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Effect of Planting Material on Growth and Yield of Turmeric

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***Curcuma longa* L. (Zingiberaceae) rhizomes, commonly known as turmeric, is a rhizomatous, herbaceous, monocotyledonous spice as well as medicinal plant and has been traditionally used as a source of coloring matter for foods, cosmetics and textiles and as a medicinal ingredient of formulations of the Indian system of medicine for several common ailments. Turmeric is propagated through rhizomes and large quantity of rhizome is required because of the low efficiency of vegetative propagation. In addition, during storage and cultivation, rhizomes are susceptible to diseases that cause tissue senescence and degeneration. Survival percentage of plants through rhizome is low (80 per cent) in field condition. The availability of quality planting material is also scarce during the cropping season (June – September). To overcome these problems, a trial to standardize the size of the planting material and to study the effect of the transplants on growth and yield parameters was laid out with nine different treatments. Among the various treatments, single node rhizome (5g) raised in protray (1 month) and planted in the main field recorded the highest plant height (82.79 cm), more number of leaves (7.29) and number of tillers per plant (4.00). Among the nine different treatments, single node rhizome (5 g) raised in protray (1 month) and planted in the main field recorded the maximum yield of 46.20 t/ha with the highest C:B ratio of 1: 2.47 followed by mother rhizome pieces (10-15 g) raised in protray (1 month) and planted in the main field recorded the yield of 41.87 t/ha and C:B ratio of 1:2.14 as compared to control of primary full length rhizome (25-30 g) planted directly in the field (34.47 t/ha).**

Key words: Turmeric, Rhizome, Nursery, Single node rhizome, Planting material

Turmeric (*Curcuma longa* L.) is an ancient spice, native of India and South East Asia used from antiquity as spice and a dye. Turmeric is a herbaceous perennial belonging to the family Zingiberaceae and is one of the important commercial spice crops of the tropics. Besides India, it is distributed in Cambodia, China, Indonesia, Madagascar, Malaysia, Philippines and Vietnam (Amzad Hossain *et al*., 2005). It is a popular spice in many countries of Asia (Herman and Martine 1991; Ishimine *et al*., 2003). Turmeric is propagated vegetatively using both mother rhizome as well as finger rhizome. The type of planting material used affects the vigour of plant, yield as well as the cost of production of turmeric (Kumar 2005). The time of planting also influences the growth and development of turmeric (Min *et al.* 1996; Bandopadhyay *et al*. 2005). The optimum stage of harvest plays an important role in obtaining the optimum yield and quality of turmeric (Kumar 2005). Studying the effect of rhizome size on growth and development of turmeric plants is very important for increasing yield (Xue and Stougaard, 2002 and Singh and Singh, 2003) Turmeric plant produces different sizes of finger rhizomes (R) and mother rhizome (MR), which are the only propagules for its commercial cultivation. Rhizome is the specialized plant part for propagation in turmeric, since flowering is a rare phenomenon. Even when it flowers, hardly any seed is produced. Hence, any grower should retain about 20-25% rhizome from their annual production for raising the crop in following season. Further, the rate of rhizome multiplication is very low. A single turmeric plant produces only 10-15 lateral rhizome buds in its life span of 8-10 months. Above all, storage of seed rhizome is a tedious operation, requiring more attention, time and space. Besides, they are highly prone to damages due to different factors such as adverse environment, insect and pathogen attack. Low productivity, disease susceptibility and higher cost of production are major problems faced by turmeric growers. Therefore, it is necessary to standardize the optimum size of seed rhizomes which is essential as to reduce the seed cost which ultimately pave for higher income.

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Materials and Methods

The field experiment was conducted at the College Orchard, Department of Spices and Plantation Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during 2012-13 to 2014-15. The experiment was conducted to find out the suitable planting material and its effect on the growth and yield of turmeric. The field is located at 11.00 N latitude, 77.00 E longitude with an altitude of 411 m above mean sea level. The soil of the experimental field was red sandy loam in texture. Turmeric variety CO 2 was used for this experiment.

