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Influence of seedling age, planting pattern and number of seedlings per hill on the growth and yield of finger millet

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Abstract
A field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore during *Kharif* season of 2019 (July to November) with the objective to evaluate the effect of seedling age, planting pattern and number of seedlings per hill on growth, yield attributes and yield of irrigated finger millet (*Eleusine coracana*). The experiment was laid out in split-plot design with seedling age (Main plot factor M) and planting pattern with number of seedlings per hill (Sub-plot factor S) with three replications. The main plot factor M consisted of three seedling age (14, 17 and 20 days old) and the sub-plot factor S consisted of two planting patterns *viz*., rectangular (30 cm× 10 cm) and square (25 cm × 25 cm) planting with one and two number of seedlings per hill. The experimental results showed that seedling age had significant effect on the yield of finger millet, while planting pattern with number of seedlings per hill had significant influence on growth, yield attributes and yield of the crop. Transplanting of finger millet seedlings at 20 DAS recorded higher grain and straw yields as compared to 14 and 17 days aged seedlings. Rectangular planting pattern (30 cm x 10 cm) with two seedlings per hill recorded higher grain yield and straw yields. It was statistically on par with square planting pattern (25cm x 25 cm) with two seedlings per hill. Significantly lower grain and straw yields were observed with square planting pattern (25 cm × 25 cm) with single seedling per hill, irrespective of the seedling age.

Keywords: Finger millet, seedling age, plant spacing, Number of seedlings per hill, Yield

Introduction

Finger millet (*Eleusine coracana* L. Gaertn.) with synonyms as ragi, African millet and crow footed millet is the third most important millet crop next to sorghum and pearl millet. It is considered the important staple food for the rural people of India and Africa. India contributes nearly 60% of the global finger millet production. The crop is cultivated in more than 1.19 mha area with a production of 1.98 mt and the average productivity of 1661 kg ha^{-1} (Chamoli *et al.*, 2018) [2]. Suitability of the crop in drylands due to its resilience and ability to withstand aberrant weather conditions and in soils having poor water and nutrients supplying capacity is well known to its credit. Besides, the crop is valued for its nutritious grains with high calcium, fiber content and sweet smelling straw as a feed for cattle. For a crop possessing high potential benefits, however, a declining trend in the crop productivity is noticed during the recent past which might be due to non-availability of suitable management technologies that has to be tailored with improved varieties and composites. The merits of transplanting finger millet in terms of increased yield, reduced crop duration, effective weed control, optimum plant population, uniform maturity, reduction in input cost *etc*., as compared to direct sown crop are evident across the country. But the knowledge about key factors of transplanting for increased crop productivity varied among the farmers. There are evidences that the productivity and profitability of finger millet could be increased to a certain extent by proper adoption of low/no cost agronomic practices like seedling age, plant spacing and number of seedlings per hill.

Maintenance of optimum plant population of crop per unit area depends primarily on plant characteristics, duration, soil fertility, moisture, solar radiation, planting pattern, situation of weeds, plant size, number of seedlings per hill, age of seedlings, planting time and methods (Shirtliffe and Johnston, 2002) [13]. Proper age of seedlings has a tremendous influence on the production of tillers, grain formation and other yield attributing characteristics of the crop.

