

Black Pepper

Botanical name: *Piper nigrum*

Useful plant part: Fruits / Berry

Introduction: Pepper is the most important of all spices and popularly known as the “*king of spices*’. Black pepper is a dried mature fruit of perennial ever green climbing woody vine. It is one of the most important earliest known spices produced and exported from India. It is the most valuable and important foreign exchange earner among the important spices earning nearly 50% of the total export earnings from all the spices. Because of its importance in the spices and unique position in trade and large share in export earnings, it is popularly referred as *king of spices* and *black gold* in trade.

Uses: Black pepper is used for a variety of purposes. One of the principal values of Pepper is its ability to enhance the seasoning of dishes. It is valued for its characteristic aroma, hot pungent and biting taste and is mainly used for flavouring and seasoning. It is largely used as preservative by meat packers and in canning, pickling and baking confectionery and preparation of beverages. Oil and black pepper is a valuable adjunct in flavouring of certain beverages and liquors. The oil absorbed in soaps and in perfumes. It is considered as a powerful remedy for various disorders such as dyspepsia, malaria, and delirium treatments. The aromatic odour of pepper is due to an essential oil, while the pungency is due to oleoresin. The Egyptians used it for embalming. The Asians are said to have used it as an aphrodisiac. It is extensively used in Ayurvedic medicines and pharmacological studies. Alcoholic extract of black pepper was found to be highly toxic to several weevils on stored food products. Pepper extract acts as an effective repellent. The alkaloid ‘*piperine*’ is considered to be the major constituent responsible for the bitter taste of black pepper, it is absent in the leaves and stems. *Piperine* has insecticidal effect on its own.

Area and production: Outside India it is grown in Srilanka, Malaysia, Indonesia, Brazil Mexico, China, Thailand and Madagascar. India accounts for 54% of the total area under pepper in the world but its share of production is only 26.6% whereas the other countries like Brazil, Indonesia, Malaysia accounts for lesser percentage of area but with more share in the total production due to their higher productivity. In India pepper cultivation is confined to southern states only. It is grown mainly in Kerala (96% area), Karnataka, Tamil Nadu and Pondicherry. Since, ancient times pepper is exported from India. On an average of 85% of the pepper produced in the country is exported to USA, Canada and Italy. Till 19th century India enjoyed monopolistic position in the world market. However now India lost its top position due to low productivity, poor yield and raise of Indonesia and Malaysia countries.

Botany and taxonomy

Family: Piperaceae

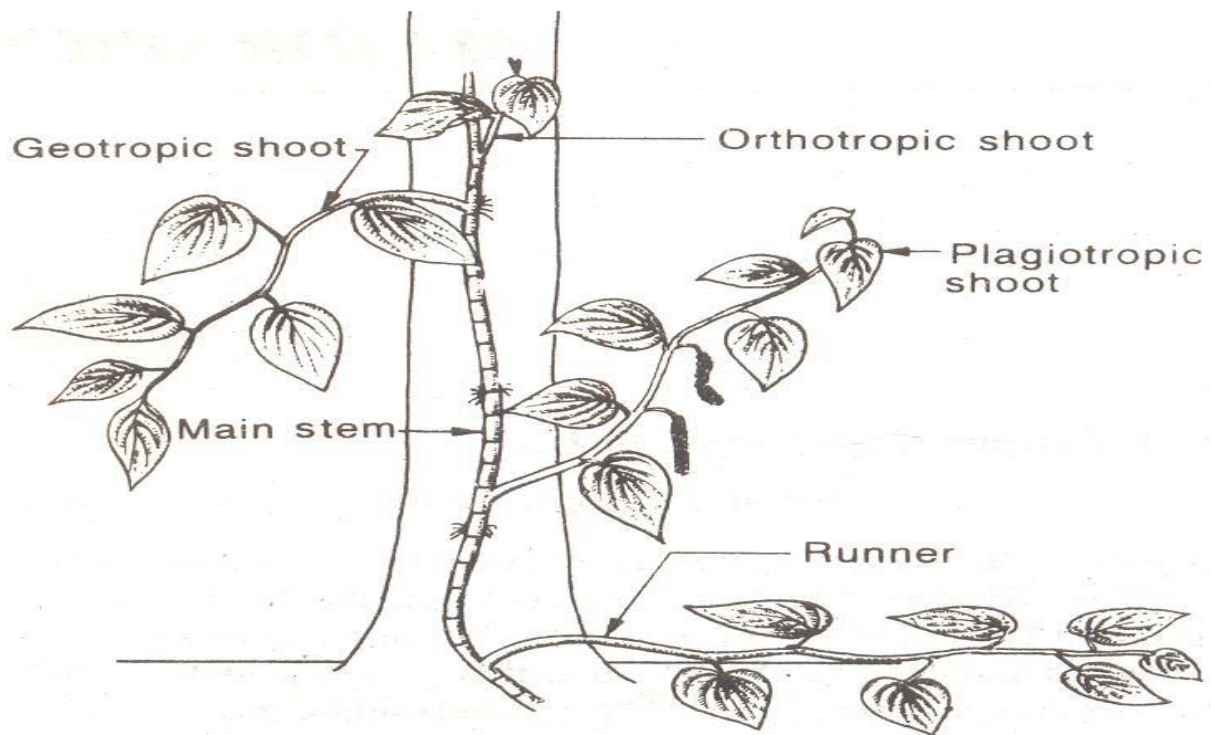
Genus: *Piper*

Species: *nigrum* Linn.