The land was ploughed thoroughly and brought to fine tilth. At the time of last ploughing, FYM was applied at 20 t ha^{-1}. Distance between two rows was 0.45 m and 0.15 m spacing between plants in a row. The plot size of the experiment was 3 X 5 m. A fertilizer dose of 25:60:106 NPK Kg ha^{-1} was uniformly applied to all the plots. Three hand weeding on 30th, 60th and 90th days after planting were given commonly for all the plots. The experiment was laid out in Randomized Block Design with nine treatments (Fig 1) and replicated thrice. The treatment details are,

T_1: Single node rhizome (5g) directly planted in the field

T_2: Two node rhizome (10g) directly planted in the field

T_3: Mother rhizome pieces (10-15g) directly planted in the field (4 pieces)

T_4: Single node rhizome (5g) raised in protray (1 month) and the transplants planted in the field

T_5: Two node rhizome (10g) raised in protray (1 month) and the transplants planted in the field

T_6: Mother rhizome pieces (10-15g) raised in protray (1 month) and the transplants planted in the field

T_7: Primary full length rhizome (25-30g) directly planted in the field

T_8: Secondary rhizomes (15-20g) directly planted in the field

T_9: Mother rhizomes (35-40g) directly planted in the field

Observations on growth and yield parameters were recorded from five plants in each replication and the mean were used for statistical analysis (Panse and Sukhatme, 1985).

Results and Discussion

The important growth traits like plant height, number of leaves and number of tillers influenced the growth and productivity of the crop (Table 1). The highest plant height (82.79 cm) was recorded by the treatment (T_4) Single node rhizome (5 g) raised in protray (1 month) and the transplants planted in the field, the lowest plant height (67.77 cm) was recorded by treatment (T_1) Single node rhizomes (5g) directly planted in the field. Among the different treatments, the number of leaves per clump ranged from 5.97 in T_1 single node rhizomes (5g) directly planted in the field to 7.29 in T_4 (Single node rhizome (5 g) raised in protray (1 month) and the transplants planted in the field). No significant difference was observed for the character among the treatments and they were on par with each other. The treatment T_4 Single node rhizome (5 g) raised in protray (1 month old) and the transplants planted in the field registered significantly the higher leaf length of 43.05 cm and this was followed by T_6 which recorded 7.04 cm. The treatment T_4 recorded the highest leaf breath (43.05 cm), which was on par with T_6 (Mother rhizome pieces (10-15g) raised in protray (1 month) and the transplants planted in the field) (39.38 cm). Leaf length, leaf breadth are reliable yield determinants in many crops. Higher leaf length will definitely be helpful for better exposure of the leaf to the sun and thus higher rate of photosynthesis (Joseph *et al*., 1981). Among the different treatments, significantly higher number of tillers per plant (4.00) was recorded by the treatment T_4 single node rhizome (5g) raised in protray (1 month) and the transplants planted in the field. Increase in tiller production may be due to the stimulation of lateral buds in higher rate due to the low level of auxin and optimum level of cyto differentiating hormones like cytokinin. The increased level of cytokinin would have promoted the vascular connections for lateral production in the form of increased number of tillers (Adamson and Hiller, 1981).

The pooled mean of three years data revealed that the treatment T_4 - Single node rhizome (5 g) raised in protray (1 month) and the transplants planted in the field recorded the maximum estimated fresh

Table 1. Effect of planting materials on growth parameters of turmeric (2011-12 to 2013-14) - Pooled data

