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DETERMINATION OF OPTIMUM SIZE OF SEED RHIZOME OF PLANTING MATERIAL ON GROWTH, YIELD, QUALITY AND PROFITABILITY OF TURMERIC

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ABSTRACT

The experiment was conducted at Horticulture experimental area, CoA (College of Agriculture), CAU, Iroisemba, Imphal in 2022-2023, to determination of optimum size of seed rhizome of planting material on growth, yield, quality and profitability of turmeric (*Curcuma longa* L.) cv. Lakadong. The experiment was laid out in randomized block design with three replications and six treatments. The treatment comprised different sizes of rhizome based on weight. The treatment was, T_1: 4-6 g, T_2: 8-10 g, T_3: 12-14 g, T_4: 16-18 g, T_5: 20-22 g, T_6: 24-26 g. The results show maximum plant height (121.72 cm), number of leaves per clump (15.97), number of tillers per clump (2.25), weight of clump (172.95 g), number of primary finger (7.11), primary finger weight (64.23 g), primary finger length (9.66 cm), primary finger breadth (3.87 cm), number of secondary finger (7.23), weight of secondary finger (69.73 g), length of secondary finger (3.58 cm), yield per plot (8.27 kg/3m²), yield (27.56 t/ha), dry recovery (22.97%), curcumin (6.20%), gross return (826800 Rupees/ha) and net return (460826 Rupees/ha) was recorded with the treatment T_6. The maximum breadth of clump (10.01 cm) and maximum oleoresin (11.82%) was observed in T_5. The maximum length of clump (12.61 cm) and breadth of secondary finger (3.52 cm) was obtained under the treatment T_4. The maximum benefit cost ratio (1.80) was found in T_1. Considering more yield (19.23 tones/ha), cost of production (205974 Rupees/ha), net return (370926 Rupees/ha) and highest Benefit: Cost ratio (1.80), the most effective treatment is T_1 for getting maximum profit with comparatively less investment, with reduction of ⅔ cost towards seed rhizome.

Keywords **:** *Curcuma longa* L., Lakadong, Curcumin, Net return, B: C ratio.

Introduction

Turmeric is a perennial rhizomatous herbaceous plant, it comes from Zingiberaceae family (Kamal and Yousuf, 2012). It has been used for almost 4000 years, dating back to the Vedic civilisation in India, when it was employed as a culinary spice as well as having religious significance. It contains colouring compounds known as curcuminoids. Curcuminoids include curcumin (diferuloylmethane), demethoxycurcumin, and bisdemethoxycurcumin (Pushpakumari and Pramod, 2009). Curcuminoids, which are yellow colours found in the rhizome are responsible for the coloration as well as several therapeutic qualities (Joe *et al*., 2004; Shailendra Kumar, 2022; Aggarwal *et al*., 2005). Turmeric also has many important volatile oils of which oleoresin (3-13%) is widely used in the pharmaceutical industry. Nutritional analysis of turmeric shows that 100 g of turmeric contains 390 kcal, total fat (10 g), saturated fat (3 g), calcium (0.2 g), sodium (10 g), iron (47.5 mg), phosphorous (0.26 g), thiamine(0.9 mg), riboflavin (0.19 mg), ascorbic acid (50 mg), niacin (4.8 mg), total carbohydrate (69.9 g), sugars (3 g), dietary fibre (21 g) and protein (8 g) (Balakrishnan, 2007).

The worldwide production of turmeric amounts to approximately 1.1 million tonnes per year. India holds a prominent position in the global production scenario, contributing 80% of the total production (Anon, 2023).

In the fiscal year 2021-22, India exported 0.137 million tonnes of turmeric, which was a decrease compared to the 0.183 million tonnes exported in the last year. In India major producing states are Telangana, Maharashtra, Karnataka, TN, AP, MP and WB (Anon, 2023). Indian haldi is renowned in the global market for its exceptional quality, primarily due to its high curcumin content. In Western countries, the institutional sector purchases ground turmeric and oleoresins, while the industrial sector prefers dry turmeric.

