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EFFECT OF SPACING AND POTASSIUM LEVELS ON GROWTH AND YIELD OF FINGER MILLET (*Eleusine coracana* L.)

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Abstract – A field experiment was carried out during *Kharif* season of 2020 at crop research farm of SHUATS, Prayagraj to study about the Effect of Spacing and Potassium levels on growth and yield of Finger millet (*Eleusine coracana* L.) The experiment was laid out in randomized bolck design by keeping three spacing levels, *i.e.* S - (20 x 10 cm), S2 – (30 x 10 cm) and S3 – (40 x 10 cm) and three potassium levels *i.e.* K1 – (20 kg ha^{-1}), K2 – (40 kg ha^{-1}) and K3 – (60 kg ha^{-1}) and which was replicated three times. Results revealed that spacing of 30 x 10 cm + 40 kg/ha K recorded significantly higher in plant height (98.14 cm), number of tillers per m^2 (211.00), number of effective tillers per m^2 (180.80), number of grains per earhead (2128.67), test weight (4.46 g), grain yield (3.50 t/ha) and harvest index (47.00%). However, net returns (71293.00 INR/ha) and B:C ratio (2.11) was also obtained with the application of spacing 30 x 10 cm + 40 kg/ha K. Therefore authors concluded that spacing of 30 cm x 10 cm + 40 kg/ha K can produce more grains and will be economically effective.

INTRODUCTION

Finger millet (*Eleusine coracana* L.) is cereal grass grown mostly for its grain. Finger millet is a robust, tufted, tillering annual grass, upto 170 cm high. Its inflorescence is like panicle which contain 4 – 19 finger resembles like spikes (Quatrocchi, 2006).

Finger millet has the highest amount of calcium (344 mg%) and potassium (408 mg%) about 80 – 85 % of the finger millet is amylopectin and remaining 15 to 20 % is amylose. Since ragi is gluten free, it is wonderful grain alternative for people who are gluten-sensitive. It is one of the important millets occupying highest area under cultivation among small millets. Among the small millets, finger millet ranked fourth globally based on its importance after sorghum, pearl millet and foxtail millet respectively (Gupta *et al.*, 2012).

In India, it is cultivated over an area of 1.20 million hectares with total production of about 1.99 million tons and productivity of 1656 kg per hectare. Plant spacing plays an important role on growth, development and yield of millet crops. Optimum plant density ensures plants to grow properly making better utilization of sunlight and soil nutrients.

Closer spacing hampers intercultural operations and in a densely populated crop, the inter-plant competition for nutrients, air and light is higher, which usually results in mutual shading, lodging and reduces the harvest index (Narayan *et al.*, 2018).

Potassium is an essential major plant nutrient with numerous functions. It helps in grain filling, grain weight, strengthens straw , increases disease resistance and helps the plant better to withstand stress. It involves in enzyme activation which are necessary in many metabolic activities and translocation of photosynthesis and also contributed to drought tolerance and quality improvement plants ability to withstand extreme cold and hot temperatures, pests and lodging. Potassium increases water use efficiency and transforms sugar into starch in the grain filling process (Srinivasarao, Ch. *et al.*, 2013).

MATERIALS AND METHODS

A field experiment was conducted during *Kharif* season of 2020 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P) which is

located at 25 degree 39′ 42"N latitude, 81 degree 67′56" E longitude and 98 m altitude above the mean sea level, during *Kharif* season 2020 on sandy loam soil, having nearly neutral in soil reaction (pH 7.1), organic carbon (0.112), available nitrogen (278.93 kg/ha K), available phosphorus (10.8 kg/ha) and available potassium (206.4 kg/ha). The climate of the region is semi- arid subtropical. Treatments comprised of T_1– 20 x 10 cm + 20 kg/ha K, T_2 – 20 x 10 cm + 40 kg/ha K, T_3 – 20 x 10 cm + 60 kg/ha K, T_4 – 30 x 10 cm + 20 kg/ha K, T_5 30 x 10 cm + 40 kg/ha K, T_6 – 30 x 10 cm + 60 kg/ha K, T_7 – 40 x 10 cm + 20 kg/ha K, T_8– 40 x 10 cm + 40 kg/ha K, T_9 – 40 x 10 cm + 60 kg/ha K and T_{10}–22.5 x 10 cm + 30 kg/ha K (Control). These were replicated thrice in Randomized Block Design. The recommended dose of fertilizer is 60-30-30 kg/ha NPK. Recommended dose of fertilizer was applied at the time of sowing in the form of Urea, DAP and MOP.

