The Pharma Innovation Journal 2021; 10(10): 1256-1260

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(10): 1256-1260

www.thepharmajournal.com
Received: 07-08-2021
Accepted: 09-09-2021

Mownika R
PG Student, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India.

Sanbagavalli S
Professor, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India.

Thavaprakaash N
Associate Professor, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Kalarani MK
Professor and Head, Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Renukadevi A
Assistant Professor, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Corresponding Author:
Mownika R
PG Student, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India.

Studies on crop geometry and potassium on growth and yield of foxtail millet (*Setaria italica* L.) under irrigated condition

Mownika R, Sanbagavalli S, Thavaprakaash N, Kalarani MK and Renukadevi A

Abstract
The field experiment was carried out to study the effect of crop geometry and potassium on growth and yield of foxtail millet (*Setaria italica* L.) under irrigated condition with the variety ATL 1 during summer season (March-June) of 2021 at Eastern Block farm, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore. The experiment was laid out in factorial randomized block design and replicated thrice with Factor I *viz.*, crop geometry [C_1: 22.5 × 10 cm, C_2: 30 × 10 cm, C_3: 45 × 10 cm] and Factor II *viz.*, potassium [K_1: RDF (44:22:0 NPK kg ha^{-1}), K_2: RDF + 11 kg K_2O ha^{-1}, K_3: RDF + 22 kg K_2O ha^{-1}, K_4: RDF + Potassium Solubilizing Bacteria (KSB) @ 2 kg ha^{-1} as soil application, K_5: Absolute control (without fertilizer)]. Growth, yield attributes and yield parameters such as plant population m^{-2}, plant height, number of tillers $plant^{-1}$, number of productive tillers m^{-2}, number of grains $earhead^{-1}$, grain yield ha^{-1}, straw yield ha^{-1}, test weight and harvest index were recorded. Results revealed that sowing seeds at the spacing of 30 × 10 cm recorded significantly higher yield. Application of Recommended dose of fertilizer along with 22 kg of potassium recorded higher values of growth and yield parameters. Among the treatment combinations, spacing of 30 × 10 cm with potassium application of 22 kg $ha^{-1}$of K recorded the higher grain yield.

Keywords: foxtail millet, crop geometry, potassium, irrigated

1. Introduction
Foxtail millet [*Setaria italica* (L.)] often known as italian millet or german millet belongs to the family of poaceae. It is one of the oldest cultivated millet in the world, mostly grown in Asia, America and Africa. It ranks second in the world millet production and continues to play a vital role in world agriculture, giving food to millions of people dependant on poor or marginal soils in southern Europe and in temperate, subtropical and tropical Asia (Hariprasanna, 2016) [2]. In India, foxtail millet is mostly cultivated in Tamil Nadu, Karnataka and Andhra Pradesh, contributing about 79 per cent of the total area (Munirathnam *et al.*, 2006) [8]. In India 9.1 m ha areas is under foxtail millet cultivation with production of 7.3 mt and productivity of 780 kg ha^{-1} (Monisha *et al.*, 2019) [7]. Its grain contains 12.3 per cent protein, 4.7 per cent fat, 60.6 per cent carbohydrate, 3.2 per cent ash and mineral nutrients (Singh *et al.*, 2003) [15]. Foxtail millet is high in iron and calcium and has a low phytic acid content (Sampat *et al.*, 1990) [14]. Despite its high nutritional 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 plants grow appropriately and make better use of sunlight and soil nutrients (Reddy *et al.*, 2021) [13]. 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 *et al.*, 2018) [3]. Balanced fertilization ensures that the plant receives an adequate amount of each nutrient, which is critical for yield optimization (Sundaresh and Basavraja, 2017) [17].
Foxtail millet is cultivated in low fertile dryland soils and is merely supplemented with N and P, ignoring the requirement of K due to soil, natively rich in potassium. However, long-term intense cropping without its application resulted in low to medium status and decreased potassium supply to plants and consequently reduced the crop yields. Potassium is a necessary nutrient for the activation of more than 80 enzymes throughout the plant (Sundaresh and Basavraja, 2017) [17]. It improves grain filling, grain weight, straw strength, disease resistance

and the plant's ability to handle stress.

Higher yield of foxtail millet can be realized with optimum plant density and proportionate use of three primary nutrients namely, N, P and K to provide balanced fertilization to crops (Maitra *et al.*, 2020) [6]. Considering the above facts an attempt has been made to undertake this research with the objective to study the effect of crop geometry and potassium on growth and yield of potassium under irrigated condition.

