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Studies on Suitability of Rapid Multiplication of Turmeric (*Curcuma longa* L.) for Chamarajanagara Conditions in Karnataka

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Authors Contribution

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Abstract

A field experiment was conducted during 2016-17 on rapid multiplication of turmeric to know the suitability of the technology to Chamarajanagara conditions. The data revealed that by practicing rapid multiplication of turmeric a farmers can save >80% of the seed rhizome requirement per unit area. Here, only 500 kg seed rhizomes are sufficient for producing turmeric seedlings for planting in a hectare instead of 2000 to 2500 kg in present farmers' practice. Weeding and irrigation water can be saved up to 45 days in main field. Rapid multiplication technique of turmeric recorded significantly higher number of plantlets per kg of seed rhizomes (206.71). The size of cut seed rhizome (6.77 g) has not affected the performance of the crop in the main field as at all the crop growth stages, it was recorded a significantly higher plant height (139.51 cm) and equal number of clumps (7.38) as compared to conventional propagation method provided proper seed rhizome preparation, nursery activities and growing of healthy seedlings are achieved. As relatively higher biomass (1.95 kg/plant), fresh rhizome yield per plant (1.59 kg), fresh rhizome yield (33.85 tonnes/ha) and cured rhizome yield (6.97 tonnes/ha) were recorded and overall 3.16 per cent increase in yield was also observed in the rapid multiplication technique adopted plots. Uniform establishment, growth and uniform maturity of the crop are the added advantage of this technology. For promotion of precision farming in turmeric, this technology is the first step to farmer has to adopt. The results are confirmed that rapid multiplication of turmeric is very much suited to Chamarajanagara condition.

Keywords : Rapid multiplication of turmeric, Single node cutting, Fresh rhizome, Cured rhizome, Curing percentage

Turmeric (*Curcuma longa* L.) is one of the most important spice, essentially a tropical crop grown in India. India is the largest producer and exporter of turmeric in the world and accounts for more than 50 per cent of the world trade (Philip, 1983). The crop occupies major share of area in Telengana, Tamil Nadu, Andhra Pradesh, Karnataka and West Bengal (DASD, 2016). Turmeric is valued for its deep yellow colour (0.2-8% curcumin), pungency (2.2-4.2% termerol) and aromatic flavour of volatile oil (1.5-5%). During vedic period turmeric is referred as 'earthy herb of the sun' with the orange-yellow rhizome it was regarded as the 'scared spice' (Reshma *et al.,* 2020). Chamarajanagara falls under southern dry agro climatic zone-VI of Karnataka with turmeric as a major spice crop of the district, presently growing in an area of >9750 ha (Anonymous, 2021) & 56122 tonnes production (Vinod, 2022).

As turmeric is propagated through vegetative means through rhizomes, large quantity of planting material is being used (>2.5 tonnes/ha), because of the low efficiency of vegetative propagation, which comprises >30 per cent of the production cost, also creates storage problem, handling issues, huge labour

requirement and transportation problems. It is difficult to propagate through seeds because of poor flowering and seed set. Apart from high seed rate, it is difficult to practice seed rhizome treatment because bulky nature. It indirectly affects on good management of diseases through rhizome treatment *viz.,* soft rot, leaf spot etc.

Ridges and furrow system of planting is followed in the main field, where for better establishment minimum 04-05 irrigations and 02-03 weeding should be done. It adds additional cost for production. In rainfed conditions, serious irrigation problem areas and labour shortage areas it is quite difficult to carry out the operations timely. The survival percentage of plants through rhizomes is approximately 80-85 per cent only and there is no gap filling opportunity in the main field conditions. The mortality of 10-15 per cent also seen in case of rhizome planted seedlings. The establishment of the crop is confirmed only 45 days after sowing only. The availability of quality planting material is also low during the cropping season (June - September). In order to overcome these problems, a technology of rapid multiplication of turmeric using single bud rhizome has been assessed to know the suitability to the local conditions. The present study was undertaken at ICAR-KVK, Chamarajanagara.

