Effect of crop establishment methods on performance of different finger millet {*Eleusine coracana* (L) Gaertn} varieties

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ABSTRACT

A field experiment was conducted during the kharif season of 2022 at the post-graduate experimental farm of the MS Swaminathan School of Agriculture, Gajapati, Odisha, to evaluate the effect of crop establishment methods on the performance of different finger millet varieties. The experiment was laid out in a strip plot design with three crop establishment methods {direct sowing, transplanting and system of crop intensification (SCI)} and four varieties (Arjuna, Bhairabi, Chaitanya and VL Mandua 352). The results revealed that SCI significantly improved growth parameters such as plant height, dry matter accumulation, number of tillers and leaf area index compared to other methods. Yield attributes including number of fingers per earhead, finger length, effective tillers, grains per earhead and earhead weight were also superior under SCI. Consequently, SCI recorded the highest grain yield (2,331 kg/ha), straw yield (4,873 kg/ha) and biological yield (7,205 kg/ha). Among the varieties, VL Mandua 352 performed the best, exhibiting superior growth, yield attributes and yield, followed by Chaitanya. The interaction effect between crop establishment methods and varieties was found to be non-significant for most parameters. Overall, the study highlights that adopting SCI along with high-yielding varieties like VL Mandua 352 can substantially enhance finger millet productivity under similar agro-climatic conditions.

Keywords: Finger millet; Crop establishment methods; System of Crop Intensification; Yield attributes; VL Mandua 352; Productivity

INTRODUCTION

Finger millet (*Eleusine coracana*) is one of the most important food grain crops among all the minor millets, grown on moderate hill slopes as a staple food where rice is impossible to grow (Baduni et al 2024). It is a drought-tolerant crop, grown for both grain and fodder purposes. In India, finger millet is cultivated under 1.19 million hectares and the production is 1.98 million tonnes with an average productivity of 1,661 kg per ha (Pramanick et al 2024). In Odisha, in 2023-24, this crop was grown over an area of 206.16 thousand hectares that yielded of 1,364 kg per ha (Anon 2024). As the productivity of the state is lesser than nation, it is needed to fill this gap to ensure food security for the rapidly growing population. Method of crop establishment is an important agronomic factor to enhance the crop growth, yield and quality of the produce by efficiently utilizing the resources. Farmers used to select different crop establishment methods based on their choice, leisure period, nature of the cultivated land etc. Among the various methods of millet intensification, the system of crop intensification (SCI) involves transplanting young seedlings at wider spacing, with the primary objective of obtaining higher yields with fewer inputs (Shashikala et al 2021). Therefore, the SCI method minimizes competition among plants, enabling more efficient utilization of available resources, which ultimately leads to higher yield (Bhatta et al 2017). Crop yield is influenced by several factors,

including climatic conditions, the genetic yield potential of the variety, soil (edaphic) characteristics and management practices.

Among the various factors, variety is one of the most important determinants of crop performance. The primary objective of varietal improvement is to enhance both the quality and quantity of produce (Sarawale et al 2016).

In finger millet, the development and release of high-yielding varieties have significantly contributed to yield improvement. To assess the production potential of a newly released cultivar under specific agro-climatic conditions, it is essential to evaluate it using recommended agronomic practices.

MATERIAL and METHODS

The field experiment was conducted during the kharif season of 2022 at the post-graduate experimental farm of the MS Swaminathan School of Agriculture, located in Gajapati district, Odisha (18°482 163 N latitude, 84°102 483 E longitude, 64 m amsl). The soil of the experimental site was sandy clay in texture, slightly acidic in reaction (pH 6.2) and had low electrical conductivity (0.5 dS/m). The organic carbon content was low (0.39%). The available nitrogen content was low (228 kg/ha), while available phosphorus and potassium were in the medium range (14 and 120 kg/ha respectively).

Direct sowing was carried out on 27 June 2022 and the nursery bed for transplanting and SCI was prepared on the same day. Planting under SCI was done on 11 July 2022, followed by transplanting on 18 July 2022 and the crop was harvested on 20 October 2022. The weekly minimum and maximum temperatures during the crop growth period ranged from 22 to 34°C, while relative humidity varied between 74 and 92 per cent.

The experiment was laid out in a strip plot design with three replications and twelve treatment combinations. The vertical factor consisted of three crop establishment methods (M_1: Direct sowing, M_2: Transplanting, M_3: System of crop intensification), while the horizontal factor comprised four varieties (V_1: Arjuna, V_2: Bhairabi, V_3: Chaitanya, V_4: VL Mandua 352). Seeds in direct sowing were sown at a spacing of 25 cm between rows and 10 cm between plants and the same spacing was maintained for transplanting. Under SCI, a spacing of 25 cm × 25 cm was followed.

