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Effect of seed rate and row spacing on growth and yield of finger millet [*Eleusine coracana* (L.) Gaertn]

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Abstract

The field experiment entitled, "Effect of seed rate and row spacing on the growth and yield of finger millet [*Eleusine coracana* (L.) Gaertn]" was conducted at RMD College of Agriculture and Research Station Ambikapur, Chhattisgarh during *Kharif* season of 2022. The experiment was laid out in factorial randomized block design consisting nine treatments replicated three times. The treatment comprised three seed rates *i.e.*, 4, 6 and 8 kg ha⁻¹ and three row spacing *i.e.*, 15, 20 and 25 cm. The finger millet variety Indira ragi-1 was used. The result shows the different seed rate S₃ (8 kg ha⁻¹) recorded significantly higher plant population (meter⁻¹ row length), plant height (cm), number of tillers and effective tillers (meter⁻¹ row length), biological yield (8661 kg ha⁻¹), grain yield (3024 kg ha⁻¹) and straw yield (5637 kg ha⁻¹) over 6 and 4 kg ha⁻¹ seed rate. However, dry matter accumulation (g plant⁻¹), crop growth rate (g plant⁻¹ day), grains spike⁻¹, spike weight (g), 1000 seed weight (g) were recorded higher under seed rate @ 4 kg ha⁻¹. Significantly higher gross return of (113283 ₹ ha⁻¹), net returns of (81923 ₹ ha⁻¹) and B:C ratio of 2.60 at 8 kg ha⁻¹ seed rates over 6 kg ha⁻¹ seed rate. And lowest recorded under 4 kg ha⁻¹ seed rate. Finger millet sown at 25 cm row spacing resulted in significantly higher plant population and all the growth characters and yield attributes over 20 cm row spacing. And values for all the above-mentioned observations recorded lowest under 15 cm row spacing. However, all yield characters were recorded higher under 15 cm row spacing. Significantly recorded maximum gross return of (110205 ₹ ha⁻¹), net returns of (79005 ₹ ha⁻¹) and B:C ratio of 2.52 at 15 cm row spacing over 20 cm row spacing. And lowest recorded under 25 cm row spacing. Hence, seed rate of 8 kg ha⁻¹ and row spacing of 15 cm is recommended.

Keywords: Finger millet, plant population, seed rate and row spacing

Introduction

Finger millet [*Eleusine coracana* (L.) Gaertn] is commonly known as ragi or mandua. Finger millet is originated in African highlands of Uganda and Ethiopia and it was introduced into India about 3,000 years ago. It is been cultivated in various parts of India and world. In world's finger millet is grown in more than 25 countries. In India finger millet is mostly grown in southern parts and hilly areas in the northern regions like Karnataka, Andhra Pradesh, Tamil Nadu and Uttarakhand and Himachal Pradesh. (Vijayakumari J, Mushtari BJ, Shamshad B, Sumangala G (2003) ^[10]. Finger millet is the world's most important cereal after rice, wheat, maize, sorghum and pearl millet.

According to FAO Statistics (2020), millets are cultivated globally on approximately 75.70 million hectares, producing about 90.35 million metric tonnes. In India, finger millet is grown over an area of 100.46 million hectares, with a total production of 1755.06 million tonnes and an average productivity of 1747.27 kg ha⁻¹. (Ministry of Agriculture-DMD 2020). In Chhattisgarh finger millet cover area, production and productivity respectively, 6.29 thousand ha, 1.42 thousand tones and 226 kg ha⁻¹.

Finger millet possesses a remarkable ability to withstand a wide range of environmental stresses, particularly under rainfed and moisture-limited conditions. It is an important tropical millet crop that can tolerate drought and low nutrient availability, making it well suited to dry and semi-dry regions of India. The grain is nutritionally valuable and contains important nutrients such as calcium, protein, dietary fibre and antioxidants. Its nutritional composition includes approximately 9.2% protein, 1.29% fat, 76.32% carbohydrate, 2.24% minerals and 3.9% ash, along with vitamins A and B.

The grains are also rich in phosphorus, potassium and essential amino acids. In particular, finger millet is an excellent source of calcium, containing about 410 mg per 100 g of grain, which makes it beneficial for children and elderly people. The calcium content of finger millet grain is reported to be approximately 8–10 times higher than that of wheat and rice.

