EFFECT OF SPACING AND PLANT GROWTH REGULATORS ON GROWTH AND YIELD OF FINGER MILLET (*ELEUSINE CORACANA* L.)

Abstract – A field experiment was carried out during *Kharif* season of 2021 at crop research farm of SHUATS, Prayagraj to study about the Effect of Spacing and Plant growth regulators 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 plant growth regulators *i.e.* Boric acid 3000ppm, Gibberellic acid 50ppm and Salicylic acid 40ppm which was replicated three times. Results revealed that application of spacing 40 x 10 cm + Gibberellic acid 50ppm was recorded significantly maximum plant height (81.62 cm), number of tillers per plant (6.16), plant dry weight (15.01 g/plant) and grain yield (4.23 t/ha). However, net return (Rs 72,650 Rs/ha) and B:C ratio (2.19) were recorded with treatment of 40 x 10 cm spacing + Gibberellic acid 50ppm. Therefore I concluded that spacing of 40 cm x 10 cm + Gibberellic acid 50ppm was produced more grains and economic effective .

Keywords: *Finger millet, Spacing, Plant growth regulator, Yield.*

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 (344mg%) 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.).

Foliar spray of nutrients and plant growth regulators are fastest way to boost up crop growth because the nutrients are available to plants at the initial stages and critical stages. Foliar application of nutrients and growth regulators has been suggested for increasing the fertilizer use efficiency. It provides more rapid utilization of nutrients and permits the correction of observed deficiencies in less time than that would be required by soil treatments. Growth regulators can improve the physiological efficiency including photosynthetic ability and can enhance effective partitioning of accumulates from source and sink in the field crops (Solaimalai *et al*., 2001). Salicylic acid is one such plant growth regulator, which participates in the regulation of a number of physiological events taking place in the plant (Ashraf *et al.*, 2010). Hence, the present investigation was carried out with the foliar spray of nutrients and plant growth regulators on the growth and yield of finger millet.

Plant growth regulators like salicylic acid (SA) and gibberellic acid (GA_3) are recognized endogenous regulator of plant metabolism, which mainly involved in biotic and abiotic stress. GA_3 work as a hormone in regulating plant growth. Which can stimulate the rapid stem and root growth and increase speed of germination. Boric acid significantly stimulated many growth aspects as plant height, leaf number, leaf area, haulm fresh and dry weight Salicylic acid is ortho-hydroxybenzoic acid and it is a secondary metabolite acting as analogous of growth regulating substances. Foliar application of salicylic acid exerted a significant effect on plant growth metabolism when applied at physiological concentration, and thus acted as one of the plant growth regulating substances. SA increases cell metabolic rate.

MATERIALS & 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 + Boric acid 3000ppm, T_2 – 20 x 10 cm + Gibberellic acid 50ppm, T_3 – 20 x 10 cm + Salicylic acid 40ppm, T_4 – 30 x 10 cm + Boric acid 3000ppm, T_5 30 x 10 cm + Gibberellic acid 50ppm, T_6 – 30 x 10 cm + Salicylic acid 40ppm K, T_7 – 40 x 10 cm + Boric acid 3000ppm, T_8 – 40 x 10 cm + Gibberellic acid 50ppm, T_9 – 40 x 10 cm + Salicylic acid 40ppm and T_{10} – (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).

Statistical analysis

The data recorded were different characteristics were subjected to statistical analysis by adopting Fishers the method of analysis of varianc (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

Growth attributes

Plant height (cm)

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 (81.62 cm) was recorded with application of spacing 40 x 10cm + Gibberellic acid 50ppm which was significantly superior over all other treatments and statistically at par with treatment of spacing 20 x 10 cm + Gibberellic acid 50ppm (80.70 cm) . All the stages of plant growth, plant height was found to be increased in plant density. The spacing 40 cm apart rows resulted in taller plant height as compared to other rows spacing this may be due to the 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 E.A.Ali (2011)

Number of tillers per plant

Observations regarding the tillers of finger millet are given in Table1 and there was tillers progressively increased with advancement of crop during the crop growth. At harvest, recorded with treatment of application of spacing 40 x 10 cm + Gibberellic acid 50ppm (6.16) which were significantly superior over all other treatments except with treatment of application of spacing 20 x 10 cm + Gibberellic acid 50ppm (5.93) which were statistically at par with treatment of application of spacing 40 x 10 cm + Gibberellic acid 50ppm. Wider crop geometry had given more number of tillers/plant all the growth stages compared to others. The two wider spatial arrangements of 30 x 10 cm and 40 x 10 cm appeared to encourage tiller formation. From the results it shows that there was significance difference in the number of tillers between spacing 20 x 10 cm and 30 x 10 cm of above 0.5. Also there was a significance difference in mean number of tillers between 20 x 10 cm and 40 x 10 cm of about 0.3 but ,there was no significant difference in the mean number of tillers between 30 x 10 cm and 40 x 10 cm indicating the tiller formation is encouraged by a wider spacing. The similar findings was reported by Andrew Korir et al.,(2018)

