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Effect of nitrogen and boron on growth and yield of foxtail millet

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Abstract
A field experiment was conducted during Zaid season, 2024 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University Institute of Agricultural Sciences, Prayagraj (U.P) to study the "Effect of Nitrogen and Boron on growth and yield of Foxtail millet". The soil of the experimental field was sandy loam in texture, slightly alkaline in soil reaction (pH 7.8) with low level of organic carbon (0.52%), available Nitrogen (198 Kg/ha), Phosphorus (24.5 kg/ha) and higher level of potassium (240.7 kg/ha). The experiment was laid out in Randomized Block Design with 3 replications and ten treatments. The result obtained that significantly higher plant height (50.06 cm), higher plant dry weight (24.34 g), maximum number of tillers/plant (8.93) and maximum number of grains/ear head (1409) were recorded in treatment 9 [Nitrogen (50 kg/ha) + Boron (4.5 kg/ha)] as compared to other treatments.

Keywords: Boron, economics, foxtail millet, growth, nitrogen and yield

1. Introduction

"Foxtail millet (*Setaria italica* L.) is an important crop used as a staple food in many parts of the world including arid and semi-arid areas of China, some part of India and Japan, and is grown for silage and hay in South and North America. Foxtail millet is commonly known in India as Kangni (Hindi), Kang (Gujrati), Navane (Kanada), Tenai (Tamil). It is the second most cultivated millet after pearl millet. Foxtail millet (per 100 g edible portion; 12% moisture) contains Protein (g)-11.2, Fat (g)-4.0, Ash (g)-3.3, Crude fiber (g)-6.7, Carbohydrate (g) 63.2 and Energy (kcal) 351. For vitamin, macro and micro nutrient content contains Ca (mg)-31, Fe (mg)-2.8, Thiamin (mg)-0.59, Riboflavin (mg)-0.11 and Niacin (mg)-3.2 (Gupta H. *et al*., 2024) [3]. "Foxtail millet bran contains 8-10% crude oil and is rich in linoleic (66.5%) and oleic (13.0%) acids (Liang *et al.*, 2010) [7]. It is rich in dietary fibre (6.7%), protein (11%), and low in fat (4%). Unlike rice, foxtail millet releases glucose steadily without affecting the metabolism of the human body. "Being a C4 photosynthetic crop, foxtail millet is naturally equipped with excellent water use efficiency and nitrogen use efficiency, in addition, several morpho-physiological traits including dense and deep root systems, smaller leaf area, and thickening of cell walls which were thought to lead to durable tolerance to a range of abiotic stresses mainly drought, heat, and salinity. "Foxtail millet is a native of China and is one of the world's oldest known cultivated crops. It ranks second in the total world production of millets and continues to have an important place in world agriculture providing approximately six million tons of food per annum.

Nitrogen is the major nutrient required by the millets for higher growth, yield attributes and yield (Prasad *et al.*, 2014) [8]. Studies of Hasan *et al*., (2013) [5] and Basavarajappa *et al*., (2003) [2] indicated that there was a good response of foxtail millet to varied levels of nitrogen. It is worth mentioning that nutrient management through organic sources plays a major role in maintaining soil health improves the status of soil organic matter, beneficial microbes and enzymes besides improving soil physical and chemical properties (Raviraja *et al.*, 2020) [9].

"Boron plays an important role in plant growth and nutrition and it promotes cell division, cell elongation, cell wall resistance, flowering, pollination, fruit set and sugar translocation. Boron is one of the most important micronutrients for plant growth and plays an important role in the physiological processes within plant (Tanaka and Fujiwara, 2007) [12].

2. Materials and Methods

The experiment was conducted during *Zaid season* 2024. The experiment was conducted in Randomized Block Design (RBD) consisting of three replications and ten treatments. It was laid out with the different treatments allocated randomly in each replication which is located at 25.57° "N latitude, 87.19° " E longitude, and 98 m altitude above the mean sea level (MSL). This area is situated on the right side of the river Yamuna by the side of Allahabad Rewa Road about 5 km away from Prayagraj (U.P) city.The soil of the experimental field was sandy loam in texture, slightly alkaline in soil reaction (pH 7.8) with low level of organic carbon (0.52%), available Nitrogen (198 Kg/ha), Phosphorus (24.5 kg/ha) and higher level of potassium (240.7 kg/ha). The treatment combinations are T_1: Nitrogen 30 kg/ha+ Boron 3.0 kg/ha, T_2: Nitrogen 30 kg/ha + Boron 4.5 kg/ha, T_3: Nitrogen 30 kg/ha + Boron 4.5 kg/ha, T_4: Nitrogen 40 kg/ha + Boron 1.5 kg/ha, T_5: Nitrogen 40 kg/ha + Boron 3.0 kg/ha, T_6: Nitrogen 40 kg/ha + Boron 4.5 kg/ha, T_7: Nitrogen 50 kg/ha + Boron 1.5 kg/ha, T_8: Nitrogen 50 kg/ha + Boron 3.0 kg/ha, T_9: Nitrogen 50 kg/ha + Boron 4.5 kg/ha, T_{10}: Control (RDF 50:30:20 NPK kg/ha). The observations were recorded on different growth parameters at harvest *viz.*, plant height(cm), plant dry weight (g/plant), no. of tillers/plant, no. of grains/ear head, test weight(g). Observations on growth parameters and yield attributes was recorded from the experiment and their significance was tested by RBD analysis and ANOVA and F-value at 5% level of significance.

