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RAPID CLONAL MULTIPLICATION OF ELITE CARDAMOM SELECTIONS FOR GENERATING PLANTING MATERIAL, YIELD UPGRADATION AND ITS ECONOMICS

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ABSTRACT

A high degree of variability observed in seedling progeny of cardamom, necessitates the selection and multiplication of elite clones. Field trial with multiplication of cardamom in trench system of planting revealed that 14816 planting units could be obtained with a rate of multiplication of 1:32 besides a remarkable yield of 90.25 kg dry cardamom per 0.05 ha within a short span of 20 months under controlled shade. Trench system of planting triggered better distribution of both horizontal and vertical roots enabling accelerated absorption of applied nutrients and soil moisture by providing adequate anchorage and enhanced proliferation of suckers. A net profit of Rs. 42,752 per 0.05 ha was obtained within 20 months with a BCR of 3.50 besides generation of substantial gainful employment. The rapid clonal multiplication has proved to be a simple reliable and cost effective technique, which can be easily adopted by farmers to select and multiply elite clones right on their own plantations.

Key words: Cardamom, Rapid clonal multiplication, Root distribution, Economic analysis.

INTRODUCTION

Large scale propagation of cardamom in most of the cardamom growing areas has been only through seeds. This results in heterogeneous progeny due to cross pollination (Mayne, 1951; Korikanthimath, 1992). A high degree of variability was noticed in a comprehensive field study involving 490 seedling progenies. Of these, 44.2 per cent were poor yielders (100g green capsules/plant) contributing to 12.5 per cent of the total yield, 36 per cent were medium yielders (100-300g/plant) contributing to 40.1 per cent of the total yield and 14.5 per cent had an yield range of 300-500 g/plant contributing 32.1 per cent of the total yield. The high yielding group (500-900 g/plant) was only 4.4 per cent contributing to 15.3 per cent of the total yield (Pattanshetti, 1980; Krishnamoorthy *et al.*, 1989). This necessitates the selection and multiplication of high yielders to replace the poor yielders on a large scale in cardamom plantations to step up productivity.

Clonal multiplication which ensures genetically uniform planting material can be resorted to either by macro *i.e.* clonal multiplication through rhizome under intensive care in the clonal nursery, or through micro-propagation by tissue culture under aseptic conditions. However, the cost of tissue cultured plants is high and not within the reach of small and marginal farmers who constitute nearly over 70 per cent of planters. Besides, the selections/ clones in cardamom are highly location

specific (Madhusoodanan, 1992). Under such limitations, clonal multiplication of elite clumps identified from farmer's field itself provides an easy way out. Moreover, plants raised from rhizomes bear earlier by one year compared to seedling population, thus recovering the initial investment of plantations. In view of these practical problems, a 'Rapid clonal multiplication technique' was evolved at Cardamom Research Centre, Appangala (Korikanthimath, 1992). No information is available on the economics of rapid multiplication right in the farmer's field. Hence, a field investigation was undertaken in the actual cardamom growers' field with an objective of field demonstration and to work out the economics of rapid, macro clonal propagation of elite lines of cardamom both for generating planting material and for high yield, right in the clonal nursery itself.

MATERIALS AND METHODS

The 'Rapid clonal multiplication' trial was laid out in an area of 0.05 ha at Chettolli estate, Chettalli, Kodagu District, Karnataka (between 12″25′ N latitude, 70″45′ longitude and 850 m above the MSL) during April 1989 to December, 1990. Chettalli is characterized by moderate climate, with a mean annual precipitation of 1543 mm and a mean temperature ranging from 17.8°C (minimum) to 28.5°C (maximim). The soil of the trial site was kandic paleustalf with high nitrogen, low phosphorus and medium potassium contents.

Selection and monitoring of elite mother clones: Twelve high yielding clumps free from pests and diseases, with bold capsules, retention of green colour, and dry yield ranging from 0.380 to 1.08 kg/plant were selected from a cardamom plantation planted during 1982 with seedlings (raised from seeds) after observing for a period of five crop seasons. The plant population was 5750 accommodated in a 2 ha area at a spacing of 2.1 m x 2.1 m.

