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Growth and yield of turmeric (*Curcuma longa* L.) as influenced by different rooting media and different size of rhizomes

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Abstract

The investigation entitled "Propagation studies in turmeric (*curcuma longa* L.)" was carried out during the *kharif* season at Main Agriculture Research Station, Department of Horticulture, College of Agriculture, University of Agricultural Sciences, Raichur, Karnataka during 2018-19. Effect of different types of rhizome planting material and rooting media on growth, yield and economics were recorded and statistically analyzed. The influence of effect of types of rhizome planting material and rooting media on growth parameters higher values with respect to percentage of establishment (99.17), plant height (85.37 cm), number of leaves (17.93) and girth of the stem (3.40 cm) was observed in primary rhizomes planted in mixture of cocopeat and vermicompost. Leaf area (7232.65 cm^2), leaf area index (5.35) was higher in direct planted mother rhizomes and number of tillers (3.27) was higher in secondary rhizomes in mixture of cocopeat and vermicompost. Similar trend of higher fresh weight of mother rhizome (111.80 g), primary rhizome (166.87 g) and secondary rhizomes (55.93 g) per clump, fresh rhizome yield per clump (384.47 g), per plot (12.75 kg) and per hectare (23.60 t) was higher in primary rhizomes planted in mixture of cocopeat and vermicompost. On other hand the benefit cost ratio recorded maximum of 6.71 in disc with single bud in mixture of cocopeat and vermicompost.

Keywords: Turmeric (*Curcuma longa* L.), rooting media, rhizome sizem, agricultural practices

Introduction

Turmeric (*Curcuma longa* L.) is an ancient and sacred spice of India. It is known as 'Indian saffron' because of its incomparable flavour and it is broadly utilized as an expensive substitute of saffron. Turmeric is an important commercial spice crop grown in India. The Hindus, both tribal and civilized, consider turmeric as sacred and auspicious. It is associated with several rituals from ancient period and the tradition still goes on.

Turmeric is cultivated for its underground rhizome, which is utilized as spice. It is also used for fixing in medication and cosmetic industry. It frames an imperative adjuvant in Indian culinary as it imparts colour and sweet-smelling flavour to different dishes. It is mainly used as a condiment in the preparation of pickles and curries and as a coloring substance in confectionary ventures. The turmeric rhizome contains various pigments among which 'curcumin' is the major pigment responsible for colour and it varies from 3.5 to 9.0 percent in various varieties. Turmeric is extensively used as a stimulant, blood purifier, carminative tonic remedy against skin diseases, itches and pain. It is also used as an anti-helminthes. Turmeric is used in drug industry due to its anti cancerous properties and is also considered to cure Acquired Immune Deficiency Syndrome.

Curcuma, is an important genus in the family Zingiberaceae. *Curcuma longa* has a somatic chromosome number of 2n = 63. It consists of about 110 species, distributed in tropical Asia and the Asia–Pacific region. The greatest diversity of the genus occurs in India, Myanmar, and Thailand, and extends to Korea, China, Australia, and the South Pacific.

The world production of turmeric stands around 8 lakh tones, of which the contribution of India is approximately 75-80 per cent. India is the largest producer, consumer and exporter of turmeric in the world. Turmeric is cultivated throughout India covering an area of 2.08 lakh hectares with an annual production of 1029 million tonnes and productivity of 5.1 metric tonnes per hectare (Anon., 2017) [1]. In India, Telangana, Andhra Pradesh, Orissa, West Bengal, Tamil Nadu, Assam, Maharashtra, Karnataka, Bihar and Kerala are the important turmeric growing states. In Karnataka, turmeric is being cultivated in an area of 15,000 hectare with an annual production of 76,000 MT of fresh turmeric. Belgaum, Chamarajnagara, Uttar Kannada, Hassan, Shivamoga and Chickmagalore are important districts growing turmeric (Anon., 2017) [1].

In turmeric, planting material requirement (2000 kg ha^{-1}) is high and it shares 40 percent of the total cost of cultivation. Turmeric seed rhizomes are infrequently accessible and hard to obtain. As cost of planting material is very high in turmeric, there is a need to reduce the cost of seed material by selection of rhizome of optimum size. This can be done by resorting to single bud cuttings, from secondary and primary rhizomes. With this background, the present investigation is designed to determine the optimum planting material and suitable rooting media for better growth and yield of turmeric.

