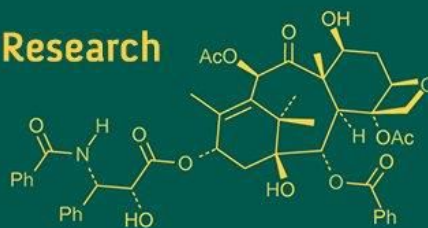
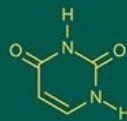
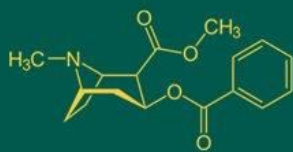


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Effect of spacing and nitrogen on yield and economics of foxtail millet (*Setaria italica* L.)

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Abstract

The field experiment was conducted during *kharif* season 2023 at the 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 experiment was layout in Randomized Block Design with ten treatments each replicated thrice. The treatment combinations are mentioned as T₁ - 25 cm x 10 cm spacing + 30 kg/ha nitrogen, T₂ - 25 cm x 10 cm spacing + 40 kg/ha nitrogen, T₃ - 25 cm x 10 cm spacing + 50 kg/ha nitrogen, T₄ - 30 cm x 10 cm spacing + 30 kg/ha nitrogen, T₅ - 30 cm x 10 cm spacing + 40 kg/ha nitrogen, T₆ - 30 cm x 10 cm spacing + 50 kg/ha nitrogen, T₇ - 35 cm x 10 cm spacing + 30 kg/ha nitrogen, T₈ - 35 cm x 10 cm spacing + 40 kg/ha nitrogen, T₉ - 35 cm x 10 cm spacing + 50 kg/ha nitrogen, T₁₀ - Control (NPK 40:20:20 kg/ha). The application of 35 cm x 10 cm spacing + 40 kg/ha nitrogen recorded significantly maximum number of seeds/ear head (181.33), test weight (2.50 g), grain yield (1.06 t/ha). It also recorded highest gross return (Rs 53190.00 INR/ha), net return (Rs 33540.50 INR/ha) and B:C ratio (1.71).

Keywords: Foxtail millet, nitrogen, spacing, yield

Introduction

A significant minor millet in the Poaceae family is foxtail millet (*Setaria italica* L.). Foxtail millet is only grown in Andhra Pradesh, Karnataka, and Tamil Nadu in India. It is a grain that is fed to cage birds and poultry as well as consumed by humans. It is a component of several culinary dishes, including malts, fermented bread, biscuits, and chapati. (Marwein *et al.*, 2019) ^[3].

Foxtail millet ranks second in the world's total millet production. It is rich in micro-nutrients and good for diabetic patients. It protects against cancer and related heart diseases. Foxtail millet comes under drought tolerant crop and it can be grown as a short-term catch crop. It is adapted to a wide range of elevation, soils, and temperatures. Millets are better adapted to dry, infertile soils than most other crops and are therefore often cultivated under extremely harsh conditions - for example, high temperatures, low and erratic precipitation, short growing seasons and acidic and infertile soils with poor water-holding capacity. Most millets have strong, deep rooting systems and short life cycles, and can grow rapidly when moisture is available. Foxtail millet is an annual grass grown for human food. 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, as well as in some other economically developed countries of the world. Nutritional composition of foxtail millet per 100 g edible portion is proteins (12.3 g), carbohydrates (60.9 g), fat (4.3 g), crude fibre (8.0g), calcium (31 mg), minerals (3.3g) and thiamine (0.59 mg). The crop water requirement of foxtail millet is less which is suitable to grow in summer season. Foxtail millet is one of the oldest small millets cultivated for food and fodder. It has a reputation for being drought-tolerant, resilient to extreme moisture stress, and adaptable to a variety of soil types. India's small millets produced 4.60 lakh tonnes of grain and had a productivity of 501 kg/ha over an area of 9.17 lakh hectares. The productivity of foxtail millet is very low compared to its potentially achievable yield owing to a lack of suitable crop management practices. Spacing is one of the major agronomic practices which requires due attention as it is being broadcasted by the farmers. (Jyothi *et al.*, 2021) ^[2]. Varieties of foxtail millet are more responsive to nitrogenous fertilizers.

Nitrogen is considered to be an important nutrient for growth and development of plants. It plays an important role in building units of proteins in the plant system. Nitrogen nutrition not only influence productivity but also quality. (Reddy *et al.*, 2019) ^[6].

population causes changes due to light intensity, humidity and temperature within canopy. Under wider spacing, plants tend to put forth a vigorous vegetative growth, while closer spacing tend to restrict the same. Optimum population level is the one, which provides the plant with the best environment to express its full capacity under the given conditions. Nutritional demand of crop can be determined by measuring nutrient uptake which may change with changing nitrogen rates and plant population.