In this protray technique of turmeric, planting material requirement will be reduced; about 75 per cent of planting material requirement can be reduced. As rhizome is cut and used for the preparation of planting material, the diseased rhizome can be eliminated. So, it helps in screening of rhizomes for diseases and the planting material will be disease free. Due to these advantages, the turmeric transplants derived from rhizome bud can be selected as the planting material for turmeric cultivation which will augment the turmeric cultivation with good propagating materials and also increase the farmer income. It is not only a simple technique for adoption, but also accounts high success rate (Chandana, 2021).

Brief Review on Rapid Multiplication of Turmeric

Hossain *et al.* (2005) studied on effects of seed rhizome size on growth and yield of turmeric (*Curcuma longa* L.) they opined that seed rhizomes with a greater diameter developed vigorous seedlings. The plants grown from 30-40g and 50g shows maximum in plant height (140 cm) tiller number (3.5) and leaf number (12-14/plant) shoot dry weight (40 g/plant) which were significantly higher than those from lighter rhizome.

Malhotra *et al.* (2016) reported that single bud techniques of turmeric for seedlings production in portray was more beneficial as compared to direct planting method. Hence, to overcome these constraints rapid multiplication of turmeric through single bud method is one of the best methods (Thapa *et al.,* 2017).

Advantages in Single Bud Rhizome Method of Planting

- Reduction in the requirement of seed rhizome quantity by 75 per cent, saving huge quantity of rhizome which can be used for commercial purpose
- Reduction in the cost of planting material
- Saving land usage 1-2 months from normal duration period of the crop
- Overcoming the disease incidence and also a screening for disease infected materials
- Effective biological control of diseases
- Early rhizome development (starts from three months after planting)
- Overcoming the delay in monsoon arrival up to 1-2 months
- Production of healthy, uniform and disease free planting materials
- Uniform growth in the main field

Material and Methods

The experiment was conducted at ICAR-KVK Chamarajanagara during the *kharif* season of 2016-17. Improved variety IISR Pratibha was used. The trails were laid out in Randomized complete block design (RCBD) with seven replications and three treatments. The treatment details are as follows:

T1 - Planting of whole rhizomes : In normal planting farmers are planting whole seed rhizomes, it contains

6-8 nodes, weighing of 50-100 gm. Seed rhizomes rate is >2500 kg/ha.

T2 - Planting of cut rhizomes : UAS-B recommendation, where cutted rhizomes of 30-40 gm weight, contains 3-4 nodes are using for planting. Seed rhizomes rate is approximately 2000kg/ha.

T3 - Rapid multiplication of turmeric : Single nodes weighing 6-7 gm are using to raise healthy plants and planted in the main field. Seed rhizomes rate is 500 kg/ha.

The plot size is 3m x 2m (36 plants) and sowing (T1 and T2) & planting (T3) were done during second week of June in ridges & furrows. The spacing followed was 45 cm x 30 cm. For the treatment rapid multiplication of turmeric (T3), the cut rhizomes were planted in protrays during first week of May.

Methodology Followed for Raising Seedlings is as Follows

- Select healthy turmeric rhizomes of cv. IISR Pratibha
- One month before planting, the seed rhizomes are cut in to single buds with small rhizomes weighing 6-7gm.
- Treat the single bud cut pieces with mancozeb 2gm + quinalphos 2ml per litre of water for 30 minutes - before planting in the pro-trays (Anonymous, 2015).
- Fill the pro trays (50 well) with nursery medium containing partially decomposed coir pith and vermicompost (50:50), enriched with Trichoderma @ 10gm/kg of mixture.
- Plant the treated turmeric sprout buds in to pro-trays (single node cut pieces) and irrigate immediately.
- To get early and uniform sprouting, the trays are kept airtight, cover the trays with tarpaul by keeping trays one by one.
- Can see the germination within 08 to 10 days of planting, then trays are kept in shade.
- Irrigate only when media is dry. A good root mass is observed with in a period of 03 weeks.
- Healthy seedlings will be ready for transplanting by 35 to 45 days.