Hence the production of healthy seed material and reduction of size of seed material is the need of the hour. Keeping this

in view the following objectives have been formulated to conduct the present experiment.

Materials and Methods

Investigations on "Propagation studies in turmeric (*Curcuma longa* L.)", Effect of rhizome types on growth and yield of turmeric and effect of propagation media on growth of turmeric sprouts was under taken at Main Agriculture Research Station, Department of Horticulture, College of Agriculture, University of Agricultural sciences, Raichur, Karnataka during 2018-19. The study was carried out with 10 treatments. The experiment was laid out in a randomized block design (RBD) replicated thrice. Statistical analysis was carried out as per Panse and Sukhatme (1967) [8] was referred for determination of standard error of mean (S.Em.±) and critical difference (C.D). Involving different types of rhizome planting material and rooting media i.e whole mother rhizome direct planting (control), whole primary rhizome in cocopeat, whole Secondary rhizome in cocopeat, disc with single bud in cocopeat, whole primary rhizome in vermicompost, whole secondary rhizome in vermicompost, disc with single bud in vermicopost, whole primary rhizome in mixture of cocopeat and vermicopost (1:1), whole secondary rhizome in mixture of cocopeat and vermicopost (1:1), disc with single bud in mixture of cocopeat and vermicopost (1:1). Plots of 5.4 m^2 size were prepared after which ridges and furrows were prepared at a spacing of 45 cm × 30 cm (59,259 plants ha^{-1}).

Results and Discussion

Growth characters

Table 1 provides that there was a significant variation in percentage of establishment, plant height, number of leaves per plant, number of tillers, plant girth was recorded among ten treatments used for the study. Rooting media and planting materials influenced significantly in the per cent field establishment. Significantly highest field establishment of 99.17, 99.17 and 98.33 per cent at 45 days after transplanting in T_1 (whole mother rhizome direct planting), T_8 (whole primary rhizome in mixture of cocopeat and vermicompost) and T_2 (whole primary rhizome in cocopeat) respectively. Disc with single bud in cocopeat (T_4) and whole primary rhizome in vermicompost (T_5) were found to be significantly poor in per cent field establishment. Maximum per cent field establishment indicates maximum population in the field, the expression of maximum yield by T_8 (whole primary rhizome in mixture of cocopeat and vermicompost) might also be under the influence of maximum population Balwinder and Gill (2010) [2].

The plant height at various stages of growth was under the significant influence due to types of rhizome planting materials and media. The use of (T_8) primary rhizome as a planting material with 1:1 ratio of cocopeat and vermicompost influenced significantly higher on plant height (85.37 cm). T_4 (Disc with single bud in cocopeat), T_3 (whole secondary rhizome in cocopeat) were found to be significantly inferior for plant height throughout the growth stages. This vigorous nature of T_8 might have influenced the higher rhizome yield per hectare Hanamashetti *et al*. (2002) [4] and Manhas and Gill (2012) [5].

The effect of types of rhizome planting materials and rooting media had significant effect on number of leaves per plant at all the stages of growth. T_8 (whole primary rhizome in mixture of cocopeat and vermicompost) was recorded maximum number of leaves per plant (17.93) followed by T_1 (mother rhizome direct planting) (17.60). Disc with single bud in cocopeat and vermicompost (T_4, T_7) treatments were found to be significantly inferior for the number of leaves per plant at all the stages of the growth. Among the vegetative parameters number of leaves per plant being the important parameter towards effective photosynthesis and production of photosynthetes, the expression of maximum number of leaves by T_8 might also had influenced on the rhizome yield and yield attributes Deshmukh *et al*. (2005) [3].

Effect of types of rhizome planting materials and media on the number of tillers per plant. Significant variation was observed for this parameter Secondary rhizome in mixture of cocopeat and vermicompost (3.27). T_8 (Whole primary rhizome in mixture of cocopeat and vermicompost) expressed on par relation (2.67). Least was observed in disc with single bud in cocopeat (1.17). More number of tillers per plant will influence the rhizome yield normally. The higher rhizome yield of T_8 (Whole primary rhizome in mixture of cocopeat and vermicompost) might be influenced by higher values of yield attributing character Singh *et al*. (2013) [9].

