lowest (48.95) in V_1. Chlorophyll content of rice showed statistically significant result due to different phosphorus fertilizations **(Table 1)**. At 30 DAT, highest chlorophyll content (52.83) was observed in P_3 which reduced slightly by 7.20% in P_2 but significantly by 25.5% for P_1. At 60 DAT, highest chlorophyll content (55.37) was observed in P_3 which is statistically similar with P_2 and reduced significantly by 23.06% in P_1. Significant interaction was found between varieties and phosphorus fertilization in chlorophyll content of rice **(Table 1)**. At 30 DAT maximum chlorophyll content (54.13) was found in the combination of V_2 with P_3 and the minimum (37.85) was observed in V_1 with P_1. At 60 DAT maximum chlorophyll content (56.50) was found in the combination of V_2 with P_3 and the minimum (40.77) was observed in V_1 with P_1.

Effective tiller hill^{-1}

Table 1: Varietal differences, Effect of phosphorous fertilization and Interaction effects in plant height, total number of tiller hill^{-1}, no of effective tiller hill^{-1}, no of non effective tiller hill^{-1} and Chlorophyll Content (ChN_{SPAD}) of boro rice.

Variety	Plant Height				Total no of tiller hill^{-1}	No of effective tiller hill^{-1}	No of non-effective tiller hill^{-1}	Chlorophyll Content (ChN_{SPAD})	
	30DAT	60DAT	90DAT	120DAT				30DAT	60DAT
V_1	21.16±0.86	40.43±2.19	88.22±3.67	97.17±4.13	18.94±0.82	13.07±0.86	5.87±0.24	45.63±2.43	48.95±2.40
V_2	21.74±0.79	43.04±2.09	91.75±3.66	101.47±3.73	19.64±0.70	14.33±0.82	5.31±0.26	48.47±2.38	51.03±2.18
LS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	5.79	10.57	7.22	6.27	6.34	14.71	14.85	9.72	8.64
Treatments									
P_1	18.57±0.39b	35.13±1.39b	77.98±2.17b	85.73±2.34b	16.69±0.46b	11.32±0.73b	5.37±0.31	39.32±1.77b	42.60±1.41b
P_2	22.30±0.48a	43.36±1.79a	92.75±2.74a	103.37±2.36a	20.02±0.46a	14.44±0.80a	5.58±0.36	49.00±1.67a	52.00±1.63a
P_3	23.49±0.55a	46.70±1.94a	99.22±2.58a	108.86±2.76a	21.16±0.53a	15.34±0.84a	5.82±0.32	52.83±1.92a	55.37±1.93a
LS	0.05	0.05	0.05	0.05	0.05	0.05	NS	0.05	0.05
CV%	5.79	10.57	7.22	6.27	6.34	14.71	14.85	9.72	8.64
Interaction									
V_1P_1	18.06±0.37b	33.21±1.43c	75.87±2.52c	82.46±2.51b	16.03±0.39b	10.47±0.61b	5.56±0.30	37.45±2.15c	40.77±1.79c
V_1P_2	22.08±0.62a	42.40±2.37ab	91.61±4.30ab	102.01±3.70a	19.90±0.77a	13.93±1.32ab	5.97±0.55	47.91±2.69ab	51.83±2.60ab
V_1P_3	23.36±0.86a	45.67±2.30a	97.18±3.86a	107.05±3.99a	20.89±0.80a	14.81±1.26a	6.09±0.47	51.53±2.35a	54.24±2.71a
V_2P_1	19.08±0.60b	37.05±2.00bc	80.09±3.57bc	89.01±3.23b	17.36±0.70b	12.18±1.25ab	5.18±0.58	41.20±2.74bc	44.43±1.84bc
V_2P_2	22.52±0.84a	44.32±.3.09ab	93.90±4.21a	104.73±3.49a	20.14±0.66a	14.94±1.11a	5.20±0.46	50.08±2.37a	52.15±2.56ab
V_2P_3	23.63±0.88a	47.73±3.05a	101.27±3.79a	110.66±4.36a	21.42±0.82a	15.87±1.28a	5.55±0.46	54.13±3.36a	56.50±3.17a
LS	0.05	0.05	0.05	0.05	0.05	0.05	NS	0.05	0.05
CV%	5.79	10.57	7.22	6.27	6.34	14.71	14.85	9.72	8.64

