



ORGANIC CULTIVATION OF PERENNIAL SPICES IN THE ANDAMAN AND NICOBAR ISLANDS

Ajit Arun Waman



2025



ICAR-CENTRAL ISLAND AGRICULTURAL RESEARCH INSTITUTE
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Disclaimer

In cases where information/ studies based in Andaman and Nicobar Islands are not available, authors have used the appropriate technical recommendations from various organizations working on these crops with location-based modifications, wherever required. The purpose of the same is to spread the good technologies among the island stakeholders.

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BLACK PEPPER
(Piper nigrum L.)

1. BLACK PEPPER (*Piper nigrum* L.)

Introduction

Black pepper is a native species of the Western Ghats of India and is known as the King of Spices. It is commercially cultivated in the southern states of India and is an introduced species in the Andaman and Nicobar Islands. Black pepper is commercially cultivated in parts of these islands, while some farmers cultivate it in their backyards for own uses. It is a perennial, climbing evergreen plant, growing to a height of about 10 m over the live or dead supports. Fruits are aromatic and pungent due to the presence of alkaloid- piperine. Though the crop is sensitive to biotic stresses, it could be grown organically, provided appropriate care is taken in some crucial aspects.

Varieties

Panniyur -1 is a high yielding hybrid, suitable for commercial cultivation under open condition; whereas Panniyur-2 and Panniyur-5 are shade tolerant varieties suitable as intercrop in coconut and arecanut plantations. Experiments at ICAR-CIARI, Sri Vijaya Puram suggested that improved varieties IISR-Malabar Excel and IISR-Girimunda are suitable for cultivation on gliricidia standards. In areas with high water table, varieties such as IISR-Thevum and IISR-Sakthi could be used as these could reduce the incidence of foot rot, which is prevalent in these islands. Further, use of black pepper grafted on Brazilian pepper (*Piper colubrinum*) as rootstock could help in reducing the foot rot disease. However, whenever grafted pepper is used, provision of irrigation during dry period is required to avoid drying of plants.

Propagation

Vegetative propagation using stem cuttings is desirable in pepper to obtain true to type plants. Potting mixture (soil: farmyard manure, 1:1) should be added with *Trichoderma harzianum* (10^7 cfu/g) @ 1 g/kg of mixture and mixed well to protect against soil borne infections. Runners from heavy yielding vines could be used for preparation of two to three node cuttings during March. Leaves should be trimmed off and such prepared cuttings could be planted in polythene bags filled with the said substrate. Bags could be maintained in naturally ventilated polyhouse or shade net house. Provision of micro-sprinklers is required to maintain desired microclimate in the nursery. Cuttings will put forth new leaves and when the leaves turn mature, they could be used for planting during May - June.

Alternatively, serpentine layering has been identified as a superior method of propagation as each node gives rise to one plant. In this method, mother plants are maintained in the polybag and the growing shoot is trained over the filled in polybags arranged in front of each mother plant in a series. As and when the shoot grows, the node with cream-white roots is pressed against the substrate of polybag and secured using an inverted 'v' shaped clip made up using a coconut leaf midrib. The pressed nodes are then covered with substrate for facilitating quick development of roots. As the vine grows forward, the mother plant and its succeeding plants are detached from backside and subjected to hardening. The remaining plants are carefully shifted backwards so that the last plant occupies the original position of the mother plant,

while the growing end is continued for production of more plants in the next batch.

Planting and aftercare

Pepper is mostly cultivated as a mixed crop or intercrop in the plantations of arecanut and coconut in the islands, wherein these plants serve as standard for the pepper vines. In coconut, two vines per standard and in arecanut one vine per standard could be planted leaving about 1.2 m and 0.6 m distance from the stem, respectively. Pits of about 60 cm × 60 cm × 60 cm should be dug, leaving one meter distance from arecanut and 1.5 m from coconut base to avoid overlapping of root systems. However, in cases wherein climbing of palms is desirable for harvesting of nuts, direct training over palms could pose difficulties. For this, standards such as gliricidia could be planted in the interspaces of coconut and arecanut and black pepper vines could be trained over those. Three rows of gliricidia could be accommodated in between two rows of coconut at a spacing of 2 m × 2 m, while one standard could be planted at the centre of four arecanut palms.

