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'*Guni*' Method (System of Ragi Intensification) for Enhanced Yield, Nutrient Uptake and Economics in Finger Millet

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ABSTRACT: Finger millet is called as Climate Change Compliant Crop, owing to its capability to withstand water stress, nutrition stress and warming stress. The productivity of finger millet under dry land conditions is low owing to low yielding varieties and poor management practices. Method of planting or establishment and planting geometry plays important role in harnessing the resources to fullest potential. Of late, System of Crop Intensification (SCI) concept is becoming popular in many crops. A study was carried out at Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad to evaluate the performance of rainfed finger millet (cultivar; Bharathi) in '*guni*' method (System of Ragi Intensification, SRI) of planting at different crop geometry during the *kharif* season in 2019-20. The experiment was assigned twelve treatments, laid out in split plot design with three replications. The treatments included: Main plots: 3 methods of establishment; M_1: Direct line sowing, M_2: Transplanting of 25 days old seedlings, M_3: Transplanting of 25 days old seedlings in '*Guni*' method; Subplots: 4 planting geometries; S_1: 30 × 10 cm, S_2: 30 × 30 cm, S_3: 45 × 45 cm and S_4: 60 × 60 cm. The results revealed that number of ear heads, finger length and ear head weight were significantly higher in *guni* method compared to transplanting and direct sowing. Even though large number of ear heads were produced at 30 × 10 cm geometry, the ear head weight, mean finger length were superior at wider spacing. The grain yield (3423 kg ha^{-1}), straw yield (4939 kg ha^{-1}) were significantly enhanced by transplanting of 25 days old seedlings in '*guni*' method at 45×45 cm spacing over other treatment combinations. The nutrient uptake (N, P and K) and B-C ratio were also higher in '*guni*' method at 45 × 45 cm spacing but N availability after the harvest of the crop was lower in '*guni*' method compared to direct sowing and transplanting. Hence, it can be concluded that transplanting of 25 days old seedlings in '*guni*' method with 45 × 45 cm spacing performed better than mere transplanting of 25 days old seedlings and direct line sowing method in finger millet.

Keywords: Economics, Finger millet, '*Guni'* method, Plant Uptake, Yield attributes, Yield.

INTRODUCTION

Finger millet is small seeded grass, self-pollinated, robust, tufted and tillered annual cereal crop (Michaelraj and Shanmugam 2013). The crop can withstand three challenges *i.e.* warming stress, water stress and nutrition stress therefore; called as Climate Change Compliant Crop (CCCC) (Ferry, 2014). It is cultivated over an area of 1.19 million hectares with a production of 1.98 million tonne giving an average productivity of 1661 kg per ha. Karnataka accounts for 56.21 and 59.52% of area and production of finger millet followed by Tamil Nadu (9.94% and 18.27%), Uttarakhand (9.40% and 7.76%) and Maharashtra (10.56% and 7.16%), respectively (http://www.indiastat.com). It is still dominated as marginal crop and grown under poor management. Rigorous research efforts have been made to improve the productivity and sustainability of finger millet since half century in India. With the release of new varieties along with good agronomic practices, it has been possible to achieve substantial increase in yield levels and productivity. Production potential of finger millet under dry land conditions is influenced by many factors *viz.*, improved varieties, methods of planting or establishment, planting geometry, nutrient management etc. In this direction, the method of establishment called System of Crop Intensification (SCI) is a recent practice and not much work has been done on this aspect.

System of Crop Intensification previously called as System of Root Intensification (SRI) was practiced only in rice to increase the yield of rice (Abraham *et al.*, 2014) by planting the single young seedling at wider spacing. SCI approach facilitates the use of young seedling and wider spacing. The main objective of SCI is to produce more from less using fewer seed and less water but manage the relationship between plant and soil so this is called as low input approach (Abraham *et al.*, 2014). It enables the crop to grow and develop potentially which provides enhanced production in sustainable and ecofriendly manner. Therefore, classical crop cultivation practices needs to overhaul by adopting system of crop intensification for more profitable and sustainable agriculture (Gupta *et al*., 2018).

