



# CULTIVATION PRACTICES FOR SMALL CARDAMOM



एप्यारिसेस बोर्ड  
भारत

**Indian Cardamom Research Institute**

Spices Board

(Ministry of Commerce & Industry)

Myladumpara, Nedumkandam 685 553

Idukki, Kerala



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## **CULTIVATION PRACTICES FOR SMALL CARDAMOM**

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## INTRODUCTION

Small cardamom (*Elettaria cardamomum* Maton) enjoys a unique position in the international spices market. The plant is a large perennial, herbaceous rhizomatous monocot, belonging to the family *Zingiberaceae*. It is a native of the evergreen forests of the Western Ghats of southern India, which incidentally is also the centre of origin. The cardamom of commerce is the dried ripe fruit (capsules) of cardamom plant. This is often referred as the 'Queen of Spices' because of its very pleasant aroma and taste, and is highly valued from ancient times.

Cardamom is grown extensively in the hilly regions of South India at elevations of 800-1300 MSL as an under crop in forest lands. It is also grown in Guatemala, Sri Lanka, Papua New Guinea and Tanzania. Till early 1970s, India was the main producer and exporter of this commodity. Now Guatemala has emerged as world's largest producer (more than 55 per cent of the total global production) offering stiff competition to Indian cardamom in the international market. In India, cardamom is cultivated in the southern states of Kerala, Karnataka and Tamil Nadu. Kerala accounts for 70 per cent of the cultivation followed by Karnataka (20 per cent) and Tamil Nadu (10 per cent). As per the advance estimate of the Spices Board, the total area under cardamom in India is around 69,190 hectares with production of 22,520 MT (2020-21).

Cardamom is used for flavoring various food preparations, confectionery items and beverages. It is also used for medicinal purposes, both in modern and indigenous systems. In the Middle East countries, cardamom is mainly used for preparation of *Gahwa* (cardamom flavoured coffee).

It is basically a sciophyte plant growing under shade in evergreen forests. It is propagated through seeds, suckers and tissue culture plantlets. The

plants mature in about 20-22 months after planting. Economic yield starts from third year of planting and it continues up to 8-12 years for high yielding varieties depending upon the level of management. The life span of a plant is 30 years or more, but each pseudostem is biannual in nature.

A mature plant may measure two to four meters in height. It is a shallow rooted plant. Tiller production takes place throughout the year. However, peak period is from January to March. Flowers are borne on panicles, which emerge directly from the swollen base of the aerial shoot. It is a cross-pollinated plant and pollination occurs by external agents like honeybees.

## VARIETIES

Two varieties of cardamom plants are identified and they are *Elettaria cardamomum* Maton var. *major* comprising indigenous types of Sri Lanka and *Elettaria cardamomum* Maton var. *minor* comprising cultivars like, *Mysore*, *Malabar* and *Vazhukka*. These types are grown in different tracts and are mostly identified on the nature of panicles, size of plants and other morphological characters. Cardamom varieties are highly location specific.

The panicles are erect in cultivar '*Mysore*' prostrate in '*Malabar*' and intermediate (pendent) in '*Vazhukka*'. Panicles may be branched or simple. The peak period of panicle emergence is from November to March. Flowering normally commences from February and extends to October, May–August being the peak flowering period. After fruit set, about 90-120 days are required for the fruits to attain maturity. The capsules are globose or ovoid or narrowly ellipsoid to elongate in shape, trilocular, containing 15-20 seeds. On maturity, seeds turn dark brown to black in colour and capsule is pale green to dark green. The main features of three cultivars are given below.

## **Malabar**

These cardamom plants have medium size and attain two to three-meter height on maturity. The dorsal side of leaves may be pubescent or glabrous. The panicles are prostrate and the capsules are globose to oblong shaped. This variety is better suited to areas of 600 to 1200 meter elevation. *Malabar* type is relatively less susceptible to thrips infestation. It can thrive under low rainfall conditions.

## **Mysore**

Plants are robust and attain 3 to 4 meter height. The leaves are lanceolate or oblong-lanceolate and glabrous on both sides. Panicles are erect and the capsules are ovoid, bold and dark green in colour. They are better adapted to altitudes ranging from 900 to 1200 meters from mean sea level (msl) and thrive well under assured, well-distributed rainfall conditions.

## **Vazhukka**

This is considered to be a natural hybrid of cultivar *Malabar* and *Mysore* and consequently, the plants belonging to this group exhibit various characteristics intermediate to these two types. The plants are robust like cv. *Mysore*. Its leaves are deep green, oblong to lanceolate or ovate, panicles are semi-erect (pendent) and capsules are bold, globose or ovoid in shape. It is extensively cultivated in Kerala and Tamil Nadu at elevations ranging from 900 to 1200 meters above sea level.

## **High Yielding Varieties and Selections**

Various research institutions working on cardamom have released a number of elite location specific high yielding clones with superior capsule characters. Prominent among them are detailed in Table 1.

In addition to this, there are several high yielding landraces selected by farmers. The most popular and widely cultivated farmer selection is 'Njallani Green Gold' which has very high yield potential and good quality characters. Others prominent selections are Thiruthali, Pappalu, Arjun, Elarajan, Wonder Cardamom, Panikulangara Green Bold-1, Patchaikkai etc.

No	Selection / Varieties	Cultivar	Distinguishing Characters	Area of Adaptability	Source	Yield Potential (Kg / ha)
1	ICRI - 1	Malabar	An early maturing profusely flowering variety; medium sized panicle with globose, bold, dark green capsules; essential oil content 8.65%; dry recovery 22.9%.	South Idukki zone of Kerala, where the rainfall is well distributed	ICRI Spices Board, Myriadumpara Idukki, Kerala	660
2	ICRI - 2	Mysore	Performs well under irrigated conditions; suitable for higher altitude; capsules medium long and parrot green; essential oil content 6.66%; dry recovery 22.5%.	Cardamom growing tracts of Kerala and parts of Tamil Nadu	ICRI Spices Board, Myriadumpara, Idukki, Kerala	750
3	ICRI - 3	Malabar	Early maturing type; non-pubescent leaves; oblong bold, parrot green capsules; essential oil content 6.6%, dry recovery 22.5%.	Cardamom growing tracts of Karnataka	RRS, ICRI Spices Board Sakleshpur, Karnataka	1000
4	ICRI - 4	Malabar	An early maturing variety adaptable to low rainfall area; medium sized panicle; globose bold parrot green capsules; dry recovery 17%.	Adapted to Lower Pulney Hills of Tamil Nadu	RRS, ICRI Spice Board Thadiankudisi, Tamil Nadu	650
5	ICRI - 5	Malabar	Hybrid variety; early bearing; high yield; high oil content; deep green bold capsule; moderately tolerant to rot disease; essential oil content 7.13%; dry recovery 23.15%.	Kerala and parts of Tamil Nadu	ICRI Spices Board, Myriadumpara Idukki, Kerala	1650