Chromosome No. : $2n=2x=52$

Origin: western Ghats of South India (Malabar)

Botany: Black Pepper is an evergreen perennial woody climber reaching to a height of 10 m or more. It has extensive but shallow root system. The vines branch horizontally from the nodes but do not grow longer. Based on the growth habits, morphological characters and biological functions, five *distinct types* of stem portions can be defined in the shoot system of a pepper vine.



Branching in Pepper

1. **Main stem:** It originates from a seed or from a stem cutting. It climbs on a support with the aid of aerial or adventitious roots.
2. **Runner shoots:** They are produced from the basal portion of the main stem, growing at right angle to the main stem, usually restricted up to 50 cm from the ground.
3. **Fruiting branches (plagiotropics):** They are produced from the nodes of the main stem and they grow laterally more or less at right angles to the main stem, bearing the spikes.
4. **Topshoots (orthotropics):** Vegetative shoots which arise on the top portion of the main shoots. It gives a bushy appearance with stouter, thicker internodes and with large number of adventitious roots at the nodes. They are used for the *propagation*.
5. **Hanging shoots (geo tropics):** In a fully grown vine, some of the plagiotropics at the top portions are seen to give rise to special type of shoots which hang down and grow geotropically. Leaves are broadly lanceolate, alternate, simple, dark green and shiny above, pale green and gland dotted under neath. Size and shape vary according to the variety. The inflorescence is a *catkin*. Born on opposite side to the leaves on plagiotropic branches, 5-15 cm long, bearing 50-150 minute flowers. The flowers are monoecious or dioecious or hermaphrodite (bisexual) forms occurs in different varieties.

High yielding forms should have more percentage of bisexual flowers and in cultivated varieties these plants will be more than 80%. Male flowers are very few 1-19% in different varieties. The fruit is a single seeded berry, sessile, small globose or oval. It has thin pulpy pericarp around the seed. It takes approximately 6 months to mature after flowering. Each spike produces 50-60 fruits. The skin (exocarp) turns from green to red on ripening and black on drying.

Soil: Pepper can be grown in a wide range of soils such as clay loam, red loam, sandy loam and lateritic soils with a pH of 4.5 to 6.0. It thrives better in soils rich in organic matters.

Climate: Pepper is a tropical plant it requires warm & humid climate for commercial production. It grows successfully between 20° N and South latitude and from sea level up to 1500 m above MSL. The crop tolerates temperature between 10°C to 40°C. But it requires an

optimum temperature of 25 to 35 degrees Celsius. A well distributed annual rainfall of 125 to 200 cm is considered ideal for pepper. Prolonged droughts stop the vegetative growth of the vines.

Varieties: More than 75 cultivars of pepper are being cultivated in India. Majority of the cultivated types of Pepper are monoecious.

Karimunda: Most popular variety throughout Kerala. A prolific and regular bearer. Dry recovery is 35%. Yields good quality of Pepper. Suitable for *intercropping as well as for high density cropping*.

Kalluvally: This is grown in North Kerala. It is hardy and regular bearer. It withstands water stress and is *moderately tolerant to Phytophthora wilt*. Spikes are medium long and have a characteristic twisting due to very thick setting. Driage is 40%. It is grown either alone or mixed with other cultivars.

Recently a number of improved cultivars have been evolved and released. They are Panniyur 1, 2 (Krishna), 3 (Shima), 4, 5, 6 and 7: released from Kerala Agricultural University, Pepper Research Station, Panniyur.

IISR Thevam, IISR Malabar Excel, IISR Girimunda, IISR Sakthi, PLD-2

- Lower elevation and less shady areas- Panniyur 1
- Higher elevation and more shady areas - Karimunda
- Inter cropping in Arecanut – Panniyur 5

Improved varieties of black Pepper: Name of hybrid / variety

	Parentage	Parentage Yield / vine(Kg)
Panniyur-1	F1 hybrid Uthirankotah x Cheriyaaniakadan	2.5
Panniyur-2 Krishna	Open pollinated seedlings of Balankottah	4.5
Panniyur-3 (Shima)	F1 hybrid of Uthirankotah x Cheriyaaniakadan	4.4
Panniyur-4	Selection from Kuthravally II	2.3
Panniyur-5	Open pollinated progeny of Perum kodi	2.75
Sreekara	Selection from Kanmundu (KS 14)	4.8
Subhakara	Selection from Kariamunda (KS27)	4.2
Panchami	Selecton from Aimpiriyam Coll . 856	5.2
Pournami	Selection from Ottaplackal Type coll. No.812	4.7

Sreekara, Subhakara, Panchami, Pournami – Released from NRCS, Calicut.

Malabar types: grown in Malabar region in Kerala. Examples are Kalluvally, Balankottah. They are suitable for *shade*, Cheriyaakody, uthirankottah have high percentage of pistillate flowers.

Malnad types: grown in malnad of Karnataka. Workaiamarata variety is preferred for white pepper other examples include Doddagya, Karimarata, Arasilamarata, Malligesara, Tisara.

Travancore types: These are hardy; the cuttings root easily and climb the support without external help. e.g.. Karimunda, veluthanamban (tolerant to wilt), kuthiravally, chola.

