occurred by the factors such as ecological factors, bio-physical potential yield and actual yield is high. This variation is However, in most of the rice growing areas, the gap between position in rice area and fourth position in rice production (BRRI, 2000).

Among the rice growing countries, Bangladesh occupies third consumption takes place in Asian countries (Islam et al., 2010). tons (FAO, 2011). Out of this almost 90% rice production and area and it constitutes about 97% of the total cereal production of the country (Bari et al., 1997). Out of total rice production in this country about 47% comes from boro rice, and the rest 8% and 45% comes from aus and aman rice, respectively (BBS, 2000). Therefore, Boro rice is the most important rice crop in Bangladesh with respect to its high yield and contribution to total rice production.

A large proportion of world’s population utilizes rice (*Oryza sativa* L.) as staple food (Islam et al., 2010; Ater et al., 2011). Most of the cultivated rice varieties are high yielding variety (HYV) which are generally nutrient exhaustive than land races. This is resulting in problems of P, K, and S deficiency in soil along with inherited N deficiency (Ali et al., 1997; Saleque et al., 1998). On global scale the cultivation of rice is carried out rendering more than two thirds unavailable (Friesen et al., 1997). Phosphorus is mostly available for plant uptake when soil pH is between 6.5 and 7.5. Moreover, Khulna region is situated in saline zone therefore availability of P is very much critical (P value of the experimental site: 11.20 ppm).

Phosphorus not only enhances yield but also reduces spikelet sterility. But the main problem concerning P fertilizers is its fixation with soil complex within a very short period of time. Phosphorus as a nutrient element plays a vital role in an array of functions necessary for healthy plant growth, contributing to structural strength, crop quality, seed production, and more. The transformation of solar energy into usable compounds is largely possible because of phosphorus. Adequate phosphorus nutrition enhances many aspects of plant physiology including the fundamental process of photosynthesis, nitrogen fixation, flowering, fruiting and maturation. Much of the P in the P compounds is not immediately available for plant uptake. Plants rarely absorb more than 20% of the total fertilizer P applied (Friesen et al., 1997). Phosphorus is most available for plant uptake when soil pH is between 6.5 and 7.5. Moreover, Khulna region is situated in saline zone therefore availability of P is very much critical (P value of the experimental site: 11.20 ppm).

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Soil in the southwestern region of Bangladesh is quite different from other parts of Bangladesh. There is a fertilizers recommendation on AEZ basis and crop based but there is no site specific fertilizers recommendation in the southwestern coastal region.

**INTRODUCTION**

In Bangladesh, the agriculture sector plays a very important role in the economy of the country accounting for 15.33% of total GDP and provides employment for many people (AIS, 2017). Agriculture in Bangladesh is dominated by intensive rice cultivation. Rice covers almost 80% of the total cropped area and it constitutes about 97% of the total cereal production of the country (Bari et al., 1997). Out of total rice production in this country about 47% comes from boro rice, and the rest 8% and 45% comes from aus and aman rice, respectively (BBS, 2000). Therefore, Boro rice is the most important rice crop in Bangladesh with respect to its high yield and contribution to total rice production.

The experiment was carried out during the period from January to May, 2018 at Professor Purnendu Gain Field Laboratory of Agrotechnology Discipline, Khulna University to evaluate the effect of phosphorous (P) on yield and yield attributes of BRRI dhan28. The experiment was consisted of seven P doses viz. T0 = without phosphorus (P), T1 = 9 kg P ha−1, T2 = 12 kg P ha−1, T3 = 15 kg P ha−1, T4 = 18 kg P ha−1, T5 = 21 kg P ha−1 and T6 = 24 kg P ha−1 as treatments. The experiment was laid out in a randomized complete block design (RCBD) with three replications. Only the grain yield and biological yield showed significant variations due to the effect of different rates of phosphorous. Others growth and yield attributes varied insignificantly. The result of this experiment showed that the highest grain yield (3.82 t ha−1) and biological yield (10.87 t ha−1) was obtained from 21 kg P ha−1 (T5). There was an increasing trend of grain yield with the increase of phosphorous level up to 21 kg P ha−1 and then it declined. From the result of this experiment it could be revealed that 21 kg P ha−1 gives better result regarding grain yield of HYV rice variety BRRI dhan28 at Batiaghta upazila of southwestern Bangladesh.

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BRRI dhan28 most popularly cultivated rice variety in Boro season in this region. Thus, it is important to investigate the performance of BRRI dhan28 to phosphorous variation in this area. The present experiment was undertaken with the following objectives—

i. To evaluate the growth and yield response of BRRI dhan28 at different rates of phosphorus application.

ii. To find out the optimum rate of phosphorus for growth, yield and yield attributes of BRRI dhan28 in Batagaha upazila of southwestern Bangladesh.

