Ankur Shukla
M.Sc. Agronomy IFTM
University Moradabad, Uttar
Pradesh, India

Raghvendra Singh
Young Professional, KVK Basuli
Mahrajganj, Uttar Pradesh,
India

Sandeep Kumar Singh
M.Sc. Agro meteorology
ANDUAT Kumarganj Ayodhya,
Uttar Pradesh, India

Shivanand
Research Scholar Agronomy
ANDUAT Kumarganj Ayodhya,
Uttar Pradesh, India

Dev Mani Shukla
M.Sc. Biochemistry CSAU
Kanpur, Uttar Pradesh, India

Ram Singh
M.Sc. Agro meteorology
ANDUAT Kumarganj Ayodhya,
Uttar Pradesh, India

Study the effect of boron levels on yield attributes of rice crop

Ankur Shukla, Raghvendra Singh, Sandeep Kumar Singh, Shivanand, Dev Mani Shukla and Ram Singh

Abstract
The present study entitled "Response of Boron Levels and Application Methods on Growth and Yield of Rice (*Oryza sativa* L.)" in north- western plain zone of India was carried out at School of Agricultural Science and Engineering, IFTM University, Moradabad in 2018-19. The ten treatments T_1 = 100% RDF (150 :60 :40 kg ha^{-1}); T_2 = 100% RDF + 0.5 kg B ha^{-1} (SA); T_3 = 100% RDF + 0.5 kg B ha^{-1}(SA) + 0.2% B spray at 25 & 50 DAT; T_4 = 100% RDF + 0.5 kg B ha^{-1} (SA) + 0.3% B spray at 25 & 50 DAT; T_5 = 100% RDF + 1.0 kg B ha^{-1}(SA); T_6 = 100% RDF + 1.0 kg B ha^{-1} (SA) + 0.2% B spray at 25 & 50 DAT; T_7 = 100% RDF + 1.0 kg B ha^{-1} (SA) + 0.3% B spray at 25 & 50 DAT; T_8 = 100% RDF + 2.0 kg B ha^{-1}; T_9 = 100% RDF + 2.0 kg B ha^{-1} (SA) + 0.2% B spray at 25 & 50 DAT; T_{10} = 100% RDF + 2.0 kg B ha^{-1} (SA) + 0.3% B spray at 25 & 50 DAT combination were tested in randomized block design (RBD) with three replication.

T_{10} observed significant increase in all yield attributes *viz.*, no. of tillers per m^2 area, panicle length (cm), number of filled grain panicle^{-1}, number of unfilled grain panicle^{-1}, 1000- seed weight (g), grain yield (q ha^{-1}), biological yield (q ha^{-1}) and harvest index respectively, over rest of the treatments. In T_{10} treatments significantly increased the no. of tillers m^2 area (199.65, 210.70, 212.50 and 213.15) 30, 60, 90 and harvest stage, fresh weight (66.79 g, 147.50 g, 163.00 g and 163.05 g plant^{-1}) at 30, 60, 90 and harvest stage, panicle length (31.55 cm), number of filled grain panicle^{-1} (191.20), number of unfilled grain panicle^{-1} (20.80), biological yield (7.7 t, 10.5 t and 18.1 t ha^{-1}) and harvest index (42.26 %) respectively.

Keywords: Response, boron, tillers, filled, penicle, biological

Introduction
Rice is the important staple food crop for more than two third of the population of India. The slogan 'Rice is life' is most appropriate for India as this crop plays a vital role in our national food security and is a means of livelihood for millions of rural households. Rice belongs to family graminaceae or grass family.

World's food security is under threat due to the stagnated or stunted yields as main staple food crops. Rice (*Oryza sativa* L.) is one of the most important field crops after wheat in the world providing staple food to the millions. It is an indispensable source of calories for almost half of the population with in Asia. More than 90% of the world rice is produced and consumed in Asia, which is a native for 60% of the earth's population. Rice is the first most important crop in India where it is grown in an area of 43.9 million ha^{-1} with a total production of 106.77 million tonnes and an average productivity of 24.32 q ha^{-1} (Anonymous, 2015) [4]. Uttar Pradesh ranks second after West Bengal where the total production is 14.41 million tonnes with a share of 13.80% to total rice production in the country (Anonymous, 2014) [3].

India has the largest acreage under rice *i.e.* 44 million hectares, with a production of about 141 million tones and the national productivity of 3.21 t ha^{-1}. The burgeoning population of our country may stabilize around 1.4 and 1.6 billion by 2025 and 2050, requiring annually 380 and 450 mt of food grains respectively (Yadav *et al.* 2009) [25].

