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Nitrogen and boron fertilization on growth and yield in rice grown in lowland soils

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Abstract

Field experiment was conducted in the Farmers field (Sandy clay loam –*Typic Ustifluvents*) at kuttalam to study the effect of nitrogen and boron on growth and yield in rice. The treatments consisted of Factor A- Nitrogen levels, 0, 75, 150, 225 kg ha^{-1} and Factor B- Boron levels 0, 1.5, 3.0 kg ha^{-1}.Totally fifteen treatments were conducted in a FRBD design with three replications. The test crop was rice with variety ADT 46. The results demonstrated that that application of nitrogen or boron alone or both significantly increased the growth and yield in rice. Application of nitrogen and boron recorded highest growth and yield than in individual application. The highest growth parameters *viz*., plant height (111.8cm), no. of tillers/hill (22.6), LAI (4.8), chlorophyll content (46.3 SPAD value) were recorded in N_3B_1 (225 kg N ha^{-1} and 1.5 kg B ha^{-1}) in rice. With Respect to nitrogen alone, the highest plant height (106.5cm), no. of tillers/hill (20.1), LAI (4.6), chlorophyll content (43.7 SPAD value) were observed in N_3 (225 kg ha^{-1}). Further More, the results suggested that with regards to boron alone, the highest plant height (91.7cm), no. of tillers/hill (15.6), LAI (4.0), chlorophyll content(36.3 SPAD value) were registered in B_1(1.5kg ha^{-1}). The highest grain and straw yield (5631.3, 7637.1 kg ha^{-1}) were recorded in N_3B_1. Among the nitrogen treatments, the highest grain (5344.3 kg ha^{-1}) and straw yield were recorded in N_3. With regards to B alone, the highest grain (4695 kg ha^{-1}) and straw yield (6509 kg ha^{-1}) were recorded in B_1. This study concluded that for attaining maximum yield in nutrients deficient soil (N and B), application of 225 kg N ha^{-1} and 1.5 kg B ha^{-1} found to be beneficial to the farmers.

Keywords: nitrogen, boron fertilization, growth, lowland soils

Introduction

Rice occupies 52% of the total grain production and 55% of total cereal production in India. India ranks next to china in rice occupying an area of 43.4 million ha with production of about 112.9 million tonnes in 2017-18 (Anonymous, 2017) [4]. In Tamil nadu rice is cultivated with an area of 22 lakh hectares with an annual production of 7.2 million tonnes. Nitrogen is the key nutrient that mostly limits the rice production (Nayak *et al.* 2014) [15]. N is the most important nutrient that determines rice yield due to its role in photosynthesis, tiller production and more panicle formation (Biswajit Saha *et al.* 2017) [18]. Imbalanced N application resulted in limited yield and poor in grain quality (Gewaily *et al.* 2018) [10]. Optimum dose of N fertilization is important in the growth and development of rice (Noor, 2017) [16].

Similarly, Yoseftabar (2013) [23] found significant increase in plant growth parameters and grain yield at the rate of 100, 200 and 300 kg N ha^{-1}. Boron is the second most important micronutrient next to zinc made deficient in Indian soils. Soils of about 56 % of the state are found to be deficient in available boron (< 0.5 mg kg^{-1}) (Shukla *et al.* 2014) [20]. Boron influences the grain setting, better pollination, and also favours the enzymes production (Firdous *et al.* 2017) [8]. Application of non-judicious NPK fertilizers only has made the soil deficient in micronutrients particularly in boron. Accelerated depletion of micronutrients from the soil which resulted in severe micronutrients deficiency in many parts of India. Boron fertilizers in addition with NPK nutrients is needed in the days to come to improve the growth and yield of rice in lowland soils (Patel *et al.* 2019) [17]. The response of nitrogen on growth and yield of rice is well documented, but the interaction effect of nitrogen along with boron is very meager. With this perspective, the present investigation was carried out to study the various levels of N and B on growth and yield in rice.