MATERIALS AND METHODS

The field experiment was carried out during Boro season from January to May, 2018 at Professor Pramatha Cumi Field Laboratory under Khulna University, Khulna. The soil of the experimental area was medium low land, fairly leveled, well drained and silty loam type. BRRI dhan28 a high yielding variety of rice was used in this experiment and collected from Bangladesh Rice Research Institute, Joydebpur, Gazipur. The treatments of this experiment were T0 = without phosphorus, T1 = 9 kg P ha⁻¹, T2 = 12 kg P ha⁻¹, T3 = 15 kg P ha⁻¹, T4 = 18 kg P ha⁻¹, T5 = 21 kg P ha⁻¹ and T6 = 24 kg P ha⁻¹. The fertilizer TSP was used as the source of phosphorous. Other nutrients were used as per the recommended dose (AEZ basis) (FRO, 2012). All the fertilizers except P were applied and thoroughly mixed with the soil 10 days before the final land preparation. Then was applied as top dressing in three equal splits.

The experiment was laid out in a Randomized Complete Block Design (RCBD), with three replications. The treatments were randomly distributed to the unit plots in each block. The unit plot size was 4.0 m length and 2.5 m wide. About 40 days old seedlings were transplanted maintaining a spacing of 25 cm between the rows and 15 cm between the hills. Inter-cultural operations such as gap filling, weeding, irrigation and plant protection measure were taken as and when necessary and kept usual and uniform for all the experimental plots.

Data on growth parameters such as plant height, tiller number and shoot dry weight, yield such as grain yield and straw yield, yield attributes such as effective tillers hill⁻¹, panicle length, grain number panicle⁻¹, 1000 grain weight and harvest index were collected and recorded.

At each sampling, data were recorded from five randomly selected hills in each unit plot. Before harvesting 5 hills were uprooted randomly from each plot for taking yield components data. The harvested crop of each plot was bundled separately, tagged properly and brought to the clean threshing floor. Grain and straw yield were recorded from whole plot basis. The grain and straw yield were adjusted to 14% moisture level. Grain yield and harvest index were calculated using the following formulae:

\[
\text{Grain yield (at 14\% moisture content) =} \ \frac{\text{WEIGHT OF GRAIN}}{100 - 14} \times 100
\]

\[
\text{Harvest index (\%) =} \ \frac{\text{Economic yield}}{\text{Biological yield}} \times 100
\]

Finally the recorded data were accumulated and tabulated for analysis of variance technique using Statistical Tool for Agricultural Research (STAR) and the means among the treatments were compared by Duncan’s New Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Effect of phosphorous rates on growth parameters

Plant height (cm): Phosphorous rates had no significant influence on plant height (Table 1). Numerically the longest plant (86.27 cm) was obtained from 21 kg P ha⁻¹ (T₅) while the shortest was recorded from control treatment (T₀). Similar result was observed by Shiferwa et al. (2012) who reported that P variation had no significant effect on plant height of rice. The result also supported by Fayisa and Welbira (2016).

| Treatments | Plant height (cm) | Tiller No. hill⁻¹ | Shoot dry weight hill⁻¹ (g) |
|------------|------------------|------------------|----------------------------|
| T₀ (without P) | 74.67 | 15.00 | 114.00 |
| T₁ (9 kg P ha⁻¹) | 75.67 | 17.67 | 120.00 |
| T₂ (12 kg P ha⁻¹) | 78.53 | 17.00 | 125.67 |
| T₃ (15 kg P ha⁻¹) | 78.80 | 18.33 | 122.83 |
| T₄ (18 kg P ha⁻¹) | 80.40 | 18.33 | 127.33 |
| T₅ (21 kg P ha⁻¹) | 86.27 | 19.00 | 130.17 |
| T₆ (24 kg P ha⁻¹) | 80.17 | 16.53 | 121.50 |

Effect of phosphorous rates on yield and yield components

Effective tiller hill⁻¹: Number of effective tiller hill⁻¹ did not vary significantly due to different rates of phosphorous (Table 2). It was noticed that the highest number of effective tiller hill⁻¹ (15.00) was produced in 24 kg P ha⁻¹ (T₆) whereas, the lowest was observed in 21 kg P ha⁻¹ (T₅). The result also supported by Sahar and Burbey (2003) that without phosphorus produce shortest panicle in the low land rice.

Panicle length (cm): Phosphorous rates had no significant effect on panicle length (Table 2). The longest panicle (20.33 cm) was found in 21 kg P ha⁻¹ (T₅) whereas, the shortest (18.33 cm) was recorded from control treatment (T₀). The result also supported by Sahar and Burbey (2003) that without phosphorus produce shortest panicle in the low land rice.