3. Results and Discussion

3.1 Growth Attributes

3.1.1 Plant height (cm)

The data revealed in Table no. 1 that the significantly higher plant height (50.06 cm) was recorded in treatment 9 with application of Nitrogen 50 kg/ha+ Boron 4.5 kg/ha at 60 DAS. However, the treatment 3(44.86) [Nitrogen (30 kg/ha) + Boron (4.5 kg/ha)] and treatment 6 (46.13) [Nitrogen (40 kg/ha) +Boron (4.5 kg/ha)] was found to be statistically at par with treatment 9 [Nitrogen (50 kg/ha + Boron (4.5 kg/ha)] in Table 1. The maximum plant height was attained by the regular supply of plant nutrients during all growth stages, through a supply of Nitrogen and Boron. Nitrogen is a component of porphyrins of chloroplasts and hence increased nitrogen fertilization increased the growth and yield of crop due to maximum photosynthates production. This resulted in enhanced morphological characters i.e., plant height, leaf area and dry matter accumulation which was reflected in higher straw yield. These findings are in support of (Kalaghatagi *et al.*, 2000) [6]. Boron enhances the differentiation of tissue cell division and nitrogen absorption from the soil.

3.1.2 Plant dry weight (g)

The data revealed in Table no. 1 that the significantly higher plant dry weight (24.34 g) was recorded in treatment 9 with application of Nitrogen 50 kg/ha+ Boron 4.5 kg/ha at 60 DAS. However treatment 6 (23.01) [Nitrogen (40 kg/ha) + Boron (4.5 kg/ha)] was found to be statistically at par with treatment 9 [Nitrogen (50 kg/ha + Boron (4.5 kg/ha)] in Table 1. This might be due to Nitrogen application which has many important functions in plant growth and development, such as involvement in the biosynthesis of chlorophyll, respiration, chloroplast development and improves the performance of photosystems, which resulted in higher dry weight (Srihari *et al.*, 2023) [11].

Boron is a second most important micronutrient after zinc its deficiency impaired the biomass production via way of means of manipulation relative attention of man or woman detail in addition to the stability amongst positive nutrient factors inside plants (Tariq and Mott, 2007) [13]

3.1.3 Crop Growth Rate (g/m^2/day)

The data revealed that during 45-60 interval DAS, no significant difference was recorded among all the treatments. Statistically highest crop growth rate (18.90 g/m^2/day) was recorded in treatment 7 [Nitrogen (50 kg/ha) + Boron (1.5 kg/ha)].

3.1.4 Relative Growth Rate (g/g/day)

The data revealed that during 45-60 interval DAS, no significant difference was recorded among all the treatments. Statistically highest relative growth rate (0.049 g/g/day) was recorded in treatment 8 [Nitrogen (50 kg/ha) + Boron (3.0 kg/ha)].

Table 1: Effect of Nitrogen and boron on growth attributes of Foxtail millet

Treatment	Treatment combinations	Plant height (cm)	Plant dry weight (g)	Crop Growth Rate (g/m^2/day)	Relative Growth Rate (g/g/day)
T_1	Nitrogen 30 kg/ha + Boron 1.5 kg/ha	43.53	20.66	14.80	0.041
T_2	Nitrogen 30 kg/ha + Boron 3.0 kg/ha	44.32	22.75	18.20	0.039
T_3	Nitrogen 30 kg/ha + Boron 4.5 kg/ha	44.86	23.30	14.20	0.043
T_4	Nitrogen 40 kg/ha + Boron 1.5 kg/ha	42.73	22.34	16.90	0.036
T_5	Nitrogen 40 kg/ha + Boron 3.0 kg/ha	41.33	22.72	17.10	0.048
T_6	Nitrogen 40 kg/ha + Boron 4.5 kg/ha	46.13	23.01	17.60	0.045
T_7	Nitrogen 50 kg/ha + Boron 1.5 kg/ha	40.76	21.30	18.90	0.041
T_8	Nitrogen 50 kg/ha + Boron 3.0 kg/ha	42.73	21.13	13.90	0.049
T_9	Nitrogen 50 kg/ha + Boron 4.5 kg/ha	50.06	24.34	18.70	0.037
T_{10}	Control + RDF (NPK-50:30:20 kg/ha)	44.46	21.96	17.80	0.033
	F Test	S	S	NS	NS
	SEm (±)	2.15	1.02	2.55	0.01
	CD (p=0.05)	5.39	1.49	-	-