Planting method varies among farmers according to their choice; leisure period, labour availability and wage rates etc. The most practiced method in finger millet is broadcasting and random transplanting. There is uneven distribution of plants which causes the competition among plants for moisture and nutrients. Yield enhancement in finger millet is possible when cultivated with SCI, because there is less competition among plants and weed, plants can utilize below and above ground resources efficiently (Bhatta *et al*., 2017). *Guni* or *guli* is the vernacular name in Kannada language representing the idea of SCI in finger millet also called as scooping method. In '*guli'* ragi cultivation, young millet seedlings 20–25 days old are transplanted into holes spaced 45 × 45 cm in a square grid pattern, two seedlings per hole. Guli ragi includes putting a handful of compost or manure into each hole along with the seedlings to boost soil fertility (Adhikari *et al*., 2018). Further, when the plants are established in a square grid, inter-cultivation between rows is possible in perpendicular directions, not just between rows. It is similar to SRI method of paddy cultivation called as "System of Ragi Intensification" (http://agritech.tnau.ac.in). In the awake of the attempts to popularize this concept and surge in the interest of farmers, a need has risen to generate the scientific data to validate this concept.

MATERIALS AND METHODS

A field experiment was conducted during *kharif*, 2019-2020 at Agricultural College Farm, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad with twelve treatments laid out in split plot design with three replications. The soil of the experimental site was sandy clay loam in texture, neutral in reaction (pH 7.11), low in organic carbon (0.48 %) and available nitrogen (121 kg ha^{-1}), medium in available phosphorous (32.2 kg ha^{-1}) and available potassium (219 kg ha^{-1}). Treatments included Main plots; Methods of establishment M_1: Direct line sowing, M_2: Transplanting of 25 days old seedlings, M_3: Transplanting of 25 days old seedlings in '*Guni*' method; Subplots: planting geometries: 4, S_1: 30 × 10 cm, S_2: 30 × 30 cm, S_3: 45 × 45 cm and S_4: 60 × 60 cm. Finger millet variety 'Bharati' (UR 762) was used for the experiment.

The experimental field was ploughed under dry condition with tractor drawn disc plough followed by ploughing with cultivator and the clods were broken with rotovator. Finally, the field was uniformly leveled and laid out into experimental plots separated by buffer channels as per the treatments. Direct sowing was taken up as per the treatments on 18th July, 2019. On the same day, seeds were sown in the nursery for transplanting in M_2 and M_3. The nursery area taken for raising seedlings was @ 150 m^2 per ha. The land was ploughed and beds were prepared with a bed size of 2.0 m × 2.0 m. The seeds were line sown evenly on the beds. Powdered FYM was evenly sprinkled to cover the seeds and watering was done at evening hours. After 15 days top dressing was done at 250 g of urea for every seed bed. Seedlings were ready for transplanting at 25 DAS. In M_2 treatment i.e., transplanting of the seedlings were taken up in different geometries as per the treatments @ 2-3 seedlings per hill on 12th August, 2019. For '*guni'* method, the individual plots were uniformly leveled and small *gunis* or scoops were formed manually using spade at an intersect point of 30 cm × 10 cm, 30 cm × 30 cm, 45 cm × 45 cm and 60 cm × 60 cm spacing. A well rotten FYM @ 1 kg/scoop as spot placement was made to '*guni'* planting method. On the same day i.e., 12th August, 2019, transplanting of 25 days old seedlings was done in the centre of the '*guni'* @ 2-3 seedlings per hill. The row to row and plant to plant spacing were kept 30 cm × 10 cm, 30 cm × 30 cm, 45 cm × 45 cm, 60 cm × 60 cm as per the treatments.