Transplanting of over aged seedlings rather exhibit poor plant stand and below average yields (Faruk *et al.* (2009) [5]. Crop geometry is also an important factor that favours better utilization of available resources and inputs through increased photosynthesis to produce higher crop yields. Any crop requires an optimum plant spacing beyond which it doesn't produce higher yield on an area basis (Thakur *et al.*, 2010) [14]. Closer spacing hinders several intercultural operations and very often, a densely planted crop results in lower yield due to mutual shading effect. Whereas, wider spacing could result in lesser plant population per unit area. Maximum benefits could be arrived under optimum plant spacing between and within plant rows. Number of seedlings per hill is another desirable agronomic factor for successful crop production as it affects plant population per unit area, availability of sunlight and nutrients, photosynthesis and respiration, which ultimately influence the yield contributing characters and yield (Chowdhury *et al.*, 1993) [3]. More number of seedlings per hill increase the inter-specific competition for tiller formation, solar radiation interception, total sun shine reception, nutrient uptake, rate of photosynthesis and other physiological phenomena which eventually affects the growth and development of plants (Bozorgi *et al.*, 2011) [1]. While lesser number of seedlings per hill may cause insufficient tiller number, thus keeping space and nutrients underutilized, resulting in lower grain yield. Therefore, optimum number of seedlings per hill is found essential which may facilitate the plant to grow properly both in its above and below ground parts. Considering the above mentioned key factors, the present research was conducted to find the optimum age of seedlings, planting pattern and number of seedlings per hill for maximizing the productivity of finger millet under irrigated condition in Tamil Nadu.

Materials and methods

The experiment was conducted in Field number 37F at Eastern Block farm, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore during *Kharif*, 2019 (July to November). Geographically, this farm is located at 11°01'N latitude, 76°93' E longitude and at an altitude of 437 m above mean sea level. The soil of the experimental site was slightly alkaline with pH of 7.99 and low soluble salts (EC-1.2 dS m^{-1}). Initial nutrient status of the experimental plot was low in available nitrogen (228 kg ha^{-1}), medium in available phosphorus (16.3 kg ha^{-1}) and high in available potassium (560 kg ha^{-1}) with medium range of organic carbon content (0.74%).The experiment was laid out in split-plot design as main plot factor (M) and sub-plot factor (S) with three replications. The main plot factor consisted of three seedling age (14, 17 and 20 days old) and the sub-plot factor S consisted of two planting patterns *viz*., rectangular (30 cm× 10 cm) and square (25 cm × 25 cm)planting with one and two number of seedlings/hill.

For this study, a nursery area was selected at a well-drained location and raised beds of 1.5 m width with convenient length were prepared. Finger millet variety CO 15 was used with seed rate of 7.5 kg ha^{-1}. For each age of seedlings, nursery sowing was carried out in three different dates with two days interval. The main field was prepared with 12.5 t ha^{-1} of FYM applied at last ploughing and 12.5 kg TNAU MN mixture blended with 2 kg of *Azozpirillum* and *Phosphobacteria* were applied during transplanting. The recommended dose of fertilizers for finger millet crop in the State is 60:30:30 kg N, P_2O_5 and K_2O /ha. The experimental plot received half dose of nitrogen (30 kg ha^{-1}), full dose of phosphorus (30 kg ha^{-1}) and potassium (30 kg ha^{-1}) as basal application and remaining half dose of nitrogen (30 kg ha^{-1}) was top dressed at 30 DAT. Seedlings of 14, 17 and 20 days old were uprooted separately from the respective nursery and transplanted in the experimental plot as per the requirement of treatments. All management practices were done as and when necessary. Five hills were randomly tagged from the net plot area of each treatment for recording crop growth and yield attributes whereas the whole net plot area of treatment plot was harvested to assess grain and straw yields.

Results and discussion

The results on various growth parameters, yield attributes and yields of finger millet as influenced by seedling age, planting pattern and number of seedlings per hill are provided in Tables 1, 2 and 3. Data on grain and straw yields are represented in Figure 1 and 2.

Effect of seedling age on growth, yield attributes and yield of finger millet

The experimental results showed that, seedling age had no significant effect on most of the growth attributes of finger millet like plant height, Leaf area index and number of tillers except dry matter production at harvest stage which was significantly influenced by the seedling age. However, numerical difference in plant height was observed with planting of 20 days old seedlings (M_3), producing taller plants over the seedlings of 14 and 17 days old (M_1 and M_2). The results were in accordance with the findings of Durga *et al.* (2015) [4] who opined that plant height did not significantly differ among different seedling ages in finger millet at Rajendranagar, Hyderabad. Similar trend was observed in case of LAI also wherein, numerically higher values (7.59) was found with planting of 20 days old seedlings (M_3) as compared to transplanting of younger seedlings (17 days and 14 days old,). Transplanting of 20 days old seedlings produced higher number of total tillers per hill (5.79) while the 14 days old seedlings produced only lower number of tillers (5.12). Decreased number of tillers in younger seedlings might be due to more time to recover after transplanting. The result was in accordance with the findings of Faruk *et al.* (2009) [5], Sarker *et al.* (2013) [11] and Durga *et al.* (2015) [4] in rice.