The seed rate for direct sowing was 8 kg per ha, while for nursery bed preparation under transplanting and SCI, it was 4 kg per ha. Each plot measured 5 m × 4 m and was separated by a bund of 25 cm width and an irrigation channel of 50 cm. The recommended dose of fertilizers for finger millet was 50:30:20 kg per ha of N, P_2O_5 and K_2O, applied through urea, SSP and MOP respectively. Half of the nitrogen and the full dose of phosphorus and potassium were applied at the time of direct sowing, transplanting and SCI, while the remaining dose of nitrogen was applied at 35 DAS/DAT.

Destructive plant samples were collected from each plot at 30, 60 and 90 DAS as well as at harvest, for recording observations. The data were analyzed statistically using standard ANOVA techniques and the significance of differences among treatment means was tested using appropriate critical difference (CD) values at the 5 per cent level of significance (Gomez and Gomez 1984).

RESULTS and DISCUSSION

Effect of crop establishment methods on growth parameters of finger millet

The growth parameters such as plant height, dry matter accumulation, number of tillers per m^2 and leaf area index (LAI) were noted to be influenced significantly with different crop establishment methods (Table 1). The maximum plant height (114 cm), dry matter accumulation (731.47 g/m^2) and LAI (3.35) were obtained under SCI method and the minimum (105 cm, 582.37 g/m^2 and 2.86 respectively) in direct sowing. SCI and transplanting methods resulted in higher number of tillers per m^2 at 90 DAS (106.49 and 92.83 respectively) as compared to direct sowing (81.84) which was at par with transplanting method.

Among varieties, VL Mandua 352 and Chaitanya exhibited maximum plant height (113 and 111 cm respectively), which were at par. However, Chaitanya was at par with Arjuna (109 cm). Minimum plant height was observed in Bhairabi (106 cm). VL Mandua 352 also recorded maximum dry matter accumulation (759.13 g/m^2) and LAI at 90 DAS (3.15) as compared to minimum in Arjuna (584.96 g/m^2 and 3.06 respectively). VL Mandua 352 and Chaitanya

Table 1. Effect of crop establishment methods on growth parameters of finger millet varieties

Treatment	Plant height at harvest	Dry matter accumulation at harvest (g/m^2)	Number of tillers/m^2 at 90 DAS	Leaf area index at 90 DAS
Crop establishment method (M)				
M_1: Direct sowing	105	582.37	81.84	2.86
M_2: Transplanting	109	651.88	92.83	3.12
M_3: System of crop intensification	114	731.47	106.49	3.35
SEm±	0.12	3.09	4.30	0.005
$CD_{0.05}$	0.77	12.13	16.87	0.021
Variety (V)				
V_1: Arjuna	109	615.89	90.38	3.10
V_2: Bhairabi	106	584.96	87.11	3.06
V_3: Chaitanya	111	660.98	96.14	3.11
V_4: VL Mandua 352	113	759.13	101.25	3.15
SEm±	0.51	3.56	2.84	0.004
$CD_{0.05}$	2.30	12.31	9.81	0.012
Interaction (M×V)				
SEm±	0.79	14.10	5.31	0.009
$CD_{0.05}$	NS	NS	NS	NS

resulted in higher number of tillers per m^2 (101.25 and 96.14) as compared to Bhairabi (87.11 cm) and Arjuna (90.38), which were at par and also at par with Chaitanya.

Wider spacing along with liberal supply of nutrients and less competition of the resources might have lead to increased plant height, number of tiller per m^2 and leaf area index which in turn resulted in higher dry matter accumulation under system of crop intensification. These results are in agreement with those of Dahal and Khadka (2012), Dereje et al (2016), Somashekhar and Loganandhan (2020) and Debbarma et al (2024). High photosynthetic capacity may be responsible for the increase in all growth parameters in VL Mandua 352 which is also the reason of higher yield. The increase in growth parameters in finger millet was also reported by Kavitha et al (2010) and Hussain et al (2012).

Effect of crop establishment methods on yield attributes of finger millet

Data given in Table 2 reveal that number of fingers per earhead (7.16) and finger length (7.25 cm) were higher in SCI as compared to direct sowing (6.04 and 5.91 cm respectively) and transplanting (6.34 and 6.14 cm respectively), the latter two being at par. There was no effect of sowing methods on 1000-seed weight. Number of effective tillers per m^2 (99.00), number of grains per earhead (2,580) and dry weight of earhead (7.93 g) were also maximum in SCI and lowest in direct sowing (77.43, 2,265 and 5.82 respectively).

Higher number of fingers per earhead (6.77 and 6.53) was recorded in VL Mandua 352 and Chaitanya respectively, as compared to lower in Bhairabi (6.34) and Arjuna (6.41), which were at par and also at par with Chaitanya. VL Mandua 352 showed maximum number of tillers per m^2 (94.41), finger length (6.98 cm), number of grains per earhead (2,501) and dry weight of earhead (7.53 g) and Bhairabi, the minimum (84.09, 6.01 cm, 2,296 and 6.36 cm respectively). However, the varieties did not differ among themselves in 1,000-seed weight. The interaction effect of crop establishment methods and varieties was also non-significant. In SCI, the provision of adequate spacing, proper nutrient supply, reduced competition and the transplanting of young seedlings with soil and keeping the roots intact resulted in improved yield attributes in VL Mandua 352. These findings are also supported by Debbarma et al (2024).