Propagation: Pepper is invariably propagated vegetatively (**stem cuttings**). This is because of variation shown by the seedling progenies and also that the seedlings become dioecious and come to bearing very late (7-8 years). Pepper is propagated by *cuttings raised mainly for the runner shoots*. Cuttings from lateral branches are seldom used, because reduced number of fruiting shoots, short living and bushy in habit.

The selection of mother vine for perpetuation is done as follows;

1. A variety suitable for locality should be selected for instance *Panniyur-1* for open place and *Ballankottah* for shady location.
2. A variety should be selected depending upon the system of cultivation to be followed for instance, *Kalluvally*, *Panniyur-1* for monocrop system. *Balankottah*, *Karimunda* for mixed cropping.
3. A high yielder with high % of bisexual flowers should be selected. The runner shoots are separated from the vine in February – March and after trimming in leaves, cuttings of 2-3 nodes each are planted either in nursery beds or polythene bag filled with fertile soil. Cuttings from middle 1/3rd of the shoots are desirable as they are high yielding. Adequate shade is provided and irrigated frequently. The cutting will be ready for planting in May – June.

Rapid multiplication technique in pepper

A rapid multiplication technology has been developed by NRCS, Calicut. In this a trench of 0.75 m deep 0.3 m wide having convenient length is made. The trench is filled with rooting medium (preferably forest soil, sand, cow dung 1:1:1). Split halves of bamboos with septa having 8 – 10 cm diameter and 1.25 to 1.5 m length are fixed at 45° angle on a strong support. The bamboos can be arranged touching one another. Rooted cuttings are planted in the trench at the rate of one cutting each for one bamboo. The 10 cm portion of the bamboo are filled with a rooting medium (coir dust and cattle manure at 1 : 1 ratio) and the growing vine is tied to the bamboo in such a way as to keep the nodes pressed into the rooting medium. The tying could be done with dried banana sheath fibre. The vines are irrigated regularly. As the vines grow up, filling up the bamboo with rooting medium and tying each node, pressing it down to the rooting medium are to be continued regularly. For rapid growth each vine is fed at 15 day interval with 0.25 litres of nutrient solution prepared by dissolving Urea (1kg), 0.75 kg SSP, MOP (0.5 kg) and Megnesium sulphate (0.25 kg) in 250 litres of water. When the vine reaches the top in about 3 to 4 months, the terminal bud is nipped off and the vine is crushed at about 3 nodes above the base, in order to activate the axillary buds. After about 10 days, each vine is cut at the crushed point and removed from the rooting medium and each node is separated. Such cuttings with bunch of roots intact are planted in poly bags filled with pot mixture and kept in cool humid place. Care should be taken to keep the axil above the soil. The buds start developing in about 3 weeks when the poly bags can be removed and kept in semi shade. Subsequent harvesting can be had at every 2 – 2 ½ months time.

Advantages:

- Multiplication is rapid
- The root system is well developed.
- Better field establishment and more vigorous growth as a result of better root system

Selection of site: Well drained, leveled land and hill slopes are suitable for growing pepper. When they grown on a sloppy land, the slopes facing south should be avoided and the lower half of north and north eastern slopes are preferred for planting. So that the vines are not subjected to the scorching effect of the sun during summer.

System of cultivation: Pepper cuttings are generally planted with onset of South West monsoon. When pepper is grown as pure crop, pits of 0.5 m³ are dug at a spacing of 2.5 x 2.5 m. Erythrina stem cuttings of 2 m length from 2 year old seedlings are planted on receipt of early monsoon showers. Certain other trees like silver oak, *Ailanthus excelsa* and *Garuga pinnata* are also used. With onset of regular rains, 2 or 3 rooted cuttings are planted around the base of the standard nearly 30 cm away. But in case of coconut and areca nut which have a thick intercoiled root not close to the trunk. Pepper cuttings are to be planted 100 to 120 cm away from the tree trunk. Initially the vines may be allowed to climb on a stick or pole about

2 m tall which is tied to the trunk in a slanting position. After one year when the vine has attained sufficient length it may be separated from the temporary stake and the lower leaves may be nipped off. A narrow trench of 15 cm deep and wide should be prepared from the base of the vine to the base of the tree trunk. The vines may be placed in the trench in such a way that the growing tip is tied to the trunk while other parts of vine are covered with soil. A small ridge is formed over the trench, which should not be disturbed while doing intercultural operations to the palm.

Irrigation

Protective irrigation in basins during December - May at 10 days interval.

Cultural operations: The pepper vines are tied firmly as and when they grow. The tying is done around the node, so that the nodal region is firmly attached and pressed against the standards so as to allow the roots to cling to the standards. This is an important operation which has to be attended to carefully as otherwise the vine will have no support. The another practice is that when vine reaches at a height of 75 to 100 cm without branches all the leaves are removed except the terminal 3-4 leaves. The defoliated portions are covered with friable fine soil. This aid in establishing a well developed root system and lateral branches may arise out of them.

Training and Pruning: The vines are trimmed at the top and prevented from growing too tall for convenience of picking. In Tamil Nadu, pepper vines trained on Silver oak standards are pruned at 6 m height from ground level for easy picking. The vines are trained up the support to give one main shoot and two lateral orthotropic shoots. These are pruned regularly to encourage the development of lateral fruiting branches but these lateral branches should not be tied to support, as this would discourage the bushy side growth. The vines are first pruned back to 15-20cm from the ground level, when they developed to 8-9 nodes length. Second pruning is done when further 9-10 nodes have been produced, to a height of 3-4 nodes of the previous cut. In this way vines are pruned 7-9 times until they reach the top of the support about 3 m high. When this is achieved, the terminal growth of vine is arrested by frequent pinching. The lower portion of vine is kept clean and unbranched at least a meter from ground level.

