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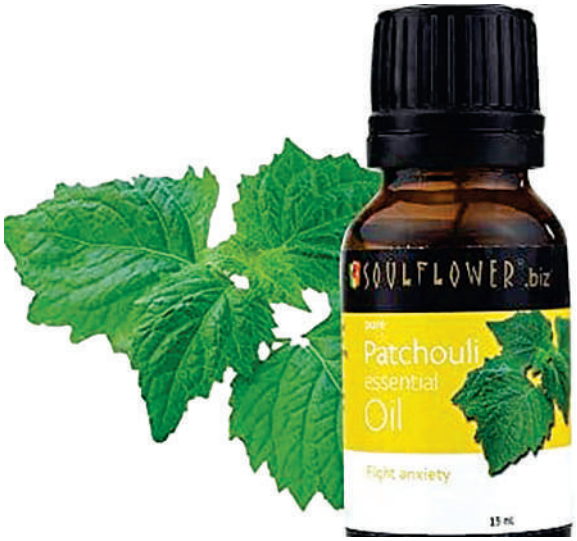
Patchouli cultivation – A boon for resource poor farmers

Patchouli has been identified as one such essential oil bearing aromatic plant with immense export potential. Patchouli oil production could be a rural based, labour intensive, low cost agro-base cottage industry, which will give large-scale employment in rural and hilly areas. Being a shade loving plant, it can easily be grown as an intercrop amidst fruit trees, arecanut and coconut plantation etc. It can also be easily cultivated in flood free fallow or wastelands. This will provide some extra income for the farmers. India can be a key player in the production of this essential aromatic oil. CSIR-CIMAP has done vast research to develop suitable varieties and agro-technology for patchouli farming.

Scope and market potential of patchouli cultivation

Patchouli belongs to family Lamiaceae and its botanical name is *Pogostemon cablin*. It is an aromatic herb. This crop is mainly cultivated for its oil and oil is used in manufacturing of perfumes, cosmetics, medicines etc. Patchouli has many species but *Pogostemon cablin* is the only superior species which is grown for oil purpose. It is perennial and erect plant. Leaves contain aromatic oil which is an essential component in the plant. In patchouli oil approx. 40-45% cablin alcohol is present. Mainly two important compounds are present in the oil of patchouli i.e patchoulol and norpatchoulenol.

Patchouli oil is one of the best fixatives for heavy perfumes with long lasting qualities. It is a perfume and is highly valued in perfumes, soaps, cosmetics and flavour industries. It is also used as a scent in several products like paper towels, laundry and air fresheners. In many countries like Japan and Malaysia, patchouli oil is also used as an antidote against venomous snakebites. Oil's scent is also used for inducing relaxation. Some Chinese medicines with its oil are used in headaches, cold, nausea, diarrhoea and abdominal pain. Patchouli oil is a vital ingredient and used as a 'base' material in perfumery business. There is no other substitute for patchouli oil, which increase its worth and in demand within the perfumery market. Consumption of patchouli oil within the world is approximate at 2000 t each year. The present consumption of patchouli oil in the world is about 800-1000 metric tonnes per annum. In India, consumption has gone up to regarding 300 tonnes each year whereas the production is below 50 tonnes. Hence, the country principally depends on imports primarily from other countries like Indonesia. India has a vast scope to enter the world market.



Improved varieties

There are some important varieties which are developed and recommended by CIMAP, Lucknow.

1. **CIM-Samarth:** It is fast growing variety, can be grown in shady as well as open field. It is tolerant to several diseases.
2. **CIM-Utkrisht:** It is a new developed variety of patchouli. Production potential of this variety is more than CIM-Samarth. It's cultivation can be done in shady area as well as in open field without much effort.

Soil requirement

For patchouli crop, the soil should be medium type, loamy and fine texture. Soil should be in well drained condition. Water logged soil should be avoided due to more nematode attack problem and root rot disease. It is a partial shade loving plant so can be easily grow in partial shady areas as well as an intercrop or main crop.

Climate

It grows well under humid condition of 70-75% humidity. Generally, coastal areas are more suitable for this crop. Beside this plenty of sunlight is required. For good growth of the crop, temperature should be in between 25 to 30°C, it is an ideal temperature for it's growth. The crop can be successfully grown in fairly heavy and evenly distributed rainfall form 150-300 cm per annum.