Recently, ICAR-CIARI, Sri Vijaya Puram has developed a high-density planting system for intensive cultivation of black pepper under open conditions. In this method, black pepper vines are grown on gliricidia as a standard at 2 m × 2 m spacing. Under this system, about 2,500 vines of pepper could be accommodated in one hectare. In other cases, normal spacing of 3 m × 3 m could be followed. Pits should be added with well decomposed farmyard manure (5 kg), neem cake (1 kg) and rock phosphate (150 g) and filled with top soil. At the centre of the pit, small planting

hole could be scooped out considering the size of the polybag in which the plants were raised. After planting, the soil around the plants should be pressed firmly and watering should be done. Providing mulching helps in retention of soil moisture.



*Planting of black pepper on glyricidia in the interspaces of coconut.
Use of weed mat in the interspaces help in management of weed
menace*

Crop management

For application of manures, basins of about 10-15 cm depth and 50-75 cm radius should be made (depending upon plant age) at the onset and end of monsoon. Well decomposed farmyard manure of (10 kg) mixed with *Azotobater* (50 g/vine) should be added to the basins of mature vines (above 3 years old) along with 1 kg vermicompost. Application of ash @ 500 g to 1 kg/ vine depending on age of the plants is desirable for meeting

the potassium requirement. Further foliar micronutrient mixtures developed at ICAR-Indian Institute of Spices Research, Kozhikode are recommended @ 5 g/lit during May-June and September-October. Mulching of vines with green leaves @ 10 kg/plant is desirable during October onwards to conserve the moisture.



Black pepper trained on arecanut palm

Considering the acidic condition of the island soils, application of lime (about 500 g/plant) every alternate year (during April-May) is required to maintain the pH in the optimum range. Recently, ICAR-IISR, Kozhikode has developed a granular lime-based *Trichoderma* formulation- Tricholime, which could not only neutralize the soil acidity, but could also promote the plant growth while protecting them from soil-borne pathogens. In the islands, though good rainfall is received during 7 to 8 months, the plants need to be irrigated during drier parts of the year. If left unirrigated, termites are known to attack the standards as well as vines. The younger plants need to be provided with protected irrigation to avoid field mortality.

As the plants grow, the growing shoots of vine should be tied to the gliricidia, apart from pruning of vines to promote induction of fruiting branches. Similarly, the standards of gliricidia need to be pruned thrice a year i.e. August, November and April. If the standards are not showing vigorous growth, pruning could be done twice a year. Use of cover crop such as cowhage (*Mucuna pruriens*) is known to avoid soil erosion, apart from adding organic matter and nutrients to the soil. Weeds are a major issue in the Andaman Islands that can affect the yields. Hand weeding accompanied by use of brush cutter is required to keep the weeds under control. Further, observations at ICAR-CIARI experimental farm suggested that in the flat lands, use of black weed mat (110 GSM thickness) is encouraged. Though the initial investment would increase, these mats have life of 5 to 7 years and thereby reducing the labour requirement for weed control.

Pests and diseases

Under island conditions, root/ foot rot is a commonly noticed disease especially in low lying areas and during rainy season. Identification of the onset of disease is important as the disease spreads rapidly damaging the plantations completely. Providing proper drainage is must as black pepper is prone to root/ foot rot disease in poorly drained fields. Further, removal of dead and diseased vines, avoidance of movement of soil and tools from infected vines to other vines is required. As the disease is difficult to control in advance stages, biocontrol agents such as *Trichoderma* spp. are required to be applied before onset of monsoon. To avoid slow decline and nematode problem, *Pochonia chlamydosporia* (50 g/vine) along with suitable carrier such as farmyard manure or vermicompost has been recommended by ICAR-IISR, Kozhikode. Restricted use of Bordeaux mixture spray @ 1% is advocated and use of resistant varieties such as IISR-Sakthi and IISR-Thevum could be beneficial in such cases.