All agronomic practices *viz.,* irrigation, manuring, fertilizer application, weeding, plant protection were done according to the UHS, Bagalkote recommendations for turmeric production (Anonymous, 2015). The observations were recorded in 03 phase's *viz.,* seed rhizome preparation phase, nursery management phase and at field level. During seed preparation and nursery management, the cost of rhizome per unit area, cost incurred for rhizome treatment, labour requirement, chemical cost and other expenditure was observed.

At field condition vegetative growth parameters like plant height, number of clumps were recorded

Comparison of direct sowing and transplanting (Rapid multiplication) method of turmeric on sprouting and vegetative phases of the plant

Growing phase	Direct sowing method (whole seed)	Transplanting method (rapid multiplication)
Sprouting phase	20 -25 DAS	Plants have 3-4 leaves (1 month old)
Vegetative phase		
One month after planting	2-3 leaves per plant	6-7 leaves per plant
Tillering stage	3 MAS	1 ½ - 2 MAP
Rhizome development phase	Starts from 5 MAS	Starts from 3 MAP
Rhizome maturation phase	7-9 MAS	6-7 MAP

Source : Malhotra *et al.,* 2016

at different stages of crop growth *viz.,* @ 30days, 60 days, 90 days and at final stage of the crop. Crop was harvested during second week of February, 2017. Yield parameters like biomass of the plant, fresh rhizome yield per plant, fresh rhizome yield per hectare, cured rhizome yield and curing percentage of different treatments were recorded from five randomly selected and tagged plants in each replication. Mean values were computed. Curing percentage was computed by considering the loss of weight in rhizome after curing and the difference expressed as percentage. The data obtained were statistically analysed following statistical procedures outlined by MSTAC computer software program (Bricker, 1991).

Results and Discussion

Seed Rhizome Preparation : Significant differences were noticed with respect to the seed rhizome requirement per unit area, it was recorded that seed rate is very low *i.e.,* 500 kg/ha in the treatment T_3 (Rapid multiplication of turmeric) as compared to T_1 (2500 kg/ha) and T_2 (2000 kg/ha) (Table 1). The data revealed that by practicing rapid multiplication of turmeric a farmer can save up to 80 per cent of the seed rhizomes requirement and the production cost of Rs.31,000 to 13,500 per ha. Here, only 500 kg seed rhizomes are sufficient for producing turmeric seedlings for planting in a hectare instead of 2000 to 2500 kg in present farmer's practice. Rapid multiplication technique of turmeric recorded significantly higher number of plantlets per kg of seed rhizomes (206.71) followed by T_2 (62.17) and least was observed in T_1 (52.79). It was clearly evident that 6.77 g cut rhizome is sufficient to get healthy seedlings. By practicing proper rhizome preparation and nursery management within 35 days vigorous and healthy turmeric seedlings will be ready for transplanting to the main filed. Instead of using bigger size rhizomes (32 to 39.30 gm), a single node cut piece (6.77 gm) is sufficient to raise healthy seedlings and all the treatment were performing on par in the main field at all the crop growth stages (Prasath *et al.,* 2017). Rapid multiplication of turmeric is not only a simple technique for adoption but also accounts high success rate. By practicing rapid multiplication of turmeric 3 to 4 irrigations, 02-03 weeding can be avoided in the main field in early stage of the crop establishment, which not only save the production cost and also has impact on increase in overall output of the crop.