Field preparation

Two deep ploughings are recommended to make soil fine texture for good crop establishment. Level the field properly so that water logged condition should not be there and another advantage of land leveling is that it helps in saving of water by uniform distribution of water in the field whenever irrigation is applied.

Propagation

It is usually propagated by rooted cuttings grown in the nursery. Patchouli cuttings are made from healthy main stem of 10-12 cm length with 3-4 nodes. Leaves should be removed. These cuttings are planted in the nursery in the month of April-May. Cuttings can be grown in soil as well as in poly bags. Soil of polybag or in nursery area; it should be well mixed with FYM. Fillings in the polybag should be prepared in the ratio of 1:1 (one part of soil and one part of FYM). Before planting of cuttings in nursery area or in polybags, cutting should be well treated with fungicide like Bavistin/Dithane M-45/Captan and basal portion must be treated with rooting hormone such as Rootex and then planting is to be done in nursery

Patchouli plants in nursery

beds with 2-3 cm spacing as well as in polybags. 200 sq.m. area is sufficient for raising plants for one hectare area. Cuttings become ready for transplanting in about 8-10 weeks.

Transplanting

Transplanting of rooted cuttings is always recommended during monsoon season because of maximum establishment of crop and to minimise the cost of irrigation. Transplanting should be done at a spacing of 50 cm × 50 cm.

Manures and fertilizer

At the time of field preparation, about 10-15 ton of FYM/ha or 7 tonne/ha vermicompost should be applied and thereafter fertilizer application schedule should be started on soil test basis. Fertilizer application depends upon soil fertility status. In general, patchouli crop requires high dose of urea and potassium and lesser phosphorous. The NPK requirement is in the ratio of 150:50:50 kg/ha. Apply phosphorous and potassium at the time of field preparation and nitrogen should be applied in 4 splits at equal intervals.

Weed management

For proper growth and to get maximum yield potential of crop, the crop should be weed free, weeding should be done whenever it is required. During first 40 days, weed management is an important step, if not done, production potential of the crop is reduced.

Irrigation

First irrigation just after transplanting and rest as per need. Water logging should be avoided. Irrigation is done for 3-4 days for the first 15-20 days after planting in the field and later done at 8-15 days interval. Water logging should be avoided. Under conventional method, number of irrigation per year will be around 60 (no watering during monsoon) with each irrigation lasting for 3 hours with 5 HP motor. Under drip system of irrigation, irrigation is provided by a drip with nozzles at a distance of 45 cm from each other, which discharge water at a rate of 2 L water/hour. Irrigation for 30 minutes per day is adequate. In hot and dry season, it should be up to a maximum of 60 minutes in two installments.

Pests and diseases

Pests: Major pests of patchouli crop are leaf caterpillar and white fly. To control these, may use Dichlorophos or Monocrotophos etc. After 2-3 years of cropping of patchouli, nematode problem also arises in the field. To control nematode problem in the field, use Carbofuran @ 15-20 kg/ha.

Diseases: Leaf blight, root rot and wilt are the major fungal diseases in the crop. To control these, may apply any fungicides such as Bavistin/Captan/DithaneM-45 @ 2 ml/lt. of water or sometimes may drench in case of soil borne diseases at 3-4 days interval.

Harvesting

The crop is ready for first harvesting after transplanting in 5-6 months, when the leaves turn pale green in colour. Subsequent harvests can be done in every three months interval. Crop should be harvested with sharp cutting tool. Crop cutting should be done 20-25 cm from the apex with a sharp cutting tool. The new shoots come from the nodes and if the cutting is done at too low level, the next harvest will be affected. In rainy season, after each cutting, spray of fungicides is recommended to minimise the incidence of any fungal disease in future crop. The right time for harvesting is when the plants are about 1 m high, leaves turn pale green or slightly brown in colour. Subsequent harvests can be done every three months. Once planted,

CIM-Utkrisht

CIM-Samarth

Agro-silviculture of patchouli crop

it can be maintained for 3 years.

Post harvesting

After harvesting, the biomass is dried under shade for 4 to 5 days. Drying shed with thatched roof and mud floor is constructed with a drying area of 100 sq. m. Essential oil is extracted by steam distillation, requiring the cell walls of the leaves to be ruptured. This can be achieved by steam scalding, light fermentation, or by drying. After harvesting, biomass should be dried under shade for 3-5 days. Essential oil is extracted by steam distillation.

