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SPIKELET FERTILITY IMPROVEMENT OF BORO ADVANCED LINE (CN6) THROUGH SUPPLEMENTED NUTRIENT MANAGEMENT

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ABSTRACT

The experiment was conducted in the Boro season of 2016-17, at Bangladesh Rice Research Institute (BRRI) farm under the Agro Ecological Zone (AEZ 28) Modhupur Tract. CN6 is a high spikelet bearing early maturing advanced line of rice but low in spikelet fertility. Supplemented nutrient management was examined to increase its spikelet fertility. Five treatments were used in this experiment. The treatments were as follows: T_1 = BRRI recommended fertilizer dose + MgO @ 0.05%, T_2 = BRRI recommended fertilizer dose + 60 g MoP + 60 g elemental S (80% wp) + 20 g $ZnSO_4$, T_3 = BRRI recommended fertilizer dose + Boron @ 5 ppm, T_4 = BRRI recommended fertilizer dose + Copper @ 5 ppm) and T_5 = BRRI recommended fertilizer dose alone. The experiment was conducted in Randomized Complete Block design with three replications. The results revealed that Treatment T_3 (BRRI recommended fertilizer dose + Boron @ 5ppm) produced the more number of grains per panicle with an average of 201 which is 19.9% higher number of grains per panicle over the BRRI recommended fertilization under the treatment of T_5. However, higher grain yield were recorded in treatment T_3 compare to the control treatment T_5 (BRRI recommended fertilization). Taken together, our results suggested that BRRI recommended fertilization alone with supplemented nutrient management, especially boron, significantly increased the spikelet fertility of the CN6 advanced line of Boro rice resulting higher yield.

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INTRODUCTION

Micronutrients are as important as macronutrients in plant nutrition and the deficiency of micronutrients is considered one of the major causes of declining the productivity trends in rice growing countries including Bangladesh (BFRG, 2012). The importance of micronutrients in rice production is increasing in recent years due to the use of high yielding verities and hybrid cultivars in Bangladesh. Micronutrients are needed in trace amounts but their adequate supply improves nutrient availability and positively affects the cell physiology that is reflected in yield as well (Taiwo et al., 2001). Deficiency of micronutrient is considered as one of the major causes of the declining rice productivity. Micronutrients have crucial role in various plant metabolic processes and have direct role in photosynthesis Boron (B), a nonmetal micronutrient, is essential for normal growth and development of plants, including rice (Gupta, 1979; Dunn et al., 2005); its essentiality was first reported in 1933 (Warington, 1933). Boron is used in small amounts as a micronutrient either alone or within macronutrient fertilizers. Grain yield is depressed by adverse effects of B deficiency on reproductive growth even while the effect on vegetative growth is imperceptible. Copper play an important role in activating the enzymatic activities and is required for lignin synthesis. Copper helps in pollination and seed setting (BFRG, 2012). Copper helps in pollination and seed setting (BFRG, 2012). Micronutrients including Zn and B are very important for better reproductive growth and development of crop plants.

Foliar and soil application are common but often costly methods for micronutrient addition. Foliar fertilization alone may not fulfill the long-term demand of crops and should be considered a supplementary approach to soil application (Bell and Dell, 2008). Foliar applications of B and Cu serve as a good source, particularly in supplying rice plants with the nutrients that are crucially needed in growth stage. The B requirement varies from crop to crop. Foliar B application is an effective strategy for improving B supply to plants especially when root growth is restricted due to dry soil conditions.

Food security is under threat due to stagnant yields of the main staple food crops (FAO, 2016). Rice (Oryza sativa L.) is an important grain with about 50% of the world's population depending on it as their staple food, particularly in fast growing and population-dense regions of the world (Fageria and Baligar, 2003). Rice provides 21% of the energy and 15% of the protein requirements of human populations globally (Maclean et al., 2002). While increased wages, labor scarcity, water shortages, and nutrient mining are concerns for successful rice production. In order to improve crop productivity, the limiting micronutrient(s) must be identified and the soils should be enriched with the addition of those micronutrients in properly balanced fertilizer programme. CN6 is a high spikelet bearing early maturing advanced line of rice with low spikelet fertility, it is hypothesized that, micronutrient plays an important role for increasing spikelet fertility of CN6. With this view a field experiment was conducted to find out appropriate micronutrients that would be effective for increasing spikelete fertility of CN6.