Vegetative Growth : Significant differences were noticed among the treatments with respect to plant height at different stages of crop growth (Table 2). The treatment T_3 was recorded highest plant height at all the stage of crop growth (41.55cm, 84.55cm, 123.25cm & 139.51cm @ 30 DAP, 60 DAP, 90 DAP and final stage respectively) followed by T_2 and

Table 1

Seed rhizome requirement and seed preparation parameters

Treatments	Seed rhizomes required (t/ha)	Number of plantlets per kg of seed rhizomes	Weight of the single plantlet (g)	Cost of the seed rhizome preparation (Rs./ha)
T_1 - Planting of whole rhizomes (Seed rhizomes rate is 2500 kg/ha)	2.5	52.79	39.30	93,750
T_2 - Planting of cut rhizomes (Seed rhizomes rate is 2000kg/ha)(UAS B recommendation)	2.0	62.17	32.00	76,250
T_3 - Rapid multiplication of turmeric (Seed rhizomes rate is 500kg/ha).	0.5	206.71	6.77	62,750
SEM +/-		1.82	0.41	-
CD @ 5%		5.61	1.26	-
F test		*	*	-

TABLE 2

Vegetative growth at different stages of crop

Treatments	Plant height (cm) @				Number of clumps @			
	30 DAS	60 DAS	90 DAS	210 DAS	30 DAS	60 DAS	90 DAS	210 DAS
T_1 - Planting of whole rhizomes (Seed rhizomes rate is 2500 kg/ha)	25.84	68.80	105.20	119.25	1.40	3.83	6.23	7.44
T_2 - Planting of cut rhizomes (Seed rhizomes rate is 2000kg/ha) (UAS-B recommendation)	28.77	69.50	106.80	121.60	1.21	3.50	6.44	7.34
T_3 - Rapid multiplication of turmeric (Seed rhizomes rate is 500kg/ha)	41.55	84.85	123.25	139.51	1.40	3.79	6.35	7.38
SEM +/-	0.64	1.20	0.97	1.31	0.06	0.18	0.09	0.06
CD @ 5%	1.96	3.70	2.97	4.03	0.18	0.55	0.26	0.19
F test	*	*	*	*	NS	NS	NS	NS

least was observed in T_1. This might be due to well established healthy seedlings shown vigour in growth and recorded highest plant height in initial stages. For T_2 and T_3 even though the seed rhizomes of bigger sizes are planted in the main field, congenial condition is required for early germination and better establishment. The availability of the moisture, weed competition in early stages has affect on emergence and establishment of the crop.

Number of clumps produced per plant has direct influence on the yield. No significant differences among treatments on number of clumps produced per plant at all the stages of growth were evident (Table 2). It was recorded equal number of clumps per plant at 30 DAP, 60 DAP & 90 DAP and at final stage of the crop. This is clearly shows that even the plants raised from the single nodes can perform equally once the plants are established in the main field. This also shows that, the management of seed rhizome is very much important, than the size. As once it emerges as a healthy plant and planted in the field, the favourable conditions, environment will boost and enhances the growth and plant acts normal, produces more and normal number of potential clumps per plant (Manjunathgoud, 2002). It clears the doubt on how establishment of single node cutting seedling on par with the bigger sizes rhizomes which have more number of nodes.

TABLE 3

Yield parameters

Treatments	Total biomass of the single plant (kg)	Fresh Rhizome Yield (kg)/plant	Fresh rhizome yield (t/ha)	Curing per centage	Cured Rhizome yield (t/ha)
T_1 - Planting of whole rhizomes (Seed rhizomes rate) is 2500 kg/ha	1.91	1.38	32.81	20.65	6.77
T_2 - Planting of cut rhizomes (Seed rhizomes rate is 2000kg/ha) (UAS-B recommendation)	1.76	1.36	32.65	20.50	6.69
T_3 - Rapid multiplication of turmeric (Seed rhizomes rate is 500 kg/ha)	1.95	1.59	33.85	20.60	6.97
SEM +/-	0.04	0.03	0.24	0.29	0.07
CD @ 5%	0.11	0.10	0.73	0.90	0.22
F test	*	*	*	NS	*

Rapid Multiplication of Turmeric Methodology

Rhizomes cut in to single node pieces

Seed treatment by 2gm mancozeb + 2ml quinalphos per litre of water for 10-15 min

Media preparation

filling up of the trays

Germination within 02 weeks

Good root mass developed at 3 week sowing

45 days Seedings ready for transplanting

Transplanting of turmeric seedlings

Copmparision of growth and yield attributes of different treatment

Transplanting of turmeric seedlings

Yield Parameters

A significant variation was noticed for yield and yield attributes between the treatments. Table 3 shows highly significant variations among the treatments for the production of the biomass of the plant, fresh rhizome yield per plant, per hactare and cured rhizome yield.

