Effect of Nitrogen and Iron on Growth and Yield of Foxtail millet (*Setariaitalica*L.)

ABSTRACT:

The ~~Field~~ field experiment was conducted during *Zaid* season 2022 at the experimental field of Crop Research Farm, Department of Agronomy, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology, and Sciences, Prayagraj and Uttar Pradesh, India. The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.3), low in organic carbon (0.48%), available nitrogen (230 kg/ha), available phosphorus (13.60 kg/ha) and available potassium (215.4 kg/ha). The treatments consist of 3 levels of Nitrogen (40 Kg, 50 Kg, 60 Kg/ha) as a basal application and Iron (0.2, 0.4, and ~~0.6~~0.6 %) as foliar spray along with control. The experiment was layout in Randomized Block Design with Ten treatments each replicated thrice. Growth attributes namely higher plant height (101.57cm), maximum dry weight/plant (14.83 g), more number of tillers/hill (8.87) and yield attributes namely higher panicle length (18.61 cm), grains/panicle (1389.30), grain yield (17.96q/ha) and straw yield (25.32q/ha) were observed with application of nitrogen 60Kg/ha and iron 0.6%.

Keywords: ***Foxtail millet, Nitrogen, Iron, Growth Parameters, Yield attributes, Yield.***

Introduction:

Foxtail millet (*Setariaitalica* L.) is one of the oldest cultivated millets and the most economically important species of the genus Setaria. 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. It is native to China and regarded as an elite, drought-tolerant crop. In India, Andhra Pradesh, Karnataka, and Tamil Nadu are the three major foxtail miller growing states, contributing about 79 per cent of the total cultivated area of about 6 lakh hectares, with a production of 3 lakh tons and a productivity of 602 Kg/ha during 2017-2018. It has a total production of 2.29 mt from an area of 1.057 mha around the world. Foxtail millet (*Setaria italica* L.) is one of the oldest cultivated millet and mosteconomically important species of the genus Setaria. It ranks second in the total world production ofmillets and it continues to have an important place in world agriculture providing food for millions ofpeople in arid and semiarid regions. It is native to China and regarded as an elite drought-tolerant crop. In India, Andhra Pradesh, Karnataka and Tamil Nadu are the major foxtail miller growing statescontributing about 79 per cent of the total cultivated area of about 6lakhhectareswithproductionof3lakhtonesandproductivityof602Kg/haduring 2017-2018. It has the total productionof 2.29 m.t from the area of 1.057 m.ha in the world. Foxtail millet has a very good nutritional profile and is ahead of rice and wheat in terms of protein, fiber, minerals, and vitamins. It has good nutritional values: proteins (12.3 g), carbohydrates (60.9 g), fat (4.3 g), crude fiber (8.0 g), calcium (3.1 g), vitamins, and thiamin (50 mg) per 100 g. About 8–14% of the oil being extracted from the bran of foxtail millet can be used as oil after refinement **Munirathnam*et al*., 2006**. Unlike rice, foxtail millet releases glucose slowly without affecting the metabolism of the human body because of its low glycericindex. Foxtail millet has a very good nutritional profile and is ahead of rice and wheat in terms ofprotein, fiber, minerals and vitamins. It has good nutritive values, proteins (12.3 g),carbohydrates (60.9 g), fat (4.3 g), crude fiber (8.0 g), calcium (3.1 g), vitamins and thiamin (50 mg)per100g.About 8-14% oil is being extracted from the bran of foxtail millet, whichcan be used as oil after refinement **Munirathnam *et al*., 2006**. Unlike rice, foxtail millet releaseglucoseslowlywithoutaffectingthemetabolismofthehumanbodywithlowglycericindex.

Nitrogen is one of the most important fertilizers for crop growth and is widely used in the farming community. Nitrogen is required for the formation of amino acids, proteins, nucleic acids, enzymes, co-enzymes, and alkaloids. In the presence of solar energy, nitrogen containing chlorophyll fixes atmospheric carbon dioxide as carbohydrates, improving crop quality. Nitrogen fertilization improves food grain protein quality by increasing the proportion of glutamic acid. Grain should contain more proline and methionine and less Lysine and Lucine.Nitrogen is one of the most important fertilizer for crop growth and is widely used in the farming community. Nitrogen is required for the formation of amino acids, proteins, nucleic acids, enzymes, co-enzymes, and alkaloids. In the presence of solar energy, nitrogen containing chlorophyll fixes atmospheric carbon dioxide as carbohydrates, improving crop quality. Nitrogen fertilization improves food grain protein quality by increasing the proportion of glutamic acid. grains should contain more proline, methionine, and less Lysine and Lucine.