Achieving higher crop yield largely depends on maintaining an optimum plant population, which can be ensured through the use of an appropriate seed rate. Seed rate is an important factor influencing crop establishment, growth, development and ultimately the yield of the crop. Similarly, row spacing plays a significant role in promoting healthy crop growth and improving yield potential by facilitating efficient utilization of available resources such as soil moisture, nutrients, light and carbon dioxide. The choice of suitable seed rate and row spacing also affects the degree of intra- and inter-specific competition among plants for these essential resources, thereby influencing crop growth, development and final productivity.

Materials and Methods

The experiment was conducted during the *Kharif* season of 2022 at the RMD College of Agriculture and Research Station, Ambikapur, Chhattisgarh. The experimental site is located at 23.15° N latitude and 83.15° E longitude, with an elevation of 623 m above mean sea level (MSL). The climate of Surguja district falls under the Eastern Plateau and Hilly region. The area receives an average annual rainfall of approximately 1210 mm, of which nearly 78% is concentrated within a four-month period, mainly from June to September.

The experiment was conducted using a factorial randomized block design (RBD), comprising nine treatment combinations involving three seed-rate levels and three row-spacing levels, with each treatment replicated three times. The crop was sown on 12th July 2022, Indira ragi-1 variety of finger millet was used. Seed rate was adjusted as per treatments in different Row spacing. In line sowing row to row spacing 15 cm, 20 cm and 25 cm was maintained and dropping the seeds at requisite line to line. However, in the line sowing method, seed rate was kept 4, 6 and 8 ha⁻¹ and no gap filling and thinning was done for desirable plant population (meter⁻¹ row length) and Recommended dose of nutrient was 60: 30: 20 kg ha⁻¹ N, P₂O₅ and K₂O which was applied through urea, single super phosphate and muriate of potash, respectively. The whole amount of phosphate and potash at 50 % nitrogen was applied as basal dose and remaining nitrogen was applied in two equal splits, 1/4 at 30 DAS and 1/4 at before emergence of spike. Five plants were selected randomly from each plot and tagged for recording growth parameter viz, plant height (cm), number of tillers and effective tillers (meter⁻¹ row length) dry matter accumulation (g plant⁻¹) and crop growth rate (g plant⁻¹ day⁻¹) and yield attributing parameters viz, grains spike⁻¹, spike weight (g) and 1000 seed weight (g) The crop was harvested at maturity on 16th November (124 DAS). Harvesting was done by manually by sickle. The harvested seeds were cleaned through winnowing to remove threshed spikelets and other extraneous materials. Following threshing and winnowing, the seed yield obtained from each net plot was recorded separately for each treatment and replication. The

recorded yield was then converted into kg ha⁻¹ using the respective treatment-wise conversion factor for statistical analysis. After collecting and separating the seed yield from each net plot, the quantity of by-products, including stalk and straw, was also recorded and analyzed. The cost of cultivation for each treatment was estimated based on the prevailing local rates of field operations and inputs used during the experiment. For treatments showing significant effects, the standard error of the mean (S.E.m ±) and critical difference (CD) were determined at the 5% level of significance.

Results and Discussion

Effect of seed rate (kg ha⁻¹)

The variable performance of finger millet was recorded with different seed rate the finger millet sown at 8 kg ha⁻¹ seed rate resulted in significantly higher plant population (meter⁻¹ row length), plant height (cm), number of tillers and effective tillers (meter⁻¹ row length), biological yield (8661 kg ha⁻¹), grain yield (3024 kg ha⁻¹) and straw yield (5637 kg ha⁻¹) over 6 kg ha⁻¹ seed rate. Values for all the above-mentioned observations recorded lowest under 4 kg ha⁻¹ seed rate.

However, dry matter accumulation (g plant⁻¹), crop growth rate (g plant⁻¹ day), grains spike⁻¹ (g), spike weight (g), 1000 seed weight (g) were recorded higher under seed rate @ 4 kg ha⁻¹. Significantly recorded maximum gross return of (113283 ₹ ha⁻¹), net returns of (81923 ₹ ha⁻¹) and B:C ratio of 2.60 at 8 kg ha⁻¹ seed rates over 6 kg ha⁻¹ seed rate. And lowest recorded under 4 kg ha⁻¹ seed rate. Higher plant density with 8 kg ha⁻¹ seed rate reduced the yield attributes per plant to a considerable extent due to competition among the plants is more. Wherever, higher grain yield per hectare was recorded with higher seed rate that might be due to a greater number of plants per unit area that was compensate the yield reduction per plant and resulted in overall higher yield.