Plant dry weight (g/plant)

Observations regarding the plant dry weight are given in table 1 and there was plant dry weight had consecutively increased from 20 DAS to at harvest. At harvest , maximum plant dry weight (15.01 g) recorded with treatment of application of spacing 40 x 10 cm + Gibberellic acid 50ppm which were significantly superior over all other treatments except with treatment of application of spacing 20 x 10 cm + Gibberellic acid 50ppm (14.13g), which were statistically at par with treatment of application of spacing 40 x 10 cm + Gibberellic acid 50ppm. Increased plant population due to closer placing and double seedling/hill increased the number of tillers and eventually plant dry matter production. 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).

Yield

Grain yield (t/ha)

Treatment with application of spacing 40 x10 cm + Gibberellic acid 50ppm was recorded maximum Grain yield (4.23 t/ha) which was significantly superior over all other treatments except with the treatment of application of spacing 20 x 10 cm + Salicylic acid 40ppm (3.97 t/ha) which were statistically at par with the treatment with spacing 40 x10 cm + Gibberellic acid 50ppm. Optimum planting pattern is the prerequisite for proper utilization of growth resources and ultimately to exploit the potential productivity of any crop. The higher grain yield was recorded from the interaction effect of 30 cm spacing 15 kg/ha (2214.4 kg/ha). Similar findings were reported by Nigus and Birhanu (2018).

Stover yield (t/ha)

Treatment with application of spacing 40 x 10 cm + Gibberellic acid 50ppm was recorded maximum stover yield (5.01 t/ha) which was significantly superior over all other treatments except with the treatments 30 x 10 cm + Gibberellic acid 50ppm(4.84 t/ha) and 20 x 10cm + Salicylic acid 40ppm (4.78 t/ha) are statistically at par with the treatment with spacing 40 x 10 cm + Gibberellic acid 50ppm. More plant population owing to closer spacing at 40 x 10 cm might have contributed to maximum plant dry matter production and number of leaves which ultimately enhanced the straw yield. Similar findings have also been reported earlier by (Rajesh,2011) and Kalaraju et al.(2011)

Harvest index (%)

Treatment with application of spacing 40 x 10 cm + Gibberellic acid 50ppm which was recorded maximum Harvest index (45.77%) which was significantly superior over all other treatments expect with the treatments 20 x 10 cm + Gibberellic acid 50ppm (42.42%), 20 x 10cm + Salicylic acid 40ppm (45.37%), 30 x 10cm + Gibberellic acid 50ppm (43.13), 40 x 10cm + Salicylic acid 40ppm (44.96) are statistically at par with the treatment with spacing 30 x 10 cm + Gibberellic acid 50ppm. This was mainly due to increase of grain yield with optimum straw yield which in turn resulted in higher harvest index. These results were in confirmity with findings of Kumar et al. (2019).

Economics

Maximum net reurns (Rs 72650.00 /ha) and B:C ratio (2.19) was obtained with application of spacing 40 x 10 cm + Gibberellic acid 50ppm which was significantly superior over rest of the treatments.

CONCLUSION

On the basis of one season experimentation application of spacing 40 cm x 10 cm + Gibberellic acid 50ppm was found more productive (2.19 t/ha) as well as economics (72650.00 Rs/ha).

References

Ali , E.A. 2011. Impact of row spacing and nitrogen rates on grain yield and nitrogen use efficiency of pearl millet in sandy soil. *Journal of Sebha University – (Pure and Applied Sciences)* **10**(1).

Andrew korir., Peter Kamau. and David Mushimiyimana. 2018. Effect of fertilization and spacing on growth and grain yield of finger millet (*Eleusine coracana* L.) In Ainimoi, Kericho Country, Kenya. *International Journal of Advanced Research and Publication ISSN* : 2456-9992 Vol 2.

Ashraf MN, Akram A, Arteca RN, Foolad MR. The physiological, biochemical and molecular roles of brassinosteroids and salicylic acid in plant processes and salt tolerance. Crit. Rev. Plant Sci. 2010; 29:162-190.

