



Effect of Spacing and Potassium Levels on Growth and Yield of Foxtail Millet (*Setaria italica* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted to determine the influence of spacing and potassium levels on foxtail millet (*Setaria italica* L.) during the (*Zaid*) 2022 with 9 treatments with Factor I (*viz.* spacing at 25 x 10 cm, 30 x 10 cm and 35 x 10 cm) respectively and Factor II (*viz.* potassium at 10, 20 and 30 kg/ha). The soil experimental plot was sandy loam texture. The experiment laid out in factorial Randomized Block Design at Crop Research Farm, Department of Agronomy, Faculty of Agriculture, SHUATS, Prayagraj (U.P). Giving of Spacing 30x10cm + 30 kg/ha Potassium recorded highest plant height in treatment 6 (104.40 cm), plant dry weight in treatment 9 (12.58g), treatment 6 is highest grain yield (2.11 t/ha) and stover yield (3.95 t/ha).

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1. INTRODUCTION

Foxtail millet is one of the oldest small millets cultivated for food and fodder. It is known for its drought tolerance and can withstand severe moisture stress and also suited to wide range of soil conditions. In India, Andhra Pradesh (4,79,000 ha), Karnataka (2,32,000 ha) and Tamilnadu (20,000 ha) are the major Foxtail millet growing states contributing about 90 per cent of the total area under cultivation. Andhra Pradesh is a major Foxtail millet growing state contributing about 79 per cent of the total area. However, the yields per unit area are very low as the crop is mainly grown on marginal lands besides lack of high yielding varieties. Foxtail millet is comparable to that of super cereals like rice and wheat due to its adaptability to poor environment and input management. It is suitable for inclusion in multiple or intercropping systems because of its short duration hence deserves a greater importance than other millets. "Variation in the plant 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. Despite its high nutrition value, the average yield of foxtail millet is low as compared to the potentially achievable yield due to inadequate planting density, insufficient fertilizer application and a lack of proper management methods. Optimum plant density ensures that plant grow appropriately and make better use of sunlight and soil nutrients" Reddy [1]. "In a densely populated crop intercultural operations are hampered and inter plant competition for nutrients, air and light is increased resulting in mutual shadowing, lodging and a lower harvest index" Hebbal (2018).

"Potassium is an important ion in maintaining physiological plant water relations and is an essential macronutrient required for proper development of plants, in addition to activation of numerous enzymes. Potassium plays an important role in the maintenance of electrical potential gradient across cell membrane, generation of turgor and is the major cat ion in the maintenance of anion balance. It improves drought, disease or pest tolerance in crop besides improving quality of the produce. It is a

soil aggregating agent which is known to have positive effect on soil physical properties and subsequently crop yields. Recent studies showed declining status of potassium in Indian soils in most of the states from high to medium or medium to low status. It was considered that Indian soils are rich in K and seldom recommended K fertilizers to crops. High crop K removal than K addition by farmers and imbalanced use of NPK fertilizers are contributing to large scale K mining leading to emergence of K deficiency in soils and crops. Red, lateritic and shallow black soils have undergone K fertility depletion. K recommendation needs revalidation across the agro climatic zone considering the variation in the soil type and crop potential. Further, fertilizer recommendations are being made based on available K status, but significant proportion of plant need is met from non-exchangeable fraction of K. Therefore, there is a need to consider both the fractions of K in soils for potassium fertilizer recommendation to crops and awareness on K use by farmers in K deficient regions needs more emphasis. K is a necessary nutrient for the activation of more than 80 enzymes throughout the plant" Sundaresh and Basavraja (2017).

Given the foregoing above information, an effort has been undertaken to conduct this research with the goal of examining the relationship between crop spacing and potassium levels on growth and yield.

