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Response of two boro rice (*Oryza sativa*) varieties to nitrogen fertilizer application and their influence on yield and protein content

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Rice (*Oryza sativa* L.) is a staple food in many countries, particularly in Asia, where it is consumed daily by billions of people (Paul *et al.* 2021a, Muthayya *et al.* 2014). Bangladesh advantages from agro-ecologically and geographically favourable circumstances that facilitate rice production (Bell *et al.* 2018, Akter *et al.* 2022). Despite rice being cultivated on 28.89 million acres of land, the annual rice yield of 38.14 million tonnes is considerably lower compared to other more advanced rice-producing nations (FAO 2022). Bangladesh, has been putting numerous efforts such as modern farming technique, high yielding rice varieties to increase output and enhance the system for producing rice as a whole.

Moreover, different plant varieties have distinct genetic traits that influence growth rate, adaptation to specific climates and yield potential, leading to variations in overall productivity and quality of produced (Paul *et al.* 2021b, Hasan *et al.* 2023). *Boro* rice is the most significant contributor to overall rice production (around 55%), followed by *Aman* and *Aus* (BBS 2021). In recent time, BRRI Dhan89 and Bangabandhu Dhan100 have gained popularity among farmers due to their higher yield potential, adaptability, nutrient composition and diverse uses (BRRI 2021). Again, fertilizer application of soil is a crucial component since it provides essential nutrients to plants, promoting healthy growth and higher crop yields (Sabil *et al.* 2023). Nitrogen fertilizer application is indeed crucial for rice plants as it plays a significant role in their growth and development (Wang *et al.* 2022). Rice plants have a high demand for nitrogen throughout their growth stages. Adequate nitrogen supply promotes vigorous vegetative growth, leading to increased tiller production, leaf area expansion and higher biomass accumulation (Sahoo *et al.* 2022). Therefore, the present study was undertaken to evaluate the effect of two *Boro* rice varieties selection and nitrogen fertilizer application on yield contributing characteristics, yield and grain protein content of two *Boro* rice varieties.

A study was carried out during 2021–22 at Regional Station of Bangladesh Rice Research Institute, Sirajganj, Bangladesh to examine the response of two *Boro* rice varieties to nitrogen fertilizer application and their influence on yield and protein content. The study comprised of five nitrogen levels, viz. 0 (T_1), 90 (T_2), 120 (T_3), 150 (T_4) and 180 (T_5) kg/ha and two rice varieties [BRRI dhan89 (V_1) and Bangabandhu dhan100 (V_2)]. The experiment followed a completely randomized block design (CRBD) with three replications. The field preparation involved ploughing, puddling, and leveling before planting seedlings. Forty days old seedlings were transplanted with a spacing of 25 cm × 15 cm and fertilizer applications were done including different N doses as per treatment specification, as well as recommended TSP, MoP, Gypsum, and $ZnSO_4$ at the rate of 55, 80, 60, and 6 kg/ha, respectively. Triple super phosphate (TSP), muriate of potash (MoP), Gypsum, and $ZnSO_4$ were applied at the final stage of land preparation, and three equally spaced urea application were made at 15, 30, and 45 days after transplanting (DAT). Intercultural operations were performed as needed throughout the growth stages.

The data collected and compiled for the studied parameters were subjected to analysis of variance (ANOVA) by computer operated statistix 10. The mean differences among treatments were adjudged by Tukey HSD (P<0.05). Principal component analysis (PCA) was done using the "GGally" and "factoextra" packages (Imran *et al.* 2023).

SPAD value: Two rice variety along with different N fertilizer application levels had substantial influence on SPAD value/plant of transplanted *Boro* rice (Fig. 1A). The highest SPAD value/plant (45.42) was found from BRRI dhan89 along with 90 kg N/ha at 45 DAT and the lowest SPAD value/plant (29.22) was found from Bangabandhu dhan100 along with control at 45 DAT. Higher SPAD value was obtained from the application of higher level of