Gomez, K.A. and Gomez, A.A. 1984. Statistical procedures for agricultural research 2nd edition. *New York, 680p*.

Gupta, N., Gupta, A.K., Gaur, V.S. and Kumar, A. 2012. Relationship of nitrogen use efficiency with the activities of enzyme involved in nitrogen uptake and assimilation of finger millet genotypes grown under different nitrogen inputs. *Science World Journal* **1**: 10

Jackson, ML. 1973. Soil chemical analysis. *Prentice Hall of India Pvt. Ltd. New Delhi.*

Kalaraju, K., Kumar, N.S., Nagaraja, N. and Ningappa, K.B. 2009. Effect of methods of planting on growth and yield of finger millet genotypes under organic farming. *Res. Crops* **10**: 20-24.

Narayan Hebbal, B.K., Ramachandrappa, Mudalairiyappa. and Thimmegouda, M.N. 2018. Yield and economics of Finger millet with establishment methods under different planting geometry and nutrient sources. *Indian J. Dryland Agric. Res. & Dev.* **33**(1) : 54-58.

Nelson, D.W. and Sommers, L.E. 1975. A rapid and accurate procedure for estimation of organic carbon in soil. *Proceedings of Indian Academy of Science* **64**; 1815-1826.

Nigus, C. and Melese, B. 2018. Inter Row Spacing and Seed rate Effect on Finger millet (*Elusine coracana* L.) Production in Merblekhe District – Ethiopia. *American journal of Research Communication* **6**(8): 22-29.

Praveen Kumar, A., Parasuraman, P., Sivagamy K. and Shivakumar, B. 2019. Growth, yield and economic of irrigated finger millet as influenced by system of finger millet as influenced by system of finger millet intensification (SFI) practices in north eastern zone of Tamil nadu. *Journal of Pharmacognosy and Phytochemistry* **8**(3): 600-663.

Quattrocchi, U. 2016. CRC World dictionary of grasses : common grasses , scientific names, eponyms, synonymes and etmology. *CRC Press, taylor and francis group, Boca Raton USA.*

Rajesh, K. 2011. System of crop intensification in finger millet (*Eleusine coracana* L.) under irrigated condition. *M. Sc. (Ag.) Thesis, TNAU,Coimbatore*.

Solaimalai A, Sivakumar C, Anbumani S, Suresh T, Arulchelvan K. Role of plant growth regulators in rice production - A Review, Agric. Rev., 2001; 22:33-40.

Subbiah, B. and Vand Asija, G.L. 1956. A rapid procedure for estimation of available nitrogen in soils. *Current Science*. **25:** 259-260.

Table 1 Effect of spacing and biofertilizer on growth attributes, yield and economics of Finger millet

Treatments	Growth attributes			Yield			Economics	
	Plant height (cm)	Tillers per plant	Dry weight (g/plant)	Grain yield (t/ha)	Stover yield (t/ha)	Harvest index (%)	Net return (INR/ha)	B:C ratio
20 x10 cm + Boric acid 3000ppm	77.87	5.33	12.12	2.77	4.70	37.08	35620	1.05
20 x 10 cm + Gibberellic acid 50ppm	80.70	5.93	14.13	3.39	4.60	42.42	51250	1.52
20 x 10cm + Salicylic acid 40ppm	75.04	4.90	10.63	3.97	4.78	45.37	65590	1.94
30 x 10cm + Boric acid 3000ppm	79.32	5.33	12.61	3.14	3.90	39.63	45110	1.35
30 x 10cm + Gibberellic acid 50ppm	79.73	5.36	10.40	3.49	4.84	43.13	53990	1.62
30 x 10cm + Salicylic acid 40ppm	76.04	5.16	11.48	3.04	4.63	39.63	42580	1.27
40 x 10 cm + Boric acid 3000ppm	76.90	5.06	10.86	3.04	3.76	44.70	42770	1.28
40 x 10cm + Gibberellic acid 50ppm	81.62	6.16	15.01	4.23	5.01	45.77	72650	2.19
40 x 10cm + Salicylic acid 40ppm	73.85	4.50	9.67	3.35	4.10	44.96	50490	1.51
22.5 x 10 cm + 60:30:30 kg/ha NPK	72.02	5.20	9.12	2.21	3.63	37.84	23170	0.70
SEm (±)	0.323	0.227	0.344	0.20	0.090	1.25		
CD (0.05%)	0.962	0.671	1.022	0.58	0.268	3.70		