Mean values in a column having the same letters or without letter do not differ significantly as per DMRT, **CV**= Co-efficient of variation, **LS**= Level of significant, **DAT**= Days After Transplanting, **V_1**=BRRI dhan28, **V_2**= BRRI dhan58, **T_1**= P_2O_5 100 kg/ha, **T_2**= P_2O_5 150 kg/ha , **T_3**= P_2O_5 200 kg/ha.

Statistically non significant differences were observed in no of effective tiller hill^{-1} of rice presented in Table 2. The highest number of effective tiller hill^{-1} (14.33) was observed in V_2 and the lowest (13.07) was in V_1. Number of effective tiller hill^{-1} was significantly affected due to different doses of phosphorus fertilizers (Table 2). The highest number of effective tiller hill^{-1} (15.34) was recorded in P_3 and the lowest (11.32) was in P_1. Effective tiller hill^{-1} was significantly higher in P_3 which reduced by 5.86% and 26.20% in P_2 and P_1, respectively. The interaction effect between rice varieties and different phosphorus fertilization on effective tiller hill^{-1} showed significant results (Table 2). Numerically the highest number of effective tiller hill^{-1} (15.87) was found in the combination of $V_2P_3$and the lowest number of effective tiller hill^{-1} (10.47) was found in the combination of V_1P_1.

Non-Effective tiller hill^{-1}

Number of non-effective tiller hill^{-1} was non-significant in case of rice varieties (Table 2). The highest number of non-effective tiller hill^{-1} (5.31) was observed in V_2 and the lowest (5.87) was in V_1. Number of non- effective tiller hill^{-1} was not significantly affected due to different phosphorus fertilizer rates (Table 2). The highest number of non-effective tiller hill^{-1} (5.82) was recorded in P_3 and the lowest (5.37) was in P_1. Non-effective tiller hill^{-1} reduced significantly 4.12% and 7.73% in P_2 and P_1, respectively in comparison to P_3. The interaction effect between rice varieties and different phosphorus fertilization on non-effective tiller hill^{-1} was non-significant (Table 2). The highest number of non-effective tiller hill^{-1} (6.09) was found in the combination of V_1P_3 and the lowest number of non-effective tiller hill^{-1} (5.18) was found in the combination of V_2P_1.

Panicle Length (cm)

No remarkable difference in the length of the panicle was observed between the two rice varieties (Table 2). V_2 produced a comparatively higher value (23.23 cm) than that of V_1 (22.48 cm). Phosphorus fertilization had a remarkable effect on the rice panicle length (Table 2). In this case, the highest value (24.94cm) was recorded in P_3, which significantly reduced by 4.73% and 20.32% in P_2 and P_1, respectively. Statistically significant effect was observed in the length of panicle due to the interaction between rice varieties and phosphorus fertilization (Table 2). The highest length of the panicle (25.23cm) was obtained from the treatment combination of $V_2 P_3$ and the lowest length of panicle (19.27 cm) was found in treatment combination of V_1P_1.

Grains Panicle^{-1}

There was no significant in no of grains panicle^{-1} was observed between the two rice varieties and V_2 produced a maximum (185.66) grains panicle^{-1} and which was 4.51 higher than V_1 (Table 2). Phosphorus fertilization significantly influenced no of grains panicle^{-1}(Table 2). The highest grains panicle^{-1} (200.70) was recorded from P_3 and the lowest no of grains panicle^{-1} (154.33) was recorded from P_1. Statistically significant effect was observed in no of grains panicle^{-1} due to the interaction between variety and different doses of phosphorus fertilizer (Table 2). The highest grains panicle^{-1} (204.14) was acquired from V_2P_3 and the lowest grains panicle^{-1} (148.11) was achieved from V_1P_1.