Chemical analysis of soil

Composite soil samples are collected before layout of the experiment to determine the initial soil properties. The soil samples are collected from 0-15 cm depth and were dried under shade, powdered with wooden pestle and mortar, passed through 2 mm sieve and were analyzed for organic carbon by rapid titration method by Nelson (1975). Available nitrogen was estimated by alkaline permanganate method by Subbiah and Asija (1956), available phophorus by Olsen's method as outlined by Jackson (1967), available potassium was determined by using the flame photometer normal ammonium acetate solution and estimating by using flame photometer (ELICO Model) as outlined by Jackson (1973) and available $ZnSO_4$ was estimated by Atomic Absorption Spectrophotometer method.

Statistical analysis

The data recorded were different characteristics were subjected to statistical analysis by adopting Fishers the method of analysis of variance (ANOVA) as described by Gomez and Gomez (2010). Critical difference (CD) values were calculated the 'F' test was found significant at 5% level.

RESULTS AND DISCUSSION

Effect of spacing and potassium levels on plant height of finger millet

Observations regarding the plant height of finger millet are given in Table 1 and there was an increasing in crop age plant height was progressively increased with the advancement during the experimentation. The analysis on plant height was significantly higher in all the different growth intervals with the levels of spacing and potassium. At harvest, maximum plant height (98.14 cm) was recorded with appliaction of spacing 30 cm x 10 cm + 40 kg/ha potassium which was significantly superior over all other treatments and and statistically at par with the treatment of spacing 20 x 10 cm + Potassium 40 kg/ha (95.06 cm). It might be due to all the stages of plant growth. The spacing 30 cm a part rows resulted in taller plant height as compared to other row spacing this may be due to competition between plants for light within dense plant population. Also, high plant density could reduce light intensivity within plant canopy and encourage IAA synthesis and increase stem elongation. The similar findings were reported by Ali (2011).

Effect of spacing and potassium levels on number of tillers per m^2

Observations regarding the tillers of finger millet are given in Table 1 and there was tillers progressively increased with advancement of crop during the crop growth. At harvest, maximum number of tillers per m^2(201.6) recorded with application of spacing 30 cm x 10 cm + 40 kg/ha K which was significantly superior over all other treatments except with the application of spacing 20 x 10 cm + Potassium 40 kg/ha (201.6), 30 x 10 cm + 20 kg/ha K(192.5) and 20 x 10 cm + 20 kg/ha K(187.2) which were statistically at par with the application of spacing 30 x 10 cm + Potassium 40 kg/ha. Wider crop geometry had given more number of tillers per plant at all the growth stages compared to others. It might be that spacing levels that were tested did not have a significant effect on plant height and leaf length but, significantly influenced the number of tillers with the closer spacing of 20 cm x 10 cm showing a significantly lower tillering compared to the wider spacing of 30 x 10 cm and 40 x 10 cm. This was an accordance with the earlier findings of Andrew Korir *et al*., (2018).