6	ICRI - 6	Malabar	Regular yielder; high oil content; deep green long bold capsule; moderately tolerant to rot pathogens thrips, borer and drought; dry recovery 19%.	Kerala and parts of Tamil Nadu	ICRI Spices Board, Myladumpara, Idukki, Kerala	1200
7	ICRI - 7	Vazhukka	Hybrid variety; panicles possess angular green bold capsules; essential oil content 8.84%; dry recovery 22.24%.	Suitable for Wayanad, Kerala	ICRI Spices Board, Myladumpara, Idukki, Kerala	700
8	ICRI - 8	Malabar	Capsules are dark green and bold; high recovery of bold capsules with 71% of the capsules produced is above 7 -5 mm	Karnataka	ICRI Regional Station, Spices Board, Sakleshpur, Karnataka	1200
9	PV -1	Malabar	An early maturing variety with slightly ribbed light green capsules; short panicle; close racemes; narrowly ellipsoid to elongate capsules; dry recovery 19.9%	All Cardamom growing tracts in Kerala and parts of Tamil Nadu.	CRS, KAU, Pampadumpara Idukki, Kerala	500
10	PV - 2	Vazhukka	High yielder; deep green long bold capsule; essential oil content 6.6%; dry recovery 23.8%	Cardamom growing tracts of Kerala	CRS, KAU, Pampadumpara Idukki, Kerala	1200
11	Mudigere-1	Malabar	Tolerant to hairy caterpillars and white grubs; short panicle; oval bold, pale green capsules; tolerant to thrips and shoot borer; essential oil content 8%; dry recovery 20%	Grows in the traditional cardamom growing tracts of Karnataka	ZAHRS, UAHS, Mudigere, Karnataka	275

12	Mudigere-2	Malabar	Suited for cultivation in valleys in Karnataka; essential oil content 8%	Suited for Karnataka (valley areas)	ZAHRS, UAHS, Mudigere, Karnataka	475 (Rain fed)
13	Mudigere-3	Malabar	Tolerant to thrips and borers	Cardamom growing tracts of Karnataka	ZAHRS, UAHS, Mudigere, Karnataka	400
14	Appangala-1	Malabar	Suitable for intensive cultivation both under monocrop and mixed crop conditions; early maturing variety; highly adaptive and produces 89% bold capsules	All cardamom growing tracts of Karnataka & Wayanad of Kerala	ICAR-IISR, Appangala, Karnataka	745
15	Appangala-2	Malabar	High yielding and resistant to cardamom mosaic virus / Katte; essential oil content 6.2%; dry recovery 21.10%	All cardamom growing tracts of Karnataka & Wayanad of Kerala	ICAR-IISR, Appangala, Karnataka	927
16	IISR Suvasini	Malabar	An early maturing variety suitable for high density planting long panicle; oblong bold, parrot green capsules; essential oil content 8.7%; dry recovery 22%	All cardamom growing tracts of Karnataka and Wayanad of Kerala	ICAR-IISR, Appangala, Karnataka	400
17	IISR Avinash	Malabar	Resistant to rhizome rot disease and leaf blight diseases; high quality elongated capsules; essential oil content 6.7%, dry recovery 20.8%	Kodagu, North Wayanad, Hassan and Chikmagalur	ICAR-IISR, Karnataka.	850
18	IISR Vjetha	Malabar	Tolerant to Katte disease; essential oil content 7.9%; dry recovery 20.8%	Kodagu, North Wayanad, Hassan and Chikmagalur	ICAR-IISR, Appangala, Karnataka	650

Table 2: High yielding farmers' selections of small cardamom

Sl No	Landrace	Farmer	Cultivar	Characteristics	Yield (Kg/ha)
1	Njallani Green Gold	Sebastian Joseph	Mysore	Robust nature of tiller; round bold green capsules	3000
2	Pappalu	K V Paulose	Vazhukka	Capsules dark green and ovoid shape; tolerant to thrips, stem borer, root grub and capsule rot	3000
3	Arjun	Menuvin Joseph	Vazhukka	Round bold green coloured capsules; moderately thrips tolerant; suitable for organic cultivation	2500
4	Elarajan	Benny Kalarickal	Vazhukka	Pale green colour oval capsule	2500
5	Thiruthali	T P Joseph	Malabar	Slender pseudostem; tolerant to shoot borer	2500
6	Wonder Cardamom	Sabu Varghese	Mysore	Suitable to low altitude and low rainfall areas	2000
7	Panikulangara Green Bold -1	Joy Peter	Vazhukka	Long bold parrot green capsules; this clone performs well under rain fed conditions with less shade	3000
8	Patchaikakai	Ramaiah	Malabar	Drought tolerant nature; most suitable for lower elevation areas of Tamil Nadu	1500

## **PLANTING MATERIAL PRODUCTION**

### **Vegetative (Sucker) Propagation**

Sucker multiplication may be taken up from the first week of March to September depending upon the weather conditions. A suitable site may be selected in open, gently sloping and well-drained areas near a water source. Trenches of 45 cm width, 45 cm depth and convenient length are to be taken across the slope along the contour at 1.8 m apart. Trenches are to be filled with equal quantities of humus rich topsoil, sand and composted cattle manure. Uproot a part of the high-yielding, disease free mother clump identified in the plantation. Care should be taken to identify and collect mother clumps only from areas totally free from viral diseases. Trim the roots and separate suckers so that the minimum planting unit consists of one grown up tiller with a growing young shoot. Plant them at a spacing of 100 cm in filled up trenches making a small pit. Apply 50 grams of Mycorrhizae (AM fungi) before planting of the suckers in the pit. Provide sufficient mulch and stake each planting unit. Provide overhead *pandal* as in the case of seedlings nursery and remove shading material with the onset of monsoon. Provide irrigation once in a fortnight and adopt necessary plant protection measures. Apply fertilizers NPK 25: 25: 50 grams per sucker in two to three splits from two months after planting. Apply neem cake at 100-150 g per plant along with fertilizers. On an average 15-20 good quality planting units (one grown up sucker with a growing young shoot) could be produced from a mother clump within ten months of planting. Before planting, suckers may be dipped in 1% *Pseudomonas* for 5-10 minutes for encouraging the growth and preventing disease incidence.

### **Seedling Nursery**

#### **Primary Nursery**

Select nursery sites on gentle sloppy areas and preferably near a perennial water source. Clean the area from all existing vegetation,

stumps, roots, stones, etc. In the cleared area, beds can be prepared having one-meter width, 20 cm height and at required length, generally six meters. Jungle topsoil can be spread to a thickness of two to three cm on the beds. Fully ripened bold capsules from high yielding and disease-free mother clumps of known source can be collected from second and third harvests for seed extraction. One kg of fresh capsules would give 350-400 fruits depending on variety, seed size and number of seeds/capsule. Seeds after extraction should be washed using water to remove the mucilage. It is then mixed with wood ash and dried in shade. About 175-200 g seeds are required to raise quality seedlings required for one hectare. Seeds are to be sown as early as possible, preferably within 15 days after extraction since seeds lose their viability on storage. Sowing in September gives maximum germination under field conditions; winter and peak southwest monsoon period should be avoided. Even under ideal conditions, the germination is often less than 50 per cent only. Breaking of hard seed coats through seed treatment with acid or similar chemicals improves germination. Acid scarification with 25 per cent Nitric acid for 10 minutes to break the seed coat will enhance germination. The seed is ready for sowing the next day. Sowing can be done in lines in rows at a distance of 10 cm. Seed rate is 30 to 50 grams per 6 X 1 meter size bed. After sowing, cover the bed with a thin layer of fine soil and then with mulch material, such as *potha grass* or paddy straw. Avoid the contact of mulch material with the soil by spreading the mulch over tree twigs laid across the bed. Water the beds to sufficient moisture conditions. Once sprouting is observed, remove the mulch and cover the bed with thinly sliced mulch material in between rows. To protect the seedling from direct sunlight, provide an overhead *pandal*. Germination commences 20 to 25 days after sowing and continues for further 30 to 40 days. Seedlings when reach four to six leaf stage (five-six months after sowing) is transplanted to secondary nursery.

