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Response of crop geometry and organic manure on growth and yield of finger millet (*Eleusine coracana* L.) at Prayagraj condition

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Abstract
A field experiment was conducted during *Kharif* season of 2023-24 at the Crop Research Farm. Department of Agriculture and Allied Science, United University, Rawatpur, Jhalwa, Prayagraj (UP) to study about "Influence of crop geometry and organic manure on growth and yield of finger millet (*Eleusine coracana* L.)'' of Prayagraj, U.P. The experiment was carried out to find the performance of finger millet, which laid out in Randomized Block Design (RBD) & replicated thrice. Three planting geometry; 30 x 15 cm^2, 20 x 20 cm^2, 40 x 10 cm^2 planted in three, Results revealed that growth parameters such as plant height and number of tillers, dry weight. panicle length were more under (40 x 10 cm) spacing. In comparison to other treatments, the highest T_8 (40 x 10+ poultry manure 2 t/ha) gave better results at the harvest stage in terms of plant height (101.01 cm), number of tillers/hill (6.02), dry weight (26.01g), panicle length (9.01 cm), number of grains per panicle (864), and test weight (3.70 g). There was a significant difference observed between the treatments in terms of grain yield (3.05 t/ha), stover yield (4.42 t/ha), cost of cultivation (Rs 26833.20/ha), gross return (Rs 82878.5/ha), net return (Rs 56045.30), and B:C ratio (2.08).

Keyword: Spacing, organic manure, yield, finger millet

Introduction
Finger millet (*Eleusine coracana*) is an ancient cereal crop that is widely grown in Africa and Asia. Finger millet is commonly known as Ragi belongs to the *Poaceae* family is widely cultivated in various parts of India and in the entire world. India is the major producer of finger millet contributing nearly 60% of the global production. Finger millet has the ability to adjust itself to different agro-climatic conditions which reflects it having highest productivity among millets. Finger millet ragi or mandua is one of the important millet grown extensively in various regions of India and Africa. (Gull *et al*., 2014) [1]. The grain content 9.2% proteins, 1.29% fats, 76.32% carbohydrates, 2.2% mineral, 3.90% ash, 0.33% calcium. Vitamin A, B and phosphorus are also present in smaller quantity, iodine content in finger millet is reported to be the highest among food grain (Upadhyaya, 2011) [6].

Plant geometry plays an important role on growth, development and yield of crops. Improper spacing reduces the yield but optimum spacing ensures plants to grow properly making better utilization of sunlight and nutrients. Hence, maintenance of an optimum level of finger millet plant population in the field is necessary to maximize the grain yields. In Karnataka, the average yield of finger millet is higher under square planting with young single seedling $hill^{-1}$ (Kalaraju *et al*., 2011) [2]. Further wider spacing facilitates inter row and intra row weed control, enabling farmers to use simple weeding tools to incorporate the weeds to increase the soil fertility (Kumar Rangesh *et al*., 2018) [5]. Fertilizer application not only influences the economic return of the investment through optimized yield and quality, but also causes minimum level of environmental hazard (Pallavi *et al*., 2016) [4].

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, poultry manure, etc. The application of FYM in the soil helps in increasing the fertility of the soil as physical condition including its water holding capacity. Organic manures, which were perhaps the major sources of plant nutrients in traditional agriculture, receive less emphasis with the advent of high analysis chemical fertilizers. FYM not only supply macronutrients but also meet the requirement of micronutrients besides improving soil health. Organic manure influence both yield and plant micronutrients need and thus help to sustain crop productivity.

Materials and Methods

An experiment was conducted during *Kharif* season 2023 at the Crop Research Farm of United University, Rawatpur, Jhalwa, Prayagraj 211012, Uttar Pradesh, India. The field was well leveled having good soil condition. Geographically, Rawatpur, Jhalwa, Prayagraj falls in subtropical climate and is situated at 25.390 N latitude, 81.750 E longitude with an altitude of 113 meters above mean sea level. The experimental site is situated in main campus of university at the distance of 15 km from Prayagraj district headquarter.