MATERIALS AND METHOD

The experiment was carried out in the Boro season of 2016-17, at the BRRI research farm, Gazipur, Bangladesh. The advanced line of Boro rice, CN6, was the test crop under five treatments. The treatments were: T_1 = BRRI recommended fertilizer dose + MgO @ 0.05%), T_2 = BRRI recommended fertilizer dose + 60 g MoP + 60 g elemental S (80% wp) + 20 g $ZnSO_4$, T_3 = BRRI recommended fertilizer dose + Boron @ 5 ppm, T_4 = BRRI recommended fertilizer dose + Copper @ 5 ppm and T_5 = BRRI recommended fertilizer dose alone. BRRI recommended fertilizer doses were used as N-P-K-S-Zn @120-19-60-20-4 kg ha^{-1}. Urea, TSP, MoP, Gypsum, $ZnSO_4.H_2O$, $CuSO_4$, and H_3BO_3 were applied as the sources of N-P-K-S-Zn-Cu-B. Split application of urea was done as 1/3rd at 20 DAT + 1/3rd at 35 DAT + 1/3rd at 56 DAT (before panicle initiation stage) (BRRI, 2015). Full dose of P, K, S and other macronutrient fertilizers were applied at the final land preparation. The experiment was conducted in Randomized Complete Block design with three replications. The soil at the study site was fine silty clay loam type. The location previously had a 3-season rice. The field was cleared and manually ploughed to provide a fine tilth for cultivation. Each plot was demarcated with a 40 cm walk way and a plot size of 3.2 m x 2.2 m. All the micronutrients were foliar sprayed at panicle initiation (PI) stage and grain soft dough stage. Sterility, grains per panicle and 1000-grains per panicle were taken from panicles of ten hills.

Heading was considered as 80% of the tillers had more than 50% of the panicle exerted. The crop reused maturity when 90% of the spikelet turned from green to yellowish. At maturity, a 5.0 m^2 area was harvested for grain yield. Grain yield and 1000-grains weight was adjusted to 14% moisture content. Weeds were manually controlled (2 times) 20 days after sowing and at maximum tillering stage. And all other agronomic and pest management practices were followed as and when necessary. Temperature data was collected from plant physiology division, BRRI, Gazipur. Statistical analysis was performed using statistic 10.0 software. The least significant difference (LSD) at 5% probability was used to compare means of the treatments. Phonological stages include seedling establishment, maximum tillering, booting, heading, anthesis and maturity was determined. The cumulative growing degree days were calculated by summing the daily mean temperature above base temperature, expressed in degree day. This was determined by using the following formula as per (Nuttonson, 1995). The weather data was collected from the physiology division of BRRI, Gazipur.

$$GDD = \frac{(Tmax + Tmin)}{2} - T\ base$$

Where,

T base = Minimum threshold/base temperature (10°C), T max = Daily maximum temperature (°C),
T min = Daily minimum temperature (°C)

RESULTS AND DISCUSSION

Temperature from heading to maturity

Average minimum and maximum temperatures were recorded 23.2 º C and 33.6º C respectively. Temperature did not exceed 35º C during flowering, but 9 days after flowering it goes up to 35 º C for consecutive six days (9-16 April) (Figure1).