2. MATERIALS AND METHODS

"A field experiment was conducted during zaid 2022, at Crop research farm of Department of Agronomy at Sam Higginbottom University of Agriculture, Technology, and Sciences, Prayagraj which is located at 25° 24' 42" N latitude, 81° 50' 56" E longitude and 98 m altitude above the mean sea level (MSL). To assess the effect of spacing and potassium on growth and yield of Foxtail millet (*Setaria italica* L.). The experiment was laid out in Randomized Block Design comprising of 9 treatments which are replicated thrice. Each treatment net plot size is 3m × 3m [2]. The treatments are categorized as with 3 levels of plant geometry and 3 levels of potassium when applied in combinations as follows, (T₁) 25x10cm + 10kg/ha potassium, (T₂) 25x10cm + 20kg/ha potassium, (T₃) 25x10cm + 30kg/ha potassium, (T₄) 30x10cm + 10kg/ha potassium, (T₅) 30x10cm + 20kg/ha potassium, (T₆) 30x10cm + 30kg/ha potassium,

(T₇) 35x10cm + 10kg/ha potassium, (T₈) 35x10cm + 20kg/ha potassium, (T₉) 35x10cm + 30kg/ha potassium, . "The foxtail millet crop was harvested treatment wise at harvesting maturity stage. Growth parameters viz. plant height (cm), dry matter accumulation (g plant⁻¹) were recorded manually on five randomly selected representative plants from each plot of each replication separately and after harvesting, seeds were separated from each net plot and were dried under sun for three days. Later winnowed, cleaned and grain yield per ha was computed and expressed in kgs per hectare. After complete drying under sun for 10 days stover yield from each net plot was recorded and expressed in tonnes per hectare. The data was computed and analysed by following statistical method" of Gomez and Gomez (1984).

2.1 Physical and Chemical Analysis of Soil

The soil sample were collected randomly from 0 to 15 cm depth from 5 spots of the experimental field just before layout of experiment. A representative homogenous composite sample was drawn by mixing all these soil samples, which was analysed to determine the physical-chemical properties of soil. Sand (59.60%) unit by using Bouyoucos hydrometer method, Bouyoucos1962. silt (25.27%) unit and clay (15.13%) unit. The textural class is sandy Loam by using USDA Triangle method soil survey1975. Chemical analysis of soil at pre-experimental stage organic carbon (0.48%) Walkey and Black method (Jackson,1973), phosphorous (13.6) kg/ha Olsen colorimetric method (Olsen,1954) potassium (215.4 kg/ha Flame photometer method (Toth and Prince,1949), Available Sulphur(12.41ppm) Turbidimetric Method (Chesnin and Yien,1950) Available Zinc (7.2) Atomic Absorption Spectrometer method (Lindsay and Norvell,1978), pH (7.2) Glass electrode pH meter (Jackson,1973), EC (0.26) Method No. 4, USDA Hand Book No.60 (Richards,1954).

3. RESULTS AND DISCUSSION

3.1 Effect of SPACING and Potassium on Growth Parameters

3.1.1 Plant height

It is evident from Table 1. that plant height measured increased with advancement in crop growth.

Maximum plant height of 104.40 cm was recorded at 80days in treatment (6) Spacing 30x10cm + 20 kg/ha Potassium. whereas treatments Spacing 35x10cm + 10 kg/ha Potassium, Spacing 35x10cm + 20 kg/ha Potassium, Spacing 30x10cm + 20 kg/ha Potassium recorded statistically at par with the treatment (6) Spacing 30x10cm + 30 kg/ha Potassium. .The plant height of foxtail millet increased significantly due to spacing and potassium. Spacing shows the higher plant height, in the foxtail millet. It might be due to better utilization of minerals, nutrients, water, solar radiation etc. Similar results reported by Shinggu and Gani [3] & Sujith Reddy and Shikha Singh [1]. "Potassium is involved in number of physiological processes, protein synthesis and activation of enzymes. Recent studies showed declining status of K in Indian soils in most of the states from high to medium or medium to low status" [4]. In the present investigation, the crop responded up to 35 kg K₂O ha⁻¹. Potassium aggregating agent which is known to have positive effect on soil physical properties such as plant height, healthy growth etc and subsequently crop yields.