Effect of spacing and potassium levels on dry matter accumulation (g/m^2)

Observations regarding the dry matter accumulation are given in Table 1 and there was dry matter accumulation had consecutively increased

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

Treatments	Plant height (cm)				Number of tillers per m²				Dry matter accumulation			
	40 DAS	60 DAS	80 DAS	At harvest	40 DAS	60 DAS	80 DAS	At harvest	40 DAS	60 DAS	80 DAS	At harvest
20x10 cm + 20 kg/ha K	11.13	24.20	43.40	93.03	83.20	120.00	168.00	187.20	158.72	499.84	521.50	595.20
20x10cm + 40 kg/ha K	11.93	24.93	45.53	95.06	89.60	134.40	189.07	201.60	180.64	549.12	571.89	649.60
20x10cm + 60 kg/ha K	10.20	22.66	41.13	89.26	80.00	116.80	171.20	180.80	109.12	362.56	453.12	526.40
30x10 cm + 20 kg/ha K	11.33	24.73	44.80	93.93	80.00	125.00	185.00	192.50	101.92	292.32	326.14	350.00
30x10 cm + 40 kg/ha K	12.66	25.93	46.26	98.14	99.00	144.00	201.00	211.00	111.62	345.33	379.49	382.60
30x10 cm + 60 kg/ha K	10.66	23.13	42.86	90.53	64.00	109.00	175.00	187.10	78.12	254.98	289.24	319.20
40x10 cm + 20 kg/ha K	10.26	22.86	42.46	90.13	57.30	87.33	130.66	162.50	46.20	153.96	177.90	199.20
40x10 cm + 40 kg/ha K	10.80	24.00	43.33	91.66	62.00	96.00	142.00	150.13	54.96	171.90	195.96	217.80
40x10 cm + 60 kg/ha K	9.60	21.40	40.73	87.4	54.00	84.66	135.33	142.00	43.02	129.96	167.94	189.00
22.5 x 10 cm + 60:30:30 kg/ha NPK	7.80	19.93	39.73	83.46	52.00	91.00	121.00	131.40	60.60	203.30	263.20	296.00
SEm (±)	0.31	0.57	0.76	0.98	4.16	3.46	4.21	9.31	10.65	18.13	17.17	18.36
CD (0.05%)	0.94	1.70	2.28	2.927	12.38	10.30	12.51	27.67	31.65	53.86	51.04	54.55

from 20 DAS at the harvest. At harvest, maximum dry matter accumulation (649.6 g/m^2) was recorded with application of spacing 20 cm x 10 cm + 40 kg/ha potassium which were significantly superior over all other treatments except with application of spacing 20 x 10 cm + potassium 20 kg/ha (595.2 g/m^2) which were statistically at par with the application of spacing 20 x 10 cm + Potassium 40 kg/ha. Increased plant population due to closer spacing and double seedling/hill increased the number of tillers and eventually plant dry matter accumulation. Improvement of leaves might have increased the photosynthetic efficiency of finger millet and have induced to produce plant dry matter production. This was an accordance with the earlier findings of Rajesh (2011).

Effect of spacing and potassium levels on yield attributes and yield of finger millet

Maximum number of effective tillers per m^2 (180.80) was recorded with application of spacing 30 cm x 10 cm + 40 kg/ha K which were significantly superior over all other treatments except with the application of spacing 20 x 10 cm + 40 kg/ha K (173.16), 30 x 10 cm + 20 kg/ha K(166.53) and 20 x 10 cm + 20 kg/ha K(160.16) which was statistically at par with the application of spacing 30 x10 cm + 40 kg/ha K. Maximum number of grains per earhead (2128.67) was recorded with application of spacing 30 x10 cm + 40 kg/ha K which was significantly superior over all other treatments except with the application of spacing 20 x 10 cm + 40 kg/ha K (2013) which were statistically at par with the application of spacing 30 x10 cm + 40 kg/ha K. Maximum test weight was recorded with application of spacing 30 x 10 cm + 40 kg/ha K which were significantly superior over all other treatments except with the application of spacing 20 x 10 cm + 40 kg/ha K (4.18 g), 30 x 10 cm + 20 kg/ha K (4.15 g), 20 x 10 cm + 20 kg/ha K(4.08) and 40 x 10 cm + 40 kg/ha K (4.07g) which were statistically at par with application of spacing 30 x 10 cm + 40 kg/ha K. Plant spacing 30 cm x 10 cm provides favourable microclimate to crop for effective utilization of available moisture, nutrient and its early adoption leads to better partitioning of photosynthates to reproductive parts there by recording better growth and yield attributes. The similar findings were reported by Gondal *et al.* (2017). Maximum grain yield (3.47 t/ha) was obtained with application of spacing 30 cm x 10 cm + 40 kg/ha K which was significantly superior over all other treatments except with the treatment of

