



E-CONTENT

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Topic: Cultivation & Uses of SPICES: Clove, Pepper, Nutmeg & Mace

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CLOVE / Laung

Clove is a spice that has been used for its medicinal properties, aromatic qualities, and culinary applications.

Intensely pungent and flavoured, cloves were the riches that drew the dhows and clippers of the colonial era to **Zanzibar**, giving the tiny Indian Ocean archipelago economic influence and resonance far beyond its size. Once upon a time, the wizened, never-opened buds of the stunted evergreens were worth more than their weight in gold. European powers went to war over them in the 17th century; Zanzibari rulers made smuggling them punishable by death.

The clove of commerce is the aromatic, dry, fully grown, but unopened flower buds of the clove tree *Syzygium aromaticum*; Family: **Myrtaceae**. **The Islands of Zangibar, Pemba and Indonesia** are the major producers of clove in the world. In India, clove is mostly grown in the hilly tracts of Tamil Nadu, Kerela and Karnataka.

Botany:

Clove is an evergreen tree. It is native to the **Molucca islands** in Indonesia and is extensively cultivated in various tropical regions around the world.

The clove plant is a medium-sized tree that can reach heights of 8-12 meters. It has a straight trunk with smooth grey bark. The leaves are simple, opposite, and elliptical in shape, with a glossy dark green colour. The flowers are small and numerous, with a characteristic crimson colour. These flowers are grouped into terminal clusters and have a strong, aromatic fragrance. The most valuable part of the clove plant is the unopened flower buds, which is harvested for culinary and medicinal purposes.

The flowers are bisexual and have a cup-shaped hypanthium at the base. Each flower has numerous stamens and a single pistil. The fruits of the clove plant are berry-like and develop from the swollen floral tube after fertilization. These fruits are single seeded.

Cultivation:

The cultivation of clove involves several stages, from planting to harvesting.

- a. **Soil and climate:** The first step in clove cultivation is selecting the appropriate location for planting. Clove trees thrive in well-drained, fertile soils with a pH between 6.0 and 7.0. The ideal climate for clove cultivation is warm and humid, with temperatures ranging between 20⁰C and 30⁰C.
- b. **Propagation:** Clove trees are propagated through seeds or cuttings. Seeds can be sown directly into the soil or germinated in a seedbed before transplanting to the main field. Cuttings, on the other hand, are taken from mature clove trees and planted directly into the field.
- c. **Planting:** Clove trees are usually planted during the rainy season, as they require ample water for growth. Seedlings are spaced 3-4 meters apart in rows with a 2-meter distance between rows.
- d. **Growth Cycle:** Clove trees take approximate 5-7 years to reach maturity and produce flowers. The flower buds are handpicked and dried to develop into cloves.
- e. **Harvesting:** The cloves are harvested when they reach the desired size and colour, usually between 6-12 months after flowering. Harvesting is done manually, as the flower buds are easily damaged,
- f. **Post-harvest Processing:** After harvesting, the cloves are cleaned, sorted, and dried in the sun or with artificial heat to preserve their quality and aroma.



A Twig with young buds



Clove-Dried unopened buds

USES

Clove is a versatile spice with a wide range of uses including culinary applications, medicinal benefits, aromatic uses, insect repellent properties, and decorative purposes.

A. Culinary Uses:

- **Flavouring Agent:** Cloves are commonly used as a flavouring agent in both sweet and savoury dishes. They add a warm, aromatic flavour to foods and are often used in baking, particularly in the preparation of gingerbread, pumpkin pie, and other desserts. In savoury dishes, cloves are used in soaps, stews, marinades, and rice and spicy flavour.
- **Whole / Ground:** Cloves can be used whole or ground depending on the recipe. Whole cloves are often added to dishes during cooking and then removed before serving, while ground cloves are used in spice blends and rubs.

B. Medicinal Uses:

- **Dental Health:** Clove oil has been used traditionally for its analgesic and antiseptic properties in dental care. It is commonly used to alleviate toothaches and gum pain. Clove oil is also found in some dental products such as toothpaste and mouthwash due to its potential benefits for oral health.

CAPSICUM L. [PEPPER / CHILI PEPPER / MIRCHA]

Chili Pepper (*Capsicum* spp., Family *Solanaceae*), also called as pepper, is a main spice and vegetable crop and cultivated all over the world for fresh, dried, and processed products.

It is known as the most valuable crop of India. It is used as a principal ingredient of various curries and chutneys, also used in vegetables, spices, condiments, sauces and pickles. Pungency in chillies is due to the active constituent "**Capsaicin**", an alkaloid. Chilli was introduced in India by the Portuguese in Goa in the middle of 17th century and since then it had rapidly spread throughout the country.

Origin and Occurrence

The genus *Capsicum* is native to tropical and subtropical America, in a wide region comprising Mexico and northern Central America, the Caribbean, the lowland Bolivia, the northern lowland Amazonia, and the mid-elevation southern Andes, where archaeological evidence suggests use of this spice crop since 6000 BC. At present 35 *Capsicum* species is reported, five of which, namely, *C. annum*, *C. baccatum*, *C. chinense*, *C. frutescens*, and *C. pubescens* have been domesticated and widespread with different terms depending on the

region of cultivation. Overall, the present term “**chili pepper**” refers to varieties with small and spicy fruits, on the contrary, the term “**sweet pepper**” refers to varieties with larger fruits and little or no spicity.

The oldest variety of chilli in the globe is the Tepin or Chiltepin pepper (*Capsicum annuum* var. *glabriusculum*) which is usually known as the “**Mother chilli**”.

At the beginning, fruits of *Capsicum*, were exchanged for black pepper (*Piper nigrum*), a species similar in taste. For this reason, it was incorrectly named “pepper”. It was Fuchs, who proposed for the first time in 1543, the botanical term *Capsicum*, which was adopted later in 1753 by Linneous. The genus name *Capsicum* derives from a Greek-based derivative of the Latin word “Kapsimo” or ‘**kapto**’, meaning ‘**to bite**’, in reference to the heat or pungency of the species fruit. Although it has also been speculated to derive from the Latin word ‘**capsa**’, a box, referring to the shape of the fruit in forms of the typical species. The common name ‘chile’ is a variation of ‘chil’, derived from the **Nahutal (Aztec) dialect**. In Indian English, the word “capsicum” is used exclusively for *Capsicum annuum*. All other varieties of hot capsicum are called chilli.