Traditionally, turmeric is propagated through rhizomes, including both primary and mother rhizomes. This method necessitates a substantial quantity of seed rhizomes, typically ranging from 2000 to 2500 kg per hectare. These seed rhizomes contribute significantly to the production costs, accounting for 40% of the total expenses. However, there are challenges associated with this approach. The availability of high-quality planting material during the cropping season is limited, and storing the voluminous seed rhizomes from the previous crop is susceptible to damage from pathogens and insect pests. Additionally, the cost of acquiring planting material is Squite high in turmeric cultivation. The use of large size rhizomes of turmeric results in higher loss of potential commercial product, while randomly selecting small-sized seed rhizomes is not feasible, as smaller seeds lead to reduced growth and yield (Hailemichael and Tesfaye, 2008). Further smallest seed size with single node rhizome (5 g) raised in protray (1 month) and planted in the main field recorded the highest plant height, number of leaves and number of tillers/plant, maximum yield with the highest C:B ratio (Chitra, 2016). Considering these factors, along with the growing demand for turmeric and turmeric powder both in India and internationally, there is a pressing need to lower the cost of seed material. This can be achieved by exploring alternative sowing methods and adopting a more discerning approach in selecting seed rhizomes of the ideal size.

Materials and Methods

The experiment on determination of optimum size of seed rhizome of planting material on growth, yield, quality and profitability of turmeric was conducted during 2022-23 at the horticulture experimental field, CoA, Central Agricultural University, Iroisemba (Manipur). The experiment was laid out in randomized block design with three replications and six treatments. The treatment comprised different sizes of rhizome based on weight. The treatment was, T_1: 4-6 g, T_2: 8-10 g, T_3: 12-14 g, T_4: 16-18 g, T_5: 20-22 g, T_6: 24-26 g. Raised beds of size 3.0 × 1.0 m^2 and 15 cm high were prepared. The rhizome bits were treated with a solution mixture of Metalaxly (3 g/l) for 30 min. The treated rhizomes bits were raised in protrays having a composition of FYM and soil in the ratio of 3:1. Seedlings of 45 days old were transplanted in the main field. The variety used for the study was Lakadong. The treatment comprised different sizes of rhizome based on weight as given below (Fig.1).

Fig. 1 : Different grades of rhizome

The planting and harvesting of the crop was done during middle of May and of January respectively. The organic input (FYM) was applied @ 20 t/ha. The requirement of fertilizer @150, 60 and 150 kg/ha N, P_2O_5 and K_2O was applied in the field, respectively (Medda, 2000). The sources of NPK fertilizer were adjusted with the application of Urea, MOP and SSP. Nitrogen was applied in 3 split doses, i.e., at basal, 45 days and 90 days after planting (DAP). Complete dose of phosphorous were applied at basal with compost @ 25 t/ha. Potassium fertilizer was administered in two separate applications, with half of the dose applied at 45 (DAP) and the remaining half at 90 DAP. The first irrigation was given immediately after planting, the subsequent irrigation were given depending upon the soil moisture and weather condition. Turmeric rhizomes were planted 3-4 cm in depth. Following planting, the crop was mulched from paddy straw @10 t/ha. Additional mulching of 5 t/ha was applied at 45 days and again at 90 days after planting. Earthing up was done before 2nd and 3rd mulching. Rhizome bits of 4-6 g, 8-10 g, 12-14 g and 16-18 g were placed in protrays for sprouting during middle of May. 45 days old plants were transplanted in the field. As per conventional method the rhizome bits of 20-22 g and 24-26 g were planted in the field during middle of May. Observations on growth parameters were recorded in five randomly selected plants at 60, 90, 120 and 150 days after planting but both yield and quality parameters were assessed from the clump of these randomly selected plants after harvesting.

