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

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 soil. 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 30×10cm + 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).

Key words: Foxtail millet, Potassium, Spacing, Yield.

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 (4,79000 ha), Karnataka (2,32000 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 in adequate 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 (2021)** . “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 under gone 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.

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^{o} 24' 42'' N latitude, 81^{o} 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". [24] The treatments are categorized as with 3 levels of plant geometry and 3 levels of potassium when applied in combinations as follows, (T_1) 25x10cm + 10kg/ha potassium ,(T_2) 25x10cm + 20kg/ha potassium, (T_3) 25x10cm + 30kg/ha potassium , (T_4) 30x10cm + 10kg/ha potassium ,(T_5) 30x10cm + 20kg/ha potassium,(T_6) 30x10cm + 30kg/ha potassium, (T_7) 35x10cm + 10kg/ha potassium, (T_8) 35x10cm + 20kg/ha potassium, (T_9) 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).**

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 (Oslen,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)

RESULTS AND DISSCUSION

Effect of Spacing and potassium on growth parameters:

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 30×10cm + 20 kg/ha Potassium. whereas treatments Spacing 35×10cm + 10 kg/ha Potassium, Spacing 35×10cm + 20 kg/ha Potassium, Spacing 30×10cm + 20 kg/ha Potassium recorded statistically at par with the treatment(6) Spacing 30×10cm + 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 (2012)** & **Sujith Reddy** and **Shikha Singh (2021)**. "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

K_2O 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.

Dry matter accumulation

The treatment highest plant dry weight was found at 80 days in treatment Spacing30×10cm + 30 kg/ha Potassium (9.31g). However, treatment Spacing 35×10cm + 30 kg/ha Potassium, Spacing35×10cm + 10 kg/ha Potassium was found to statistically at par with treatment Spacing30×10cm + 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 K_2O 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 (2021), Srinivasa *et al* (2019).**

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 Spacing35×10cm + 30 kg/ha Potassium resulted in significantly highest ear head length (18.90 cm). However, Spacing30×10cm + 30 kg/ha Potassium, Spacing35×10cm + 20 kg/ha Potassium were found to be statistically on par with Spacing35×10cm + 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 K_2O 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* (2019)**.

Number of grains/ear

Significant effect was observed by the statistical analysis of number of grains/ear. Treatment (6) Spacing30×10cm+ 30 kg/ha Potassium recorded significant and highest number of grains/ear head (1452). However, Spacing35×10cm + 10 kg/ha Potassium, Spacing35×10cm + 30 kg/ha Potassium recorded statistical parity with Spacing30×10cm + 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 K_2O 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 (2021).**

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 Spacing30×10cm+ 30 kg/ha

Potassium (2.11 t/ha), however Spacing35×10cm+ 30 kg/ha Potassium treatment were found to be statistically on par with Spacing30×10cm+ 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*. (2021).**

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 Spacing30×10cm + 30 kg/ha Potassium, however Spacing35×10cm + 30 kg/ha Potassium, Spacing35×10cm + 20 kg/ha Potassium treatment were found to be statistically on par with Spacing30×10cm + 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 K_2O 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.* (2021), Sujith Reddy and Shikha Singh (2021).**

CONCLUSION

The results revealed that application of Spacing 30×10cm + 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.

REFERENCES

1. Attar, A. V., Patil, B. T., Bhalekhar, M. N. and Shinde, K. G., Effect of spacing and fertilizer levels on growth, yield and quality of garden pea (*Pisum sativum* L.) CV. Phule priya. *Bioinfolet*,2013, **10**(4B): 1240-1242 2.
2. Avasthe, R.K., Verma, S., Ashok Kumar and Rahman, H.Performance of rice (*Oryza sativa*) varieties at different spacing under system of rice intensification (SRI) in mid hill acid soils of Sikkim Himalayas. *Indian Journal of Agronomy*.2012, **57**(1): 32-37.
3. Basavarajappa, R., Prabhakar, A. S. and Halikatti, S. I. Effect of tillage practices,organics, nitrogen levels and their interactions on yield and economics of foxtail millet during kharif. *Karnataka Journal of Agriculture Sciences*.2002, **15** (3): 485- 490.
4. Brar, M. S., Bijya, S. K. and Shrinivasa Rao, C. H., Role of potassium nutrition in nitrogen use efficiency in cereals. *Int. Pot. Inst., Indian*.2011, 3: 221 – 223.
5. Charate, S., Thimmegowda, M. N., Rao, G. E., Ramachandrappa, B. K. and Sathish, A. Effect of nitrogen and potassium levels on growth and yield of little millet (*Panicum sumatrense* L.) under dryland alfisols of southern Karnataka. *International Journal of Pure & Applied Bioscience*, 2018, **6** (6), 918- 923.
6. Gabatshele, M. L., Thembinkosi, M., Phizana M., Christopher M., and Witness M., Growth and effect of two pearl millet land races as affected by the intra-row spacing. *International journal of current Microbiology and Apllied sciences* ;2014 ,3: 505-515.
7. Jadhav, S. G., Chavan, D. A. and Waghmare, Y. M. Effect of plant spacing, growth regulator and nutrient management on yield, quality and economics of bt cotton. *Journal of Cotton Research development*; 2015, 29(1): 48-52.
8. Kamal, I. A., Siddig, A. M. A., Ali, H. B. and Thabit, A. H. Effect of plant spacing and variety on performance of rain-fed pearl millet (*Pennisetum glaucum* L.) grown on two soil types at zalingei area, Sudan. *Journal of Science Technology*;2013, **3**(5).
9. Maitra, S., Ghosh, D.C., Sounda, G. and Jana, P.K. Performance of intercropping legumes in finger millet (*Eleusine coracana*) at varying fertility levels. *Indian Journal of Agronomy*,2001**, 46**(1): 38- 44.
10. Mownika R, Sanbagavalli S, Thavaprakaash N, Kalarani MK and Renukadevi K. Studies on crop geometry and potassium on growth and yield of foxtail millet (*Setaria italica* L.) under irrigated condition.
11. The Pharma Innovation Journal; 10(10): 1256-1260. Nagappa Govinakoppa, Deepak Kamatar, Anil Kumar H and T Sudha . Impact of fertilizer, spacing and genotypes on yield, income and related traits in little millet. *The Pharma Innovation Journal*;2021, SP-**10**(10): 132-138
12. Rashid Khan, M., Murshedulalam and Rezaulkarim, Integrated nutrient approach to increase the yield in rice cv. BRRI dhan44, *Life Science Journal*.,2006, **10**(4): 172-181. 12.
13. Sangeeta, Surakod, V. S., Patil, M. B., Ashwathama, V. H. And Patil, P.V., Effect of crop geometry on pearl millet (*pennisetum glaucum* (l.) r. br.) under dryland conditions. M.Sc. Thesis, *UAS Dharwad*, 21- 22.
14. Srinivasa DK, Chikkaramappa T, Basavaraja PK, Sukanya TS, Murali K and Chamegowda TC . Status of different forms of potassium under foxtail millet crop as