Dry matter production was significantly affected by the age of seedlings and it was increased with increase in seedling age. Significantly higher DMP of 11895 kg $ha^{-1}$was produced with transplanting of 20 days old seedlings at harvest, followed by 17 old seedlings. The lowest DMP of 9108 kg ha^{-1} was recorded with transplanting of 14 days old seedlings. The reason might be that older seedlings performed comparatively better in terms of establishment and vigour than very young seedlings throughout the crop period which reflected in higher DMP.

Seedling age had no significant effect on yield attributes *viz*., number of earheads, earhead weight, number of fingers, finger length, number of grains per earhead and thousand grain weight, which were mainly determined by the varietal characters. More number of earheads per hill were obtained from transplanting of 20 days old seedlings (5.5) followed by 17 and 14 days old seedlings. Similarly transplanting of 20 days old seedlings recorded significantly higher length of earheads (9.38 cm) compared to the age of 14 and 17 days. The grain and straw yields were also significantly influenced by the age of seedlings in finger millet. Transplanting of 20 days old seedlings (M_3) recorded the highest grain yield (3805 kg ha^{-1}) and straw yield (8417 kg ha^{-1}). It was followed by transplanting of 17 and 14 days old seedlings (M_2 and M_1).

The results were conformity with the findings of Kumar *et al.* (2019) [8] in finger millet and Sarker *et al.* (2013) [11] in rice.

Effect of planting pattern and number of seedlings per hill on growth parameters, yield attributes and yield of finger millet

The results of the experiment revealed that planting pattern and number of seedlings per hill showed significant variation among different growth attributes of the crop. Among the two planting patterns, rectangular planting (30 cm × 10 cm) with two seedlings per hill produced taller plants (146.86 cm) than square planting (25 cm × 25 cm) with single seedling per hill. The reason might be that the more number of plants per unit area with two seedlings per hill created the competition for sunlight, which resulted in increased upward growth of plants. More tillers per hill were produced from square planting with two seedlings per hill (6.65) and the least from rectangular pattern with single seedling (4.27). Square planting allowed the plant to produce abundant tillers by minimizing its competition. Nevertheless, rectangular planting observed significantly more number of tillers per unit area, which was mainly attributed by higher plant population than square planting. Comparatively higher LAI values were recorded with rectangular planting with two seedlings per hill (9.94) and the least LAI value was recorded with square planting with single seedling per hill (4.45). Higher LAI indicated that more number of leaves occupied per unit area in rectangular planting than square planting. Similarly, two seedlings per hill could produce higher number of leaves than single seedling per hill. The highest DMP of 12833 kg ha^{-1} was recorded from rectangular planting with two seedlings per hill and the lowest of 7986 kg ha^{-1}from square planting with single seedling per hill at harvest. Higher plant density per unit area in rectangular planting and two seedlings per hill might be the reason for getting higher biomass production.

Square planting had advantageous effects on tillers development, earhead length and earhead weight. Transplanting of single seedling per hill recorded higher values of earhead length and earhead weight compared to two seedlings per hill. In case of tillers, two seedlings per hill produced more number of tillers than single seedlings per hill. Efficient utilization of all resources, less intra specific competition for nutrients among square planting and single seedling may be attributed for superior earhead length and earhead weight of finger millet. The present results were in consonance with those of Hebbal *et al.* (2018) [6] and Shinggu and Gani (2012) [12].