Results and Discussion

The data for turmeric growth (table 1), yield (table 2 and 3), quality (table 4) and economic (table 5) are provided respectively.

The growth parameters varied significantly with seed rhizome size in the growth stages. Increasing trend was recorded with increase in seed rhizome size (4-6g to 24-26g), with maximum height of plant (121.72 cm), number of tillers clump^{-1} (2.25), number of leaves clump^{-1} (15.97) under T_6. This can be attributed to that of bigger rhizome size having enough stored food material which eventually helps in better generation and for supply of food material for good growth. These results are in conformity with the findings of Manhas and Gill, 2010; Kumar and Gill, 2011; Bhanumurthy *et al*., 2018. Similar findings were also reported by Hailemichael and Tesfaye, 2008; Monnaf *et al*., 2010; Chandrasekhar 2018 in ginger.

Table 1: Determined of different size of seed rhizome on height of plant, No. of tillers clump^{-1} and No. of leaves clump^{-1}.

Treatments	Height of plant (cm)		No. of tillers clump^{-1}		No. of leaves clump^{-1}	
	60 days after planting	150 days after planting	60 days after planting	150 days after planting	60 days after planting	150 days after planting
T_1	52.68	103.45	0.11	1.20	5.14	12.22
T_2	67.42	104.89	0.23	1.92	5.94	13.14
T_3	66.09	105.02	0.32	2.10	5.86	13.96
T_4	66.46	105.20	0.46	2.06	6.88	14.42
T_5	69.27	110.90	0.52	2.22	6.96	15.61
T_6	67.96	121.72	0.91	2.25	7.20	15.97
S.Em (±)	**0.03**	**0.39**	**0.04**	**0.04**	**0.07**	**0.19**
CD 5%	**0.10**	**1.18**	**0.11**	**0.11**	**0.22**	**0.57**

Different seed rhizome size exerted significant variation on yield parameters of turmeric during the experiment trail. Maximum weight of clump (172.95 g), number of primary finger (7.11), primary finger weight (64.23 g), primary finger length (9.66 cm), breadth of primary finger (3.87 cm), number of secondary finger (7.23), weight of secondary finger (69.73 g), length of secondary finger (3.58 cm), yield per plot (8.27 kg/3m²) and yield (27.56 t/ha) was recorded in T_6. The effectiveness of various rhizome treatments can be attributed to the source-sink relationship, where the mother rhizomes serve as a more significant sink than the fingers. The movement and utilization of nutrients and assimilates are more pronounced in heavier rhizomes, consequently leading to a quantitative and qualitative improvement when using larger-sized rhizomes. The number and size of the turmeric plants decreased as the weight of the planting material decreased, which is consistent with the findings reported by Kumar and Gill (2011) and Manhas and Gill (2010). The maximum length of clump (12.61 cm) and breadth of secondary finger

(3.52 cm) was obtained under the treatment T_4. The maximum breadth of clump (10.01 cm) and maximum oleoresin (11.82%) was observed in the treatment grown under T_5. In the T_1, highest benefit cost ratio (1.80) was recorded.

Table 2: Characteristics of the primary and secondary finger (Number, weight, length and breadth) of turmeric as determined by optimum size of seed rhizome.

Treatments	Characters of primary finger				Characters of secondary finger			
	Number	Weight (g)	Length (cm)	Breadth (cm)	Number	Weight (g)	Length (cm)	Breadth (cm)
T_1	5.06	58.01	7.82	3.23	6.02	42.40	1.96	2.60
T_2	6.42	58.36	7.44	3.34	6.56	46.36	1.63	2.80
T_3	6.86	63.18	7.32	3.01	6.23	53.43	2.24	3.12
T_4	6.92	60.09	7.96	3.56	6.99	68.95	2.66	3.52
T_5	7.01	62.43	8.01	3.63	7.04	67.38	2.92	3.50
T_6	7.11	64.23	9.66	3.87	7.23	69.73	3.58	3.46
S.Em (±)	**0.01**	**0.22**	**0.02**	**0.03**	**0.03**	**0.23**	**0.05**	**0.02**
CD 5%	**0.03**	**0.67**	**0.07**	**0.10**	**0.10**	**0.69**	**0.16**	**0.07**

Table 3: Characters of clump (weight, length and breadth) and yield attributes of turmeric as determined by optimum size of seed rhizome.