Iron is a micronutrient that is required by almost all living organisms because it is involved in metabolic processes such as DNA synthesis, respiration, and photosynthesis. Iron also activates many metabolic pathways and is a prosthetic group constituent of many enzymes. The primary causes of iron chlorosis are an imbalance between the solubility of iron in soil and the plant's demand for iron. Although abundant in most well-aerated soils, iron has low biological activity because it forms highly insoluble ferric compounds at neutral pH levels. 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. **Rout and Sahoo, 2015.**

Materials and Methods

In order to study the two micronutrients with foliar spray, Iron and Silicon were taken. The experiment was conducted during *Zaid* 2022 at the Crop Research Farm, Naini Agricultural Institute, SHUATS, Prayagraj. The experimental site of the study is geographically located at 25.28^{o}N latitude, 81.54^{o}E longitude, and 98 m altitude above the mean sea level (MSL). The soil of the experimental field, which is a part of the 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 analyses. The treatments consist of basal applications of nitrogen (40, 50, 60 Kg/ha) and foliar sprays of iron (0.2, 0.4, 0.6%). The experiment was layout in a randomized block design with ten treatments, each replicated thrice and a control, i.e., recommended N, P, and K (50:30:20 Kg/ha). In order to study the two micronutrients with foliar spray, Iron and Silicon were taken. The experiment was conducted at during *Zaid* 2022, at Crop Research Farm, Naini Agricultural Institute, SHUATS, Prayagraj. The experimental site of the study is geographically located at 25.28°N latitude, 81.54°E longitude and 98 m altitude above the mean sea level (MSL). 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 treatments consist of basal application of nitrogen (40, 50, 60 Kg/ha) and foliar spray of iron (0.2, 0.4, 0.6%). The experiment was layout in randomized block design with ten treatments each replicated thrice and control i.e., recommended N, P and K (50:30:20 Kg/ha).The plots were prepared with a dimension of 3m × 3m and seeds were sown with a spacing of 30cm × 10cm. At 14 DAS, plants were thinned to maintain an appropriate plant density. Weeds were controlled manually at 12 and 21 DAS with the help of Khurpi to minimize crop weed competition. Growth characteristics, namely plant height (cm), dry weight (g), and number of tillers/hill, were recorded. Irrigations were given uniformly and regularly to all plots as per requirement so as to prevent the crop from water stress at any stage. The crop was harvested at the right physiological maturity stage, and their post-harvest observations such as panicle length (cm), grains/panicle, grain yield (t/ha), and straw yield (t/ha) were recorded. The data recorded for different characteristics were subjected to statistical analysis by adopting the method of analysis of variance (ANOVA) as described by Gomez (1984). The crop was harvested separately from each plot, taking up 1.0 m^2 area i.e., 80 DAS. Thereafter, the produce from the netted plot was tied in separate bundles and then tagged. The tagged bundles were allowed for sun drying in the field, and after drying on the threshing floor, the weight of the bundles was recorded for obtaining the biological yield. The threshing of foxtail millet was done manually by beating it with a stick, and then the seeds were separated by winnowing.The plots were prepared with dimension of 3m × 3m and seeds were sown with a spacing of 30cm × 10cm.At 14 DAS plants were thinned to maintain appropriate plant density. Weeds were controlled manually at 12, 21 DASwith the help of Khurpi to minimize crop weed competition. Growthcharacteristics namely plant height (cm), dry weight (g), number of tillers/hill, were recorded. Irrigations were given uniformly and regularly to all plots as per requirement so as to prevent the crop from water stress at any stage. The crop was harvested at right physiological maturity stage and their post-harvest observations such as panicle length (cm), grains/panicle, grain yield

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Resultsand Discussions

Growth parameters

Table.1 Pertaining the details of effect of nitrogen and ironon growth parameters of foxtail millet.