The crop was firstly introduced in Europe by Christopher Columbus during his travels after the discovery of America in the fifteenth century and later spread to Africa and Asia. The flourishing commercial exchanges of Spanish and Portuguese facilitated the spread of pepper around the globe, with an immediate success due to a well acclimatization in the regions, where they were used as a spice from that part of the population who could not afford to purchase cinnamon, nutmeg, and other spices that are widely used for seasoning and preserving food.

Major chilli growing countries are India, China, Pakistan, Indonesia, Korea, Turkey and Sri Lanka in Asia; Nigeria, Ghana, Tunisia and Egypt in Africa; Mexico, United States of America in North & Central America; Yugoslavia, Spain, Romania, Bulgaria, Italy and Hungary in Europe and Argentina, Peru and Brazil in South America. India is the world leader in chilli production followed by China & Pakistan.

Basically, the colour diversity of *Capsicum* fruit is linked to the presence of pigments like chlorophyll (green), anthocyanins (violet/purple), α -carotene, β -carotene, zeaxanthin, lutein, and β -cryptoxanthin (yellow/ orange).

Its fruit forms are varied, from large to small, sweet to sour, and very hot/pungent to bland.

Despite being a single species, *C. annuum* has many forms, with a variety of names, even in the same language. A variety that produces **capsaicin** is colloquially known as a hot pepper or chili pepper. In British English, the sweet varieties are called “peppers” and the hot varieties “chillies”.

Botany

Within the family Solanaceae, the genus *Capsicum* can be recognised by its shrubby habit, actinomorphic flowers, distinctive truncate calyx with or without appendages, anthers opening by longitudinal slits, nectaries at the base of the ovary and the variously coloured and usually pungent fruits.

The Properties of Pepper

The uniqueness of pepper is the typical pungency due to the presence of *capsaicinoids*. Capsaicinoids are secondary metabolites and derivatives of phenylpropanoids produced in placental epidermis cells and accumulated in structures (blisters) located on the placenta surface. The hotness sensation when consumed is given by the interaction with *vanilloid* receptors, supposed to be a mechanism of defence against mammalian herbivory. *Capsaicin* and *dihydrocapsaicin* are the two predominant compounds, accounting for almost 90% of total capsaicinoids.

CAPSICUM DIVERSITY

(*Capsicum* clades and related species, main features and native area)

Cladea, species name, chromosome number	Pungency	Fruit colour	Area of origin
1. <i>Annuum</i> (x=12)			
<i>C. annuum</i>	Non-pungent and pungent	Variable	Central and south America regions
<i>C. annuum</i> var. <i>glabriusculum</i>	Pungent	Red	Venezuela, central america
<i>C. chinense</i>	Pungent	Variable	Central America, Colombia, Ecuador, south-eastern Brazil, Venezuela
<i>C. frutescens</i>	Pungent	Variable	Central America, central-eastern Brazil, Colombia, Ecuador, Venezuela
<i>C. galapagoense</i>	Pungent	Red	Galapagos Islands
2. <i>Baccatum</i> (x=12)			
<i>C. baccatum</i> var. <i>baccatum</i>	Non-pungent and pungent	Variable	Argentina, Bolivia Paraguay, Peru'
<i>C. baccatum</i> var. <i>pendulum</i>	Non-pungent and pungent	Variable	Argentina, Bolivia Paraguay, Peru'
<i>C. baccatum</i> var. <i>umblicatum</i>	pungent	Variable	Argentina (north and central), Bolivia (lowlands)
<i>C. chacoense</i>	Pungent	Red	Argentina, Bolivia, paraguay
<i>C. praetermissum</i>	Pungent	Red	South-eastern Brazil
3. <i>Tovarii</i> (x=12)			
<i>C. tovarii</i>	Pungent	Red	Perù
4. <i>Pubescens</i> (x=12)			
<i>C. pubescens</i>	Pungent	Variable	Argentina, Bolivia, central America, Ecuador, Perù
5. <i>Purple corolla</i> (x=12)			
<i>C. cardenasii</i>	Pungent	Red	Bolivia (highlands)
<i>C. eximium</i>	Pungent	Red	Argentina (north and central), Bolivia (lowlands)
<i>C. eshbaughii</i> *	Pungent	Red	Bolivia (lowlands)
6. <i>Atlantic forest</i> (x=13)			
<i>C. campylopodium</i>	Pungent	Greenish-yellow	South-eastern Brazil
<i>C. cornutum</i>	Pungent	Greenish-yellow	South-eastern Brazil
<i>C. friburgense</i>	Pungent	Greenish-yellow	South-eastern Brazil
<i>C. hunzikerianum</i>	Pungent	Greenish-yellow	South-eastern Brazil
<i>C. mirabile</i>	Pungent	Greenish-yellow	South-eastern Brazil
<i>C. pereirae</i>	Pungent	Greenish-yellow	South-eastern Brazil
<i>C. recurvatum</i>	Pungent	Greenish-yellow	South-eastern Brazil
<i>C. schottianum</i>	Pungent	Greenish-yellow	South-eastern Brazil
<i>C. villosum</i> var. <i>villosum</i>	Pungent	Greenish-yellow	South-eastern Brazil
7. <i>Longidentatum</i> (x=13)			

