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Influence of Nitrogen and Iron on Yield and Economics of Foxtail Millet (*Setaria italica* L.)

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ABSTRACT

A field experiment was conducted during *zaid* season (April - July) 2022 at experimental field of Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India. The treatments consist of 3 levels of nitrogen (40 kg, 50 kg, 60 kg/ha) applied in 2 doses (Basal and 20 DAS) and foliar application of Iron (0.2, 0.4, 0.6%) at 30, 45 DAS along with control. The experiment was layout in Randomized Block Design with ten treatments each replicated thrice. The treatment combinations are T_1- 40 kg N + 0.2% Iron, T_2- 40 kg N + 0.4% Iron, T_3- 40 kg N + 0.6% Iron, T_4- 50 kg N + 0.2% Iron, T_5- 50 kg N + 0.4% Iron, T_6- 50 kg N + 0.6% Iron, T_7- 60 kg N + 0.2% Iron, T_8- 60 kg N + 0.4% Iron, T_9- 60 kg N + 0.6% Iron, T_{10}- Control (RDF: 50:30:20 NPK kg/ha). Significantly higher plant height (101.57 cm), maximum plant dry weight (14.83 g), more number of tillers per plant (8.87) and yield attributes namely higher panicle length (18.61 cm), grains per panicle (1389.30), grain yield (1.79 t/ha), straw yield (2.53 t/ha), maximum gross return (88180.00 INR/ha), net return (60638.00 INR/ha) and benefit cost ratio (2.20) were obtained highest in the treatment 9, with the application of 60 kg/ha Nitrogen and 0.6% Iron.

Keywords Foxtail millet, Nitrogen, Iron, Yield attributes, Yield, Economics.

INTRODUCTION

It is the second most widely planted species of millet and the most important in East Asia. This is extensively grown in the arid and semi-arid regions of Asia and Africa and as well as in some other economically developed countries of the world (Sathisha *et al.* 2019). Worldwide production of millets is 89.17 mm tons from an area of 74.00 mha in 2020. 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. Agricultural statistics at a glance : Ministry of Agriculture, Government of India, New Delhi 2022. In terms of protein, fiber, minerals, and vitamins, foxtail millet has a superior nutritional profile compared to rice and wheat. It has good nutritive value as it is rich in proteins (12.3 g), carbohydrates (60.9 g), fat (4.3 g), crude fiber (8.0 g), calcium (3.1 g), vitamins

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and thiamin (50 mg) per100 g. The grains are a good source of Beta-carotene, antioxidants, dietary fiber and minerals like Ca, Fe, Mg, Z (Murugan and Nirmala 2006). One of the world's oldest crops, foxtail millet is mostly grown in arid and semi-arid regions of Asia and Africa, as well as in some other economically developed nations where it is more frequently used for bird feed (Swaroop and Debbarma 2023).

The most crucial role of N in the plant is its presence in the structure of the protein, the most important building substance from which the living material or protoplasm of every cell is made (Bhatta *et al.* 2020). In addition, "nitrogen is also found in chlorophyll, the green coloring matter of leaves. Nitrogen occupies a conspicuous place in plant metabolism. All vital processes in the plant are associated with protein, of which nitrogen is an essential constituent (Singh *et al.* 2019). Although increased N application has resulted in higher yields, the relationship is not linear, it is necessary to determine the optimal economic application for each cultivar in order to balance the expense of extra N inputs with incremental yield growth. The availability of N affects crop development, including seedling emergence, tillering, canopy formation, and grain filling, all of which have the potential to effect eventual production and set the crop's nutritional needs (Koppu *et al.* 2022).

Iron (Fe) is present at high quantities in soils but its availability to plants is usually low and therefore Fe deficiency is common problem. It helps in formation of chlorophyll and its an important constituent of enzyme nitrogenase, which is essential for nitrogen fixation. It has an essential role in nucleic acid metabolism. It activates number of enzymes, including aminolevolinic acid synthetase and coproporphyrinagen oxidase and a structural component of hemes, hematin, and leg hemoglobin (Sunnam *et al*. 2020).