2. Materials and Methods

The field experiment was conducted in Field No. 37F at Eastern Block Farm, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore during summer season (March-June) of 2021. The farm is located in the western agro climatic zone of Tamil Nadu at 11º02' N latitude, 76º94' E longitude and at an altitude of 427 m above MSL. The experiment was designed in factorial randomized block design and replicated thrice with Factor I *viz.*, crop geometry [C_1: 22.5 × 10 cm, C_2: 30 × 10 cm, C_3: 45 × 10 cm] and Factor II *viz.*, Potassium [K_1: RDF (44:22:0 NPK kg ha^{-1}), K_2: RDF + 11 kg K_2O ha^{-1}, K_3: RDF + 22 kg K_2O ha^{-1}, K_4: RDF + Potassium Solubilizing Bacteria (KSB) @ 2 kg ha^{-1} as soil application, K_5: Absolute control (without fertilizer)]. The crop was sown during third week of March 2021 and the nutrients N, P and K were applied to each plot in the form of urea, single super phosphate (SSP) and muriate of potash (MOP) according to the treatments assigned. Entire dose of phosphorus and potassium were applied as basal and nitrogen was applied in two equal splits, 50 % each at basal and 15th day after sowing. The crop was matured at 90 days and harvested in the first forthnight of June 2021. The data on growth characters, yield parameters, yield and harvest index were recorded and statistically analysed, using the analysis of variance (ANOVA) for factorial randomized block design as proposed by Gomez and Gomez (2010) [1]. The critical difference was calculated at 0.05 probability level, if the treatment difference was determined to be significant ('F' test). Non-significant treatment differences were denoted by 'NS.'

3. Results and Discussions

3.1. Effect of crop geometry and potassium on growth parameters of foxtail millet

Planting geometry and potassium had a remarkable effect on the growth of foxtail millet. Among the various crop geometries tried, adoption of the spacing of 22.5 × 10 cm recorded significantly highest plant population of 40.27 plants m^{-2} (Table.1). With regard to the plant height and number of tillers $plant^{-1}$ adoption of the spacing at 45×10 cm recorded the significantly highest values (112.58 cm and 2.56, respectively) followed by the adoption of spacing at 30 × 10 cm (105.28 cm and 2.48, respectively). The increase in plant height under wider spacing might be due to the increase in area for absorption of more water and nutrients from the soil, more light interception for effective photosynthesis which further leads to the increase in plant height and in the production of more number of tillers (Kalaraju *et al*., 2009) [5] due to the less competition between the plants (Prakasha *et al*., 2018) [11]. In addition, it may also due to the increase in cell division, cell expansion and elongation due to the adoption of wider spacing (Janani *et al*., 2021) [4]. These findings are in line with Nandhini and Sridhara (2019) [9], Prakasha *et al*. (2018) [11], Janani *et al*. (2021) [4] in foxtail millet, finger millet and barnyard millet, respectively. The lowest plant height (101.43 cm) and number of tillers $plant^{-1}$ (1.28) were recorded under the spacing of 22.5 × 10 cm.

Table 1: Effect of crop geometry and potassium on growth parameters of foxtail millet at maturity stage

Treatment	Plant population (m^2)	Plant height (cm)	No. of tillers $plant^{-1}$
Crop Geometry (C)			
C_1: 22.5 × 10 cm	40.27	101.43	1.28
C_2: 30 × 10 cm	29.67	105.28	2.48
C_3: 45 × 10 cm	19.27	112.58	2.56
SEd	0.92	3.37	0.05
CD (P=0.05)	1.89	6.89	0.10
Potassium (K)			
K_1: RDF (44:22:0 NPK kg ha^{-1})	29.56	106.97	2.07
K_2: RDF + 11 kg K_2O ha^{-1}	29.78	112.36	2.20
K_3: RDF + 22 kg K_2O ha^{-1}	30.33	116.70	2.20
K_4: RDF + Potassium Solubilizing Bacteria (KSB) @ 2 kg ha^{-1} as soil application	29.67	109.37	2.13
K_5: Absolute control (without fertilizer)	29.33	86.74	1.93
SEd	1.19	4.34	0.07
CD (P=0.05)	NS	8.90	0.13
Interaction			
SEd	2.06	7.52	0.11
CD (P=0.05)	NS	NS	0.23

With respect to potassium, application of RDF + 22 kg K_2O ha^{-1} recorded significantly maximum plant height of 116.70 cm and number of tillers $plant^{-1}$ of 2.20 followed by RDF + 11 kg K_2O ha^{-1} with plant height of 112.36 cm and number of tillers $plant^{-1}$ of 2.20 and the minimum plant height (86.74 cm) and number of tillers $plant^{-1}$ (1.93) were recorded in absolute control.