Recommended dose of N, P_2O_5 and K_2O (40:30:25 kg ha^{-1}) were applied in the form of urea, single super phosphate and muriate of potash. Half dose of N and full dose of P_2O_5 and K_2O were applied as basal dose. Remaining quantity of nitrogen was applied to soil in two equal splits at tillering and panicle emergence.

Sampling: In order to record the yield parameters in each net plot, five representative plants were randomly selected and tagged. All the successive observations were recorded on the selected plants during the crop growth period. One row on either side of the plot and two plants on either end of each row were harvested as border rows. Besides this, one crop row was ear marked for periodical destructive sampling to estimate leaf area and dry matter production. The remaining plants in the plot were considered as net plot including five tagged plants which were harvested separately and after recording yield was added to net plot yield. The ear heads of finger millet in the net plot were harvested separately for each treatment at harvest stage and dried separately. Then ear heads of each plot were threshed manually, winnowed and cleaned separately. The straw in each net plot was harvested separately and sun dried. The grain and straw weight were recorded and converted to hectare. Experimental data obtained were subjected to statistical analysis adopting Fisher's method of 'analysis of variance' as out lined by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

A. Yield attributes

The yield attributes like number of ear heads per square meter, weight of ear head, and length of finger were significantly influenced by establishment method and crop geometry while number of fingers per ear head and test weight varied only due to crop geometry. The number of ear heads per unit area increased significantly with transplanting 25 days over direct line sowing and in *guni* method again over transplanting method. Highest number of ear heads were produced at 30 x 10 cm spacing compared to all the other wider spacing. But the mean weight of single ear head was more than doubled at each successive wider spacing compared to the previous one. Highest weight (13.1g) was recorded at 60 × 60 cm. Further, it was also significantly superior in *guni* method compared to direct sowing. Similarly, the mean finger length was enhanced significantly in transplanting method over direct sowing and further with *guni* method. Crop geometry also influenced the finger length which was enhanced significantly at 60 × 60 cm over 30 × 30 cm and 30 × 10 cm.

The number of ear heads per square meter and length of the fingers were also discernibly influenced by the interaction of both establishment method and crop geometries (Table 1). The combination of transplanting of 25 days old seedlings in *guni* method with 30 cm x 10 cm crop geometry recorded distinct and significantly higher yield attributes as compared to rest of the treatment combinations tested. On the other hand, the significantly lowest number of ear heads per square meter, number of fingers per ear head and length of the finger of finger millet was recorded with the treatment combination of direct line sowing with 60 cm × 60 cm crop geometry. Further, the treatment combination of direct line sowing with 45 cm × 45 cm crop geometry and transplanting of 25 days old seedlings with 60 cm × 60 cm crop geometry were at par to each other and significantly superior over direct line sowing with 60 cm × 60 cm crop geometry combination. The higher number of ear heads per square meter and test weight with transplanting of 25 days old seedlings in *guni* method with 30 cm × 10 cm crop geometry could be marked out due to presence of more number of plants per unit area with concurrent availability of space, moisture content and nutrients *guni* method. The interaction effect between establishment method and crop geometry was not significant with respect to weight of ear head (g), number of fingers per ear head and test weight of finger millet.

Ahiwale *et al.* (2011) also found that the finger millet crop established by transplanting at 20 cm × 15 cm spacing (Thomba method) produced higher ear weight and grain weight per ear. Further, the present results are in consonance with those of Navale (2013).