Regulation of shade: In Pepper plantation, shade is given to the pepper vines, especially during the hot weather to keep the soil cool and moist and to allow sun light during cool weather to encourage production of flowers and fruits. The young vines should be protected from hot sun during the summer months by providing them with artificial shade. Regulation of shade by lopping the braches of standards is necessary not only for optimum light to the vines but also for enabling the standards to grow straight. Excessive shading during flowering and fruiting encourages pest infestation. Adequate mulch with green leaves, saw dust or coir dust or organic matter should be given towards end of the North East monsoon. The base of the vine should not be disturbed to avoid root damage. During the second year, practically the same cultural operations are repeated. Lopping of standards should be done carefully from 4th year onwards. From the 4th year, usually 2 diggings are given one during May – June and the other towards the end of South West monsoon in October and November. Growing cover crops like *Calapogonium mucanoides*, *Mimosa invisa* are also recommended under west coast conditions to provide an effective cover to prevent soil erosion during rainy season. Further, they dry away during summer leaving thick organic mulch.

Manuring: Judicious and regular manuring is necessary to get good yields. About 10 kg of well rotten cattle manure or compost is given in April – may. Fertilizers to supply 100 g

Nitrogen, 40 grams phosphate and 140 grams of Potash per standard for vines at 3 years and above age may be applied annually in 2 split doses in April-May and August – September. During the first year of planting 1/3rd of above dose and in second year 2/3 rd of the above dose may be given. Manures are applied around the vines at a distance of 30 cm and forked in to the soil. Lime may be applied at the rate of 500 grams per standard. During April in alternate years .

Harvesting: Pepper vines start yielding usually from the 3rd or 4th year. The vines flower in May-June. It takes 6-8 months from flowering to ripening stage. Harvesting is done from November to February in plains and January to March in hills. When one or two berries on spike turn red in early the whole spike is plucked. Yields vary with the variety and season. A full bearing vine yields one kg of dry pepper. However, individual vines recorded yields up to 3-5 kg of dried pepper. Harvesting of pepper is carried out according to the purpose for which it is harvested. For preparation of white pepper the berries are harvested at a slightly advanced stage of ripeness i.e. when the berries turn red (bright orange). To get black pepper the berries are gathered at younger stages.

Yield: Pepper vine attain full bearing stage in the 7th or 8th year after planting and yield starts decline after 20-25 years and replanting has to be done thereafter. 7th or 8th year old pepper vine gives 800 to 1000 kg of Black Pepper per ha.

Fruit drop

The spike shedding can be reduced by foliar spray of Diammonium Phosphate 1.0 % four times viz., before flower initiation (May), during new leaves and flower emergence (June) before spike initiation (July) and pinhead stage of berries (August).

Plant protection

Pests

Pollu Beetle and Leaf Caterpillars

Spray Quinalphos 25 EC 2 ml/lit once in July and again in October.

Leaf gall and thrips

Spraying Monocrotophos 36 WSC 1.5 ml/lit or Dimethoate 30 EC @ 2 ml/lit or Chlorpyrifos 2 ml/lit or Dichlorvos 76 WSC 1 ml/lit or Phosphomidan 40 SL @ 2 ml/lit three rounds at monthly intervals starting from new flush formation.

Top shoot borer

Top shoot borer can be controlled by spraying Monocrotophos or Quinalphos (0.05%) on terminal shoots at monthly intervals (during July – October) to protect emerging new shoots.

Diseases

Foot rot

Nursery

Apply *Trichoderma viride* @ 1g/kg of pot mixture. Mulch the pot mixture with 150 gauge polythene sheet for 30 days and inoculate with *Pseudomonas*.

Main field

Any of the following formulation can be drenched in the soil twice (May –June and October - November).

- Neem cake 1/2 kg per vine + Swabbing of Bordeaux paste upto 1 m from the ground level.
- *Trichoderma viride* @ 20 g/vine + FYM or Bordeaux mixture 1 % or Metalaxyl-Mancozeb @ 2 g/lit.

- Neem cake 2 kg per vine + 0.1% Metalaxyl (pre monsoon foliar spray and soil application).
- *Pseudomonas fluorescens* (50 g) (pre and post monsoon) + neem cake (2 kg) (post monsoon) + metalaxyl 0.1 %.

Slow decline (Slow wilt): causal organism- nematodes. Apply Phorate 10 G @ 30 g or Carbofuran 3G @100g per vine (May–June and September - October) + Copper oxy Chloride @ 0.2 % (Soil drenching) or Potassium phosphonate @ 0.3% or Metalaxyl @ 0.1 %.

Anthracnose: Foliar spray with Bordeaux mixture @ 1 % or Mancozeb @ 0.2 %.

Nematode: Soil application *Bacillus subtilis* (BbV 57) or *Pseudomonas fluorescens* @ 10 g/vine is recommended for the management of root knot and reniform nematode population in Black pepper.

Processing of pepper: Almost all the produce in India is processed in to black pepper and only a very limited quantity is converted in to white pepper.