<i>C. longidentatum</i>	Non-pungent	Greenish-yellow	Central-eastern Brazil
8. Bolivian(x=*)			
<i>C. caballeroi</i>	Pungent	Red	Bolivia (lowlands)
<i>C. minutiflorum</i>	Pungent	Red	Bolivia (lowlands)
<i>C. ceratocalyx</i>	Pungent	Red	Bolivia (highlands)
<i>C. coccineum</i>	Pungent	Red	Bolivia, western Brazil
9. Flexuosum			
<i>C. flexuosum</i>	Non-pungent and pungent	Red	South-eastern Brazil, north-eastern Argentina and eastern Paraguay
10. Caatinga(x=13)			
<i>C. caatingae</i>	Pungent	Greenish-yellow	Central-eastern Brazil
<i>C. parvifolium</i>	Pungent	Greenish-yellow	Central-eastern Brazil, Colombia, Venezuela
11. Andean (x = 12)			
<i>C. rhomboideum</i>	Non-pungent	Red	Central America, Colombia, Ecuador, Perù, Venezuela
<i>C. scolnikianum</i>	Non-pungent	Red	Colombia, Ecuador, Perù
<i>C. geminifolium</i>	Non-pungent	Red	Ecuador, Perù
<i>C. lanceolatum</i>	Non-pungent	Red	Ecuador, Perù, central America
<i>C. dimorphum</i>	Non-pungent	Red	Colombia, Ecuador, Perù

a. According to Carrizo García *et al.* (2016)

b. At maturity stage

*chromosome number not reported

CULTIVATION

In India, majority of the chillies consumed in Andhra Pradesh are farmed in Guntur, Warangal, Prakasam, East and West Godavari, and Khammam. Additionally, they are grown in West Bengal, Assam, Gujarat, Madhya Pradesh, and Uttar Pradesh.

STATE	Major Chilli farming tracts
Andhra Pradesh & Telangana	Guntur, Warangal, Khammam, Prakasam, Krishna, Hyderabad, Nizamabad, Cuddapah, Rajmundary and Nellore.
Karnataka	Dharwad, Mysore, Hassan, Bangalore, Bellary, Ranibennur, Hubli and Gadag.
Maharashtra	Nagpur, Nasik, Ahmednagar, Solapur, Aurangabad, Nanded and Amravati.
Punjab	Amritsar, Nabha and Patiala.
Tamilnadu	Coimbatore, Ramanathapuram, Tuticorin, Tirunelveli, Virudunagar, Kanyakumar, Madurai, Salem, Tiruchi, Villupuram and Cuddalore.
West Bengal	Murshidabad, South & North 24 Parganas, Nadia, Coochbehar and Jalpaiguri.

Soil

Chilli is grown in many types of soils-sandy to heavy clay. A well-drained, fairly light fertile loam with a fair moisture holding capacity is ideal. The light soils produce better quality fruits than heavy soils. Chilli crop prefers a soil reaction ranging from pH 6–7.

Varieties

CH-1: Developed by PAU, Ludhiana.

CH-3: Developed at PAU, Ludhiana.

CH-27;

Punjab Sindhuri;

Punjab Tej;

PunjabSurkh;

Pusa Jwala;

Pusa Sadabahar;

Kashi Vishwanath;

Sankeshwar.

Land preparation

Carry out ploughing for 2-3 times and clod crushing after each ploughing. Add compost or Farm Yard Manure @150-200 qtl/acre and mix well in the soil 15-20 days before sowing. Form ridges and furrows at spacing of 60cm. Apply 0.8 kg/acre of Azospirillum and 0.8 kg/acre of Phosphobacteria by mixing with 20 kg of FYM.

IMP: Do not cultivate Tomato and Chilly crop in same field or in nearby field, as pest and diseases are similar. Also spread anthracnose and bacterial disease. When it is intercropped with onion and coriander, it gives additional income also helps in controlling weed population. For nematodes control, take onion, garlic or merry gold as intercrop.

Nursery Management & Transplanting

Nursery Preparation: Form raised beds of 1 m width and convenient length. Mixsterilized cocopeat@300kg with 5 kg neem cake along with Azospirillum and phosphobacteria each@1kg.

Approximately 1.2 kg of cocopeat is required for filling one protray. 120 protrays are required for the production of 11,600 seedlings, which are required for one acre land. Sow the treated seed in protrays@1 seed per cell. Cover the seed with cocopeat and keep the trays one above the other and cover with a polythene sheet till germination starts. After sowing of seeds in nursery, cover bed with 400 mesh nylon net or thin white cloth. It helps to protect seedlings from pest-disease attack. After 6 days place the protrays with germinated seedlings individually on the raised beds inside the shade net. Water with rose can everyday upto seed germination. Drench with 19:19:19 @ 0.5% (5gm/Ltr) at 18 days after sowing.

Transplantation in Field: After 30-40 days, seedlings are ready for transplantation. For transplantation 6-8 week old or 15-20 cm height seedlings are selected.

Sowing

Time of sowing:The ideal time for raising nursery is from October end to mid of November. Cover the nursery area with 50 % shade net and cover the sides using 40 / 50 mesh insect proof nylon net. Seedlings are ready for transplantation in 30-40 days (Usually in February - March).

Spacing Use row to row spacing of 75 cm and plant to plant spacing of 45 cm.

Method of sowing: Transplantation method is used.

Seed

Seed Rate: For varieties use seed rate of 200 gm/acre and 80-100 gm/acre for hybrids.

Seed Treatment: To protect crop from various soil borne disease seed treatment is necessary. Before sowing do seed treatment with Thiram@3gm or Carbendazim@2gm/kg. After chemical treatment, treat seed with Trichoderma@5gm/kg or Pseudomonas fluorescens@10gm/kg. Keep it in shade and use it for sowing. Do watering with rosecan on daily basis. Drench the nursery with Copper oxychloride@2.5gm/ltr of water at 15days interval to prevent crop from damping off disease.

To protect against wilt, sucking pest, dip roots for 15 min in Trichoderma harzianum@20gm/Ltr+0.5ml/Ltr Imidacloprid before transplanting. Seedling inoculation with VAM supplemented with nitrogen fixing bacteria, save super phosphate by 50% along with saving of 25% nitrogen application.

Fungicides:

For seed treatment use one fungicide from the following

Fungicide name	Quantity (Dosage per kg seed)
Carbendazim	2 gm
Thiram	3 gm

Fertilizers

Fertilizer Requirement (kg/acre)

UREA	SSP	MURIATE OF POTASH
55	75	20

Nutrient Value (kg/acre)

NITROGEN	PHOSPHORUS	POTASH
25	12	12

Apply Nitrogen@25kg in form of Urea@55kg/acre, Phosphorus@12kg in form of Single Super Phosphate@75kg and Potash@12kg in form of MOP (Muriate of Potash)@20kg/acre. Apply half dose of Nitrogen and full dose of Phosphorus and Potash at time of transplanting. Apply remaining amount of nitrogen after first picking.