1000 grain weight (g)

No remarkable difference in 1000 grain weight (g) was found between two rice varieties and maximum 1000 grain weight (23.09) was found in V_2 and minimum was found in V_1 (22.72) (Table 2). Different phosphorus fertilization did not influence 1000 grain weight (g) of rice varieties (Table 2). The highest 1000 grain weight (23.18)was found in P_3, which reduce slightly by 0.64% and 2.93% in P_2 and P_1, respectively. No remarkable effect was observed in 1000 grain weight (g) due to the interaction between variety and different phosphorus fertilization(Table 2). The highest 1000 grain weight (23.30 g) was recorded from V_2P_3 and the lowest 1000 grain weight (22.18g) was obtained from V_1P_1.

Grain yield (t ha^{-1})

Rice varieties did not differ significantly in case of grain yield. Numerically, V_2 showed the highest value (7.66 t ha^{-1}) than V_1(7.27 t ha^{-1}). In this case, V_2 exceeded V_1 by 5.36% (Table 2). Grain yield is significantly influenced by different phosphurus fertilizer doses(Table 2). The highest grain yield (8.26 t ha^{-1}) was obtained from P_3 which reduced slightly by (5.44%) in P_2 and significantly by 22.88% in P_1. The interaction between variety and phosphorus fertilization had a statistically significant effect on grain yield of rice varieties (Table 2). Interaction of V_2 with P_3 produced the highest grain yield (8.37 t ha^{-1}), while V_1P_1 produced the lowest grain yield (5.92 t ha^{-1}).

Straw yield (t ha^{-1})

There was no significant difference in straw yield was viewed between two rice varieties of which V_2 produced the highest value (9.10 t ha^{-1}) (Table 2). This value was 5.93% higher than that in V_1 The application of different phosphorus fertilizer significantly influences straw yield of rice vareities (Table 2). The highest straw yield (9.81 t ha^{-1}) was recorded from P_3 which reduced slightly by 5.91% in P_2 and significantly by 23.95% in P_1. Statistically significant effect was observed in straw yield due to the interaction between variety and phosphorus fertilization (Table 2). The highest straw yield (10.05 t ha^{-1}) was achieved from V_2P_3 and the lowest straw yield (7.01 t ha^{-1}) was obtained from V_1P_1.

Biological yield (t ha^{-1})

There was no remarkable difference in biological yield was noticed between the two rice varieties in which V_2 produced the highest value (16.76 t ha^{-1}). This value was 5.87% higher than that in V_1(Table 2). Biological yield is significantly influenced by different doses of phosphorus fertilizers (Table 2). The highest biological yield (18.07 t ha^{-1}) was obtained from P_3, which reduced slightly by 5.7% in P_2, but significantly by 23.79% in T_1. Statistically significant effect was observed in biological yield due to the interaction effect of variety and phosphorus fertilization (Table 2). The highest biological yield (18.42 t ha^{-1}) was obtained from V_2P_3 and the lowest biological yield (12.93 t ha^{-1}) was achieved from V_1P_1.

Harvest index (%)

Statistically non sifnificant difference in harvest index was found between two rice varieties (Table 2). The highest value for harvest index(45.91) was found in V_1,which is only reduced by 0.39% in V_2. Significant differences were observed due to phosphorus fertilization in case of harvest index of rice (Table 2). The highest harvest index (45.88) was achieved from P_2, and lowest (45.73) was found in P_3. The harvest index showed a statistically significant effect due to the interaction between variety and phosphorus fertilization. The highest harvest index(46.00) was achieved from V_1P_3 and the lowest harvest index (45.48) was obtained from V_2P_3 (Table 2).