The rapid multiplication of turmeric has produced relatively higher bio mass (1.95 kg/plant), followed by T_1 and least was observed in T_2. This might be due to planting of healthy seedlings has boosted the overall growth of the plant.

Rapid multiplication of turmeric had highest fresh rhizome yield per plant (1.59 kg), per hectare (33.85 tonnes) and cured rhizome yield (6.97 tonnes/ha), 3.16 per cent higher yield was recorded. This might be due to use of healthy seedlings, well establishment of the crop in the initial period, uniform growth; highest plant height in all the stages of crop growth contributed more towards higher yield. It shows the opportunity of the technology that by following this and precision farming, there is a chance of enhancing the yield per unit area.

There is no significant differences were observed with the curing percentage, it shows difference in the planting material may not affects the accumulation of the substrates in the rhizomes. The variety has exhibited its potential with respect to curing percentage, irrespective of the size of the planting material used for the propagation.

The technology rapid multiplication of turmeric is well suited for Chamarajanagar condition, as huge area is covered under turmeric (>9750ha) by adopting rapid multiplication technology, we can save up to 59.71 crore kg of seed rhizome in a season. Savings of Rs.31,000 to 13,500/- per ha. is an additional benefit. Apart from huge irrigation water can be saved in the initial stage of the crop. Save on labour charges for weeding in initial period boost good establishment of the crop in the initial period of the crop. Moreover this is a suitable technology to introduce new improved varieties, because only 450-500 kg of seed rhizomes is sufficient for a hectare area. This is highly suitable technology where precision farming can be promoted indirectly, without compromising the yield >80 per cent of the seed rhizome can be reduced.

The main drawback of rapid multiplication technology is seedlings should be raised atleast 35-45 days earlier for the season. The seedling should be raised by farmers only because each seedling costs 75 paise Rs.1.00.

Surely this technology changes the crop dynamics in the area and there is a chance of enhancing the yield by many fold.

Cost Economics : Higher returns of Rs.2,85,650 /ha and higher B:C ratio of 3.15 has recorded in T_3. This might be due to savings on irrigation, weeding and 80 per cent on seed rhizome in the early stages of the crop. Reduction of Rs.12,700 to 30,220 was noticed

TABLE 4

Cost economics of different treatments

Treatments	Gross returns (Rs/ha) (Rs 60/kg)	Cost of cultivation (Rs/ha)	Net Returns (Rs/ha)	B:C Ration
T_1 - Planting of whole rhizomes (Seed rhizomes rate is 2500 kg/ha)	4,06,200	1,62,750	2,43,450	2.49
T_2 - Planting of cut rhizomes (Seed rhizomes rate is 2000 kg/ha) (UAS-B recommendation)	4,01,400	1,45,250	2,56,150	2.76
T_3 - Rapid multiplication of turmeric (Seed rhizomes rate is 500kg/ha)	4,18,200	1,32,550	2,85,650	3.15

as compared to T_3 and T_2 treatments. Higher yield contributed to increase in gross income and higher B:C ratio of T_3.

Thus it can be concluded that by practicing rapid multiplication of turmeric, a farmers can save >80 per cent of the seed rhizome requirement per unit area. In turn it saves the production cost up to Rs.13,500 to 31,000 per ha. Here, only 500 kg seed rhizomes are sufficient for producing turmeric seedlings for planting in a hectare instead of 2000 to 2500 kg in present farmer's practice. Weeding and irrigation water can be saved up to 45 days in main field. Uniform establishment, growth and uniform maturity of the crop are the added advantage of this technology. For promotion of precision farming in turmeric, this technology is the first step to farmer has to adopt. The results are confirmed that rapid multiplication of turmeric is very much suited to Chamarajanagara condition.

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