MATERIALS AND METHODS

The experiment was conducted during *zaid* season 2022 at crop research farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (UP). The soil of the experimental field constituting a part of central Gangetic alluvium is neutral and deep. Pre-sowing soil samples were taken from a depth of 15 cm with the help of an auger. The composite samples were used for the chemical and mechanical analysis. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.8), low in organic carbon (0.62%), available nitrogen (225 kg/ha), available phosphorus (38.2 kg/ha) and available potassium (240.7 kg/ha). The treatments consist of Nitrogen 40 kg/ha, 50 kg/ha, 60 kg/ha and foliar application of iron ($FeSO_4$) 0.2%, 0.4%, 0.6% at 30, 45 days after sowing. The data recorded on different aspects of crop like yield attributes and yield and were subjected to statistical analysis by variance method and economics was also calculated.

RESULTS

At harvest, Table 1 the data recorded highest panicle length (18.61 cm) in treatment 9 (N at 60 kg/ha + 0.6% Iron). However, treatment 8 (N at 60 kg/ha + 0.4% Iron) (18.19 cm) was statistically at par

Table 1. Effect of nitrogen and iron on yield attributes and yield of foxtail millet.

Sl. No.	Treatment combinations	Panicle length (cm)	Grains/ panicle (cm)	Grain yield (t/ha)	Straw yield (t/ha)
1	N at 40 kg/ha + 0.2% Iron	16.19	1220.00	1.43	2.14
2	N at 40 kg/ha + 0.4% Iron	16.32	1223.80	1.47	2.17
3	N at 40 Kg/ha + 0.6% Iron	16.45	1240.90	1.48	2.20
4	N at 50 kg/ha + 0.2% Iron	16.74	1255.27	1.50	2.21
5	N at 50 kg/ha + 0.4% Iron	17.23	1276.33	1.54	2.27
6	N at 50 kg/ha + 0.6% Iron	17.51	1299.57	1.61	2.30
7	N at 60 kg/ha + 0.2% Iron	17.83	1316.73	1.69	2.36
8	N at 60 kg/ha + 0.4% Iron	18.19	1337.97	1.76	2.46
9	N at 60 kg/ha + 0.6% Iron	18.61	1389.30	1.79	2.53
10	Control (50:30:20 NPK kg/ha)	16.34	1222.47	1.46	2.16
F-test		S	S	S	S
SEm (±)		0.20	17.54	0.02	0.03
CD (p = 0.05)		0.60	52.12	0.07	0.08

Table 2. Effect of nitrogen and iron on economics of foxtail millet.

Sl. No.	Treatment combinations	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net returns (INR/ha)	BC ratio (B:C)
1	N at 40 kg/ha + 0.2% Iron	26722.00	71775.00	45053.00	1.68
2	N at 40 kg/ha + 0.4% Iron	27002.00	73200.00	46198.00	1.71
3	N at 40 kg/ha + 0.6% Iron	27282.00	74145.00	46863.00	1.71
4	N at 50 kg/ha + 0.2% Iron	26852.00	74940.00	48088.00	1.79
5	N at 50 kg/ha + 0.4% Iron	27132.00	76645.00	49513.00	1.82
6	N at 50 kg/ha + 0.6% Iron	27412.00	79490.00	52078.00	1.89
7	N at 60 kg/ha + 0.2% Iron	26982.00	82925.00	55943.00	2.07
8	N at 60 kg/ha + 0.4% Iron	27262.00	86385.00	59123.00	2.16
9	N at 60 kg/ha + 0.6% Iron	27542.00	88180.00	60638.00	2.20
10	Control (50: 30:20 NPK kg/ha)	26572.00	72985.00	46413.00	1.74

