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Impact of Establishment Methods and Organic Manures on the Growth of Finger Millet (*Eleusine coracana* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted in certified organic field SMOF, SHUATS during *Kharif* season (2021 and 2022) to study the impact of establishment methods, solid and liquid organic manures on growth of finger millet. The experiment was carried out in split-split plot design replicated thrice with 27 treatments. Treatments comprised of three establishment methods (Line sowing, Broadcasting and Transplanting), three solid organic supplements (100% FYM, 100% poultry manure and 100% vermicompost) each in combination with three different liquid organic supplements (3% panchagavya, 3% jeevamrutham and 3% vermiwash, respectively). All three parameters recorded no significant effect at 40 DAS.

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However, at 80 DAS significantly higher plant height 97.85 cm in second year, number of tillers 3.87 and 3.83 first year and pooled respectively, dry weight 49.54, 46.90 and 48.22 g/plant in first, second year and pooled respectively was recorded in Transplanting + Vermicompost + Panchgavya.

Keywords: Finger millet; organic manure; vermicompost; poultry manure; panchagavya; growth.

1. INTRODUCTION

"Finger millet (*Eleusine coracana* L.) is one among the foremost important millet grown for both grain and fodder purpose in India. Finger millet also called as ragi contains higher calcium content which was 10 times more than rice or wheat" [1]. "Finger millet was the third most millet next to sorghum and pearl millet. In India, finger millet constitutes an area of 1.19 m ha with annual production of 1.98 m t and productivity of 1662 kg/ha. In Tamil Nadu, finger millet could be a prominent crop among small millets growing in a part of 0.86 L ha with 3.21 L t production and 3714 kg/ha productivity" (INDIASTAT, 2018).

"The main reasons for low productivity is due to an imbalance in nutrients coupled with adverse climatic conditions, late transplanting, faulty methods of cultivation and little or no use of fertilizers" [2]. "The secret of boosting its yields mainly lies in suitable planting method and properly fertilizing the crop. Proper sowing method is the important non-monetary input in crop production, which affects the crop growth, yield and quality to greater extent. Method of sowing is important agronomic factor affecting the productivity of crop. Method of establishment play important role to fully exploit all available resources for growth as it provides optimum growing condition" [3].

"Intensive cultivation, unbalanced and inadequate fertilizers with restricted use of organic manures have made soil deficient in nutrients and health" [4]. "Therefore, organic farming is gaining importance which mainly involves the use of on-farm resources largely avoiding the utilization of chemical fertilizers. Liquid and solid manures having higher amount of beneficial microbes, macro and micro nutrients, essential amino acids, growth promoting substance like IAA, GA may greatly help in increasing soil microbial population and soil fertility further increasing the crop growth, yield and quality" [5]. "Organic farming practices are gaining importance as farmers realized benefits in terms of soil fertility, soil health and sustainable productivity. Most of the research on organic production of finger millet was applied with utilization of FYM, green manures, compost, neem cake, etc. Less number of researches was done on the effect of liquid organic manures like panchagavya, jeevamrutham, vermiwash alone or together with solid organic manures in finger millet Organic liquid formulations like jeevamrutha and panchgavya helps for quick build-up of soil fertility through enhanced activity of microflora and fauna" [4]. These have the properties of both fertilizer and biopesticide and play a key role in promoting growth and immunity to the plant system. Any combination that reduce the dependence on chemical fertilizers and other resources can go an extended way in maintain the soil fertility as well as the financial conditions of the farming community. Hence, the experiment was carried out with an objective to find out the effect of solid and liquid organic supplements on growth and yield of transplanted finger millet.

