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Growth, Yield and Quality of Finger Millet (*Eleusine coracana* L. Gaertn) as Influenced by Crop Geometry and Age of Seedlings

Dibbagandla Prasanna Kumar*, Sagar Maitra and Tanmoy Shankar

Department of Agronomy, M.S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi-761 211, India

*Corresponding author: prasannakumar64555@gmail.com

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ABSTRACT

A field experiment was conducted during *kharif*, 2018 at Bagusala farm, M. S. Swaminathan School of Agriculture under Centurion University of Technology and Management, Paralakhemundi, Odisha. The experimental soil was sandy loamy texture with pH 6.5, OC (0.41), and low in available N (73.4 kg ha^{-1}), high in available P (30.2 kg ha^{-1}) and medium in available K (152.4 kg ha^{-1}). This experiment was laid out in a Randomized Complete Block Design with nine treatments comprising of T1: transplanting of 15 days old seedling at 20 cm × 20 cm, T2: transplanting of 15 days old seedling at 25 cm × 25 cm, T3: transplanting of 15 days old seedling at 30 cm × 30 cm, T4: transplanting of 20 days old seedling at 20 cm × 20 cm, T5: transplanting of 20 days old seedling at 25 cm × 25 cm, T6: transplanting of 20 days old seedling at 30 cm × 30 cm, T7: transplanting of 25 days old seedling at 20 cm × 20cm, T8: transplanting of 25 days old seedling at 25 cm × 25 cm and T9: transplanting of 25 days old seedling at 30 cm × 30 cm. The treatments were replicated thrice with Vakula variety at seed rate of 5 kg ha^{-1}. The results of the field experiment showed that finger millet performed well in sandy loam soils of South Odisha at a spacing of 25 cm × 25 cm with 20 days old seedlings in terms of growth and productivity, but these agronomic management did not influence the quality parameters.

Keywords: Finger millet, Crop geometry, Age of seedling, Growth, Yield, Quality

Finger millet (*Eleusine coracana* L. Gaertn) is an ecologically sound crop and it requires very less moisture and nutrient and with respect to production in our country it has the pride of place in having the highest productivity among the small millets (Maitra *et al*. 1998; Seetharam and Krishne Gowda, 2007). Finger millet grain contains a good dietary fibre of finger millet protects against hyperglycemia, phytates against oxidation stress by chelating iron and some phenolic and tannins act as antioxidants (Antony and Chandra, 1998). Due to these qualities it is now considered as a 'nutri-cereal' in the world of escalating malnourished population and it can play a major role in nutritional security (Brahmachari *et al.* 2018; Mishra, 2019). In India finger millet is cultivated in an area of 1.27 M ha with a production of 2.61 M t and productivity is 1489 kg ha^{-1}. The acreage of finger millet in Odisha is 1.66 lakh ha with production about 1.61 lakh tonnes (Agriculture Statistics at a Glance, 2017). The average productivity in the state is only 970 kg ha^{-1} which is far below than the national average. Actually, the crop is cultivated in marginal lands and fragile ecological conditions with improper agronomic management in the state. In south Odisha region, harsh and unfavourable climatic conditions coupled with poor soil make agricultural production system a gamble due to high risk of uncertainties during *kharif* season. Under such circumstances, it is a suitable crop to the resource poor farmers as it is hardy in nature with wider adaptability. However, there is an urgent need to increase the productivity of finger millet as well as to achieve the maximum potential of the improved varieties. Crop geometry is an important factor to achieve higher production by better utilization of moisture and nutrients from the soil (root spread) and above ground stature (plant canopy) by harvesting maximum possible solar radiation and in turn better photosynthates assimilation (Uphoff *et al*. 2011). The ideal crop geometry has to be adopted for getting optimum plant stand in the field which results in satisfactory yield. The age of seedlings is another important factor as it has a tremendous influence on the tiller dynamics, tiller production, grain formation and productivity (Pasuquin *et al*., 2008). Hence, the present experiment was carried out to find the influence of planting geometry and age of seedling on growth, yield and quality of *kharif* finger millet in south Odisha conditions.

