RESEARCH ARTICLE

Physiological Characters and Yield of Transplanted Finger Millet (*Eleusine Coracana* L.) as Influenced by Different Plant Geometry and Graded NPK Levels

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ABSTRACT

A field experiment was conducted at Agricultural College and Research Institute, Killikulam, Tamil Nadu during *Rabi* season (Oct - Mar) 2018 – 19 to evaluate the effect of different plant geometry and graded NPK levels on the performance of finger millet (*Eleusine coracana* L.) under transplanted condition. The experiment was planned with different spacing in combination with different fertilizer levels *viz*., Absolute control (Random planting without fertilizer application), farmer practices (30 × 10 cm + 100% RDF), square planting of 25 × 25 cm with 100%, 125 % and 150 % RDF, square planting of 30 × 30 cm 100 % 125 % and 150 % RDF. SPAD values were found to increase progressively from 30 to 60 DAT but declined at harvest. Among all the treatments, higher SPAD value and light interception percentage were recorded under plant spacing of 25 × 25 cm + 150 % RDF (47.30 & 71.02, 61.55 & 88.24 and 29.17 & 83.68 at 30, 60 and 90 DAT, respectively). It was significantly on par with the spacing of 25 × 25 cm + 125 % RDF (45.62 & 70.15, 59.43 & 87.30 and 27.60 & 82.16 at 30, 60 and 90 DAT, respectively). The treatment 25 × 25 cm with 150 % RDF was identified as the best yield attributes, and yield-producing treatment as it has recorded higher no. of productive tillers hill^{-1} (7.3), no of fingers earhead^{-1} (7.5), finger length (cm) (9.8) and test weight (g) (2.8), grain (2692 kg ha^{-1}) and straw yield (4129 kg ha^{-1}) and it was on par with 25 × 25 cm + 125 % RDF. The lowest SPAD values, light interception percentage, yield attributes and yield were recorded in absolute control.

Keywords: *Light interception; SPAD values; Transplanted finger millet; Yield attributes*

INTRODUCTION

Finger millet (*Eleusine coracana* L.) is a pioneer millet crop mostly grown in the arid and semi-arid tropics of India and Africa. It is the main stable food for economically weaker section, especially for hilly livelihood. Among the millets, it ranks third in the country, in both area and production after sorghum and pearl millet. In India, finger millet is being cultivated in an area of 1.16 m ha with a production of 1.99 m t, and the productivity is 1724 kg ha^{-1}. In Tamil Nadu, finger millet is a major crop among small millet. It is grown in an area of 0.82 L ha with a production of 2.9 L t and a productivity of 3481 kg ha^{-1} (Indiastat, 2021). Other major finger millet growing states in India are Karnataka, Tamil Nadu, Andra Pradesh, Orissa, Jharkhand, Maharashtra and Uttaranchal. Finger millet is an important income and food security crop, particularly for people with small land holdings in rural areas. It is easily stored longer than most cereals and therefore is considered a useful famine crop (FAO, 2012). Finger millet contains the highest calcium content (300–350 mg/100 g) among the small millets (Rao *et al*., 2017). Finger millet contains a relatively higher amount of calcium and dietary fiber than other cereals (Wondimu, 2001). The nutritional value of finger millet per 100 g represent: 7.6 g protein,

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1.5 g fat, 88 g carbohydrate, 37 mg calcium, 0.48 mg Vitamin A, 0.33 mg thiamine (B1), 0.11 mg Riboflavin (B2), 1.2 g Niacin and 3 g fibre (Chethan and Malleshi 2007).

Low finger millet production is caused by the lack of an appropriate plant population, poor cultivation techniques, and little or no fertilizer application. Plant geometry plays a significant role in better utilizing soil moisture and nutrients (root spread) and above-ground development (plant canopy) by capturing as much solar energy as feasible. The ideal plant population exerts close to maximal pressure to extend the use of available environmental resources, resulting in better crop yield. Since there is less space between the plants when the plant density is higher, there is more competition between the plants for different growth elements, reducing the yield per plant. Wider spacing is superior over narrow spacing for increased grain yield. The key to increase production is to fertilize the crop appropriately. A decline in crop yields is mainly caused by loss of soil fertility, where factors such as erosion, nutrient imbalance, and inherently low soil fertility play an essential role (Wondimu, 2001). Among the seventeen nutrients N, P and K are essential for the growth and productivity of crops. Nitrogen is expensive essential nutrients for crops, and judicious supply is a key factor in enhancing use efficiency with minimal environmental impact. Phosphorous is an essential macro-element for the metabolic process such as photosynthesis, energy transfer, synthesis, and breakdown of carbohydrates. Potassium plays a foremost role in imparting drought resistance and disease resistance. It is essential for crop plants. With these considerations in mind, the current study was conducted to examine the impact of various plant geometry and graded NPK levels on the physiological characteristics and yield of transplanted finger millet.