Field trials laid out in RBD (random block design) with three replications and ten treatments were conducted to study the effect of crop geometry and organic manure practices on yield and yield attributes of finger millet during the *Kharif* season of 2023. The experimental site was sandy clay loam in texture and pH (6.7), slightly alkaline in reaction with low organic carbon (0.56%), available nitrogen, and medium in available phosphorous and potassium content. Three different spacing's, viz., 20 x 20 cm, 30 x 15 cm, and 40 x 10 cm, were kept, and three organic manures—sheep manure (2 t/ha), poultry manure (2 t/ha), and vermicompost (5 t/ha)—were kept in different plots. The treatment combinations that were used for this experiment are T_1: 20 × 20 cm + 2.0 t/ha sheep manure, T_2: 20 × 20 cm + 2.0 t/ha poultry manure, T_3: 20 × 20 cm + 5.0 t/ha Vermicompost, T_4: 30 × 15 cm + 2.0 t/ha sheep manure, T_5: 30 × 15 cm + 2.0 t/ha poultry manure, T_6 : 30 × 15 cm +5.0 t/ha Vermicompost, T_7: 40 × 10 cm + 2.0 t/ha sheep manure, T_8: 40 × 10 cm + 2.0 t/ha poultry manure, and T_9: 40 × 10 cm + 5.0 t/ha Vermicompost, and T_{10} absolute control. Yield parameters like Plant height, Dry weight, Productive tillers /hill, ear head weight, panicle length, number of fingers ear head -1 and test weight were recorded. Grain and straw yields of finger millet was calculated to t/ha. The data was statistically analysed at 0.05 level of probability following the procedure outlined by Panes and Sukhatme (1978).

Results and Discussion

Growth attributes

Table: 1 showed how organic manure and row spacing affected the growth characteristics of finger millet (*Eleusine coracana* L.). The following are classified as growth attributes: plant height (cm), plant dry weight (g/plant), number of tillers.

Plant height

At harvest, significantly higher plant height (101.01 cm) was recorded with the treatment T_8 (spacing 40 x 10 cm + poultry manure). However, the treatments T_9 (40 x 10 cm+ vermicompost 5 t/ha), (99.09 cm) and T_7 (40 x 10 cm+sheep manure), (97.21 cm), was found to be statistically at par with T_8 (40 x 10 cm + poultry manure).

Dry weight

At harvest, significantly higher dry weight (26.01g) was recorded with the treatment T_8 (spacing 40 x 10 cm + poultry manure). However, the treatments T_9 (40 x 10 cm+ vermicompost 5 t/ha), (22.69 g) and T_7 (40 x 10 cm+sheep manure), (22.16 g), was found to be statistically at par with T_8 (40 x 10 cm + poultry manure).

Number of tillers

At harvest, treatment with T_8 (40 x 10 cm poultry manure 2 t/ha) was recorded maximum number of effective tillers per plant (6.02) which is significantly superior all over the T_9 (40 x 10 cm vermicompost 5 t/ha) (5.23) and T_7 (40 x 10 cm + sheep manure 2 t/ha) (5.13) was statistically at par with treatment T_8 (40 x 10 cm + poultry manure 2 t/ha).

Yield attributes

Table: 2 Revealed that the effect of spacing and organic manure on yield attributes and yield of Finger Millet (*Eleusine coracana* L.). Yield attributes include the parameters like, number of grain / panicle, test weight (g), grain yield (t/ha), Stover yield (t/ha), biological yield (t/ha) and Harvest index (%).

Number of grains/panicle

Significantly higher No. of grain / panical was observed with the T_8 (spacing 40 x 10 cm + poultry manure) which was (864) over rest of the treatments except T_9 (40 x 10 cm+ vermicompost 5 t/ha) (846.67) and T_7 (40 x 10 cm+sheep manure) (778.33) which are statistically at par with T_8 (spacing 40 x 10 cm + poultry manure).