Treatment T_8 (whole primary rhizome in mixture of cocopeat and vermicompost) at all the stages of crop growth exhibited significant and highest stem girth i.e. 3.40 cm followed by mother rhizome direct planting 3.38 cm. Least was observed in secondary rhizome in cocopeat 2.63 cm. The extent of stem thickness would influence the strength of the pseudo stem Neeraja *et al.* (2017) [7].

Yield parameters

Data on different rhizome characters *viz*., Number of primary rhizomes, number of secondary rhizomes, weight of primary rhizomes, weight of secondary rhizomes, rhizome yield per clump and rhizome yield per hectare are presented in Table 2.

The effect of types of rhizome planting material and rooting media on the number of mother, primary and secondary rhizomes per clump exhibited significantly superior performance through T_8 (Whole primary rhizome in mixture of cocopeat and vermicompost) was significantly superior with respect to more number of mother rhizome (4.50), primary rhizome (11.40) and secondary rhizome (8.90) per clump. Least number of mother, primary and secondary rhizome was observed in disc with single bud in cocopeat. As the number of mother, primary and secondary rhizomes per clump are influencing yield and yield parameters, either significantly or statistically higher numbers of these characters shall influence the fresh rhizome yield. Hence the T_8 (Whole primary rhizome in mixture of cocopeat and vermicompost) had the higher rhizome yield per hectare Balwinder and Gill (2010) [2].

T_8 (Whole primary rhizome in mixture of cocopeat and vermicompost) was found to be significantly superior for average fresh weight of mother rhizome (111.8 g), primary rhizome (166.87 g) and secondary rhizome (55.93 g). Mother rhizome direct planting has on par with T_8. Least fresh weight was observed in disc with single bud in cocopeat. The superior performance of T_8 might to be

attributed to the mixture of rooting media comprised of cocopeat and vermicompost in 1:1 ratio and primary rhizome as a planting material which helped in getting high root mass per seedling (Deshmukh *et al*. (2005) [3].

The use of types of rhizome rooting media and planting materials exhibited significant variation among different treatments. The yield per clump, per plot and per hectare showed wide range of variation for fresh rhizome yield. The treatment T_8 (Whole primary rhizome in mixture of cocopeat and vermicompost) exhibited significantly higher fresh rhizome yield of 384.47 g per clump, 12.75 kg and 23.60 t per hectare followed by T_1 (Whole mother rhizome direct planting). T_4 (Disc with single bud in cocopeat) was emerged as significantly least treatment for fresh weight of rhizome. Higher rhizome weight per clump and per plot shall result in higher rhizome yield per hectare as they directly influence the yield. Transplanting of turmeric plants raised in mixture (1:1) cocopeat and vermicompost using primary rhizome would yield significantly higher fresh rhizome yield per hectare and as primary rhizome with more reserved food and more number of buds might have contributed towards bigger clumps and higher yield Manhas *et al*. (2011) [6].

Table 1: Effect of different planting material and rooting media on vegetative growth of turmeric

Treatments	Percentage of establishment	Plant height (cm)	Number of leaves	Number of tillers per plant	Girth of the stem (cm)
T_1	99.17	81.47	17.60	2.57	3.38
T_2	98.33	78.90	16.63	1.67	3.30
T_3	96.67	69.23	13.13	2.17	2.63
T_4	94.17	64.27	11.50	1.17	2.77
T_5	94.17	77.23	15.90	2.13	3.13
T_6	95.83	72.67	15.73	2.90	2.80
T_7	95.83	65.83	14.07	2.10	2.60
T_8	99.17	85.37	17.93	2.67	3.40
T_9	95.67	71.40	15.43	3.27	2.93
T_{10}	95.83	70.70	14.90	2.50	2.77
Mean	96.48	73.71	15.28	2.31	2.97
S.Em ±	0.29	3.56	1.03	0.31	0.15
C.D. at 5%	0.87	10.57	3.07	0.92	0.45

Treatment details: T_1: Whole mother rhizome direct planting (control), T_2: Whole primary rhizome + cocopeat, T_3: Whole secondary rhizome + cocopeat, T_4: Disc with single bud + cocopeat, T_5: Whole primary rhizome + vermicompost, T_6: Whole secondary rhizome+ vermicompost, T_7: Disc with single bud + vermicompost, T_8: Whole primary rhizome + mixture of cocopeat and vermicompost (1:1), T_9: Whole secondary rhizome+ mixture of cocopeat and vermicompost (1:1), T_{10}: Disc with single bud + mixture of cocopeat and vermicompost (1:1).