### **Secondary Nursery**

There are two methods of raising seedlings in secondary nursery: bed and polybag.

## **Bed Nursery**

Prepare beds as in primary nursery. A layer of cattle manure and wood ash may be spread on the bed and mixed with soil. Seedling of three to four leaf stages from the primary nursery beds can be transplanted in the secondary nursery at a distance of 20 to 25cms. Mulching and watering of beds should be done immediately after transplanting. Overhead *pandal* can be erected to protect seedlings from direct sunlight.

## **Polybag Nursery**

Black HM/HDP bags of size 20 X 20 cm having minimum 100 GSM thickness with three to four holes at the bottom can be used for this purpose. Fill the bags with potting mixture in the ratio of 3:1:1 of jungle topsoil, cow dung and sand. The bags may be arranged in rows of convenient length and breadth for easy management. One healthy and disease free seedling at three to four-leaf stage can be transplanted into each bag. Cardamom plants from secondary nursery/polybags can be transplanted to the main field during the last week of May after receipt of southwest monsoon.

## **FIELD PLANTING AND AGRONOMIC MANAGEMENT**

### **Land Preparation**

For planting in a new area, ground should be cleared and if it is a replanting area, old plants should be removed. Shade regulation, terracing and preparation of pits should be done during summer months.

### **Shade Regulation**

Shade regulation is one of the important practices that should be attended during summer (March–April) in the new planting areas and during May–June after the receipt of summer showers in the existing plantation. If there is thick shade, branches should be chopped off to provide filtered light of 40 to 60 per cent of the open area. If area is open due to tree fall, planting of quick growing tree species like *Karuna* (*Vernonia arborea*), *Corangati* (*Acrocarpus fraxinifolius*), *Chandana* *Viambu* (*Toona ciliata*), *Njaval* (*Syzygium cumini*), *Jack tree* (*Atrocarpus*

*hetrophyllus*) etc. should be taken up to protect the plants from direct sunlight.

### **Pit Opening**

Field operations are to be undertaken with the objective of preventing soil erosion and to conserve soil moisture. In sloppy areas, soil should be protected from soil erosion for which planting should be taken up in terraces. Terraces should be made at required distances on contours depending on the spacing adopted. Pits of 90 X 90 X 45 cm can be prepared before commencement of monsoon, about 1/3 of the pit should be filled with top soil and 1/3 should be filled with 1:3 mixture of organic manure and topsoil.

### **Planting**

Planting materials of high yielding variety suitable for the areas may be selected for planting. They may be planted in the already prepared and filled pits and plants should be protected from wind by staking. For high yielding varieties plant to plant distance may be kept at 3 X 3 meters (1111 plants per hectare). Immediately after planting, the plant base should be mulched well with available dried leaves to prevent soil erosion and to conserve moisture. Planting should be done diagonally to the slope to reduce runoff.

### **Weed Management**

Two or three rounds of hand weeding at the plant base during May, September and December/January and slash weeding in the inter-space are advisable. Use of spade for weeding is to be avoided as it will loosen the soil and cause soil erosion. The weeded materials may be used for mulching. Mechanical weeding using weed cutter is economical and ensures timely weeding in the initial years of plant establishment.

### **Irrigation**

Irrigation is required generally during summer months and also during periods of prolonged dry spells, if they coincide with the critical periods of plant growth when development of young tillers and panicles takes

place. Water may be stored during the rainy season through various water harvesting measures without causing damage to the location and ecosystem. Irrigation can be done through different methods such as hose irrigation, sprinkler irrigation, drip irrigation or micro-sprinkler/mist/fogger irrigation. Hose irrigation can be done at weekly intervals at the rate of 20-30 liters per plant depending upon the clump size. In the case of sprinklers, irrigation with an amount of water equivalent to 35 to 45 mm rain at fortnightly intervals is recommended under normal conditions. In case of drip or micro sprinkler irrigation, water at the rate of five to six liters per clump per day can be given. Under Karnataka conditions, application of 40 liters of water per clump approximately 10 to 20 days' interval as hose irrigation in the plant base was found to increase the yield.

Fogger/mist irrigation system is used largely to create a suitable microclimate within the plantation eco-system thereby providing favorable environment for growth, flowering and seed setting. The frequency of operation of the irrigation systems depends on the macroclimate in the plantation area and hence has to be standardized for specific local weather situations. Irrigation is to be undertaken with utmost care to avoid excess wetness at the plant base for prolonged periods to prevent occurrence of rot diseases.

### **Soil and Water Conservation**

Opening of a rectangular silt pit (1.0 X 0.5 X 0.6 meter) in between four plants will help in soil and water conservation on gentle slopes. If the slope is steep, construction of stone pitching walls at 10-20 meter intervals across the slope and also making water collecting trenches along drainage channels at selected intervals will be helpful in non-landslide prone areas.

### **Forking and Mulching**

As far as possible, the entire plantation and particularly the plant base are to be kept under mulch for reducing evaporation loss, suppress weed growth and to maintain optimum soil temperature. It is very essential to keep the plant base mulched (5-10 cm thick), except during

periods of heavy monsoon (June to September). However, in situations where soil has become compact and hard, forking the plant base to a distance up to 90cm and to a depth of 9-12 cm may be beneficial to enhance root proliferation, better infiltration of summer showers and for improving soil aeration. Forking could be done with the cessation of North East monsoon during November-December taking care to cause least damages to the root system.

### **Trashing and Pruning**

Trashing consists of removing old tillers, dead rhizome, dry leaves and leaf sheaths. This operation may be carried out once in a year at any time after the receipt of the pre-monsoon showers in May. Pruning is the operation undertaken with sharp sickles for removing the dead and hanging leaves from the pseudo-stem. Care should be taken not to peel off the leaf sheath from the pseudostem. This operation may be done during January and during September, which coincides with the peak thrips population. The resultant plant materials obtained through pruning can be used for mulching.

### **Earthing up**

Whenever the top soil covering the plant base is washed away and the rhizomes and roots are exposed, earthing-up of the plant base with top soil is recommended during November-December, before the withdrawal of North East monsoon. While carrying out this operation, care should be exercised to ensure that only top soil is used, and it is evenly and thinly spread at the base covering only half the bulb portion of the rhizome. This operation helps to keep the top 10 to 15 cm soil loose and friable enabling easy root penetration and water percolation.

## **NUTRIENT MANAGEMENT**

### **Lime Application**

Application of lime or dolomite is essential if pH of the soil is < 5.5. Though the quantity of lime is to be arrived at by assessing the lime requirement of the soil, for practical purposes, application of agricultural lime is recommended at one kg per plant per year for soils with pH

below 5.0 (or 2 kg dolomite) and half a kg of lime (or 1 kg dolomite) when pH is between 5-5.5. Lime is to be applied in one or two splits during May and September. Fertilizer shall be applied only after 15-20 days of lime application.

