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Galleria mellonella
Larvae Mass Culture

EPN Emergence

*Farm Friendly
Research*

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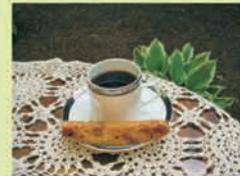
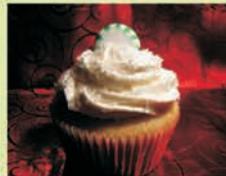


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INDIAN CARDAMOM RESEARCH INSTITUTE

-Looking Forward

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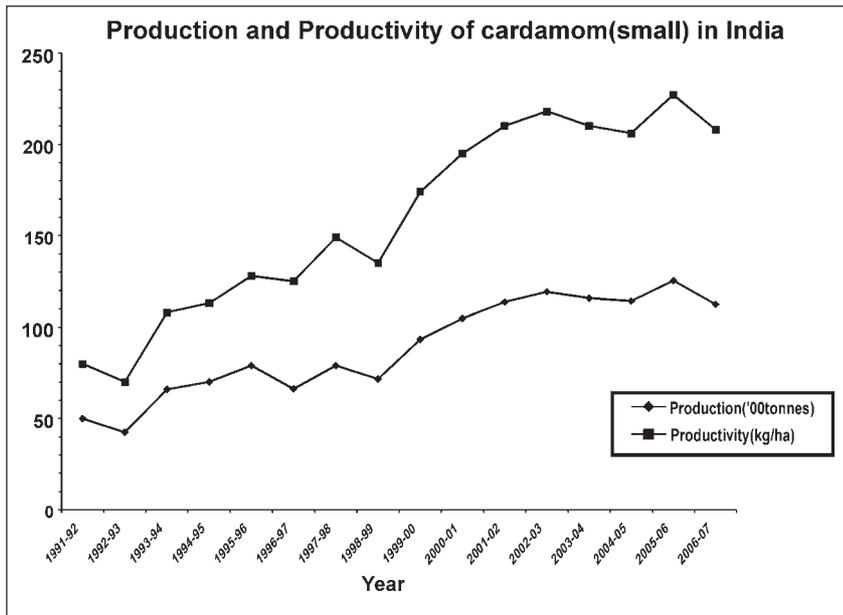
The Spices Board (erstwhile Cardamom Board) established Indian Cardamom Research Institute at Myladumpara in Idukki district of Kerala in 1978. The objective of the institute was to take up need based adaptive research programmes for developing appropriate technologies for increasing production and productivity of cardamom. Subsequently in 1980, two regional stations were opened at Sakleshpur (Karnataka) and Thadiankudisai (Tamil Nadu) to formulate location specific strategies in the respective areas of the cardamom tract in the Western Ghats. The research and development centre of large cardamom started at Pangthng, Sikkim during 1983 was brought under ICRI in 1987 as one of its regional stations. In the course of time the institute has diversified its activities on other spices such as vanilla,

black pepper, ginger, turmeric, chilly, culinary herbs and tree spices (variety of clove and nutmeg). Besides, the institute also takes up responsibility for transferring technologies to farming community imparting technical guidance and training and also in the production and supply of quality planting material with an objective to increase production and productivity of cardamom. These programmes are implemented through the research departments such as Crop Improvement, Biotechnology, Agronomy and Soil Science, Plant Pathology, Entomology, Post harvest technology and Transfer of technology.

The multidisciplinary research activities undertaken at ICRI helped to bridge the gap between overage and achievable maximum productivity and also could break the yield barriers /

production constraints. A glance at comparative production scenario of cardamom prior to 2000 and in the millennium years will illustrate the role of research and development programmes. During 1990 India's production was only 4750 metric tonnes and it has gone up to 9330 metric tonnes by 1999. In the millennium year (2000) the production touched 10,480 metric tonnes and there after it was on the increasing trend except for one or two crop seasons (2004-05 and 2005 - 06) due to adverse weather conditions. However it was above the production realized before 2000. In the recent years the production and productivity increased substantially in spite of the fact that the area under cardamom reduced drastically from 1.05 lakh hectare (1987-88) to 73,100 hectares (2005-06). The increased trend in the





productivity from 195 kg / ha (2000-01) to 238 kg / ha (2005-06) clearly illustrates the significant role of research and development.

The production gains and quality up gradation of cardamom could be assured to adequate and sustained research efforts in multidisciplinary directions of plant improvement, nutrient scheduling, agronomic practices, effective management of pests and diseases and development of adequate technology for processing, storage and product diversification.

ICRI Contributions to cardamom industry

Improved Cardamom Varieties - ICRI has contributed substantially to the cause of

cardamoms (small and large) and also other spices. ICRI has the largest germplasm repository of small cardamom at Myladumpara and its regional stations. Since 2000 germplasm conservations conducted with the financial support of ICAR (NATP-PB) in the National parks, Reserve forests, and Plantations has resulted with the collection of over 230 accessions and over 25 landraces / elite clones. The magnitude of variability has been assessed and are being conserved for utilization. In addition to clones released for Kerala (ICRI-1&2), Karnataka (ICRI-3) and Tamil Nadu (ICRI-4), a hybrid in cardamom ICRI-5 and a selection ICRI-6 were released for the cardamom tracts of Kerala. Considering the adaptability of cardamom, high

yielding location specific clones have been identified for various regions of the cardamom tract. Among them, MHC-18 (Wayanad), MHC-10 and TDK-87 (Tamil Nadu), SKP-170 & SKP-187 (Karnataka) are very prominent. Besides highly promising hybrids developed at Myladumpara like MHC-23 & MHC-24 developed at Myladumpara are in various stages of testing.

Identifications of resistant / tolerant varieties in cardamom were another area of concern. Research thrust has been focused on developing tolerant lines against biotitic (*Azhukal* & *Katte* diseases and *Thrips* and biotitic (drought) stress. In this regard, germplasm surveys have been undertaken to 'hot spots' / problematic areas of the cardamom tract. The collected 'escapes' / tolerant lines are being screened for further investigations. The mutation studies (Physical) under taken to develop '*Katte*' tolerant lines in Karnataka have resulted a few tolerant lines and are being demonstrated in the farmer's field in the hot spot areas of '*Katte*' infection.

Integrated Nutrient Management

Integrated Nutrient Management strategies involving organic farming technologies have been



strengthened in cardamom for achieving sustainable production. Even through fertilizer schedules for different zones of the cardamom tract have been recommended, the current approach is to refine the technology through the diagnosis of the nutritional requirement. Surveys conducted on the 'micro nutrient states showed that Zinc and Boron are deficient in cardamom soils. Foliar application of Zinc sulphate @ 500 ppm and soil application Boron in the form of commercial grade Borax at the rate of 7.5 Kg / hectare is recommended to tackle the deficiency problems. Beneficial effect of liming cardamom soils in altering the soil pH for better growth and yield of cardamom has been demonstrated.

Studies on the effect of Bio fertilizers revealed that application of *Azospirillum* and *Phosphobacteria* @ 50 grams each per plant along with recommended dose of fertilizers and FYM significantly increased the cardamom yield. In Karnataka, application of 75:37.5:150 kg NPK per hectare per year + *Phosphobacterium* @ 50 grams + 5 kg FYM per plant gave the highest cardamom yield when compared to fertilizer application without biofertilizers. Highest dry

weight of capsules was recorded with the application of inorganic nitrogen 100 per cent + *Azospirillum* 50 grams + 5kg FYM (447.5 kg ha - 1). Further the role of FYM in increasing the yield of cardamom in combination with biofertilizer, *Azospirillum* has been ascertained. Adoption of integrated nutrient management involving organic and biofertilizer consortium with VAM, *Azospirillum* and *Phosphobacteria* are being advocated in the nutrition management of cardamom..

Cardamom is a shade looking crop, cultivated as pure crop under tree's canopy. Emphasis has been given to cardamom - based cropping systems to increase unit area income and the plantation as a sustainable one. Introduction of crops like black pepper, thipali, mali mulaku, coffee, areca nut etc in the initial years of cardamom growth has been recommended. The use of rubber as a shade tree the cardamom in the fringe areas of the cardamom tract is also feasible to generate sustainable income from the plantations.

Integrated Disease Management

As many as 25 different types of fungal diseases have been reported in soil and among these 'Azuka' or *Capsule rot* and

Clump rot are the major ones. Recently wide spread occurrence of *Fusarium* diseases has been identified. Integrated diseases management strategies using plant sanitation and fungicides and of eco friendly systems involving the use of bio agents and beneficial micro organisms such as *Trichoderma* and *Pseudomonas* are being recommended. The need for implementation of effective replanting schedule coupled with practice of mono cropping is advocated for 'Katte' eradication.

The efforts of the institute on the use of bio - agents such as *Trichoderma*, *Bacillus sp*, *Pseudomonas* etc for diseases management in cardamom became popular. Two indigenous strains of *Trichoderma* viz. ICRI isolate T12 (*Trichodrama haszianum*) and T14 (*T.viride*) isolated from the cardamom soils are found very effective in the management of cardamom diseases. VAM inoculation at the seedling stage significantly enhanced growth and vigor of the seedlings.

Integrated Pest Management

An integrated Pest Management package developed was refined to address the pest problems very effectively reducing the pesticide load considerably in plantations. This was achieved



through appropriate combination of cultural, mechanical and chemical measures and its application in the right time. A total of seven insecticide sprays a year will control both thrips and borer in Kerala region. For Karnataka only four rounds are sufficient (January, March, May and September / October). For Tamil Nadu five rounds are required. Phosalone, being a less toxic insecticide to bees (Pollinators) may be preferred for spraying during peak flowering. To safeguard honeybees, the major pollinator of cardamom, insecticides may be applied in the afternoon hours.

A few commonly and locally available plants such as *Vitex negundo*, *Lantana camara*, *Spathodea companulata* and *Chrysanthemum* possess insecticidal properties. Essential oils of caraway, oreganum and thyme are found to have nematicidal activity against the root knot nematodes *Meloidogne incognita* and *Meloidogyne javanica* at concentration of 125 u/1 *in vitro* and 100 u /kg in soil. The white fly population can be maintained at a very low level by the parasitoids, *Encarsia septentrionalis* and *E. dialeurodis* and predators, *Mallada bonninensis*, mites etc

Large cardamom

ICRI undertakes research

on Large cardamom (*Amomum subulatum* Roxb.) popularly known as 'Bada Elachi', which is extensively cultivated in the sub - Himalayan tracts of North Eastern Hills of India. Research thrust was given on the production, protection and post harvest processing aspects of the crop. Germplasm inventorisation carried out at various centers including the border areas of India-Bhutan and Nepal have resulted in the collection of many variants and allied taxa like *Amomum dealbutum*, *Amomum kingsii*, *Costus speciosus*, *Hedychium* sps etc. Evaluation of the germplasm accessions has resulted in the identification of a few elite clones such as SBLC-5, SBLC-47, and SBLC-50 etc. Out of these, SBLC-5 and SBLC-50 were released for large scale collection under the name ICRI-Sikkim-1 and ICRI-Sikkim-2. These selections exhibit an yield potential of 748 and 834 kg/ha respectively. Further may high yielding clones having an yield potential of above 1000 kg/ha are in the pipeline for release and among these SCC-72, SCC-75 and SCC-81 are the prominent ones.

Performance evaluation of tissue culture derived plants *Vis* a *Vis* open pollinated seedlings of large cardamom revealed that tissue culture plants are uniform and are superior to

open pollinated seedlings.

Sikkim state was declared as an organic one in the country. Formulation of sustainable agro techniques with special emphasis on organic farming, development of effective and economically viable strategies for Integrated Nutrient Management (INM), Integrated Pest Management (IPM) as well as post harvest technology were addressed well.

ICRI designed improved Post harvest system for curing large cardamom was resulted in producing export quality product fetching substantial higher remuneration to farmers.

1. Cardamom Production - Challenges in India

1.1. High cost of Production

Cost of production and productivity are two important factors, which determine the competitiveness of the commodity in the market. Now the productivity of cardamom in India has reached to the tune of 238 Kg. /hectare (that was never realized before) but the cost of cultivation also increased along with it. Guatemala produces 28,000 tonnes annually from around 67,000 hectare with an edge over India in production and productivity. In India the labour component involved in production is very high and the cost of labour





exceeds more than 50 per cent of total expenditure. The cost of cultivation in Guatemala is reported to be around Rs. 1.05 lakhs/hectares for the initial three years after planting which is about one third of cost of cultivation recorded in India. The non-availability of skilled laborers for harvesting and post – harvest handling reduces the productivity in terms of competitiveness in the global market.

1.2. Sustainability of productivity in the plantation

In cardamom plantations yield variation becomes a regular phenomenon and this has to be circumvented with appropriate technologies. High production technologies are available in the research institutions working on cardamom and implementation of these technologies would enhance the crop yield. Presently cardamom harvest is completed with six to eight rounds of picking under high management system. Number of pickings has to be reduced without affecting the total yield level and quality of produce. The employment of unskilled workers contributes the quality deterioration. In Guatemala, cardamom harvest is completed with three to four rounds in a crop season without reducing the total yield and quality. This

adds to the advantage of Guatemala to reduce about sixty per cent of the expenditure earmarked for harvest and post harvest handling. Emphasis has to be given to isolate varieties having synchronized flowering / fruiting to maintain the yield level constantly and at the same time reducing the cost of the harvest.