MATERIAL AND METHODS

A field experiment was conducted during *Rabi* season (October – March) of 2018-19 at the garden land of Agricultural College and Research Institute, Killikulam. The experimental field is geographically located in the southern part of Tamil Nadu at 8°46' N latitude and 77°42' E longitude with an altitude of 40 m above MSL. The investigational site is located in a semi-arid tropical region. The mean annual rainfall is 626.6 mm received on 37 rainy days.

The location's mean maximum and minimum temperature are 34.2 ^{0}C and 22.5 ^{0}C, respectively. The relative humidity ranged from 60 to 80 per cent. The soil texture of the experimental field was sandy clay loam. Co (Ra) 15 was used as a test variety. The experiment was conducted in a RBD with eight treatments replicated thrice. The experiment was planned with the following treatments *viz.,* Absolute control (Random planting without fertilizer application) (T_1), 30 × 10 cm + 100% RDF (T_2), 25 × 25 cm + 100% RDF (T_3), 25 × 25 cm + 125% RDF (T_4), 25 × 25 cm + 150% RDF (T_5), 30 × 30 cm + 100% RDF (T_6), 30 × 30 cm + 125% RDF (T_7) and 30 × 30 cm + 150% RDF (T_8). The nursery area required for raising seedlings for one ha area is 500 m^2. The land was ploughed, and beds were prepared with a bed size of 3.0 m x 1.5 m with a height of 10 cm and between beds 30 cm was given. Every bed was applied with 2 kg of FYM and 0.5 kg of Urea. Carbendazim @ 4 g kg^{-1} was used for seed treatment. The treated seeds were broadcasted @ 5 kg ha^{-1}. The seeds were covered by hand slightly. Powdered FYM was evenly sprinkled over the bed to cover the seeds which are exposed, and watering was done at evening hours, and beds were covered with paddy straw. After 15 days top dressing was done at 250 g of urea for every seed bed. Seedlings were ready for transplanting at 20 DAS.

The main field was ploughed twice with a mould board plough followed by harrowing and leveling. The beds and channels were formed with specific dimensions and by providing irrigation channels. The required amounts of fertilizer were applied to each experimental plot as per treatments. The entire dose of P and K and one-half dose of N were applied at the time of final field preparation just before transplanting as basal in the form of Urea, DAP and MOP. The leftover nitrogen was applied in two equal splits at 30 and 45 DAT. Field was irrigated before transplanting, and then 20 days old, seedlings were pulled out from the nursery and transplanted in the experimental plots. Irrigation and plant protection were done as per recommendation. The ear heads from the net plots were harvested, dried, threshed independently and the weight of grain was noted for each plot at 14 per cent moisture content. The straw of the crop was also harvested from the net plots at ground level and sun dried separately and the weight was recorded. Light intensity at different heights (top of the crop canopy and at ground level) was recorded by using the lux meter and calculated by following equation.

$$\text{Light interception (\%)} = \frac{\text{Light intensity at canopy top} - \text{Light intensity at canopy bottom}}{\text{light intensity at canopy top}}$$

The chlorophyll meter SPAD 502 was used for measures the SPAD values by inserting a middle portion of younger leaves and older leaves. No. of productive tillers hill^{-1}, no. of fingers ear head^{-1}, finger length, 1000 grain weight, grain, and straw yield were recorded as per the procedure. Plant samples and the calculated data were subjected to statistical analysis as per the guidelines given by Gomez and Gomez. (1984).

RESULTS AND DISCUSSION

Effect on physiological parameters

The SPAD meter values, which directly reflect the amount of chlorophyll present in the leaf, were found to increase progressively from 30 to 60 DAT and declined at harvest in all the treatments. This may be due to a steady loss of plant growth enhancing substances over a period of plant growth and decreased in applied NPK. The results were in accordance with the findings of Chandana *et al*. (2018). The data on SPAD values and light interception percentage were analyzed and presented in Table 1. At 30, 60 and 90 DAT maximum SPAD value was registered with a spacing of 25 × 25 cm + 150% RDF (47.30, 61.55 and 29.17 at 30, 60 and 90 DAT, respectively) and it was comparable with the spacing of 25 × 25 cm + 125% RDF (45.62, 59.43 and 27.60 at 30, 60 and 90 DAT, respectively). This might be due to the increased accessibility of nitrogen, which is a main constituent of chlorophyll with increased fertilizer nitrogen and optimum spacing, enhancing the light interception by crop canopy results in higher SPAD value. This result was in conformity with the findings of Thumar *et al*. (2016). Light interception percentage increased progressively up to 60 DAT and decreased towards harvest. The higher light interception at 60 DAT might be due to more number of tillers hill^{-1} and high dry matter production obtained at this stage. More number of tillers hill^{-1} intercept abundant rate of light interception. Similar result was reported by Baskar *et al*. (2013).

Effects on yield attributes and yield

The yield attributes and yield of finger millet were significantly influenced by different plant geometry and graded NPK levels.