Test weight (g)

The test weight (g) as Influence of crop geometry and organic manure on growth and yield of finger millet (*Eleusine coracana* L.) Table 2.

Treatment with T_8 (40 x 10 cm + poultry 2 t/ha) was recorded no of test weight (3.70 g) which is significantly superior all over the treatments with T_9 (40 x 10 cm + vermicompost 5 t/ha) no of test weight (3.67 g) and T_7 (40 x 10 cm + sheep manure 2 t/ha) no. of test weight (3.63 g) were statically at par with treatment T_8.

Grain yield

Significantly superior all over the treatments with T_9 (40 x 10 cm + vermicompost 5 t/ha) no of grain yield (2.79) and T_7 (40 x 10 cm + sheep manure 2 t/ha) no. of grain yield (2.61) were statically at par with treatment T_8.

Straw yield

Treatment with T_8 (40 x 10 cm + poultry 2 t/ha) was recorded no of straw yield (4.42) which is significantly superior all over the treatments with T_9 (40 x 10 cm + vermicompost 5 t/ha) no of straw yield (4.26) and T_7 (40 x 10 cm + sheep manure 2 t/ha) no. of straw yield (4.03) were statically at par with treatment T_8.

Biological yield

Treatment with T_8 (40 x 10 cm + poultry 2 t/ha) was recorded biological yield (7.47) which is significantly superior all over the treatments with T_9 (40 x 10 cm + vermicompost 5 t/ha) biological yield (7.05) and T_7 (40 x 10 cm + sheep manure 2 t/ha) biological yield (6.54) were statically at par with treatment T_8.

Harvest index (%)

Treatment with T_8 (40 x 10 cm + poultry 2 t/ha) was recorded Harvest index (42.14) which is significantly superior all over the treatments with T_9 (40 x 10 cm + vermicompost 5 t/ha) no of harvest index (42.09) and T_7 (40 x 10 cm + sheep manure 2 t/ha) harvest index (41.64) were statically at par with treatment T_8.

Economics of treatment

Economics evaluation of the treatments was done on the basis of gross return, net return and B:C ratio. In table: 3, maximum gross return (₹82878.5/ha), net return (₹ 56045.30 /ha) and B: C ratio (2.08) which were recorded with the application of T_8 (40×10 cm + 2.0 t/ha poultry manure). This might be due to higher yield in this treatment compared to other treatments.

Table 1: Effect of spacing and organic manure to number of growth attributes of finger millets

Tr. No.	Treatment combination	Growth attributes		
		Plant height(cm)	Dry weight(g)	No. of tillers/plant
T_1	Spacing 20 x 20 cm + Sheep manure 2 t/ha	85.05	17.68	3.70
T_2	Spacing 20 x 20 cm + Poultry manure 2 t/ha	87.94	20.18	3.99
T_3	Spacing 20 x 20 cm + Vermicompost 5 t/ha	86.61	19.98	3.97
T_4	Spacing 30 x 15 cm + Sheep manure 2 t/ha	92.40	20.43	4.69
T_5	Spacing 30 x 15 cm + Poultry manure 2 t/ha	92.90	21.91	5.12
T_6	Spacing 30 x 15 cm + Vermicompost 5 t/ha	92.61	20.91	5.05
T_7	Spacing 40 x 10 cm + Sheep manure 2 t/ha	97.21	22.16	5.13
T_8	Spacing 40 x 10 cm + Poultry manure 2 t/ha	101.01	26.01	6.02
T_9	Spacing 40 x 10 cm + Vermicompost 5 t/ha	99.09	22.69	5.23
T_{10}	100% RDF (Control)	88.33	16.73	3.24
	F-test	S	S	S
	Sem±	2.73	1.46	0.39
	CD (p=0.05)	8.11	4.36	1.17

Table 2: Effect of spacing and organic manure to number of yield attributes of finger millets.