Harvesting and postharvest handling

The plants start bearing after 3 to 5 years of planting depending on the management practices followed. Harvesting is done from December to February in most parts of the islands. The harvesting maturity in pepper could be judged by change of colour of one or two berries on the spikes from green to yellow or red. At this time, the whole spike is plucked from the branches. If the harvesting is delayed, ripe berries may drop off thereby reducing the yield or they get foraged by the birds. Similarly, if immature berries are harvested, they tend to remain hollow. After harvesting, the spikes should be kept in

shade for a day, after which the berries could be separated from the spikes. The berries could be dried under sun over a mat for 7 to 10 days until the outer skin becomes black, shrunken and assumes characteristic wrinkled appearance of commercial black pepper with moisture content of <10%.

To improve the quality, appearance and hasten the drying process, blanching of separated berries is advocated. For this, separated berries could be taken in a basket or cloth and dipped in hot water for about 2 minutes prior to sun drying. Improper drying results in fungal contamination in produce thereby poisoning the produce with aflatoxins at times. Hot air drying has been recommended to eliminate the contamination. As the islands get unseasonal rains at times, produce dried in different batches (especially those involving short exposure to rains) should not be mixed together. The produce is then packed in grain storage bags or multi-layered packs to avoid moisture absorption during the storage.



Ripening of one or few berries indicating stage of harvesting of the spike



Fresh berries separated from spikes (left), blanching (centre) and blanched berries (right)



Sun drying of blanched berries on clean mats



CINNAMON **(*Cinnamomum verum*)**

2. CINNAMON (*Cinnamomum verum*)

Introduction

True cinnamon (*Cinnamomum verum* L.) is a native plant of Sri Lanka and Southern parts of India. It is commercially cultivated in the states of Karnataka, Tamil Nadu, Kerala, coastal Maharashtra, while it is being promoted in non-traditional states such as Uttarakhand and northeast India as well. It is an introduced species in Andaman and Nicobar Islands, and has very good scope for cultivation as intercrops in the existing coconut and arecanut plantations. However, most of the markets are regularly selling bark of Chinese cinnamon/ cassia (*C. cassia*), Indonesian cinnamon (*C. burmanii*), Vietnamese (*C. loureiroi*) and Indian cassia (*C. tamala*) in the name of cinnamon; the cassia (source of potentially harmful coumarin) being the dominant one.

Promotion of true cinnamon, which contains least content of coumarin is desirable. As of now, cultivation of cinnamon is restricted to only a few states on limited scale and promotion of its cultivation is desirable to reduce the import of cinnamon/cassia in the country. Most of the existing plantations of cinnamon are of seedling origin and hence, wide variability is seen in the growth, yield as well as quality parameters. In order to improve the yield and quality of this valuable spice, scientific cultivation and processing is desirable.

Varieties

Peeling is the most important yet time consuming operation in the cinnamon cultivation and labour cost is

the prime factor contributing to the cost of production. Hence, selection of varieties which are easy to peel, adaptable to the island climate, high yielding and of superior quality are a pre-requisite. For open cultivation in the islands, variety Konkan Tej has been found to be the most suitable, while for intercropping purpose, Yercaud-1 was promising. Further, ICAR-CIARI, Sri Vijaya Puram has identified superior germplasm of cinnamon for cultivation in the islands.

Propagation

Though seeds are the easiest means of multiplication of cinnamon, considering the wide variability in the population, adoption of vegetative propagation technique is advocated. Under island condition, efficient air layering technique has been developed at ICAR-CIARI, Sri Vijaya Puram. For this, terminal shoots of about 25 cm length are selected during first week of July from the mother plants of the improved varieties. Leaves should be removed from the region (25 cm from terminal end) and a ring of bark of about one-inch size should be removed from there using a stainless-steel knife. The exposed wounded region (between two cuts) should be scraped gently using the knife and covered with moistened coir pith compost followed by wrapping with a transparent polythene. Use of rooting hormones is known to promote production of proper roots. Though rooting can be obtained even without use of rooting hormone, use of hormone (IBA 4,000 ppm) is desirable to get uniform, profuse rooting which in turn facilitates better success. The wrapped polythene should be secured tightly with a thread.