MATERIAL AND METHODS

The field experiment was conducted during *kharif* season (June to October) of 2018 at Bagusala Farm (23°39′ N latitude, 87°42′ E longitude) of M. S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi, Gajapati district, Odisha to evaluate the growth and productivity of finger millet as influenced by crop geometry and age of seedlings. The variety of finger millet was Vakula. In the experiment, three different crop geometries viz. 20 cm × 20 cm, 25 cm × 25 cm, 30 cm × 30 cm and three age of seedlings viz. 15, 20 and 25 days old were considered and the treatments were as follows. T_1: Transplanting of 15 days old seedlings at 20 cm × 20 cm, T_2: Transplanting of 15 days old seedlings at 25 cm × 25 cm, T_3: Transplanting of 15 days old seedlings at 30 cm × 30 cm, T_4: Transplanting of 20 days old seedlings at 20 cm × 20 cm, T_5: Transplanting of 20 days old seedlings at 25 cm × 25 cm, T_6: Transplanting of 20 days old seedlings at 30 cm × 30 cm, T_7: Transplanting of 25 days old seedlings at 20 cm × 20 cm, T_8: Transplanting of 25 days old seedlings at 25 cm × 25 cm, T_9: Transplanting of 25 days old seedlings at 30 cm × 30 cm. The raised nursery was prepared with a dimension of 4m length and 1.5 m width. Seed sowings was done at different dates to get respective aged seedlings (15, 20 and 25 days old) to transplant on same day. Soil of the experimental field was sandy loam in texture with following physic-chemical properties Field was laid out in Randomized Complete Block Design (RCBD) with three replications. Each plot size was 4×3 m. FYM at the rate of 5t ha^{-1} was applied to all the experimental plots uniformly before final puddling and levelling. The applied recommended dose of N, P_2O_5 and K_2O was 40 kg ha^{-1}, 20 kg ha^{-1} and 20 kg ha^{-1} respectively. Half dose of nitrogen and full dose of phosphorous and potassium were applied at basal application just before transplanting while the remaining half dose of nitrogen was applied after 21 days after transplanting. The crop received a total rainfall 1144 mm during the period of experimentation. Observations on growth parameters, grain and straw yields were recorded and chemical analysis was done for quality parameters by applying the standard procedure to obtain the nutrient and protein content of finger millet. The data were analyzed statistically and presented.

RESULTS AND DISCUSSION

Growth

The growth parameters of finger millet were influenced by planting geometry and age of seedling (Table 1). At harvest stage of finger millet, the treatment T_4 (transplanting of 20 days old seedlings with 20 cm × 20 cm) produced the maximum plant height (100.6 cm) and the treatment was statistically at par with T_5 (transplanting of 20 days old seedlings at 25 cm × 25 cm) and T_6 (transplanting of 20 days old seedlings at 30 cm × 30 cm). Further, the treatment T_4 (transplanting of 20 days old seedlings with 20 cm × 20 cm) resulted in significantly more plant height than the treatments like T_1 (transplanting of 15 days old seedlings at 20 cm × 20 cm), T_2 (transplanting of 15 days old seedlings at 25 cm × 25 cm), T_3 (transplanting of 15 days old seedlings at 30 cm × 30 cm), T_7 (transplanting of 25 days old seedlings at 20 cm × 20 cm), T_8 (transplanting of 25 days old seedlings at 25 cm × 25 cm) and T_9 (transplanting of 25 days old seedlings at 30 cm × 30 cm). Earlier Patil *et al*. (2018) and Prakasha *et al*. (2018) noted similar type of observations. At harvest stage, the treatment T_8 (transplanting of 25 days old seedlings at 25 cm × 25 cm) produced

Table 1: Effect of crop geometry and age of seedling on growth and yield of finger millet at different growth stages