Boron (B), a non-metal micronutrient, is essential for normal growth and development of Rice crop (Dunn *et al.* 2005) [7]. Boron deficiencies occur over a much wider range of soils and crops in comparison to any other micronutrient deficiency. Boron deficiency has been reported in 80 countries and for 132 crops around the world. Soil orders with prevalent B deficiency are ultisols, lithic inceptisols, lithic fluvents, alfisols, psamments, oxisols, spodosols and andepts.

Boron plays a major role in plant vital activities such as cell division, leaf and flower bud formation, glucose metabolism and hydrocarbons and their transport, root growth, cell wall formation and material transportation between cells. Boron transport and transfer in plant is relatively low and thus its concentration in lower parts of the plant is higher. Most of boron transport is through xylem vessel. Boron is mostly concentrated in anther, stigma and ovary.

Corresponding Author:
Ankur Shukla
M.Sc. Agronomy IFTM
University Moradabad, Uttar
Pradesh, India

According to boron effect in increasing sugar and hydrocarbons transport through phloem (Moeinian *et al.* 2011) [16]. It has been reported that Boron deficiency limits reproductive growth. In wheat, B deficiency causes pooranther and pollen development, low grain set and stunted growth.

One of the primary functions of boron in vascular plants has been related with the cell wall structure and function. There is direct evidence for a role of boron in cross-linking of cell wall rhamnogalacturonan II (RGII) and pectin assembly showing that boron is essential for cell wall structure and function (O'Neill *et al.* 2004) [17]. As a result, boron has a critical role in growing tissues. Actually, boron deficiency decreases or inhibits the growth of both vegetative and reproductive plant parts (Dell and Huang 1997) [6]. Boron deficiency inhibits root elongation through the limiting of cell enlargement and cell division in the growing zone of root tips and that in the cases of severe boron deficiency, root growth is ceases leading to the death of root tips (Mahmoud 2010) [14].

Material and Methods
The present study intitled "Response of boron levels and application methods on growth and yield of rice (*Oryza sativa* L.)" was conducted during *kharif* season of 2018, at the experimental farm of IFTM University, Lodhipur Rajput Delhi Road NH-24, Moradabad, Uttar Pradesh. The ten treatments T_1 = 100% RDF (150 :60 :40 kg ha^{-1}); T_2 = 100% RDF + 0.5 kg B ha^{-1} (SA); T_3 = 100% RDF + 0.5 kg B ha^{-1}(SA) + 0.2% B spray at 25 & 50 DAT; T_4 = 100% RDF + 0.5 kg B ha^{-1} (SA) + 0.3% B spray at 25 & 50 DAT; T_5 = 100% RDF + 1.0 kg B ha^{-1}(SA); T_6 = 100% RDF + 1.0 kg B ha^{-1} (SA) + 0.2% B spray at 25 & 50 DAT; T_7 = 100% RDF + 1.0 kg B ha^{-1} (SA) + 0.3% B spray at 25 & 50 DAT; T_8 = 100% RDF + 2.0 kg B ha^{-1}; T_9 = 100% RDF + 2.0 kg B ha^{-1} (SA) + 0.2% B spray at 25 & 50 DAT; T_{10} = 100% RDF + 2.0 kg B ha^{-1} (SA) + 0.3% B spray at 25 & 50 DAT combination were tested in randomized block design (RBD) with three replication.

The data recorded in the experiment were analyzed statistically with the help of electronic calculator following the procedure for randomized block design (RBD) given by Gomez & Gomez (1984). The standard errors of the mean were calculated in each item of investigation and critical differences (CD) at 5% level were worked out for comparing the treatment means whenever 'F' test was found significant. The analysis of the variance table has given in the appendices. The data are illustrated with the help of diagrams wherever, felt necessary. The distribution of degree of freedom for various sources of variations is given.

Result and discussion
The maximum number of effective tillers m^{-2} area of rice (179.200) respectively, was recorded with the application of T_{10}[2.0 kg B ha^{-1}(SA) + 0.3 % B spray twice at 25 & 50 DAT] Table-1.This may be attributed to the reason that B is more responsible for increasing productive tillers, enhancing productivity of tillers with all yield parameters increase. These are in conformity with those already reported by Rashid *et al.* (2004 & 2007) and Ahmad and Irshad (2011) [21, 1].