Use of coir pith compost facilitates rooting within 45 to 50 days and the roots could be seen through the polythene. Such layers should be harvested from the plant and coir pith compost should be removed by dipping the cut end of the layer inside water. Leaves should be cut to retain 1/4th of its length and layers should be planted in the polybag filled with soil and farmyard manure (1:1, v:v) as substrate. Hardening should be done in naturally ventilated polyhouse or shade net house with intermittent micro-sprinkler facility. New leaves appear in these layers within few days, which does not necessarily suggest success of the layer and one should wait till the new leaves turn mature. Layers could be used in the subsequent monsoon for planting purpose.

In cases where improved varieties are not available and large number of plants are required, seedlings could be raised from available seeds. However, during the nursery, seedlings showing red/ purple new flush should be retained and green flush types should be removed. Seedlings are considered ready for planting when they reach about 30 to 40 cm in height.

Planting and aftercare

Cinnamon is a hardy crop that grows well in the warm and humid climate of the Andaman Islands. Cultivation of cinnamon could be done as an intercrop or sole crop, especially on the farm boundaries. Commercial plantations in coconut and arecanut as intercrops are desirable. Cinnamon in its natural habitat grows as a large tree and the same could be seen in plants which are not maintained in the farm or plants which are left

unharvested. For commercial cultivation, pits of about 45 cm × 45 cm × 45 cm size should be dug out at 2 m × 2 m spacing. In the coconut orchards, between two rows of coconut, three rows of cinnamon could be accommodated.

Similarly, cinnamon could be successfully cultivated as an intercrop in well-spaced arecanut plantations (2.7 m × 2.7 m), in which one air layer of cinnamon could be planted at the centre of four arecanut palms. Planting should preferably be done during onset of monsoon. Pits should be added with well rotten farmyard manure (6 to 8 kg) and mixed well with top soil. The pit should be leveled and planting hole should be scooped out to match the dimension of the polybag in which the plants have been raised. Planting material should be carefully placed in the hole and soil around the plants should be pressed firmly to avoid any gap between the roots and soil. Plants should be irrigated immediately after planting.

Crop management

The plants should be covered with agro shade net (50%) or tree guards to protect any damage from the sun during initial period of establishment (up to 2 years), after which it can tolerate the open sun as well. For this, about 1.2 m high shade net should be secured around the plants using wooden poles. Application of farmyard manure (10 to 15 kg) or vermicompost (2 kg) is beneficial. Application of green leaf manures such as gliricidia (8 to 10 kg) in the basins could supplement the nutrients to the soil. Application of Vesicular Arbuscular Mycorrhiza @ 3 kg/tree was found to be improve growth and yield of cinnamon under Tamil Nadu conditions. Plants should be irrigated during the dry

period i.e. January to May to protect the crop from drying. Use of drip irrigation is recommended as it saves water and promotes plant growth.



Use of tree guards to provide shade to young plants

Pests and diseases

No serious pests or diseases are noticed in cinnamon in these islands except for seasonal incidence of leaf eating caterpillar which is common when new leaves emerge out. As the damage is generally limited, no control is required. However, in cases with severe damage, spraying Bt formulation is beneficial. Some incidence of scales is noticed in overly shaded plantations or in nurseries, which can be managed with neem oil spray (0.5%) at three weeks interval.

Harvesting and postharvest handling

Cinnamon is a perennial plant that can grow for several decades. In cultivation, the plant is regularly pruned so

as to maintain it in the form of a short bush. This regular harvesting also keeps the above ground part of the plant lighter, while the roots grow profusely even when the plant is propagated by air layers. Thus, the general assumption that air layered plants of cinnamon could get uprooted easily in the cyclones/ heavy winds is not true. In order to form the low bush, after about 2 years of plant growth, the main shoot should be cut at about 15 cm from ground. This practice is required to promote the growth of lateral shoots and after few days, only a few well-spaced straight growing shoots should be retained. These shoots get ready for harvesting when the branches attain cricket stump size (3.5 to 4.0 cm) thickness. Thinner branches though produce quality quills, the yields are generally reduced; while if the branches are allowed to grow further, the thickness of bark also gets increased with reduction in aroma. This means, thicker bark could give higher yields but the oil content is generally reduced. Hence, to get optimum yields with superior aroma, selection of cricket stump size shoots is desirable. After first harvest that generally occurs after 4-5 years from planting, the plants could be harvested every alternate year.