Among the interaction effects, spacing of 45 × 10 cm and RDF + 22 kg K_2O ha^{-1} recorded significantly higher number of tillers $Plant^{-1}$ (2.80). It might be due to the less competition between the plants for sunlight, nutrients and space and application of sufficient amount of K fertilizer which leads to balanced fertilization to the crop.

3.2. Effect of crop geometry and potassium on yield attributes of foxtail millet

With regard to the crop geometry, adoption of the spacing of 45 × 10 cm recorded significantly maximum yield attributes *viz.*, number of grains (2520 $earhead^{-1}$) and 1000 grain weight (2.79 g) (Table.2) followed by the spacing of 30 × 10 cm with number of grains earhead^{-1} of 2283, and 1000 grain weight of 2.73 g. However, maximum number of productive tillers m^{-2} (61.00) was attained with plant spacing of 30 × 10 cm. The increase in plant spacing leads to the effective utilization of available resources such as sunlight, water and nutrient for the plant growth which further leads to the increase in photosynthetic rate and enhancement of yield attributing characters (Pramanik and Bera, 2013) [12]. The synthesized photosynthates might be translocated to the growing panicles which results in the grain filling and increase in the weight of the panicles (Pradeep Kumar, 2018) [10]. The minimum values of the yield attributes were recorded under the spacing of 22.5 × 10 cm. This indicates that, whenever the plant population exceeds the optimum level, it increases the competition among plants leading to the lesser availability of nutrients, sunlight and other resources which become severe (Janani *et al*., 2021) [4].

Considering the potassium levels, application of RDF + 22 kg K_2O ha^{-1} produced the higher yield attributes *viz.*, number of productive tillers m^{-2} (66.16), number of grains earhead^{-1} (2688) and 1000 grain weight (2.81) of foxtail millet over the other potassium levels and it was followed by the application of RDF + 11 kg k ha^{-1} with 63.69 productive tillers m^{-2}, 2569 number of grains earhead^{-1}and 1000 grain weight of 2.78 g. The lower values of the yield attributes were recorded under absolute control. Potassium involved in the various metabolic activities such as translocation of photosynthates, transforming the sugar into starch in the grain filling process (Srinivasarao *et al.,* 2013) [16]. These translocated photosynthates increases the individual grain weight which result in the increase in 1000 grain weight of the crop.

3.3. Effect of crop geometry and potassium on yield of foxtail millet

Yield of foxtail millet significantly varies with the different plant geometries. Adoption of the plant spacing of 30 × 10 cm recorded significantly higher grain (2245 kg ha^{-1}) and straw yield (4877 kg ha^{-1}) of the crop and the spacing adoption of 22.5 × 10 cm ranks next with 2023 and 4764 kg ha^{-1}of grain and straw yield, respectively. The increase in grain yield might be due to the adoption of optimum spacing which leads to the optimum plant population resulting in the higher grain yield. The adoption of optimum spacing reduces the competition among the crops which further increase the effective utilization of available resources and increases the productive potential of crops (Prakasha *et al*., 2018) [11]. Lower yield (1664 and 3603 kg ha^{-1}of grain and straw yield, respectively) was recorded under the spacing of 45 × 10 cm due to lesser plant population when compared to other crop geometries studied.

Among the different potassium levels, application of RDF + 22 kg K_2O ha^{-1} produced significantly maximum grain (2361 kg ha^{-1}) and straw yield (4959 kg ha^{-1}) of foxtail millet followed application of RDF + 11 kg K_2O ha^{-1} (2244, 4819 kg ha^{-1}of grain and straw yield respectively). Minimum yield (1183 and 3005 kg ha^{-1}of grain and straw yield, respectively) was observed under absolute control. Proper planting density and fertilization can resolve the contradictions in yield attributes *viz.*, number of grains earhead^{-1} and 1000 grain weight which can successfully increase the yield (Yang *et al*., 2012) [18].