2. MATERIALS AND METHODS

A research trial was conducted at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) during *kharif* season of 2021 and 2022 finger millet sown by broadcasting, line sowing and transplanting with spacing of 30 cm x 10 cm. The location is situated at 25.57^{o} N latitude, 87.19^{o} E longitude and at an altitude of 98 m above mean sea level. In broadcasting method of establishment, seeds and fertilizers were dispersed randomly in the experimental plot. In line sowing method, seeds were sown directly and application of fertilizers were done in rows with a definite spacing of 30 cm x 10 cm. Whereas, in transplanting method, 18 days old seedlings were transplanted with a definite row to row and plant to plant pattern of 30 cm x 10 cm with 2 seedlings each. For this, one raised nursery beds were prepared and seeds were sown on beds in a row, so that

seedlings can be uprooted easily at the time of transplanting. As it is a rainfed crop, no irrigation is needed but after transplanting two irrigations with alternate days were given for better crop establishment. Manually two hand weedings were done at 25 and 50 DAS/DAT with '*khurpi'*. At every 20 days interval, observations such as plant height, number of total tillers/plant, Leaf Area Index (LAI) and dry weight. Solid organic manures *viz.* Framyard manure, Poutry manure and Vermicpompost were applied to fulfil the nitrogen requirement. Liquid manures- Vermiwash, Jeevamrutha and Panchgavya were applied to Finger millet crop at an interval of every 20 days after sowing. Necessary aftercare operations were followed as per the recommendations. No major pest and disease incidences were noticed during crop growth. Experimental data collected was subjected to statistical analysis by adopting Fisher's method of Analysis of Variance (ANOVA) as outlined by Gomez and Gomez (1984). Critical Difference (CD) values were calculated whenever the 'F' test was found significant at 5 per cent level.

3. RESULTS AND DISCUSSION

3.1 Plant Height

There was no significant effect in number of tillers at 40 DAS and pooled. AT 80 DAS significantly higher plant height was recorded in Transplanting + VC + Panchgavya (97.85 cm) was recorded in second year. However, treatments Direct sowing + VC + Vermiwash, Transplanting + FYM + Panchgavya, Transplanting + FYM + Vermiwash, Transplanting + PM + Jeevamrut, Transplanting + PM + Vermiwash, Transplanting + PM + Panchgavya and Transplanting + VC + Vermiwash were statistically at par with Transplanting + VC + Panchgavya. This might be due to higher macro and micro nutrient content of the poultry manure which enables continuous slow and steady release of nutrients coupled with panchagavya foliar spray increased the nutrient uptake which might have helped in better growth [6].

3.2 Number of Tillers

There was no significant effect in number of tillers at 40 DAS in both the years and pooled. There was significant effect of interaction effect at 80 DAS in first year and pooled. In first year significantly highest number of tillers was recorded in Transplanting + VC + Panchgavya (3.87). Direct sowing + FYM + Panchgavya, Direct sowing + PM + Panchgavya, Direct sowing + PM + Vermiwash, Direct sowing + VC + Panchgavya, Direct sowing + VC + Vermiwash, Transplanting + FYM + Panchgavya, Transplanting + PM + Jeevamrut, Transplanting + PM + Vermiwash, Transplanting + VC + Vermiwash were statistically at par with Transplanting + VC + Panchgavya. Further, in pooled significantly highest number of tillers was recorded in Transplanting + VC + Panchgavya (3.83). Treatments Direct sowing + PM + Panchgavya, Direct sowing + VC + Panchgavya, Transplanting + FYM + Panchgavya, Transplanting + PM + Vermiwash and Transplanting + VC + Vermiwash were statistically at par with Transplanting + VC + Panchgavya. Transplanted plants would have utilized the available sources such as spacing, forage area for root system, light utilization further enhanced the tiller development [7]. This ensured continuous availability of nutrients throughout the crop growth stages due to steady transformation, mineralization, solubilisation, decomposition of minerals and nutrients that might helped in ensuring superior yield attributing characters by organics. Similar findings were observed with Gawade et al. [8] and Ananda et al. [9].