Black pepper: It consists of fully developed, but unripe dried berries of Pepper. The harvested spikes are sun dried for 7 to 10 days on cement floor or mats, until the outer skin becomes tough black, shrink and wrinkled. Drying is carried till the moisture content gets reduced to 10-15%. Then the dried berries are separated from the spikes by beating or rubbing between hands or trampling them under the feet. For making good quality of Black pepper of uniform colour, the separated berries are collected in a perforated bamboo basket or vessel and the basket with the berries is dipped in boiling water for 1 minute. The basket is then taken out and drained. The treated berries are sun dried on a clean bamboo mat or cement floor. The recovery of black berry is about 33 % (26 to 36% depending upon the variety).

White Pepper: This consists of dried ripe fruits without pericarp (skin). It is prepared by removing the outer skin along with the pulp before drying. White pepper is prepared by one of the two methods.

I. Water steeping technique (traditional method)

II. Steaming or boiling technique (improved method)

I. Water steeping technique: It is a traditional and slow method. It involves 5 steps.

1. Steeping: Spikes with fully ripe berries are filled in gunny bags and are steeped in flowing water for about 7 -8 days. During this steeping process, the skin gets loosened from the seed. **2. Depulping:** At the end of steeping, the berries are taken out and the skin with the pulp is removed either by rubbing between hands or by trampling under feet.

3. Washing: These depulped seeds are then washed and cleaned with fresh water repeatedly (3-4 times)

4. Drying: The cleaned seeds are sun dried for 3-5 days on cement floor or mats till they become white and the moisture gets reduced to 10-15%.

5. Polishing: The dried seeds are now dull white with colour. They are further cleaned by winnowing or by rubbing with a cloth. The percentage of recovery of white pepper is about 25% of ripe berries.

II. Steaming or boiling technique: This is an improved and quick method developed at CFTRI, Mysore. It involves 4 steps.

1. Boiling: Freshly harvested spikes or berries are boiled for about 15 minutes.

2. Depulping: The boiled berries are then pulped mechanically. Boiled berries passes through motorized fruit pulping machine.

3. Bleaching: The depulped berries are washed thoroughly by using bleaching powder or any bleaching agent.

4. Drying: The cleaned berries are sun dried for 3-5 days on cement floor or mats till they become white and the moisture gets reduced to 10-15%.

Cardamom

Origin: western Ghats of South India (Kerala)

Useful plant part: Fruit (capsule)

Introduction: Cardamom is popularly known as the *Queen of Spices* and also *Green Gold*. It is one of the ancient species of India and is also one of the most valued spices of the world. It is next only to black pepper as the largest foreign exchange earner among various Indian spices. Cultivation of Cardamom is mostly concentrated in the evergreen rainy forests of Western Ghats in South India. Besides India, Cardamom is cultivated in Guatemala, Tanzania, Srilanka, Vietnam, Cambodia and Newguinea. Among three cardamoms small one is the most popular species. India has the largest area (90% of the world area) and is also largest producer (70%). But of late India is facing still competition from *Guatemala* in the world market for the top position. In India the cultivation of small cardamom is mainly confined to the southern states viz., Kerala (60%), Karnataka (30%), Tamilnadu (10%). Among the different spices, exported from India cardamom ranks *second* after black pepper. Nearly 40% of the production is exported to more than 60 countries.

Importance/ uses: Cardamom is used for flavouring and seasoning various food stuffs, confectionery, beverages and liquors. In Arab countries, a beverage of cardamom flavoured coffee is prepared called '*Gawa*'. It is generally offered to guests at social and religious functions. In Srilanka cardamom is used in manufacturing liquors. The essential oil of cardamom is used for medicinal 28 purposes both in allopathy and in Ayurveda. It is used as powerful aromatic stimulant, carminative, stomachic and diuretic. Cardamom seeds are chewed to prevent the bad bread, indigestion, nausea and vomiting. Eating one cardamom daily with a table spoon of honey improves eye sight and strengthens the nervous system and keeps one healthy. It is believed by some people that excessive use of cardamom causes impotency.

Botany and taxonomy

Genus: *Elettaria*

Species: *cardamomum*

Botanical name: Small Cardamom: *Elettaria cardamomum* (L.) Maton (Malabar cardamom)

Large Cardamom: *Amomum subulatum* (native to Eastern Himalayas)

Bengal cardamom: *Amomum aromaticum*

Family: Zingiberaceae

Cultivated cardamom has chromosome number $2n = 48$.

Out of the above species, most popular species occupying a premier position is small cardamom. Large cardamom is mainly cultivate in Darjeeling, Assam, Himalayas, Nepal, Bhutan, Thailand, Indonesia. Bengal cardamom is grown in Northern Bengal.

Botany: Cardamom is an herbaceous perennial plant having underground rhizomes. A fully grown plant is about 2- 4 m height. The real stem of the plant is the underground rhizome. The aerial pseudo stem is made up of leaf sheaths. Leaves are lanceolate with dark green colour. It has shallow root system; inflorescence is a long panicle with racemose clusters arising from the underground stem but comes up above the soil. Flowers are bisexual, pale white fragrant flowers. Fruit is trilocular capsule. Flower initiation takes place in March – April and from initiation to full bloom it takes nearly 30 days; from bloom to maturity it takes 5 – 6 months. Honey bee is the principle pollinating agent.