Materials and Methods

Field experiment was conducted in the farmer's field at Kuttalam, Tamil Nadu, during 2020 in sandy clay loam (Padugai Series- *Typic Ustifluvents*) in samba season to study the nitrogen and boron on growth and yield in rice. The treatments consisted of Factor A- N0- no nitrogen, N_1- 75 kg ha^{-1}, N_2- 150 kg ha^{-1}, N_3- 225 kg ha^{-1}, N_4- 300 kg ha^{-1}. Factor B- B0- no boron, B_1- 1.5 kg ha^{-1}, B_2- 3.0 kg ha^{-1}. Totally fifteen treatment combinations were replicated thrice. The experimental soil was sandy clay loam (Padugai series- *Typic Ustifluvents*) with pH (6.9), EC (0.17), available nitrogen (228.4kg ha^{-1}), available phosphorus (14.3 kg ha^{-1}), available potassium (270.5 kg ha^{-1}) and

available boron (0.31 mg kg^{-1}). The experiment was laid out in a factorial randomized block design. A medium duration rice variety cv. ADT 46 was used as a test crop. The experimental site was puddled thrice to bring satisfactory tilth. After levelling, the plots were laid out as per the specification of plot size (5×4 m^2). Totally 45 plots, were raised and the bunds were strengthened in between replication to prevent seepage of water and nutrients from one plot to another. The recommended dose of 150: 50: 50 N, P_2O_5 and K_2O ha^{-1} were followed for fertilizer application through urea, superphosphate and muriate of potash. Zinc (zinc sulphate) was applied @25 kg ha^{-1} as basal dose. Boron was applied through sodium tetraborate or borax ($Na_2B_4O_7$). All the plots received uniform doses of phosphorus (50 kg ha^{-1}), potassium (50 kg ha^{-1}) and zinc sulphate (25 kg ha^{-1}). The spacing adopted was 15 × 10 cm and gap-filling was done at 7 DAT. The entire dose of P was applied basally before transplanting. Nitrogen and potassium were applied in two split doses. The water level was maintained upto 2.5cm uniformly throughout the field trial. The growth parameters (plant height, no. of tillers/hill, LAI, chlorophyll content (SPAD) were observed at tillering, panicle initiation and harvest stages of rice. The crop was harvested after attaining physiological maturity. The grains were separated by threshing from each plot. The grain and straw yield was computed and expressed as kg ha^{-1}.

Results and Discussion

Growth Parameters

There was significant (p=0.05) increase in growth parameters with the application of either nitrogen or boron applied alone or both over control (Table 1, 2). Application of both nitrogen and boron has proved better than their individual effect. The highest growth parameters *viz*., plant height (111.8cm), no. of tillers/hill (22.6), LAI (4.8), chlorophyll content (46.3 SPAD value) were recorded in N_3B_1 (225 kg N ha^{-1} and 1.5 kg B ha^{-1}) in rice. The reason for increased plant height might be due to better plant nutrition and balanced interaction of nitrogen and boron. More number of tillers/hill may be due to higher availability of N and B resulted in efficient utilization for cell multiplication and formation of nucleic acid. Similar results were reported by (Achin Kumar and Singh, 2017) [2]. The increase in the LAI could be attributed to enhanced production of carbohydrate which might have resulted in leaf expansion. Positive aspects of nitrogen with boron might be attributed to higher LAI (Zhang *et al.* 2020) [25]. Chlorophyll colouration is related to the amount of nutrients absorbed by the plants from soil. Integration of nitrogen and boron provides macronutrient and micronutrient which are assimilated by the plants and utilized for various metabolic activity to synthesis chlorophyll (Zayed *et al.* 2011) [24].

Application of nitrogen (225 kg ha^{-1}) N_3 recorded highest plant height (106.5cm), no. of tillers/hill (20.1), LAI (4.6) and chlorophyll content (43.7 SPAD value). The increase in the plant height might be due to increased cell division, cell elongation. Increase in plant height might be primarily due to improved vegetative growth and supplementary contribution of nitrogen (Mahajan *et al*. 2010) [11]. Increased levels of N favours the greater absorption of nutrients resulted in rapid expansion of foliage, better accumulation of photosynthates finally the more number of tillers (Dakshinamurthy *et al.* 2015) [6]. The higher LAI may be due to an appropriate nitrogen rate could ensure that rice canopy. Similar results were documented by (Zhang *et al.* 2020) [25]. Application of nitrogen fertilizer increased the cell division and formation of photosynthetic pigments resulted in higher chlorophyll content. Improved nitrogen availability increased the chlorophyll content (Gholizadeh *et al.* 2017) [9].

