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Title: Crop Growth and Seed Quality of BRRI dhan28 Rice as Influenced by Nitrogen Rates

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ABSTRACT

Nitrogen as a major plant nutrient element limits rice production to a great extent. The current inquiry was done to verify the role of various nitrogen levels on growth of crop and seed quality of Boro rice *cv.* BRRI dhan28.The research was directed in a Randomized Complete Block Design (RCBD) and imitated quadruple. The treatments consist of six nitrogen doses, N_0= 0, N_1 = 35, N_2 = 70, N_3 = 105, N_4 = 140, and N_5 = 175 kg N ha^{-1}as urea. Data on crop growth as well as seed quality characters were assembled and scrutinized statistically. Results disclosed that CGR and RGR were the maximum at 45-60 DAT when a dose of 175 kg ha^{-1} was maintained. The seed quality parameters were greatly influenced by various nitrogen treatments except germination (%) and the higher three nitrogen doses displayed significantly superior performances compared to the lower three nitrogen levels. Conversely, nitrogen application reveals linear but weak linkage with seed quality attributes. It could be concluded that application of nitrogen @ 105 kg ha^{-1}or higher dose is proper for better crop progression and production of premium class seeds from BRRI dhan28.

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INTRODUCTION

Globally rice is cultivated in more than hundred states and the main food stuff for 50% of the world's people (Fukagawa and Ziska, 2019). It also provides more than 20% of the calories in use worldwide (Sharif et al., 2014). World population is projected to rise to 8.5 billion by the year 2025 (Haque and Haque, 2016) and to sustain the self-sufficiency in rice, it is thus indispensable to harvest about 60% extra rice than what is produced now (Khatun et al., 2014). Use of quality seed is inevitable to comply with this objective. Inadequacy of good seed is one of the constraints of rice production for high yielding varieties in Bangladesh. Different state and non-government organizations supply only about 20% of entire seed requirements for Bangladesh. It has been suggested by some investigators that crop yield may be amplified up to 15-20% by means of quality seed only (Bhuiyan et al., 2002; Farooq, 2006). Seed quality relies not only on heredity, but also on climate and agronomic practices, during crop growth period (Zhou et al., 2018). Seed yield of rice can be improved through appropriate fertilizer application without impeding seed quality.

Nitrogen is the top-ranked yield-limiting plant nutrient for rice cultivation globally, especially in Asia (Saleque et al., 2004). Plant growth is extremely suffered when suboptimal dose of nitrogen is used, which markedly diminishes the crop yield. It is a matter of fact that improper use of nitrogen, in lieu of offering yield advantage, may lessen the same (Adhikari et al*.,* 2018). It has been discoursed that nitrogen captivated by rice in the vegetative phase supplied in growth during reproductive stage via translocation (Shi et al., 2017). Several studies have demonstrated that a correct nitrogen level is vital for better rice yield (Chamely et al., 2015; Jahan et al., 2014; Khatun et al., 2014; Khatun et al., 2016). Proper application of nitrogen fertilizers can significantly enhance both yield and quality of rice (Khatun et al., 2015; Khuang et al., 2008).Conversely, both extra and inadequate N amount can decline rice yield to a large degree (Awan et al., 2011). Higher proportions of N could enhance grain yield but decrease the grain excellence (Manzoor et al., 2006). Extra N rate creates tender plants, heightens their sensitivity to moisture and temperature trauma, vulnerable to wilting and insect-pest attack which finally yield poor quality seed in rice crop (Balasubramaniyan, 2007). There are very few studies available on how nitrogen management instigates the growth and seed quality of Boro rice. Keeping the above scenario in mind, this study was started to examine the effect of nitrogen on growth and seed quality of Boro rice.