Varieties

Based on the size of the fruit, two varieties are broadly recognized viz., *Elettaria cardamomum* var. *major* consisting of wild indigenous types and var. *minor* comprising the cultivated types viz., Mysore, Malabar and Vazhukka (natural hybrid between Mysore and Malabar). The cultivated types are identified mainly based on the nature of panicle shape and size of the fruits as follows.

Sl. No.	Particulars	Mysore type	Malabar type	Vazhukka type
1	Plant stature	Robust	Medium sized	Robust
2	Panicle	Erect	Prostrate	Semi-erect
3	Capsule	bold, elongated	round to oblong	round to oblong
4	Adaptability	high altitudes (900 – 1200m)	low altitudes (600 – 900 m)	wide range
5	Productivity	More	Less	Less
6	Resistance	Withstand to Winds	More tolerant to thrips and less susceptible to drought	More tolerant to thrips and less susceptible to drought
7	Fruits shape	Pods are bold and elongated	Roundish or egg shaped	Roundish to Long

Malabar: Mudigree 1, Mudigree 2, CCS 1, PV 1, ICRI 1, ICRI 3, TKD 4, IISR Suvarna, IISR Vijetha, IISR Avinash, **Mysore:** ICRI 2, **Vazhukka:** PV2, Njallani (Green gold)

Improved varieties:

Coorg cardamom Malabar selection– 1 (CCS– 1) (Malabar type): it yields 408 kg per ha dry capsules under rainfed conditions. It was released by National Cardamom Research Station (NCRS), Appangala.

Mudigere– 1 (Malabar type): it yields 250 to 300 kg per ha of dry capsules. It was released by Regional Agricultural Research station, Mudigere (Karnataka).

ICRI– 1 (Malabar type): it yields 265 to 650 kg of dry capsule/ha.. Released by Indian Cardamom Research Institute, Myladumpara.

ICRI– 2 (Mysore type): it yields 375 to 760 kg of dry capsule/ha. Released by Indian cardamom Research Institute, Myladumpara.

PV– 1 (Malabar type): it yields 500 kg of dry capsule. Released by Cardamom Research Station, Pampadumpara.

SKP– 14 (Malabar type): it yields 430 to 590 kg dry capsule per ha. Released by ICRI Regional station, Saklespur, Karnataka.

Soils: Grows best on well drained humus rich forest soils. Water logging and excessive soil moisture conditions are detrimental. Moisture level should be 40 to 50% of the field capacity of the soil. An ideal site is a sloppy land with good drainage. In India cardamom is grown on red, deep and good textured laterite forest soils having plenty of humus and leaf mould. Ideal pH is 5.0 to 6.5

Climate: Small cardamom is a humid tropical plant. It is grown under natural conditions of ever green forests at an elevation from 600 to 1500 m above MSL. Optimum elevation is 900 to 1200 m. The plant prefers temperature of 10 to 35°C and a well distributed rainfall of 1500 mm per annum. Summer showers are essential during summer i.e. February – April for panicle initiation. Otherwise it affects yield. It does not stand drought and is highly sensitive to winds. Under exposed conditions, the plant does not attain its full vegetative growth because of sun scorching. It grows luxuriantly under shade. Shade trees besides providing

shade create a congenial micro climate in the plantation. It keeps the surroundings humid and cool. Moderate shade, high humidity, cool surroundings, well distributed rainfall and wind less areas is very essential for the satisfactory performance of Cardamom.

Propagation: Cardamom can be propagated by seeds, rhizomes and suckers. Out of which seed propagation is most preferred because of certain advantages over vegetative propagation.

By seed: Propagation by seeds prevents spread of *khatte disease*. This is the most common and widely prevalent method. A large number of seedlings can be raised within a short time. The main disadvantage is that the progeny is highly variable with no uniformity in the yield. The seeds also do not remain viable for longer time.

By rhizomes: Planting material of rhizomes is collected by uprooting 2 to 2 ½ year old clumps. These materials are noted for their high yields. The advantage of this material is greater uniformity and earlier bearing habit compared to 30 seedlings. One of the very serious disadvantage is that Cardamom Mosaic Disease spreads through rhizomes. Plantations raised by vegetative means are short lived. Getting adequate plant material is another difficulty. If rhizomes are used for propagation continuously. The plants tend to loose their vigour after a few generations. Due to these limitations farmers use seedlings only.

Nursery site and planting: Seedlings are normally raised in primary and secondary nurseries. The nursery site should be selected on gentle sloppy lands, having an easy access to a water source. Raised beds are prepared after digging the land to a depth of 30- 45 cm. The beds of 1 m width and of convenient length raised to a height of about 30 cm are prepared. A fine layer of humus rich forest soil is spread over the beds. Seeds are to be collected from well ripe capsules. Immediately after harvesting, the husk is removed and seeds are washed repeatedly in water for removing the mucilaginous coating. After draining the water the beds are to be mixed with wood ash and dried in shade for a day. In order to ensure uniform and early germination, seeds should be sown immediately after extraction. If the sowing is delayed, pre sowing treatment of seeds with 25% Nitric acid for 10 min is advisable to get a quick and higher germination. One kg of capsules may produce 5000 seedlings.