The highest panicle length of rice (31.55 cm) respectively, was noticed with the application of T_{10} [2.0 kg B ha^{-1}(SA) + 0.3 % B spray twice at 25 & 50 DAT] Table-1.This may be attributed to the reason that B is already beneficial for improving the panicle length and directly affected. These are in conformity with those already reported by Mehmood *et al.* (2009) [15] and Phonglosa *et al.* (2018) [18].

Maximum number of grains panicle^{-1} (212.00) respectively, was recorded with the application of T_{10} [2.0 kg B ha^{-1}(SA) + 0.3 % B spray twice at 25 & 50 DAT] Table-1.This may be attributed to the reason that B applied at heading or flowering stage in rice increased and better improving the number of grains panicle^{-1}.In rice, B induces panicle numbers plant^{-1} and reduces poor grain fertility. These are in conformity with those already reported by Lin and Zhu (2000) [13], Ramanthan *et al.* (2002), Rashid (2006), Ziaeyan and Rajaie (2009) [26] and Hussain *et al.* (2012) [9]

Maximum number of filled grains panicle^{-1} (191.20) respectively, were recorded with the application of T_{10}[2.0 kg B ha^{-1}(SA) + 0.3 % B spray twice at 25 & 50 DAT] Table-2.This may be attributed to the reason that B is responsible for better seed setting and illustrated significant effect on number of filled grains. In rice, B reduces panicle sterility and induces the fertility due to high pollen and anther development and pollen germination which induces the number of filled grains panicale^{-1} and therefore, yield. These are in conformity with those already reported by Aslam *et al.* (2002) [5], Ali *et al.* (2016) and Rani and Latha (2017) [20].

Minimum number of unfilled grains panicle^{-1} of rice (20.80) respectively, were noticed with the application of T_{10}[2.0 kg B ha^{-1}(SA) + 0.3 % B spray twice at 25 & 50 DAT]Table-2.This may be attributed to the reason that B deficiency, pollen grain appears empty and induces sterility in rice and directly affected the pollen vitality. These are in conformity with those already reported by Dell and Huang (1997), Rashid *et al.* (2007) and Garg *et al.* (1979) [6, 22, 8].

1000 seed weight of rice was found maximum (31.06 g) respectively, with the application of T_{10}[2.0 kg B ha^{-1}(SA) + 0.3 % B spray twice at 25 & 50 DAT] Table-2.This may be attributed due to the reason that, B application appreciably reduced panicle sterlity and increase weight of 1000 seed and starch content.These are in conformity with those already reported by Jana *et al.* (2005) [10], Rashid *et al.* (2006), Ziaeyan and Rajaie (2009) [26], and Rehman *et al.* (2012) [24].

The grain yield of rice was recorded maximum (76.80 t ha^{-1}) respectively, with the application of T_{10} [2.0 kg B ha^{-1}(SA) + 0.3 % B spray twice at 25 & 50 DAT] Table-3. This may be attributed due to the reason that, B fertilization improves paddy yields due to the reduced panicle sterility and an increased number of productive tillers, which results in higher grain yield of rice. These results are in conformity with those already reported by Khan *et al.* (2006) [11], Rashid *et al.* (2004 and 2007), Ziaeyan and Rajaie (2009) and Rashid *et al.* (2009) [21, 26].

The biological yield of rice was recorded maximum (181.75 t ha^{-1}) respectively, with the application of T_{10} [2.0 kg B ha^{-1}(SA) + 0.3 % B spray twice at 25 & 50 DAT] Table-3.This may be attributed due to the grain and straw yields were recorded highest in this treatment so biological yield was increased. B is show better result for enhancing the biological yield of rice. The same findings also reported by Ziaeyan and Rajaie (2009) [26].

The Harvest index of rice was observed maximum (42.26 %) respectively, with the application of T_{10}[2.0 kg B ha^{-1}(SA) + 0.3 % B spray twice at 25 & 50 DAT] Table-3.This may be attributed due to the reason that, B element increases grain yield in this treatment, this result revealed that increasing harvest index. B fertilization is playing an important role in improving the harvest index. These are in conformity with those already reported by Hussain *et al.* (2012) [9] and Kumar *et al.* (2015) [12].

Table 1: Number of effective tillers m² Panicle length (cm) and grains panicle⁻¹ area as influenced by different levels and application methods of B.