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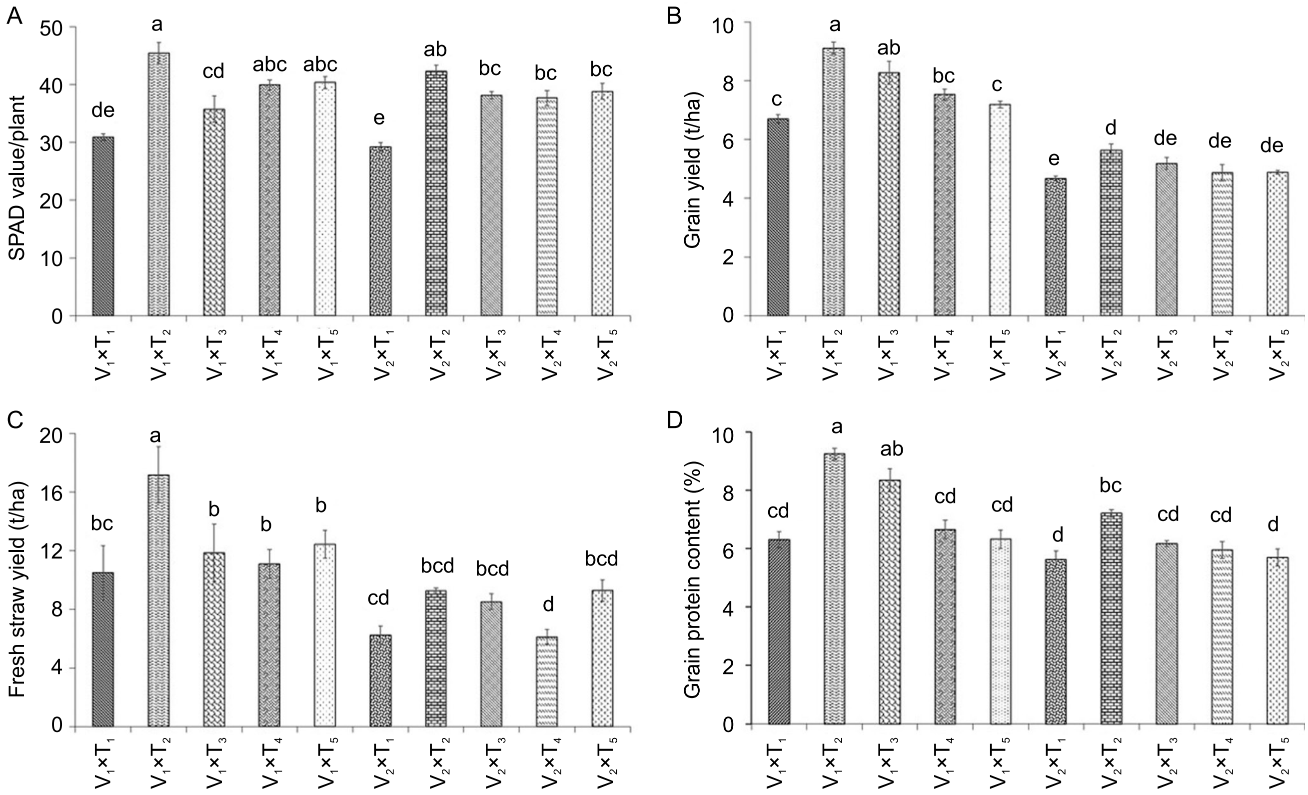
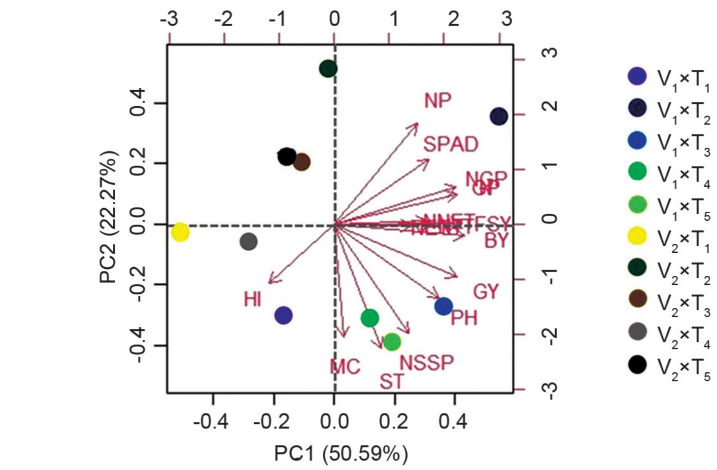


Fig. 1 Interaction effect of variety and nitrogen fertilizer. (A) SPAD value; (B) Grain yield; (C) Fresh straw yield and (D) Protein content of transplant *Boro* rice. Different letters were analyzed by Tukey HSD (P<0.05).
Refer to methodology for Treatment details.

N. This might be because of the application of N enhance photosynthetic performance at all growth stages which also might cause a large variation in the chlorophyll content (Muhamud *et al.* 2022).