The high yielding clumps (plants) were earmarked and part of the clump uprooted and subcloned, leaving the major portion of mother clump in its original place for continuous sucker production for further use in clonal propagation. Regular schedule of cultural operations were followed to ensure vigorous proliferation of suckers. A part of the clump earmarked in the plantation was carefully uprooted without injuring the rhizomes. After trimming the roots, the suckers were separated, in such a way that each planting unit consisted of one grown up tiller along with a growing shoot. The top of the longest tiller (Pseudostem) was trimmed to suppress apical dominance. The rhizomes were treated for 5 minutes with Emisan (0.2%) and planted at a spacing of 1.8 m x 0.6 m in trenches.

Planting technique: The site of clonal nursery had a gentle eastern slope. Trenches of 45 cm width x 45 cm depth and convenient length were taken 1.8 m apart across the slope. The soil from top 20 cm depth was excavated and heaped on the upper side of the trenches. The lower 25 cm depth of soil was excavated and heaped on the lower side of the trenches all along the line and firmly pressed to form a bund to prevent soil erosion. The soil excavated first from top 20 cm along with equal proportions of humus-rich top jungle soil, sand and cattle manure was filled back in the trenches and scuffled thoroughly leaving a depression of 5 cm at the top, to facilitate mulching and retention of soil moisture.

Regular cultural practices, irrigation (twice a week) and plant protection measures were carried out as per the package of practices recommended in 'High Production Technology of Cardamom' (Korikanthimath and Venugopal, 1989).

Management of overhead shade: An overhead pandal was erected using locally available silver oak poles, cross bars and twigs with leaves to allow filtered sunlight. The shading material on the pandal was removed during active monsoon rains (June-November) for better tillering and growth as the sky remained cloudy. The overhead pandal was again covered with silver oak (*Grevillea robusta*) leafy twigs with the cessation of rains (November to May), to provide adequate filtered sunlight for proliferation of suckers.

Monitoring of sucker production and yield: Total number of tillers produced at the 10th and 20th month after planting (MAP) was counted in each clump and average was calculated. Ripened cardamom capsules were harvested periodically at intervals of 15 days, from August to December, and cured in flue pipe drier.

Root distribution: At the end of final round of harvest, the base of cardamom clumps was exposed by waterjets to study both lateral and vertical distribution of roots.

Economic analysis: Economics of clonal multiplication in cardamom both for yield and planting material was worked out and tabulated. The parameters like costs, gross and net returns, return per rupee invested on labour, and per day return were computed. The financial feasibility measures *viz.*, BCR and NPW were worked out at 18 per cent discount rate.

RESULTS AND DISCUSSION

Proliferation of suckers and generation of clonal planting material

On an average, 40 suckers per planting unit were produced within a span of 10 months in the clonal nursery. From a modest estimate of 50 per cent survival of these suckers/clump, 20 planting units per mother sucker (rhizomes) could be obtained within 10 months of planting. As the proliferation of suckers was quite encouraging with an adequate development of rhizomes which store photosynthates/ carbohydrates for initiation of panicles, the entire population of 463 clonal material in 0.05 ha was retained and continued to find out the yield potentiality of these clones in the clonal nursery. Thus, the pseudostem with swollen base along with its food storage organs (rhizomes), serves as a new planting unit for macro-propagation. The new organs, emerging directly from the rhizome obtain their supply of photosynthates in turn from the rhizome. Through labelled assimilates, it was conclusively proved that rhizome is the major sink in a tiller (Vasanth Kumar *et al.*, 1989). New tillers and panicles emerge from the swollen base of pseudostem throughout the year (Kuruvilla *et al.*, 1992). The provision of adequate sunlight, trench system of planting, regular irrigation coupled with timely implementation of calendar of operations were the important

contributing factors for the high rate of proliferation of suckers in the clonal nursery.

At the end of 20 months, a total of 14816 planting units were produced from an area of 0.05 ha, starting from 463 mother planting units accommodated in the clonal nursery. The rate of multiplication of planting material was 1:32 at the end of 20 months, besides resulting in early bearing and contributing to substantial yield.