with treatment 9. More grains/panicle (1389.30) in treatment 9 (N at 60 kg/ha + 0.6% Iron). However, treatment 8 (N at 60 kg/ha + 0.4% Iron) (1337.97) was statistically at par with treatment 9. Higher grain yield (1.79 t/ha) in treatment 9 (N at 60 kg/ha + 0.6% Iron). However, treatment 8 (N at 60 kg/ha + 0.4% Iron) (1.76 t/ha) was statistically at par with treatment 9. Higher stover yield (2.53 t/ha) in treatment 9 (N at 60 kg/ha + 0.6% Iron). However, treatment 8 (N at 60 kg/ha + 0.4% Iron) (2.46 t/ha) was statistically at par with treatment 9.

Economics

Table 2 Gross return (88180.00 INR/ha), Net return (60638.00 INR/ha) and Benefit cost ratio (2.20) was found to be highest in treatment 9 N at 60 kg/ha + 0.6% Iron.

DISCUSSION

Higher number of grains per panicle might due to the application of nitrogen increases the fertility of flowers and increase in leaf area and duration and resulted into increase in supplying assimilates for the sink (Kakarla *et al.* 2021). Nitrogen application increases the activity of cytokinins in plant which leads to the increased cell-division and elongation. Nitrogen is a component of porphyrins of chloroplasts and hence, increased nitrogen fertilization increased the growth and yield of crop due to increased photosynthates production (Buduri *et al.* 2020). Increase in nitrogen supply might have increased all the growth parameters, yield attributing characters which ultimately contributed to increase in yields (Reddy *et al.* 2016). The transition of tissue diffrentiative from somatic to reproductive meristemic activity and development of floral primordial may have accelerated with an increase in nitrogen availability, leading to the lengthening of the ear head. Due to per unit cost of nitrogen is lower when supplied through urea as compared to other sources which directly reflect the net returns and B/C ratio (Surya *et al.* 2020). Beneficial effects of nitrogen on cell division and elongation, formation of nucleotides and co-enzymes which resulted in increased meristematic activity and photosynthetic area and hence more production and accumulation of photosynthates, yielding higher green fodder and dry matter (Mane and Singh 2017). Crops supplied with adequate nutrients have more vegetative growth, longer linear growth rate and more dry matter accumulation which directly related to an increment in stover yield (Gebreslassie Hailu, Mohammed 2022). Iron also helps in the proliferation of roots and thereby increasing the uptake of the plants nutrients from the soil supplying in to the aerial parts of the plant and ultimately enhancing the vegetative growth of the plant (Maharana and Singh 2021). Iron role in starch formation and protein synthesis as well as maintenance and synthesis of chlorophyll in plants (Vaja *et al.* 2020). Foliar applications of Fe may be necessary to increase yields due to their vital role in crop growth, involvement in photosynthetic processes, respiration, and other biochemical and physiological activities (Divya *et al.* 2021). Iron plays major role in vigorus growth due to cellular growth, differentiation and metabolic changes in plants and it was attributed with high yield attributes and grain yield (Surya *et al.* 2022).

CONCLUSION

From the results, it is concluded that with the application of Nitrogen 60 kg/ha along with foliar application of 0.6% Iron at 30, 45 DAS in foxtail millet produced higher yield attributes, yield and B: C ratio.

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REFERENCES

Bhatta RD, Amgain LP, Subedi R, Kandel BP (2020) Assessment of productivity and profitabilty of wheat using Nutrient expert. *Heliyon* 6:04144. https://doi.org/10.1016/j. heliyon. 2020.e04144.

Buduri B, Marri P, Dawson J (2020) Effect of levels of nitrogen and potassium on growth and yield of pearl millet (*Pennisetum glaucum* L.). *Int J Curr Microbiol Appl Sci* 9 (11) : 2194—2197. https://doi.org/10.20546/ijcmas.2020.911.261.

Divya SB, Singh R, Wasim K (2021) Effect of foliar application of iron and zinc on yield and economics of finger millet (*Eleusine coracana* L). *The Pharma Innov J* 10 (4) : 897—899.