Table 2. Effect of spacing and potassium levels on yield attributes, yield and economics of finger millet

Treatments	Yield attributes			Yield			Economics	
	No. of effective tillers/ m^2	No. of grains/ earhead	Test weight (g)	Grain yield (t/ha)	Stover yield (t/ha)	Harvest index (%)	Net return (INR/ha)	B:C ratio
20cm x 10cm + 20kg K/ha	160.16	1898.67	4.08	2.83	3.97	41.43	51376.00	1.52
20cm x 10cm + 40kg K/ha	173.43	2013.00	4.18	3.46	4.33	44.39	70033.00	2.06
20cm x 10cm + 60 kg K/ha	150.83	1645.67	3.94	1.90	4.22	31.03	21186.00	0.59
30cm x 10cm + 20kg K/ha	166.53	1925.67	4.15	3.33	4.17	44.32	66617.00	1.99
30cm x 10cm + 40kg K/ha	180.80	2128.67	4.46	3.50	3.94	47.00	71293.00	2.11
30cm x 10cm + 60kg K/ha	155.96	1736.33	3.97	2.63	4.12	38.89	44950.00	1.32
40cm x10cm + 20kg K/ha	120.16	1643.67	3.71	2.10	3.91	35.11	29787.00	0.89
40cm x 10cm + 40kg K/ha	119.66	1759.67	4.07	2.76	4.05	40.81	47454.00	1.41
40cm x 10cm + 60kg K/ha	106.33	1587.33	3.44	1.76	4.01	30.54	17120.00	0.50
22.5 x 10 cm + 60:30:30 kg/ha NPK	94.66	1545.67	3.24	1.63	3.94	29.45	16535.00	0.50
SEm(±)	7.17	53.37	0.14	0.21	0.29	2.52		
CD (p=0.05)	21.33	158.59	0.44	0.63	0.86	7.51		

application of spacing 20 x 10 cm + 40 kg/ha K (3.46 t/ha), 30 x 10 cm + 20 kg/ha K (3.33 t/ha) which were statistically at par with the treatment with spacing 30 x10 cm + 40 kg/ha K. Comparing to control plot grain yield increase by upto 54.28%. It might be the higher grain yield was recorded from the interaction effect of 30 cm spacing + 15 kg/ha (2214.4 kg/ha). Maximum stover yield (4.33t/ha) was recorded with application of spacing 20 cm x 10 cm + 40 kg/ha K which was significantly superior over all other treatments and remaining all other treatments are statistically at par with the treatment with spacing 30 x 10 cm + 40 kg/ha K. It might be more plant population owing to closer spacing at 20 x 10 cm might have contributed to maximum dry matter accumulation and number of leaves which ultimately enhanced the straw yield. Similar findings was reported earlier by Kalaraju *et al.* (2011). Maximum Harvest index (47%) was recorded with application of spacing 30 x 10 cm + 40 kg/ha K which was significantly superior over all other treatments except with the treatment of application of spacing 20 x 10 cm + 40 kg/ha K (44.39%), 20 x 10 cm + 40 kg/ha K (44.32%), 20 x 10 cm + 20 kg/ha K (41.43%) and 40 x 10 cm + 40 kg/ha K (40.81%) which were statistically at par with treatment with spacing 30 x 10 cm + 40 kg/ha K. It might be mainly due to increase of grain and straw yield which in turn resulted in higher harvest index.

Effect of spacing and potassium levels on Economics of finger millet

Maximum net reurns (Rs 71293.00 /ha) and B:C ratio (2.11) was obtained with application of spacing 30 x 10 cm + 40 kg/ha K which was significantly superior over rest of the treatments.

CONCLUSION

On the basis of one season experimentation application of spacing 30 cm x 10 cm + 40 kg/ha K was found more productive (3.5 t/ha) as well as economics (71293.00 Rs/ha).

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