3.3 Dry Weight

However, in the first year of 80 DAS significantly higher dry weight was recorded in Transplanting + Vermicompost + Panchgavya (49.54 g/plant). Treatments Transplanting + Farmyard Manure + Panchgavya, Transplanting + Farmyard Manure + Jeevamrut, Transplanting + Farmyard Manure + Vermiwash, Transplanting + Poultry Manure + Panchgavya, Transplanting + Poultry Manure + Vermiwash and Transplanting + Vermicompost + Vermiwash were statistically at par with Transplanting + Vermicompost + Panchgavya. Similarly, in the second year Transplanting + Vermicompost + Panchgavya (46.90 g/plant) recorded significantly higher dry weight. However, treatments Transplanting + Farmyard Manure + Panchgavya, Transplanting + Farmyard Manure + Vermiwash, Transplanting + Poultry Manure + Panchgavya, Transplanting + Poultry Manure + Jeevamrut, Transplanting + Poultry Manure + Vermiwash, Transplanting + Vermicompost + Jeevamrut and Transplanting + Vermicompost + Vermiwash were statistically at par with Transplanting + Vermicompost +

Table 1. Interaction effect of establishment methods, solid and liquid organic manures on plant height

Plant Height (cm) 40 DAS													
Treatment		**2021**				**2022**				**POOLED**			
		L1	**L2**	**L3**	**Mean**	**L1**	**L2**	**L3**	**Mean**	**L1**	**L2**	**L3**	**MEAN**
DR	O1	36.71	36.56	35.66	36.31	33.00	31.85	33.95	32.93	34.85	34.20	34.80	34.62
	O2	39.12	35.46	39.83	38.13	41.07	34.75	37.45	37.76	40.09	35.11	38.64	37.95
	O3	38.15	35.99	36.87	37.00	37.44	31.61	34.83	34.63	37.80	33.80	35.85	35.81
BR	O1	33.13	28.17	32.47	31.26	29.76	27.46	28.76	28.66	31.45	27.81	30.62	29.96
	O2	35.83	34.46	32.20	34.16	35.79	34.09	34.49	34.79	35.81	34.28	33.35	34.48
	O3	32.70	31.12	32.25	32.02	34.99	35.41	33.54	34.65	33.84	33.27	32.90	33.33
TR	O1	42.00	40.82	42.35	41.72	40.95	37.44	39.93	39.44	41.48	39.13	41.14	40.58
	O2	48.07	41.84	46.02	45.31	48.69	41.13	44.31	44.71	48.38	41.49	45.17	45.01
	O3	43.95	41.48	44.28	43.24	48.90	41.44	44.24	44.86	46.43	41.46	44.26	44.05
Mean		38.85	36.21	37.99	37.68	38.95	35.02	36.83	36.94	38.90	35.62	37.41	37.31
F-test		NS				NS				NS			
SEm±		1.96				1.60				1.23			
CD (P=0.05)		-				-				-			

Plant Height (cm) 80 DAS													
Treatment		**2021**				**2022**				**POOLED**			
		L1	**L2**	**L3**	**Mean**	**L1**	**L2**	**L3**	**Mean**	**L1**	**L2**	**L3**	**MEAN**
DR	O1	79.89	76.58	79.42	78.63	79.94	75.30	77.78	77.67	79.92	75.94	78.60	78.15
	O2	83.65	82.07	83.03	82.92	85.01	80.23	85.23	83.49	84.33	81.15	82.63	82.70
	O3	80.10	79.97	82.53	80.87	82.37	80.17	87.73	83.42	81.24	80.07	82.13	81.15
BR	O1	74.62	74.58	74.32	74.51	74.42	70.38	73.78	72.86	74.52	72.48	74.05	73.69
	O2	79.38	73.33	78.14	76.95	75.18	73.13	74.61	74.31	77.28	73.23	76.37	75.63
	O3	76.59	76.66	75.48	76.24	80.72	79.46	81.95	80.71	78.65	78.06	78.72	78.48
TR	O1	92.42	85.71	90.92	89.68	89.89	86.51	87.72	88.04	90.66	86.11	89.32	88.70
	O2	98.38	88.17	91.45	92.67	94.29	91.30	94.58	94.58	98.11	89.74	93.01	93.62
	O3	96.16	89.66	93.60	93.14	97.85	86.12	93.40	91.27	95.22	87.89	93.50	92.20
Mean		84.58	80.75	83.21	82.84	84.30	84.41	80.29	84.09	82.93	80.52	83.15	82.70
F-test		NS				S				NS			
SEm±		2.65				2.29				1.74			
CD (P=0.05)		-				10.24				-			