3.2 Dry Matter Accumulation

The treatment highest plant dry weight was found at 80 days in treatment Spacing30x10cm + 30 kg/ha Potassium (9.31g). However, treatment Spacing 35x10cm + 30 kg/ha Potassium, Spacing35x10cm + 10 kg/ha Potassium was found to statistically at par with treatment Spacing30x10cm + 30 kg/ha Potassium. The dry weight of foxtail millet increased significantly due to spacing and potassium. Spacing shows the higher dry weight it might be due to better utilization of minerals, nutrients, water, solar radiation etc. Potassium is involved in number of physiological processes, protein synthesis and activation of enzymes. In the present investigation, the crop responded up to 35 kg K₂O ha⁻¹. Potassium aggregating agent which is known to have positive effect on soil physical properties such as plant height, healthy growth etc and subsequently crop yields. Similar results reported by Sujith Reddy and Shikha Singh [1], Srinivasa et al. [5].

3.3 Effect of Spacing and Potassium on Yield and Yield Attributes: Length of Ear (cm)

Significant effect was observed by the statistical analysis of length of ear Treatment Spacing

35×10cm + 30 kg/ha Potassium resulted in significantly highest ear head length (18.90 cm). However, Spacing 30×10cm + 30 kg/ha Potassium, Spacing 35×10cm + 20 kg/ha Potassium were found to be statistically on par with Spacing 35×10cm + 30 kg/ha Potassium. Sufficient interception of sunlight promotes efficient photosynthesis activities and ultimately greater accumulation of photosynthates under wider spacing. Narrow spacing with dense plant population resulted in the lower values of yield attributes. Potassium is involved in number of physiological processes, protein synthesis and activation of enzymes. In the present investigation, the crop responded up to 35 kg K₂O ha⁻¹. Potassium aggregating agent which is known to have positive effect on soil physical properties such as plant height, healthy growth etc and subsequently crop yields. Similar results reported by Srinivasa et al. [5].

3.4 Number of Grains/ Ear

Significant effect was observed by the statistical analysis of number of grains/ear. Treatment (6). Spacing 30×10cm+ 30 kg/ha Potassium recorded significant and highest number of grains/ear head (1452). However, Spacing 35×10cm + 10 kg/ha Potassium, Spacing 35×10cm + 30 kg/ha Potassium recorded statistical parity with Spacing 30×10cm + 30kg/ha. The yield attributes of foxtail millet increased significantly due to spacing and potassium. It may be due to less competition exerted for light, moisture and nutrients. Sufficient interception of sunlight promotes efficient photosynthesis activities and ultimately greater accumulation of photosynthates under wider spacing. Narrow spacing with dense plant population resulted in the lower values of yield attributes. Potassium is involved in number of physiological processes, protein synthesis and activation of enzymes. In the present investigation, the crop responded up to 35 kg K₂O ha⁻¹. Potassium aggregating agent which is known to have positive effect on soil physical properties such as plant height, healthy growth etc and subsequently crop yields. Similar results reported by Sujith Reddy and Shikha Singh [1].

3.5 Grain Yield (t/ha)

The grain yield showed increasing trend with the application of spacing and potassium in foxtail millet. The highest grain yield was obtained with the treatment Spacing 30×10cm+ 30 kg/ha

Potassium (2.11 t/ha), however Spacing 35×10cm+ 30 kg/ha Potassium treatment were found to be statistically on par with Spacing 30×10cm+ 30 kg/ha Potassium. The grain yield of foxtail millet increased significantly due to spacing and potassium. It may be due to less competition exerted for light, moisture and nutrients. Sufficient interception of sunlight promotes efficient photosynthesis activities and ultimately greater accumulation of photosynthates under wider spacing. Narrow spacing with dense plant population resulted in the lower values of yield attributes. Potassium is involved in number of physiological processes, protein synthesis and activation of enzymes. In the present investigation, the crop responded up to 35 kg K₂O ha⁻¹. Potassium aggregating agent which is known to have positive effect on soil physical properties such as plant height, healthy growth etc and subsequently crop yields. Similar results reported by Mownika et al. [6-23,2].