Yield and yield contributing characters: Interaction effects of variety and levels of nitrogen fertilizer application significantly affected all the studied parameters except number of non-productive tillers/hill, moisture content (%) and harvest index (%) (Table 1, Fig. 1B and C). Result of this study revealed that BRRI dhan89 along with 120 kg N/ha produced the tallest plant (114.57 cm), number of total tillers/hill (12.67) and productive tillers/hill (11.67), while Bangabandhu dhan100 along with control produced the shortest plant (103.47 cm), number of total tillers/hill (7.33) and effective tillers/hill (7.0) (Table 1). Again, the highest number of sterile spikelet/ panicle (24.47) with 13.42% sterility were obtained from BRRI dhan89 along with 180 kg N/ha (Table 1). In addition, BRRI dhan89 along with 90 kg N/ha provided the highest number of panicle/hill (12.23), grains/panicle (167.17), and biological yield (26.29 t/ha), while the lowest number of panicle/



Plant height = PH
No. of total tillers/hills = NTT
No. of effective tillers/hill = NET
No. of non-effective tillers/hill = NNET
No. of panicle/hill = NP
Moisture content percentage = MC
Grain yield = GY
No. of grains/panicle = NGP
No. of sterile spikelets/panicle = NSSP
Sterility percentage = ST
Fresh straw yield = FSY
Biological yield = BY
Harvest index percentage = HI
Nitrogen percentage = N
Grain protein content = GP
SPAD value/plant = SPAD

Fig. 2 Principal component analysis (PCA) was used to visualize the interactions between the nitrogen fertilizer doses and variety.
Refer to methodology for Treatment details.

Table 1 Interaction effect of variety and nitrogen on yield attributes, yield and nitrogen content of transplant *Boro* rice

Variety × Nitrogen application (kg/ha)	Plant height (cm)	No. of total tillers/hill	No. of productive tillers/hill	No. of non-productive tillers/hill	No. of panicle	Moisture content (%)	No. of grains/ panicle	No. of sterile spikelet/ panicle	Sterility (%)	Biological yield (t/ha)	Harvest index (%)	Nitrogen content (%)
$V_1 \times T_1$	108.67abc	8.667cd	8bc	0.6667	9.3c	20.643	131.57c	17ab	11.446a	17.2bcd	38.952	1.0085cd
$V_1 \times T_2$	108.56abc	11abc	9.667ab	1.3333	12.233a	18.663	167.17a	16.733ab	9.062ab	26.285a	34.863	1.4789a
$V_1 \times T_3$	114.57a	12.667a	11.667a	1	10.7abc	21.41	158.37ab	19.333ab	10.887ab	20.146b	41.632	1.3349ab
$V_1 \times T_4$	109.4abc	10.333abc	9bc	1.3333	9.5c	22.41	153.27abc	19.533ab	11.249ab	18.631bc	40.421	1.0656cd
$V_1 \times T_5$	112.13ab	10.667abc	9.333abc	1.3333	9.1c	20.59	154.63abc	24.467a	13.419a	19.644b	36.758	1.0117cd
$V_2 \times T_1$	103.47c	7.333d	7c	0.3333	9.467c	20.167	134.67bc	11.7ab	7.986 ab	10.908e	43.162	0.9003d
$V_2 \times T_2$	105.74bc	9.667bcd	8.333bc	1.3333	11.8ab	19.19	155.67abc	8.667b	5.281b	14.91cde	37.78	1.1536bc
$V_2 \times T_3$	107.01bc	12ab	11.667a	0.3333	10.067bc	18.053	146.8abc	12.967ab	8.042ab	13.707de	37.926	0.9872cd
$V_2 \times T_4$	103.68c	10abcd	9bc	1	9.167c	20.72	145.77abc	14.4ab	8.953ab	10.997e	44.435	0.9525cd
$V_2 \times T_5$	106.15bc	10abcd	9bc	1	9.833bc	18.23	144.9abc	13.133 ab	8.211ab	14.162de	34.676	0.9109d
Level of significance	*	*	*	NS	*	NS	*	*	*	*	NS	*
CV (%)	2.46	10.25	11.15	49.97	7.53	8.93	5.69	29.52	24.06	8.48	8.94	7.04
SEM(±)	2.1109	0.8104	0.737	0.4037	0.5601	1.287	7.0378	3.5634	1.6686	1.1893	2.9885	0.0621

In a column, figures with the same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per Tukey HSD, $P< 0.05$). *, Significant at 5% level of probability; NS, Not significant. Refer to methodology for Treatment details.