Treatments	Plant height (cm)	No. of tillers	No. of leaves	Leaf length (cm)	Leaf breadth (cm)
T_1	67.77	3.01	5.97	27.69	9.09
T_2	70.91	2.88	6.08	28.34	9.26
T_3	71.34	2.91	6.84	33.25	9.82
T_4	82.79	4.00	7.29	43.05	14.01
T_5	65.61	3.02	6.9	35.36	11.14
T_6	76.88	3.21	7.04	39.38	12.69
T_7	69.78	3.25	6.87	35.08	10.15
T_8	70.35	2.73	6.72	29.79	9.57
T_9	81.19	3.11	6.93	36.23	12.09
SED	0.96	0.09	0.67	3.40	1.10
CD (P = 0.05)	2.04	0.20	1.43	7.21	2.23
CV (%)	1.32	2.92	9.94	9.93	10.12

rhizome yield of 46.20 t/ha with the highest C:B ratio of 1:2.47 followed by the treatment T_6 - Mother rhizome pieces (10-15 g) raised in protray (1 month) and the transplants planted in the field with estimated fresh rhizome yield of 41.87 t/ha and C:B ratio of 1:2.14 as compared to control (34.47 /ha). Increased rhizome yield might be attributed to better crop growth in terms of quick emergence, higher plant height, more leaf area, more roots and tillers plant^{-1}, which intercepted more photosynthetically active radiation and resulted in higher values of yield attributing characters thus ultimately contributed towards higher yield of the crop. The impact of size of planting material could be clearly observed from the increased number of rhizomes, enhanced rhizome sizes and higher rhizome weights as compared to whole finger rhizome as planting material in turmeric.

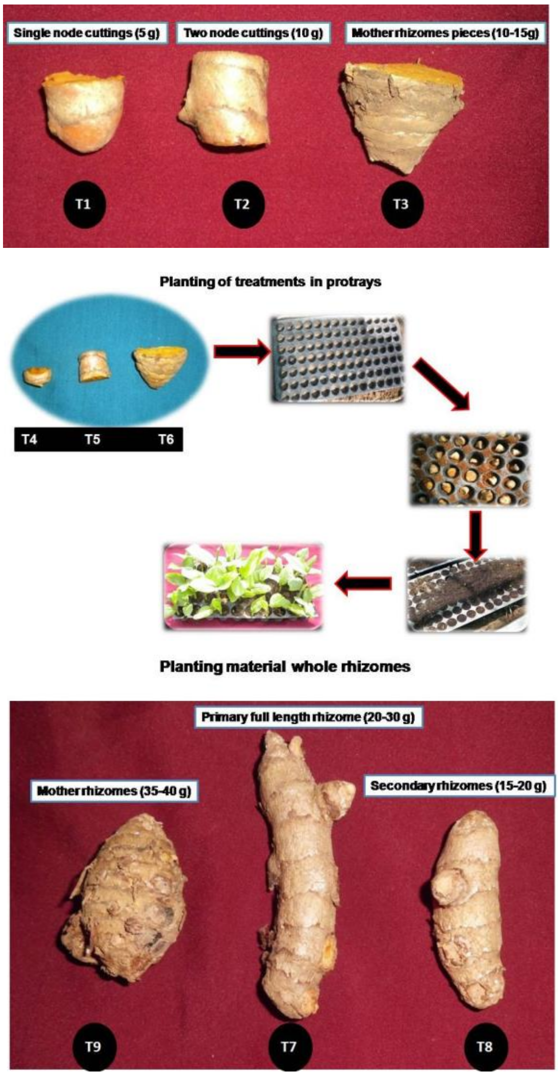

Fig 1. Different types of turmeric planting material

Among the various treatments, single node rhizome (5g) raised in protray (1 month) and the transplants planted in the field responded very well and showed higher value for growth and yield characters. The vigor of transplants can be related to the size of the assimilate pool. In bare root ones, this pool is the main energy source for the emission and growth of new roots to replace those damaged at digging or cut off before planting. In these transplants, the root system is embodied by substrate and root damage at planting is minimized. Nevertheless, new roots are not immediately able to absorb water and nutrients and plants are susceptible to stress in the days after planting (Gautier *et al*., 2001). In turmeric plant, this phenomenon may be stronger than in other species, because it is considered as having a slow root growth. Higher plant growth was also recorded at the end of the experiment on plants from plug transplants and data confirm results reported by other authors (Durner, 1999; Bish *et al*., 2002; Larson and Ponce, 2002; Hochmuth *et al*., 2006a, b; Giménez *et al*., 2009). These findings also agree with the turmeric plug transplants having intact root system.