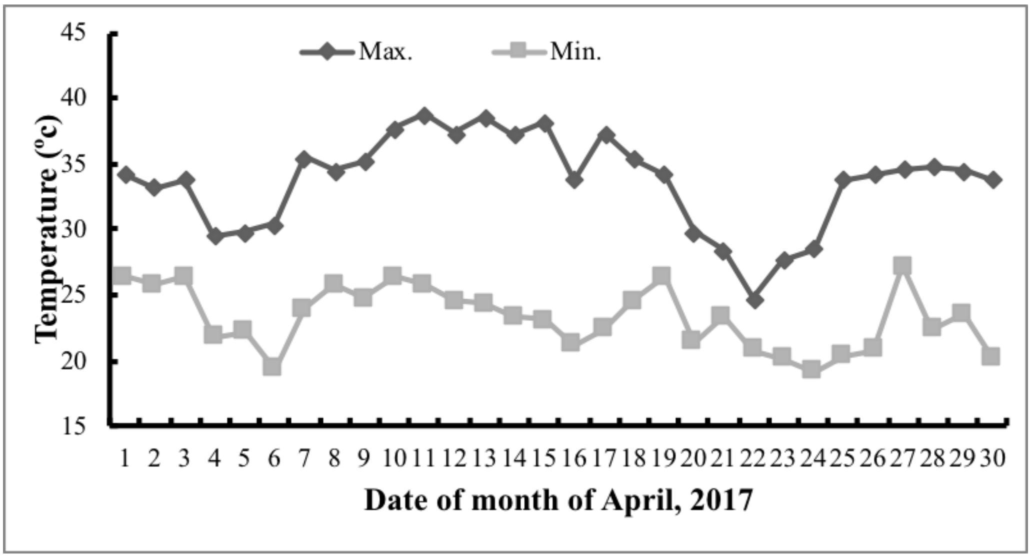


Figure 1. Temperature from heading to maturity of CN6, Boro, 2016-17, BRRI, Gazipur

Yield and yield components

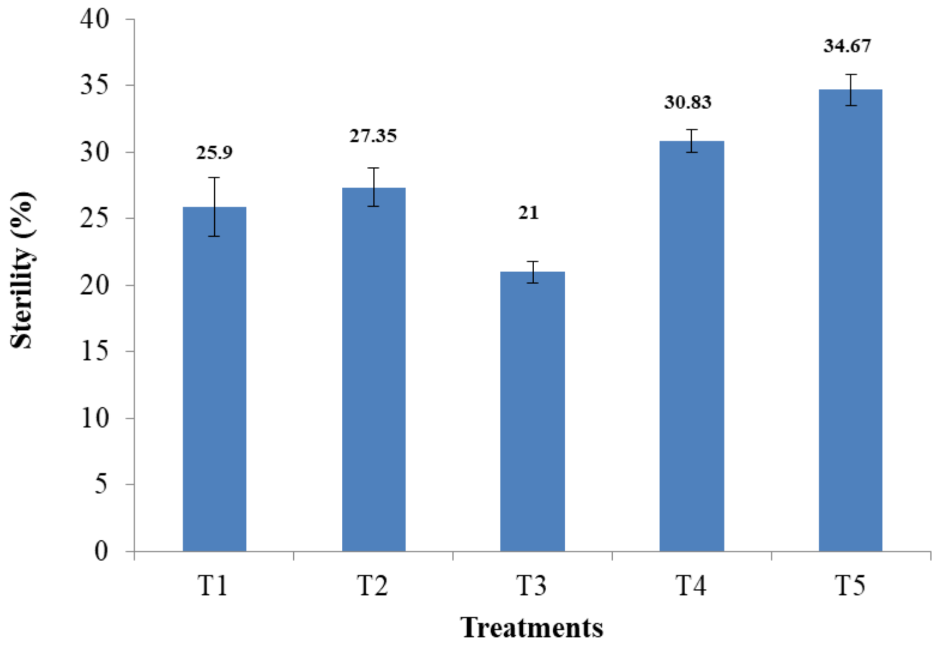
The number of grains per panicle differed significantly among the treatments. Treatment T_3 (BRRI recommended fertilizer dose + Boron @ 5ppm) and T_1 (BRRI recommended fertilizer dose + MgO @ 0.05%) produced the higher number of grains per panicle. Rest of the treatments produced similar number of grains per panicle. Treatment T_3 and T_1 produced 19.9% and 13% higher number of grains over the control treatment, T_5 (BRRI recommended fertilizer dose). Treatment T_2 (BRRI recommended fertilizer dose + 60 g MoP + 60 g elemental S (80% wp) + 20 g $ZnSO_4$) and T_4 (BRRI recommended fertilizer dose +Copper @ 5ppm) produced 4% and 3% higher number of grains over BRRI recommended fertilizer dose (T_5).