1.3. Indiscriminate use of pesticides

Cardamom is susceptible to an array of pests and diseases. Infestation of pests and disease causes significant crop loss in plantation. A large number fungicides and insecticides are used indiscriminately in the plantation for their management. Such indiscriminate use may lead to pesticide residual problems in the commodity. The importing countries will reject in the consignment if the residual level above the situated level and this in turn adversely affect the export performance of Indian cardamom. Japan was the steady and reliable market for cardamom and the country has been importing around 30 – 40 per cent of the total export of India. Recently insecticides such as *Triazophos* and *Profenphos* were detected in the consignment exported from India. The importing countries are very stringent about the

quality aspects including the toxicity level of insecticides. It is therefore research on IPM should be intensified on a holistic perspective including an identification and multiplication of local isolates of bio-agents for the management of pest and disease of cardamom. Pesticide residue content above the permitted limit may cause challenge in the domestic trade also in the future. Necessary steps have to be taken to maintain the tolerance level of the pesticide residues as per the stipulation of the importing countries. Planters should consult Institutions like ICRI, ICAR, SAU's, etc for latest technology developed in the lines of IPM research.

1.4. Organic cardamom

The demand for organic food is increasing rapidly in the world over particularly in the developed countries. The organically derived commodity fetches 20 to 50 per cent higher price compared to one obtained from conventional farming. Cardamom is not presently amenable to organic system of cultivation due to its inherent pests and disease problems. Application of inorganic fertilizers augments the crop yield substantially. In the event of changing consumer preference towards organic



cardamom, suitable varieties/ organic production technologies are to be developed for sustainable production of organic cardamom. The niche markets for organic cardamom for organic cardamom are to be exploited.

2. Steps for Mitigating Challenges

Cardamom Industry in India encountered with many constraints, which adversely affect the production. The future of the industry in the country depends on the cost effectiveness in production, quality up gradation and product diversification. ICRI has identified a few priority themes to address these issues and research on these lines are initiated.

2.1 Location specific varieties and hybrids

The varietal improvement programmes undertaken in various research institutions resulted in the releases of over 10 clones and hybrid having yield potential as well as resistance/ tolerance of disease. Further, in recent years, a few improved 'land races' in cardamom have been located by farmers. Among them 'Njallani green gold' identified by Shri Sebastian Joseph, Njallani is the ruling cardamom variety

cultivated in the cardamom tract of Kerala, Besides, *Panikulangara, Valley green bold, Vander cardamom, Palakudi, Elarani I and Elarani - II, Kalarikkal white cardamom and PNS Vaigal* are also getting popular. The performance of these improved clones and landraces are location specific and this necessitates the need for developing varieties with wider adaptability. Production of hybrids using the improved clones / landraces suited to respective agro ecological conditions and their exploitation for yield and other desirable traits will contribute to substantial increase in production.

2.2 Cost effectiveness

Cost of production and productivity per unit area determine the competitiveness of commodity in the market. The productivity of cardamom in India is about 238 kg/hectare with a production of about 12000 metric tonnes under moderate management. On the other hand Guatemala produces around 28,000 metric tonnes under low management practices even at high productivity (about 315 kg/hectares) level compared to India. The cost of cultivation in India is around Rs. 2.0 to 2.5 lakhs per hectare per year where as in Guatemala cost of

cultivation in Guatemala is reported to be around Rs. 1.05 lakhs/hectares for the initial three years after planting which is about one third of cost of cultivation recorded in India. The labour component involved in production is very high and the cost of labour exceeds more than 60 per cent of total expenditure. The non-availability of skilled laborers for harvesting and post - harvest handling reduces the productivity in terms of quality and quantity will make the commodity cost effective. Mechanization of harvesting and other field operations will reduce the cost of cultivation and research on this has to be intensified.

2.3 Sustainability of productivity in the plantations.

In cardamom plantations yield variation becomes a regular phenomenon due to many factors. It includes production technologies related to INM, IPM, Harvest and Post harvest operations and agro ecological condition under which the crop is grown on comparison of the cardamom scenario in India and Guatemala, it is very evident that agro ecological conditions such as soil, weather conditions such as rain fall distribution, total rainfall, number of rainy days, temperature etc are very



favorable to achieve maximum production in Guatemala. On the technology front, though India has an edge over Guatemala but it is far behind in terms of cost effectiveness due to high cost of production. Emphasis has to given to develop varieties having synchronized flowering / fruiting, resistance / tolerance to abiotic and stress to maintain the yield level constantly and at the same time reducing the cost of harvest.

2.4. Good Agricultural Practices of Quality Spice Production (GAP)

For the effective dissemination of technologies Spices Board has designed a training programme on *Good Agricultural Practices for Quality Spice Production* to the unemployed youths. This programme is parallel to the extension services of the Board. Techniques for the quality planting material production, integrated nutrient, pest and disease management, preparation and use of organic inputs and post harvest operation including the value addition of spices will be trained After completion of the training, trainees can continue to engage in the agricultural based activities for the production of good quality spice and also act as resource

person to spice growers who are interested in sourcing their expertise. Scientist – Farmer interface is another mode or technology transmission undertaken by the Institute. Mobile Agri-clinic is also made available to provide advisory services to farmers. Training programme is also offered to farmers and extension officers for on – farm production of bio agents and on its effective usage. Demonstration of high production technology with the integrated management of nutrient, pest and diseases is being undertaken in the farmer’s field. Farmer’s cell functioning at ICRI will coordinate the extension and advisory services and also distribute the planting materials, bioagents and other inputs required by the farmer.

2.5. Product diversification development

Product diversification and development is another area, which can contribute substantially to increase the consumption at the national/ international level. Presently cardamom finds a place in the preparation of food, sausages and bakery products etc. It is an important ingredient in garam masalas, combination of spice of many vegetarian and non-vegetarian dishes and also in tooth pastes, chewing gum, ice

cream. Though cardamom has been used in many ways, its medicinal applications are not fully exploited. Blending with tea, wide range of uses in small

2.6. Ecosystem Conservation.

Cardamom is shade loving plant pruning of shade trees is very essential for tillering and growth performance. However, excessive shade regulation is very much detrimental particularly when irrigation is not done during summer. In order to exploit the yield potential of improved varieties / Landraces of cardamom over regulation of shade is practiced in the plantation limiting the shade level to the tune of 20 to 30 percent. This causes variation in the weather conditions resulting in the outbreak of pests and diseases in the plantations.

In order to overcome ill effects of the excess shade regulation, forest ecosystem should be conserved for the long-term sustainability of cardamom and weather condition in the eco-system. Afforestation is to be carried out with suitable tree species. The traditional wisdom of maintaining 50 per cent shade has to be reintroduced in every plantation, required even at the cost of reduction in productivity.





CARDAMOM REPLANTATION PROGRAMME LAUNCHED IN KARNATAKA



Shri. Jairam Ramesh, Hon'ble Union Minister of State for Commerce and Power, speaking at the launching of Cardamom Replantation Programme in Karnataka

Shri. Jairam Ramesh, Hon'ble Union Minister of State for Commerce and Power launched the Cardamom Replantation Programme in Karnataka on 22nd January 2009 by distributing the cardamom replanting subsidy cheques to the beneficiary farmers. During the interaction with farmers the Minister informed that Rs.120 crore has been earmarked in the 11th Plan for replanting cardamom in Kerala, Tamil Nadu and Karnataka and Rs.37 crore will be spent for replanting cardamom in 15,000 hectares in Karnataka. He also told that 60 per cent of growers who have availed of this subsidy were small growers

and 33 per cent subsidy will be given to growers having four hectares and 25 per cent will be granted to growers who have more than four hectares of land.

The Minister asked the Karnataka cardamom growers

to increase the cardamom production since the production level in Karnataka is 35 kg to 40 kg per acre while the same is more than 120 kg in Kerala and Tamil Nadu. He also said that a e-auction center for Karnataka will be considered only when the cardamom production reached 3000 tonnes in the next three years. The Minister interacted with the representatives of Karnataka Planters' Association and Karnataka Growers' Federation.

Shri. H.Vishwanath, Member, Spices Board, Shri. Ajoy Thippaiah Chairman, Karnataka Planters' Association, and Shri.Mohan Kumar, General Secretary, Karnataka Growers' Federation were spoke on the occasion . Shri. H.S.Srinivasa, Joint Director, Spices Board, Sakleshpur welcomed the gathering.



The Minister giving away the subsidy cheque to Shri. K.K.Gopala, a cardamom grower in Somwerpet, Kodagu District.





FUSARIUM DISEASES, A THREAT TO SMALL CARDAMOM PLANTATIONS

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Small cardamom is affected by a number of fungal diseases. Diseases such as the capsule rot (azhukal) caused by *Phytophthora meadii* and the rhizome rot caused by *Pythium vexans* and *Rhizoctonia solani* are comparatively severe and affect the crop production. In recent studies carried out in many cardamom plantations in Idukki districts of Kerala showed that *Fusarium oxysporum*, the well known wilt fungus is becoming a major pathogen to small cardamom. The wide spread “foliar yellowing and plant decline” noticed in several cardamom plantations of Idukki District was reported to be caused by this fungal wilt pathogen.

Fusarium diseases in small cardamom

The major diseases caused by *Fusarium oxysporum* in small cardamom are root tip rot and leaf yellowing,

pseudostem rot, panicle blight and rhizome rot. These diseases are often severe and wide spread and lead to crop losses.

1. Root tip rot and leaf yellowing

Root tip rot and leaf yellowing occur wide spread in several cardamom plantations in Idukki district of Kerala. The disease makes its appearance after the monsoon rains and becomes severe during summer months. The symptoms are yellowing of the foliage resulting in leaf drying. Usually, the symptoms starts from the older basal leaves onwards and reaches towards the middle portion of the tillers. The younger most leaves will be green in colour. The earlier affected basal leaves become fully yellow and soon dry off. Characteristic visible symptoms are seen in the root system also. The root tip portions of affected plant show symptoms of decay, proceeding slowly towards the

plant base. Such roots show shriveling and an off white to grey colour at the root tips. If sufficient moisture is present in the soil, the affected portions show decay. During dry weather, these portions become shriveled.

2. Pseudostem rot

It is a characteristic infection seen on the pseudostem (tillers) in small cardamom. The symptoms of this disease develop in the form of dark brownish, round or oval necrotic patches on the pseudostems, and at the base of the petioles. These portions elongate and the infection spread towards leaf sheaths. At a later stage, the pseudostem at the lesion portion splits off or tears resulting in the breaking and falling of tillers. Due to this it is also called stem lodging disease. The infection is seen usually on any portion of the matured tillers. In severe cases, many tillers fall off, the leaves



dry and give a burnt appearance.

3. Panicle blight

A type of blight disease resulting in the drying of flower buds, young capsules and panicle tips is noticed in several cardamom plantations in Idukki district over the past few years. The disease is observed after the south west monsoon season or sometimes immediately after the monsoon rains are over. In severe cases, even the mature capsules dry off. The symptoms are so characteristic that the drying starts from the panicle tip onwards and proceed towards the base of the panicle (Fig.3). The dried portions sometimes show slight pinkish to purple colour.

4. Rhizome rot

Rhizome rot commonly known as clump rot is a wide spread disease in Kerala, Karnataka and in heavy rainfall areas of Tamil Nadu. It is caused by the fungal pathogens viz., *Pythium vexans* or *Rhizoctonia solani*. However, rhizome rot caused by *Fusarium oxysporum* Schlecht which is a soil borne fungal pathogen, affects the cardamom plants during post monsoon period when the soil moisture is comparatively lower or limiting.. The disease is characterized by development of rots on

rhizomes which spreads towards upwards to the tillers and downwards to the root system of the plant (Fig.4). The affected plants also show foliar yellowing.

Fusarium disease management in cardamom plantations

1. Chemical control

Field control trials using systemic chemical fungicides showed that *Fusarium oxysporum* disease infections in small cardamom can be brought under control with the use of chemical fungicides viz., Carbendazim (0.2 per cent), Hexaconazole(0.2 per cent) or Thiophanate methyl (0.2 per cent) as spraying and soil drenching. The phytosanitary operations should be carried out on top priority to reduce the pathogen inoculum load in the cardamom plantations. Three rounds of applications of chemical fungicides may be given at monthly intervals starting from August.

2. Use of bio control agents

Microbial antagonists are increasingly being used for the management of soil borne plant pathogens such as *Fusarium oxysporum*. The fungal bioagent *Trichoderma harzianum* is a potential antagonist for management of root rot and leaf yellowing of small cardamom. Use of bioagents such as

Trichoderma harzianum as basal application and *Pseudomonas fluorescens* as spray and soil drenching was very effective in controlling the disease in the field. This offers an additional advantage for the organically managed cardamom plots where the use of fungicide is excluded. Use of consortium of microbial antagonists alongwith vermicompost is a new approach for biological control of *Fusarium* diseases of small cardamom in plantations.

Integrated Management for *Fusarium* disease

The planters may adopt the following tips for the management of *Fusarium* diseases and foliar yellowing in cardamom plantations.