Also to obtain high yield take spray of MAP 12:61:00@75gm/15Ltr water at 40-45 days after transplanting at branch growing stage. To Increase yield along with to obtain more number of pickings, apply sulphur/Bensulf@10kg/acre and spray Calcium Nitrate@10gm/Ltr water at flowering stage.

Water Soluble Fertilizer

10-15 days after transplantation, spray 19:19:19 with micronutrients@2.5-3gm/Ltr of water. Then after 40-45 days spraying of 20% Boron@1gm+Micronutrients@2.5-3gm/Ltr of water

should be done. When crop is in flowering stage sprayed 0:52:34@4-gm+micronutrients@2.5-3gm/Ltr of water. In fruiting stage sprayed 0:52:34@4-5gm+Boron@1gm/Ltr of water. When crop is fruit formation stage sprayed 13:0:45@4-5gm+Calcium nitrate@2-2.5gm/Ltr of water.

Growth regulators

To control flower drop and to get good quality fruit, take spray of NAA (naphthalene acetic acid)@4ml/15 ltr of water at flower initiation stage. Care during flowering & fruit set gives upto 20% more yield. Spray Homobrassinolide@5ml/10Ltr of water at flowering thrice at 15 days gap. To increase fruit set having good quality. Spray Triaccontanol growth regulator at 1.25ppm(1.25ml/Ltr) on 20,40,60 and 80th day of planting.

Irrigation

Peppercan't withstand heavy moisture so apply irrigation only when needed. Heavy irrigation causes lanky vegetative growth and flower drop. Number of irrigation and interval of irrigation depend on soil and climatic condition. If plant show drooping at 4 pm, it is indication of plant needed irrigation. Flowering and fruit development are most critical stages of water requirement. Stagnation of water should not be allowed in nursery and field as it causes fungal infection.

Plant protection



• Pest and their control

Fruit borer:

Caterpillar eat leaves of crop afterward they enter into fruit and caused heavy loss in yield management. Collect and destroy damaged fruits and grown up caterpillars. Set up pheromone traps for *Helicoverpa armigera* or *Spodoptera litura* at 5 Nos./acre.

To control pod borers apply poison bait balls made up of bran-5 kg, Carbaryl-500 gm, Jaggery-500 gm and sufficient amount of water. If infestation of fruit borers is observed. spray Chlorpyrifos + Cypermethrin (Nurel-D/Amla) @30 ml+Teepol@0.5 ml in 12 Ltr of water

with power sprayer. Spray with Emamectin benzoate 5% SG @4 gm/10 Ltr of water or Flubendiamide 20 WDG@6 gm/10 litre of water.

Mite: These are widely distributed pest observed throughout the world. Nymphs and adults feed exclusively on the lower side of the leaves. For effective control Spiromesifen 22.9SC@200ml/acre/180Ltr of Water is sufficient

Aphid: They attack mostly in winter month and later stage of crop. They suck sap from the leaf. They excrete honey like substance and develop sooty mold i.e. blackish colour fungus on the calyx and pods thus deteriorate quality of product. Aphids also work as important insect vectors for chilli mosaic. Mosaic disease transmitted by aphids cause 20-30% loss.

To control Aphids, Acephate 75SP@5gm/Ltr or Methyl demeton 25EC 22ml/Ltr of water is used. Soil application of granular insecticides viz. Cabofuran, Phorate @4-8kg/acre on 15 and 60 days after transplanting were also effective.

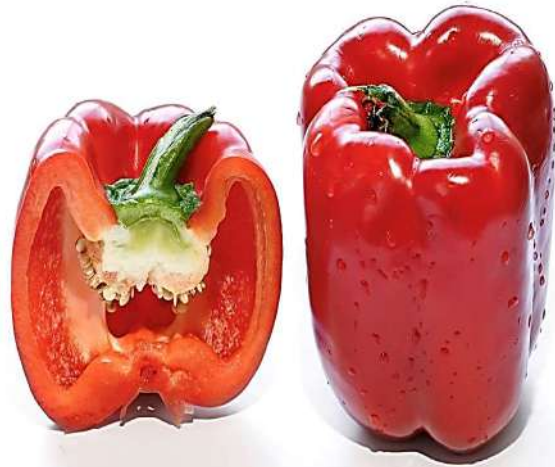
Disease and their control

- ❖ **Powdery Mildew:** White powdery growth in patches on lower side of leaves. It parasitizes the plant. In severe infestation, it causes defoliation. To control spray of Hexaconazole@1ml/Ltr of water, 2-3 times with interval of 10 days is effective.
- ❖ **Phytophthora Blight:** It is caused by fungus *Phytophthora capsica*. It is a soil borne disease Cloudy weather is favourable for spread of this disease. It causes defoliation.

Harvesting

Chilly can be harvested green or left to ripen on plant. To increase number of picking, spray of Urea@10 gm/ltr and soluble K@10 gm/ltr (1% solution of each) with 15 days interval during harvesting is beneficial.



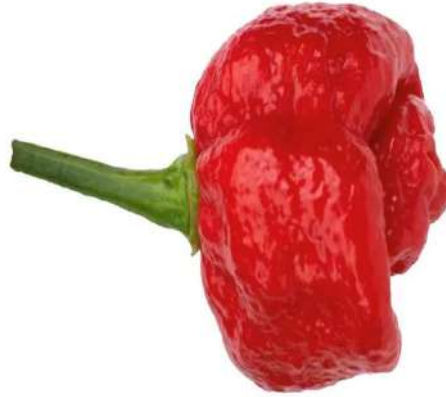


Hottest Chili of India

[Bhut Jolokia / Ghost Pepper / Bhutan pepper (*Capsicum chinense*Jacq.)]



1.



2.



3.