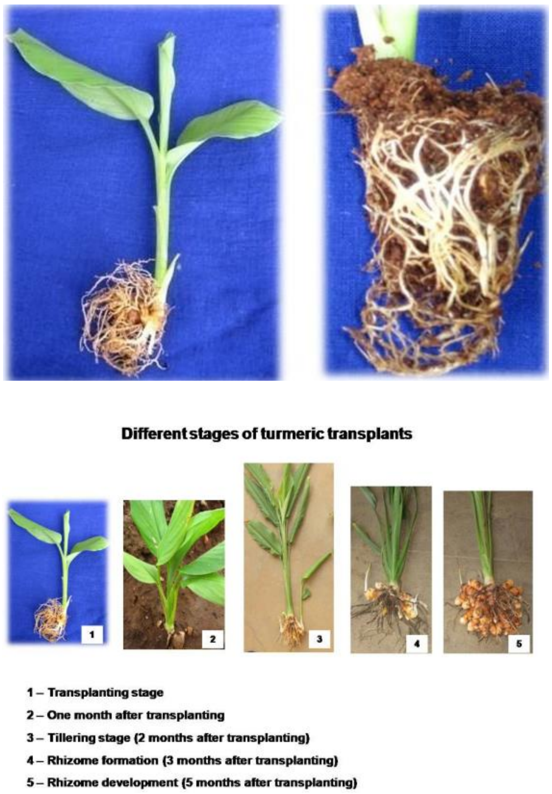

Fig 2. Vigorous shoot, root growth and different growth stages of turmeric transplants

The results from this study indicate that turmeric plants established in the field using rooted transplants resulted in a higher rhizome yield than plants generated from finger rhizome directly planted in the field. This corroborates earlier data of Islam *et al*. (2002),who, in a study on sweet potato growth and yield from plug transplants, planted intact or without roots, determined that the overall growth and yield of the plug transplants (as shown in Fig 2) was greater than that of the conventional unrooted rhizomes. It can be concluded that turmeric single node rhizome transplants significantly improved growth and yield of turmeric. A key objective in any agricultural operation is the recovery of the investment in the shortest time possible.

Table 2. Effect of planting materials on yield parameters of turmeric (2011-12 to 2013-14) - Pooled data

Trts.	Fresh weight of rhizomes /plant (g)			Rhizome yield /plot (15 m^2)	Estimated fresh rhizome yield (t/ha)	B:C ratio
	Mother rhizome	Primary rhizome	Secondary rhizome			
T_1	83.67	101.83	45.99	39.20	28.74	1.24
T_2	92.59	109.96	60.50	42.81	31.39	1.31
T_3	96.29	124.77	71.93	46.82	34.33	1.68
T_4	133.55	162.55	85.58	63.00	46.20	2.47
T_5	101.07	146.10	72.43	48.26	35.39	1.61
T_6	125.11	148.33	72.83	57.10	41.87	2.14
T_7	94.33	138.37	68.97	47.02	34.47	1.36
T_8	86.99	119.85	61.21	44.12	32.35	1.26
T_9	99.66	148.91	72.70	53.67	39.35	1.64
SED	21.89	36.37	12.59	8.89	-	-
CD (P = 0.05)	47.71	79.25	27.43	19.37	-	-
CV (%)	21.58	27.27	18.51	18.11	-	-

This can be achieved, in part, by producing better quality planting material that has the capacity to establish itself rapidly in the field, and that has the potential to reach high levels of production within the cropping season. The results of this trial demonstrate the advantages of plug transplants over traditional rhizome planting.

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