Materials and Methods

The experiment was carried out during the *kharif* season of 2022 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (Allahabad) which is located at 25° 24' 42" N latitude, 81° 50' 56" E longitude, and 98 m altitude above the mean sea level. 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 (Allahabad) city. The soil of the experimental field constitutes a part of central gangetic alluvium and is neutral and deep. The soil was sandy loam in texture, low in organic carbon and medium in available nitrogen, phosphorus, and low in potassium and zinc. The soil samples were collected randomly from 5 spots at 0 to 15 cm depth with the help of auger just before layout of experiment. The soil reaction of the sandy was 15.13%, the organic Carbon was 0.48%, the available, the phosphorus was 13.6 Kg/ha, the potassium was 215.4 Kg/ha, the zinc was 0.76ppm. Foxtail millet (*Setaria italica* L.) variety 3088 were selected for sowing. Seeds were sown in line manually on 2023. Seeds were covered with the soil immediately after sowing. The spacing adopted was according to the treatment details and the seeds were drilled at 3-4 cm depth. All the treatments were applied by balancing to the initial soil test values and crop requirements to justify the crop response to the supplied nutrients in both years.

Results and discussion

Yield attributes

Number of ear head/m²

At harvest, the data recorded highest number of ear head/m² (170.80) in 25 cm x 10 cm spacing with 40 kg/ha nitrogen. However, 35 cm x 10 cm spacing with 40 kg/ha nitrogen, 25 cm x 10 cm spacing with 30 kg/ha nitrogen was found to be statistically at par with 25 cm x 10 cm spacing along with 40 kg/ha nitrogen.

Number of seeds/ear head

At harvest, the data recorded more seeds/ear head (181.33) in 35 cm x 10 cm spacing along with 40 kg/ha nitrogen. 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.*

Test weight (g)

At harvest, the data recorded higher test weight (2.50 g) in 35 cm x 10 cm spacing with 40 kg/ha nitrogen. However, 25 cm x 10 cm spacing with 30 kg/ha nitrogen, 35 cm x 10 cm

spacing with 50 kg/ha nitrogen was found to be statistically at par with 25 cm x 10 cm spacing along with 30 kg/ha nitrogen.

Grain yield (t/ha)

At harvest, the data recorded higher grain yield (1.06 t/ha) in 35 cm x 10 cm spacing along with 40 kg/ha nitrogen. However, 35 cm x 10 cm spacing with 50 kg/ha nitrogen, 30 cm x 10 cm spacing with 30 kg/ha nitrogen was statistically at par with 35 cm x 10 cm spacing along with 40 kg/ha nitrogen.

An adequate amount of sunshine encourages effective photosynthesis, which leads to a larger concentration of photosynthates at wider spacing and eventually increases grain production. Similar findings were also reported by Yadav *et al.*, (2023) ^[9]. Nitrogen plays a major role in the biosynthesis of IAA and especially due to its role in the initiation of primordial reproductive parts portioning of photosynthetic towards them which promotes the grain yield. Similar findings were also reported by Rao *et al.*, (2019) ^[4].

Straw yield (t/ha)

At harvest, the data recorded higher straw yield (6.99 t/ha) in 25 cm x 10 cm spacing along with 50 kg/ha nitrogen. However, in 25 cm x 10 cm spacing with 40 kg/ha nitrogen, 25 cm x 10 cm spacing with 30 kg/ha nitrogen was statistically at par with 25 cm x 10 cm spacing along with 50 kg/ha nitrogen. under wider spacing sufficient consumption of sunlight promotes efficient photosynthesis activities and ultimately greater accumulation of photosynthates. Narrow spacing with dense plant population resulted in the lower amount of straw yield. Similar findings were also reported by Yadav *et al.*, (2023) ^[9]. A higher production of fodder was likely produced by the application of nitrogen, which encouraged improved crop growth and development. These findings corroborate the results of Tiwana *et al.*, (2004) ^[7].

Harvest index (%)

At harvest, the data recorded maximum harvest index (24.58%) in 35 cm x 10 cm spacing along with 40 kg/ha nitrogen. However, in 35 cm x 10 cm with 30 kg/ha nitrogen, 25 cm x 10 cm spacing along with 40 kg/ha nitrogen was statistically at par with 35 cm x 10 cm spacing along with 40 kg/ha nitrogen.