### **Application of Organic Manures**

Application of decomposed farmyard manure or compost at 5-10 kg per plant may be made during May-June. The manures should be thoroughly mixed with surface soil after application. Under irrigated condition, manuring can be done in two splits, one in May and the subsequent application during September. Organic manures such as neem cake (one kg per plant), bone meal (one kg per plant) or vermicompost (one kg per plant) have beneficial effects on root proliferation and plant growth and also helps to reduce nematode and root grub infestation.

### **Schedule for Application of NPK Fertilizers**

#### **Soil Application**

<b>Age of plants</b>	<b>Rain-fed areas (Kg/ha)</b>	<b>Irrigated areas (Kg/ha)</b>
First year of planting	Nitrogen-25 Phosphorus -25 Potassium -50 (2 Split applications)	Nitrogen-25 Phosphorus -25 Potassium -50 (2 Split applications)
Second year of planting	Nitrogen-40 Phosphorus -40 Potassium -80 (2 Split applications)	Nitrogen-60 Phosphorus -60 Potassium -80 (3 Split applications)
Third year of planting (Stabilised yield)	Nitrogen-75 Phosphorus -75 Potassium -150 (2 Split applications)	Nitrogen-125 Phosphorus -125 Potassium -250 (3 Split applications)

Zinc (Zinc sulphate) shall be applied as foliar spray at 250 g /100 liters twice a year. Under high production technology, where crops are harvested from 18 months onwards, fertilizer recommendations for a full-grown plantation could be adopted from the second year onwards.

Fertilizers could be applied in smaller doses in four or more splits after every harvest or combining both soil and foliar application of fertilizers. Whenever, the plant growth is affected due to root damage (root grub/ *Fusarium* disease/soil compactness), foliar application of DAP (one per cent) + MoP (one per cent) or 1 per cent 19:19:19 complex fertilizer could be adopted.

### **Time of Application**

<b>Soil application</b>	May/June September/October December /January
<b>Foliar application</b>	August/September October/November December /January

### **Methods of Application**

#### **Soil Application**

After removing the mulches around the plant base, the fertilizers may be applied in a circular band of width 15 cm, leaving 30 cm from the plant base and thoroughly mixed with the top five to seven cm of the surface soil with a hand fork. The fertilizer-applied area may be covered again with mulches.

#### **Fertilizer Drenching**

For improving cardamom production, fertilizer drenching with five liters/clump of fertilizer solution prepared by mixing one kg MoP + 600 g DAP+ 400 g Urea dissolved in 100 liters of water may be practiced for yielding plants. Drenching may be adopted at monthly intervals excluding heavy rainfall periods. The fertilizer drenching standardized by ICRI (equivalent to NPK at 150:150:300 kg/ha) was found to be an economical practice for achieving higher production.

#### **Foliar Application**

The spray solution, containing the fertilizer in the prescribed proportions, may be applied to the foliage of the plant covering both sides of the

leaves. The plant should have sufficient turgidity at the time of foliar application lest it would wilt. A clear sky or even a cloudy condition may be considered suitable for undertaking foliar application. Avoid very dry/hot periods or noon hours for foliar spraying.

### **Application of Micronutrients**

Soil fertility survey conducted by ICRI showed that Sulphur deficiency is widespread in cardamom soils while Zinc and Boron deficiency is observed in certain areas. Application of Zinc to the foliage is found to enhance not only cardamom growth and yield but also the quality of the produce. Hence, it is recommended that Zinc may be applied as a foliar spray as Zinc sulphate at 250 g/100 liters of water during April-May and September-October. Zinc should be applied alone and not to be mixed with any insecticide/fungicide/fertilizer since Zinc may precipitate and become unavailable to the plants. Soil application of Boron in the commercial grade borax at the rate of 7.5 kg/ha is recommended in boron deficient areas. It may be applied in two doses along with NPK fertilizers. Otherwise boron may be applied alone as foliar dose by using borax (at 0.25 %) during April-May and September-October. Nutrient grade Sulphur viz., Bentonite Sulphur may be applied at the rate of 20 kg per hectare along with NPK fertilizers in Sulphur deficient areas.

## **MANAGEMENT OF DISEASES**

### ***Azhukal* or Capsule Rot Disease**

*Azhukal* (rotting) is caused by the fungus *Phytophthora nicotianae* var. *nicotianae* and / or *P. meadii*. The disease starts with the onset of southwest monsoon in June and becomes severe during July-August months. It may continue to prevail up to November–December, if weather is favorable for development. Symptoms of rotting appear on all plant parts. First, symptoms appear on the young leaves or on capsules in the form of water soaked lesions. In leaves, these areas enlarge, become necrotic and gradually the leaves shrivel and begin to shred. Finally, the affected leaves break at the base of the petiole and remain hanging. Rot affects the capsules of all ages. Affected immature capsules soon decay and fall off within three to five days and mature

capsules get shriveled on drying. Infection on the panicle appears usually on panicle tip and proceeds downwards. Such portions later decay if moisture is in excess. In severe cases, infection spreads over to the rhizomes and tillers also. Decayed tillers break and fall off at the collar region. Though all the varieties are susceptible to the disease, cultivar *Malabar* is more severely affected. The disease spreads through soil, water and wind. The predisposing factors favoring *azhukal* incidence are heavy and continuous rainfall, excess soil moisture, thick shade, overcrowding of plants and prevalence of inoculum in the soil.

### **Clump Rot or Rhizome Rot**

It is also a fungal disease occurring during the monsoon season. Symptoms of disease are yellowing of leaves and decay of tillers starting from the collar region. The decay extends to the rhizomes and roots also. Rotten rhizomes become soft, dark brown coloured and ultimately result in the total death of the plant. Affected tillers fall off by a slight disturbance. The disease is caused by soil-borne fungi such as *Pythium vexans* and *Rhizoctonia solani*.

## **Integrated Management of Capsule and Rhizome Rot**

### **Plant Sanitation**

Regulate shade before onset of monsoon (May-June), avoid close planting, replanting has to be done for senile plantation. Minimum irrigation should be followed during summer months, trash the plants, cut, remove destroy diseased parts. Remove mulch from the base and ensure proper drainage.

### **Chemical Control**

After completing the above mentioned plant sanitation measures, spray Bordeaux mixture (1%) or Fosetyl-Aluminium (Aliette) 80WP (0.2 %) (200 g / 100 liters of water). The first spray should be done during May–June before the onset of monsoon and subsequent spray may be done during July–August. A third spray may be given in the month of September if the monsoon is prolonged and disease is still persistent.

Spray Bordeaux mixture on the entire portion of the plant at the rate of 500 ml to one liter per plant. Drenching plant base with Copper oxychloride (0.2%) (200 g / 100 liters) was found effective in reducing soil inoculum and further disease spread. The fungicide Aliette (0.2 %) (200g/100 liters of water) also can be sprayed on the leaves at the rate of 500 ml to one liter per plant.