4.



5.

World Ranking: Hottest Chillies

1. Carolina Reaper, 2. Trinidad Morugo Scorpion, 3. Trinidad Scorpion Taylor, 4. Naga Viper, 5. Bhut Jolokia

The *Carolina Reaper* holds the title of the hottest chili in the world, boasting an exceptional level of spiciness.



Bhut Jolokia-A twig with fruit

Uses of Capsicum

Capsicum has diverse uses across culinary, medicinal, and ornamental domains.

- ✓ **Culinary Uses:** *Capsicum* is a popular ingredient in various cuisines worldwide. It is used fresh in salads, salsas, and sandwiches, as well as cooked in stir-fries, curries, stews, and sauces. Additionally, capsicum is often preserved through methods such as pickling, drying, or processing into paprika or chili powder.
- ✓ **Medicinal Uses:** Capsicum contains **capsaicin**, a compound known for its analgesic properties. It is used in topical creams and ointments for pain relief associated with arthritis, neuropathy, and muscle aches. Moreover, capsaicin is believed to have potential health benefits such as aiding digestion and boosting metabolism.
- ✓ **Ornamental Uses:** Certain varieties of capsicum plants are grown for their ornamental value due to their vibrant coloured fruits. They are utilized in landscaping, decorative containers, and ornamental gardens to add visual appeal.



AB



C



DE



Fig. Mature fruits of wild *Capsicum* species: A. *C. chacoense*, B. *C. praetermissum*, C. *C. eximium*, D. *C. annum* var. *glabriusculum*, and E. *C. flexuosum*

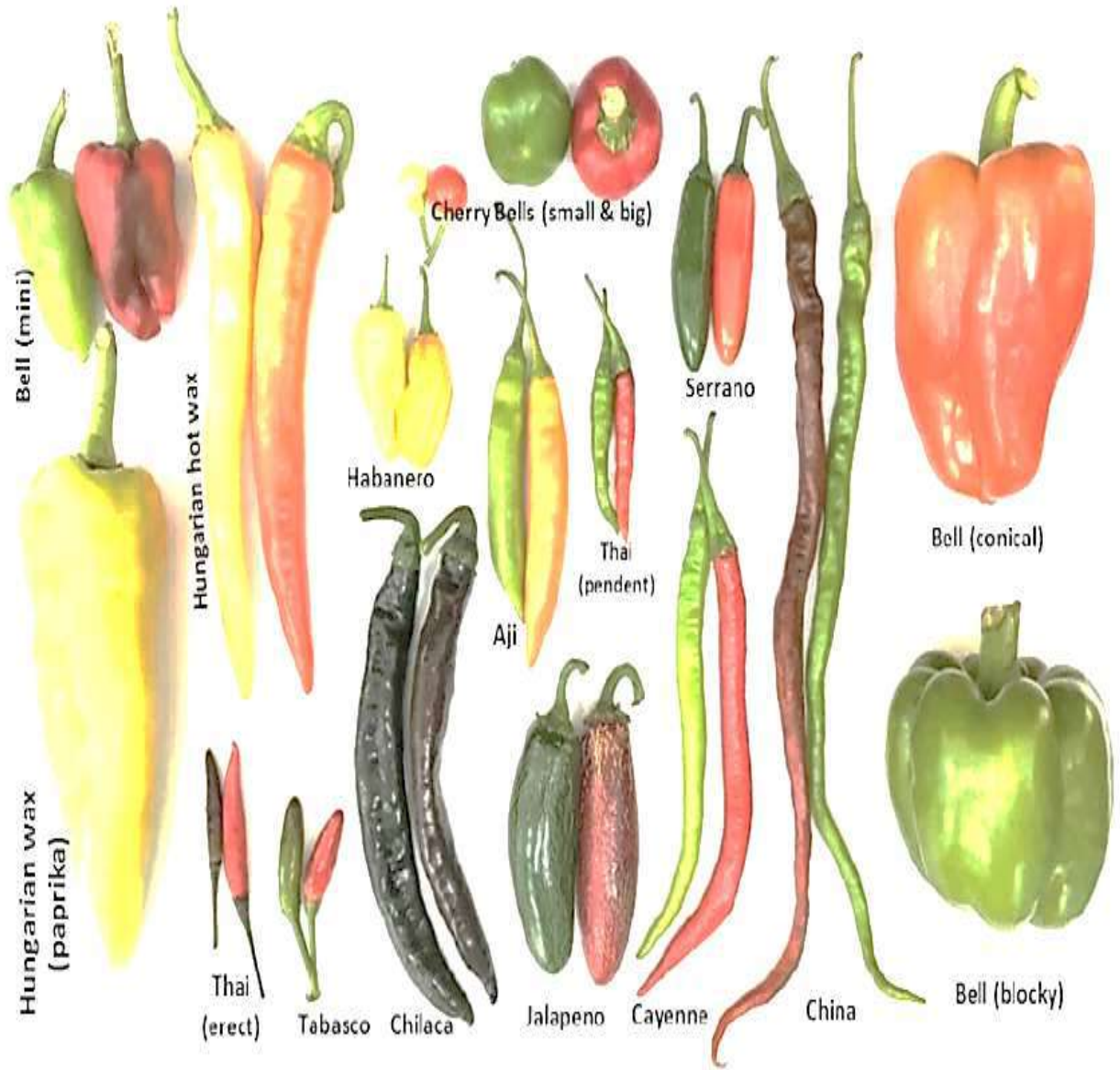


Fig: Popular pod types of Hot and Sweet peppers

Prof. A

15

NUTMEG & MACE

Nutmeg (*Myristica fragrans* Houtt.) is a spice crop belonging to the family Myristicaceae. The NUTMEG (Jayafal) of commerce is the kernel which is hard and brown, enclosed in a thin brittle shell. Surrounding this shell is aril which is scarlet in colour and furnishes the MACE (Javitri) of commerce.

Nutmeg is the seed of an apricot-like fruit of the nutmeg tree and mace is its aril, a thin leathery tissue between the stone and the pulp. Both spices are strongly aromatic, resinous and warm in taste. Mace is generally said to have a finer aroma than nutmeg, but the difference is small. Nutmeg quickly loses its fragrance when ground.