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Table 2 : Varietal differences, Effect of phosphorous fertilization and Interaction effects on yield and yield contributing characters of rice

Variety	Panicle Length(cm)	No of Grain panicle^{-1}	1000 Grain Weight	Grain Yield (t ha^{-1})	Straw Yield (t ha^{-1})	Biological Yield (t ha^{-1})	Harvest Index(%)
V_1	22.48±0.88	177.28±8.76	22.72±0.21	7.27±0.38	8.56±0.47	15.83±0.84	45.91±0.28
V_2	23.23±0.79	185.66±7.87	23.09±0.20	7.66±0.29	9.10±0.40	16.76±0.68	45.73±0.26
LS	NS	NS	NS	NS	NS	NS	NS
CV%	5.03	8.6	2.57	7.45	9.58	8.49	2.03
Treatments							
P_1	19.87±0.42b	154.33±5.68b	22.50±0.20	6.31±0.27b	7.46±0.35b	13.77±0.61b	45.84±0.45
P_2	23.76±0.46a	189.37±6.31a	23.03±0.23	7.81±0.20a	9.23±0.33a	17.04±0.52a	45.88±0.31
P_3	24.94±0.49a	200.70±6.10a	23.18±0.27	8.26±0.21a	9.81±0.33a	18.07±1.33a	45.73±0.26
LS	0.05	0.05	NS	0.05	0.05	0.05	NS
CV%	5.03	8.6	2.57	7.45	9.58	8.49	2.03
Interaction							
V_1P_1	19.27±0.44b	148.11±5.65c	22.18±0.21	5.92±0.38b	7.01±0.46c	12.93±0.81c	45.79±0.82
V_1P_2	23.51±0.71a	186.45±10.70ab	22.92±0.33	7.73±0.31a	9.11±0.49ab	16.84±0.81ab	45.95±0.37
V_1P_3	24.65±0.72a	197.27±10.31a	23.07±0.38	8.14±0.33a	9.58±0.53a	17.72±0.86a	46.00±0.36
V_2P_1	20.47±0.57b	160.55±9.53bc	22.81±0.24	6.70±0.26b	7.91±0.45bc	14.61±0.70bc	45.89±0.58
V_2P_2	24.00±0.71a	192.28±8.72a	23.15±0.37	7.89±0.32a	9.35±0.52ab	17.24±0.82a	45.81±0.57
V_2P_3	25.23±0.78a	204.14±8.24a	23.30±0.45	8.37±0.32a	10.05±0.47a	18.42±0.79a	45.48±0.36
LS	0.05	0.05	NS	0.05	0.05	0.05	NS
CV%	5.03	8.6	2.57	7.45	9.58	8.49	2.03

kg/ha Mean values in a column having the same letters or without letter do not differ significantly as per DMRT, **NS**= Non-significant, **CV**= Co-efficient of variation, **LS**= Level of significant, **V_1**=BRRI dhan28, **V_2**= BRRI dhan58, **T_1**= P_2O_5 100 kg/ha, **T_2**= P_2O_5 150 kg/ha , **T_3**= P_2O_5 200.