The incidence of leaf blight is observed from the month of October to February. In areas covered by severe fog, the severity is more. Brown dry areas of varying sizes develop on the lamina. It is caused by *Phytophthora meadii*. It can be controlled by one or two rounds of spray with Bordeaux mixture (1%) or (0.2 %) Aliette (200g/100 liters)

### **Biological Control**

The biocontrol agents such as *Trichoderma harzianum* and *Pseudomonas fluorescense* can effectively control rot diseases. The bio agents may be mixed @ 1 lit / 100 litre of water and incorporated in the well decomposed cow dung for mass multiplication. The moisture of cow dung should be maintained at 50% and kept under shade. After 10 to 15 days, apply in the plant base @ 2 to 5 kg depending on the size of the clump before onset of monsoon (May-June) and also post monsoon (September-October). The solid culture of bioagent can also be mixed @ 1kg in 100 kg of cow dung.

If the soil is drenched with Copper oxychloride or other fungicides, *Trichoderma* / *Pseudomonas* should be applied only after or before 15 days.

### **Fusarium Disease**

*Fusarium* infections on pseudostems and roots are very common in plantations in Idukki. The disease manifests towards the end of the monsoon season and becomes more prominent in dry plots and lasts up to summer months. Yellowing of leaves is commonly noticed. Round to oval shaped brown lesions develop on the pseudostem. These later elongate and as infection proceeds a deeper layer of the pseudo stem gets discolored. The pseudostem breaks at this point. Lesions are also

noticed at the collar region and such tillers become brittle and break off. However, the affected region does not possess any foul smell. In some cases, rotting of the root tips followed by die back of roots is observed. The lower leaves of affected tillers become yellowish and gradually dry off. Drying symptoms also appear on the panicle tips, leading to die back of the panicles.

## **Management**

After monsoon, cover the exposed root with soil, mulching and sufficient irrigation should be provided. Shade has to be provided in exposed area. Trash and clean the plant base during March–April before the onset of monsoon. Ensure shade in the plantation towards the end of monsoon showers. As a prophylactic measure, drench the plant basins with copper oxychloride (0.2%) during August–September. *Trichoderma harzianum* and *Pseudomonas fluorescence* mass multiplied on suitable carrier media may be applied to plant basins @ 1-5 kg depends on the size of the clump during May–June and September–October.

## **MINOR DISEASES**

### **Leaf Blight**

Leaf blight sometimes referred to as *chenthal* is caused by *Colletotrichum gloeosporioides* and assumes severity during the post-monsoon period. The disease initially manifests on the leaves as water soaked lesions which later coalesce to form yellowish-brown to reddish-brown patches and subsequently withers off. In the advanced stages, several such lesions develop on young and older leaves, which eventually dry up and gives a burnt appearance to the plants.

### **Management**

Destroy leaf blight affected portions and plant debris during May before the onset of monsoon. Maintain optimum shade levels of 40–60% filtered light. Undertake shade management before the onset of South West monsoon season. As prophylactic measure, spray Bordeaux

mixture (1%) @ 0.5-1 liter / plant during May–June before the onset of monsoon season and repeat in August–September.

### **Leaf Blotch**

Leaf blotch disease occurs during the rainy season as water soaked lesions on the leaves and appears in round. The diameter of the lesion is almost equal to the width of the lamina. On underside of the leaves cottony growth of the mycelia are observed. In recent years, the disease has become severe in areas with more shade. It is caused by the fungus *Phaeodactylum alpiniae*.

### **Management**

Undertake shade management before the onset of South West monsoon season. As prophylactic measure, spray Bordeaux mixture (1%) @ 0.5-1 liter / plant during May–June before the onset of monsoon season and repeat sprays in August–September.

### **Leaf Spots and Rusts**

Various types of leaf spots are found to affect the leaves. These are *Sphaceloma* leaf spot caused by *Sphaceloma cardamomi*, *Cercospora* leaf spot caused by *Cercospora zingiberi* and leaf rust caused by *Phakospora elettariae*. The *Sphaceloma* leaf spot is seen in main plantation as scattered spherical blotches on the leaves. It starts as small spots measuring a few milli-meters and later several spots coalesce to form larger areas. The *Cercospora* leaf spots are found in the nursery and plantations in the form of rectangular muddy red stripes running along the veins. Leaf rust is often seen on mature leaves as whitish powdery pustules on the under surface of the leaves with corresponding yellow necrotic patches on the upper surface. Diseased leaves show a rusty appearance.

### **Management**

The leaf spots can be reduced to some extent by spraying with one or two rounds of Bordeaux mixture (1%) at 15 days' intervals.

## **DISEASES IN THE NURSERY**

### ***Phyllosticta* Leaf Spot**

Leaf spot caused by the fungus *Phyllosticta elettariae* found in primary nurseries is destructive especially in Karnataka. It appears during February-April with the receipt of summer showers. Disease appears as small round or oval spots, which are dull-white in colour. These spots later become necrotic and leave a hole (shot hole) in the center. The spots may be surrounded by a water soaked area. High intensity of disease is noticed in open nurseries exposed to direct sunlight.

### **Management**

Prophylactic spraying with Bordeaux mixture (1%) may be given on the leaves. First spray is to be given during March–April depending on the receipt of summer showers and subsequent sprays at fortnightly intervals. Two to three rounds of spraying may be given. Clipping and destruction of severely affected leaves before spraying of fungicides is to be done to arrest further spread to the remaining healthy leaves. In addition to fungicidal sprays, the following supplementary measures may also be followed.

- ❖ Sow the seeds in August–September, to ensure sufficient growth of seedlings.
- ❖ Avoid exposure to direct sunlight from top or sides and provide adequate shade.
- ❖ Do not raise the nursery continuously on the same site.

### **Damping Off or Seedling Rot**

The disease appears after the receipt of summer showers and when there is excessive soil moisture due to improper drainage. Leaves turn pale and their tips become yellow. Gradually, these symptoms spread over the entire leaf extending to leaf sheath resulting in wilting of seedlings. The collar portion decays and the entire seedlings die. Infection spreads in the nursery beds resulting in death of seedlings in small patches. In grown up seedlings, rotting extends from the collar

region to the rhizomes resulting in their decay and ultimate death of the plant. The disease is caused by soil borne fungi such as *Pythium vexans* and *Rhizoctonia solani*.

### **Management**

- ❖ In the primary nursery, practice thin sowing for avoiding overcrowding of seedlings.
- ❖ Provide adequate drainage facilities.
- ❖ Remove affected seedlings early and maintain proper phytosanitary measure in nursery.
- ❖ When infection is noticed, drench the nursery beds with Copper oxychloride 0.2 per cent.
- ❖ Pretreatment of seeds with *Trichoderma* or *Pseudomonas* before sowing reduces disease incidence.
- ❖ Application of *Trichoderma* at 100 g per square meter of bed protects the seedlings from disease.

### **Clump Rot or Rhizome Rot**

This disease occurs in 6 to 18 months old mature seedlings of the secondary nursery (transplanted in poly bags or beds). It is seen during the monsoon season when soil moisture is excess due to improper drainage. Early symptoms appear as pale yellow colour along leaf margins and withering of seedlings. Rotting or decay starts at the collar region and it spreads to rhizomes and roots. In severe cases, the collar region breaks off and the seedlings collapse. The disease is caused by the soil borne fungi *Pythium vexans* and *Rhizoctonia solani*.

### **Management**

- ❖ Uproot and destroy all the affected seedlings in a nursery.
- ❖ Regulate irrigation of nursery beds. Do not use excess water for irrigation.
- ❖ Remove mulch materials of nursery beds and rake the soil gently.

- ❖ Drench the nursery beds with 0.2% of Copper oxychloride (200g/100 lit) at the rate three to five liters per square meter. Two to three rounds of COC may be drenched at 15 - 20 days' intervals.