MATERIALS AND METHODS

Experimental site

The present study was performed in Boro season (November to May) at the Professor Dr. Purnendu Gain Field Laboratory of Agrotechnology Discipline at Khulna University. The investigational site is located in the Ganges Tidal Flood Plain (AEZ-13). Climate of the study site receives low temperature and humidity during the winter season and moderately high temperature, humidity, and a heavy precipitation during the summer and rainy season. The texture of the experimental soil is silt-loam with pH 7.90, electrical conductivity 5.04 dS m^{-1}, organic matter 1.66%, nitrogen 0.17%, phosphorus 11.63 µg g^{-1}, potassium 0.47 µg g^{-1}, sulphur 96.44 µg g^{-1}, zinc 0.76 µg g^{-1} and boron 0.63 µg g^{-1} soils (SRDI, 2017).

Treatments and experimental design

The experiment was carried out following a Randomized Complete Block Design (RCBD) and the treatments were replicated four times. Five nitrogen doses along with a control formed the 6 treatments of the experiment. The treatments were-

N_0: 0 kg, N_1 = 35 kg, N_2 = 70 kg, N_3 = 105 kg, N_4 = 140 kg, N_4 = 175 kg N ha^{-1}

Seed collection and seedling raising

BRRI dhan28, a high yielding rice variety developed by Bangladesh Rice Research Institute (BRRI) was used as plant material in the study. Seeds were collected from authorized dealer and soaked in water for 24 hrs. Rice seeds began germination within 2 days of immersion and became ready for seeding in 72 hours. The seed bed was made puddled with repeated plowing and laddering. The sprouted seeds were scattered in the nursery bed as evenly as possible.

Preparation of main field

The experimental land was tilled on with a tractor; afterwards the field was watered and prepared by several repeated plowings and harrowing tailed by laddering to get better tilth field. All types of weeds and residues were taken out of the field. Each of the plots were prepared and leveled with a wooden plank.

Crop management

A fertilizer dose of 60 kg TSP, 90 kg MoP, 6 kg zinc sulfate and 52 kg gypsum $ha^{-1}$was used in the experimental plots. Except urea, complete doses of other fertilizers were given as basal and systematically amalgamated into the soil. Urea was top dressed thrice equally at 20, 35, and 50 days after transplanting (DAT). Forty days old seedlings were pulled up from the nursery bed and were transplanted. Three seedlings were given hill^{-1} and a distance of 25 x 15 cm was maintained properly. Two hand weeding were done at 30 and 50 DAT. Furadan 5G was applied to combat ufra disease of rice and malathion was used to control insects. Rice crop was harvested when 90% of the grain turns golden yellow.

Data Collection

Crop growth rate (CGR)

CGR was recorded using oven dried plants of each hill at five growth stages started from 30 DAT and continued up to 90 DAT and was calculated by the following formula-

$CGR = (W_2-W_1)/(T_2-T_1)$ g m^{-2} d^{-1}.

Where, W_1 = Dry biomass of 1st sampling; T_1= 1st sampling time

W_2= Dry weight of sampling; T_2= 2nd sampling period.

Relative growth rate (RGR)

RGR was recorded from the oven dry weight of plants started from 30 DAT and continued till 90 DAT. RGR was calculated by using the given formula-

$CGR = (\log W_2-\log W_1)/(T_2-T_1)$ g g^{-1} d^{-1}.

Seed quality parameters

Seed germination and seedling vigor test were employed for judging the quality rice seeds.

Seed color

The seed color was assessed by Munsell Color Chart. The Munsell system specifies colors based on three aspects: hue (basic color), chroma (intensity), and value (lightness). It was generated by Professor Albert H. Munsell in the early 20th century and accepted by the United States Department of Agriculture (USDA) during 1930s.