Table 2. Interaction effect of establishment methods, solid and liquid organic manures on number of tillers

No. of tillers													
40 DAS													
Treatment		**2021**				**2022**				**POOLED**			
		L1	**L2**	**L3**	**Mean**	**L1**	**L2**	**L3**	**Mean**	**L1**	**L2**	**L3**	MEAN
DR	O1	1.60	1.40	1.47	1.49	1.33	1.20	1.40	1.31	1.47	1.30	1.43	1.40
	O2	1.80	1.67	1.53	1.67	1.47	1.27	1.67	1.47	1.63	1.47	1.60	1.57
	O3	1.80	1.60	1.53	1.64	1.53	1.47	1.53	1.51	1.67	1.53	1.53	1.58
BR	O1	1.33	1.13	1.33	1.27	1.40	1.27	1.53	1.40	1.37	1.20	1.43	1.33
	O2	1.60	1.40	1.33	1.44	1.53	1.40	1.33	1.42	1.57	1.40	1.33	1.43
	O3	1.80	1.33	1.53	1.56	1.73	1.33	1.67	1.58	1.77	1.33	1.60	1.57
TR	O1	1.73	1.53	1.93	1.73	1.73	1.53	1.80	1.69	1.73	1.53	1.87	1.71
	O2	2.07	1.33	1.47	1.62	1.93	1.40	1.60	1.64	2.00	1.37	1.53	1.63
	O3	2.00	1.73	1.60	1.78	1.67	1.67	2.00	1.78	1.83	1.70	1.80	1.78
Mean		90.23	86.54	89.51	88.76	89.22	83.96	88.01	87.06	89.73	85.25	88.76	87.91
F-test		NS				NS				NS			
SEm±		2.79				2.94				1.92			
CD (P=0.05)		-				-				-			
No. of Tillers													
80 DAS													
Treatment		**2021**				**2022**				**POOLED**			
		L1	**L2**	**L3**	**Mean**	**L1**	**L2**	**L3**	**Mean**	**L1**	**L2**	**L3**	**MEAN**
DR	O1	3.33	3.07	3.20	3.29	3.40	3.33	3.20	3.22	3.37	3.20	3.20	3.26
	O2	3.47	3.20	3.27	3.38	3.60	3.40	3.33	3.38	3.53	3.30	3.30	3.38
	O3	3.73	3.00	3.40	3.49	3.40	3.33	3.27	3.22	3.57	3.17	3.33	3.36
BR	O1	3.10	2.60	3.13	2.93	2.87	2.47	2.67	2.71	3.03	2.53	2.90	2.82
	O2	2.93	2.87	2.47	3.09	2.80	2.87	3.00	2.87	2.87	2.83	3.23	2.98
	O3	2.73	2.67	2.47	3.02	2.67	2.67	2.93	2.80	2.80	2.73	3.20	2.91
TR	O1	3.60	3.20	3.07	3.31	3.65	3.27	3.40	3.40	3.60	3.23	3.23	3.36
	O2	2.87	3.27	3.73	3.36	3.60	3.47	3.60	3.56	3.23	3.37	3.77	3.46
	O3	3.87	3.07	3.53	3.49	3.80	3.20	3.53	3.51	3.83	3.13	3.53	3.50
Mean		**3.32**	**3.10**	**3.36**	**3.26**	**3.30**	**3.01**	**3.24**	**3.19**	**3.31**	3.06	**3.30**	3.22
F-test		S				NS				S			
SEm±		0.20				0.16				0.11			
CD (P=0.05)		0.64				-				0.37			

Table 3. Interaction effect of establishment methods, solid and liquid organic manures on dry weight