Yield attributes such as number of productive tillers hill^{-1} (7.3), number of fingers earhead^{-1} (7.5), finger length (9.8 cm), and test weight (2.8 g) were higher with the spacing of 25 × 25 cm + 150% RDF followed by 25 × 25 cm + 125% RDF. Wider spacing with higher dose of fertilizer might have attributed to development of effective source with better translocation of synthates from source to sink resulted in higher yield attributes. The lower yield attributes were recorded under absolute control. The combination of different spacing with graded NPK levels registered grain and straw yield from 1659 and 3077 to 2692 and 4129 kg ha^{-1} respectively. Higher grain and straw yield was recorded under the spacing of 25 × 25 cm + 150% RDF (2692 and 4129 kg ha^{-1}), which was on par with a spacing of 25 × 25 cm + 125% RDF (2646 and 4081 kg ha^{-1}). Wider spacing with higher dose of fertilizer might have attributed to the development of effective source with better translocation of synthates from source to sink, resulting in higher yield. Similar results were found by Maniaji and Waigoge. (2018), Anitha *et al*. (2017), Jat *et al*. (2017) and Mudalagiriyappa *et al*. (2015). It might also be due to the receipt of adequate moisture, light by the plants under wider spacing which resulted in a better environment for growth and more food supply to the plant's reproductive parts (Uddin *et al*., 2011). Square planting (25 × 25 cm) of finger millet with 150 % and 125 % RDF showed 41.8 and 39.4 % respectively, higher grain yield over farmer practices. Yield obtained from spacing of 30 × 30 cm was lower than spacing adopted at 25 × 25 cm because wider spacing does not support the plant to produce higher productive tillers even when we apply higher fertilizer doses. The lowest grain and straw yields of 1659 and 3077 kg ha^{-1}, respectively, were recorded with absolute control.

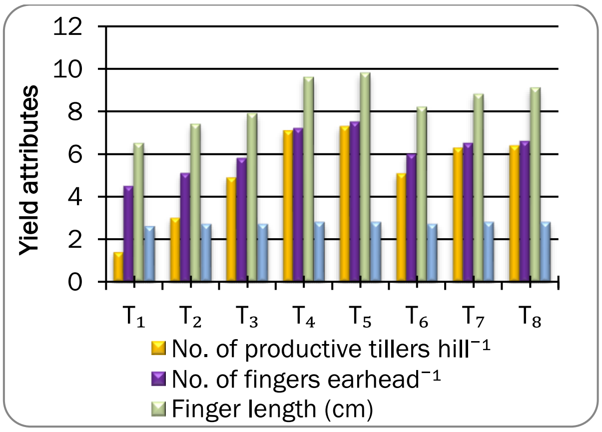

Fig 1. Effect of different plant geometry and graded NPK levels on yield attributes of transplanted finger millet

Table 1. Effect different plant geometry and graded NPK levels on light interception (%) and SPAD values of transplanted finger millet

T. No.	Treatment	SPAD values			Light interception (%)		
		30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
T_1	Absolute control	28.03	32.15	15.63	55.14	63.57	66.09
T_2	30 × 10 cm + 100 % RDF	33.24	39.42	18.95	60.37	72.05	70.25
T_3	25 × 25 cm + 100 % RDF	37.18	46.12	21.86	64.25	76.30	74.68
T_4	25 × 25 cm + 125 % RDF	45.62	59.43	27.60	70.15	87.30	82.16
T_5	25 × 25 cm + 150 % RDF	47.30	61.55	29.17	71.02	88.24	83.68
T_6	30 × 30 cm + 100 % RDF	38.64	47.30	22.05	64.96	78.16	75.74
T_7	30 × 30 cm + 125 % RDF	42.09	52.15	24.71	67.14	82.19	78.65
T_8	30 × 30 cm + 150 % RDF	43.11	53.62	25.15	68.51	83.97	79.87
	SEd	1.07	2.38	0.94	0.72	1.21	0.93
	CD (P=0.05)	3.24	4.75	1.91	1.45	2.70	1.91

Table 2. Effect different plant geometry and graded NPK levels on grain and straw yield (kg ha^{-1}) of transplanted finger millet

T. No.	Treatment	Grain yield	Straw yield
T_1	Absolute control	1659	3077
T_2	30 × 10 cm + 100 % RDF	1898	3328
T_3	25 × 25 cm + 100 % RDF	2294	3726
T_4	25 × 25 cm + 125 % RDF	2646	4081
T_5	25 × 25 cm + 150 % RDF	2692	4129
T_6	30 × 30 cm + 100 % RDF	2358	3789
T_7	30 × 30 cm + 125 % RDF	2478	3913
T_8	30 × 30 cm + 150 % RDF	2514	3950
	SEd	54	59
	CD (P=0.05)	112	121

Conclusion

From the experiment, it is concluded that SPAD values and light interception were higher in square planting (25 × 25 cm) with 150% recommended level N, P and K fertilizer. The same treatment also produced higher yield attributes, grain and straw yield. On the basis of monetary value transplanting the finger millet at optimum plant population of 25 × 25 cm with application of 125% RDF was found to be best choice for obtaining higher yield and profitability.

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Ethics statement

No specific permits were required for the described field studies because no human or animal subjects were involved in this research.

Consent for publication

All the authors agreed to publish the content.

Competing interests

There were no conflicts of interest in the publication of this content.

Author contributions

All authors are equally contributed.

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