The established clumps in the clonal nursery were uprooted after the last round of picking and split into sections consisting of at least one mature sucker along with a young growing shoot (planting unit). Well formed planting material always resulted in more shoots per clump and early bearing. The planting materials (rhizomes) produced in the above system were used for planting in the main field for large-scale commercial cultivation of cardamom. Besides meeting farmer's own requirement of clonal material, the excess planting material could always be sold to other farmers as there has been a great demand for quality clones.

Yield

A remarkable yield of 90.29 kg dry cardamom per 0.05 ha was obtained within a short span of 20 months in the high density planting (1.80 x 0.6m) in clonal nursery (Plate 3). This worked out to be 183.14 g dry cardamom per plant besides generating 32 planting units per mother rhizome (Plate 1). The initial supply of stored food material (photosynthates) from the mother rhizome planted in clonal nursery enhanced the rate of proliferation of suckers triggered by the trench system

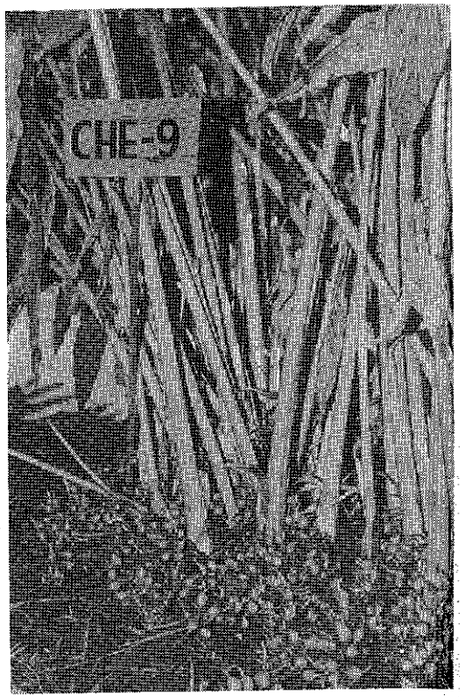

Plate 1: Close up view of high density planting of cardamom in bearing (18 months old)

of planting and regulation of adequate sunlight filtered from overhead pandal. This advanced the bearing of cardamom by almost 12 months compared to raising of cardamom in the main field by using seedlings (raised from seeds) beneath evergreen shade trees in the forest ecosystem. This observation is in conformity with the earlier study of Korikanthimath (1992) Thus, it was possible to get early and quick income to meet the initial investment incurred on establishment and maintenance of the plantation.

Root distribution

At the end of the final round of harvest, the base of the clumps were subjected to washing by waterjets and

exposed to study the lateral spread of the roots. It was observed that 75 per cent of the root were confined to 30 cm around the base, 16 per cent between 30-45 cm and only 4 per cent in a radius of 45-60 cm (Plate 2). The vertical profile of excavated root zone revealed that the maximum number of roots could penetrate upto 50 cm (85%) and the rest upto 65 cm (Plate 3). The trench system of planting triggered better development of both horizontal and vertical distribution of roots and accelerated effective absorption of applied nutrients and soil moisture by providing adequate anchorage. This also enhanced proliferation of suckers.

Economic analysis

i) Partitioning of input costs

It was observed from Table 1 that amongst the various input costs incurred towards raising of clonal nursery both for yield and planting material, the cost towards labour was the highest (Rs 8844/0.05 ha) accounting for 58.74 per cent of total expenses. This highlighted the importance of labour input in clonal multiplication of elite lines in cardamom both for yield and planting material generation. The

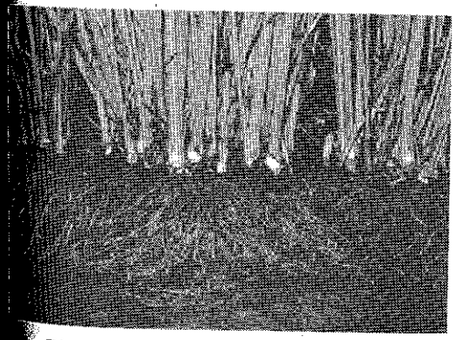

Plate 2: Horizontal distribution of cardamom roots in clonal nursery (20 months old).