hill (9.1), grains/panicle (131.57), grain yield (4.66 t/ha), fresh straw yield (6.12 t/ha) and biological yield (10.91 t/ha) were recorded in BRRI dhan89 along with control (Table 1). Furthermore, the highest grain yield (9.11 t/ha) and fresh straw yield (17.17 t/ha) were obtained from BRRI dhan89 along with 90 kg N/ha, and the lowest grain yield (4.66 t/ha) and fresh straw yield (6.12 t/ha) were recorded BRRI dhan89 along with control (Fig. 1B and C). A similar result by the study of Chhanda *et al.* (2021) also upholds the current experiment. This might be because of the varietal differences due to heredity or major varietal characters (Chamely *et al.* 2015). In a study of similar kind, Mrudhula *et al.* (2020) also found that capability of N probably favoured the cellular activity during panicle initiation and development that led to increase yield and yield contributing characters. Data also showed that application of N fertilizer more or less than 90 kg/ha increased the sterility percentage or hamper the grain formation which ultimately results in decreased yield/ha.

Nitrogen and grain protein content: Interaction of variety and nitrogen fertilizer levels exerted a significant influence on N and grain protein content of transplant *Boro* rice (Table 1, Fig. 1D). The highest N content (1.48%) was reported from BRRI dhan89 along with 90 kg N/ha and the lowest N content (0.90%) was testified in Bangabandhu dhan100 along with control (Table 1). Again, the highest protein content (9.24%) was detected from BRRI dhan89 along with 90 kg N/ha and the lowest value (5.63%) was identified from Bangabandhu dhan100 along with control (Fig. 1D). In earlier study stated that, increasing the N fertilizer level will increase N content, grain protein and component protein content of rice (Zhu *et al.* 2017). Present study also suggested that nitrogen and protein content of grain lowered if N fertilizer application rate increased or decreased than 90 kg/ha, because in this case, rice plant did not get the optimum amount of N which ultimately affected the grain quality.

Nitrogen fertilizer doses-varieties interaction measurement using principal component analysis (PCA): A principal component analysis (PCA) was carried out to assess the interactions between the nitrogen fertilizer doses and varieties (Fig. 2). According to the positive and negative values of PC1 and PC2, PCA scores split ten combination of nitrogen fertilizer doses and varieties. The PC1 and PC2 together displayed 72.86% of the data variability across the nitrogen fertilizer doses and varieties and all of the rice components that were examined. PC1 demonstrated 50.59% data variability in this case and separated $V_1 \times T_2$, $V_1 \times T_3$, $V_1 \times T_4$, and $V_1 \times T_5$, from $V_1 \times T_1$, $V_2 \times T_1$, $V_2 \times T_2$, $V_2 \times T_3$, $V_2 \times T_4$, and $V_2 \times T_5$ for their positive and negative PC scores, respectively. Aside from that, PC2 displayed 22.27% data variability.

SUMMARY

The present study carried out during 2021–22 at Regional Station of Bangladesh Rice Research Institute, Sirajganj, Bangladesh showed combined cultivation of

BRRI dhan89 along with 90 kg N/ha fertilizer application provided the highest panicle/hill, grains/panicle, grain yield, fresh straw yield and biological yield in *Boro* season. So, in order to get the better grain yield, BRRI dhan89 to be cultivated along with 90 kg N/ha fertilizer application may be recommended for cultivation in *Boro* season.

REFERENCES

Akter M, Paul N C, Sarkar S K, Mahapatra C K, Sarkar M A R and Paul S K. 2022. Growth analysis of short duration transplanted *Aus* rice (cv. Parija) under three agronomic practices. *Archives of Agriculture and Environmental Science* **7**(1): 51–60. https://doi.org/10.26832/24566632.2022.070108

BBS (Bangladesh Bureau of Statistics). 2021. Preliminary Report on Agriculture Census-2019, Statistics Division, Ministry of Planning, Government of peoples Republic, Bangladesh, Dhaka. pp. 254. https://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/c645bd51_3cb5_4f53_86f9_7d29244caa4e/2022-12-26-08-36-394361bc904a7651ef763a4ff8033b67.pdf

Bell R W, Haque M E, Jahiruddin M, Rahman M M, Begum M, Miah M M, Islam M A, Hossen M A, Salahin N, Zahan T and Hossain M M. 2018. Conservation agriculture for rice-based intensive cropping by smallholders in the eastern Gangetic plain. *Agriculture* **9**(1): 5. https://doi.org/10.3390/agriculture9010005

BRRI. 2021. BRRI annual report for July 2020–June 2021. Bangladesh Rice Research Institute, Gazipur, Bangladesh.