Plant height (cm)

At harvest, higher plant height (101.57 cm) was recorded significantly in treatment no. 9 [N at 60 kg/ha + 0.6% Iron]. However, treatment no. 8 [N at 60 kg/ha + 0.6% Iron] (100.65 cm) was found to be statistically at far with treatment no. 9.

Nitrogen application might have resulted in cell elongation and increased chlorophyll content and net photosynthetic rate, which attributed to the increase in plant height. Similar findings were reported by **Venkataramon*et al.*, 2000**.

The increased availability of iron to plants might have stimulated the metabolic and enzymatic activities, resulting in an increase in the growth of the crop. Similar findings were also reported by **Yadav *et al.*, 2013.**

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Dry weight (g)

At harvest, maximum plant dry weight (14.83 g) was significantly higher in treatment no. 9 [N at 60 kg/ha + 0.6% Iron]. However, treatment no. 8 [N at 60 kg/ha + 0.4% Iron] (14.62 g) was found to be statistically at far with treatment no. 9.

Nitrogen is the main component of the protoplasm, which is involved in metabolic processes like photosynthesis, cell division, and cell elongation. Which have contributed to the increase in the dry matter accumulation. Similar findings are reported by **Rekha and Prasad 2020.**

Number of tillers/hill

At harvest, more tillers/hill (8.87) were recorded significantly in treatment no. 9 [N at 60 kg/ha + 0.6% Iron]. However, treatment no. 8 [N at 60 kg/ha + 0.4% Iron] (8.80) was found to be statistically at far with treatment no. 9.

Nitrogen is involved in the development of strong cell walls and consequently, straw, which might result in increased tillering. Similar findings were reported by **Ayub*et al.*, 2007.**

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Iron is involved in chlorophyll synthesis, grain formation, and dry matter production, which ultimately lead to final yield characteristics such as the number of effective tillers per plant. Similar findings were reported by **Gupta *et al.*, 2002**.

Yield attributes

Table.2 Pertaining the details of the effect of nitrogen and iron on the yield attributes of foxtail millet.

Panicle length (cm)

Panicle length was significantly influenced by the application of nitrogen and iron. At harvest, the data recorded the highest panicle length (18.61 cm) in treatment no. 9 [N at 60 kg/ha + 0.6% Iron]. However, treatment no. 8 [N at 60 kg/ha + 0.4% Iron] (18.19 cm) was statistically at par with treatment no. 9.

Application of nitrogen fertilizer at the right time improves the rate of photosynthesis, root growth and development, and elongation of structural tissues such as the stalk in cereals.Similar findings were reported by **Pandey and Sinha 2010.**

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Grains/panicle

The data of grains/panicle were significantly influenced by the application of nitrogen and iron. At harvest, the data recorded more grains/panicle (1389.30) in treatment no. 9 [N at 60 kg/ha + 0.6% Iron]. However, treatment no. 8 [N at 60 kg/ha + 0.4% Iron] (1337.97) was statistically at par with treatment no. 9.

A higher number of grains/panicle might be due to the application of nitrogen, which increases the fertility of flowers and increases leaf area and duration and results in an increase in supplying assimilates for the sink. Similar findings were reported by **Mousavi *et al*.2012.**

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Grain yield (q/ha)

The data on grain yield was significantly influenced by nitrogen and iron. At harvest, the data recorded a higher grain yield (17.96 q/ha) in treatment no. 9 [N at 60 kg/ha + 0.6% Iron]. However, treatment no. 8 [N at 60 kg/ha + 0.4% Iron] (17.65 q/ha) was statistically at par with treatment no. 9.

Nitrogen being a major nutrient that increases grain yield as well as improves root growth and development owing to all physicochemical processes impacted. Similar findings were reported in 2009 by **Ayub*et al*. 2009.**

Iron plays a major role in the biosynthesis of IAA, especially due to its role in the initiation of the primordial reproductive part and the portioning of photosynthetic towards them, which promotes the yield. A similar result was also observed by **Rao et *al*. 2019.**

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Straw yield (q/ha)

The data on stover yield was significantly influenced by nitrogen and iron. At harvest, the data recorded a higher stover yield (25.32 q/ha) in treatment no. 9 [N at 60 kg/ha + 0.6% Iron]. However, treatment no. 8 [N at 60 kg/ha + 0.4% Iron] (24.61 q/ha) was statistically at par with treatment no. 9.