The highest plant height (91.7cm) was recorded in B_1 (1.5 kg ha^{-1}). Application of boron increased the plant height may be due to increased vegetative growth (Muhammad Aamer *et al.* 2020) [12]. Among the boron levels, the highest no. of tillers $hill^{-1}$ (15.6), LAI (4.0) and chorophyll content (43.7 SPAD value) were recorded in B_1 (1.5 kg ha^{-1}). Mubshar *et al.* (2012) [13]; El-Dissoky *et al.* (2013) [7]; Abde-Motagally and El-Zohri (2016) [1] also reported significant increase in growth parameters in various crops due to application of boron. This enhancement in plant growth due to boron application at tillering and booting (grain filling) stage indicates the importance of B in nitrogen and phosphorus usage by plants at this stage (Ahmed; 2001) [3]. Rehman *et al.* (2014) [19] also observed that applied B improved leaf elongation, tillering and leaf chlorophyll contents.

Table 1: Effect of nitrogen and boron on growth parameters in rice in sandy clay loam soil

Treatments	Plant height (cm)	No. of tillers/hill	LAI	Chlorophyll content (SPAD value)
N levels (kg/ha)				
(N_0) 0	78.4	9.0	3.2	27.6
(N_1) 75	82.1	10.9	3.4	29.2
(N_2) 150	87.6	13.5	3.7	32.6
(N_3) 225	106.5	20.1	4.6	43.7
(N_4) 300	92.9	16.6	4.2	38.3
C.D. @ 5%	1.02	0.35	0.04	0.50
B levels (kg/ha)				
(B_1) 0	86.6	13.1	3.7	32.9
(B_2) 1.5	91.7	15.6	4.0	36.3
(B_3) 3.0	90.1	13.4	3.7	33.6
C.D. @ 5%	0.79	0.27	0.03	0.38

Table 2: Interaction effect of nitrogen and boron on growth parameters in rice in sandy clay loam soil

Treatments	Plant height (cm)	No. of tillers/hill	LAI	Chlorophyll content (SPAD value)
NoB_0	77.2	8.7	3.1	27.2
N_1B_0	81.1	9.9	3.3	28.4
N_2B_0	86.1	12.4	3.6	30.9

N_3B0	98.3	18.7	4.5	41.8
N_4B_0	90.3	15.7	4.0	36.5
N_0B_1	79.7	9.4	3.3	28.0
N_1B_1	83.4	10.6	3.6	30.4
N_2B_1	88.7	15.4	4.0	35.4
N_3B_1	111.8	22.6	4.8	46.3
N_4B_1	95.1	18.2	4.5	41.2
N_0B_2	73.8	9.0	3.3	27.6
N_1B_2	81.8	10.2	3.3	28.7
N_2B_2	88.0	12.7	3.6	31.6
N_3B_2	109.3	19.1	4.5	43.0
N_4B_2	93.3	16.0	4.0	37.3
C.D. @ 5%	1.77	0.62	0.08	0.86

Rice yield

There was significant (p=0.05) increase in grain and straw yield with the application of either nitrogen or boron applied alone or both over control (Table 3, 4). The highest grain (5631.3 kg ha^{-1}) and straw yield (7637.1 kg ha^{-1}) were registered in N_3B_1 (225 kg N ha^{-1} and 1.5 kg B ha^{-1}). The best treatment caused (53.9, 45.8%) increase in grain and straw yield over control. The increased in the grain yield might be due to synergistic effect of nitrogen and boron on flowering and fruit setting (Bandita Jena and Nayak, 2016) [5]. Similar findings were also observed by (Nagula *et al.* 2015) [14]. With respect to nitrogen alone, the highest grain (5344.3 kg ha^{-1}) and straw yield (7309.4 kg ha^{-1}) were recorded in N_3 (225 kg ha^{-1}) and declined thereafter (N_4). The best treatment caused (46.1, 39.5 %) increase in grain and straw yield over control. Higher levels of nitrogen upto N_3 caused reduction in panicle sterility resulted in marked improvement in yield attributes The adequate assimilation of carbohydrates in the panicle proved instrumental in increasing grain number per panicle due to application of nitrogen resulted in higher yield (Srivastava *et al.* 2006) [22]. With respect to the B alone, the highest grain (4695 kg ha^{-1}) and straw yield (6509 kg ha^{-1}) were recorded in B_1(1.5 kg ha^{-1}) and declined in B_2 (3.0 kg ha^{-1}). The the best treatment caused (27.5, 23.9 %) increase in grain and straw yield over control. B showed marked stimulating effect on protein synthesis and increased panicle length due to effective translocation of carbohydrates and thus decreased sterility percentage and increased the number of grains $panicle^{-1}$ which ultimately resulted in higher grain yield (Subedi *et al.* 1997) [21].