Naturally, nutmeg is limited to the Banda Islands, a tiny archipelago in Eastern Indonesia (Moluccas). Main producing countries today are Indonesia (East Indian Nutmeg) and Grenada (West Indian Nutmeg); the latter is regarded as inferior.

These spices have been appreciated since Roman times. Because of its very limited geographical distribution, nutmeg and mace became known in Europe comparatively late (11th century). Although nutmeg was available in Europe since the 13th century, significant trade started not before the 16th century, when Portuguese ships sailed to India and further, to the famed spice islands (Moluccas). During the 17th century, the Dutch succeeded in monopolizing the nutmeg trade, as they did with cloves. This situation changed only in the 18th century, when the Frenchman Pierre Poivre succeeded in smuggling nutmeg trees from the Bandas to Mauritius and thereby broke the Dutch monopoly. The British East India Company introduced this tree to Penang, Singapore, India, Sri Lanka and the West Indies.

Nutmeg also contains a volatile oil (6-16%), starch (14-25%), furfural (1.15%) and pectin (0.5-0.6%), mace contains a volatile oil (4-15%), amlodextrin (25%).

While separating the seeds from the testa and aril, some seeds are broken and such broken ones are rejected.

Origin and distribution

Nutmeg is a native of Moluccas Islands of Indonesia, East Indies or spice Islands. It is now grown in tropical countries of world, but cultivated on a large scale in the Malayan region. The British East India Company introduced this spice in India in 1800 AD. The countries producing nutmeg apart from Malaysia are Indonesia, Grenada, Sri Lanka, India, Tanzania, Mauritius, Reunion, Trinidad and Tobago and China. The major importing country of nutmeg and mace from India is Russia.

Historical Significance

Nutmeg has a rich historical significance and has been highly valued for centuries. It was one of the most sought-after spices during the European Age of Exploration and was a major driver of global trade and exploration. In the 17th century, nutmeg was so highly prized that it led to conflicts between European powers, particularly the Dutch and the British, resulting in the control of nutmeg-producing islands.

Area and production

The annual world production is approximately 8000 tonnes of nutmeg and 1000 tonnes of mace, eighty five per cent of which is produced in Indonesia and Grenada followed by Sri Lanka. Relatively small quantities are exported from India. In India nutmeg is presently grown in Ernakulam, Cannanore, Kottayam, Thrissur, Idukki, Allepy, Mylapuram, Thiruvananthapuram, Palghat and Calicut districts of Kerala (3,502 ha), Dakshina Karnataka (110 ha) and also Andaman and Nicobar Islands. Total Indian production of nutmeg and mace is 5537 and 5919 tonnes per year, respectively. In India nutmeg is also grown near couratallam of Tirunelveli district and round about the Burliar zone of the eastern slopes of the Nilgiris, Anjarakandi near Coonoor of Tamil Nadu and Karnataka. Arakuvalley in Andhra Pradesh and Wynad in Kerala are well suited for its cultivation.

Botanical description

The nutmeg tree is a medium-sized evergreen tree that can reach heights of up to 20 meters. It has dense foliage with dark green, glossy leaves that are oblong-lanceolate in shape. The branches are spreading with dark grey bark. The tree produces small, pale yellow flowers that are either male or female. Nutmeg trees are dioecious in nature (male and female flowers occur in different trees). The fruit of nutmeg tree, which is similar in colour and size to apricot, splits when ripe revealing the brilliant red arils encasing the brown nut. The nutmeg seed is encased in a mottled yellow, edible fruit, which splits open to reveal the vibrant red aril. The red arils on drying become orange in colour and are the mace of commerce. The nut is also dried until the kernel inside rattles.

The female and male trees can easily be identified by a trained eye in that male trees have erect branches and the leaves are generally smaller in size and conspicuously less leafy than female trees. The shape of the tree also is not regular. The calcium oxalate content of the leaves is also taken as a criterion for identification of sex in nutmeg.

Nutmeg contains about 10% essential oil, which is mostly composed of terpene hydrocarbons (pinenes, camphene, p-cymene, sabinene, phellandrene, terpinene, limonene, myrcene, together 60 to 90%), terpene derivatives (linalool, geraniol, terpineol, together 5 to 15%) and phenylpropanes (myristicine, elemicine, safrol, together 2 to 20%). Of the latter group, myristicine (methoxy-safrol) is responsible for the hallucinogenic effect of large nutmeg dosages (typically, one or more nuts). Oil of mace (up to 12% in the spice) contains the same aroma components in slightly different amounts.

Climate

Nutmeg thrives well in warm humid conditions in locations with an annual rainfall of 150 cm to 250 cm and temperature of 25-35°C. It grows well from sea level up to an elevation of 1300 m. Partial shade appears to be beneficial in early growth stages 1300 m.

Soil

For cultivation of nutmeg, river banks and hill valleys with clay loam, sandy loam and red laterite soils rich in humus are ideal for its growth. Both dry climate and waterlogged conditions are not good for nutmeg. It can grow well even in comparatively poor types of soils

provided the soil is not sandy and not too wet or dry. A certain amount of iron in the soil is said to be beneficial to nutmeg trees.

Varieties

There are two basic types of nutmeg valued in the world trade. They are West India and East India types. The West Indian variety is grown in the Islands of Grenada and Trinidad, while the East Indian nutmegs are highly aromatic and superior compared to that of West Indian. The fruits of East Indian nutmeg are ovoid, approximately 2.25 to 2.75 cm long, 1.75 to 2.25 cm in diameter, and longitudinally wrinkled. The colour is greyish brown, with furrows network of dark brown-veins, in which the volatile oil is found.

'Konkan Sugandha' is an improved variety of nutmeg released from Konkan Krishi Vidya Peeth, Depoli in Maharashtra.

Another high yielding nutmeg line 'A 9/4', a clonal selection has been released as IISR Vishwashree with an average yield of 1000 fruits/tree at eighth year @ 360 per hectare with an average yield of 3122 kg dry nut and 480 kg mace per hectare. This line possesses 7.3 per cent oil in nut and mace, 13 per cent oleoresin in mace and 2.5 per cent oleoresin in nut. This variety also contains 30.9 per cent butter in nut.