Yield

The yield under drip irrigation is nearly 2 times that of conventional method. Under conventional irrigation, the average yield of green leaves is 20 t (3 cuttings) per ha p.a. while it is 40 t (3 cuttings) per ha under drip irrigation. As an intercrop, 4 t dry biomass per ha per year can be expected. It has 2.0-2.5% essential oil and average oil yield is 60-75 kg/ha.

Economics

The cost of cultivation is ₹ 50,000 (per ha) while the income is ₹ 1,50,000 (per ha) giving a net profit of ₹ 1,00,000 (per ha).

SUMMARY

The current production of patchouli oil in India is not sufficient to fulfill domestic demand and the country has to depend upon massive import. Hence, to meet the country's demand and realizing the export potential of oil, increase in area of cultivation and production of patchouli oil has to be stressed. Large-scale production of good quality patchouli oil is quite possible in India, which may provide an economically viable option to the traditional agriculture and shifting cultivation practices. Patchouli oil production could be rural based labour intensive, low cost agro-based cottage industries that will generate huge employment opportunities for resource poor farmers.

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Soursop – A wonder fruit

Soursop (*Annona muricata* L.) which belongs to Annonaceae family is an evergreen tree species known for its anti-cancer properties, due to its annonaceous acetogenins content. It is a native of Central America and bears the largest fruit among Annonas. It is mostly distributed in tropical and subtropical regions of the world. In regions where sweet fruits are preferred, as in South India and Guam, the soursop has not enjoyed great popularity. Soursop grows on a limited scale in Southern India, in states like Tamil Nadu, Karnataka, Andhra Pradesh and Kerala. It also thrives wild throughout the Southern Sub-tropical India.

THE soursop is truly tropical. It does not tolerate frost and grows well in well-drained and semi-dry soil up to an elevation of 300 msl. The optimal range of latitude is between 27°N and 22.5°S. It grows and produces well at 21 to 30°C, being very sensitive to severe changes in temperature, especially if the limit of 12°C is reached. Young trees in exposed places are killed only by a few degrees of frost. Temporary defoliation and interruption of fruiting occurs when the temperature drops near freezing. However, good productive orchards are found at altitudes of up to 1,100 m.

Soursop (*Annona muricata*) has three general classification: sweet, sub-acid and acid and then subdivided as round, heart-shaped, oblong or angular and finally classed according to flesh consistency which varies from soft and juicy to firm and comparatively dry. Some popular annonas are the true custard apple, or bullock's heart or Ramphal (*A. reticulata* Linn.), the sugar apple or sweetsop or Sitaphal or Custard apple (*A. squamosa* Linn.) and the cherimoya (*A. cherimola* Mill.). The tree is low-branching and bushy but slender because of its upturned limbs, and reaches a maximum of 7.5-9 m in height. Young branchlets are rusty-hairy. The leaves, normally evergreen, are alternate, smooth, glossy, dark-green on the upper surface, lighter beneath; oblong, elliptic or narrow-obovate, pointed at both ends and highly aromatic when crushed. The flowers, which are borne singly, may emerge anywhere on the trunk, branches or twigs. They are short-stalked, 4 to 5 cm long, plump, and triangular-conical, the three fleshy, slightly spreading, outer petals yellow-green, the three close-set inner petals pale-yellow. Soursops are more or less oval or heart-shaped, sometimes irregular, lopsided or curved due to improper carpel development or insect injury. They range in size from 10-30 cm long and up to 15 cm in width, weight ranges from 0.3 kg up to 6 kg compound and covered with a reticulated, leathery-appearing but tender, inedible, bitter skin from which protrude few or many stubby, or more elongated and curved, soft, pliable "spines". The tips break off easily when the fruit is fully ripe. The skin of the immature fruit

Soursop tree

Flower bud

Flower

is usually dark-green, becoming slightly yellowish-green before the fruit is soft to the touch. The inner surface of the skin is granular and separates easily from the mass of snow-white, fibrous, juicy segments-much like flakes of raw fish-surrounding the central, soft-pithy core. In aroma, the fruit is somewhat pineapple-like, but its musky, sub-acid to acid flavor is unique. Most of the closely-packed segments are seedless. In each fertile segment there is a single oval, smooth, hard, black seed, 1.25 to 2 cm long; and a large fruit may contain a few dozen to 200 or more seeds. The fruit consists of about 67.5% edible white pulp with a pleasing fragrance and flavor. It is a good source of vitamins B and C with some calcium and phosphorus.