The interaction effect between crop geometry and potassium were found significant for number of productive tillers m^{-2} (Fig. 1), grain yield (Fig. 2) and straw yield. The combined effect of the adoption of spacing of 30 × 10 cm and RDF + 22 kg K_2O ha^{-1} recorded the significant interaction with regard to number of productive tillers m^{-2} (77.60) and grain yield (2683 kg ha^{-1}) of foxtail millet. Adoption of optimum spacing and fertilization with the essential nutrients helps in better growth and photosynthesis, which further increase the grain yield of crop.

This study clearly indicated that the blanket recommendation of 100 per cent RDF (44:22:0 kg NPK ha^{-1}) recommendation without potassium application to foxtail millet reduced the crop growth and yield attributes and also modification in the RDF is required through evaluation of different levels of potassium.

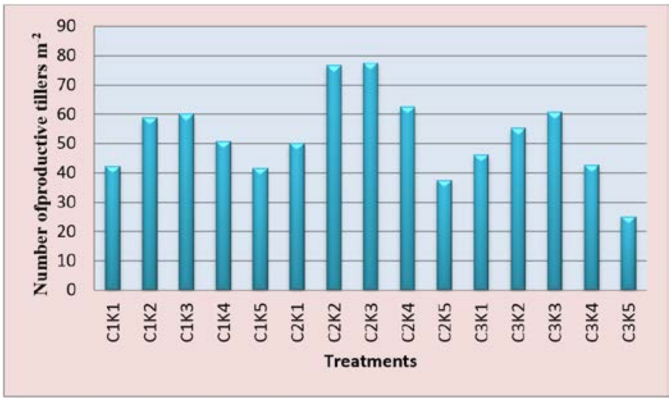

Fig 1: Interaction effect of crop geometry and potassium on number of productive tillers m^{-2}

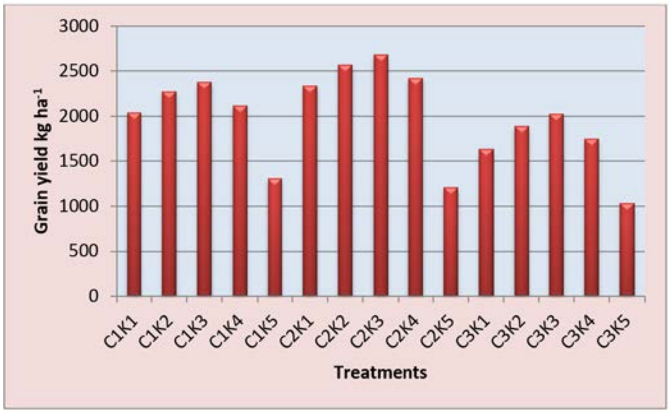

Fig 2: Interaction effect of crop geometry and potassium on grain yield (kg ha^{-1}) of foxtail millet

Table 2: Effect of crop geometry and potassium on yield attributes and yield of foxtail millet.

Treatment	No. of productive tillers m^{-2}	No. of grains earhead^{-1}	1000 grain weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index
Crop geometry (C)						
C_1: 22.5 × 10 cm	50.76	1901	2.62	2023	4764	0.30
C_2: 30 × 10 cm	61.00	2283	2.73	2245	4877	0.31
C_3: 45 × 10 cm	46.04	2520	2.79	1664	3603	0.31
SEd	1.55	62.98	0.07	49.02	109.78	0.01
CD (P=0.05)	3.17	129.01	NS	100.41	224.88	NS
Potassium (K)						
K_1:RDF(44:22:0 NPK kg ha^{-1} as per CPG)	46.22	2221	2.73	2005	4622	0.30
K_2:RDF +11 kg K_2O ha^{-1}	63.69	2569	2.78	2244	4819	0.32
K_3:RDF +22 kg K_2O ha^{-1}	66.16	2688	2.81	2361	4959	0.32
K_4:RDF + Potassium Solubilizing Bacteria (KSB) @ 2 kg ha^{-1}	52.04	2314	2.74	2095	4668	0.31
K_5: Absolute control (without fertilizer)	34.82	1381	2.51	1183	3005	0.28
SEd	2.00	81.31	0.09	63.28	141.72	0.01
CD (P=0.05)	4.10	166.56	0.19	129.63	290.31	0.02
Interaction						
SEd	3.46	140.83	0.16	109.61	245.47	0.02
CD (P=0.05)	7.10	NS	NS	224.53	NS	NS

4. Conclusion
From the above study, it could be concluded that the spacing of 30 × 10 cm with application of 22 kg of K was recommended to obtain maximum yield in foxtail millet under irrigated condition.