5.DISCUSSION

The differential growth and yield observed among rice varieties can be attributed to their inherent genetic characteristics, which play a pivotal role in shaping their responses to environmental conditions and nutrient availability (Shahin *et al.*, 2023). The unique genetic composition of each variety dictates specific growth habits, nutrient uptake efficiencies, and stress tolerance levels. BRRI dhan28 and BRRI dhan58 exhibit significant genetic variations that likely influence root architecture, photosynthetic efficiency, and nutrient use efficiency (Li *et al.*, 2023). These differences impact the varieties' abilities to absorb and utilize phosphorus, a critical nutrient for plant development. Genetic disparities between BRRI dhan28 and BRRI dhan58 may affect critical growth stages, including tillering, panicle initiation, and grain filling. Such variations contribute to observed differences in plant height, tiller number, panicle length, grain number, and overall yield. The interaction of these genetic traits with environmental factors, such as soil fertility, water availability, and climatic conditions, underscores the complexity of growth and yield outcomes (Bhardwaj *et al.*, 2024). Phosphorus (P) plays a critical role in energy transfer within plants, being a key component of adenosine triphosphate (ATP) (Khan *et al.,* 2023), which is essential for various physiological processes, including cell division and elongation (Kayoumu *et al.*, 2023). Increased phosphorus availability likely enhances the plant's energy status, leading to increased cell division and elongation, thereby resulting in taller plants. This mechanism aligns with findings from Karmakar (2016) and Reddy et al. (2005), who reported increased plant height with higher phosphorus fertilization. Phosphorus is essential for root development, which aids the plant's ability to produce additional tillers (Thrupthi *et al.*, 2023). Enhanced root systems increase nutrient and water intake, resulting in the development of more tillers. This observation agrees with the findings of Islam et *al.* (2011). Furthermore, phosphorus is required for the synthesis of nucleic acids and the creation of cell membranes, both of which are critical for chloroplast growth and function (Khn *et al.*, 2023). Improved chloroplast function increases photosynthetic efficiency, resulting in higher chlorophyll content. Effective tillers, those who contribute to grain production, are critical for yield improvement. Phosphorus promotes root development, nutrient uptake, and energy availability, hence facilitating the setting up of effective tillers (Thrupthi *et al.*, 2023). Longer panicles with more spikelets can lead to better grain output. Phosphorus increases the plant's general vigour, resulting in improved panicle growth and elongation. During reproductive development, phosphorus influences flowering and grain formation (Sun *et al.*, 2023). Adequate phosphorus promotes optimal energy transfer and metabolic activity throughout these important periods, resulting in increased grain set and grain numbers per panicle (Wang *et al.*, 2023). Furthermore, a steady supply of energy and nutrients during grain filling, accompanied by appropriate phosphorus, can result in somewhat heavier grains. Phosphorus supports overall plant growth and development, resulting in increased biomass production, including both grain and straw. The increased straw yield under higher phosphorus levels indicates enhanced vegetative growth and structural development, which are important for supporting high grain yield (Thrupthi *et al.*, 2023 and Khan *et al.*, 2024). These findings underscore the multifaceted role of phosphorus in enhancing various growth parameters and yield components in rice plants.

5. CONCLUSION

The experiment conducted at the Agronomy Field Laboratory, University of Rajshahi, aimed to evaluate the response of boro rice varieties BRRI dhan28 and BRRI dhan58 to different phosphorus fertilizer doses. Results indicated that BRRI dhan58 consistently outperformed BRRI dhan28 across most growth and yield parameters, including plant height, tiller numbers, chlorophyll content, panicle length, grain yield, straw yield, and biological yield. Specifically, the highest phosphorus dose (P_3 = 200 kg/ha) significantly enhanced these parameters, resulting in the best overall performance, especially in combination with BRRI dhan58. This combination (V_2P_3) achieved the highest values in plant height, total tillers, effective tillers, chlorophyll content, panicle length, total grains per panicle, 1000-grain weight, grain yield, straw yield, and biological yield. The study concluded that BRRI dhan58 is superior to BRRI dhan28, and the application of 200 kg/ha of P_2O_5 is most effective in enhancing rice yield.