Sowing may be taken up during November – January and is done in rows. Deep sowing should be avoided for better and quick germination. Seeds are mulched to a thickness of 2 cm with paddy straw or any locally available material and are watered regularly. The germination commences in about 30 days and may continue to a month or two. After germination the mulch is to be removed.

Seed rate: 10 g per m² of nursery bed area. An over head pandal with a height of 2 m is quite desirable. Materials like coir mat, coconut leaves or tree species which do not shed their leaves easily may be used but the coir mat is prepared as it allows uniformly filtered light. The excess seedlings are to be thinned out of it after 75 – 80 days sowing. When the seedlings attain 5-6 leaf stage light earthing up is to be done. This would encourage better tillering and proper growth of seedlings. Generally in Kerala and Tamil Nadu the seedlings are transplanted to the secondary nursery when they attain 4 – 6 leaf stage. The beds are prepared in the same manner as that of primary nursery. Seedlings are transplanted in the secondary nursery in March – May at a spacing of 20 x 20 cm and mulched. Immediately beds are to be covered with an over head pandal and should be watered regularly. Recently instead of secondary nursery beds, the seedlings are also raised in poly bags containing rich forest soil. Manuring at the rate of 90 g N, 60 g of P, and 120 g of K per bed of 5 x 1 m size

in 3 equal split doses at an interval of 45 days is recommended to produce healthier seedlings. The first dose of fertilizers may be applied 30 days after transplanting in the secondary nursery.

Rapid Clonal multiplication technique developed by Cardamom Research Centre, Appangala:

Cardamom is propagated mainly through seeds and also through suckers each consisting of at least one old and a young aerial shoot. The suckers are commonly used for gap filling but suckers may not be available in larger numbers. Therefore rapid clonal multiplication technique evolved by *NRCS-Cardamom Research Centre, Appangala* is proved to be quick, reliable and economical for production of large number of quality planting materials. The site selected for their method should have a gentle slope and must be nearer to the water source. Trenches of 45 cm width 45 cm depth and of any convenient length may be taken across the slope or along the contour at 1-8 m apart. The top 20 cm depth soil is excavated separately and heaped on the upper side of the trench. The lower 25 cm soil is excavated and heaped on lower side of the trenches all along the line.

The top soil is mixed with equal portions of humus rich jungle soil, sand and cattle manure and filled back by leaving a depression of 5 cm at the top to facilitate mulching for retention of soil moisture. Suckers each consisting of one grown up tiller and a growing young shoot are placed at a spacing of 0.6 m in the trenches during march – October. Regular cultural operations are to be followed including a high fertilizer dose of 100: 50: 200 kg NPK / ha in 6 split doses at 60 days interval along with neem cake at 250 g per plant. Irrigation should be provided at least twice a week. Overhead pandal at a height of 3.6 m covered with coir mat or leafy twigs of any shade tree may be provided during non-rainy season. Within a period of 12 months, a plant could produce at least 32-42 suckers which may yield at least 16-21 planting units i.e. about 1.5 lakh planting units per ha.

Planting: The best season of planting seedlings or suckers is May- June after the receipt of monsoon showers. The seedlings or suckers are planted in the pits up to collar region for better growth. Cloudy days with light drizzle are ideal for planting.

Shade and shade regulation: Cardamom is a shade loving plant (*pseophyte*). Shade helps to regulate soil moisture as well as temperature and provides congenial micro climate for cardamom. Shade protects plants from sun-scorching, rains and winds. Shade trees provide mulch material through fallen leaves on the surface and prevent soil erosion through their root system. Excess shade is also quite detrimental and shade has to be regulated so as to provide 50-60% filtered sunlight.

In South India, many trees are available in the natural habitat to provide shade but an ideal shade tree should have a wider canopy, minimum side branching and it should not shed the leaves during flowering phase of Cardamom, so as not to affect pollination. Some of the common shade trees in cardamom estates are karimaram (*Diospyros ebenum* and *D. elongi*), *Mimusops elangi*, Balangi (*Artocarpus fraxinifolius*), Jack, Red cedar (*Cedrella toona*). The temporary shade trees like *Erythrina lithosperma* and *E. indica* are the most unsuitable but they compete for nutrients and soil moisture and hence not suitable as permanent shade trees. In order to provide adequate light during monsoon, shade regulation may be taken up before the onset of monsoon. A two tier canopy with a height of not more than 3m between the lower and higher canopy may be maintained. Areas exposed to western side should have adequate shade.

Manuring: Cardamom is a surface feeder and its growing areas are usually subjected to heavy rain fall conditions, the top soil is subjected to frequent leaching, resulting in the loss

and plant nutrients, even though there is annual replenishment of nutrients through the incorporation of fallen leaves of shade trees and cardamom plants. Therefore manuring is very essential.

Under irrigated conditions – 75 kg N; 75 kg P and 150 kg K per ha.

Under rain fed conditions – 30 kg N + 60 kg P and 30 kg K per ha.

Organic manures may be applied at the rate of 5 kg per plant.

Two split doses one during May – June for production of suckers, Second during September to October for initiation of panicle. Half dose can be applied during first year. Full dose can be applied from second year onwards. Being a surface feeder deep placement of fertilizer is not advocated. These fertilizers are applied 30 cm away from the plant.

Irrigation: Cardamom is generally raised as rain fed crop. However, it responds well to irrigation. It is necessary to irrigate the crop during dry periods to get increased yields. Since, cardamom is raised under evergreen forests and on undulated terrain, conventional irrigation methods are not useful.