More uptake of nutrients by nitrogen probably improved the growth and development of crops, resulting in improved fodder yield. Similar findings were reported by **Tiwana*et al.* 2004.**

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Conclusion

By the above study, we suggest that higher plant height (101.57 cm), a higher maximum dry weight (14.83 g), and a higher number of tillers/ hill (8.87) were recorded in treatment no. 9 with application of Nitrogen 60 kg/ha with a combination of Iron 0.6%. Maximum yield attributes, *viz.*, panicle length (18.61 cm), grains/ panicle (1389.30), grain yield (1.79 t/ha), and straw yield (2.53 t/ha) were recorded in treatment no. 9 with the application of Nitrogen 60 kg/ha and Iron 0.6%.By the above study we suggest that higher plant height (101.57 cm), maximum dry weight (14.83 g), more number of tillers/ hill (8.87) was recorded in treatment no.9 with application of Nitrogen 60 Kg/ha with combination of Iron 0.6%. Maximum yield attributes *viz.*, panicle length (18.61 cm), grains/ panicle (1389.30), grain yield (1.79 t/ha), straw yield (2.53 t/ha) were recorded in treatment no.9 with the application of Nitrogen 60 Kg/ha and Iron 0.6%.

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

Sl No.	Treatment combination	Plant height (cm)	Dry weight (g)	No. of tillers/hill	CGR ($g/m^2/day$)	RGR (g/g/day)
1.	N 40Kg/ha + 0.2% Iron	90.80	12.51	7.20	8.39	0.024
2.	N 40Kg/ha + 0.4% Iron	91.47	12.65	7.33	7.92	0.023
3.	N 40Kg/ha + 0.6% Iron	92.64	12.98	7.33	8.28	0.023
4.	N 50Kg/ha + 0.2% Iron	93.90	13.25	7.47	8.11	0.022
5.	N 50Kg/ha + 0.4% Iron	94.83	13.60	8.13	7.54	0.019
6.	N 50Kg/ha + 0.6% Iron	97.03	13.85	8.33	7.88	0.020
7.	N 60Kg/ha + 0.2% Iron	99.15	14.35	8.40	8.28	0.020
8.	N 60Kg/ha + 0.4% Iron	100.65	14.62	8.80	8.16	0.020
9.	N 60Kg/ha + 0.6% Iron	101.57	14.83	8.87	7.96	0.018
10.	Control (RDF-50:30:20 NPK Kg/ha)	91.20	13.19	7.27	9.16	0.026
	F Test	S	S	S	NS	NS
	SEm (±)	0.35	0.07	0.08	0.30	0.094
	CD (p=0.05)	1.04	0.21	0.23	-	-

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

Sl No.	Treatment combination	Yield attributes and Yield					
		Panicle length (cm)	Grains/panicle (no.)	Test weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)
1.	N 40Kg/ha + 0.2% Iron	16.19	1220.00	3.00	1.43	2.14	40.19
2.	N 40Kg/ha + 0.4% Iron	16.32	1223.80	3.19	1.47	2.17	40.36
3.	N 40Kg/ha + 0.6% Iron	16.45	1240.90	3.22	1.48	2.20	40.31
4.	N 50Kg/ha + 0.2% Iron	16.74	1255.27	3.23	1.50	2.21	40.13
5.	N 50Kg/ha + 0.4% Iron	17.23	1276.33	3.32	1.54	2.27	40.48
6.	N 50Kg/ha + 0.6% Iron	17.51	1299.57	3.33	1.61	2.30	41.14
7.	N 60Kg/ha + 0.2% Iron	17.83	1316.73	3.39	1.69	2.36	41.78
8.	N 60Kg/ha + 0.4% Iron	18.19	1337.97	3.46	1.76	2.46	41.75
9.	N 60Kg/ha + 0.6% Iron	18.61	1389.30	3.50	1.79	2.53	41.50
10.	Control (RDF-50:30:20 NPK Kg/ha)	16.34	1222.47	3.21	1.46	2.16	40.40
	F Test	S	S	NS	S	S	NS
	SEm (±)	0.20	17.54	0.10	0.24	0.41	0.59
	CD (p=0.05)	0.60	52.12	-	0.71	1.23	-