Treatments	Plant height (cm)	Number of tillers m^{-2}	Dry matter accumulation (g m^{-2})				Yield (kg ha^{-1})	
			25 DAT	50 DAT	75 DAT	Harvest	Grain	Straw
T_1 - Transplanting of 15 days old seedlings at 20 cm × 20 cm	91.3	45.6	74.5	178.6	312.5	421.3	936	3238
T_2 - Transplanting of 15 days old seedlings at 25 cm × 25 cm	89.2	42.7	76.6	192.7	336.4	456.9	1063	3603
T_3 - Transplanting of 15 days old seedlings at 30 cm × 30 cm	87.6	39.8	71.9	181.4	321.2	437.2	1069	3655
T_4 - Transplanting of 20 days old seedlings at 20 cm × 20 cm	100.6	55.7	78.4	232.5	441.8	578.5	1280	4185
T_5 - Transplanting of 20 days old seedlings at 25 cm × 25 cm	99.7	56.9	82.5	261.7	506.1	632.5	1482	4786
T_6 - Transplanting of 20 days old seedlings at 30 cm × 30 cm	98.6	50.8	76.3	212.4	350.2	461.8	1253	4134
T_7 - Transplanting of 25 days old seedlings at 20 cm × 20 cm	95.2	60.1	87.2	212.5	431.2	542.3	1262	4151
T_8 - Transplanting of 25 days old seedlings at 25 cm × 25 cm	93.8	62.6	81.3	232.9	447.0	580.2	1302	4231
T_9 - Transplanting of 25 days old seedlings at 30 cm × 30 cm	92.6	58.1	78.5	218.7	345.2	452.4	1218	4043
SEm±	1.69	1.03	1.68	3.82	6.57	9.29	32.2	76.4
CD (P= 0.05)	5.07	3.09	5.02	11.46	19.71	27.85	96.4	229.3
CV (%)	5.4	8.3	6.4	5.4	5.1	5.5	6.8	6.2

the maximum number of tillers m^{-2} (62.6) and the treatment recorded significantly greater number of tillers m^{-2} than some other treatments like T_1 (transplanting of 15 days old seedlings at 20 cm × 20 cm), T_2 (transplanting of 15 days old seedlings at 25 cm × 25 cm), T_3 (transplanting of 15 days old seedlings at 30 cm × 30 cm), T_4 (transplanting of 20 days old seedlings at 20 cm × 20 cm), T_5 (transplanting of 20 days old seedlings at 25 cm × 25 cm), T_6 (transplanting of 20 days old seedlings at 30 cm × 30 cm) and T_9 (transplanting of 25 days old seedlings at 30 cm × 30 cm). But the treatments like T_7 (transplanting of 25 days old seedlings at 20 cm × 20 cm) and T_8 (transplanting of 25 days old seedlings at 25 cm × 25 cm) were statistically at par in production of number of tillers m^{-2}. From this study, it was found that tiller production was slow with younger seedlings at initial stage and thereafter increased. The increase in tiller number with closer spacing was probably due to more population per unit area. Wider crop geometry had given more number of tillers $plant^{-1}$, but presence of more plants in unit area increased number of tillers m^{-2}. Earlier Kalaraju *et al.* (2011) and Rajesh (2011) observed the influence of crop geometry and age of seedlings on production of number of tillers of finger millet. The gradual progression was noted in production of dry matter of finger millet towards maturity with all the treatments. At final stage, the treatment T_5 (transplanting of 20 days old seedlings at 25 cm × 25 cm) registered its significant superiority over other treatments in dry matter accumulation (632.5 g m^{-2}). Moreover, it was noted that 50 DAT onwards the treatment T_5 (transplanting of 20 days old seedlings at 25 cm × 25 cm) exhibited its superiority till harvest in dry matter production of finger millet. Dry matter production is the result of cumulative and complementary effect of other growth attributes. The higher dry matter production was attributed with T_5 (transplanting of 20 days old seedlings at 25 cm × 25 cm) which actually indicated more assimilate production and this was because the plants with the treatment enjoyed optimum spacing and utilized nutrients and other resources better than rest of the treatments. The results are in conformity with the findings of earlier researchers (Roy *et al.* 2002; Prakasha *et al.* 2018).

Yield

The grain and straw yields of finger millet were influenced by crop geometry and age of seedlings (Table 1). The highest grain yield of finger millet (1482 kg ha^{-1}) was obtained with T_5 (transplanting of 20 days old seedlings at 25 cm × 25 cm) which was significantly more than all the other treatments. The next best treatment was T8 (transplanting of 25 days old seedlings at 25 cm × 25 cm) which was however, comparable with T_4 (transplanting of 20 days old seedlings at 20 cm × 20 cm), T_6 (transplanting of 20 days old seedlings at 30 cm × 30 cm), T_7 (transplanting of 25 days old seedlings at 20 cm × 20 cm) and T_9 (transplanting of 25 days old seedlings at 30 cm × 30 cm). The lowest grain yield (936 kg ha^{-1}) was recorded with T_1 (transplanting of 15 days old seedlings at 20 cm × 20 cm) which remained significantly inferior to all other treatments. The results are in conformity with the findings of Kalaraju *et al*. (2011) and Prakasha *et al*. (2018). Different crop geometries and age of seedlings resulted in significant effect on the straw yield of finger millet. Among different crop geometry and age of seedlings tried, T_5 (transplanting of 20 days old seedlings at 25 cm × 25 cm) produced significantly highest straw yield (4320 kg ha^{-1}) and it recorded significantly more straw yield than all other treatments. The increase in straw yield was probably due to adoption of planting geometry with optimum spacing and medium aged seedling for better and uniform stand which enhanced higher dry matter accumulation and this might be enhanced straw yield of finger millet. The results corroborate with the findings of AICSMIP (2013).