There was no significant difference in the 1000-grains weight. Treatment T_1 (BRRI recommended fertilizer dose + MgO @ 0.05%) produced the higher number of 1000-grains weight (17.8) and Treatment T_2 (BRRI recommended fertilizer dose + 60 g Mop+60 g elemental S (80% wp) + 20 g ZnSO4)) produced the lower number of 1000-grains weight (17.2 g). Treatment T_3 (17.7 g) and treatment T_4 (17.6 g) also produced more number of 1000-grains weight than control treatment T5 (17.5). There was significant difference in grain yield among the treatments. Higher grain yield 5.60 t ha^{-1} and 5.14 t ha^{-1} were recorded in treatment T_3 (BRRI recommended fertilizer dose + Boron @ 5ppm) and in the treatment T_1 (BRRI recommended fertilizer dose + MgO @ 0.05%) compare to the control treatment T_5 (4.76 t ha^{-1}) (BRRI recommended fertilizer dose) (Table 1). Other two treatments T_2 and T_4 produced slight lower yield 4.27 t ha^{-1} and 4.72 t ha^{-1} compare to the control treatment T_5 (4.76 t ha^{-1}). The results might be due to the spikelet fertility sensitive advanced line where B fertilization was not done. Whereas, the grain yield increased in the treatments T_3 might be due to the role of micronutrients that regulates pollen viability and seed formation. Repeated sprays can effectively sustain B supply to improve flowering (Wang et al., 1999). Boron fertilizer use (0.75 kg B ha^{-1}) reduces panicle sterility and increases productive tillers, which result in higher paddy yields (Wang et al., 1999; Rashid et al., 2004, 2007). Boron fertilization (1.0 kg B ha^{-1}) improved paddy yields in several rice genotypes (Super Basmati, Basmati-385, KS-282), which was attributed to reduced spikelet sterility and an increased number of productive tillers (Rashid et al., 2004, 2007).

Table1. Effect of micronutrient supplementation on yield and yield components of advanced line CN6, Boro, 2016-17, BRRI, Gazipur

Treatments	**Grains panicle^{-1}**	**Grains panicle^{-1} increased over Control (%)**	**1000- grain weight (g)**	**Grain yield (t ha^{-1})**
T_1= BRRI recommended fertilizer dose + MgO @ 0.05%	186	13	17.8	5.14
T_2= BRRI recommended fertilizer dose + 80% S @ 0.006% + ZnSO4 @ 0.025%	169	4	17.2	4.27
T_3= BRRI recommended fertilizer dose + Boron @ 5ppm	201	19.9	17.7	5.60
T_4=BRRI recommended fertilizer dose +Copper @ 5ppm	167	3	17.6	4.72
T_5= BRRI recommended fertilizer dose	161	---	17.5	4.76
LSD(0.05)	8.99	---	NS	0.89
CV(%)	2.70	---	2.58	9.77

D/S: 9 Dec. D/TP: 18 Jan. D/heading: 01 April D/MA: 05.05.17TGD= 147 days



T_1=BRRI recommended fertilizer dose + MgO @ 0.05%; T_2= BRRI recommended fertilizer dose + 80% S @ 0.006% +ZnSO4 @ 0.025%; T_3=BRRI recommended fertilizer dose + Boron @ 5ppm; T_4=BRRI recommended fertilizer dose +Copper @ 5ppm; T_5= BRRI recommended fertilizer dose

Figure 2. Sterility of CN6 as influenced by different micronutrients supplementation, Boro, 2016-17, BRRI, Gazipur.