Gebreslassie H, Mohammed K (2022) Effect of nitrogen and phosphorus fertilizer rates on yield and yield components sorghum (*Sorghum bicolor* L. Moench) at Kersa Woreda of Oromia region. *Int J Bioorganic Chem* 7(1): 23—29.

GOI (2022) Agricultural Statistics at a Glance: Ministry of Agriculture, Government of India, New Delhi.

Kakarla R, Umesha C, Balachandra Y (2021) Influence of nitrogen and zinc levels on pearl millet (*Pennisetum glaucum* L.). *Biological Forum – An Int J* 13 (1) : 128—132.

Koppu G, Singh R, Thakur I (2022) Effect of nitrogen and sulfur on growth and yield of wheat (*Triticum aestivum* L.). *Int J Pl Soil Sci* 34 (22) : 769—773. https://doi.org/10.9734/ijpss/2022/v34i2231433.

Maharana S, Singh S (2021) Effect of iron and zinc on growth and yield of pearl millet (*Pennisetum glaucum* (L.)). *The Pharma Innov J* 10 (10) : 546—550.

Mane S, Singh R (2017) Effect of planting geometry and different levels of nitrogen on growth, yield and quality of multicut fodder sorghum (*Sorghum bicolor* (L.) Monech). *J Pharmacog Phytochem* 6 (4) : 896—899.

Murugan R, Nirmala KA (2006) Genetic divergence in foxtail millet. (*Setaria italica* (L.) Beauv). *Ind J Genet* 66 (4) :339—340.

Reddy BPS, Madhuri KVN, Keerthi V, Prathima T (2016) Effect of nitrogen and potassium on yield and quality of pearl millet (*Pennisetum glaucum* L.). *Int J Agric Innov Res* (4) : In press.

Sathisha GS, Desai BK, Satyanarayana R, Latha HS, Yogesh LN (2019) Effect of agronomic fortification of zinc and iron on growth parameters and yield of foxtail millet (*Setaria italica* (L.)) genotypes. *J Pharmacog Phytochem* 8 (3) : 2753—2756.

Singh G, Santosh K, Singh G, Singh N (2019) Effect of integrated nutrient management on nutrient uptake and grain yield of wheat (*Triticum aestivum* L.) under irrigated conditions. *J Pharmacog Phytochem* 8(1):1077—1080.

Sunnam HK, Dawson J, Kiran PS, Vyas VV (2020) Effect of iron and zinc levels on growth and yield of chickpea (*Cicer arietinum* L.). *Int J Curr Microbiol Appl Sci* 9 (11) : 2882—2886. https://doi.org/10.20546/ijcmas.2020.911.348.

Surya K, Sanbagavalli S, Somasundaram E, Renukadevi A, Panneerselvam S (2022) Effect of potassium and foliar nutrition on yield and economics of kodo millet under irrigated condition. *Biol Forum – An Int J* 14 (3) : 42—46.

Surya TSJV, Umesha C, Sunil K, Mohan PJ (2020) Effect of nitrogen and zinc levels on growth and economics of sorghum (*Sorghum bicolor* L. Moench). *Int J Chem Studies* 8 (6) : 125—127.

Swaroop BT, Debbarma V (2023) Effect of organic manures and zinc on growth, yield and economics of foxtail millet (*Setaria italica* L.). *Int J Environ Climate Change* 13 (8) : 344—351. https://doi.org/10.9734/ijecc/2023/v13i81958.

Vaja RP, Bhuva HM, Mokariya LK, Jani CP (2020) Effect of zinc and iron fortification on growth and yield of summer pearl millet (*Pennisetum glaucum* (L.) R. Br. Emend. Stuntz). *Int J Curr Microbiol Appl Sci* 9 (10) : 2699—2704. https://doi.org/10.20546/ijcmas.2020.910.326.