influenced by graded levels of potassium in Alfisols of Chikkaballapura region, Karnataka. *International Journal of Chemical Studies*;2019, **7**(3): 3435-3441

15. Shankar Charate, Thimmegowda, M. N., Gangadhar Eswar Rao, Ramachandrappa, B. K. and Sathish, A. Effect of Nitrogen and Potassium Levels on Growth and Yield of Little Millet *(Panicum sumatrense*) under Dryland Alfisols of southern Karnataka. *International Journal of Pure and Applied Bioscience*. **6** (6): 918-923
16. Shafi Nazir, M., Hafiz M. Shafiq, Saeed, M. and Jabbar, J. Integrated nitrogen management with planting geometry for multicut hybrid sorghum. *Pakistan Journal Agriculture Sciences* . 1997,**34**(1): 1-4.
17. Shinggu, C. P. and Gani, M. Effects of planting methods, sowing dates and spacing on weed and the productivity of finger millet (*Eleusine corocana* L.) in the northern guinea savanna of nigeria. *Global Journal Bio-Science and Biotechology*.2012, **1**(2): 160-162.
18. Soomro, H. and Alam, M. S.Effect of plant geometry and nitrogen rates on quality traits and yield of wheat. *Journal of Environment Science Natural Resources.*2009,**4**(1): 172-176.
19. Sujith Reddy and Shikha Singh. Effect of spacing and potassium levels on growth and yield of finger millet *(Eleusine coracana* L.*) Asian Journal of Microbiology, Biotechnology and Environmental Sciences.* 2021**,23** (2): 158-162
20. Tetarwal, J.P. and Nanwal, R.K. Productivity of pearl millet (Pennisetum glaucum L.) as influenced by cropping systems and fertilization under rainfed conditions. *Agronomy Digest.*2002, 2: 8- 11.
21. Thavaprakaash, N., Velayudham, K. and Muthukumar, V. M. Response of crop geometry, intercropping system and INM practices on yield and fodder quality of baby corn. *Asian Journal of Scientific Research*.2008, **1**(2): 153-159.
22. Vasuki, S. B., Yogananda, D.C., Preetu, K. S. and Jayaprakash, S. M. Impact of longterm fertilizer application on soil quality, crop productivity and sustainability. Department of Soil science and Agricultural chemistry, *University of Agriculture Sciences.*2009, pp: 22.
23. Yayeh Bitew and Fekremariam Asargew, Determination of seed rate and inter row spacing for finger millet production (*Eleusine coracana* L.) in north western Ethiopia. *International Journal of Reserach Rev.*2014, **1**(4)
24. Mohan N, Singh S. Effect of organic manures and sources of sulphur on growth and yield of kharif pearl millet (Pennisetum glaucum L.). The Pharma Innovation Journal 2022; 11(3): 2257-2261

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

Growth Attributes

S.No	**Treatment combinations**	**Plant height (cm)**	**Dry weight (g)**
1.	25×10cm+ 10 kg/ha K	94.53	9.94
2.	25×10cm+ 20 kg/ha K	94.00	10.17
3.	25×10cm+ 30 kg/ha K	96.47	10.42
4.	30×10cm+ 10 kg/ha K	95.43	10.19
5.	30×10cm+ 20 kg/ha K	101.03	11.25
6.	30×10cm+ 30 kg/ha K	104.40	12.58
7.	35×10cm+ 10 kg/ha K	97.73	11.99
8.	35×10cm+ 20 kg/ha K	100.03	11.07
9.	35×10cm+ 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

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.	25×10cm+ 10 kg/ha K	15.80	1150	1.51	3.72
2.	25×10cm+ 20 kg/ha K	16.63	1196	1.64	3.75
3.	25×10cm+ 30 kg/ha K	17.47	1250	1.69	3.82
4.	30×10cm+ 10 kg/ha K	16.97	1272	1.61	3.74
5.	30×10cm+ 20 kg/ha K	17.90	1297	1.79	3.75
6.	30×10cm+ 30 kg/ha K	18.20	1452	2.11	3.95
7.	35×10cm+ 10 kg/ha K	17.60	1397	1.90	3.77
8.	35×10cm+ 20 kg/ha K	18.53	1365	1.82	3.85
9.	35×10cm+ 30 kg/ha K	18.90	1415	2.04	3.90
	F test	S 0.08	S 0.31	S 18.61	S 0.03
	SEm±				
	CD (P=0.05)				

	0.25	0.91	55.28	0.08