3.2 Yield and Yield Attributes

3.2.1 Number of Tillers/plant

The data revealed in Table no. 2 that During 60 DAS, significant maximum no. of tillers/plant (8.93) was recorded in Treatment 9 [Nitrogen (50 kg/ha) + Boron (4.5 kg/ha)]. However, treatment 6 [Nitrogen (40 kg/ha) + Boron (4.5 kg/ha)], was found to be statically at par with treatment 9 [Nitrogen (50 kg/ha) + Boron 4.5 kg/ha)]. A considerable rise in plant dry matter might be due to increased nitrogen levels could be linked to nitrogen's effect on raising the amount and effectiveness of chlorophyll, which influences photosynthetic efficiency and the synthesis of other nitrogen compounds. Similar findings were reported by (Arshewar *et al.*, 2018) [1].

Table 2: Effect of Nitrogen and boron on yield and yield attributes of Foxtail millet

Treatments	Treatment combinations	Yield and yield attributes		
		Number of tillers/plant	Number of grains/ear head	Test weight (g)
T_1	Nitrogen 30 kg/ha + Boron 1.5 kg/ha	5.60	1067.05	2.51
T_2	Nitrogen 30 kg/ha + Boron 3.0 kg/ha	8.06	1109.69	3.24
T_3	Nitrogen 30 kg/ha + Boron 4.5 kg/ha	6.66	1144.0	2.94
T_4	Nitrogen 40 kg/ha + Boron 1.5 kg/ha	7.93	1188.02	3.37
T_5	Nitrogen 40 kg/ha + Boron 3.0 kg/ha	6.73	1215.03	3.34
T_6	Nitrogen 40 kg/ha + Boron 4.5 kg/ha	8.40	1363.0	2.98
T_7	Nitrogen 50 kg/ha + Boron 1.5 kg/ha	7.26	1304.0	3.04
T_8	Nitrogen 50 kg/ha + Boron 3.0 kg/ha	7.40	1246.0	3.55
T_9	Nitrogen 50 kg/ha + Boron 4.5 kg/ha	8.93	1409.0	3.56
T_{10}	Control + RDF (NPK-50:30:20 kg/ha)	7.73	1015.45	3.07
	F Test	S	S	NS
	SEm (±)	0.29	23.71	0.32
	CD (p=0.05)	0.85	72.24	-

3.2.2 Number of grains/ear head

The data revealed in Table no. 2 that Treatment 9 [Nitrogen (50 kg/ha) + Boron (4.5 kg/ha)] recorded significantly higher number of grains/ear head (1409.00). However, treatment 6 [Nitrogen (40 kg/ha) + Boron (4.5 kg/ha)] was statically at par with the treatment 9 [Nitrogen (50 kg/ha) + (Boron 4.5 kg/ha)].Boron, required for cell differentiation, development and growth of pollen grains. Nitrogen provides potential for many of the enzymatic transformations. Several of these enzymes are involved in chlorophyll synthesis and grain formation resulting in higher grains/panicle. Similar results are observed by (Vaja *et al.*, 2020) [14].

3.2.3 Test weight (g)

The data revealed in Table no. 2 that the Higher test weight (3.56 g) was recorded in treatment 9 [Nitrogen (50 kg/ha) + Boron (4.5 kg/ha) and lowest test weight (2.51 g) was recorded in treatment 1 [Nitrogen (30 kg/ha) + Boron (1.5 kg/ha)] though there was non-significant difference among other treatments.

4. Summary and Conclusion

The present study or experiment titled "Effect of Nitrogen and Boron on growth and yield of Foxtail millet (*Setaria italic* L.)" was carried out at Crop Research Farm (CRF), Department of Agronomy, SHUATS, Prayagraj, U.P. The results of the study have been summarized in this section. The result obtained that significantly higher plant height (50.06 cm), higher plant dry weight (24.34 g), maximum number of tillers/plant (8.93) and maximum number of grains/ear head (1409) were recorded in treatment 9 [Nitrogen (50 kg/ha) + Boron (4.5 kg/ha)] as compared to other treatments. It is concluded that with the application of Nitrogen 50 kg/ha along with and Boron 4.5 kg/ha (Treatment 9), was observed with higher growth attributes and yield attributes in Foxtail millet.

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