The cause of cardamom plant yellowing in the respective cases may be observed and the control measures may be applied accordingly. Leaf yellowing may be due to root rot caused by *Fusarium oxysporum*, foliar fungal infections such as leaf rust or chenthal, root damage caused by root grub, nematode infestation, whitefly attack and due to nutrient deficiency.

As most of the roots are damaged the uptake of nutrients is obstructed and the plants show yellowing in the case of root rot caused by *Fusarium oxysporum*.



Phytosanitation by pruning dry leaves, uprooting and removal of diseased tillers, panicles and rhizomes may be carried out. Destroy them by burning or deep burying. The phytosanitary operations should be on top priority to reduce the pathogen inoculum load in the cardamom plantations.

Subsequently soil drenching and spraying should be carried out thrice at monthly intervals using chemical fungicides such as carbendazim (0.2 per cent), Thiophanate methyl (0.2 per cent) or hexaconazole (0.2 per cent) in the plantations for management of *Fusarium* diseases. Three rounds of applications may be given during August,

September and October months.

Root rot affected plantations may be given foliar sprays with 1-2 per cent DAP depending on the age of the plant.

Apply biocontrol agents such as 1 per cent *Trichoderma harzianum* (10⁹cfu/ml) as basal application and 1 per cent *Pseudomonas fluorescens* (10⁹cfu/ml) as spray and soil drenching after 10 days of fungicidal application. Repeat the application of biocontrol agents (twice) in the cardamom plantations.

Nematode infestation also causes yellowing and plant decline. For controlling the nematode and root grub, apply carbofuran (Furadan)60-80

grams per plant alongwith 300-500 grams neem cake. Drench the plant base with 0.2 per cent chloropyrifos (200ml in 100litres of water) for the control of root grubs. Apply EPN (Entomo Pathogenic Nematode) at the rate of 1,00,000 ijs(infective juveniles) per plant as an effective biocontrol method.

If whitefly infestation is noticed, install yellow sticky traps in the plantations for the management of adult white flies. Also spray an emulsified mixture of neem oil 500 ml with 500 ml sandovit in 100 liters of water on the lower surface of leaves for management of whitefly nymphs.

Cardamom suckers for planting should be collected from disease free plantations.



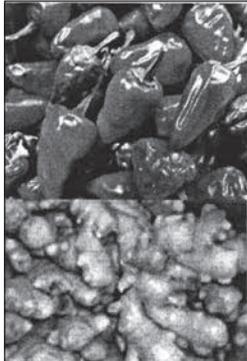
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Shri.Prahlad Joshi, M.P. Dharwad is seen inaugurating the Chilly seminar by pouring water to a chilli plant



A view of planters attending the seminar.

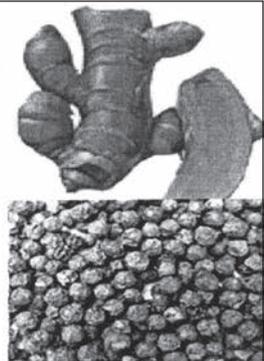


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S P I C E I N D I A





INTEGRATED PEST MANAGEMENT IN CARDAMOM

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Proper identification of pests and their natural enemies is necessary to take-up effective pest management measures that are cost effective as well as eco-friendly. There are few persistent pests and few occasional ones in cardamom. The pest management becomes efficient when it is undertaken at the correct time, at the right stage and with the best method. Control measures also vary with the agro-climatic conditions, especially with reference to rainfall, humidity and temperature. So, a thorough knowledge on time of occurrence of pests is required to take-up timely and need-based management.

i. Cardamom thrips:

The colonization of thrips on cardamom could easily be identified by its damage symptom (scab) on capsules. Thrips are microscopic insects and can be seen on unopened leaves, leaf sheaths, flower bracts and flower tube. The adults (black) and young ones

(white) feed on surface tissues of panicles and capsules. Injury to panicles result in its stunted growth, and the injury on tender capsules develop as scabby growth. Such capsules have less number of seeds and fetch a low price in the market.

In small cardamom, thrips population will be high during summer months (pre-monsoon period – January to May) due to its higher multiplication rate. With the onset of monsoon, thrips population gradually declines and becomes minimal during peak rainy period (June & July). Thrips population again builds-up during post-monsoon period (August – December), but comparatively lesser than in the pre-monsoon period.

Accordingly, the frequency of insecticide application should be higher (once in 30-days) during summer, coinciding with higher population, and once in 45-days after rainy period coinciding with lesser population.

ii. Borer:

Borer damage on cardamom is a serious problem in Kerala, Karnataka and Tamil Nadu. The damage is caused by early to mature larvae of borer, and can easily be recognized by the excretory frass material coming out through the bore hole. It bores panicles, tillers and capsules of cardamom and cause severe crop loss. The borer infested tillers exhibit “dead heart symptom”.

The borer infests cardamom shoot, panicle or capsules. The adult emergence has to be monitored for taking-up proper management measures. This can be achieved by keeping the borer infested shoots in closed container. The larva infesting the shoot becomes pupa and later emerges as orange coloured moth with black spots. The adults, after a period of five days, start laying eggs. The eggs are to be destroyed before they hatch or before the mature larva bore into shoot. Once the larva goes inside the shoot, it is very difficult to control the pest.



iii. Cardamom root grubs:

Root grub problem is severe in less-shaded areas. Adults of the pest are small beetles (four to six mm. length) with shiny metallic blue, green or greenish brown colour. 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, dadeps, etc. Grubs (larvae) are (C-shaped) short and stout, feed on roots and become mature in 45-60 days. Grubs have two periods of occurrence, the first during April – July and the second during August – January. Pupation takes place in an earthen cocoon. The pest completes life cycle in 65 – 102 days during first generation and 73 – 111 days during second generation.

iv. Root knot nematode:

Root knot nematodes, which can be seen only under microscope, infect cardamom roots. Common symptoms of attack are narrowing and thickening of leaves, reduction of inter-nodal length and consequent appearance of rosette leaves. Knots develop on roots and may block uptake of nutrients.

v. Cardamom whitefly

The adult fly is a small soft bodied insect with two pairs of

white wings. The oval-shaped, small, young ones (nymphs) are seen sucking plant juice from the under surface of leaves. This leads to severe yellowing of leaves, and thus affects the vitality of plant. The life cycle is completed within two-three weeks.

vi. Red spider mite:

This is a minor pest, which is small and red in colour, occur during summer months. The mites spin webs on the under surface of the leaves and live inside the webs. They puncture the plant cells with their stylets and suck the cellular material. This results in the formation of characteristic white blotches on the leaves. Mites take 15 to 20 days to complete its life cycle.

vii. Other minor pests:

Other minor pests of cardamom are hairy caterpillars, shoot fly, lace wing bug, mid rib caterpillar, cardamom aphid and cutworms.

Holistic approach:

When compiling all the operations to be adopted for the management of pests of cardamom, the package will have the following units/methods, under Integrated Pest Management.

Cultural method (Table. 1)

i. Removal of dried leaves of

cardamom in January – February and again in May, September-October (if necessary) to reduce thrips and root grub.

ii. Regulation of shade, judiciously to avoid open patches which may lead to root grub problem.

Mechanical method (Table. 2)

i. Collection of root grub beetles during March – April and August – October using insect net to reduce beetle population.

ii. Removal of hairy caterpillars found on the tree trunks manually and destroying them.

Behavioural method (Table. 3)

i. In case of whitefly infestation, fix yellow sticky traps (rectangular metal sheets or plastic sheets of yellow colour coated with castor oil or grease fixed three feet above ground in cardamom field) to attract the white fly adults and get destroyed.

Chemical method (Table. 1)

The need-based insecticide schedule for management of important pests is given in table 1 which involves a total of seven rounds per year under rain-fed condition.

Biological method

A lot of natural enemies are available in cardamom fields. They infect/parasite/ predate on egg, larvae/nymphs, adults



Table 1: INTEGRATED PEST MANAGEMENT UNDER DIFFERENT CONDITION (foliar pests) Tentative schedule

<p>1. Cultural control a.Prune dried leaves in January end (before first spray), and also in September. b.Trash dried panicles, shoot and leaves in May end. These operations clear the dried parts of plants and facilitate spray fluid falling on panicles and young shoots.</p>		
<p>2. Trap crop Shoot borer larva prefers to feed on castor capsules than on cardamom; if castor is grown on open area /boundary, borer may infest castor inflorescence/ capsule and they may be destroyed by crushing castor capsules infested with shoot borer larva.</p>		
<p>3. CHEMICAL CONTROL KERALA – RAINFED CONDITION I spray: (Feb. 1st week) Quinalphos or Phenthoate @ 200 ml (or) 150ml /100 liters water. II spray (Mar.2nd week) Profenophos or Monocrotophos @ 150 ml (or) 200ml / 100 liters water. III spray (Apr.3rd week) Chlorpyriphos or phosalone @ 200 ml/ 100 liters water. IV spray (May 4th week) Acephate (150 gm) in 100 liters water. V spray (July end) Quinalphos or Phenthoate @ 200 ml (or) 150ml /100 liters water. VI spray (Sep. / Oct.) Profenophos (OR) Monocrotophos @ 150 ml (or) 200ml / 100 liters water. VII spray (December) Methylparathion @ 100 ml / 100 liters water.</p>	<p>KERALA – IRRIGATED CONDITIOIN I spray (Feb.1st week) Quinalphos OR Phenthoate @ 200 ml (or) 150ml /100 liters water. II spray (Mar.1st week) Profenophos @ 150 ml/ 100 liters water. III spray (Apr.1st week) Chlorpyriphos or Phosalone @ 200 ml/ 100 liters water. IV spray (May 1st week) Acephate 200 gm in 100 liters water. V spray (June 1st week) Monocrotophos 200ml / 100 liters water VI spray (Jul. end / August) Quinalphos or Phenthoate @ 200 ml(or) 150ml / 100 liters water. VII spray (September) Profenophos @ 150 ml/ 100 liters water. VIII spray (early November) Monocrotophos 200 ml/ 100 liters water IX spray (Dec.3rd week) Methylparathion 100 ml / 100 liters water.</p>	<p>TAMIL NADU – LOWER PULNEYS I spray (Dec.-Jan.) Monocrotophos @ 200ml or Quinalphos @200ml in 100 liters of water. II spray (Mar.- Apr.) Chlorpyriphos @200ml in 100 liters of water. III spray (May-Jun.) Profenofos @ 150ml in 100 liters of water. IV spray (Aug.) Quinalphos @ 200ml or Monocrotophos@ 200ml in 100 liters of water. V spray (Oct.) Methyl parathion@ 100ml in 100 liters of water.</p> <hr/> <p>KARNATAKA I spray –Jan. Quinalphos @ 200ml in 100 liters of water II spray -Ma. Chlorpyriphos @200ml /100 liters of water. III spray -May Phasalone @ 200ml/in 100 liters of water. IV spray - Sep.-Oct. Profenophos @ 150ml or Methyl parathion @ 100ml in 100 liters of water.</p>
<p>4.Biological control : If fresh borer is seen on the tiller, inject <i>Bacillus thuringiensis</i> (@2 ml/liters of water) 5-10 ml through bore hole.</p>		
<p>5. Mechanical control: Removal of hairy caterpillars found on the tree trunks manually and destroying them.</p>		

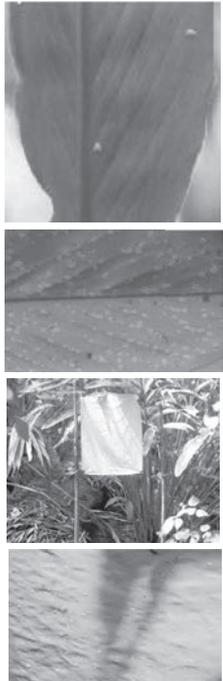


Table 2: INTEGRATED MANAGEMENT OF CARDAMOM ROOT GRUB

Stage of pest & Period of occurrence	Method of control
Adult beetle March – April & August – September	Mechanical control: Collection and destruction of adult with insect net. Chemical control: Insecticide sprayed for thrips / shoot borer can also reduce grubs by direct killing of adults as well as deterring the beetles from egg laying. Biological control: Spray of fungus suspension (<i>Beauveria bassiana</i> @ 10 ⁸ spores/ml) on adult beetle.
Grub April/May & September/October	Chemical control: Chlorpyrifos 20 EC 0.04% a.i. (200 ml in 100 lit. water; 2-5 lit. drenching at plant base). Phorate 10G 20-40 gms / clump (to be applied within 4-6 inches around the clump). Biological control: Soil application of <i>Metarhizium anisopliae</i> (@ 10 ⁸ spores / gm) 25gms/plant mixed with compost. Local strain of EPN (<i>Heterorhabditis indica</i>) application @ 1,00,000 nematodes (ijs) / plant.