Spikelet Sterility of the advanced line CN6

There were significant differences among the treatments regarding sterility percentage. All micronutrient supplemented plot had statistically lower sterility percentage than the control treatment, T_5. Maximum spikelet sterility percent (34.67%) was found in the control treatment (T_5) of the advanced line which is a serious problem to release the cultivars in Bangladesh. Treatment T_1 ,T_2, T_3 and T_4 had about 8.77%, 7.32%, 13.67% and 3.84% lower spikelet sterility, respectively than the control treatment T_5 (Fig. 2) The used management practices improve the spikelet fertility significantly. Parallel to the macronutrient, micronutrient management improves the spikelet fertility in the advanced line CN6.

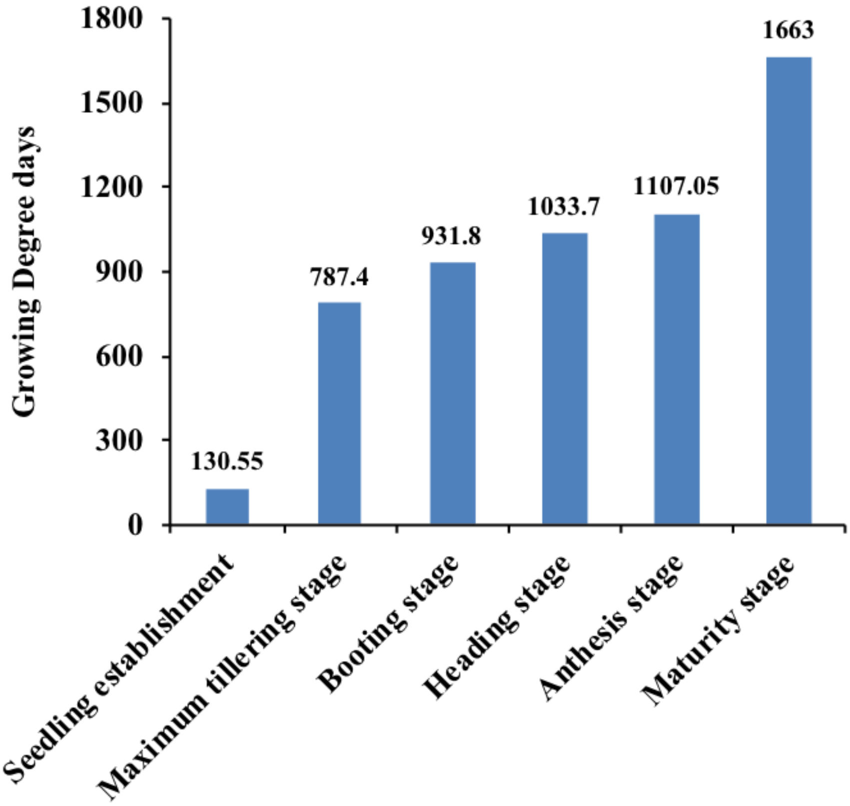


Figure 3. Growing degree days at different phonological stages of Boro advanced line (CN6)

Growing Degree Days (GDD)

Growing degree days accumulated at the different phonological stages were calculated during the growth of rice is presented in fig. 3. The lowest heat unit, Growing Degree Days (GDD) requirement was observed in the CN6 at seedling establishment stage, where as in the successive phonological stages like maximum tillering, booting, heading, an thesis and maturity the heat unit (GDD) increased. The highest heat unit, Growing Degree Days (GDD) requirement was found in the CN6 at maturity stage.

CONCLUSION

On an average 34.67% sterility was observed in CN6. The BRRI recommended fertilizer alone with Boron had positive effects on increasing the spikelet fertility.

CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

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