Cultivation

Nutmeg cultivation primarily takes place in tropical regions, with the majority of production occurring in Indonesia, followed by Grenada, Sri Lanka, and India. The cultivation process involves several steps:

Propagation

Nutmeg can be propagated by seeds as well as vegetatively by patch budding and epicotyl grafting. The percentage of success in the vegetative methods of propagation is between 38-80%. The bio-technological method of in vitro synthesis of mace has been standardised.

Propagation by seeds

Nutmeg trees are usually propagated through seedlings. For raising seedlings, only well matured large seeds of uniform size, shape, light brown colour with thick mace and low terpene content are collected during month of June and July. The seeds are dehusked and dried for a day before sowing. The seeds soon lose viability and should be sown immediately. One kilogram contains about 200 small seeds or 90 big sized seeds. The average number of small, medium and big seeds is 125 in a kilogram. Seeds are collected from regular bearing and high yielding trees, yielding more than 10,000 fruits per tree per year and having 30 g wet weight per fruit, 1 g wet weight of mace per fruit and 10 g wet weight of nuts per fruit. Seeds (7-9 g in weight) are sown three days after extraction. The seeds begin to germinate in four to six weeks. The sprouted seeds at 2-leaf stage and having 15-20 cm height are transferred to polythene bags or when the seedlings are six months old, they are potted and allowed to

remain in the pots for about a 12 to 18 months prior to planting in the main field. Regular care regarding watering is necessary for good germination.

Vegetative Propagation

Although, nutmeg can be vegetatively propagated by patch budding, epicotyl grafting, and layering. The grafting and layering methods are employed to maintain the desired characteristics of high-yielding trees. The grafting method has been reported more easy and successful. For epicotyl grafting the selected root stock should have thick stem (diameter of 0.4 cm or more) with sufficient length to give a cut of 3 cm long. The scions with 2-3 leaves, collected from the high yielding trees can be used for the grafting purpose. The stock and scion should have approximately the same diameter. A 'v' shaped cut is to be made in the stock and tapered scion is fitted carefully into the cut. The root stocks used for grafting or budding are *M.beddomei* and *M.malabarica*. Tying may be done with 300 gauge polythene strips. The completed grafts are to be planted in long polythene bags, containing coir dust as medium upto half of their length. After planting in bags the grafts are to be covered with polyethylene bags to prevent drying of scion and should be kept in a cool shaded place protected from direct sunlight. After one month, the bags can be opened and those grafts showing sprouting of scions may be transplanted in bags, containing a mixture of soil, sand and cowdung in the ratio of 1:1:1 and kept in shade. The polythene bandage covering the grafted portion can be removed after three months of transplanting. During grafting, precautions should be taken to prevent wilting of scions and to complete the grafting as soon as possible after detachment of shoots. Since the exudates from cuts pose a problem by covering the cut surfaces in the grafting process hindering union, the root stocks are to be prepared earlier than the scion, so that by the time the scion is ready, exudation in the root stock, might have ceased. Orthotropic shoots or straight growing shoots are used to get normal shaped nutmeg tree. If the lateral branches are used a shrubby spreading plant will result which is difficult to convert to a normal nutmeg tree.

Sex Problem in Nutmeg

Nutmeg is a dioecious plant and sex of the trees is known only after the trees flower i.e. about six or seven years after planting. Since the pistillate trees bear profusely it is necessary to have a maximum number of them interplanted with a few male trees for pollination.

Land Preparation and Planting

The soil should be well-drained, fertile, and rich in organic matter.

The planting is done at the beginning of rainy season, usually between March and May. Seeds are initially grown in nurseries for 12 to 18 months before being transplanted to the main field.

A spacing of 8 m x 8 m or 9 m x 9 m is required for nutmeg plantations. Pits of about 0.75 m to 0.90 m cube are dug and filled with organic manure and soil about 15 days earlier to planting.

The plants should be shaded by planting banana or *Glyricidia* to protect them from sun scorch in the early stages. Permanent shade trees are to be planted when the site is on hilly slopes and nutmeg is grown as a monocrop. Nutmeg can be grown also as mixed crop in the old coconut and arecanut gardens where light shade conditions are

suitable. One nutmeg can be planted at the centre of 4 coconut plants while in arecanut nutmeg can be planted at every third row so that within the square formed by 4 nutmeg plants, there are 9 arecanut seedlings.

Manures and Fertilizers

Farm yard manure is applied at 10 kg per pit and gradually increased to 50 kg per plant for 15 years old tree. The fertilizer doses vary with the age. In the first year after planting a dose of 20 g N, 18 g P₂O₅ and 50 g K₂O is given per plant. The dosage for the second year is 40 g; 36 g; 100 g and after five years it is 100 g; 90 g; 25 g and after fifteen year a dose of 500 g; 250 g; 1000 g of N: P₂O₅ and K₂O, respectively are applied.

The manure may be applied in shallow trenches dug sufficiently away from the base of the tree. The manures and fertilizers are applied twice a year-one in May-June and the other in September-October, depending upon the moisture availability/rainfall.

Care and maintenance

Regular weeding and irrigation are required for good growth, early bearing and higher yield. Irrigation in summer months is a must in dry areas. For 4-years old plants, 20 lit. of water per plant thrice a week are given and the quantity increased at the stages of growth. Gramaxone can be used for chemical weed control. In lighter soils the plant basins are mulched with heavy mulches of organic matter.

Pests and diseases

Pests

Scale insects (*Parasaisettia nigra*, *Pseudaulacospis cockerelli*)

Scale insects have been found to occasionally infect tender leaves and shoots generally in the nursery. Spraying of 0.05 per cent Monocrotophos or Quinalphos will control the pest infestation.

Diseases

Die back (*Diplodianatalensis*)

Drying up of mature and immature branches from the tip downwards is noticed in the affected plants. The infected branches should be cut and cut ends pasted with Bordeaux Mixture. Spraying trees with 1 per cent Bordeaux mixture is also recommended.

