Effect of Nutrient management on growth and yield of foxtail millet

ABSTRACT

The field experiment was conducted during *ZAID* season 2023 at experimental field of Crop Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India. In the present study, Effect of nutrient management on growth and yield of foxtail millet. The treatments consisting of three levels of Recommended Dose of Fertilizer (RDF) *viz*., 100% RDF (60-30-30Kg/ha), 75% RDF (45-22.5-22.5 Kg/ha) and 50% RDF (30-15-15kg/ha) along with three different micro nutrients *viz*., Zinc - 0.5 kg/ha, Boron - 0.5 kg/ha and Iron - 0.5 kg /ha. There were 10 treatments each replicated thrice. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.3), available kg/ha). Results revealed that higher plant height (84.20 cm), plant dry weight (10.61 g), number of tillers/ hill (4.53), length of ears (9.20 cm), number of ears/plant (4.47), test weight (3.47 g), grain yield (1.22 t/ha), straw yield (2.80 t/ha) were recorded in treatment 8 (NPK 100% RD F + Boron 0.5 kg/ha). Maximum gross return (INR 48,408.33), net return (INR 30,913.33) and B:C ratio (1.77) were also recorded in treatment 8 (NPK 100% RDF + Boron 0.5 kg/ha) . It can be concluded that the application of NPK 100% RDF +Boron 0.5kg/ ha (Treatment 8)

Keywords: *Boron, Economics, Foxtail millet, Iron, zinc.*

nitrogen (278.93 kg/ha), available phosphorus (15.4 kg/ha) and available potassium (173.7

recorded higher yield and benefit cost ratio in foxtail millet.

1.INTRODUCTION

"Foxtail millet (*Setaria italica* L.) is known as Italian millet, German millet and Korralu, Kangu, Kangani, Koni and Kaon in different parts of India. It is one of the oldest crops cultivated for food, grain, hay and pasture. It ranks second in the total world production of millets and it continues to have an important place in world agriculture providing food for millions of people in arid and semiarid regions", Sahoo *et al*, (2020). "In India, Andhra Pradesh, Karnataka and Tamil Nadu are the major foxtail millet growing states. Foxtail millet has a very good nutritional profile and is a head of rice and wheat in terms of proteins, fiber, minerals, vitamins. It has good nutritive value, as it is rich in proteins (12.3g), Carbohydrates (60.9g), fat (4.3g), crude fiber (8.0g), calcium (3.1g). The grain is a good source of Beta carotene, which is the precursor of vitamin A" (Murugan and Nirmala ,2006). According to FAO, "the world production of millets is 89.17 million metric tonnes from an area of 74 million ha. India is the largest producer of millets in the world". "India is the global leader in production of millets with a share of around 15% of the world total production. In India, millets are cultivated majorly in 21 states in an area of
12.53 million hectares, producing 15.53 million tonnes with a yield of 1237 kg/ha" (Assocham, (2022). "In India area under the cultivation of small millets is 0.459 m. ha, production is 0.33 m. tons and its productivity is 809 kg/ha, Foxtail millet predominates all millets in terms of productivity, yielding about 2166 kg/ha" (GOI,2021-22).

"NPK fertilization practices increase fertilizer utilization efficiency, leading to optimal economic benefits. Thus, it is crucial to maintain a balanced supply of these essential nutrients to achieve optimal plant growth, development, and yield while minimizing the negative effects of excess or inadequate supply" (Manjunath and Debbarma, 2023).

“Zinc plays a vital role in biosynthesis of Indole Acetic Acid (IAA). It helps in formation of nucleic acids and synthesis of proteins”, (Manjunath and Debbarma, 2023).

“Boron plays an important role in the physiological process of plants, such as cell elongation, cell division, germination and growth of pollen grains, sugar translocation and movement of growth regulators within the plant, lignin synthesis, cell maturation, meristematic tissue development and protein synthesis. The application of boron also promotes the absorption of nitrogen from soil”. (Manjunath and Debbarma, 2023).

“Iron is important in many physiological and biochemical pathways in plants. It is required for a wide range of biological functions because it is a component of many vital enzymes, such as cytochromes of the electron transport chain. Iron is involved in the synthesis of chlorophyll in plants and is required for the maintenance of chloroplast structure and function” (Grace *et al*, 2023) .