Filled grain panicle⁻¹: Application of different rates of phosphorous had no significant influence on number of filled grains hill⁻¹ (Table 2). The number of filled grains hill⁻¹ varied from 716.67 to 1055.67. The numerically maximum number of
filled grain hill\(^{–1}\) (1055.67) was observed in 21 kg P ha\(^{–1}\) (T\(_5\)) whereas, the minimum (716.67) was found in control treatment (T\(_0\)).

**Unfilled grain panicle\(^{–1}\)**: Application of different rates of phosphorous had no significant influence on unfilled grains hill\(^{–1}\) (Table 2). The maximum number of unfilled grains hill\(^{–1}\) (143.33) was recorded in control treatment (T\(_0\)) whereas, the minimum (102.67) was found in 24 kg P ha\(^{–1}\) (T\(_6\)).

**1000 grain weight (g)**: Different rates of phosphorous did not affect 1000-grain weight significantly (Table 2). Numerically the highest 1000-grain weight (22.83 g) was recorded from 21 kg P ha\(^{–1}\) (T\(_5\)). On the other hand the lowest 1000-grain (20.50 g) was found in control treatment (T\(_0\)).

**Grain yield (t ha\(^{–1}\))**: Results of the experiment regarding grain yield of BRRI dhan28 was significantly influenced by different rates of phosphorous application (Figure 1). Though there was no significant difference among the P variation on yield components but numerically panicle length, grain panicle and 1000 grain weight gradually increased with the increase of P upto 21 kg ha\(^{–1}\) that helps to enhance grain yield. The grain yield varied from 3.20 t ha\(^{–1}\) to 3.82 t ha\(^{–1}\). The highest grain yield was obtained from 21 kg P ha\(^{–1}\) (T\(_5\)) which was statistically similar to 18 kg P ha\(^{–1}\) (T\(_4\)) and 15 kg P ha\(^{–1}\) (T\(_3\)). On the other hand the lowest grain yield (3.20 t ha\(^{–1}\)) was obtained from control treatment (T\(_0\)). Similar result was also found by Zaman et al. (1995) and they reported that grain yield was increased significantly by increasing P application over control.

**Straw yield (t ha\(^{–1}\))**: Due to different rates of phosphorous straw yield was not influenced significantly (Table 2). However 18 kg P ha\(^{–1}\) (T\(_4\)) produced the highest straw yield (7.27 t ha\(^{–1}\)) while the lowest (6.15 t ha\(^{–1}\)) was obtained from 12 kg P ha\(^{–1}\) (T\(_2\)).

Table 2. Effects of different P rates on yield component and yield of BRRI dhan28

| Treatment | Effective tiller hill\(^{–1}\) | Panicle length (cm) | Filled grain hill\(^{–1}\) | Unfilled grain hill\(^{–1}\) | 1000-grain weight (g) | Straw yield (t ha\(^{–1}\)) | Biological yield (t ha\(^{–1}\)) | Harvest index (%) |
|-----------|------------------|-------------------|------------------|------------------|------------------|------------------|-------------------|------------------|
| T\(_0\) (without P) | 14.00 | 18.33 | 908.33 | 143.33 | 20.50 | 6.17 | 9.37b | 34.29 |
| T\(_1\) (9 kg P ha\(^{–1}\)) | 14.33 | 18.66 | 716.67 | 108.00 | 20.67 | 6.15 | 9.62ab | 35.88 |
| T\(_2\) (12 kg P ha\(^{–1}\)) | 14.73 | 19.33 | 867.67 | 109.67 | 21.00 | 6.95 | 10.35ab | 32.85 |
| T\(_3\) (15 kg P ha\(^{–1}\)) | 14.67 | 18.80 | 860.33 | 105.33 | 22.17 | 6.65 | 10.21ab | 34.88 |
| T\(_4\) (18 kg P ha\(^{–1}\)) | 13.67 | 18.87 | 826.00 | 108.67 | 21.50 | 7.27 | 10.87a | 33.17 |
| T\(_5\) (21 kg P ha\(^{–1}\)) | 14.67 | 20.33 | 1055.67 | 105.37 | 22.83 | 6.98 | 10.87a | 35.12 |
| T\(_6\) (24 kg P ha\(^{–1}\)) | 15.00 | 18.93 | 858.00 | 102.67 | 21.00 | 6.60 | 10.00ab | 35.03 |

**Level of significance** | NS | NS | NS | NS | NS | NS | ** | NS |

**CV (%)** | 11.94 | 7.44 | 15.39 | 15.58 | 4.82 | 6.46 | 4.76 | 3.70 |

NS = Non-significant, CV = Co-efficient of variation, ** = Significant at 1% level of significance
REFERENCES

AIS (Agricultural Information Service). 2017. Krishi Diary, Khamarbari, Farmgate, Dhaka, Bangladesh.