Chamely S G, Islam N, Hoshain S, Rabbani M G, Kader M A and Salam M A. 2015. Effect of variety and nitrogen rate on the yield performance of *boro* rice. *Progressive Agriculture* **26**(1): 6–14. https://doi.org/10.3329/PA.V26I1.24508

Chhanda T A, Sarkar M A, Perveen S, Hossain M M and Hasan A K. 2021. Effect of variety and nitrogen fertilizer management on the growth and yield of Transplant *aman* rice. *Research in Agriculture Livestock and Fisheries* **8**(3): 281–89. https://doi.org/10.3329/ralf.v8i3.57402

FAO (Food and Agricultural Organisation). 2022. World Food and Agriculture-Statistical Yearbook Food and Agricultural Organization of the United Nations, Rome, Italy. https://doi.org/10.4060/cc2211en

Hasan M R, Sabil A S, Haque M M, Ahamed K U, Imran S and Mahamud M A. 2023. Growth and yield performance of hybrid rice varieties under varying zinc levels. *Archives of Agriculture and Environmental Science* **8**(3): 281–89. https://doi.org/10.26832/24566632.2023.080302

Imran S, Mahamud M A, Paul N C, Chakrobortty J, Sarker P, Paul S, Tahjib-Ul-Arif M and Rhaman M S. 2023. Seed priming and exogenous application of citric acid enhance seedling growth and photosynthetic pigments and mitigate oxidative damage of soybean (*Glycine max)* under salt stress. *Archives of Biological Sciences* **75**(4): 407–18. https://doi.org/10.2298/ABS230804033I

Mahamud M A, Rahman M M, Hassan M A, Maniruzzaman M, Bahadur A S, Imran S and Paul N C. 2022. Assessing the influence of integrated nutrient management on growth and yield of Black gram (*Vigna mungo* L.). *Archives of Agriculture and Environmental Science* **7**(3): 407–14. https://doi.org/10.26832/24566632.2022.0703015

Mrudhula K A, Veni B K and Suneetha Y. 2020. Study of different nitrogen levels on growth, yield and economics of rice variety BPT 2270-Bavapurisannalu under low land condition. *International Journal of Current Microbiology and Applied Sciences* **9**(9): 2020. https://doi.org/10.20546/ijcmas.2020.909.xx

Muthayya S, Sugimoto J D, Montgomery S and Maberly G F. 2014. An overview of global rice production, supply, trade, and consumption. *Annals of the New York Academy of Sciences* **1324**(1): 7–14. https://doi.org/10.1111/nyas.12540

Paul N C, Paul S K, Salam M A and Paul S C. 2021a. Dry matter partitioning, yield and grain protein content of fine aromatic *boro* rice (cv. BRRI dhan50) in response to nitrogen and potassium fertilization. *Bangladesh Journal of Botany* **50**(1): 103–11. http://dx.doi.org/10.3329/bjb.v50i1.52677

Paul N C, Tasmim M T, Imran S, Mahamud M A, Chakrobortty J, Rabbi R H, Sarkar S K and Paul S K. 2021b. Nutrient management in fragrant rice: A review. *Agricultural Sciences* **12**(12): 1538–54. https://doi.org/10.4236/as.2021.1212098

Sabil A S, Haque M M, Ahamed K U, Hasan M R, Paul N C and Mahamud M A. 2023. Influence of seedling age and integrated nutrient management on growth and yield of aromatic rice (cv. BRRI dhan34). *Archives of Agriculture and Environmental Science* **8**(2):182–90. https://doi.org/10.26832/24566632.2023.0802014

Sahoo S, Mohapatra B K, Paikaray R K, Jena S N, Rath B S, Biswal S, Panda R K, Mishra K N, Dwibedi S, Nayak A K and Mahanta R R. 2022. Impact of site specific nitrogen management on growth parameters, productivity and profitability of *kharif* rice. *International Journal of Environment and Climate Change* **31**: 1921–30. https://doi.org/10.9734/ijecc/2022/v12i122117

Wang B, Zhou G, Guo S, Li X, Yuan J and Hu A. 2022. Improving nitrogen use efficiency in rice for sustainable agriculture: strategies and future perspectives. *Life* **12**(10): 1653. https://doi.org/10.3390/life12101653

Zhu D W, Zhang H C, Guo B W, Xu K, Dai Q G, Wei H Y, Gao H, Hu Y J, Cui P Y and Huo Z Y. 2017. Effects of nitrogen level on yield and quality of japonica soft super rice. *Journal of Integrative Agriculture* **16**: 1018–27. https://doi.org/10.1016/S2095-3119(16)61577-0