## **MANAGEMENT OF PESTS**

### **Cardamom Thrips (*Sciothrips cardamomi* (Ramk.))**

Thrips is the most destructive and persistent pest of cardamom and found in all cardamom growing areas. It colonises and breeds in different parts of the plant such as unopened leaves, leaf sheaths, flower bracts and flower tubes. Adults and nymphs of the insect cause damage to panicles and capsules. Thrips lacerate the surface tissues with mandibles and suck the exuding plant sap. Injury to panicles result in its stunted growth and the injury on tender capsules develop as scabby growth on capsules. Affected capsules appear malformed, shriveled and sometimes with slits. Such capsules have less number of seeds; seeds are underdeveloped and inferior in aroma. Affected capsules fetch a very low price in the market. Thrips infestation results in nearly 45-48 per cent crop loss.

Adult insect is greyish brown, 1.25 to 1.5 mm long and with two pairs of fringed wings; females lay minute eggs below epidermis which hatch out into nymphs in 8-12 days. Nymphs grow by feeding on plant sap; after passing through three larval (nymph) and a non-feeding pupal stage they become adults, thus completing the life cycle in 27 to 33 days. Population of the pest is maximum in summer (February-May), minimum in rainy periods (June- July) and low in August-December.

### **Management**

Removal of dry leaves as well as leaf sheath (trashing/pruning) during January, May and September.

Spray Quinalphos 25% EC at 120 ml / 100 liters of water or Diafenthuron 50% WP at 80 g / 100 liters of water or Lambda-Cyhalothrin 04.90% CS at 40 ml / 100 liters of water.

### **Shoot/ Panicle/ Capsule borer (*Conogethes* sp.)**

Infestation of borer on capsule, panicle and shoot is a serious problem on cardamom in Kerala, Tamilnadu and Karnataka. The pest is the larva of a lepidopteron, *Conogethes* spp. Adult is a medium sized orange yellow moth (22-24mm) with a number of black dots on its wings.

The moths feed on nectar and do not cause direct damage to cardamom. A female moth lays about 20–35 eggs singly or in groups of two or three on leaf margin, leaf axils, panicles and racemes.

Eggs hatch within five-six days. Emerging larvae bore into tender panicles or unopened leaf spindles or immature capsules. When panicles and racemes are attacked, the portion ahead of the site of entry dries off. In case of the capsules, the larvae feed on the seed and the capsules become empty. At a later stage the larvae bore into the shoots. They feed the central core of the pseudostem resulting in decaying of the central spindle and the characteristic dead heart symptom develops. A fully grown larva is 30–35 mm long with pale purple body and black head. After a pre-pupal period of two to four days, it becomes a brown pupa. Adult emerges in about 11–15 days from pupa through the bore hole. The life cycle is completed within 41–68 days during summer and prolongs up to 123 days in post monsoon period. Pest infestation is pronounced in three seasons: January–February, May–June and September–October. However, overlapping generations do occur in between. Insecticide sprays at late stages of the larvae which bore in pseudostem may not give adequate control of the pest. For effective management, the insecticide has to be targeted on early stages of the larvae, which are usually present on panicles/ racemes within 15–20 days after adult emergence in the field.

### **Management**

- ❖ Rouging and destruction of infested tillers during September–October.
- ❖ Conserving of predators and parasitoids viz., *Agrypon* sp. and *Apanteles* sp.

- ❖ Spray Diafenthiuron 50% WP at 80 g / 100 liters of water or Lambda-Cyhalothrin 04.90% CS @ 40 ml / 100 liters of water within 20 days of adult moth emergence.

### **Root Grub (*Basilepta fulvicorne* (Jacoby))**

Root grub is a serious pest damaging the roots of cardamom. Nutrient uptake is reduced due to root damage leading to yellowing of leaves. The pest problem is severe in less shaded areas.

Adult of the pest is a small beetle four to six mm length shiny metallic blue, green or greenish brown colour. Females are bigger than males. They are seen on cardamom leaves during morning and evening hours but do not feed on cardamom. The beetles feed on leaves of jack, mango, guava, dadepts, etc.

Beetles occur in March–April and August–September. Females lay about 124–393 eggs in batches of 12–63 on dry cardamom leaves or mulches. The minute creamy white grubs hatch out from eggs, fall on the ground, reach the root zone and start feeding the roots. Grubs have two periods of occurrence, the first during April–July and the second during September to January.

Grubs (larvae) feed on roots, become mature in 45–60 days. They are short and stout, 'C' shaped. Pupation takes place in an earthen cocoon. The pest completes its life cycle in 65–102 days during first generation (March–August) and 73–111 days during second generation (September–February).

### **Management**

- ❖ Avoid planting of jackfruit, mango, fig etc. as shade trees as these trees are alternate hosts of the pest.
- ❖ Mulching of plant base with leaves of wild *Helianthus* sp. to prevent egg laying of adult beetles.
- ❖ Earthing up and de-trashing.
- ❖ Application of local strain of EPN (*Heterorhabditis indica*) infected *Galleria* cadaver @ 4 cadavers /plant.

## **Nematodes (*Meloidogyne* spp)**

Root knot nematodes, (*Meloidogyne* spp) infest cardamom roots. Common symptoms of attack are narrowing of leaves, thickening of veins, reduction of internodes length and consequent appearance of rosette leaves. Roots branch heavily and galls appear on them. Plant growth becomes highly stunted.

Egg, larva and adult are the different stages in the life cycle of the pest. Second stage larvae infect rootlets and induce formation of giant cells called galls. Larvae moult thrice and form adults. Female secretes a gelatinous matrix into which eggs are extruded.

### **Management**

- ❖ Frequent change of nursery beds will help to reduce nematode infection in nurseries.
- ❖ Avoid shade trees such as dadaps and intercrop like bananas in cardamom cultivation.
- ❖ Application of *Paecilomyces lilacinus* at 25 g / plant with compost.
- ❖ Application of neem cake at 500g to 1 kg depends on the size of the clump in May–June/ September.

## **MINOR PESTS**

### **Early Capsule Borer (*Jamides alecto*)**

It is a minor pest of cardamom in Karnataka region and may be serious in a few pockets. Caterpillars of this insect bore and feed flower buds, flowers and capsules. A circular hole is made on immature capsule and the larva feeds the entire seed making capsules empty. The pest incidence is seen from June to September.

Adult is a medium sized blue butterfly with metallic lusture on the upper surface. Larval period lasts for 18-20 days. Each larva feeds about 25-27 capsules to attain maturity. Pupation takes place in debris near the inflorescence. The life cycle is completed within 38-45 days.

## **Cardamom Whitefly (*Singhiella cardamomi*)**

White fly is considered a minor pest but severe infestation is noticed in plantations where synthetic pyrethroids is used consistently or higher than the recommended concentration of insecticides are used or when more frequent insecticide spray than the recommended level or when mixing of two or more insecticides are done or when spraying with same insecticides throughout the year.

The adult fly is a small soft bodied insect about two mm long with two pairs of white wings. Female lays eggs on the lower surface of leaves; eggs are cylindrical, pale yellow when freshly laid and gradually turn brown. There are four nymphal stages. The first instar larva crawls on the leaf and finds out a feeding site in the lower surface of leaves and all the later stages are completed at that spot. The nymphs are elliptical and pale green to yellow.