Sometimes, because of indiscriminate use of insecticides flare up of minor pest like whitefly may be noticed. The management strategy is given below:

Table. 3 MANAGEMENT OF CARDAMOM WHITEFLY

<p>Reason for white fly outbreak</p> <p>1. White fly is only a minor pest in cardamom. (Fig. 1)</p> <p>2. It may become a major pest only under the following circumstances:</p> <p>a. When insecticides are used more than the recommended level.</p> <p>b. When insecticides are sprayed at higher concentration.</p> <p>c. When only one or two molecules of insecticides are sprayed throughout the year.</p> <p>d. when spray is done by mixing two or three different insecticides.</p> <p>e. When beneficial organisms / natural enemies are destroyed due to excessive use of insecticides.</p>		<p>Key to Keep away white fly</p> <ol style="list-style-type: none"> 1. Use only recommended insecticides and restrict number of sprays on need-basis. 2. Use only recommended concentration of the insecticides. 3. Do not use mixtures of two or more insecticides 4. Do not use synthetic pyrethroids consistently. <p>Ecofriendly method of managing cardamom whitefly</p> <p>If white fly becomes a major problem, do not resort for chemical insecticide use, and do the following</p> <ol style="list-style-type: none"> 1. Identify the stage of the whitefly. 2. If it is only adult whitefly, install yellow sticky trap. 3. If it is adult fly and nymphs, install yellow sticky traps and also spray neem oil and soap solution on the under surface of leaf.
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and keep the pest level under check. When the chemical insecticides are used on need-basis, the natural enemy population can also be maintained and augmented.

If fresh borer is seen on the tiller, inject *Bacillus thuringiensis* (@2 ml/lit. of water) 5-10 ml through bore hole, without monitoring adult emergence (Table. 1).

Entomopathogenic nematodes (EPN) are insect infecting nematodes, available in all cardamom soil. Its population in soil is much below its infectivity level. So, it must be multiplied and applied for the management of

cardamom root grubs. ICRI has proved EPN application as a very effective management strategy for the management of cardamom root grubs @ 4 cadavers per plants or @1,00,000 ijs per plants (Table. 2).

Application of 300-500 ml neem oil in 100 liters water (alongwith sticking agent) effectively manages young ones (nymphs) of cardamom whitefly (Table. 3)

Trap crops (Table. 1)

Planting of castor as trap crop is effective for attracting shoot borer, since it feed on castor capsules. Later remove and destroy the inflorescence /

capsule of castor, once they are infested with larvae of shoot borer.

Root grub beetles prefer to feed on jack leaves during evening / night hours. Regulate jack to have lower canopy and spray *Beauveria bassiana* fungus to control the beetles.

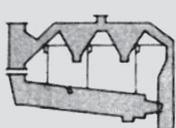
This Integrated Pest Management package is very effective for the management of pests of cardamom (Table. 1, 2). Excessive use of insecticides leads to outbreak of minor pests like whitefly, etc. which can be managed effectively adapting package given in Table. 3



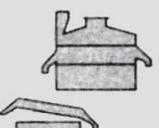


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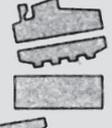
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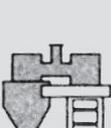
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CARDAMOM - HARVEST AND POST HARVEST PRACTICES

K.M. Kuruvilla, K.Reji and J. Thomas
Spices Board

Indian Cardamom Research Institute,
Kailasanadu P.O., Myladumpara ñ 685 553
Idukki Dt.

Indian cardamom occupies an enviable position in the global spices market due to its unique flavour and aroma. Cardamom possesses high moisture content at the time of harvest (>80 per cent) like other spice crops. During processing, the moisture content of the freshly harvested capsules is reduced from 80 to 10-12 per cent without losing quality traits such as colour, aroma and volatile oil content etc. While giving importance to production and productivity, emphasis should also be given to the quality of the produce as the consumers are highly concerned about the quality. Quality of the produce can be achieved through timely harvest and adoption of scientific post harvest operations. Application of recommended pesticides at the safe dose and at the correct stage using appropriate method of application ensures negligible poison contamination. At farm level, cardamom should be harvested at correct maturity stage without physical damage

followed by the employment of proper processing techniques involving various unit operations such as washing, drying, cleaning grading and packaging till marketing of the produce.

Cardamom plants generally start bearing from 18-24 months after planting depending upon the type of planting materials used. Flowers are borne on panicles arise directly from the base of the pseudo-stem (tillers). Panicles appear from December onwards and the flowering continuous normally for a protracted period of about six to eight months. The climate and varietal differences influence the time and duration of flowering. It takes nearly 30 days from bud to flower and bear fruits immediately under favourable conditions. A flower takes 120-135 days to form a ripened fruit depending up on the environmental conditions. The fruits are small trilobular capsules having varying shapes, round, oval and

angular. Capsule contains 15 to 20 black coloured seeds at maturity. Lack of synchronised flowering necessitates several rounds of harvest in cardamom. Capsules are picked at an interval of 25 to 30 days in Kerala and Tamil Nadu and in Karnataka 20 to 25 days interval is adopted depending upon the environmental conditions. By and large, harvesting starts from July-August and continues till January-February in Kerala and Tamil Nadu, whereas in Karnataka it commences in August and continues till December - January. However, under irrigated condition with judicious management supplemented by favourable conditions, crop is harvested through out the year.

Stage of harvest

The harvesting is a labour intensive operation that needs the constant attention of the farmers. Harvesting of capsules in the correct maturity stage will improve the quality of the produce. Ripened fruits or



physiologically ripened (Karikai) alone are to be harvested to get better liter weight, colour and prescribed market demanded quality. Small immature capsules bring about uneven shrivelled and undesirable colour after processing. Faulty picking of immature capsules alone could lead to a realisable crop loss even up to 40 per cent. Studies on stage of harvesting on recovery percent in Malabar type of cardamom revealed that highest dry weight of 285 grams could be obtained from one kg of wet (green) capsules when picked at ripened (fruit) stage followed by 240 grams and 140 grams when picked at physiologically mature and immature stages, respectively. In a random market sample study conducted, it was noticed that the extent of immature capsule was as high as 42 per cent, followed 34 per cent by fully ripened capsules and the rest 24 per cent by physiologically mature capsules. A little care on the stage of harvest by the farmer could help him to get better market price realisation.

Harvesting of capsules should be carried out when the seeds inside the capsules have become brownish to black in colour. Two types of picking are practiced in cardamom and they are 'light picking' and

'hard picking'. When light picking is done, great care is to be exercised in harvesting only the green matured capsules. This process will naturally give less quantity crop per each round harvest. While doing hard picking immature capsules are also removed. This process reduces curing percentage but increases picking average, secures green coloured capsules and also reduces the chances of fruit drop. It will be ideal to harvest physiologically matured to fully ripened stage so as to allow the capsules for the proper seed development 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 splitting at the time of drying which in turn fetches low market value. Percentage of dry recovery is highest (24 per cent) in the fully ripened capsules followed by the one harvested at physiological maturity (20 per cent) and in immature stage (14 per cent). Studies on physiological maturity and chlorophyll content indicated that harvesting at "touch and drop" stage increases yield by about 13per cent with marginal increase in litre weight. The chlorophyll content (greenness) starts declining when the capsules reach an age of 100 days from flowering while dry

matter accumulation continues till harvest (touch and drop stage). The post ripening loss of green colour was significant and steep in *Malabar* types indicating that picking interval has to be closer in such cultivars.

Immediately after harvesting capsules are to be washed in water as the dirt and soil attached to soil affect its quality. Draining of water is essential to get good quality cardamom. Farmers treat the harvested capsules treated with two per cent washing soda (Sodium bi carbonate) for 10 minutes for obtaining better colour and to prevent growth of mould. However, this practise is to be discouraged as the product colour may fade faster on storage and an avoidable chemical could be kept at bay from a natural product. Heaping of capsules after harvest may be avoided as it affects the quality of the processed produce.

Curing

Cardamom curing may be defined as the process in which moisture of freshly harvested capsules is reduced from 80-85 per cent to 10-12 per cent at optimum temperature. The moisture content of the capsules husk is around 80 per cent and this has to be removed completely during the process



of drying. Drying is the most important unit operation that determines the colour and aroma of the end product. Apart from quality in terms of colour, flavour components such as 1-8 cineole, terpenyl acetate, linalool etc., are also governed. There are two types of drying namely natural (Sun-drying) and artificial (firewood, electricity, kerosene, liquid petroleum gas)

Natural (sun drying)

In this method the harvested capsules are directly dried under sun it requires five-six days or more depending on availability of sunlight. Uniform drying of capsules is not possible in this method as the cardamom harvest commensurate with rainy season in the cardamom tract. The quality of capsules in terms of its colour is adversely affected due to loss of greenness in the processed cardamom. Further the frequent turning of capsules leads to splitting and deterioration of the quality. Capsules dried under this method are not preferred for export. This method is mainly practiced in Karnataka. Karnataka is one of the leading states engaged in the production of bleached cardamom. Recent studies revealed that black coloured blanket kept on the capsules spread under the sun

augmented the drying process and also provides green colour to the produce.

Bleaching of cardamom leads to loss of volatile oils. Bleached cardamom is greenish white or golden yellow in colour. Bleaching can be done either on dried cardamom capsules or with raw capsules. Bleaching powder, powdered sulphur, potassium metabisulphite, hydrogen peroxide and sodium silicate are the agents commonly used for bleaching cardamom.

Artificial drying

Artificial drier are further categorized into conventional (flue pipes dryers) and other types depending up on the source of fuel employed for cardamom processing.

Conventional curing

Conventional curing of cardamom regulates temperature, humidity and aeration inside the curing chamber and this may influence the quality constituents of cardamom capsules. It is the most commonly adopted method of cardamom curing in the plantations.

In majority of the plantations in Idukki district of Kerala, conventional curing chamber with firewood as fuel are used. The heat is generated from an external furnace and

conducted in the chamber by means of flues. A hot air chamber may be a ventilated building with walls of bricks or stones and with a tiled roof. A ceiling may be provided at the roof and it has definite advantage. Racks of convenient length and height (below 2m) may be arranged in tiers 20 to 25 cm apart to permit easy manipulation of trays. Racks holding rectangular trays are to be fitted to the side walls for accommodating large quantities of cardamom capsules. The trays consist of ordinary reaper frames with wire mesh. Flue pipes made of galvanized iron sheets are provided in the furnace from one end to the other from the furnace to chimney pipe to expel the smoke through the roof.

Drying should be carefully controlled and should not be too rapid. The harvested capsules are spread in a single layer on trays. After keeping cardamom trays in the racks curing room is closed and heating is done by burning firewood in the furnace. The hot air passes through the pipes placed a few centimetres above the floor enhances the room temperature to 45 -55 °C and this temperature status should be maintained for three to four hours. At this stage the capsules sweat and with the enhanced temperature, give off



moisture. The ventilators are opened for sweeping out water vapour from the drying fruits. Exhaust fans can also be used for the speedy removal of moisture. After the complete removal of water vapour, ventilators are closed and the temperature inside the chamber is maintained at 40-45 °C for about 18 to 24 hours. The temperature is again raised to 50 °C for another one or two hour for completing the curing process. After about 9 to 12 hours, the bottom and the top trays are rotated to enable them to receive uniform heating during the curing. It may take 24 to 28 hours to complete the curing process. When cured, cardamoms should be hard and aromatic. During the curing process cardamom should not be exposed to strong light as it bleaches them.

A hot air chamber with inside dimensions of 4.5 m x 4.5 m and a ceiling at a height of about 2.5 m is sufficient to process 2000 kg of cardamom per year. A tray 26 x 20 cm contains 3.6 to 5.5 kg green cardamom. Half cubic yard of good hard fire wood is needed to dry about 450 kg green cardamom.

Electrical drier

Different types of electrical dryers are available in the plantations and among them a

dryer with dimension of 90 cm long and 84 cm width is common. Aluminium trays (24) having a size of 81 cm length and 40 cm breadth can be pile done over the other with a gap of 2 cm between the two trays. Raw capsules (fresh) are to be spread uniformly throughout the drier by fans. It takes about 10-12 h on drying 50 kg fresh capsules by maintaining a temperature ranging from 45-50°C. The processed cardamom will have the medium green colour. The wide uses of electrical driers in the cardamom tract are still under question due to frequent power failures. Further splitting of cardamom capsules are also high compared to the conventional system.

Considering the environmental degradation due to tree felling for fuel source, many types of dryers have been developed in recent years for processing cardamom processing. In recent years, kerosene / diesel and liquid petroleum gas (LPG) used dryers are available in the cardamom tract. Indian Cardamom Research Institute of Spices Board is also engaged in developing and standardization of new technologies for cardamom processing with least quantity of firewood and alternative source of fuel which are cost

effective and eco-friendly for cardamom processors. Feasibility of using LPG as an alternate fuel for cardamom has been investigated. LPG was used with the help of two canteen type burners placed in the furnace of conventional curing house. The flue pipe was modified to promote direct transfer of hot air to the lower chamber of the curing house. It is feasible to use LPG for curing cardamom and quality and recovery was found good. It has an advantage in maintaining the temperature and humidity at desirable levels. However, cardamom processing with LPG in the existing conventional curing house may take more time compared to firewood used curing system.

Improved Driers

Further improved curing systems using LPG, kerosene and diesel as fuel source have also been encountered in the plantations. Performance of systems such as Kardi (diesel +LPG) and Zindry (diesel and firewood) were evaluated and compared conventional types with regard to their efficiency in terms of curing time duration, cost of drying, out turn of quality produce etc. Results revealed that different performance of curing systems differed with regard to the curing time, cost of drying etc.