Fruit rot (*Colletotrichum gloeosporoides* and *Botrydeplodiatheobromae*)

Immature fruit rot and shedding are noticed in some trees without any apparent sings of infection. In case of fruit rot, the infection starts from the pedicel as dark lesions. They gradually spread to the fruit causing brownish discoloration of the fruit resulting in rotting. In advanced stages, the mace also rots emitting a foul smell.

Bordeaux mixture (1%) or Diafottan or Blue copper or Dithane M-45 at 0.5% concentration is to be sprayed when the fruits are half mature to control this disease.

Leaf blight caused by *Botrydiploдиеatheobromae*, **shot hole** by *Colletotrichum gloeosporiodes*, **leaf spot** by *Alternaria citri*, **algal leaf spot** by *Cephaleuros Sp.* **Sooty**

mould caused by *Phragmocapinus betle* and **thread blight** (*Marasmius pulcherima*, *Marasmius equicrinus*) are the other common diseases of nutmeg, which can be controlled by spraying 1% Bordeaux mixture repeatedly.

Harvesting and yield

The female nutmeg tree starts fruiting from the sixth year. But, the peak harvesting period is reached after 15 or 20 years and continue for 40 years or more. The fruits are ready for harvest in about 9-12 months after flowering. When the fruit turns yellow or orange-red, it is harvested by hand. Flowering and harvesting continue throughout the year. But, June-August or December – May is the peak period.

The fruits are ripe and ready for harvest when the pericarp splits open. Harvesting is done by a bill hook. The fruits are split open, the outer fleshy portion is removed, and the mace is manually separated from the nut. Then, the nut and mace are dried separately in sun on a drying yard. The mace should be dried for 10-15 days and the nuts for 4-8 weeks till the kernel rattles within the shell. The scarlet coloured mace gradually becomes yellowish brown and brittle when the drying is completed. The fresh pericarp can be used for making pickles, jams and jellies.

A tree of 15 years and above will yield about 1000 - 2000 or more fruits and large trees which are over 30 years of age may yield about 3000-10000 fruits per year. The yield per hectare may vary from 1000-1500 kg of nutmegs and 200-500 kg of mace per annum. Mace to nutmeg ratio is about 3:20 on weight basis. Generally if the fruit weight is 60 g, 6-7 g nutmeg and 3-4 g mace could be recovered. The rest will be pericarp. For every 100 kg nutmeg, a tree produces only 4 kg of mace.

Drying

The nutmeg seeds are dried under the sun or in drying sheds for several days to reduce their moisture content. This process helps preserve the seeds and enhances the flavour of the spice.

Grading and processing

The dried nutmegs are graded by hand according to quality, weight, shape, size and colour. After grading the nutmegs are fumigated with methyl bromide to protect them from storage pest.

Storage

Nutmeg and mace should be stored in airtight containers in a cool, dry place to maintain their quality and flavour.

The following classification have been made in nutmeg trade.

Whole and sound nutmeg: This is used in spice trade as **(a) large (b) medium and (c) small**
Sound shrivels: These are employed for grading but are usually too expensive for oil distillation.

Rejections: Considerably low-priced, this grade can be used for distillation of oil.

Broken and warmy: This grade is also suitable for oil distillation.

The grades of mace are as follows;

Banda Mace is considered to be the finest. It has a bright orange colour and fine aroma.

Jave Estate Mace is golden yellow, interspersed with brilliant crimson streaks.

Siauw Mace is of lighter colour than Banda mace and contains less volatile oil.

West Indian Mace, often regarded as the fourth grade of East Indian mace.

‘Banda’ and ‘Penang’ Maces are considered by the trade all the world over as of *superior quality*. Mace is available in the market as ‘whole’, ‘broken’ or ‘ground’.

Uses

Historically, grated nutmeg was used as a sachet, and the Romans used it as incense. Around 1600 it became important as an expensive commercial spice in Western world and was the subject of Dutch plots to keep prices high and of English and French counterplots to obtain fertile seeds for transplantation. The nutmeg sold whole were dipped in lime to prevent their sprouting.

Mace is used to flavour milk-based sauces and is widely used in processed meats. It is also added sparingly to delicate soups and sauces with fish or seafood. Pickles or chutneys may be seasoned with mace. Nutmeg is a traditional flavouring for cakes, gingerbreads, biscuits and fruit or milk puddings. Today, nutmeg's popularity has shrunken and the spice is less used, still most in Arab countries, Iran and Northern India, where both nutmeg and mace appear in delicately-flavoured meat dishes.

In Western cuisine, nutmeg and mace are more popular for cakes, crackers and stewed fruits; nutmeg is sometimes used to flavour cheese. The combination of spinach with nutmeg is somewhat a classic, especially for Italian stuffed noodles. The greatest lovers of nutmeg in today's Europe, though, are the Dutch. They use it for cabbage, potato and other vegetables, but also for meat, soups, stews and sauces. Since quite a large fraction of nutmeg is today grown in Grenada, nutmeg has entered several Caribbean cuisines. In Grenada, it's omnipresent, the locals even eating nutmeg-flavoured ice cream! Nutmeg is an optional ingredient in a famous Caribbean spice paste, Jamaican jerk.

In Indonesia, the (woody and very sour) pulp is used to make a delicious jam with fine nutmeg aroma. In Malaysia the **fleshy outer husk is crystallized or pickled and then sold as a delicious snack**. Nutmeg is a narcotic in excess quantities. It is astringent, a stimulant and an aphrodisiac. Nutmeg oil is used in perfumes and ointments.

It is important to note that consuming large amounts of nutmeg can be toxic and lead to adverse effects due to its high content of *MYRISTICIN*.



Nutmeg (Jayafal), Mace and its powder



anasi



Dried Mace (Javitri)



Mature Nutmeg fruit

Prof. AKS



anasi

Nutmeg(Dark brown)& **Mace** (Pink)



Nutmeg flower



Nutmeg tree with mature fruits

Prof. AKSingh,



Different parts of the Nutmeg plant

Declaration

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