3.6 Stover Yield (t/ha)

The stover yield of foxtail millet was also influenced by the application of spacing and potassium. Highest stover yield (3.95 t/ha) was recorded Spacing 30×10cm + 30 kg/ha Potassium, however Spacing 35×10cm + 30 kg/ha Potassium, Spacing 35×10cm + 20 kg/ha Potassium treatment were found to be statistically on par with Spacing 30×10cm + 30 kg/ha Potassium. The stover yields of foxtail millet increased significantly due to spacing and potassium. "It may be due to less competition exerted for light, moisture and nutrients. Sufficient interception of sunlight promotes efficient photosynthesis activities and ultimately greater accumulation of photosynthates under wider spacing. Narrow spacing with dense plant population resulted in the lower values of yield attributes. Potassium is involved in number of physiological processes, protein synthesis and activation of enzymes. Recent studies showed declining status of K in Indian soils in most of the states from high to medium or medium to low status" (Brar et al., 2011). In the present investigation, the crop responded up to 35 kg K₂O ha⁻¹. Potassium aggregating agent which is known to have positive effect on soil physical properties such as plant height, healthy growth etc and subsequently crop yields.

Similar results reported by Mownika et al. [24], Sujith Reddy and Shikha Singh [1].

Table 1. Effect of spacing and potassium levels on growth attributes of foxtail millet

S. No	Treatment combinations	Plant height (cm)	Dry weight (g)
1.	25x10cm+ 10 kg/ha K	94.53	9.94
2.	25x10cm+ 20 kg/ha K	94.00	10.17
3.	25x10cm+ 30 kg/ha K	96.47	10.42
4.	30x10cm+ 10 kg/ha K	95.43	10.19
5.	30x10cm+ 20 kg/ha K	101.03	11.25
6.	30x10cm+ 30 kg/ha K	104.40	12.58
7.	35x10cm+ 10 kg/ha K	97.73	11.99
8.	35x10cm+ 20 kg/ha K	100.03	11.07
9.	35x10cm+ 30 kg/ha K	103.10	12.21
	F test	S	S
	Sem (±)	0.08	1.55
	CD (P=0.05)	0.25	4.59

Growth Attributes

Table 2. Effect of spacing and potassium levels on yield attributes of foxtail millet

S. No.	Treatment combinations	Yield attributes			
		Length of ear (cm)	No.of grains/ear	Grain Yield (t/ha)	Straw yield (t/ha)
1.	25x10cm+ 10 kg/ha K	15.80	1150	1.51	3.72
2.	25x10cm+ 20 kg/ha K	16.63	1196	1.64	3.75
3.	25x10cm+ 30 kg/ha K	17.47	1250	1.69	3.82
4.	30x10cm+ 10 kg/ha K	16.97	1272	1.61	3.74
5.	30x10cm+ 20 kg/ha K	17.90	1297	1.79	3.75
6.	30x10cm+ 30 kg/ha K	18.20	1452	2.11	3.95
7.	35x10cm+ 10 kg/ha K	17.60	1397	1.90	3.77
8.	35x10cm+ 20 kg/ha K	18.53	1365	1.82	3.85
9.	35x10cm+ 30 kg/ha K	18.90	1415	2.04	3.90
	F test	S	S	S	S
	Sem (±)	0.08	0.31	18.61	0.03
	CD (P=0.05)	0.25	0.91	55.28	0.08

4. CONCLUSION

The results revealed that application of Spacing 30x10cm + 30 kg/ha Potassium recorded Maximum plant height (104.40 cm), highest plant dry weight (12.58g), length of ear (18.90 cm), grain yield (2.11 t/ha), harvest index and hence, can be recommended to the farmers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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