On comparison, LPG and conventional chambers had relatively more time to complete the cardamom processing. Improved types such as Kardi and Zindry could maintain relatively high temperature inside the systems, which enables to complete the curing process with less time duration. These systems had an advantage to provide high percentage of good quality produce with respect to colour and less percentage of splits in the processed samples.

Besides colour, many other factors decide the quality constituents responsible for flavour and aroma. Moisture content, volatile oil, oleoresin, chlorophyll, total ash and acid insoluble ash contents were determined in the cardamom samples obtained under various methods of processing. All these parameters varied under different systems used for processing the cardamom samples. Moisture plays a vital role in the preservation of quality of produce on storage. Improved types like Kardi and Zindry had an advantage over other systems in maintaining low moisture levels. The Kardi and Zindry systems favoured relatively high percentage of oleoresin but low values of volatile oil. It may be due to the fact that high temperature maintained in these systems

would have led to the loss of flavour components dissolved in the soil. A perusal of the total chlorophyll content in the processed samples indicated high temperature maintained in the Zindry type drier did not affect the total chlorophyll content of the sample.

Moisture content

Moisture content of the commercial cardamom samples available in the market ranges from 7 to 20 per cent depending on the regions and mode of curing. High moisture contents leads to quality deterioration. The moisture content above 10 per cent is detrimental to the retention of chlorophyll and green colour. In general 8 to 10 per cent moisture is ideal for the retention of green colour and it is also depend on the type of curing employed.

Grading and packing

Cardamom capsules have to be polished after drying. Polishing is generally done by rubbing against the hard surface. In recent years it is done with help of machine which can be operated either manually or with electric motor. Since cardamom is a high value spice crop all care should be given for efficient processing and grading. The quality of produce is related to moisture level, clearness, appearance, colour, extraneous matter etc. Quality

specifications are restricted to attributes of physical nature and include colour, size, litre weight, freedom from microbial, insect and pest contamination. Sieves of different mesh sizes such as 6, 7, 7.5 and 8mm are available which are operated manually. Motorized machines like Carpol can also be used for polishing as well as grading of capsules. After sieving the capsules they are grouped in different grades. Agmark grades and Indian specifications or standards are on the basis of important quality factors like colour, weight per volume (litre), size and percentage of empties, malformed, shrivelled and immature capsules. About 22 separate specifications have been laid out for different qualities / types of cardamoms such as Alleppy green, Coorge green, Bleached, Half bleached, Bleached white, Mixed cardamom and cardamom seeds. After grading, cardamom capsules need to store over a period of time. Incidence of pests during storage impairs the quality of produce and therefore adequate strategies need to be evolved to minimise storage infestation. For efficient retention of green colour during storage, it is necessary that cardamom should be dried down to a moisture content of 10-12 per



cent. Use of 300 gauge black polythene lined gunny bags improves the storage efficiency. It is advisable to keep these bags in wooden boxes, which prevent damage of capsules by rodents.

Futuristic Approach

Cardamom is being processed in the conventional curing chambers in majority of plantations. However, with the introduction of improved driers like Kardi and Zindry the use of conventional curing chamber is in the declining trend. Non availability of adequate firewood for processing, lack of skilled workers and realisation of low price for the commodity processed in the conventionally curing chamber compared to the improved driers are among the few factors which warrants the employment of improved driers.

Recently efforts are being initiated to modify the conventional curing house to become more efficient and cost effective for processing cardamom. The conventional curing chamber comprises of a lower chamber and an upper chamber. The lower chamber is occupied with the flue pipes attached to the furnace. The fresh cardamom capsules are placed on the upper chamber which is ventilated and made of bricks invariably. The hot air

liberated from the flue pipes passes through the capsules placed on the upper chamber or racks through the conventional principle. The system is modified limiting the room to the half size giving provision for limiting the hot air in high intensity with the RCC ceiling of the perforated floor made to separate the lower and upper chamber. The hot air confined to a small area in the lower chamber is allowed to pass through a small hole specially made for releasing the hot air to the tank (300 kg capacity) placed on the upper chamber A tank fabricated at a size of 5x1.5 feet made of iron poles and with wire mesh at bottom will be sufficient to store 300kg fresh capsules for processing. An exhaust fan is used to blow the hot air directly to the tank placed two to three feet above the open space in which exhaust fan is fitted. Fresh capsules are loaded in the tank. The perforated bottom (made of wire mesh) permits the flow of hot air released from the lower chamber. The use of exhaust fan augments hot air flow leading to uniform drying of capsules. Care should be taken to avoid loss of heat energy through any other means for which chamber need to be properly insulated. The moisture liberated from the capsules should be released through the ventilators without settling down. Unlike in the

conventional curing chamber, the ventilators are kept opened for the speedy removal of moisture from the capsules. It is estimated that for processing about 300 kilogram capsules the exhaust fan requires an electricity of 380 W, tentatively seven to eight units as against 30 to 40 units required for operating 1.5 HP motor used in the improved driers. Through this modified technology cardamom can be processed with 18-20 hours without losing the quality (colour) by saving the fuel source to the tune of 30-40 per cent. The labour requirement is also minimal due to obvious reasons. The cost of drying may come around Rs. 2/- per kg. The conventional system can be modified with an investment of Rs.25,000 – Rs. 30,000. This technology is found to be economically viable and being practiced in many plantations. This can be treated as hybrid technology which encompasses both conventional as well as the improved technology developed by entrepreneurs recently. This technology needs to be further validated with more scientific interventions.

Radio Frequency (RF) Technology

The Society for Applied Microwave Electronic Engineering and Research (SAMEER), Mumbai has



developed RF technology for drying agriculture commodities. The principle is based on the heating property of radio frequency waves on selected material having polar structure. Moisture present in the cardamom capsules could also be removed by employing the technology. A preliminary collaborative study is initiated by ICRI with SAMEER for testing the feasibility of the technology for curing cardamom.

Conclusion

Post harvest processing of

cardamom capsules determines the colour of the capsule apart from value added products such as volatile oil, oleoresin content etc. The factors such as temperature, humidity and aeration in the curing chamber influence the quality of the produce. The cardamom industry owes a lot to many enterprising individuals and firms who have worked tirelessly to revolutionise cardamom curing so that better quality cardamom are produced by the farmers. These dryers have reduced the fuel

consumption by 40% and made the curing processes more operational friendly. Recent innovations of converting conventional curing houses to fuel efficient curing chambers is gaining acceptance due to its simplicity, user friendliness and cost effectiveness.

Like Radio Frequency (RF) technology, efforts should be made to utilise other the non-conventional source of energy like solar, wind etc so that the Alleppy Green Cardamom gets greener and sweeter.



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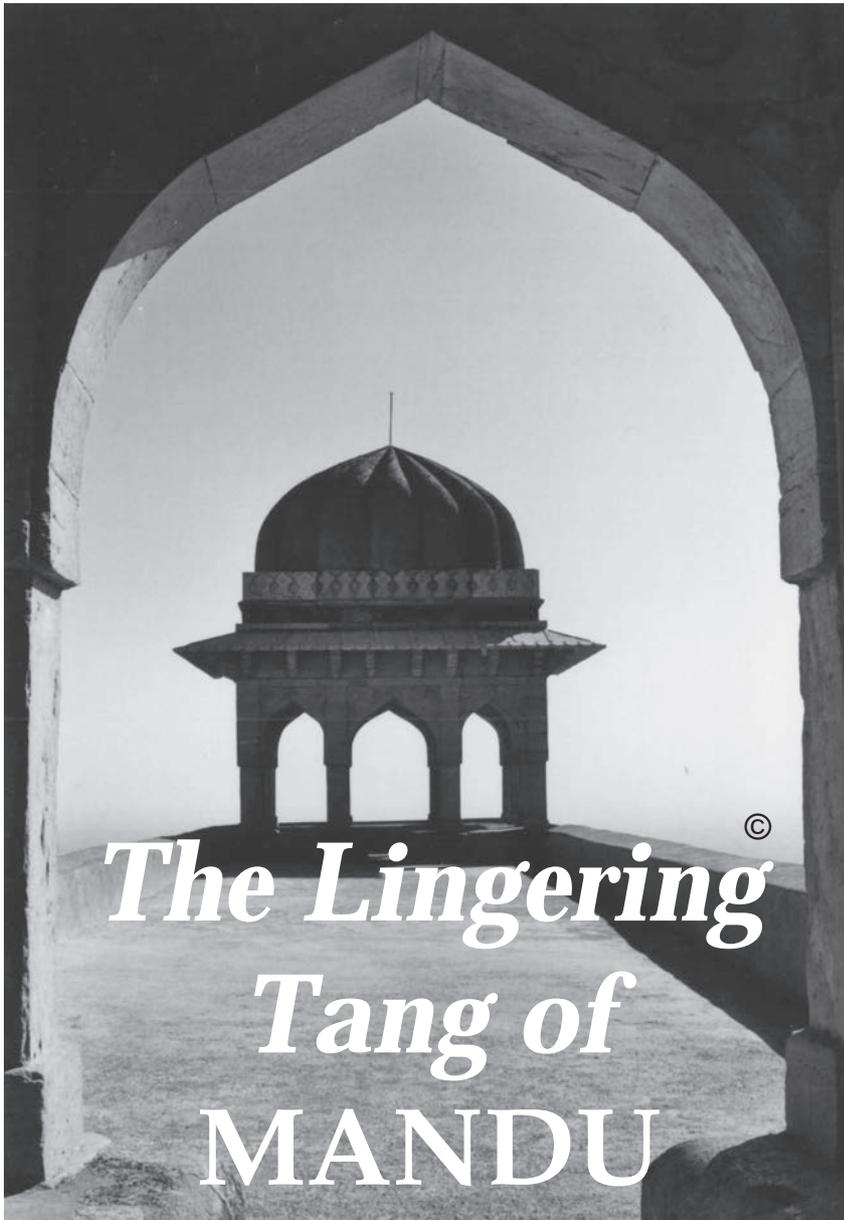
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S P I C E I N D I A





The Lingering Tang of MANDU

The beautiful Roopamati's pavilion

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History scrolled through our minds as we drove out of Indore.

Scrub lands gave way to rock-strewn, sub-montane slopes. The rugged topography could have influenced the

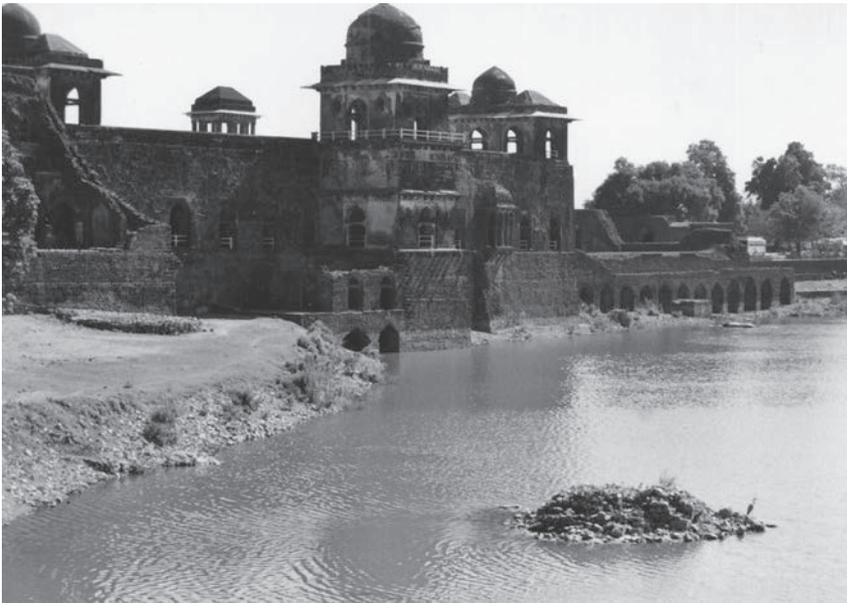
Turkish Tughlaks to appoint the Afghani Ghuris to rule this territory as their governors. Governor Dilawar Khan Ghori, sensing the declining powers of his overlords, declared himself independent of distant Delhi. When his son, Alp Khan,

ascended the throne in 1405, he went further, changed his name to Hoshang Shah, and shifted his capital to Mandu.

The great era of the plateau fortress had begun.

But Mandu is not so much a fort as it is a very exclusive pleasure resort particularly beautiful just after the monsoon. Silver streams cascade off the dark escarpment, the vegetation is lush and green and the village, which spreads all through Mandu, gives it a very humane character. The fortifications are restricted to the perimeter of this vast complex which is about seven km east to west and more than seven km north to south. Inside these frowning battlements, however, Mandu soon became a place where great Islamic emperors unwound with their concubines and courtiers and where Ghiyath-ud-Din, the ruler and pampered son of the founder of Mandu, had a seraglio of 15,000 women.

One would have imagined that Ghiyath-ud-Din would have been pre-occupied with his in-house obligations, warding off attacks by his Desperate Housewives, but he was, clearly, made of sterner stuff. He found time to build the unique Hindola Mahal: the Swing Palace. It got its name from the fact that its massive, arched, walls slope inwards like the supports of a gigantic swing. It was, probably, an audience



The Jhaz Mahal or ship palace

hall with fretted stone screens which are works of art. It is easy to imagine the king holding court, surrounded by his glittering nobles: a powerful potentate in every sense of the term!