Table 3: Effect of nitrogen and boron on grain and straw yield (kg/ha) in rice

Treatments	Grain yield (kg/ha)	Percent increase over control	Straw yield (kg/ha)	Percent increase over control
N levels(kg/ha)				
(N_0)0	3749.2	1.00	5288.9	0.19
(N_1) 75	3965.2	6.58	5704.8	6.83
(N_2) 150	4404.7	20.42	6227.8	18.73
(N_3) 225	5344.3	46.10	7304.9	39.51
(N_4) 300	4902.8	34.03	6757.0	29.04
C.D @ 5%	45.3	-	50.6	---
B levels(kg/ha)				
(B_1) 0	4331.9	17.90	6098.0	15.71
(B_2) 1.5	4695.0	27.55	6509.9	23.97
(B_3) 3.0	4392.8	19.42	6162.0	16.91
C.D @5%	35.09	---	39.2	----

Table 4: Interaction effect of nitrogen and boron on grain and straw yield (kg/ha) in rice

Treatments	Grain yield	Per cent increase over control	Straw yield	Per cent increase over control
N_0B_0	3656.4	----	5234.2	----
N_1B_0	3860.3	2.82	5517.3	2.20
N_2B_0	4201.3	14.88	6056.2	15.03
N_3B_0	5178.2	41.56	7103.9	35.68
N_4B_0	4763.4	30.23	6578.7	25.63
N_0B_1	3829.3	0.72	5348.5	0.41
N_1B_1	4147.5	13.36	5979.4	14.18
N_2B_1	4726.5	29.23	6536.0	24.83
N_3B_1	5631.3	53.93	7637.1	45.83
N_4B_1	5140.3	40.53	7048.8	34.60
N_0B_2	3761.8	2.28	5283.9	0.17
N_1B_2	3887.7	3.55	5617.8	4.10
N_2B_2	4286.5	17.16	6099.1	16.33
N_3B_2	5223.6	42.80	7173.8	37.03
N_4B_2	4804.7	31.34	6643.5	26.90
C.D@ 5%	78.47	----	87.6	---

Conclusion

It may be concluded that application of nitrogen and boron (225 kg ha^{-1} and 1.5 kg ha^{-1}) N_3B_1 was recorded highest growth and yield in rice. Among the nitrogen treatments, the highest growth parameters and yield were recorded in N_3 (225 kg ha^{-1}). However, with respect to B levels, B_1 (1.5 kg ha^{-1}) was recorded highest growth parameters and yield in rice.