Grain yield was the result of complex morphological and physiological processes affecting each other. Increased values of yield attributes in square planting does not meet the yield obtained from higher population of rectangular planting. Increased number of seedlings increased the yield of crop by producing more number of earheads per hill. Ultimately the higher grain yield (3853 kg ha^{-1}) was recorded with the rectangular planting with two seedlings per hill, which was statistically on par with square planting with two seedlings per hill (3633 kg ha^{-1}). The straw yield was highest under rectangular planting with two seedlings per hill (8613 kg ha^{-1}). The highest plant population (3,33,333 plants ha^{-1}) in rectangular planting favours highest straw yield compared to less population (1,60,000 plants ha^{-1}) in square planting. Whereas the lower grain yield and straw yield were recorded with square planting pattern with single seedling per hill (3344 kg ha^{-1} and 7777kg ha^{-1} respectively). This was corroborated with the early findings of Korir *et al.* (2018) [7], Maobe *et al.* (2014) [9], Rasool *et al.* (2012) [10] and Faruk *et al.* (2009) [5], who reported that closer spacing with two seedlings per hill had advantageous effect on yield compared to wider spacing.

Table 1: Effect of seedling age, planting pattern and number of seedlings per hill on growth attributes of finger millet at harvest

Treatments	**Plant height (cm)**	**LAI**	**Tillers per hill (Nos.)**	**Dry matter production (kg ha^{-1})**
Seedling age (M)				
M_1 (14 days old seedlings)	141.56	6.55	5.12	9108
M_2 (17 days old seedlings)	142.50	7.27	5.43	10353
M_3 (20 days old seedlings)	143.00	7.59	5.79	11895
SEd	3.68	0.59	0.31	276.63
CD (p=0.05)	NS	NS	NS	768.05
Planting pattern (S)				
S_1 (30×10 cm with 1 seedling hill^{-1})	144.34	8.35	4.27	10989
S_2 (25×25 cm with 1 seedling hill^{-1})	138.94	4.45	5.62	7986
S_3 (30×10 cm with 2 seedlings hill^{-1})	146.86	9.94	5.24	12833
S_4 (25×25 cm with 2 seedlings hill^{-1})	139.27	5.80	6.65	10000
SEd	2.46	0.34	0.31	324.15
CD (p=0.05)	5.17	0.72	0.64	681.02
Interaction (M×S)				
SEd	5.21	0.78	0.55	559
CD (p=0.05)	NS	NS	1.28	NS

Table 2: Effect of seedling age, planting pattern and number of seedlings per hill on yield attributes of finger millet

Treatments	**Number of earheads hill^{-1}**	**Earhead weight (g)**	**Length of earhead (cm)**	**Number of grains earhead^{-1}**	**No. of fingers earhead^{-1}**	**Finger length (cm)**	**1000 grain weight (g)**
Seedling age (M)							
M_1 (14 days old seedlings)	4.9	8.42	8.81	2184	7.47	7.76	2.78
M_2 (17 days old seedlings)	5.2	8.53	9.18	2208	7.55	7.74	2.73
M_3 (20 days old seedlings)	5.5	8.68	9.38	2285	7.60	7.89	2.82
SEd	0.29	0.53	0.08	30.14	0.25	0.06	0.06
CD (p=0.05)	NS	NS	0.22	NS	NS	NS	NS

Planting pattern(S)							
S_1 (30×10 cm with 1 seedling hill^{-1})	4.2	8.14	8.69	2205	7.49	7.98	2.79
S_2 (25×25 cm with 1 seedling hill^{-1})	5.4	9.60	10.61	2411	7.78	8.17	2.95
S_3 (30×10 cm with 2 seedlings hill^{-1})	5.0	7.10	8.18	2081	7.48	7.44	2.64
S_4 (25×25 cm with 2 seedlings hill^{-1})	6.3	9.33	9.01	2205	7.41	7.60	2.72
SEd	0.25	0.45	0.30	51.47	0.22	0.22	0.06
CD (p=0.05)	0.53	0.95	0.64	108.14	NS	0.46	0.12
Interaction (M×S)							
SEd	0.48	0.86	0.46	82.89	0.41	0.34	0.11
CD (p=0.05)	1.13	NS	NS	NS	NS	NS	0.24