B. Yield

Data presented in Table 2 indicated that grain and straw yield were influenced by establishment method, geometry and their interaction. Among all the tested combinations, M_3S_3 (Transplanting of 25 days old seedlings in *guni* method with 45 cm × 45 cm crop geometry) recorded the significantly higher grain yield (3423 kg ha^{-1}), straw yield (4939 kg ha^{-1}) and harvest index (0.38) which was comparable with M_3S_4 (Transplanting of 25 days old seedlings in *guni* method with 60 cm × 60 cm crop geometry) treatment combinations. On the other hand, the significantly lowest grain yield of 1663 kg ha^{-1} and straw yield of 3245 kg ha^{-1} was recorded with the treatment combination of M_1S_4 (Direct line sowing with 60 cm × 60 cm) and which was statistically comparable with that of M_1S_3 (Direct line sowing with 45 cm × 45 cm) crop geometry. Under optimum spaced environment (45 cm × 45 cm), the number of productive tillers per unit area and weight of ear heads were higher on per unit basis eventually which results in production of higher grain yield at the end. These results are also in consonance with the findings of Uphoff (2002) in SRI method of rice cultivation. Harvest index was also higher in *guni* method and 45 × 45 cm spacing. Roy *et al*. (2002); Zhu *et al*. (2002) also reported that planting of finger millet under wider spacing than closer spacing improved canopy photosynthesis, increased the percentage of productive tillers and ear head formation. Adhikari (2016) reported from Odisha that improved varieties of finger millet produced 4.8 tonnes/ha under SCI/SFI management, while local varieties gave 4.2 tonnes/ha with these methods. The highest yield recorded was 6 tonnes/ha. On fertile soils, finger millet yields with SCI methods have been found to average 4.5–4.7 tonnes/ha, a four-fold increase over farmers' usual yields. In Nepal also, SCI grain yield was 82% higher than with direct-seeding, and 25% more than transplanting (Bhatta *et al*., 2017). Natarajan *et al*. (2019) from Tamil Nadu reported that 30 cm × 30 cm and 25 × 25 cm (wider spacing) was found to give better yields of finger millet in SCI compared to closer spacing i.e., 20 cm × 20 cm.

C. Crop Nutrient Uptake

Nutrient uptake is the process of nutrient movement from an external environment into plant. It is one of the fundamental processes of plant's life which involves qualitative change where an abiotic material becomes a component of a cell, capable of further assimilation.

Higher nitrogen (109.8 kg ha^{-1}), phosphorus (24.1 kg ha^{-1}) and potassium (62.9 kg ha^{-1}) uptake was evident from M_3S_3 (transplanting of 25 days old seedlings in '*guni'* method with 45 cm × 45 cm crop geometry) which was statistically at par with that of M_3S_4 i.e., transplanting of 25 days old seedlings in '*guni'* method with 60 cm × 60 cm crop geometry treatment combinations. On the other hand, the significantly lowest nitrogen uptake of 62.4 kg ha^{-1}, phosphorous uptake of 12.1 kg ha^{-1} and potassium uptake of 45.0 kg ha^{-1} was recorded with the treatment combination of M_1S_4 (direct line sowing with 60 cm × 60 cm) and which was statistically comparable with that of M_1S_3 (direct line sowing with 45 cm × 45 cm) crop geometry. The higher uptake in grain and straw was due to increased growth parameters like plant height, number of leaves plant^{-1}, number of tillers hill^{-1} dry matter production and yield parameters like number of productive tillers hill^{-1}, number of finger hill, finger length, grain yield plant^{-1}, ear head weight and 1000 grain weight in widely spaced plants which was due to favorable environment and less competition among plants provided by wider spacing helped the plants to take up more nutrients. Ram *et al*. (2014); Kumar (2015) also reported the similar findings.

Table 1: Yield attributes of finger millet as influenced by methods of establishment and crop geometry.

Treatment	Number of ear heads m^{-2}				Weight of ear head (g)				Number of fingers ear $head^{-1}$				Length of finger (cm)				Test weight (g)			
	Establishment method (M)																			
Crop geometry (S)	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	99.7	119.3	138.0	119.0	2.9	3.1	3.1	3.0	4.0	4.3	4.3	4.2	4.4	4.6	4.8	4.6	3.03	2.80	3.07	2.97
S_2	57.3	79.3	79.7	72.1	6.1	5.8	6.8	6.2	4.0	4.7	5.7	4.8	4.4	4.9	5.0	4.8	3.10	3.23	3.23	3.19
S_3	30.3	42.3	62.3	45.0	9.1	10.1	9.4	9.5	5.7	5.3	6.0	5.7	4.9	5.4	5.8	5.4	3.20	3.27	3.40	3.29
S_4	21.7	30.7	37.7	30.0	11.8	13.1	14.4	13.1	6.0	6.0	6.3	6.1	5.0	5.7	5.9	5.5	3.15	3.43	3.40	3.33
Mean	52.3	67.9	79.4		7.5	8.0	8.4		4.9	5.1	5.6		4.7	5.1	5.4		3.12	3.18	3.28	