The nymph and adult suck sap from leaves and the leaf becomes yellow and subsequently dry leading to drastic reduction in yield. The nymphs and adults excrete sticky honey dew which drops on to lower leaves, black sooty mould develops on these, which interrupts photosynthesis of the leaves. Puparia, which adhere to the leaves after emergence of adults, appear as scaly patches on the lower surface of affected leaves. The life cycle is completed within two-three week.

### **Management**

The flies are attracted towards yellow colour. Yellow plastic sheets coated with castor oil or grease will serve as sticky traps. By placing such yellow sticky traps (YST) between rows of cardamom plants, the population of adults can be monitored as well as managed.

### **Hairy Caterpillars**

They are a group of defoliator caterpillars of cardamom which are polyphagous. Eight species of hairy caterpillars have been found to damage cardamom plants. Among them *Eupterote undata*, *E. fabia*, *E. cardamomi*, *E. canairica*, *E. mollis* and *E. blanda* are more destructive. They occur sporadically, feeding shade tree leaves at early stages and

cardamom leaves at later stage. Moths emerge in June–July and lay about 300–400 eggs on the under surface of leaves of shade trees. Eggs hatch in 15–25 days. Larval stages extend up to three months. When the north-eastern monsoon ceases, caterpillars drop down to cardamom and start feeding on its leaves. Larvae make cocoons within which they pupate.

### **Management**

Hairy caterpillars congregate on tree trunks during day time, mechanical control becomes easy. Larvae can be collected and destroyed.

### **Shoot Fly (*Formosina flavipes*)**

The adult fly lays cigar-shaped white eggs in between leaf sheath and pseudostem on the top whorl. Emerging maggots (larvae) enter the pseudostem reach down the base by feeding the core tissue resulting in drying of the terminal leaf (Dead Heart Symptom). Infestation is more on plants in open areas. The pest activity starts during November and is at its peak in March-April. The spray given for the major pests like thrips and borer also keeps down shoot fly infestation.

### **Management**

- ❖ Place fish meal trap in the infested cardamom plantations to trap the adult flies.

### **Lace Wing Bug (*Stephanitis typicus*)**

It is a polyphagous pest and seen in a group. Nymphs and adults are found on the lower surface of leaves. They suck the cell sap from leaves, resulting in greyish yellow spots on leaves. Adult is a small dull coloured bug with transparent lace wings. Damage is very severe in summer months in certain isolated pockets in open areas.

### **Red Spider Mites (*Tetranychus* sp.)**

Red spider mite is a minor pest and occurs on cardamom in small numbers during summer months without causing serious damage.

The mite becomes a serious pest only in plantations where insecticide spray is too frequent, with higher concentration or consistent spray of synthetic pyrethroids. Excess application of nitrogen may attract mite infestation.

The mites spin webs on the under surface of the leaves and live inside the webs. They are dark brown and actively move about inside the web on the lower surface of the leaf. They puncture the plant cells with their cheliceral stylets and suck the cellular material, which reduces the chlorophyll content. This results in the formation of characteristic white blotches on the leaves and devitalization of plants. The affected leaves look dirty white; the under surface of the infested leaf with fine delicate silken thread, eggs and excreta looks ashy white and dusty. The affected leaves gradually dry up and in severe cases it leads to the death of the plants.

### **Cardamom Aphid (*Pentalonia nigronervosa* f. *caladii* van der Goot)**

The cardamom aphid is of concern not as a pest of the crop, but as a vector of the virus, which causes the serious disease *Katte* in cardamom. Adults are dark brown in colour. They reproduce by viviparous and parthenogenetic means. A female may give birth to 8–28 offspring. The nymphs moult thrice and become adults in about 15 days. Population of the insect is high during January–February. They are also found on *Colocasia* sp. *Alocasia* sp. and *Caladium* sp.

**Table 1.** Waiting period of approved insecticides for small cardamom

SI No	Insecticides	Target pests	Waiting period (days)
1	Diafenthion 50%WP	Thrips and capsule borer	7
2	Quinalphos 25% EC	Thrips	30
3	*Lambda-cyhalothrin 04.90% CS	Thrips and Shoot and capsule borer	34

\* Spray recommended only once in a year.

## Management of Viral Diseases

Name of disease	Symptoms & mode of spread	Management of viral disease
Mosaic or Katte disease	<p>The first visible symptoms appear on the youngest leaf of affected tillers as spindle shaped chlorotic flecks.</p> <p>These flecks develop into slender discontinuous strips of pale green and dark green margin.</p> <p>The leaf sheaths and pseudostems also show mosaic pattern.</p> <p>It spreads through aphid vector <i>Pentalonia nigronervosa</i>.</p>	<p>Keep a constant surveillance on the occurrence of katte disease.</p> <p>Plant only healthy katte free seedlings for raising plantations.</p>
Nilgiri necrosis disease	<p>Diseased plants show alternate light green and whitish to yellowish streaks on the leaves in the form of mosaic.</p> <p>Later these stripes become necrotic with reddish brown colour followed by tearing of lamina.</p> <p>The leaves are crinkled with wavy margin</p> <p>Tillers show reduction in height</p> <p>Later, these stripes become necrotic with reddish brown colour followed by tearing of lamina.</p>	<p>Avoid rhizome planting using materials taken from disease affected gardens.</p> <p>Practice regular rouging (uproot and destroy).</p> <p>Repeat tracing of affected plants and rouging at week intervals for at least four consecutive months.</p>
Kokke kandu disease	<p>Its characteristic symptom 'hook- like tiller' it is locally called as 'Kokke Kandu'.</p> <p>The characteristic symptoms are continuous or discontinuous intra-veinal clearing, stunting, resetting, loosening of leaf sheath, shredding of leaves and clear mottling on stem.</p> <p>Clear light green patches with three shallow grooves are seen on the immature capsules.</p> <p>Cracking of fruits and partial sterility of seeds are other associated symptoms.</p> <p>Transmitted through cardamom aphid, <i>P. nigronervosa</i> in a semi persistent manner.</p>	<p>Gap fill with healthy disease free materials.</p> <p>Destroy alternative host plants like <i>Amomum</i>, <i>Alpinia</i>, <i>Curcuma</i>, <i>Colocasia</i> etc., if they show symptoms of katte.</p>
Nilgiri necrosis disease	<p>The disease was characterized by continuous or discontinuous spindle shaped yellow or light green intravenous streaks along the vein and midrib.</p> <p>These streaks later coalesce together and impart a yellow or light green colour to the vein.</p> <p>Discontinuous spindle shaped motting on pseudo stem &amp; petioles also noticed.</p> <p>In severe cases, tillering in an infected plant was suppressed.</p>	

## **HARVESTING**

### **Stage of Harvest**

The capsules should be harvested when they attain physiological maturity (*Karinkai*) to fully ripened stage so as to allow the capsules for proper seed set and to obtain higher recovery. However, over ripening should be avoided as it results in loss of capsules due to rodents and squirrels in the field and also splitting at the time of drying which in turn leads to low premium price in the market. Recovery is highest (24 per cent) in the fully ripened capsules followed by the one harvested at physiological maturity (20 per cent) and at immature stage (14 per cent). The oil content varies with the maturity of capsules.