Nutrient content

The planting geometry and age of seedling did not influence the N, P and K content of finger millet grain and straw significantly (Table 2). Moreover, the similar trend was observed in protein content of grains. Among different treatments, the N content of finger millet grain was more in the treatment T_9, but it remained statistically at par with others. The highest value of N content in straw (0.37%) was noted with T_4 (Transplanting of 20 days old seedlings at 20 cm × 20 cm), T_5 (Transplanting of 20 days old seedlings at 25 cm × 25 cm), T_6 (Transplanting of 20 days old seedlings at 30 cm × 30 cm), T_7 (Transplanting of 25 days old seedlings

Table 2: Effect of crop geometry and age of seedling on quality of finger millet

Treatments	N content (%)		P content (%)		K content (%)		Protein content (%) in grain
	Grain	Straw	Grain	Straw	Grain	Straw	
T_1 – Transplanting of 15 days old seedlings at 20 cm × 20 cm	1.35	0.35	0.27	0.33	0.33	1.36	8.40
T_2 – Transplanting of 15 days old seedlings at 25 cm × 25 cm	1.36	0.35	0.28	0.34	0.35	1.38	8.50
T_3 – Transplanting of 15 days old seedlings at 30 cm × 30 cm	1.35	0.36	0.28	0.33	0.34	1.36	8.40
T_4 – Transplanting of 20 days old seedlings at 20 cm × 20 cm	1.37	0.37	0.30	0.35	0.36	1.40	8.60
T_5 – Transplanting of 20 days old seedlings at 25 cm × 25 cm	1.38	0.37	0.30	0.35	0.36	1.40	8.60
T_6 – Transplanting of 20 days old seedlings at 30 cm × 30 cm	1.37	0.36	0.28	0.34	0.34	1.37	8.60
T_7 – Transplanting of 25 days old seedlings at 20 cm × 20 cm	1.38	0.37	0.29	0.35	0.34	1.36	8.60
T_8 – Transplanting of 25 days old seedlings at 25 cm × 25 cm	1.37	0.35	0.29	0.35	0.35	1.37	8.60
T_9 – Transplanting of 25 days old seedlings at 30 cm × 30 cm	1.39	0.36	0.28	0.34	0.33	1.36	8.70
SEm±	0.09	0.01	0.01	0.01	0.01	0.03	0.11
CD (P= 0.05)	NS	NS	NS	NS	NS	NS	NS
CV (%)	8.2	10.4	9.8	12.3	12.2	5.4	2.3

at 20 cm × 20 cm). The P content of grain was maximum (0.30%) with T_4 (Transplanting of 20 days old seedlings at 20 cm × 20 cm), T_5 (Transplanting of 20 days old seedlings at 25 cm × 25 cm). But maximum value of P content in straw was with T_4 (Transplanting of 20 days old seedlings at 20 cm × 20 cm), T_5 (Transplanting of 20 days old seedlings at 25 cm × 25 cm), T_7 (Transplanting of 25 days old seedlings at 20 cm × 20 cm) and T_8 (Transplanting of 25 days old seedlings at 25 cm × 25 cm). In case of K content in grain and straw, the maximum values were noted with T_4 (Transplanting of 20 days old seedlings at 20 cm × 20 cm) and T_5 (Transplanting of 20 days old seedlings at 25 cm × 25 cm). The treatment T_9 (Transplanting of 25 days old seedlings at 30 cm × 30 cm) expressed the highest protein content (8.70%) and it remained statistically at par with other treatments.

CONCLUSION

The results of the field experiment concluded that among all the different crop geometries and age of seedlings finger millet grown in sandy loam soils of South Odisha, a spacing of 25 cm × 25 cm with 20 days old seedlings resulted in better growth and productivity, but these agronomic management did not influence the quality parameters.

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