Treatments	Number of effective tillers m² area	Panicle length (cm)	Number of grains panicle⁻¹
T_1- RDF	157.4	29.6	199.4
T_2- RDF + 0.5 kg. B ha⁻¹ (SA)	158.2	30.1	199.4
T_3- RDF + 0.5 kg. B ha⁻¹ (SA) + 0.2% B spray at 25 & 50 DAT	158.2	30.2	195.2
T_4- RDF + 0.5 kg. B ha⁻¹ (SA) + 0.3% B spray at 25 & 50 DAT	158.5	30.6	196.7
T_5- RDF + 1.0 kg. B ha⁻¹ (SA)	164.3	30.7	199.4
T_6- RDF + 1.0 kg. B ha⁻¹ (SA) + 0.2% B spray at 25 & 50 DAT	167.8	30.8	199.4
T_7- RDF + 1.0 kg. B ha⁻¹ (SA) + 0.3% B spray at 25 & 50 DAT	169.0	30.9	199.4
T_8- RDF + 2.0 kg. B ha⁻¹ (SA)	170.5	31.2	203.7
T_9- RDF + 2.0 kg. B ha⁻¹ (SA) + 0.2% B spray at 25 & 50 DAT	175.9	31.3	211.9
T_{10}- RDF + 2.0 kg. B ha⁻¹ (SA) + 0.3% B spray at 25 & 50 DAT	179.2	31.6	212.0
SEm±	0.27	0.34	0.16
CD at 5%	0.81	1.01	0.47

Table 2: No. of filled grain panicle⁻¹, unfilled grain panicle⁻ and 1000 seed weight (g) as influenced by different levels and application methods of B.

Treatments	No. of filled grains panicle⁻¹	No. of unfilled grains panicle⁻¹	1000 seed weight (g)
T_1- RDF	141.9	57.5	28.9
T_2- RDF + 0.5 kg. B ha⁻¹ (SA)	148.7	50.7	29.0
T_3- RDF + 0.5 kg. B ha⁻¹ (SA) + 0.2% B spray at 25 & 50 DAT	154.2	41.0	29.2
T_4- RDF + 0.5 kg. B ha⁻¹ (SA) + 0.3% B spray at 25 & 50 DAT	160.3	36.4	29.5
T_5- RDF + 1.0 kg. B ha⁻¹ (SA)	163.9	35.5	29.5
T_6- RDF + 1.0 kg. B ha⁻¹ (SA) + 0.2% B spray at 25 & 50 DAT	165.0	34.4	29.6
T_7- RDF + 1.0 kg. B ha⁻¹ (SA) + 0.3% B spray at 25 & 50 DAT	171.4	28.0	29.9
T_8- RDF + 2.0 kg. B ha⁻¹ (SA)	176.1	24.6	30.1
T_9- RDF + 2.0 kg. B ha⁻¹ (SA) + 0.2% B spray at 25 & 50 DAT	187.0	24.9	30.2
T_{10}- RDF + 2.0 kg. B ha⁻¹ (SA) + 0.3% B spray at 25 & 50 DAT	191.2	20.8	31.1
SEm±	0.27	0.49	0.28
CD at 5%	0.82	1.45	0.84

Table 3: Grain yield (t ha⁻¹), Biological yield (t ha⁻¹) and Harvest index (%) as influenced by different levels and application methods of B.

Treatments	Grain yield (t ha⁻¹)	Biological yield (t ha⁻¹)	Harvest index (%)
T_1- RDF	5.4	14.7	38.8
T_2- RDF + 0.5 kg. B ha⁻¹ (SA)	5.6	15.2	39.9
T_3- RDF + 0.5 kg. B ha⁻¹ (SA) + 0.2% B spray at 25 & 50 DAT	5.9	15.5	40.5
T_4- RDF + 0.5 kg. B ha⁻¹ (SA) + 0.3% B spray at 25 & 50 DAT	6.0	15.8	41.0
T_5- RDF + 1.0 kg. B ha⁻¹ (SA)	6.5	15.9	41.2
T_6- RDF + 1.0 kg. B ha⁻¹ (SA) + 0.2% B spray at 25 & 50 DAT	6.7	16.1	41.3
T_7- RDF + 1.0 kg. B ha⁻¹ (SA) + 0.3% B spray at 25 & 50 DAT	6.8	16.3	41.5
T_8- RDF + 2.0 kg. B ha⁻¹ (SA)	7.0	16.7	41.6
T_9- RDF + 2.0 kg. B ha⁻¹ (SA) + 0.2% B spray at 25 & 50 DAT	7.3	17.6	41.8
T_{10}- RDF + 2.0 kg. B ha⁻¹ (SA) + 0.3% B spray at 25 & 50 DAT	7.7	18.1	42.3
SEm±	0.057	0.05	0.19
CD at 5%	0.171	0.14	0.56

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