Dry weight													
40 DAS													
Treatment		**2021**				**2022**				**POOLED**			
		L1	**L2**	**L3**	**Mean**	**L1**	**L2**	**L3**	**Mean**	**L1**	**L2**	**L3**	**MEAN**
DR	O1	6.20	5.15	6.48	5.94	5.71	4.82	5.38	5.31	5.96	4.99	5.93	5.62
	O2	8.41	6.64	7.35	7.47	6.28	5.14	6.14	5.86	7.34	5.89	6.75	6.66
	O3	7.38	5.74	6.45	6.52	8.41	6.59	7.93	7.64	7.90	6.17	7.19	7.08
BR	O1	5.11	4.71	4.77	4.86	5.15	4.97	4.98	5.03	5.13	4.84	4.87	4.95
	O2	5.14	4.24	5.03	4.80	5.38	5.24	5.87	5.50	5.26	4.74	5.45	5.15
	O3	5.48	5.21	4.58	5.09	7.99	9.48	7.75	8.41	6.73	7.34	6.17	6.75
TR	O1	7.28	7.99	8.86	8.04	6.48	5.95	5.52	5.99	6.88	6.97	7.19	7.01
	O2	9.49	8.14	9.10	8.91	9.10	7.36	6.58	7.68	9.30	7.75	7.84	8.30
	O3	10.16	8.42	9.05	9.21	9.86	9.10	8.38	9.12	10.01	8.76	8.72	9.16
Mean		1.59	1.46	1.75	1.60	1.42	1.27	1.56	1.42	1.51	1.36	1.66	1.51
F-test		NS				NS				NS			
SEm±		0.24				0.23				0.12			
CD (P=0.05)		-				-				-			
Dry Weight													
80 DAS													
Treatment		**2021**				**2022**				**POOLED**			
		L1	**L2**	**L3**	**Mean**	**L1**	**L2**	**L3**	**Mean**	**L1**	**L2**	**L3**	**MEAN**
DR	O1	35.14	34.70	38.08	33.94	33.12	35.57	33.12	33.94	34.13	35.14	35.60	34.96
	O2	41.57	36.96	42.31	38.72	40.03	38.09	38.05	38.72	40.80	37.53	40.18	39.50
	O3	44.45	37.95	39.72	40.49	38.53	40.20	42.73	44.82	39.99	39.08	41.23	40.10
BR	O1	34.70	34.85	41.57	34.20	35.70	33.96	32.95	33.87	35.20	34.41	37.26	35.62
	O2	36.09	34.98	38.95	38.05	39.85	38.98	35.31	36.05	37.97	36.98	37.13	37.36
	O3	36.05	33.98	39.54	34.24	34.70	34.20	33.83	38.91	35.38	34.09	36.69	35.38
TR	O1	46.73	45.49	47.73	47.24	46.42	34.97	43.06	36.15	46.98	39.34	45.77	44.03
	O2	47.53	44.20	46.44	46.06	44.82	41.95	43.20	44.35	45.78	44.64	47.40	45.94
	O3	49.54	43.70	48.48	45.22	46.90	43.78	45.06	45.24	48.22	43.08	45.82	45.37
Mean		**40.01**	**37.97**	**38.81**	**40.83**	**40.90**	**37.74**	**38.92**	**39.19**	**40.49**	**38.25**	**40.67**	**39.81**
F-test		S				S				S			
SEm±		1.46				1.70				0.99			
CD (P=0.05)		4.77				5.54				3.24			

Panchgavya. Also, in pooled significantly higher dry weight was recorded in Transplanting + Vermicompost + Panchgavya (48.22 g/plant). Treatments Transplanting + Farmyard Manure + Panchgavya, Transplanting + Farmyard Manure + Vermiwash, Transplanting + Poultry Manure + Panchgavya, Transplanting + Poultry Manure + Vermiwash and Transplanting + Vermicompost + Vermiwash were statistically at par with Transplanting + Vermicompost + Panchgavya. Transplanting and organic nutrients increase of dry weight is due to the fact that the crop absorbed proportionately higher amount of N, P and K due to their higher availability under lower plant population and less competition among the plants for growth resources. The increased growth attributing characters in respect to the application of organic supplements might be due to enhanced nutrient availability [10]. Since poultry manure and panchagavya contains high nitrogen, macro and micro nutrients and growth promoting substance which helped in increased yield attributes and yield [11].

4. CONCLUSION

Transplanting finger millet seedlings along with application of solid organic manure of Vermicompost and Panchgavya recorded significantly higher growth attributes.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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