Table 3: Effect of seedling age, planting pattern and number of seedlings per hill on grain and straw yields of finger millet

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Seedling age (M)		
M_1 (14 days old seedlings)	3307	7989
M_2 (17 days old seedlings)	3627	8226
M_3 (20 days old seedlings)	3805	8417
SEd	120.50	52.88
CD (p=0.05)	334.57	146.83
Planting pattern(S)		
S_1 (30×10 cm with 1 seedling hill^{-1})	3489	8467
S_2 (25×25 cm with 1 seedling hill^{-1})	3344	7777
S_3 (30×10 cm with 2 seedlings hill^{-1})	3853	8613
S_4 (25×25 cm with 2 seedlings hill^{-1})	3633	7984
SEd	128.05	76.37
CD (p=0.05)	269.03	160.45
Interaction (M×S)		
SEd	226.75	126.17
CD (p=0.05)	NS	280.05

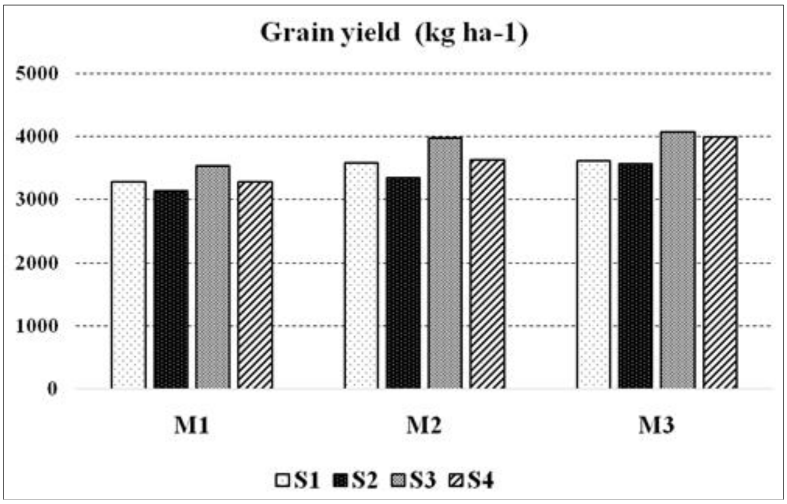

Fig 1: Effect of seedling age and planting pattern on grain yield (kg ha^{-1}) of finger millet

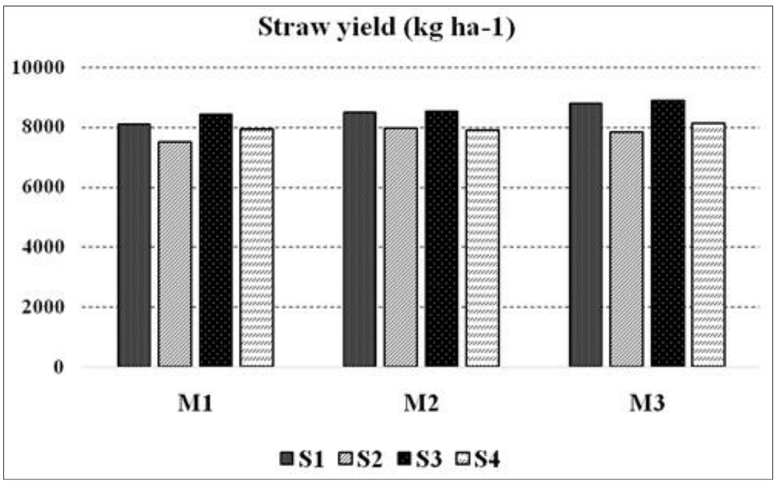

Fig 2: Effect of seedling age and planting pattern on straw yield (kg ha^{-1}) of finger millet