### **POST HARVEST OPERATIONS**

Cardamom capsules should be subjected to post harvest operations such as washing in water, curing, cleaning, grading, packing and storage. Capsules should not be stored after harvest for a longer duration as it adversely affects the quality of the end product.

#### **Curing**

Cardamom curing may be defined as the process in which moisture of freshly harvested capsules is reduced from 80 per cent to 10–12 per cent through indirect heating. Drying is the most important unit operation that determines the colour and quality of the end products. In the improved cardamom curing devices, the alternate fuel source can be used either independently or in combination with the firewood. Improved systems are advantageous in retaining high quality of produce with respect to colour and helps in substantially reducing curing time (12–18 hours).

#### **Cleaning, Grading, Packing and Storage**

Dried capsules have to be polished either manually or with the help of machines before marketing. Polishing is done by rubbing the dried capsule in a hot state against a hard surface. Polishing machines are also available which can be operated either manually, or with electric motors. Motorized machines having desired mesh can be used for

polishing as well as grading of capsules. After grading, cardamom capsules can be stored over a long duration. For efficient retention of green colour during storage, cardamom should be dried down to a moisture level of 10-12 per cent. Use of 300-gauge black polythene lined gunny bags improves the storage efficiency. Store the commodity in wooden boxes at room temperature preferably in the curing house for better storage efficiency.

## APPENDIX I

### SOIL TESTING

Spices Board has set up soil testing laboratories for testing cardamom growing soils and giving fertilizer recommendation. At present, the soil testing laboratories are functioning at the Indian Cardamom Research Institute, Myladumpara, Kerala and at the Regional Research Station, Sakleshpur, Karnataka.

#### **Why to test the soil?**

Soil testing provides precise information about the fertility of the soil for making fertilizer recommendation. Needed quantities of fertilizers of the right kind can be applied at the minimum cost. Balanced application of nutrients will ensure a better economic return to the grower.

#### **How to collect a soil sample?**

Only 5 to 10 g soil is used for each soil test. So care has to be taken to collect representative soil samples. Otherwise, precision in analysis and interpretation will have no value. While collecting the samples, the following points have been taken note of:

1. Sample should be collected from a field once in three to four years preferably during February –April.
2. Total area should be divided into different slopes such as gentle, medium, steep and swampy area. Each category should be again divided into approximately plots of five acres and if there are certain pockets where plants are very poor in growth, those pockets should be sampled separately.
3. Soil samples should be taken from root zone in the row, leaving 30 cm from plant base.
4. The selected site should be cleaned from weeds, dry leaves and other mulch materials.

5. With the help of spade (*mammatty*) soil can be cut in an angle from both sides, which will form a V-shape pit at a depth of 15cm, and the cut soil should be removed.
6. With the help of a knife, soil should be scraped from both the sides of V shaped pit in a thin layer along the cutting in full depth. Auger can also be used for soil sample collection.
7. From each five-acre plot, around 10 samples may be collected diagonally and all these samples should be gathered into one in a big polythene sheet. Then mix it well, remove plant materials and spread the soil in a square shape in thin layer. Then make four quarters by drawing diagonal lines and discard any opposite two quarters and again mix the remaining two quarters. Do the same processes until your sample become 500 grams.
8. The soil should be packed in polythene or cloth bag after shade drying for one to two days and tied properly. Planter's name and address and field number may be given in a small piece of paper and kept inside the bag. For each five acres of land one sample should be send to the Research Station of Spices Board as soon as the soil is collected. Information proforma available with field offices of the Spices Board should be filled in and sent along with the samples collected.

### **Precautions**

Avoid contamination by keeping soil samples away from stored fertilizer.

Avoid areas recently fertilized, old trenches, marshy spots, near trees, compost pits or other non-representative locations.

Avoid taking samples between rows.

## **PREPARATION OF BORDEAUX MIXTURE**

Dissolve 1 kg of Copper sulphate in 50 liters of water.

In another vessel, slake one kg of quicklime by adding small quantities of water preferably warm water (1–1.25 kg of lime can be taken). When slaking is over, make up to fifty liters by adding water and stir well to get a uniform suspension of lime. Transfer the lime suspension thus prepared through a sieve and keep separately.

Add 50 liters of the Copper sulphate solution to the 50 liters of lime solution with constant stirring. To test the correctness of the mixture, dip the edge of a brightened iron knife for a minute in the mixture. If the knife remains bright, the mixture is correctly prepared. If the knife turns rusty brown or if its brightness is lost, add more lime suspension, correctly prepared Bordeaux mixture will turn red litmus to blue and turmeric powder to orange red in colour.

### **Precautions**

- ❖ For dissolving Copper sulphate or preparing Bordeaux mixture, use copper, wooden or earthenware or plastic pots or drums.
- ❖ Use fresh quicklime
- ❖ Bordeaux mixture should be passed through a sieve before transferring to the sprayers.
- ❖ Spraying of Bordeaux mixture should be done on the same day of preparation.

## **METHODS TO CONSERVE AND AUGMENT NATURAL ENEMIES/POLLINATORS**

- ❖ Insecticides should be used judiciously at recommended rates on need basis (IPM), rather than on calendar basis.
- ❖ In addition to adoption of need-based insecticides, cultural, mechanical and behavioral management strategies may also be followed.
- ❖ On the previous evening of insecticide spray in the field, honeybee hives may be closed with moist cloth and colony may be provided with sugar syrup. The hives can be opened on the next day of spray.
- ❖ Minimum four honey bee hives may be maintained in one acre.
- ❖ Periodical removal of old honeycombs and introduction of new honey combs in appropriate seasons will avoid wax moth trouble.
- ❖ Maintenance of optimum shade (about 50 per cent) with trees like *Vernonia* which flower during January– February will encourage honeybees.
- ❖ By integrating all the plant protection techniques with the timely and required plant protection measures, the pest problem in cardamom could be reduced economically to a great extent and the natural enemy/honey bee population could be conserved / augmented.

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Notes:

A series of horizontal dotted lines for taking notes.



# HIGH YIELDING VARIETIES OF SMALL CARDAMOM RELEASED BY ICRI



**ICRI-3**



**ICRI-4**



**ICRI-5**

## NUTRIENT DEFICIENCY SYMPTOMS IN CARDAMOM



**Nitrogen deficiency:**  
Yellowing in older Leaves and stunted growth



**Phosphorus deficiency:**  
Poor root formation and leaf tip necrosis



**Potassium deficiency:**  
The leaves showing browning of tips extending downwards.



**Zinc deficiency:**  
Rosetting of cardamom tillers



**Calcium deficiency:**  
Scattered yellow spots and upward curling of leaves



**Boron deficiency:**  
crown leaves fails to expand, severe curling & reduction (choking)

## MAJOR INSECT PESTS / DAMAGE SYMPTOMS IN SMALL CARDAMOM



Thrips damage on capsules



Borer damage on shoots



Conogethes Spp. (Shoot borer)



Root grub



MAJOR FUNGAL DISEASES OF SMALL CARDAMOM

## MAJOR INSECT PESTS / DAMAGE SYMPTOMS IN SMALL CARDAMOM



**Capsule Rot**



**Rhizome Rot**



**Fusarium diseases**





# CULTIVATION PRACTICES FOR SMALL CARDAMOM



एप्यारिसेस बोर्ड  
भारत

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Spices Board

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