Seed germination test

To test the germination ability of the harvested seeds, petri-dish method was used. Two layers of blotting papers were soaked with water, put in each petri-dish and 25 seeds from each plot were placed on it. Regular watering was done to keep the filter paper moist. After a week, germination count was made and germination (%) was calculated by the formula given below-

Germination (%) = (No. of seeds germinated/Total no. of seeds set) x 100

Vigor index

Seedling vigor was tested by using two methods as follows-

1. Germination speed and
2. Seedlings length extent (Agrawal, 2018).

Vigor index = Speed of germination X Seedlings length

Speed of germination (SG)

SG was calculated from the number of germinated seedlings at the first-day after platting and continued this calculation each day until final count, when the germination finished. The next formula was used to compute SG:

SG = (No. of normal seedlings/Day of 1st tally) +...+ (No. of normal seedlings/Day of final tally)

Seedlings length measurement

Seedlings lengths were measured after a week of platting. Five seedlings from each plate were randomly selected and they were carried to clean place and measurements were done by scale in cm from place of radicle emergence to top. Then average value was recorded as seedling length.

Statistical analyses

All the gathered data were evaluated using the analysis of variance (ANOVA) procedure assisted by the computer program Statistical Tools for Agricultural Research (STAR). Means for various treatments were checked by the Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984). Bivariate analysis between nitrogen doses and seed quality attributes was performed employing simple regression analysis technique.

RESULTS AND DISCUSSION

Crop Growth Components

Crop growth rate

The trend of crop growth rate (CGR) of BRRI dhan28 has been shown in Fig. 1. CGR rates increased speedily up to 45-60 DAT and then declined distinctly. It is apparent from Fig. 1 that under different rates of nitrogen, CGR of BRRI dhan28 was gentle in primary stage that converted peaky at middle stage and once more reduced near later phase of growth. Yet, the maximum CGR (68.12 $gm^{-2}d^{-1}$) was achieved during 45-60 DAT when 175 kg N was applied to rice. On the other hand, the minimum CGR (11.80 g $m^{-2}d^{-1}$) was noted at 30-45 DAT when no nitrogen was supplied to BRRI dhan28 rice. Our results are well supported by the findings of some other investigators as Haque and Haque (2016) and Rahman et al. (2007). Sluggish CGR at initial phases of BRRI dhan28 might be explained by poorer foliage growth which is the key photosynthetic organ upon which growth rate hangs on (Islam et al., 2007). The CGR turned to low once more during advanced phase largely due to numerous causes. Important of these are-a) high leaf death after reproductive phase shrinking photosynthesis speed (Azarpour et al., 2014; Sinclair and Sheehy, 1999), b) maintenance respiration load rises over time which center on dry weight and mainly its N quantity (Penning-de-Vries et al., 1989), and c) ineffectiveness of the plants to manage post bloomy N absorption (Schnier et al., 1990; Fu et al., 2009).

Relative growth rate

RGR of the rice variety BRRI dhan28 has been shown in Fig. 2. Distinct variation was estimated in RGR at 45-60 DAT. The RGR values improved up to 45-60 DAT and then dropped sharply like CGR. This finding agrees well with the results reported by Rahman et al. (2007). The highest RGR (1.10 g $g^{-1}d^{-1}$) was computed from 175 kg N ha^{-1}that was followed narrowly by the use of140 kg ha^{-1} (1.05 g $g^{-1}d^{-1}$) at 45-60 DAT (Fig. 2). The lowest RGR (0.05 g $g^{-1}d^{-1}$) was computed from the control treatment at 75-90 DAT. The sinking pattern of net assimilation rate (NAR) might be due to fewer leaf productions at the advanced phase of crop growth (Azarpour et al., 2014). In addition, applied nitrogen fertilizer favors more leaf production causing quick canopy closure and leaf shading. Both of these phenomena block radiation penetration into the rice crop canopy and producing less assimilates which finally restricts the RGR (Haque and Haque, 2016).

Seed Quality Characters

Seed color

According to Munsell color chart notable variation was not detected in seed color due to application of nitrogen fertilizer. The seed color observed was 10YR (yellow-red) with value 7 and chroma 6-8 indicting neutral value of seed color. Khatun et al. (2014) also got analogous result examining a Boro rice variety.