next important input cost was pesticides Rs. 1617 (10.74%), followed by fertilizers and manures Rs. 1458 (9.68%) and planting materials Rs. 1157 (7.68%). The cost of cultivation was more during the first year (Rs. 8199/0.05 ha) due to establishment costs, mainly plant material, erection of overhead pandal etc. Subsequently, it was slightly less (Rs. 6856) during second year. The average cost of cultivation for two years worked out to be Rs. 7527/0.05 ha.

ii) Labour requirement

Requirement of labour for various operations of rapid clonal multiplication of elite lines in cardamom for yield and planting material generation was worked out (Table-2). The preplanting

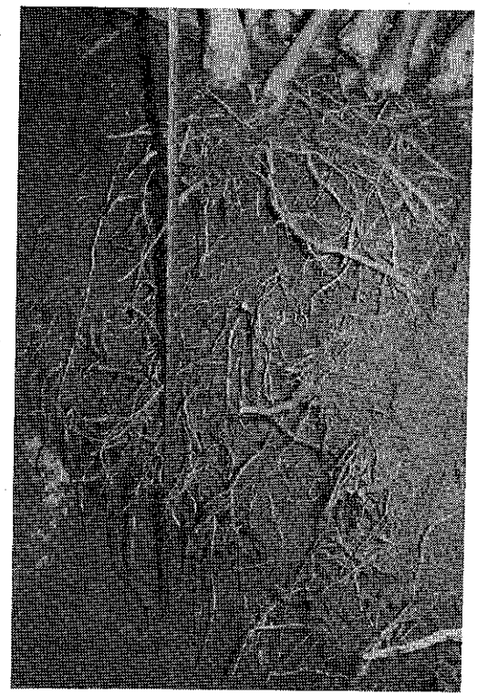

Plate 3: Vertical distribution of cardamom roots in clonal nursery.

Table 1. ***Partitioning of inputs for clonal multiplication of elite cardamom lines, both for yield and planting material generation (Rs./0.05 ha)***

Sl. No.	Particulars of input	1989-90	1990-91	Total
1.	Planting material (463 planting units)	1157	--	1157
2.	Pandal material	360	215	575
3.	Fertilizers	294	589	883
4.	Manures (compost)	250	325	575
5.	Pesticides	780	837	1617
6.	Labour wages	4693	4151	8844
7.	Fuel charges to run irrigation pumpset	285	307	592
8.	Maintenance of farm machinery	380	432	812
	Total	8199	6856	15055

operations like cleaning the open area, layout of land, opening of trenches, collection of jungle soil and filling consumed 74 mandays (48.68 per cent of total men labour requirement) compared to 12 women days during first year of establishment. Due to heavy and strenuous nature of preplanting operations, the higher involvement of men labourers becomes unavoidable during first year of planting. Some of the post-planting operations like weeding, mulching and trashing were done by women labourers accounting for 36 and 37 women labour days respectively, during first and second year of planting.

Among the post-planting operations, collection of poles, cross bars, erection and covering of overhead pandal consumed 32 men and 14 women labour days. The remaining post planting operations like application of fertilizer and manure, plant protection, cleaning of roads and drains, utilised 20 men and 13 women days during first year of planting, and during the second year (1990-91) the corresponding figures were 22 men and 15 women labour days. The requirement of men labour was more by 106 during first year for the establishment, whereas the requirement of women labour was more in second year by 41 numbers, as 62 women labourers were engaged for harvesting alone, contributing to 45.59% of total women labour used. However, the labour requirement of 247 and 182 days (both men and women) during first and second year for 0.05 ha of clonal multiplication of elite lines of cardamom both for yield and production of planting material indicated the potentiality of employment generation opportunities especially for small and marginal farmers who can be meaningfully employed on their farm round the year. Thus, totally Rs 4693 and Rs 415 ha/0.05 ha were incurred on labour during first and second year of clonal multiplication of elite lines both for yield and planting material respectively.