For comparison the mean of	SEm±	CD(P=0.05)	SEm±	CD(P=0.05)	SEm±	CD(P=0.05)	SEm±	CD(P=0.05	SEm±	CD (P=0.05)
Establishment method (M)	0.8	3.0	0.1	0.6	0.2	NS	0.07	0.27	0.06	NS
Crop geometry (S)	0.5	1.5	0.2	0.7	0.1	0.4	0.04	0.12	0.06	0.17
Sub plot (S) at same level of main plot (M)	0.9	2.7	0.4	NS	0.2	NS	0.07	0.21	0.04	NS
Main plot (M) at same level of sub plot (S)	1.3	3.8	0.5	NS	0.3	NS	0.11	0.32	0.04	NS

Establishment method:
M_1: Direct line sowing
M_2: Transplanting of 25 days old seedlings
M_3: Transplanting of 25 days old seedlings in *Guni* method (Scooping)

Crop geometry:
S_1: 30 cm × 10 cm
S_2: 30 cm × 30 cm
S_3: 45 cm × 45 cm
S_4: 60 cm × 60 cm

Table 2: Grain yield (kg ha^{-1}), Straw yield (kg ha^{-1}) and Harvest Index of finger millet as influenced by methods of establishment and crop geometry.

Treatment	Grain yield (kg ha^{-1})				Straw yield (kg ha^{-1})				Harvest Index			
	Establishment method (M)											
Crop geometry (S)	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	1747	2206	2552	2168	3936	4122	4467	4175	0.31	0.35	0.36	0.34
S_2	2028	2670	3093	2597	4057	4363	4667	4362	0.33	0.38	0.40	0.37
S_3	1915	2565	3423	2634	3336	4398	4939	4224	0.37	0.37	0.40	0.38
S_4	1663	2406	3295	2455	3245	4279	4973	4166	0.34	0.36	0.40	0.37
Mean	1838	2462	3091		3644	4290	4762		0.34	0.36	0.39	

For comparison the mean of	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)
Establishment method (M)	39	152	112	438	0.003	0.012
Crop geometry (S)	58	173	64	NS	0.006	0.019
Sub plot (S) at same level of main plot (M)	101	300	111	329	0.011	NS
Main plot (M) at same level of sub plot (S)	110	299	170	518	0.012	NS

Establishment method:
M_1: Direct line sowing
M_2: Transplanting of 25 days old seedlings
M_3: Transplanting of 25 days old seedlings in *Guni* Method (Scooping)

Crop geometry:
S_1: 30 cm × 10 cm
S_2: 30 cm × 30 cm
S_3: 45 cm × 45 cm
S_4: 60 cm × 60 cm

Table 3: Nutrient uptake (kg ha^{-1}) of finger millet as influenced by method of establishment and crop geometry at harvest.