We strolled down the main road of Mandu and to the stone stairs of the Jahaz Mahal: the so-called Ship Palace. It's a massive, sprawling, structure with squat towers, arches, pavilions and terraces. It thrusts out into a lake and, apparently, was meant to resemble a ship sailing. Clearly, the architects were not seamen! Nevertheless, the Jahaz Mahal still manages to capture an air of festivity in a rather traditional, heavy-handed, sort of way. Today, water-courses still curl with stylised formality, cupolas rise like the conical crowns of turbans, and where the tinkling

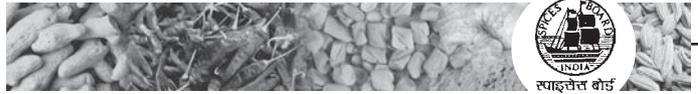
laughter of women once filled the corridors, mynahs trill before they take wing.

Both the Jahaz Mahal and the Hindola Mahal were created by the sybaritic Ghiyath-ud-Din. His father, Hoshang Shah, however, took a more serious

view of life; and of death. His tomb, some way down the road from the Jahaz Mahal, is a sombre, hulking, structure with massive, fortress-like walls and crowned with a heavy dome. It radiates implacable power and might but very little grace as if its occupant had no time for such frivolities. In fact our guide asked us to enter with our shoes. This, apparently, was the emperor's expressed wish to indicate how little he thought of his own worldly majesty and glory! There is a belief that one of the principal architects of the Taj had come to this tomb to seek inspiration for the design of that immortal memorial to love. But though his visit has, apparently, been recorded on the right jamb of the door to this tomb, the good Ustad Ahmed probably decided that the Taj should express the other end of the aesthetic spectrum!



The Hindola or swing mahal



A Colonnade in Mandu's Jami Masjid

Hoshang Shah's most majestic monument, however, rises deeper in the village: the impressive Jami-Masjid. The emperor did not live to see it completed. Nevertheless, even in its present form, it is powerful. Covering an area of 97.4 meter square it has unique acoustic properties. The voice of even the most decrepit mullah can be heard, clearly, even at the far corners of the colonnaded prayer hall. This has, probably, been achieved by the many small domes on top of the hall and it might provide a fruitful research subject for a sound engineer.

The best view of the

mosque can be had from the Ashrafi Mahal, across the road from the mosque. It was started as a school by another great ruler of Mandu, Mahmud Khalji. Then he decided to raise it to a seven-storey tower to commemorate his victory over the Rana of Mewa in Rajasthan. The revised project, however, ran short of funds. Curiously, the Rana also celebrated his victory in that battle: he decided to raise his famous Tower of Victory in Chittor and, happily, was able to complete it. 'Victory' is, clearly, a very flexible term: there are folk across the border who still believe that they won the Kargil war!

It is at this spot, at the base of the steps of the Ashrafi Mahal, that we encountered the seller of Mandu's special spice: if it can be called that. It is the gourd-like product of the massive baobab trees. The fruit of these elephantine trees, with massive, bulbous trunks, were reputed to have been brought from Africa, food for the slaves being driven to Mandu. It is said to create water in the mouth of those who chew its pulp. In all probability it causes salivation giving the illusion of water. A bystander assured us that the seeds are a good substitute for the tang of tamarind. Added a young boy, standing near him "It also gives *hausala!*" and then, seeing a puzzled expression on our faces, he translated "Courage! Courage!" We walked on, suitably instructed but we didn't risk tasting it: troubled tummies are a travel writer's doom!

Finally, we visited the Palace of Baz Bahadur and the pavilion of his beloved, Rupamati. In fact the so-called 'Rupamati's Pavilion' was really a look-out post for vigilant sentries. As for Baz Bahadur: when the Mughals invaded his territories in 1561, the timid king fled leaving Rupamati behind.

Clearly this *bahadur* hadn't imbibed the baobab's fortifying, lingering, tang of *hausala!*





HIGH YIELDING VARIETIES IN BLACK PEPPER (*Piper nigrum* L.)

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Black Pepper, known as the King of Spices, is the most important and most widely used spice in the world. The Black pepper of commerce is the mature dried berry of pepper vine, *Piper nigrum* L., a native of Western Ghats of India, which belongs to the family Piperaceae. This spice with its characteristic pungency and flavour is an ingredient in many food preparations. Pepper is a spice as well as a medicine, a sure cure for cold and fever and a component of many traditional/Ayurvedic drugs. India is the largest producer of black pepper, growing in about 1.98 lakhs hectares with an annual production of 60-65 thousands tons. Currently pepper is grown in twenty six countries. Brazil, Vietnam, Thailand, Madagascar and Sri

Lanka are the other pepper producing countries.

Cultivation in India

In India, black pepper cultivation is mainly confined to the states of Kerala, Karnataka and Tamil Nadu. Kerala is the major producer with more than 90 per cent of production followed by Karnataka and Tamil Nadu. It is also cultivated in certain pockets of other states viz., Andhra Pradesh, Pondicherry, West Bengal, Orissa, Maharashtra, Goa, Andaman & Nicobar Islands and in North Eastern States. In Kerala it is cultivated in almost all the homesteads. It is mainly cultivated on a plantation scale in districts of Idukki, Wynad and Cannanore. In Karnataka, main cultivated areas are confined to districts of Dakshina Kannada, Uttara

Kannada, Kodagu, Hassan, Shimoga and Chikmagalur areas; cultivation is mainly as inter crop in arecanut and coffee estates.

Bridging the yield gaps involves: Use of elite, improved varieties and adoption of High Production Technologies.

Cultivars

The traditional pepper growing tracts have their own popular traditional cultivars/ races named after the locality or based on plant characters or even a person who popularized the particular cultivar. There are over 60 cultivars of pepper popular among the farmers. The most important is cv. *Karimunda* because of its regular bearing, stability of yield, suitability for intercropping under varying soil and climatic conditions. The other important



Table 1. Cultivar/varieties suitable for different agro-ecological region

Agro-ecological region	Variety/Cultivars
Coastal and midland area where pepper is grown as homestead crop	Panniyur-1, Karimunda, Kalluvally, Kuthiravally, Kottanadan, Aimpiriyam, Narayakodi.
Hilly regions of Western ghats	Panniyur-1, Karimunda, Kottanadan, Aimpiriyam, Kalluvally, Neelamundi, Kuthiravally
In high altitudes (intercrop in coffee & cardamom plantation)	Panniyur-1, Panniyur-5, Karimunda, Kottanadan, Kalluvally, Aimpiriyam, Kuthiravally.
In areca gardens in the plains as a mixed crop	Panniyur-1, Panniyur-5, Karimunda, Kottanadan, Kalluvally, Aimpiriyam, Kuthiravally.
Malnad areas of Karnataka	Panniyur-1, Uddagare, Malligesara, Karimunda, Karimalligesara, Kottanadan, Aimpiriyam, Kuthiravally,

Malligesara and Uddagere (Karnataka) *Karimunda, Panniyur, Chumala* (Tamil Nadu). Cultivars/varieties suitable for different agro-ecological regions are given in Table 1.

Improved varieties:

Systematic research efforts in the last three decades, resulted in the release superior lines of black pepper varieties by hybridization/open pollination/clonal selection. Twelve improved varieties in black pepper have been released (Table 2). 7 varieties viz., *Panniyur – 1, 2, 3, 4, 5, 6* and *7* yielding between 1.27 and 2.57 tonnes/ha have been released by Kerala Agricultural

cultivars are *Kottanadan, Kuthiravally, Balankotta, Narayakodi, Aimpiriyam, Kalluvally* (Kerala) and

Table 2 : Improved varieties of pepper and their salient features.

Sl. No.	Name & Year of release	Pedigree	Yield Kg/ha (dry)	Oleoresin (%)	Essential oil (%)	Important characters
1.	<i>Panniyur-1</i> (1971)	<i>Uthirankotta X Cheriyanikanikadan</i>	1242	11.8	3.5	Suited to most pepper regions, Not suited to heavily shaded areas and high elevations.
2.	<i>Panniyur-2</i> (1989)	Open pollinated progeny of <i>Balankotta</i>	2570	10.9	3.4	Shade tolerant
3.	<i>Panniyur-3</i> (1989)	<i>Uthirankotta X Cheriyanikanikadan</i>	1953	12.7	3.1	Late maturing, suited to all pepper growing regions.
4.	<i>Panniyur-4</i> (1989)	Clonal selection from <i>Kuthiravally</i>	1277	9.2	2.1	Reported to perform well under a variety of conditions, stable yielder.
5.	<i>Panniyur-5</i> (1993)	Open pollinated progeny of <i>Perumkodi</i>	1098	12.3	3.8	Tolerant to nursery diseases and shade.



Sl. No.	Name & Year of release	Pedigree	Yield Kg/ha (dry)	Oleoresin (%)	Essential oil (%)	Important characters
6.	<i>Panniyur-6</i> (1999)	Clonal selection from <i>Karimunda</i>	2127	8.3	1.3	More number of spikes per unit area, close setting of berries with attractive bold green colour.
7.	<i>Panniyur-7</i> (1999)	Open pollinated seedling progeny of <i>Kalluvally</i>	1410	10.6	1.5	Tolerates adverse climatic conditions. The vine is vigorous, hardy and a regular bearer.
8.	<i>Subhakara</i> (1990)	Clonal selection from <i>Karimunda</i>	2352	12.4	6.0	Suited to all pepper growing regions, high quality.
9.	<i>Sreekara</i> (1990)	Clonal selection from <i>Karimunda</i>	2677	13.0	7.0	Suited to all pepper growing regions, high quality.
10.	<i>Panchami</i> (1991)	Clonal selection from <i>Aimpiriyan</i>	2828	12.5	3.4	Late maturing type, suited to all pepper growing regions.
11.	<i>Pournami</i> (1991)	Clonal selection from <i>Ottaplackal</i>	2333	13.8	3.4	Tolerant to root knot nematode.
12.	<i>PLD-2</i> (1995)	Clonal selection from <i>Kottanadan</i>	2475	15.5	3.4	Suited to all pepper growing regions, high quality

University, Panniyur, Kerala. The Indian Institute of Spices Research have released four varieties viz., *Sreekara*, *Subhakara*, *Panchami* and *Pournami* with an yield ranging from 2.3 to 2.8 tonnes/ha. the Central Plantation Crops Research Institute, Regional Station, Palode released a variety PLD-2 with a yield potential of 2.4 tonnes/hectare Among the pepper varieties *Panniyur-1*, *Panniyur-3*, *Panniyur-7* are hybrids having bold berries. *Panniyur-2* and *Panniyur-5* grow well in mixed cropping system. The yield of

Panniyur-5 is stable even under drought. Of the four improved varieties released by IISR, *Subhakara* and *Panchami* grows well under all conditions.

Pournami is a nematode tolerant line. *PLD-2* is a high quality variety with 15.5 per cent oleoresin.



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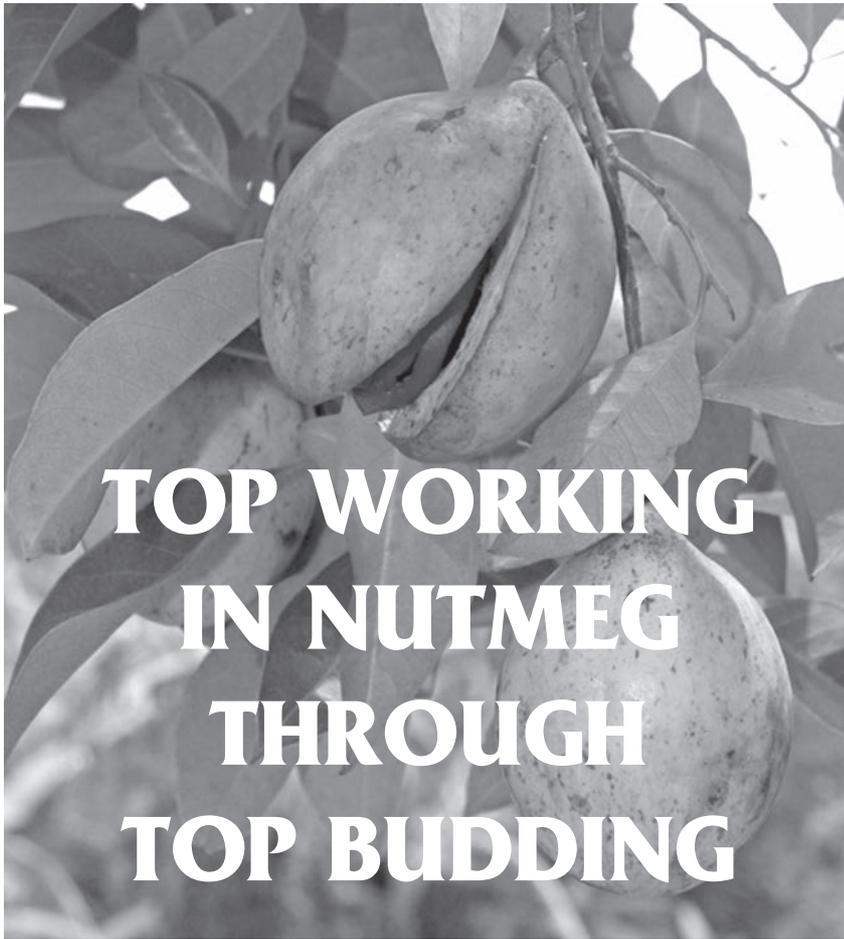
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TOP WORKING IN NUTMEG THROUGH TOP BUDDING

**J. REMA,
P.A. MATHEW &
B. KRISHNAMOORTHY**
Indian Institute of
Spices Research,
Calicut, Kerala

six-seven years when they begin to flower. The male and female trees are produced in the ratio 1:1 which means that about 50 per cent of the trees propagated by seedlings turn out to be male. Male trees are essential in a nutmeg population for pollination. One male tree is sufficient for every 10-15 female trees for pollination and the rest of the male trees available would be unproductive.