2.MATERIALS AND METHODS

A field experiment was conducted during Zaid season of 2022-2023 at Crop research farm of Department of Agronomy at Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India. which is located 98 m altitude above the mean sea level. The soil of experimental plot was sandy loamy in texture, nearly neutral in soil reaction (pH 7.3), Low in available nitrogen, medium in available phosphorus and medium in available potassium. Were determined by Jackson’s method, Subbaiah and Asija’s method, Olsen’s method, flame photometer method , respectively .The experiments were laid out in Randomized Block Design with 10 treatments each replicated thrice *viz.*, T_1- NPK 50% RDF + Zinc 0.5 kg/ha, T_2 - NPK 50% RDF + Boron 0.5 kg/ha, T_3 - NPK 50% RDF +Iron 0.5 kg/ha, $T_{4,}$- NPK 75 % RDF+ Zinc 0.5 kg /ha, $T_{5,}$- NPK 75 % RDF+ Boron 0.5 kg /ha, T_6- NPK 75 % RDF+ Iron 0.5 kg /ha, $T_{7,}$ - NPK 100% RDF+ Zinc 0.5 kg/ha, T_8.- NPK 100% RDF+ Boron 0.5 kg/ha, T_9 - NPK 100% RDF+ Iron 0.5 kg/ha,T_{10}- 30 cm × 10 cm + RDF (control).The observations was recorded for plant height (cm), dry weight (g/plant), number of tillers, crop growth rate (g/m^2/day), relative growth rate (g/g/day), Number of ears /plant , length of ears (cm), no of grains/ears, Test weight (g), grain yield (t/ha), stover yield (t/ha), harvest index(%). The data were subjected to statistical analysis by analysis of variance method, at 5% probability (Gomez and Gomez, 1976).

3. RESULTS AND DISCUSSION

3.1 GROWTH PARAMETERS

3.1.1 Plant height (cm): At 80 DAS, [Table 1] higher plant height (84.20 cm) was recorded in treatment NPK 100% RDF + Boron 0.5 kg/ha. However, the treatment T_9 was found to be statistically at par with highest.This might be due to application of NPK and boron which increased the high photosynthetic activity and chlorophyll synthesis and application of boron forming a synergistic effect with nitrogen uptake which in turn enhances vegetative growth.

Similar results reported by Manjunath and Debbarma, (2023) in finger millet.

3.1.2 Plant dry weight: At 80 DAS, [Table 1] higher plant dry weight/plant (10.61 g) was recorded in treatment NPK 100% RDF + Boron 0.5 kg/ha. However, the treatment T_9 was found to be statistically at par with T_8. This was due to application of NPK and boron which is significantly increased plant dry weight. The main contribution of photosynthetic activity which improved the cell division and cell enlargement due to increased photo synthetic rate subsequently increasing the plant dry weight. Similar findings reported by Ravi raja *et al.*, (2020).

3.1.3 Number of tillers: At 80 DAS, [Table 1] higher no. of tillers/plant (4.53) was recorded in treatment NPK 100% RDF + Boron 0.5 kg/ha. However, the treatment $T_{1,}$ T_2, $T_{4,}$ T_6 was found to be statistically at par with $T_{8.}$ The number of tillers per plant were higher due to luxuriant availability of NPK and boron for growth and development of auxiliary buds from which tillers are emerged, rapid conversion of synthesized carbohydrates into protein and consequent increase in the number and size of growing cells, resulting ultimately in increased no. of tillers. Similar findings were reported by Sandhya *et al.*, (2017) in millets, Louthar *et al.*, (2020) in little millet.

3.2 Yield attributes

3.2.1 No. of ears/plant: At harvest, [Table 2] higher number of ears/plants (4.47) was recorded in treatment of application of NPK 100% RDF + Boron 0.5 kg/ha. This might be due to cumulative effect on growth and vigour of plants.With more fertilizer applied, growth characteristics may have significantly improved because to an enhanced supply of metabolites. It's possible that higher growth components brought about by higher fertilizer levels stabilized the higher supply of photosynthates going into the ear.Similar findings reported in pearl millet by Bahadur and S.K. Chauhan. (2014).