Conclusion

In finger millet, seedlings of 20 days old performed better in terms of growth, yield parameters and yield compared to younger seedlings of 14 and 17 days old. Considering the planting pattern, profused tillering and larger earheads per hill was attributed by minimum competition in square planting as well as single seedling per hill while tillers per unit area were more in rectangular planting and two seedlings per hill. The experimental findings revealed that the productivity of finger millet could be increased with adoption of rectangular (30 cm × 10 cm) or square planting (25 cm × 25 cm) of 20 days old seedlings with two seedlings per hill for achieving higher grain and straw yields under irrigated condition.

References

1. Bozorgi HR, Faraji A, Danesh RK, Keshavarz A, Azarpour E, Tarighi F. Effect of plant density on yield and yield components of rice. World Applied Sciences Journal. 2011; 12(11):2053-2057.
2. Chamoli V, Badoni A, Bahuguna N, Joshi N. Finger millet (Eluesine coracana):-Nutritional status, health benefits and processing status-A review, 2018.
3. Chowdhury M, Sarker A, Sarkar M, Kashem M. Effect of variety and number of seedlings hill-1 on the yield and its components on late transplanted aman rice. Bangladesh J Agril. Sci. 1993; 20(2):311-316.
4. Durga KK, Rao PS, Raju K. Effect of seedling age and spacing schedule on the productivity and quality traits of rice under system of rice intensification (SRI). J cereals oilseeds. 2015; 6(3):15-19.
5. Faruk M, Rahman M, Hasan M. Effect of seedling age and number of seedling per hill on the yield and yield contributing characters of BRRI Dhan 33. Int. J Sustain. Crop Prod. 2009; 4(1):58-61.
6. Hebbal N, Ramachandrappa B, Thimmegouda M. 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.
7. Korir A, Kamau P, Mushimiyimana D. Effect of Fertilization and Spacing on Growth and Grain Yields of Finger Millet (*Eleusine Coracana* L.) In Ainamoi, Kericho County, Kenya, 2018.
8. Kumar DP, Maitra S, Shankar T, Ganesh P. Effect of Crop Geometry and Age of Seedlings on Productivity and Nutrient Uptake of Finger Millet (*Eleusine coracana* L. Gaertn). International Journal of Agriculture, Environment and Biotechnology. 2019; 12(3):267-272.
9. Maobe S, Nyang'au MK, Basweti E, Getabu A, Mwangi T, Ondicho A. Effect of plant density on growth and grain yield of finger millet (*Eleusine coracana*) under high potential conditions of Southwest Kenya. World Journal of Agricultural Sciences. 2014; 10(6):261-268.
10. Rasool F, Habib R, Bhat M. Evaluation of plant spacing and seedlings per hill on rice (*Oryza sativa* L.) productivity under temperate conditions. Pak. J Agri. Sci. 2012; 49(2):169-172.
11. Sarker T, Hossain M, Salam M, Rabbani M. Effect of seedling age and method of transplanting on the yield of Aman rice. Progressive Agriculture. 2013; 24(1-2):9-16.
12. Shinggu C, Gani M. Effects of planting methods, sowing dates and spacing on weed and the prductivity of finger millet (*Eleusine corocana* (L.) Gaertn) in the northern guinea-savanna of Nigeria. Global Journal of Bio-Science and Biotechnology. 2012; 1:160-162.
13. Shirtliffe SJ, Johnston AM. Yield-density relationships and optimum plant populations in two cultivars of solid-seeded dry bean (*Phaseolus vulgaris* L.) grown in Saskatchewan. Canadian Journal of Plant Science. 2002; 82(3):521-529.
14. Thakur A, Rath S, Roychowdhury S, Uphoff N. Comparative performance of rice with system of rice intensification (SRI) and conventional management using different plant spacings. Journal of Agronomy and Crop Science. 2010; 196(2):146-159.