These unproductive trees available in the plantation can be made productive by converting them to female trees by top working. Top working could also rejuvenate the low yielding female trees. A simple technique standardized at Indian Institute of Spices Research, Calicut, for converting unproductive male and low yielding female trees by top budding is described here.

Nutmeg, *Myristica fragrans* Houtt. is a dioecious crop which produces two distinctly different spices, namely nutmeg and mace. Nutmeg is cultivated in Kerala, Tamil Nadu, Karnataka, Maharastra and in small quantity in Andamans and Nicobar Islands. Nutmeg is the dried kernel of the seed and mace is the dried aril surrounding the seed. Besides nutmeg and mace, the crop is also valued for the oil, and

oleoresin present both in the nut and mace and for the nutmeg butter.

Nutmeg is commonly propagated through the seeds. This is not an ideal method for commercial multiplication because of its dioeciously nature. Identification of sex of nutmeg at the seedling stage is not feasible with the available techniques and if seeds are used for propagation the sex of the tree can be identified only after



Preparation of old trees for budding

Male trees sufficient for pollination of female trees are left in the nutmeg garden at the rate of one male tree for every ten female trees. Care should be taken to see that the male trees left for pollination are uniformly distributed in the garden for effective pollination. Male trees of nutmeg are beheaded leaving the first tier of branches on the tree during April - May after leaving a few branches below, just before the monsoon season and the cut end is smeared with Bordeaux mixture paste to prevent fungal infection and decay. The decapitated trees are irrigated regularly till the onset of monsoon. New shoots develop from the main trunk within 45-60 days. The newly emerged shoots are ready for budding when they attain about 4.5 to 5.0 cm girth diameter or little more than the diameter of a pencil. Budding can be done on two or three newly emerged strong shoots.

Scion bud preparation

Brown dormant buds from orthotropic shoots (direct shoots turning from green to brown) of high yielding female

trees of nutmeg collected on the same day of budding are used for budding. Patch or flap budding could be used for budding. A peeling test on the shoot has to be done before budding. If the bud peels or separates easily from the wood, budding can be done. The outer bark along with the bud about 1½ inch long is removed from the scion by giving straight cuts both horizontally and vertically just before budding.

Preparation of rootstock

Budding has to be done on the new shoot developed on the decapitated trees above the first jorket. The stock also should be active and the bark has to peel off easily. Though budding can be done through out the year budding during August to September is ideal. Care should be taken to place the bark correctly with the bud upwards. Also take precaution to prevent bud from drying, injury or from contamination.

Remove the outer bark a little more than the size of the bark to be inserted at the internodal region by giving three cuts two vertically and one horizontally on the rootstock and lift the bark as a flap. The bud is inserted under

the flap and is secured tightly with a polythene strip. Patch budding can also be done and covered with a polythene strip enclosing the bud. The polythene strip is removed after 22 - 27 days after budding by which the union would have taken place and the flap is removed exposing the bud. After successful union the top portion of the shoot of the stock plant is cut two-three inches above the bud. Bordeaux paste is applied on the cut surface. This forces the bud to grow. If any other bud other than the budded one develops remove them immediately.

If budding fails re budding can be done on a different shoot. This technique ensures 50-60 per cent success.

Top working can be used for

1. Converting unproductive male trees to female.
2. Converting low productive female/bisexual trees to high yielders.
3. For budding with trees with certain identified/specific characters.
4. *In situ* budding for raising plantations.





KARNATAKA CARDAMOM PLANTERS- GET YOUR SOIL TEST DONE AT ICRI DONIGAL

I.R. Noolvi and Sreekrishna Bhat
ICRI, Regional station, Sakaleshpur

SOIL TESTING is most important aspect in Agriculture. It provides precise information about the fertility of the soil for making fertilizer recommendation. Needed quantities are applied of the right kind at a minimum cost. Balanced application of nutrient will ensure a better economic return to the planting community.

METHOD OF COLLECTION OF SOIL SAMPLE:

Only 5 to 10 grams soil is used for each soil to 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 to be taken care.

1. Sample should be collected from field once in three-four years and it should be 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 packets should be sampled separately.

3. Soil sample should be taken from root zone in the row, leaving 30 cm from the plant base.
4. The selected site should be cleaned from weeds, dry leaves and other mulch materials.
5. With the help of a spade (mammatty) soil can be cut in an angle from both sides which will form a 'V' shape pit at a depth of 15 cm and the cut soil should be removed.
6. With the help of knife, soil should be scrapped from the sides of 'V' shaped pit in a thin layer along the cuttings in full depth.
7. From each plot around 10 samples may be collected diagonally and all these samples should be gathered in to 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 drying diagonal and discard any opposite two quarters and again mix the remaining two quarters. Do the same process 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 tide properly. Planters name and address and field number may be given in a small piece of paper and kept inside the pack. For each five acre of land one sample should be send to ICRI DONIGAL as soon as the soil is collected.

PRECAUTIONS WHILE COLLECTING THE SOIL SAMPLES:

1. Avoid contaminations by keeping soil samples away from stored fertilizers.
2. Avoid areas recently fertilized, old trenches, marshy spots, near trees, compost pits etc.
3. Avoid taking samples between rows.

All planting community of cardamom growing area in Karnataka are requested to contact ICRI, RRS, Sakaleshpur for analyzing their samples at free of cost so that fertilizer use efficiency can be achieved and reduce the cost on fertilizers.

The address is given below:

Scientist in charge,
ICRI, RRS, Sakaleshpur
Donigal Post- 573 134
Phone: 08173-244281

E Mail- sbicriskp@gmail.com ☆





VIRAL DISEASES OF CARDAMOM AND THEIR MANAGEMENT

K. Dhanapal , Joseph Thomas*
Sreekrishna Bhat and J. Thomas*

ICRI,Regional Research Station,
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* - Indian Cardamom Research Institute,
Myladumpara, Kerala-685 553

The productivity of cardamom is limited by several soil borne fungal diseases. These diseases can be controlled by plant sanitation methods coupled with fungicide and bioagent application. But this crop is also affected by three different types of viral diseases which cause plant damage and crop loss. These viral diseases are (1) Katte or Mosoic (2) “Kokke Kandu” or Hooked Tiller disease and (3) Niligiri Necrosis. Niligiri Necrosis has been reported from Niligiri (Uthagamandalam) region of Tamilnadu and few plantations in Kerala. This disease has been disappeared from plantations followed by systemic control measures. The spread of katte is limited in Kerala region followed by systemic rouging

Symptoms of Katte

Visible symptoms appear on the youngest leaf in the form of chlorotic flecks which develop into pale green discontinuous stripes. These stripes of alternate light green areas are arranged parallel to the veins from the midrib to leaf margin. Leaves emerging after infection show characteristic mosaic pattern. Mosaic type of mottling is seen

on the leave sheaths and pseudostem also. The disease is systemic and spread to all tillers of infected clump. In advance stage of infection, reduced leaves and short slender tillers are produced. Panicles will be shorter and they produce only few capsules. Infected plants never die but continuous to serve as inoculum for further spread of the disease. When the grown up plant is infected with Katte virus and clearly expressed the symptom, the plant continuous to grow and give yield on a reduced rate for three-five years.

The Causal agent and its transmission

Katte disease has been reported as a viral disease caused by Cardamom Mosaic Virus (Car MV) which belongs to potyvirus group (Poato Virus -Y group). The virus particle is extremely small: they are flexuous rod shaped infectious nucleoproteins, which can easily pass from on cell to another. The virus is systemic in infected plants and causes mosaic symptoms on leaves and tillers. The disease spread only by planting of infected rhizomes. It is not transmitted through seeds, but this disease is transmitted by

the banana aphid *Pentalonia nigronervosa f. caladii* which feed on infected and healthy plants. The virus carrying aphids (viruliferous aphid) transmit the disease within a very short time to healthy plants in a non-persistent manner to semi-persistent manner. Even a single viruliferous aphid can transmit the disease by feeding in infected and then for 10 minutes feeding on healthy plants. There is no incubation period for the virus within the insect vector's body, but there is an incubation period for the virus within the host plant which varies 20-114 days. Mosaic affected plant contains active viral particles in all plant parts except in mature seeds. Different strains of Katte virus which cause variations in the type of mosaic symptoms have been reported. These strains cause mild to sever mosaic symptoms and result in crop loss.

Occurrence of Katte disease in plantations of Karnataka and Tamilnadu

A random survey was carried out in sample plot of 37 numbers of cardamom plantations of Karnataka where



the incidence and spread of these diseases were reported in a severe stage. These include seven plantations in Mudigere area, five in Hanbal area, 17 in Saklespur and Hongedehalla area and eight plantations in Somwarpet area. Most of the plantations were in a neglected condition and the incidence of Katte disease ranged from 10 - 99 per cent. It was noticed that in all these areas, there was no proper management of plantations; manuring, irrigation and weeding. Plant protection operations such as trashing the plants, spraying of fungicides and insecticides are lacking in this area. The Katte infected plants were not removed and destroyed. Since the affected plants remaining in the field itself, the spread of the disease was faster due to aphid activity. This is resulted in a situation where the infection level has reached almost 95 - 100 percent. It is interestingly recorded that the katte incidence totally absent in ICRI,RRS,Farm, Sakleshpur. The main reason is regular monthly survey and rouging are undertaken for eradication of this disease. In Tamilnadu region, the incidence of Katte was recorded in Adalur , Pandrimalai and few areas in Anamalai hills.

Cardamom vein clearing disease or " kokke kandu" or hooked tiller

This is distributed in almost all areas of cardamom growing tracts of Karnataka only. Symptoms appear as continuous or discontinuous intraveinal clearing, rosetting of

leaves, loosening of leaf sheath, shredding of leaves, mottling on tillers. Shoot tip often bent or hook shaped. Youngest leaf entangles in older leaves. As advance stage of this disease stunting of tillers, decline in plant health and yield, short panicles, poor bearing, partial sterility of seeds are also observed. A random survey was carried out in sample plot of 37 numbers of cardamom plantations of Karnataka where the incidence and spread of these diseases were reported in a severe stage. The incidence of Kokke Kand disease was also reported to be higher, but in the present survey, it was seen only in two plantations in the sample study. It is interestingly observed that this incidence is totally absent in ICRI,RRS,Farm, Sakleshpur. The main reason is regular monthly survey and rouging undertaken for eradication of this disease. Planters can follow this practice for controlling viral diseases.

Cardamom necrosis (Nilgiri necrosis)

This disease was first reported from Nilgiris of Tamilnadu. At present this disease is restricted to some areas Munnar, Suryanelli (Kerala), Nilgiris, Anamalai (Tamilnadu) Biligiri Rangan hills (Karnataka). The symptom appears as elongated disrupted parallel lines or spots of white to yellowish shades alternates with green tissues). Some of these may turn into reddish brown in color. In advance of this disease severe stunting of tillers, distortion and

shredding of leaves, reduction of size in leaf, panicles and capsules will be noticed. Plants stop yielding and perish slowly.

Management of viral diseases in cardamom plantation

All cardamom cultivars are susceptible to the disease. Affected plants cannot be cured by any chemical treatments. Hence indirect methods are to be adopted to manage the disease.

The following are the important steps to control the spread of viral diseases

- Take-up regular survey in plantations to trace katte affected plants
- Rogue the affected plants: remove them as soon as they are traced
- Repeat tracing and removal of affected plants in three months
- Use healthy disease free seedlings for new planting
- Avoid rhizome planting using clumps taken from katte affected plantations
- Avoid transportation of infected materials
- Avoiding raising nursery near diseased areas
- Destruction of collateral host plants of the *Zingiberaceae* family
- Planting of virus resistant/ genetically transformed plants
- Vector control through spraying of suitable insecticides.