Effect of crop establishment methods on yield of finger millet

Crop establishment methods had a significant influence on grain yield of finger millet (Table 3).

Table 2. Effect of crop establishment methods on yield attributes of finger millet varieties

Treatment	Number of fingers/	1000-grain	Number of effective tillers/m^2	Finger length	Number of grains/earhead	Dry weight of earhead (g)
Crop establishment method (M)						
M_1: Direct sowing	6.04	3.09	77.43	5.91	2,265	5.82
M_2: Transplanting	6.34	3.12	91.32	6.14	2,343	7.08
M_3: System of crop intensification	7.16	3.17	99.00	7.25	2,580	7.93
SEm±	0.08	0.02	0.20	0.07	4.23	0.06
$CD_{0.05}$	0.30	NS	0.77	0.28	16.59	0.24
Variety (V)						
V_1: Arjuna	6.41	3.12	88.33	6.28	2,348	6.74
V_2: Bhairabi	6.34	3.10	84.09	6.01	2,296	6.36
V_3: Chaitanya	6.53	3.14	90.17	6.46	2,438	7.14
V_4: VL Mandua 352	6.77	3.16	94.41	6.98	2,501	7.53
SEm±	0.13	0.03	0.78	0.04	4.92	0.05
$CD_{0.05}$	0.34	NS	2.71	0.14	17.01	0.18
Interaction (M×V)						
SEm±	0.20	0.04	1.09	0.12	7.38	0.10
$CD_{0.05}$	NS	NS	NS	NS	NS	NS

Table 3. Effect of crop establishment methods on yield of finger millet varieties

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)
Crop establishment method (M)				
M_1: Direct sowing	1,900	3,773	5,673	33.53
M_2: Transplanting	2,195	4,283	6,479	33.89
M_3: System of crop intensification	2,331	4,873	7,205	32.34
SEm±	23.14	67.33	66.21	0.40
$CD_{0.05}$	90.85	264.38	259.98	NS
Variety (V)				
V_1: Arjuna	2,016	3,927	5,944	33.97
V_2: Bhairabi	1,894	3,838	5,733	33.16
V_3: Chaitanya	2,122	4,429	6,551	32.40
V_4: VL Mandua 352	2,536	5,046	7,582	33.49
SEm±	27.97	49.29	59.39	0.35
$CD_{0.05}$	96.80	170.57	205.51	NS
Interaction (M×V)				
SEm±	82.80	128.59	195.86	0.53
$CD_{0.05}$	NS	NS	NS	NS

Among them, significantly highest grain yield (2,331 kg/ha), straw yield (4,873 kg/ha) and biological yield (7,205 kg/ha) were obtained in SCI as compared to lowest in direct sowing (1,900 kg/ha, 3,773 kg/ha and 5,673 kg/ha respectively). There was no significant difference in the harvest index under different crop establishment methods.

Significantly highest grain yield (2,536 kg/ha) and biological yield (7,582 kg/ha) were obtained in VL Mandua 352 and lowest in Bhairabi (1,894 kg/ha and 5,733 kg/ha respectively). Straw yield was also recorded highest in VL Mandua 352 (5,046 kg/ha) and lowest in Bhairabi (3,838 kg/ha) and Arjuna (3,927 kg/ha), the latter two being at par. The varieties did not differ among themselves for the trait harvest index. The interaction effect of crop establishment methods and varieties was also non-significant.

Grain yield is a function of various yield parameters, which is significantly influenced by crop establishment methods. The SCI resulted in higher grain yield, primarily due to its positive effect on yield-attributing traits and dry matter accumulation, which also contributed to increased straw and biological yields.

These findings are consistent with those reported by Shrirame et al (2010), Manjunatha et al (2010) and Debbarma et al (2024). Among the varieties, VL Mandua 352 exhibited superior performance in terms of yield-attributing parameters and dry matter accumulation, resulting in higher grain, straw and biological yields compared to other varieties. Similar results have also been reported by Debbarma et al (2024).

CONCLUSION

The present study clearly demonstrates that crop establishment methods play a crucial role in determining the growth and productivity of finger millet. Among the methods evaluated, the system of crop intensification proved to be the most effective, as it improved growth parameters, enhanced yield attributes and ultimately resulted in higher grain, straw and biological yields. Varietal performance also showed a significant influence on crop productivity, with VL Mandua 352 emerging as the most promising variety due to its superior growth and yield potential.

The combined use of SCI and high-yielding varieties can, therefore, be considered a practical and efficient approach to improving finger millet production. These findings suggest that farmers, especially in regions with similar agro-climatic conditions, can achieve better yields by adopting SCI practices along with suitable high-performing varieties like VL Mandua 352.

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