iii) Economics of rapid clonal multiplication

During the two year period, the planting material and yield obtained

Table 2. ***Labour requirement of rapid clonal multiplication of elite cardamom lines for yield and planting material generation (0.05 ha)***

Sl. No.	Nature of work/ Operation	1989-90			1990-91			Total		
		Men @ RS 19	Women @ Rs 19	Amount Rs	Men @ Rs. 22.82	Women @ Rs 22.82	Amount Rs	Men	Women	Amount Rs.
1.	Cleaning the open area	4	2	114	-	-	-	4	2	114
2.	Layout of land at 1.8 x 0.6m for opening trenches	3	2	95	-	-	-	3	2	95
3.	Opening of trenches (45 x 45 m x 25m x 12 lines)	35	2	703	-	-	-	35	2	703
4.	Collection of top jungle soil, transporting & filling the trenches	32	6	722	-	-	-	32	6	722
5.	Planting of suckers	12	8	380	-	-	-	12	8	380
6.	Mulching	-	5x3	285	-	5x4	456	-	35	741
7.	Staking & tieing cardamom suckers	4	2	114	-	-	-	4	2	114
8.	Weeding	-	4x3	228	-	4x2	182	-	20	410
9.	Application of fertilizer	4	2	114	4	2	137	8	4	251
10.	Application of manure (compost)	6	3	171	6	3	205	12	6	376
11.	Collection of poles, cross bars, erection and covering of overhead pandal	32	14	874	8	4	274	40	18	1148
12.	Trashing	-	3x3	171	-	3x3	205	-	18	376
13.	Clearing of roads & drains	2	-	38	2	-	46	4	-	84
14.	Plant protection	8	8	304	10	10	456	18	18	760
15.	Irrigation	10	10	380	10	10	456	20	20	836
16.	Harvesting	-	-	-	-	62	1415	-	62	1415
17.	Processing & grading	-	-	-	6	8	319	6	8	319
	Total	152	95	4693	46	136	4151	198	231	8844

were of the order of 14,816 and 90.29 kg at an average cost of cultivation of Rs 7527 (two years average). The gross and net returns realized from the rapid clonal multiplication both for yield and planting material generation were Rs 57,807 and Rs 42,752 from 0.05 ha. The return per rupee invested on labour was 6.54 and per day return of Rs. 70.08 was obtained in this method (Table 3).

The discounted gross and net returns were Rs 41,516 and Rs 29,644

Table 3. ***Economics of clonal multiplication in cardamom for yield and planting material generation (0.05 ha)***

Variable particular		1989-90	1990-91	
Yield	- Dry cardamom (Kg)	-	90.29	
	- No. of planting units	-	14816	
Price	- Per kg of dry cardamom	-	230	
	- per planting units	-	2.50	
Gross returns	- Dry cardamom (kg)	-	20767	
	- Planting units	-	37040	
	- Total	-	57807	
Discounted gross returns @ 18% p.a.		-	41516	
Cost of cultivation (actual)		8199	6856	
Discounted cost of cultivation @ 18% p.a. 6948		4924		
Net returns (actual)		-8199	50951	
Discounted net returns @ 18% p.a.		-6948	36592	
Net Present Worth (NPW)		-	-	29644
Benefit Cost Ratio (BCR)		-	-	3.50
Return per rupee invested on labour		-	-	6.54
Per day return-		-	70.08	

respectively, with the discounted cost of cultivation of Rs. 11,872 per 0.05 ha. The economic feasibility measures, *viz.* Benefit Cost Ratio (BCR) of 3.50 and Net Present Worth (NPW) of Rs 29,644 also signify the economic sustainability of rapid clonal multiplication both for generating planting material and dry cardamom yield.

Thus, the clonal multiplication in addition to generation of employment helped to generate a modest income which would be helpful to the farmer to build up their economy. Further, there is a constant demand for planting material due to increased domestic consumption of cardamom and hence, the clonal multiplication of elite lines in cardamom both for yield and planting material generation is found to be a profitable proposition.

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