3.2.2 Length of ears: At harvest, [Table 2] higher Length of ear (cm) (9.20 cm) was recorded in treatment of application of NPK 100% RDF + Boron 0.5 kg/ha. However, the treatment $T_{7,}$ T_9 was statistically at par with treatment T_8. This might be due to the better supply of nutrients to the plants which increased the rapid growth and development. Thus, the plant received optimum nutrients produced the maximum length of ear. Similar findings reported in pearl

millet by Akhil *et al*., (2023) .

3.2.3 No. of Seeds/ear: At harvest, [Table 2] higher seeds/ears (262.47) was recorded in treatment of application of NPK 100% RDF + Zinc 0.5 kg/ha. However, the treatment $T_{4,}$ $T_{6,}$ T_8 was found to be statistically at par with $T_{7.}$ This might be due to be application of NPK favorably affected the balanced macro nutrients and zinc which acts as an activator of enzymes in plants and is directly involved in the biosynthesis of auxin which increased the seeds/ear. Similar findings reported by Swaroop *et al*., (2023).

3.2.4 Test weight (g): At harvest, [Table 2] higher test weight (3.47 g) was recorded in treatment of application of NPK 100% RDF + Boron 0.5 kg/ha. However, the treatment $T_{1,}$ $T_{3,}$ $T_{4,}$ $_{T5,}$ $T_{7,}$ T_9 was found to be statistically at par $T_{8.}$ The probable reason for increased test weight was mainly due to balanced supply of nutrients throughout the grain filling and development period which might have resulted in bold grains and consequently higher test weight. Similar findings reported in pearl millet by Kalaliya *et al*. (2022).

3.2.5 Grain yield (t/ha): At harvest, [Table 2] higher seed yield (1.22 t/ha) was recorded in treatment of NPK 100% RDF + Boron 0.5 kg/ha. Application of RDF and boron increased the concentration of nutrient ions in the soil solution and availability of sufficient nutrients might have helped in higher nutrient uptake. Which increased the growth and yield contributing characters like number of tillers, dry weight, number of seeds/ear and ear head length. which results in higher yield Mubeena *et al.*, (2019) .

3.2.6 Stover yield (t/ha): At harvest, [Table 2] higher stover yield (2.80 t/ha) was recorded in treatment of NPK 100% RDF + Boron 0.5 kg/ha. However, the treatment $T_{7,}$ T_9 was found to be statistically at par with $T_{8.}$ The straw yield increased due to better root activity and high physiological activities This was due to enhanced translocation of photosynthates from source to sink and induced growth as well as due to optimum doses of borax and NPK, improved vegetative growth, better root activity and high physiological activities. Similar findings reported in finger millet by Manjunath and Debbarma. (2023).

3.2.7 Harvest index (%): At harvest, [Table 2] higher Harvest index (30.30%) was recorded in treatment of NPK 100% RDF + Boron 0.5 kg/ha. However, the treatment $T_{1,}$ $T_{2,}$ $T_{3,}$ $T_{4,}$ $T_{5,}$ $T_{6,}$ was found to be statistically at par with T_8. Harvest index is directly correlated to the seed yield and haulm yield. Increased harvest index was due to better crop growth from early stages to at harvest. Better performance of crop from vegetative to reproductive stage.

3.3 Economics

3.3.1 Cost of cultivation: The cost of cultivation of foxtail millet was discussed in Table 3. The cost of cultivation (18,550.00 INR/ha) was found to be highest in control.

3.3.2 Gross returns: higher gross return (48,408.33 INR/ha) was recorded in treatment NPK 100% RDF + Boron 0.5 kg/ha.

3.3.3 Net returns: Significantly higher net return (30,913.33 INR/ha) was recorded in treatment NPK 100% RDF + Boron 0.5 kg/ha.

3.3.4 Benefit-cost ratio: Significantly higher benefit-cost ratio (1.77) was recorded under treatment treatments NPK 100% RDF + Boron 0.5 kg/ha.

3.4 CONCLUSION

Based on a above findings it is concluded that the application of NPK 100% along with Boron 0.5kg/ha in foxtail millet, performed better in growth and yield, and also proven profitable.