Treatment	Nitrogen uptake (kg ha^{-1})				Phosphorus uptake (kg ha^{-1})				Potassium uptake (kg ha^{-1})			
	Establishment method (M)											
Crop geometry (S)	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	69.5	78.5	88.6	78.9	12.7	14.5	17.6	15.0	50.7	56.0	62.2	56.3
S_2	76.0	89.9	100.2	88.7	13.8	16.4	20.0	16.7	55.0	62.8	69.4	62.4
S_3	66.6	89.0	109.8	88.5	12.6	18.5	24.1	18.4	47.9	63.5	77.3	62.9
S_4	62.4	86.0	107.8	85.4	12.1	17.7	24.2	18.0	45.0	60.7	74.6	60.1
Mean	68.6	85.9	101.6		12.8	16.8	21.5		49.6	60.7	70.9	
For comparison the mean of	SEm±		CD (P=0.05)		SEm±		CD (P=0.05)		SEm±		CD (P=0.05)	
Establishment method (M)	1.1		4.2		0.3		1.4		0.9		3.5	
Crop geometry (S)	1.2		3.7		0.3		0.8		0.8		2.5	
Sub plot (S) at same level of main plot (M)	2.2		6.4		0.5		1.5		1.4		4.3	
Main plot (M) at same level of sub plot (S)	2.5		6.9		0.6		1.8		1.8		5.0	

Establishment method:
M_1: Direct line sowing
M_2: Transplanting of 25 days old seedlings
M_3: Transplanting of 25 days old seedlings in *Guni* Method (Scooping)

Crop geometry:
S_1: 30 cm × 10 cm
S_2: 30 cm × 30 cm
S_3: 45 cm × 45 cm
S_4: 60 cm × 60 cm

D. Economics

Significantly higher gross returns (₹ 107614 ha^{-1}), net returns (₹ 53749 ha^{-1}) and B-C ratio (2.46) was recorded with M_3S_3 (transplanting of 25 days old seedlings in '*guni'* method with 45 cm × 45 cm crop geometry) than other combinations but statistically at par with that of M_3S_4 (transplanting of 25 days old seedlings in '*guni*' method with 60 cm × 60 cm crop geometry) treatment combination (Table 4). The treatment combination *viz*; M_3S_2 (transplanting of 25 days old seedlings in '*guni'* method with 30 cm × 30 cm) and M_3S_4 (transplanting of 25 days old seedlings in '*guni'* method with 60 cm × 60 cm) performed statistically at par to each other however both of them are significantly superior over M_3S_1 (direct line sowing with 30 cm × 10 cm). On the other hand, the significantly lowest monetary returns were recorded with the M_1S_4 combination (direct line sowing with 60 cm × 60 cm) and which was statistically comparable with that of M_1S_3 (direct line sowing with 45 cm × 45 cm) crop geometry.

The higher returns observed in '*guni'* method of establishment could be due to higher grain and straw yields obtained in this treatment. Such results were also documented by Basavaraj and Rao (1997); Shivakumar (1999). Kumar *et al*. (2019) also recorded higher B-C ratio in finger millet in System of finger millet Intensification compared to farmers practice.

E. Chemical properties of the soil after crop harvest

The data pertaining to soil pH, electrical conductivity (dS m^{-1}), organic carbon (%), available nitrogen (kg ha^{-1}), available phosphorus (kg ha^{-1}) and available potassium (kg ha^{-1}) after harvest of finger millet as influenced by establishment method and crop geometry is presented in Table 5.

The establishment methods and different crop geometries in finger millet had no influence on soil pH, electrical conductivity, organic carbon and available potassium recorded after harvest of the crop. On the other hand, there was a noticeable difference in available nitrogen and phosphorus in the soil. The available nitrogen recorded was significantly higher (173.1 kg ha^{-1}) when finger millet was grown with direct line sowing method and lowest (169.6 kg ha^{-1}) was recorded when 25 days old seedlings were grown under *guni* method of planting. Similar results were also observed with available phosphorus and available potassium with respect to method of sowing. Such similar findings were also reported by Prakasha (2015) in finger millet western dry zone of Karnataka.

The lower soil available nutrient status after harvest of crop in '*guni'* method was mainly due to higher uptake of nutrients from soil because of higher grain and straw yield. Whereas, higher soil available nutrients in wider spacing (60 cm × 60 cm) was due to lower uptake of nutrients because of realization lower grain and straw yield of finger millet.

Table 4: Economics of finger millet as influenced by methods of establishment and crop geometry.