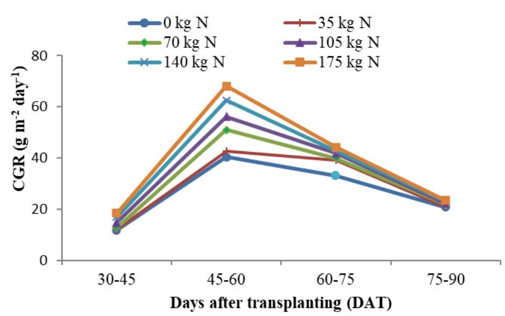

Figure 1. Crop growth rate of BRRI dhan28 rice as influenced by nitrogen levels

Seed germination

Nitrogen rates did not exert any impact on seed germination ($p \geq 0.05$) of BRRI dhan28 (Table 1). The highest germination percentage (99%) was obtained from the treatment of N_1 (35 kg N ha^{-1}) which was trailed by N_3 (105 kg N ha^{-1}) and N_5 (175 kg N ha^{-1}), and the lowest germination (95%) was obtained from N_0 (no nitrogen). These domino effects are in accordance to the observations of Khatun et al. (2014) who opined that collaborations of nitrogen and variety were insignificant on seed germination in Boro rice.

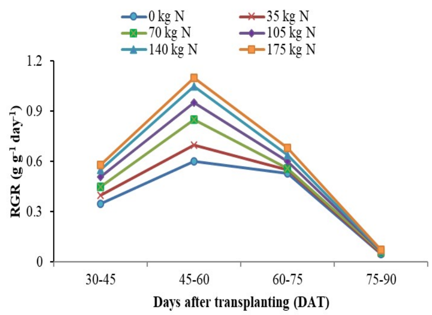

Figure 2. Relative growth rate of BRRI dhan28 rice as influenced by nitrogen levels

Table 1. Consequence of various nitrogen doses on seed quality attributes of rice

Nitrogen dose (kg ha^{-1})	**Ger. (%)**	**Ger. speed**	**Shoot length** (cm)	**Vigor index**
0	95.00	21.88 b	4.75 b	104.00 b
35	99.00	22.75 b	4.90 b	111.44 b
70	98.50	22.80 b	4.97 b	113.45 b
105	99.00	24.14 a	6.08 a	146.01 a
140	98.50	24.50 a	5.90 a	144.26 a
175	99.00	25.26 a	5.98 a	151.25 a
CV (%)	2.08	2.32	5.71	4.78

Vigor index

Vigor testing is essential as it frequently provides a good forecast of field capability and is a more profound sign of seed quality than germination check (Younis et al., 1990). Vigor index leads to the speed of germination laterally with the seedlings length. Results showed (Table 1) that vigor index was significantly influenced by different rates of nitrogen. The highest speed of germination (25.26) was recorded from N_5 (175 kg N) which was statistically at par with the treatment of N_4 (140 kg N) and N_3 (105 kgN) whereas the lowermost germination speed (23.13) was recorded from N_0. Along with this trend the highest seedling length (6.09 cm) was obtained from N_3 (105 kg N) which was statistically similar with the treatment ofN_4 (140 kg N) and N_5 (175 kg N). Conversely, the lowest seedling length (4.75 cm) was obtained from the control which was statistically alike with the N_1 (4.90 cm) and N_2 (4.97 cm). The highest vigor index (151.25) was observed in N_5 (175 kg N ha^{-1}) which was statistically similar to N_3 (146.01) and N_4 (144.26) and the lowest vigor index was obtained in N_0 (104). These results are consonance with the findings of Hara and Toriyama (1998) who stated that nitrogen in seed content has a significant role on vigor index which may be achieved by an adequate application of nitrogen to parent plants. Seeds with high nitrogen content absorb water faster which quickens the speed of germination of seed than seed with low nitrogen content. Nitrogen in seed content also initiates the seedlings length.