Treatments	Clump characters			Yield	
	Weight in gram	Length in centimeter	Breadth in centimeter	Per plot (kg/3m^2)	t/ha
T_1	120.41	10.02	8.92	5.77	19.23
T_2	139.72	10.46	8.46	6.67	21.8
T_3	146.87	11.02	9.01	7.01	23.36
T_4	158.04	12.61	9.24	7.55	25.16
T_5	164.62	11.96	10.01	7.87	26.23
T_6	172.95	11.81	9.86	8.27	27.56
S.Em (±)	**0.20**	**0.04**	**0.11**	**0.04**	**0.06**
CD 5%	**0.59**	**0.11**	**0.32**	**0.11**	**0.18**

Regarding the quality parameter, maximum dry recovery (22.97%) and curcumin content (6.20%) were noticed in T_6 and maximum oleoresin (11.82%) was observed in T_5. This can be attributed to the larger rhizome size, which contains a higher reserve of nutrients. This, in turn, promotes better vegetative growth and the accumulation of more photosynthates in the rhizomes, ultimately leading to the production of secondary metabolites such as curcumin and oleoresin. The results obtained in this study align with the findings of Kumar *et al*. (1992), who reported improved quality attributes when using mother rhizomes in turmeric cultivation.

Table 4: Dry recovery, oleoresin and curcumin percentage of turmeric as determined by the optimum size of seed rhizome.

Treatments	Quality Parameter		
	Dry recovery (%)	Oleoresin (%)	Curcumin (%)
T_1	21.39	10.82	5.82
T_2	21.61	10.02	5.48
T_3	22.05	10.87	5.58
T_4	22.67	11.02	5.98
T_5	22.84	11.82	6.12
T_6	22.97	11.45	6.20
S.Em (±)	**0.16**	**0.17**	**0.04**
CD 5%	**0.48**	**0.06**	**0.11**

The maximum cost of production (365974 Rupees/ha), gross return (826800 Rupees/ha), net return (460826 Rupees/ha) were recorded in T_6. The comparison between T_1 and T_6 clearly indicates that in order to get maximum return one has to increase Rupees 160,000 for getting extra benefit of only Rupees 89,900, considering the net return and Benefit: Cost ratio, the best treatment was T_1, which greatly reduced the quantity of planting material (⅔) with reduction of production cost as compared to conventional practice.

Table 5: Economics of turmeric as determined by optimum size of seed rhizome.

Treatment	Economics				
	Total Cost (Rupees/ha)	Projected Yield (tones/ha)	Gross Return (Rupees/ha)	Net Return (Rupees/ha)	Benefit: Cost Ratio
T_1	205974	19.23	576900	370926	1.80
T_2	237974	21.80	654000	416026	1.75
T_3	269974	23.36	700800	430826	1.60
T_4	301974	25.16	754800	452826	1.50
T_5	333974	26.23	786900	452926	1.36
T_6	365974	27.56	826800	460826	1.25

Conclusion

The growth, yield and quality of turmeric were influenced by the different seed rhizome size (4-6g, 8-10g, 12-14g, 16-18g, 20-22g and 22-24g). From the results it was observed that with the increase in seed rhizome size (4-6 to 24-26 g) growth, yield and quality parameters increased simultaneously and was found highest in (24-26 g). The highest benefit cost ratio was shown by the smallest seed rhizome size (4-6g) which decreased with increase in size of the seed rhizome.

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