Effect of row spacing (cm)

Among row spacing (cm) finger millet sown at 25 cm row spacing resulted in significantly higher plant population and all the growth characters and yield attributes over 20 cm row spacing. And values for all the above-mentioned observations recorded lowest under 15 cm row spacing. However, all yield characters were recorded higher under 15 cm row spacing. Significantly recorded maximum gross return of (110205 ₹ ha⁻¹), net returns of (79005 ₹ ha⁻¹) and B:C ratio of 2.52 at 15 cm row spacing over 20 cm row spacing. And lowest recorded under 25 cm row spacing. This may be due to higher plants within rows in wider spacing (25 cm) as compared to closer spacing (15 cm). That's why improved individual plant yield attributes and yield. These agreements with the findings of Manasa *et al* (2022) [7], Manoj Gowda *et al.* (2021) [8], Korir *et al.* (2018) [5].

Economics

Net return and B:C ratio were higher under 8 kg ha⁻¹ seed rate and 15 cm row spacing followed by 6 kg ha⁻¹ and 20 cm row spacing and lowest recorded under 4 kg ha⁻¹ and 25 row spacing.

Table 1: Plant population and Growth parameters of finger millet as influenced by seed rate and row spacing

Treatment	Plant population (meter ⁻¹ row length) at harvest	Plant height (cm) at harvest	Number of tillers (meter ⁻¹ row length) at 60 DAS	Number of effective tillers (meter ⁻¹ row length) at harvest	Crop growth rate (g plant ⁻¹ day ⁻¹) at harvest
Seed rate (kg ha ⁻¹)					
4 kg	8.38	120.22	29.77	23.33	0.026
6 kg	11.28	126.55	39.11	31.33	0.010
8 kg	14.78	133.11	45.11	37.88	0.009
S.Em. ±	0.14	0.75	0.29	0.29	0.002
C.D. (P=0.05)	0.44	2.28	0.88	0.88	0.008
Row spacing (cm)					
15 cm	9.43	123.33	35.88	28.66	0.010
20 cm	10.04	126.44	37.44	30.22	0.012
25 cm	12.91	130.11	40.66	32.66	0.022
S.Em. ±	0.14	0.75	0.29	0.29	0.002
C.D. (P=0.05)	0.44	2.28	0.88	0.88	0.008
Interaction (SxR)					
S.Em. ±	0.256	1.31	0.509	0.508	0.004
C.D. (P=0.05)	0.773	NS	NS	NS	NS

Table 2: Yield attributes, yield and economics of finger millet as influenced by seed rate and row spacing

Treatment	Grains spike ⁻¹	Spike weight (g)	1000 seed weight (g)	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	HI (%)	Net return (₹ ha ⁻¹)	B:C ratio
Seed rate (kg ha ⁻¹)								
4 kg	2435	8.56	3.06	2725	5349	32.35	71833	2.30
6 kg	2281	6.04	2.85	2882	5580	33.31	77506	2.48
8 kg	2153	4.30	2.64	3024	5637	35.73	81923	2.60
S.Em. ±	2.89	0.26	0.11	14.11	20.00	0.17	653.00	0.02
C.D. (P=0.05)	8.73	0.08	NS	42.68	60.00	0.59	1976.00	0.06
Row spacing(cm)								
15 cm	2264	6.01	2.71	2922	5625	34.16	79005	2.52
20 cm	2290	5.84	2.87	2881	5527	33.85	76862	2.45
25 cm	2316	7.06	2.97	2827	5414	33.38	75395	2.41
S.Em. ±	2.89	0.26	0.11	14.11	20.00	0.17	653.00	0.02
C.D. (P=0.05)	8.73	0.08	NS	42.68	60.00	0.59	1976.00	0.06
Interaction (SxR)								
S.Em. ±	5.00	0.46	0.203	24.44	34.66	0.30	1132.00	0.03
C.D. (P=0.05)	NS	NS	NS	NS	S	-	NS	NS

Conclusion

Based on the findings of the present thesis, it can be inferred that finger millet can achieve higher and economically viable grain yield under the prevailing agro-climatic conditions when the crop is sown at a closer row spacing of 15 cm with a seed rate of 8 kg ha⁻¹.

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