Treatment	Gross returns (₹ha^{-1})				Net returns (₹ ha^{-1})				B:C ratio			
	Establishment method (M)											
Crop geometry (S)	**M_1**	**M_2**	**M_3**	**Mean**	**M_1**	**M_2**	**M_3**	**Mean**	**M_1**	**M_2**	**M_3**	**Mean**
S_1	56331	70302	81027	69220	21446	33566	37292	30768	1.61	1.91	1.85	1.79
S_2	64907	84473	97462	82281	30021	47738	53727	43829	1.86	2.30	2.23	2.13
S_3	60791	81333	107614	83246	25906	44597	63879	44794	1.74	2.21	2.46	2.14
S_4	53130	76459	103833	77807	18245	39723	60098	39355	1.52	2.08	2.37	1.99
Mean	58790	78142	97484		23904	41406	53749		1.69	2.13	2.23	
For comparison the mean of	SEm±		CD (P=0.05)		SEm±		CD (P=0.05)		SEm±		CD (P=0.05)	
Establishment method (M)	1106		4345		1106		4345		0.30		1.00	
Crop geometry (S)	1751		5202		1751		5202		0.50		1.13	
Sub plot (S) at same level of main plot (M)	3033		9010		3033		9010		0.80		1.23	
Main plot (M) at same level of sub plot (S)	3291		8878		3291		8878		0.80		1.22	

Establishment method:
M_1: Direct line sowing
M_2: Transplanting of 25 days old seedlings
M_3: Transplanting of 25 days old seedlings in *Guni* Method (Scooping)

Crop geometry:
S_1: 30 cm × 10 cm
S_2: 30 cm × 30 cm
S_3: 45 cm × 45 cm
S_4: 60 cm × 60 cm

Table 5: Post harvest soil chemical properties as influenced by methods of establishment and crop geometry.

Treatment	pH	EC (d Sm^{-1})	OC (%)	Available Nitrogen (kg ha^{-1})	Available Phosphorus (kg ha^{-1})	Available Potassium (kg ha^{-1})
Establishment method (M)						
M_1	7.34	0.290	0.48	173.1	60.8	208.8
M_2	7.54	0.270	0.49	170.1	56.9	206.6
M_3	7.42	0.293	0.50	169.6	56.3	205.7
SEm±	0.07	0.006	0.00	0.4	0.8	0.9
CD (P=0.05)	NS	NS	NS	1.6	3.0	NS
Crop geometry (S)						
S_1	7.45	0.270	0.49	170.6	57.8	208.5
S_2	7.43	0.285	0.49	171.2	57.8	207.7
S3	7.49	0.299	0.49	170.8	58.2	206.5
S4	7.37	0.284	0.48	171.1	58.1	205.5
SEm±	0.06	0.008	0.01	0.6	0.5	0.8
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Interaction						
SEm±	0.10	0.013	0.01	1.1	0.8	1.3
CD (P=0.05)	NS	NS	NS	NS	NS	NS

Establishment method:
M_1: Direct line sowing
M_2: Transplanting of 25 days old seedlings
M_3: Transplanting of 25 days old seedlings in *Guni* Method (Scooping)

Crop geometry:
S_1: 30 cm × 10 cm
S_2: 30 cm × 30 cm
S_3: 45 cm × 45 cm
S_4: 60 cm × 60 cm

CONCLUSION

From the present study, it can be concluded that transplanting of rainfed finger millet in '*guni'* method at 45 cm × 45 cm spacing led to enhanced yield, nutrient uptake and improved economics.

FUTURE SCOPE

1. As square planting proved to be advantageous for yield improvement in finger millet, the scope of mechanization in its cultivation can be studied.
2. As FYM has become a costly input, alternate effective and cheaper sources of organic matter may be worked out for use in *guni* method.
3. Role of microbial consortia in yield enhancement of finger millet can be studied.
4. Effective weed management method needs to be evolved under wider spacing.

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