All parameters recorded at 150 days of transplanting except percentage of establishment at 45 DAT, cm= centimetre, S.Em±=Standard error of mean, C.D.=Critical difference.

Table 2: Effect of different planting material and rooting media on yield of turmeric

Treatment	Number of mother rhizome	Number of primary rhizome	Number of secondary rhizome	Weight of mother rhizomes (g)	Weight of primary rhizomes (g)	Weight of secondary rhizomes (g)
T_1	3.17	10.97	7.00	95.20	165.00	38.13
T_2	2.43	6.73	3.73	83.67	125.50	29.20
T_3	2.60	7.03	3.27	87.07	111.10	17.33
T_4	2.80	5.83	1.77	53.53	92.70	26.30
T_5	3.03	8.37	5.53	93.17	164.20	28.06
T_6	2.93	7.73	5.83	77.00	112.30	38.03
T_7	3.60	6.63	7.23	109.13	121.20	44.07
T_8	4.50	11.40	8.90	111.80	166.87	55.93
T_9	3.67	9.17	6.57	90.87	154.23	53.87
T_{10}	4.40	8.63	5.23	95.40	130.13	32.33
Mean	3.31	7.95	5.34	89.07	130.91	36.33
S.Em ±	0.27	0.76	0.62	7.58	12.26	3.78
C.D. at 5%	0.81	2.26	1.85	22.53	36.42	11.22

Treatment details: T_1: Whole mother rhizome direct planting (control), T_2: Whole primary rhizome + cocopeat, T_3: Whole secondary rhizome + cocopeat, T_4: Disc with single bud + cocopeat, T_5: Whole primary rhizome + vermicompost, T_6: Whole secondary rhizome+ vermicompost, T_7: Disc with single bud + vermicompost, T_8: Whole primary rhizome + mixture of cocopeat and vermicompost (1:1), T_9: Whole secondary rhizome+ mixture of cocopeat and vermicompost (1:1), T_{10}: Disc with single bud + mixture of cocopeat and vermicompost (1:1) g= gram, S.Em±=Standard error of mean, C.D.=Critical difference,

Table 3: Effect of different planting material and rooting media on fresh rhizome yield of turmeric

Fresh rhizome yield of turmeric			
Treatments	**g clump^{-1}**	**kg plot^{-1}**	**t ha^{-1}**
T_1	383.33	12.44	23.03
T_2	310.93	11.63	21.54
T_3	248.00	9.51	17.61
T_4	183.33	4.83	8.95
T_5	323.40	11.76	21.78
T_6	268.20	9.22	20.77
T_7	253.27	7.89	14.61
T_8	384.47	12.75	23.60
T_9	333.40	11.22	20.77
T_{10}	308.23	10.91	20.20
Mean	299.66	10.22	19.29
S.Em ±	16.48	1.18	0.88
C.D. at 5%	48.97	3.52	2.64

Treatment details: T_1: Whole mother rhizome direct planting (control), T_2: Whole primary rhizome + cocopeat, T_3: Whole secondary rhizome + cocopeat, T_4: Disc with single bud + cocopeat, T_5: Whole primary rhizome + vermicompost, T_6: Whole secondary rhizome+ vermicompost, T_7: Disc with single bud + vermicompost, T_8: Whole primary rhizome + mixture of cocopeat and vermicompost (1:1), T_9: Whole secondary rhizome+ mixture of cocopeat and vermicompost (1:1), T_{10}: Disc with single bud + mixture of cocopeat and vermicompost (1:1) g= gram, kg=kilograms, t/ha= tonnes per hectare, S.Em±=Standard error of mean, C.D.=Critical difference.

Conclusion

The use of primary rhizome as planting material in mixture of cocopeat and vermicompost resulted in significantly higher fresh rhizome yield compared to other planting material and growing media. Though the use of mother rhizome for direct planting resulted in higher yield but getting the required quantity of mother rhizome for commercial cultivation found to be difficult.

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