5. Reference

1. Gomez KA, Gomez AA. Statistical procedures for agricultural research. A Wiley Interscience's publications. John Wiley and Sons, New York, 1984.
2. Hariprasanna K. Foxtail Millet–nutritional importance and cultivation aspects. Indian farming 2016;65(12):25-29.
3. Hebbal N, Ramachandrappa BK, Thimmegouda MN. Yield and economics of finger millet with establishment methods under different planting geometry and nutrient Source. Indian Journal of Dryland Agricultural Research and Development 2018;33(1):54-58.
4. Janani G, Jawahar S, Vinod Kumar SR, Prabudoss V, Suseendran K, Kalaiayarasan C. Effect of planting geometry and NPK levels on growth and yield of transplanted barnyard millet. International Journal of Botany Studies 2021;6(4):747-752.
5. Kalaraju K, Kumar ND, Nagaraja N, Ningappa KB. Effect of methods of planting on growth and yield of finger millet genotypes under organic farming. Research on crops 2009;10(1):20-24.
6. Maitra S, Pine S, Shankar T, Pal A, Pramanick B. Agronomic management of foxtail millet (*Setaria italica* L.) in India for production sustainability: A review. International Journal of Bioresource Science 2020;7(1):11-6.
7. Monisha V, Rathinaswamy A, Mahendran PP, Kumutha K. Influence of integrated nutrient management on growth attributes and yield of foxtail millet in red soil. International Journal of Chemical Studies 2019;7(3):3536-3539.
8. Munirathnam P, Reddy AS, Sawadhkar SM. Evaluation of foxtail millet varieties under low fertility conditions. Agricultural Science Digest 2006;26(3):197-9.
9. Nandini KM, Sridhara S. Response of growth yield and quality parameters of foxtail millet genotypes to different planting density. International Journal of Current Microbiology and Applied Sciences 2019;8:1765-73.
10. Pradeep Kumar BK. Optimization of spacing and nutrients in seed production of foxtail millet (*Setaria italica* L.). M.Sc. (Agri.) Thesis. University of Agricultural Sciences, Bengaluru, 2018.
11. Prakasha G, Kalyana Murthy KN, Prathima AS, Rohani NM. Effect of spacing and nutrient levels on growth attributes and yield of finger millet (*Eleusine coracana* L. Gaertn) cultivated under guni planting method in red sandy loamy soil of Karnataka, India. International Journal of Current Microbiology and Applied Sciences 2018;7(05):1337-43.
12. Pramanik K, Bera AK. Effect of seedling age and nitrogen fertilizer on growth, chlorophyll content, yield and economics of hybrid rice (*Oryza sativa* L.). International Journal of Agronomy and Plant Production 2013;4(5):3489-99.
13. Reddy ES, Singh S. Effect of spacing and potassium levels on growth and yield of finger millet (*Eleusine coracana* L.) Asian Journal of Microbiology, Biotechology and Environment Sciences 2021;23(2):158-162.
14. Sampth TV, Razvi SM, Singh DN, Bondale KV. Small millet in Indian Agriculture. Small Millet in Global Agriculture, Oxford and IBH Publishing Co. Pvt. Ltd, 1990, 33-44.
15. Singh C, Singh P, Singh R. Impact of organic manures on foxtail millet [*Setaria italica* (L.) Beauv.] (In) Modern Techniques of Raising Field Crops: Oxford and IBH Publishing Co. Pvt. Ltd 2003, New Delhi (Eds.-II),187-191.
16. Srinivasarao C, Kundu S, Ramachandrappa BK, Reddy S, Lal R, Venkateswarlu B *et al*. Potassium release characteristics, potassium balance, and fingermillet (*Eleusine coracana* G.) yield sustainability in a 27-year long experiment on an Alfisol in the semi-arid tropical India. Plant and soil 2014;374(1):315-30.
17. Sundaresh R, Basavaraja PK. Influence of Different Levels of Phosphorus and Potassium on Growth, Yield Attributes and Economics of Finger Millet in Low Phosphorus and Potassium Soils of Eastern Dry Zone of

Karnataka, India. International Journal of Current Microbiology and Applied Sciences 2017;6(11):3559-66.
18. Yang Y, Guo P, Cao Y, Wang H, Wang Y, Yuan X *et al*. Effects of fertilizer and planting density on yield and yield components in foxtail millet hybrid Zhangzagu 5. Acta Agronomica Sinica 2012;38(12):2278-85.