Economics

Gross returns, Net returns and Benefit cost ratio were significantly influenced due to different treatments.

Cost of cultivation (₹/ha): Cost of cultivation (20518.55INR/ha) was found to be highest in 25 cm x 10 cm spacing along with 50 kg/ha nitrogen.

Gross return (₹/ha)

Gross return (53190.00 INR/ha) was found to be highest in 35 cm x 10 cm spacing with 40 kg/ha nitrogen and minimum gross return (47295.33 INR/ha) was found to be in 25 cm x 10 cm spacing along with 50 kg/ha nitrogen.

Net returns (₹/ha)

Net return (33540.50 INR/ha) was found to be highest in 35 cm x 10 cm spacing with 40 kg/ha nitrogen and minimum

net return (26776.78 INR/ha) was found to be in 25 cm x 10 cm spacing along with 50 kg/ha nitrogen.

Benefit cost ratio (B:C): The maximum Benefit cost ratio (1.71) was recorded in 35 cm x 10 cm spacing along with 40

kg/ha nitrogen which was superior to rest of all treatment combinations. The increased benefit cost ratio were mainly due to increased grain and straw yield. Similar findings were also reported by Dapake *et al.*, (2016) ^[1].

Table 1: Effect of Spacing and nitrogen on yield attributes of Foxtail millet

S. No.	Treatments	Number of ear head/m ²	Number of seeds/ear head	Test weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)
1.	25 cm x 10 cm spacing + 30 kg/ha nitrogen	157.33	148.33	2.37	1.01	6.33	13.72
2.	25 cm x 10 cm spacing + 40 kg/ha nitrogen	170.80	128.33	2.34	1.02	6.55	13.45
3.	25 cm x 10 cm spacing + 50 kg/ha nitrogen	117.07	138.67	2.33	0.88	6.99	11.28
4.	30 cm x 10 cm spacing + 30 kg/ha nitrogen	121.67	128.67	2.37	1.02	5.07	16.78
5.	30 cm x 10 cm spacing + 40 kg/ha nitrogen	134.44	111.00	2.29	0.97	5.60	14.73
6.	30 cm x 10 cm spacing + 50 kg/ha nitrogen	127.78	139.67	2.25	1.02	5.29	16.20
7.	35 cm x 10 cm spacing + 30 kg/ha nitrogen	98.10	132.33	2.25	1.03	3.69	22.51
8.	35 cm x 10 cm spacing + 40 kg/ha nitrogen	149.52	181.33	2.50	1.06	3.30	24.58
9.	35 cm x 10 cm spacing + 50 kg/ha nitrogen	88.10	144.00	2.36	1.04	3.53	22.75
10.	Control (NPK 40:20:20) 30 x 10 cm spacing	115.00	137.00	2.36	1.01	4.25	19.49
	F-Test	S	S	S	S	S	S
	Sem (+)	20.12	7.38	0.09	4.02	7.38	1.59
	CD (P=0.05)	42.27	15.50	0.18	8.45	15.50	3.34

Table 2: Effect of Spacing and nitrogen on Economics of foxtail millet

S. No.	Treatments	Cost of cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C ratio
1.	25 cm x 10 cm spacing + 30 kg/ha nitrogen	19866.35	52753.33	32886.98	1.66
2.	25 cm x 10 cm spacing + 40 kg/ha nitrogen	20192.45	53145.00	32952.55	1.63
3.	25 cm x 10 cm spacing + 50 kg/ha nitrogen	20518.55	47295.33	26776.78	1.31
4.	30 cm x 10 cm spacing + 30 kg/ha nitrogen	19736.35	52671.33	32934.98	1.67
5.	30 cm x 10 cm spacing + 40 kg/ha nitrogen	20062.45	50317.67	30255.22	1.51
6.	30 cm x 10 cm spacing + 50 kg/ha nitrogen	20388.55	52823.00	32434.45	1.59
7.	35 cm x 10 cm spacing + 30 kg/ha nitrogen	19606.35	52025.33	32418.98	1.65
8.	35 cm x 10 cm spacing + 40 kg/ha nitrogen	19649.50	53190.00	33540.50	1.71
9.	35 cm x 10 cm spacing + 50 kg/ha nitrogen	20258.55	52393.33	32134.78	1.59
10.	Control (NPK 40:20:20) 30 x 10 cm spacing	20062.45	51615.00	31552.55	1.57

Conclusion

It was concluded that spacing of 35 cm x 10 cm along with application of 40 kg/ha nitrogen (Treatment 8) recorded higher grain yield (1.6 t/ha) and benefit cost ratio (1.71) in foxtail millet.

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