6. REFERENCES

1. Alam MM, Ali MH, Amin AKMR, Mirza Hasanuzzaman. Yield attributes, yield and harvest index of three irrigated rice varieties under different levels of phosphorus. *Adv Biol Res.* 2009;3(3–4):132-139.
2. APCAS (Asia and Pacific Commission on Agricultural Statistics). Agriculture Market Information System (AMIS) in Bangladesh. Twenty-sixth session on Asia and Pacific Commission Agriculture Statistics. 2016; pp. 15-19.
3. Bhardwaj R, Khwairakpam R, Negi AS, Rawat B. Implication of Plant Functional Traits in Crop Improvement. In: Plant Functional Traits for Improving Productivity. *Singapore: Springer Nature Singapore*; 2024. p. 23-39.
4. BRRI (Bangladesh Rice Research Institute). Annual Report for the Year 1992. Gazipur-1701, Bangladesh; 1992:51-55.
5. Choudhury ATMA, Kennedy LR, Ahmed MF, Kecskes ML. Phosphorus fertilization for rice and control of environmental pollution problems. *Pakistan J Biolo Sci*. 2007;10:2098-2105.
6. Das T, Sinha AC. Effect of organic and inorganic sources of nutrients on growth and yield of rice (Oryza sativa) under terai region of West Bengal. *J Interacademicia*. 2006;10(1):16-19.
7. Dinesh S, Ishwer S, Kumar SP. Influence of different nitrogen and phosphorus levels on profitability, plant nutrient content, yield and quality in basmati cultivars. *Trends Biosci.* 2012;5(4):289-293.
8. Dobermann A, Casmann KG, Cruz PCS, Adviento MAA, Pampolino MF. Fertilizer inputs, nutrient balance and soil nutrient supplying power in intensive, irrigated rice ecosystems. III. Phosphorus. *Nutr Cycl Agroecosyst*. 1996;46:111-125.
9. Dunn DJ, Stevens G. Response of rice yields to phosphorus fertilizer rates and polymer coating. J Agril Sci. 2008;42(3):34-37.
10. FAO (Food and Agriculture Organization). Yearbook of Production. *FAO Statistics Division*. 2009:605-607.
11. He-Yuan Q, Shen QR, Kong IL, Yiong YS, Wang XX. Effect of soil moisture content and phosphorus application on phosphorus nutrition of rice cultivated in different water regime systems. *J Plant Nutr*. 2004;27(12):2259-2272.
12. Iqbal M. Yield and biomass in rice interactions of nitrogen, phosphorus and water application. Pakistan J Biol Sci. 2004;7(12):2115-2120.
13. Islam MR, Saha PK, Zaman MJ, Uddin SK. Phosphorus fertilization in inbred and hybrid rice. *J Biol Sci*. 2010;19(2):181-187.
14. Kayoumu M, Iqbal A, Muhammad N, Li X, Li L, Wang X, et al. Phosphorus availability affects the photosynthesis and antioxidant system of contrasting low-P-tolerant cotton genotypes. *Antioxidants*. 2023;12(2):466.
15. Khan F, Siddique AB, Shabala S, Zhou M, Zhao C. Phosphorus plays key roles in regulating plants' physiological responses to abiotic stresses. *Plants*. 2023;12(15):2861.
16. Khandaker MM. Effect of rate and time of phosphorus fertilizer application on growth and yield of rice. MS Thesis, Bangladesh Agricultural University (BAU), Mymensingh; 2003:1-63.
17. Kumar S, Singh RS. Phosphorus management in rice-wheat cropping system. *J Res, Birsa Agric Univ*. 2001;13(1):51-56.
18. Li Y, Tao F, Hao Y, Tong J, Xiao Y, He Z, et al. Variations in phenological, physiological, plant architectural and yield-related traits, their associations with grain yield and genetic basis. *Ann Botany.* 2023;131(3):503-519.
19. Li YF, Luo AC, Wei XH, Yao XG. Genotypic variation of rice in phosphorus acquisition from iron phosphate. Contributions of root morphology and phosphorus uptake kinetics. *Russian J.* 2007;54(2):230-236.
20. Maclean JC, Dawe DC, Hardy B, Hcttcl GP. Rice almanac (3rd edition). *CABI Publishing Willing Ford*; 2002:253.
21. Moula SM. Comparative performance of rock phosphate and TSP on T. Aman rice in Old Brahmaputra Flood Plain and Old Himalayan Piedmont plain soils. MS Thesis, Bangladesh Agricultural University, Mymensingh; 2005.
22. Myint AK, Yarnakawa T, Kajihara Y, Zenmyo T. Application of different organic and mineral fertilizers on the growth, yield and nutrient accumulation of rice in a Japanese ordinary paddy field. *Sci World J*. 2010;5(2):47-54.
23. Nair CS, Rajasree B. Efficiency of phosphate concentrate (34/74) and super phosphate at two levels on yield characters of rice in the neutral to alkaline soils of Chittoor palaghat Kerala. *Indian J Agron*. 2004;46(3):98-104.
24. Pheav S, Bell RW, White PF, Kirk GJD. Fate of applied fertilizer phosphorus in a highly weathered sandy soil under lowland rice cropping and its residual effect. *Field Crops Res.* 2003:1-16.
25. Rasavel M, Ravichandran M. Effect of zinc phosphorus and sulfur interactions on growth and yield of rice under neutral and alkali soils. *Intl J Curr Res*. 2013;5(1):65-67.
26. Sahrawat KL, Jones MP, Diatta S, Adam A. Response of upland rice to fertilizer phosphorus and its residual value in an ultisol. Commun *Soil Sci Plant Anal.* 2001;32(15-16):2457-2468.
27. Saleque MA, Abedin MJ, Panuallah GH, Bhuiyan NL. Yield and phosphorus efficiency of some low land rice varieties at different levels of soil available phosphorus. *Commun Soil Sci Plant Anal.* 1998;29:2905-2916.
28. Sanker AS, Reddy PR, Rao IVS. Nodulation and nitrogen fixation in groundnut as affected by seed size and phosphorus. *Legume Res J*. 1984:1-5.
29. Shahin MNH, Harun-Or-Rashid M, Atikuzzamman M, Uddin MR, Kobir MS. Assessment of Genetic Variability for Yield and Yield Contributing Characters in Rice (Oryza sativa L.). *Asian J Agric Hort Res*. 2023;10(4):281-296.