Proper management of plantations; manuring, irrigation and weeding should be undertaken. ☆





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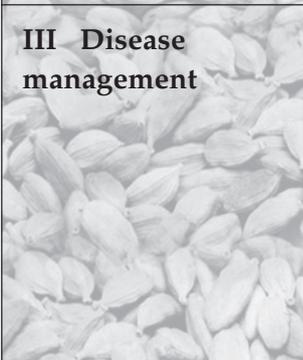
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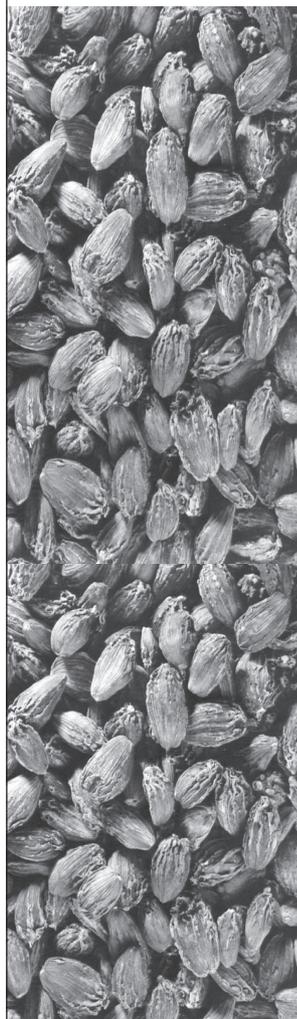


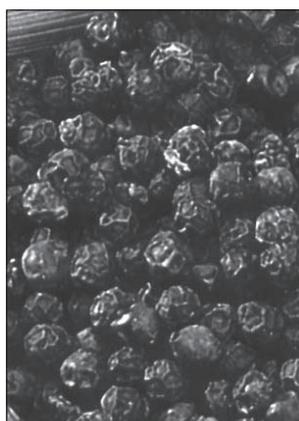
CALENDAR OF OPERATIONS FOR IMPORTANT SPICES - MARCH 2009

Timely planning and execution of farm operations based on agro-climatic conditions of the area is important for successful farming for higher productivity and sustainability. To facilitate this calendar of operations in respect of important spice crops for March is given below.

Name of the crop/ Type of operation	Details of the operations
<p>CARDAMOM I Agronomic measures</p> 	<p>NURSERY</p> <ul style="list-style-type: none"> ➤ Regular watering may be given to bed/polybag/ sucker nursery based on necessity. ➤ To control damping off/seedling rot diseases in nursery, soil drenching with 0.2 per cent copper oxychloride or 0.2 per cent mancozeb may be taken up. ➤ As bio-control measure, trichoderma or Pseudomonas or Bacillus species may be applied in the soil. ➤ For controlling leaf rot disease, spray 0.3 per cent mancozeb and for controlling leaf spots, spray 0.25 per cent difoltalan or 0.2 per cent bavistin after noticing early symptoms. <p>MAIN FIELD</p> <ul style="list-style-type: none"> ➤ Continue irrigation based on necessity wherever irrigation facility is available. ➤ Light pruning may be done by way of removing only the hanging dry leaves and sheath. This will facilitate better pest control even at low spray volume of pesticide.
<p>II Pest management</p> 	<ul style="list-style-type: none"> ➤ For Integrated Pest Management prune dry leaves without removing green leaf sheath. ➤ Apply monocrotophos @ 200 ml per 100 liters of water (spray may coincide shoot borer moth emergence).
<p>III Disease management</p> 	<ul style="list-style-type: none"> ➤ Keep constant vigil for any katte virus/kokke kandu affected plants to uproot and destroy, if found. ➤ For controlling leaf rust and chenthal & leaf spots, spray 0.25 per cent Mancozeb or Companion (two to three rounds – 30 days interval). ➤ If symptoms of stem lodging are noticed, spray 0.2 per cent Bavistin on pseudo stem. ➤ Root rot and leaf yellowing can be controlled by foliar spray and soil drenching with 0.2 per cent Bavistin or Carbendazim + Mancozeb.



	<ul style="list-style-type: none"> ➤ If symptoms of capsule brown spot (Anthracnose) is noticed, spray with 0.2 per cent Bavistin.
<p>IV Harvest and post harvest operations</p> 	<ul style="list-style-type: none"> ➤ Continue harvesting with a gap of 25-30 days depending upon the maturity of the capsules. ➤ Harvest only the matured capsules for getting better out turn. ➤ Always store the cured cardamom capsules at 10 per cent moisture in 300 gauge black polythene lined gunny bags inside wooden box to retain green colour and quality.
<p>LARGE CARDAMOM</p> 	<p>Nursery</p> <ul style="list-style-type: none"> ➤ Regular watering may be done in the sucker nursery with available water resources depending on moisture status in the soil. ➤ Dried or powdered cattle manure/organic manure/topsoil may be applied in the nurseries for healthy growth of suckers if not applied so far. ➤ Disease/pests infested suckers may be removed and destroyed. ➤ One round weeding may be attended followed by forking of soil at plant base and then plant base should be covered with top soil and then mulched. <p>Plantation:</p> <ul style="list-style-type: none"> ➤ Large cardamom plants may be irrigated at regular intervals with available water resources, depending on rainfall and moisture status in the soil. ➤ Chirke and Foorkey infected plants may be destroyed by uprooting/burial at regular intervals in the pits. ➤ Regular inspections may be carried out to observe caterpillar/shoot borer/shoot fly incidence if any and may be hand picked and destroyed mechanically. ➤ Application of cattle manure/compost/organic manures will help in getting sustained production, improving productivity and quality of the crop. ➤ One round weeding followed by mulching may be carried out to conserve soil moisture if it is not done earlier. ➤ All the aged/diseased/unproductive cardamom plants may be uprooted and destroyed and the cardamom field may be kept ready for marking lines, opening pits, so that timely replantation/gap filling operations can be taken soon after getting the rains. ➤ Arrangements may be made for getting good shade tree saplings for planting in the open/poor shaded areas.
<p>PEPPER I Agronomic measurers</p>	<p>Nursery</p> <ul style="list-style-type: none"> ➤ If preparation of pepper cuttings for propagation was not done last month, carry out the same as detailed below.

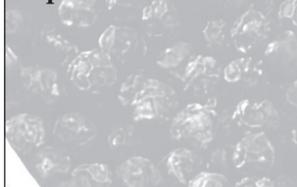


- Runner shoots already marked and coiled on wooden pegs removed. Then cut them into bits with two-three nodes by rejecting the over matured and immature portion of the vines.
- Plant these cuttings in polythene bags of 6"x4" filled with top soil, sand and farm yard manure in 3:1:1 proportion. Provide adequate holes in the polybags in the lower half of the bags.
- Arrange the polybags inside a pandal and irrigate regularly.

Main field

- Wherever irrigation facilities are available, start irrigating the plants once in a week by hose irrigation or daily by drip irrigation.

II Post harvest operations



- Continue harvesting by observing the right maturity indicated by the colour change in one or two berries in a spike from green to orange or red.
- Always ensure threshing of pepper either by manual method or using mechanical pepper thresher hygienically.
- For drying use only clean floor made of concrete, clean bamboo mats or polythene sheets to get quality final produce.

VANILLA



- Irrigation to be continued based on weather condition and necessity.
- Always ensure adequate mulch material at the base preferably with partially or fully decomposed organic debris.
- Tying of vines with the standard to be continued based on necessity.
- Pollinate the flowers manually with the help of skilled labourers between 6.00 a.m. to 1.00 p.m. on the day of opening of the flower.
- Look out for any vanilla vines exhibiting viral symptoms and remove such vines immediately and destroy.

CHILLI
I Agronomic measures

- Irrigation to be continued based on necessity and soil type.

II Pest management



- Collection of egg masses/early instar larvae of caterpillars found in groups may be done manually and destroy them.
- Erect pheromone traps for monitoring pod borers 6" above crop level @ 5 per hectare. Change the pheromone cards once in 15 days for better results.
- Spray Need Seed Kernel Extract (NSKE) five per cent or *Bacillus thuringiensis* var *kurstaki* (bio control agent) @ 500 grams/hectares for control of early instar larvae of pod borers.

III Harvest and post harvest operations

- Harvest the ripe chilli fruits and dry in clean concrete floor, polythene sheets or cement yards with intermittent turnings.
- The optimum moisture content of dried produce is 10 per cent for safe storage without any mould problem.



	<ul style="list-style-type: none"> ➤ Wherever possible use mechanical chilli drier or solar poly house driers to avoid any contamination likely to arise on open drying.
FENNEL (Kharif transplanted)	<ul style="list-style-type: none"> ➤ Harvesting of umbels may be done when they become fully matured and turn into yellowish green colour. ➤ Threshing, drying, processing and packing may be done under clean and hygienic condition. ➤ Cleaning and grading of the produce is beneficial to fetch good prices. ➤ Storage may be done in the godowns free of rodent, insects, etc. to protect the produce from contamination.
FENNEL (Rabi transplanted)	<ul style="list-style-type: none"> ➤ Harvesting of umbels may be done when they become fully matured and turn into yellowish green colour. ➤ Threshing, drying, processing and packing be done under clean and hygienic condition. ➤ Cleaning and grading of the produce is beneficial to fetch good prices.
FENNEL (Rabi drilled)	<ul style="list-style-type: none"> ➤ Harvesting of umbels may be done when they become fully matured and turn into yellowish green colour. ➤ Threshing, drying, processing and packing may be done under clean and hygienic condition. ➤ Cleaning and grading of the produce is beneficial to fetch good prices.
CUMIN 	<ul style="list-style-type: none"> ➤ Harvesting may be done in the early morning hours to prevent shattering of seeds. ➤ Threshing, drying, processing and packing may be done under hygienic condition. ➤ Cleaning and grading of the produces may be done to fetch good prices. ➤ Storage may be done in the godowns free of rodent, insects etc. to protect the produce from contamination.
FENUGREEK 	<ul style="list-style-type: none"> ➤ Crop may be harvested, threshed, dried and packed. ➤ Produce may be cleaned and graded to fetch good prices. ➤ Cleaned and graded produce may be stored for favourable market and to fetch good prices.
CORIANDER 	<ul style="list-style-type: none"> ➤ Crop may be harvested, threshed, dried and packed. Produce may be cleaned and graded to fetch good prices. ➤ After harvest, the crop may be dried under partial shade to retain the green colour and its aroma. ➤ Cleaned and graded produce may be stored for favourable market and to fetch good prices.
CELERY	<ul style="list-style-type: none"> ➤ Irrigation may be given at 15-20 days interval.



MONTHLY AVERAGE PRICES OF SPICES FOR JANUARY 2009

SPICE	CENTRE	GRADE	PRICERS/KG	
Black Pepper	Kochi	Ungarbled	114.96	
		Garbled	120.35	
Cardamom small (Auction)	Vandanmettu	bulk	470.57	
		Bodinayakanur	bulk	458.19
			Saklaspur	414.39
			Sirsi	389.17
			Maharashtra	489.02
Cardamom (L)	Siliguri	Badadana	149.35	
		Chotadana	126.90	
Chillies	Virudhnagar		51.75	
Ginger (Dry)	Kochi	Best	98.00	
		Medium	90.00	
Turmeric	Kochi	Alleppey Finger	46.50	
	Bombay	Rajpuri Finger	72.00	
	Bombay	Duggirala	41.88	
Coriander		Indori	54.50	
		Kanpuri	61.00	
		4%	100.34	
Cumin	Bombay	-	60.63	
Fennel	Bombay	-	30.88	
Fennugreek	Bombay	-	36.21	
Mustard	Chennai	-	11.00	
Garlic	Bombay	-	52.75	
Celery	Bombay	-	280.00	
Clove	Cochin	-	142.88	
Nutmeg(with shell)	Cochin	-	245.58	
Nutmeg(without shell)		-	470.77	
Mace	Cochin	-	69.83	
Cassia	Chennai	-	830.00	
Vanilla*				

SPICES SOURCES

Average FOB export price -December 2008

Prices are collected from secondary sources like Agricultural Produce Market committees, Kirana Merchants Association, India Pepper and Spice Trade Association, Licensed Cardamom Auctioneers etc.

ALL INDIA CARDAMOM AUCTION SALES AND PRICES FOR JANUARY 2009 COMPARED WITH JANUARY 2008

PERIOD	JANUARY 2009		JANUARY 2008	
	Quantity sold (Kg)	Average price (Rs./Kg)	Quantity sold (Kg)	Average price (Rs./Kg)
First week	2,16,592	445.40	1,32,287	574.49
Second week	2,91,316	446.20	1,22,221	597.46
Third week	39,431	429.91	43,630	606.79
Fourth week	2,63,635	480.15	1,17,987	614.79
Total	8,10,974	456.23	4,16,125	596.05

Source: Auction reports received from Licensed Cardamom Auctioneers





AVERAGE INTERNATIONAL SPOT PRICES FOR JANUARY 2009

SPICE	MARKET	GRADE	(USD/KG)	(RS/KG)
Black Pepper	U.S.A	MG-1	2.87	140.14
White Pepper	U.S.A	Muntok	4.54	221.69
Cardamom(Small)	Saudi Arabia	India Asta Extra Bold	13.22	645.53
Chillies	U.S.A	India S4	2.32	113.29
		Chinese Small	1.94	94.73
Ginger(Dry)	U.S.A	Chinese Sliced	1.92	93.75
Turmeric	U.S.A	AFT 5..50 Curcumin	1.87	91.31
Coriander	U.S.A	Canadian	1.52	74.22
Cumin	U.S.A	Indian	2.69	131.35
Fennel		Egyptian fancy	1.65	80.57
Fennugreek	U.S.A	Ind/Turkey	1.15	56.15
Clove	U.S.A	Mad/Zan/Com	4.72	230.48

AVERAGE IMPORT PRICE OF VANILLA IN TO USA

GRADE/ORIGIN	MARKET	NOVEMBER' 08 US \$/KG
Madagascar	USA	23.97
Indonesia	USA	16.79
India	USA	16.30
Uganda	USA	21.53

Exchange Rate 1 US \$ = Rs. 48.83

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