Food and medicinal uses

It has numerous uses. The young green fruits with seeds that are still soft can be cooked as vegetable. When ripe, the flesh can be eaten off hand or as dessert, or processed into candies, jams and jelly. Its juice is used for flavoring or packaged into refreshing guyabano drinks. The leaves are used as herbal medicine. Because the tree is small and tolerant of partial shade, it can be intercropped with coconut or with large fruit trees like mango, durian, avocado and jackfruit. Soursop leaf contains annonaceous acetogenins which exhibited significant inhibitory effects against six human cancer cell lines: lung, breast, colon, pancreatic and kidney carcinoma. It has also been found to contain compounds which were responsible for inhibiting uric acid formation in hyperuricemic induced lab wistar rat and it shows potential for developing medicine to cure gout. Soursop Leaves Crude Extract (AMCE) exhibited cytotoxicity toward breast cancer cell lines and reduced the tumor's size and weight in lab mice. Thus it is a promising candidate for cancer treatment especially in breast cancer as an alternative to conventional drugs. Extracts of *Annona muricata* and *Annona reticulata* inhibited the growth of *Plasmodium falciparum*, a malaria causing organism. The aqueous extract of *Annona muricata* (Graviola tea) has shown considerable antioxidant potentials. The bark, leaves, fruit, roots and seeds are known since long for various medicinal uses. The fruit and juice is used against worms and parasites, to cool down fevers, to increase lactation after childbirth. The seeds can be crushed and then used against internal or external parasites, head lice and worms. The tea prepared from the leaves is used as a sedative and a soporific (inducer of sleep) in the West Indies and Peruvian Andes. This infusion is also used to relief pain or for antispasmodic purposes. For liver problems, leaf tea is used in the Brazilian Amazon. Traditionally it is used in medicinal herbal drugs to cure various diseases such as for diarrhoea (fruit), cough, hypertension, rheumatism, tumours, cancer, asthma, childbirth, lagtagogue (fruit), malaria, tranquilizer, skin rashes, parasites (seeds), worms (seeds), liver problems, arthritis (used externally), etc. The leaf decoction is lethal to head lice and bedbugs. The wood is pale, aromatic, soft, light in weight and not durable. It has been used for ox yokes because it does not cause hair loss on the neck. The roots of the tree are employed as a vermifuge and the root bark as an antidote for poisoning. Nowadays people are more aware of the detrimental effects of Allelopathic medicine. So, they are starting to look for alternative medicine, which is eco-friendly and gives no side effects. Moreover, taking delicious fruits as medicine also gives an immense pleasure to the patient thereby giving an added psychological push to the healing process. People are willing to pay any amount for a side-effects-free alternative medicine. Tea prepared from soursop leaves and stem has recently been gaining wider popularity and shade dried leaves and stem fetches very premium prices in e-commerce vendors. It is more convenient to store and transport dried leaves and stem as opposed to fruits which are highly perishable and may not ripen properly in fluctuation of storage temperature. Therefore, due to changing market demand, leaf production of soursop would be a lucrative business since the leaves contain annonaceous acetogenins.

Propagation and planting

Soursop can be propagated from seed and by budding. The height of the plant is not greatly affected by budding and the majority of producers prefers using grafted

At fruit setting stage

Fruit

seedlings rather than seeded seedlings. Propagation by seed or graft is done in plastic bags in a growth medium that varies from region to region. The constituents in the growth medium in the nursery phase are very important. Depending on the material and quantity used, there is the possibility of interfering with seed germination and of phytotoxicity burning the young leaves and causing the death of the seedlings. Poor emergence of soursop seedlings is a result of poor storability of the seeds. Soursop seeds lose viability easily and do not store for a very long time and are, therefore, best sown without delay. Soursop has thick black seed coat that reduces water inhibition during the first stage of germination and therefore requires some pre-sowing treatments to enhance germination and seedling emergence. It is preferable to select only the sunken seeds when soaked in water and sowing right after extraction. The land planting field should be deep ploughed and leveled. In normal practice a spacing of 4 to 6 meters is recommended depending on climate and soil type. In high density planting, 2.4 × 2.4 m of spacing is adopted in Puerto Rico. Pit of 60 × 60 × 60 cm size are dug and filled with a mixture of 3:1 top soil and compost. It is preferable to plant in early evening or on cloudy days. Plants should be 8-12 months old and 50-90 cm in height. Plants should be watered immediately after transplanting.