Tr. No.	Treatment combination	yield attributes					
		Seed yield (t/ha)	Stover yield (t/ha)	Biological yield (t/ha)	Harvest index (%)	No of grain per panicle	Test weight (g)
T_1	Spacing 20 x 20 cm + Sheep manure 2 t/ha	2.32	3.19	5.52	38.38	693.33	2.49
T_2	Spacing 20 x 20 cm + Poultry manure 2 t/ha	2.34	3.30	5.64	39.30	721.33	2.67
T_3	Spacing 20 x 20 cm + Vermicompost 5 t/ha	2.33	3.20	5.53	38.45	703.67	2.57
T_4	Spacing 30 x 15 cm + Sheep manure 2 t/ha	2.37	3.76	6.13	39.76	722.00	2.85
T_5	Spacing 30 x 15 cm + Poultry manure 2 t/ha	2.47	3.98	6.44	41.24	739.67	3.26
T_6	Spacing 30 x 15 cm + Vermicompost 5 t/ha	2.37	3.86	6.23	40.92	732.00	3.10
T_7	Spacing 40 x 10 cm + Sheep manure 2 t/ha	2.61	4.03	6.54	41.64	778.33	3.63
T_8	Spacing 40 x 10 cm + Poultry manure 2 t/ha	3.05	4.42	7.47	42.14	864.00	3.70
T_9	Spacing 40 x 10 cm + Vermicompost 5 t/ha	2.79	4.26	7.05	42.09	846.67	3.67
T_{10}	100 % RDF (Control)	1.51	2.17	3.68	38.10	523.33	2.28
	F-test	S	S	S	NS	S	S
	Sem ±	0.14	0.36	0.39	2.70	36.21	0.15
	CD (p=0.05)	0.44	1.07	1.18	8.04	107.6	0.44

Table 3: Effect of spacing and Organic manure to Economics of finger millet.

Tr. No.	Treatment combination	Economics			
		Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
T_1	Spacing 20 x 20 cm + Sheep manure 2 t/ha	27833.20	62878.66	35045.47	1.25
T_2	Spacing 20 x 20 cm + Poultry manure 2 t/ha	26833.20	63538.16	36704.97	1.36
T_3	Spacing 20 x 20 cm + Vermicompost 5 t/ha	27833.20	62987.83	35154.63	1.26
T_4	Spacing 30 x 15 cm + Sheep manure 2 t/ha	27761.20	64804.16	37042.97	1.33
T_5	Spacing 30 x 15 cm + Poultry manure 2 t/ha	26761.20	67662.5	40901.30	1.52
T_6	Spacing 30 x 15 cm + Vermicompost 5 t/ha	27761.20	65087	37325.80	1.34
T_7	Spacing 40 x 10 cm + Sheep manure 2 t/ha	27833.20	68709.16	40875.97	1.46
T_8	Spacing 40 x 10 cm + Poultry manure 2 t/ha	26833.20	82878.5	56045.30	2.08
T_9	Spacing 40 x 10 cm + Vermicompost 5 t/ha	27833.20	76224.66	48391.47	1.73
T_{10}	100% RDF (Control)	18483.20	40961	22477.80	1.21

Summary and Conclusion

Based to these study's objectives, the application of 40 cm x 10 cm + poultry manure 2 t/ha (1) treatment combination resulted in the highest recorded plant height (101.01 cm), plant dry weight (26.01 g), number of effective tillers per plant (6.02), number of grains per spike (864), spike length (9.01 cm), test weight (3.70 g), grain yield (3.05 t/ha), and straw yield (4.42 t/ha).

With treatment combination of treatment 8 (40 cm x 10 cm + poultry manure 2 t/ha), the highest maximum gross returns (82878.5 rs /ha), net returns (56045.30 rs /ha), and benefit cost ratio (2.08) were obtained.

The application of treatment 8 (40 cm x 10 cm + poultry manure 2 t/ha) was demonstrated by the study's findings. outperformed in terms of growth and yield characteristics, proving to be more fruitful and financially feasible. Given that the results are derived from a single season's worth of research. To confirm a more accurate result, more trials are required.

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