References

1 Abdel-Motagally FMF, El-Zohri M. Improvement of wheat yield grown under drought stress by boron foliar application at different growth stages. J. Saudi Soc. Ag. Sci,2016:17:178-185.
2 Achin Kumar, Singh AP. Direct and residual effect of zinc and boron on growth parameters of rice and wheat grown in sequence in red and alluvial soils of eastern Uttar Pradesh. Int. J. Chem. Studies,2017:6(1):587-592.
3 Ahmed S. Effect of boron and zinc application on dry matter yield and nutrient uptake of wheat. In: Proc. of the International Workshop on Boron, University Bonn, Germany: 2328, 2001.
4 Anonymous. Economic Research Report, United States Department of Agriculture,2017:237:44-45.
5 Bandita Jena, Nayak RK. Enhancing nitrogen use efficiency and yield of rice with zinc and boron application in Inceptisol of Odisha. Annals of Plant and Soil Research,2016:18(1):79-82.
6 Dakshina Murthy KM, Upendra Rao A, Vijay D, Sridhar TV. Effect of levels of nitrogen, phosphorus and potassium on performance of rice. Indian J. Agric. Res,2015:49(1):83-87.
7 El- Dissoky RA, Abdel- Kadar AES. Effect of boron as a foliar application on some potato cultivars under Egyptian alluvial soil conditions. Research J. of Agric. And Biol. Sci,2013:9(5):232-240.
8 Firdous S, Agarwal BK, Kumar A, Wadood A, Shalini D. Boron translocation study in terms of its content at different growth stages in rice. Environment and Ecology,2017:35(2):681-684.
9 Gholizadeh Mohammad, Mehdi Saberioon, Mohammad Amin. Leaf chlorophyll and nitrogen dynamics and their relationship to lowland rice yield for site- specific paddy management. Information Processing in Agriculture,2017:4(4):259-268.
10 Gewaily EE, Adel M Ghoneim, Marvet MA. Effects of nitrogen levels on growth, yield and nitrogen use efficiency of some newly released Egyptian rice genotypes. Open Agriculture,2018:3(1):310-318.
11 Mahajan Naveen Singh, Sekhon NK, Rupinder Kaur. Yield and nitrogen use efficiency of aromatic rice cultivars in response to nitrogen fertilizer. J. new seeds, 2010, 356-368.
12 Muhammad Aamer, Muhammad Ali, Rashid Iqbal, Salman Ahmad, Muhammad Usman Aslam. Growth and yield response of rice varieties to foliar application of boron. Journal of biodiversity and Enviromental Sciences (JBES),2020:17(1):66-72.
13 Mubshar Hussain, Shahid Farooq. Boron application improves growth, yield and net economic return of rice. Rice Science,2012:19(3):259-262.
14 Nagula N, Biju Joseph, Gladies R. Effect of silicon and boron on nutrient status and yield of rice in lateite soils. Annals of Plant and soil Research,2015:17(3):299-302.
15 Nayak BR, Pramanik K, Panigrahy N, Desh AK, Swain SK. Yield, Nitrogen uptake and nitrogen use efficiency indices of aerobic rice (Oryza Sativa. L) Under various irrigation regimes and N; eve;s. International Journal of Bioresource Environment and Agricultural Sciences (IJBEAS),2014:1(2):8-13.
16 Noor MA. Nitrogen management and regulation for optimum NUE in maize- A mini review Soil Crop Sci, 2017. https://www.cogentoa.com/article/10.1080/23311932.2017.
17 Patel Sandeep Kumar, Singh RP, Shrivasatva Saurabh, Pandey AK, Chandel SKS. Effect of foliar application of boron at different stages of crop growth on nutrient utilization and yield of rice (Oryza sativa L.) Indian Journal of Scientific Research,2019:9(2):1-6.
18 Rjasiswajit Saha, Parimal Panda, Parthasarathi Patra, Ranajit Panda, Arindam Kundu, Singha Roy AK *et al*. Effect of different levels of nitrogen on growth and yield of rice (Oryza sativa L.) cultivars under Terai agro Climatic condition. International Journal of Current Microbiology and Applied Sciences,2017:6(7):2408-2418.
19 Rehman A, Farooq M, Atacheema Z, Nawaz A, Wahid A. Foliage applied boron improves the panicle fertility, yield and biofortification of fine grain aromatic rice. J. Soil Sci. Pl. Nutr,2014:14:723-733.
20 Shukla AK, Tiwari PK, Prakash. Response of foliar application of boron on wheat (*Triticum aestivum L.*) crop in calcareous soils of Pakistan. Academia Journal of Agricultural Research,2014:2(3):106-109.
21 Subedi KD, Budhathoki CB, Subedi M, Yabak D. Response of wheat genotype of sowing date and boron fertilization aimed of controlling sterility in rice–wheat rotation in Nepal. Plant and Soil,1997:188(2):249-256.
22 Srivastava VK, Govind Sharma, Bohra JS, Avijit Sen, Singh JP, Gowda SK. Response of hybrid rice to the application of nitrogen, magnesium and boron. Ann. Agric. Res. New Series,2006:27(4):392-396
23 Yoseftabar S. Effect of nitrogen management on panicle structure and yield in rice (*Oryza sativa L.*) Intl. J. Agri. Crop Sci,2013:5(1):1224-1227.
24 Zayed BA, Salem AKM, El Sharkawy HM. Effect of different micronutrient treatments on rice (Oriza sativa L.) growth and yield under saline soil conditions. World J. Agric. Sci,2011:7(2):179-184.
25 Zhang, Tianyi Tang, Xiangru Tang. Nitrogen effects on yield quality and physiological characteristics of Giant rice. Agron,2020:10:3-16.