Training and pruning

Soursop trees usually attain symmetrically conical shape and are adapted to the central leader system. The fruits are borne on the lateral branches and hangs down for ease of harvesting. Little pruning is not required after training of the trees. Branch pruning is done to promote uniform air movement and light penetration. Diseased, interlocking and weak branches should be removed.

Flowering and pollination

In India, soursop flowers and fruits during the months of April to October. It require 27-35 days for flower bud development from initiation to anthesis. Flowering can extend from 3-6 months. The flowers exhibit both dichogomy and a protogynous nature. Anthesis takes place between noon and 8 PM and 4 AM to 8 AM with pollen release occurring between 4 AM to 8 AM.

Manuring

Adequate fertilization of the planting pit is a basic condition for excellent seedling growth that will result in a productive adult plant producing good quality fruit. The amount of fertilizer to apply is based on soil analysis and on the volume of pit. It is recommended to apply 40 g nitrogen and 60 g potassium to one year old plant. Four and onwards, 180 g nitrogen, 120 g phosphorus and 180 g potassium should be applied to each tree. In addition adequate quality of organic manure should be applied. Fertilizer should be applied around the plant but only lightly incorporated into the soil to avoid damaging the developing root system. The required quantity of N and K fertilizer should be divided into three doses. First dose should be applied at onset of rainy season, second in the middle and third at the end of the rainy season. Water stress should be prevented to produce good crop.

Harvest and yield

The fruit is picked when full grown and still firm but slightly yellow-green. If allowed to soften on the tree, it will fall and crush. It is easily bruised and punctured and must be handled with care. Firm fruits are held a few days at room temperature. When eating ripe, they are soft enough to yield to the slight pressure of one's thumb. Having reached this stage, the fruit can be held 2 or 3 days longer in a refrigerator. The skin will blacken and become unsightly while the flesh is still unspoiled and usable. Studies of the ripening process in Hawaii have determined that the optimum stage for eating is 5 to 6 days after harvest, at the peak of ethylene production. Thereafter, the flavor is less pronounced and a faint off odor develops. The sour sop is a shy-bearer, the usual crop being 12 to 24 fruits per tree. In Puerto Rico, production of 5 to 8 tonnes per ha is considered a good yield from well-managed orchard. A study of the first crop of 5 year-old tree in Hawaii showed an average of 42.5 kg fruits per tree. Yield was slightly lower during next year. The 3rd year, the average yield was 78 kg per tree. At this rate, the annual crop would be 16 t/ha.

In India, though soursop has been introduced long back, it is grown very limited scale in the plantations. The average productivity of soursop in India is about 25-40 kg per tree. A cost and return analysis prepared by the Bureau of plant Industry for guyabano planted at 5 m × 5 m spacing shows a progressive increase in yield starting 4 years after planting with a fruit yield of 4.8 tonnes per hectare and a net profit cost ratio of 47.56% in the seventh year. In the 10th year, net profit cost ratio is

about 200% with a projected yield of 11.8 tonnes per hectare. Data obtained from Hawaii, however, disclosed that with 215 trees per hectare fruit yield in the 6th year was 18 tonnes per hectare.

Harvested fruit

Post-harvest handling

High temperature can cause premature fruit ripening and fermentation of the fruit. Fruit is harvested when fully mature and firm. The skin colour changes as the fruit approaches maturity. The immature soursop is dark green and shiny and becomes slightly yellowish green at maturity. Sour soup respiration begins to increase within a day after harvest and reaches its peak at the sixth to eighth day. Total soluble solids increase from around 10-16% during the first 3 days of ripening. The major titrable acids are malic and citric acids. After day 5 to 6 titrable acidity, produce a bland flavour and even slight odour. The optimum edible stage is at days 6-7, which coincide with ethylene production. Fruit is hand harvested and put into boxes or baskets. Harvested fruit should be handled with care to prevent bruising of the skin. Firm fruit are held after harvest for 4-7 days at room temperature before softening begins, optimum quantity processing occurring 5 and 6 days later. The skin of ripening soursop gradually turns dark brown to black, but the flesh is unspoiled. Storage below 15°C causes chilling injuries and failure to develop full flavour. At lower temperatures, skin discolouration rapidly occurs. It can be used as fresher for processing after removal of outer skin and seeds.

Export potential

In the large cities of tropical America, there is a good demand for the fruits at all the times of the year. This demand is not yet adequately met. Hence there is larger scope for exporting soursop fruits to tropical America.

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