30. Sharpley AN, McDowell RW, Kleinman PJA. Phosphorus loss from land to water: integrating agricultural and environmental management. *Plant Soil*. 2001;237:287-307.
31. Sun Y, Han Y, Xu Z, Zhang J, Shen J, Cheng L. Phosphorus partitioning contributes to phosphorus use efficiency during grain filling in Zea mays. *Front Plant Sci.* 2023;14:1223532.
32. Talukder ASMHM, Meisner CA, Sarkar MAR, Islam MS. Effect of water management, tillage options and phosphorus rates on rice in an arsenic-soil-water system. In: 19th World Congress of Soil Science, Soil Solutions for a Changing World; 2010 Aug 1-6; Brisbane, Australia. Published on DVD. pp. 62-65.
33. Tang X, Shi YM, Hao X. Phosphorus efficiency in a long-term wheat–rice cropping system in China. *J Agril Sci*. 2011;149(3):297-304.
34. Thrupthi MG, Debbarma V, Harika D. Influence of phosphorus and micronutrients on growth and yield of rice (Oryza sativa L.). Int J Environ Clim Change. 2023;13(8):162-169.
35. Tripathi BN, Dixit VK, Chaubey CN. Influence of various levels of moisture regimes, puddling and phosphorus application on the yield and nutrient uptake by rice. *Bhartiya Krishi Anusandhan Patrika*. 2001;16(1–2):45–50.
36. Wang J, Li H, Wang Q, Huang X, Hu W, Wang S, et al. Effects of phosphorus application on carbohydrate metabolism in cottonseed kernel during the key development period provided a new insight for phosphorus management in cotton production. *Ind Crops Prod*. 2023;191:115972.
37. Xu-Da Y, Tin J, Hu-Shu Y, Gao Y, Yang JC, Zhu-Quing S. Effect of N, P, K, fertilizer management on grain amylase content and RVA profile parameters in rice. *Acta Agronomica Sinica*. 2005;31(7):921-925.
38. Yosef, T. S. (). Effect of nitrogen and phosphorus fertilizer management on growth and yield of rice. *Intl. J. Agric. Crop Sci*. 2013a;5(15): 1659–1662.
39.Yosef TS. Effect of nitrogen and phosphorus fertilizer on spikelet structure and yield in rice (Oryza sativa L). *Int J Agric Crop Sci*. 2013;5(11):1204-1208.
40. Zaman S, Hashem MA, Miah MH, Mallik SA, Shamsuddoha ATM. Effect of organic and inorganic sources of nitrogen and potassium on physical and chemical properties of soil under rice cropping. *Bangladesh J Agril Sci*. 2000;27(1):71-76.
41. Khan, M.T.A.; Momen, M.B.H.; Yasmin, N.; Islam, M.R. and Salahin, M.(2024). The Collaborative Effect of Hand Weeding and Herbicide Application on the Growth and Yield of Boro Rice. *International Journal of Novel Research in Life Sciences.* Vol. 11, Issue 4, pp: (16-22). https://doi.org/10.5281/zenodo.12783751

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