Relationship of seed quality parameters with nitrogen

The outcomes of the functional relationship between different nitrogen levels and seed quality attributes were displayed in Fig. 3, Fig. 4, Fig. 5 and Fig. 6. It is obvious from the analysis that all the quality indices *viz*. germination (%), germination energy, seedlings length (cm) and seedling vigor index exhibited a linear and positive association with nitrogen doses (kg ha^{-1}). In all of the cases straight lines were obtained with R^2 values ranging from 0.4181 to 0.9653. However, the regression coefficient (b) values (0.0155, 0.0192 and 0.0084) indicate very weak linkage between nitrogen rates and seed quality characters except seedling vigor index where the value of b is 0.2298.

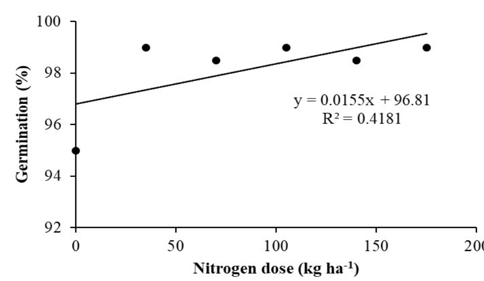

Figure 3. Relationship between germination (%) and nitrogen doses (kg ha^{-1}) in BRRI dhan28 rice

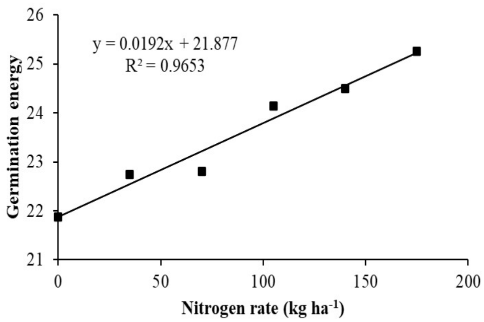

Figure 4. Association of germination energy and nitrogen rates (kg ha^{-1}) in BRRI dhan28

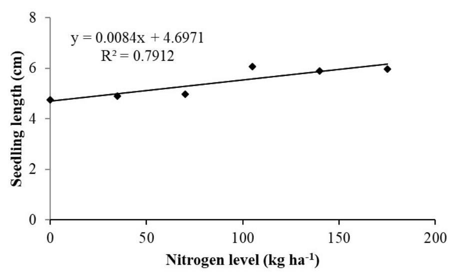

Fig. 5. Linkage between seedling length (cm) and nitrogen levels (kg ha^{-1}) in BRRI dhan28.

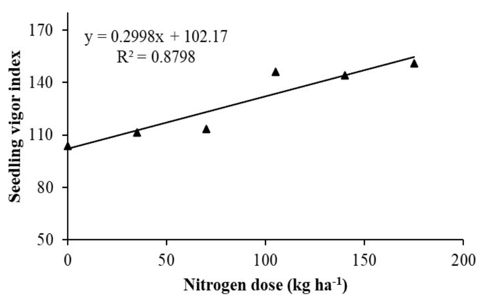

Fig. 6. Functional relationship between seedling vigor index and nitrogen fertilizer (kg ha^{-1}) in BRRI dhan28.

CONCLUSION

The findings of the current study indicated that nitrogen offered substantial influence on crop growth and seed quality parameters of BRRI dhan28 rice. The highest CGR and RGR were estimated at 45-60 DAT when nitrogen was applied @175 kg N ha^{-1}; both of them declined thereafter irrespective of nitrogen levels. Nitrogen application showed no effect on color of seed as well as on germination (%). However, germination energy, seedlings length (cm) and seedling vigor index were markedly discriminatory due to various rates of nitrogen used in BRRI dhan28 rice. The upper three doses of nitrogen (105, 140, 175 kg N ha^{-1}) displayed statistically identical results with higher values and the lower three levels (0, 35, 75 kg N ha^{-1}) exhibited the indistinguishable patterns with lower values. Consecutively the nitrogen doses provided very weak but positive association with four seed quality attributes.

Competing interest

The authors affirm that there isn't any conflict of interest with this article's publishing.

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