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Table :1. Effect of Nutrient management on growth attributes of foxtail millet

S. No	Treatment combinations	Plant height	Dry weight	No. of tillers
1.	NPK 50% RDF + Zinc 0.5 kg/ha	78.36	9.50	3.80
2.	NPK 50% RDF + Boron 0.5 kg/ha	78.60	9.75	3.67
3.	NPK 50% RDF + Iron 0.5 kg/ha	79.17	9.69	3.00
4.	NPK 75% RDF + Zinc 0.5 kg/ha	78.00	9.87	3.80
5.	NPK 75%RDF + Boron 0.5 kg/ha	76.53	9.63	3.00
6.	NPK 75% RDF + Iron 0.5 kg/ha	77.25	9.66	3.53
7.	NPK 100% RDF + Zinc 0.5 kg/ha	80.89	10.32	2.67
8.	NPK 100% RDF + Boron 0.5 kg/ha	84.20	10.61	4.53
9.	NPK 100% RDF + Iron 0.5 kg/ha	83.12	10.50	3.00
10.	Control (N, P, K - 60 , 30,30 Kg/ha)	76.47	9.56	2.67
	S. Em (±)	1.06	0.14	0.52
	CD (p = 0.05)	3.16	0.44	1.57

Table:2. Effect of Nutrient management on yield attributes and yield of foxtail millet

S.No	Treatment combination	At harvest						
		No. of ears/plant	Length of ears (cm)	No. of seeds/ear	Test weight (g)	Grain yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
1.	NPK 50% RDF + Zinc 0.5 kg/ha	4.07	8.33	242.27	3.37	1.03	2.45	29.52
2.	NPK 50% RDF + Boron 0.5 kg/ha	3.93	8.13	241.13	2.80	0.85	2.18	28.18
3.	NPK 50% RDF + Iron 0.5 kg/ha	4.13	8.27	243.87	3.10	0.94	2.29	29.23
4.	NPK 75% RDF + Zinc 0.5 kg/ha	4.07	8.27	251.87	3.17	0.86	2.43	26.17
5.	NPK 75%RDF + Boron 0.5 kg/ha	4.07	8.40	243.07	3.10	0.95	2.39	28.61
6.	NPK 75% RDF + Iron 0.5 kg/ha	4.00	8.17	254.67	2.90	0.96	2.26	29.83
7.	NPK 100% RDF + Zinc 0.5 kg/ha	4.07	8.87	262.47	3.23	1.10	2.71	28.85
8.	NPK 100% RDF + Boron 0.5 kg/ha	4.47	9.20	258.87	3.47	1.22	2.80	30.30
9.	NPK 100% RDF + Iron 0.5 kg/ha	4.00	9.00	245.27	3.10	0.95	2.64	26.51
10.	Control (N, P, K- 60, 30,30 Kg/ha)	4.13	8.27	246.20	2.60	0.88	2.16	28.99
	S. Em (±)	0.08	0.21	4.39	0.16	0.03	0.12	1.19
	CD (p = 0.05)	0.25	0.63	13.06	0.49	0.10	0.38	-

Table 3: Effect of Nutrient management on economics of foxtail millet

S.no	Treatment combination	Cost of cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C ratio
1.	NPK 50% RDF + Zinc 0.5 kg/ha	17,350.00	42,066.67	24,716.67	1.42
2.	NPK 50% RDF + Boron 0.5 kg/ha	174,95.00	35,308.33	17,813.33	1.02
3.	NPK 50% RDF + Iron 0.5 kg/ha	168,30.00	38,625.00	21,795.00	1.30
4.	NPK 75% RDF + Zinc 0.5 kg/ha	168,00.00	36,050.00	19,250.00	1.15
5.	NPK 75%RDF + Boron 0.5 kg/ha	174,95.00	39,100.00	21,605.00	1.23
6.	NPK 75% RDF + Iron 0.5 kg/ha	169,00.00	39,133.33	22,233.33	1.32
7.	NPK 100% RDF + Zinc 0.5 kg/ha	173,50.00	45,283.33	27,933.33	1.61
8.	NPK 100% RDF + Boron 0.5 kg/ha	174,95.00	48,408.33	30,913.33	1.77
9.	NPK 100% RDF + Iron 0.5 kg/ha	182,00.00	39,850.00	21,650.00	1.19
10.	Control (N, P, K- 60, 30,30 Kg/ha)	185,50.00	37,033.33	18,483.33	1.00