Ali, M.M., Shahid, S.M. Kubota, D., Masunage, T. and Wakatsuki, T. 1997. Soil degradation during the period 1967-1995 in Bangladesh. II. Selected chemical characters. Soil Science and Plant Nutrition. 43: 879-890.

Altera, E.A., Onyango, J.C., Azumal, T., Asanuma, S. and Itoh, K. 2011. Field evaluation of selected NERICA rice cultivars in Western Kenya. African Journal of Agricultural Research 6: 60-66.

Bari, M.M.G., Hossain, M.B., Kamal, A.M.A. and Samad, M.A. 1997. Biodiversity and environmental susceptibility of modern (HYV) and local aman rice variety. Bangladesh. Journal of Environmental Science (special issue) 3: 85-93.

BBS (Bangladesh Bureau of Statistics), 2000. Statistical Year Book of Bangladesh. Statistics Division, Ministry of Planning, Govt. People’s Repub. Bangladesh.

Brohi, A., Karaman, M., Aktas, A. and Savasli, E. 1998. Effect of nitrogen and phosphorus fertilization on the yield and nutrient status of rice grown on artificial siltation soil from the Kelkit River. Journal of Agriculture and Forest. 22: 585-592.

BRRI (Bangladesh Rice Research Institute). 2000. BRRI Annual Report for July 1999-June 2000. Bangladesh Rice Research Institute, Joydebpur, Gazipur, Bangladesh. pp. 50-53.

Fayisa, B.A. and Welbira, G.D. 2016. Influence of phosphorous and nitrogen fertilizer rate on grain yield of rice at kamashi zone of Benshal-gul gumuz region, Ethiopia. Journal of World Economic Research. 5(2): 8-14.

FAO (Food and Agriculture Organization). 2011. Trends of rice paddy production: monitoring the market. http://www.fao.org/esc/fr/15/70/highlight_71html.

FRG (Fertilizer Recommendation Guide). 2012. Bangladesh Agricultural Research Council (BARC). Farmgate, Dhaka. pp. 211.

Friesen, D.K., Rao, I.M., Thomas, R.J., Oberson, A. and Sanz, J.I. 1997. Phosphorus acquisition and cycling in crop and pasture systems in low fertility tropical soils. In: Ando T, Fujita K, Mae T, Matsumoto H, Mori S, Sekiya J (eds). Plant nutrition for sustainable food production and environment. Kluwer Academic Publishers, Dordrecht, pp. 493–498.

Gomez, A.K. and Gomez, A.A. 1984. Statistical Procedure for Agricultural Research. International Rice Research Institute, John Willey and Sons. New York. pp. 1-340.

Islam, M.S., Peng, S., Visperas, R.M., Sultan, M., Altaf, S.M. and Julliquir, A.W. 2010. Comparative study on yield and yield attributes of hybrid, inbred, and NPT rice genotypes in a tropical Irrigated ecosystem. Bangladesh Journal of Agricultural Research. 35: 343-353.

Sahar, A. and N. Burbey, 2003. Effect of nitrogen, phosphorus and potassium (NPK) compound doses on the growth and yield of low land rice. J. Stigma (Indonesia), 11(1): 26-29.

Sahrawat, K.L., Abekoe, M.K., Diatta, S., Tian, G., Ishida, F., Keatinge, D. and Carsky R. 2001. Application of inorganic phosphorus fertilizer. In: Proc. Symp. Sponsored by the American Society of Agronomy, USA. 5-9 November, 2000, pp: 225-246.

Saleque, M.A., Abedin, M.J., Panaullah, G.M. and Bhuiyan, N.I. 1998. Yield and phosphorus efficiency of some lowland rice varieties at different levels of soil-available phosphorus. Communications in Soil Science and Plant Analysis. 29: 2905-2916.

Shiferwa, N., Heluf, G., Sharma, J.J and Berhe, T. 2012. Effect of nitrogen and phosphorous application on yield attributes, grain yield and quality of rainfed rice (NERica-3) in Gambella, southwestern Ethiopia.

Singh, P.K. and Bharadwaj, V. 2008. Effect of different nutrient levels on yield and yield attributes of hybrid and inbred rice varieties. Oryza 44(2): 137-139.

Zaman. S.K., Razzaque, M.A., Karim, S.M.R. and Bhuiyan, N.I. 1995. Rice response to phosphorus in wetland soil. Pakistan. Journal of Science and Industrial Research. 38(11-12): 438-440.