Intercultural operations:

Weeding: 2-3 weedings per year may be necessary during May-June, August–September and December – January. Paraquat @ 625 ml in 500 litres of water may be sprayed.

Mulching: it is an important cultural operation in Cardamom. Fallen leaves of the shade trees and up rooted weeds are utilized for mulching. Mulches should be applied during November – December to reduce ill effects of drought conditions during ensuing summer.

Trashing or clearing: It consists of removing old and drying shoots of the plant once in a year with the onset of monsoon under rain fed conditions and 2-3 times in high density plantations. The plantation is provided with irrigation facilities. Weeding and clearing may be done simultaneously during May- June and August – September.

Packing and digging: At the end of the monsoon rains a light raking or digging of soil should be given around the plant up to a radius of 60-75 cm to conserve the moisture to the ensuing dry period particularly in low rainfall areas.

Earthing up: After the completion of monsoon, a thin layer of fertile soil rich in organic matter may be earthed up at the base of plant up to collar region to encourage new growth.

Cropping: Cardamom plants start bearing in about 3 years after planting. Flowering starts in April – May and continues up to August – September. Peak flowering will be in the month of May- June. From flowering to maturity the fruit takes 5-6 months.

Harvesting: Only ripe capsules are harvested at 25-30 days interval, the harvesting is completed in 5- 6 pickings. Pick only those fruits which are just ripe but not fully ripe. Fully ripe fruits tend to split on drying and do not develop the desirable dark green colour. In most of the areas the peak period of harvest is during October – November.

Yield: Although the Cardamom plant start bearing from 2nd or 3rd year of planting, an economic crop can be obtained only from 4th or 5th year. Yield varies with variety and age. Optimum average yield is 50-70 kg of dry capsule per ha. Yields decline from 10th year to 12th year.

1st year of bearing – 25-50 kg per ha (dry capsules)

2nd year of flowering 50-70 kg per ha (dry capsules)

3rd year of flowering 70-100 kg per ha (dry capsules)

Processing: The commercial product of Cardamom is the dried capsules. At the time of harvesting the capsules are juicy and fleshy, so they must be cured before sending them to the market.

Bleaching: Green colour of the cardamom capsules plays a vital role in the market. Green colour of the capsules can be preserved by *alkali treatment*. So freshly harvested cardamom capsules are soaked in 2 % *washing soda* (Na_2CO_3) solution for 10 min.

Drying: After bleaching, the capsules are dried either by sun drying or in fuel kilns and electric driers. The capsules are sun dried for 3-5 days. These capsules get bleached and does not store well. Hence, now a day's capsules are dried artificially in which drying is complete and the green colour remains. In electrical drier in capsules are dried at 45 – 50°C for 18 hours.

Fuel kilns: Temperature is set at 50 – 60°C over night. The capsules kept for drying are spread thinly and stirred frequently to ensure uniform drying. The dried capsules are rubbed with hands or coir mat or wire mesh and winnowed to remove any foreign matter.

Storage: Then they are stored according to size and colour and stored in black polythene lined gunny bags to retain green colour during storage. These bags are then kept in wooden chamber. **Sorting:** The dried capsules are stored according to their size, colour and stored in black polythene lined gunny bags to retain green colour during storage.

Plant protection

Pests

Thrips

Monocrotophos 36 % SL @10 ml/10 lit. Quinalphos 25 % EC @12 ml/10 lit.

Shoot and fruit borer

Setup pheromone trap @ 12 Nos/ha to attract and destroy the female moths.

Nematode

Fumigate the primary and secondary nursery beds using Methyl Bromide (@ 500 g/10 sq.m) or Ethylene-di-bromide (@ 20 lit/ha) or Durofume (@ 30 lit/ha) under polythene cover for 2-3 days or drench the nursery beds with 2 % Formalin.

Apply Carbofuran 3 G @ 5 kg a.i/ha

Diseases

Mosaic or Katte disease

This is a serious disease affecting the productivity of Cardamom. This is transmitted by banana aphid which can be controlled by regular spraying with Methyl demeton 25 EC or Dimethoate 30 EC or Phosphomidon 86 WSC at 750 ml/ha.

Damping off or clump rot or rhizome rot

Drench nursery with 1 lit of Formaldehyde in 50 lit water for 3 sq.m. before sowing. Prophylactic drench with 0.25% Mancozeb or 1% Bordeaux mixture immediately after germination to control *Pythium* and 0.05% Carbendazim after 15 days to control *Rhizoctonia*.

Capsule rot or panicle rot or Azhukal

Three sprays with 1% Bordeaux mixture or 0.25% Copper oxychloride or 0.2% Mancozeb just before onset of South West monsoon in early August and in September. Drench the soil with 1% Bordeaux mixture.

Large cardamom or Nepal cardamom or Greater Indian cardamom is the dried fruits of *Amomum subulatum*. It is native of Eastern Himalayan region and is now cultivated in Sikkim, Darjeeling and Assam hills.

It is a perennial crop, propagated from the seeds or cut bits of the dried rhizome. It starts bearing in 3 to 5 years after planting and the economic age of the plantation is 12 to 15 years. The fruits are about 2.5 cm long, ovoid and triangular in shape brown or pink in colour when ripe. They contain 40 to 50 seeds. Average yield is 300 to 1000 kg per ha from 4th or 5th year.