As suggested earlier, harvesting is the most labor-intensive step in cinnamon cultivation. Ease of harvesting is possible if the right practices as mentioned in this literature are adopted. Harvesting should be done in the morning hours, when the sap flow in the plant is good. To judge the readiness of the stump for harvesting, a test cut is given in which a small triangular cut of about 1 cm is given on the selected stem using a sharp knife. The bark should be then carefully lifted to see if the triangular part



Development of new sprouts after pruning/ harvesting (left) that forms stems for subsequent harvesting (right). Retention of 4-5 well spaced stems is desirable



Inward curling of the harvested bark during the process of drying

of bark comes out in single piece easily. Only such stems should be harvested, otherwise the process may get laborious. Considering the extended rainfall in the islands, harvesting could be done almost throughout the year, except for the dry spells. However, plants showing new leaves, flowers or fruits should be avoided. Immediately after harvesting, the stem pieces should be placed in the bucket/ container holding water till the harvesting is completed. This avoids drying of the sap and facilitates peeling. The stems are then made into smaller pieces of workable sizes and any branches/ knots on the stem should be removed.

The first step in the processing is scraping of the outermost bark using a stainless steel knife. The green layer of the inner tissue should also be carefully scraped off and such stems should then be taken for the subsequent step i.e. rubbing. Rubbing is the most laborious operation in which the scraped pieces are carefully rubbed using a brass rod so that the inner sap flow of the bark is improved. Recently, ICAR-CIARI has developed and patented the design of Dweep CinnRub- a novel cinnamon bark rubbing tool, which is a handy and efficient tool suitable for this purpose. This tool not only reduces the time but is also comfortable for the users as against the traditional materials used.

After rubbing of the stems, using a sharp knife, two circular cuts (rings) should be made on the bark, 15-20 cm apart (or as per the length of bark intended). A straight cut should then be made to join these two circular cuts. Using a knife, the inner bark should be peeled out from

one end and carefully worked to remove the complete bark in an opened tube-like fashion. This process followed by partial drying makes the peeled bark (quill) curl inside. The peeled bark is then dried in shade till the dried quills make fracture sound upon breaking. This may take two to five days depending on the weather conditions. In cases wherein humidity is high, the produce could be given a final drying of few hours under the sun. Otherwise, sun drying of produce should be avoided as it results in loss of aroma of the produce.

Mechanical drying has also been identified as a promising option for superior drying of cinnamon provided the produce is monitored regularly to avoid over drying and complete loss of aroma. Appearance of black fungus on the inner side of dried bark is a commonly observed issue in the island; which is mainly caused due to under drying of the produce or improper storage conditions. The produce, after proper drying, should be immediately stored in air tight containers. For marketing, the farmers could make small packets of dried produce using a food grade vacuum sealer pouch of above 90-micron thickness and store in a cool and dry place.



INDIAN BAY LEAF
(*Cinnamomum tamala*)

3. INDIAN BAY LEAF (*Cinnamomum tamala*)

Introduction

Tejpat, *tejpatta* or *biryani patti* is an important tree spice cultivated in the Andaman Islands. The term Bay Leaf is a wrongly used term for it as this name represents a completely different species (*Laurus nobilis*) of the same family, while Indian Bay Leaf is the correct term for it. Tejpat is a high-volume spice crop compared to other spices and the islands' hotel industry could provide good marketing opportunities to the local produce. A few plants in the backyards could serve as a regular source of income to the island farmers, besides meeting the household requirements. Tejpat is a hardy species, which is found to be grown in the foothills of Himalayas, to the coastal warm and humid regions of the country including Andaman Islands. Considering its wider adaptability, it could be successfully cultivated under open as well as intercropping systems in the islands.

Varieties

ICAR-CIARI, Sri Vijaya Puram has developed the first improved variety Dweep Tej 1 of tejpat for cultivation under the island conditions. The variety is characterized by high leaf yield of about 1 kg of dried leaves per meter of harvested stem, high dry recovery of 52.8%, better retention of colour on drying and good oil content (0.5%).



Dried leaves of Dweep Tej 1 variety of tejpata

Propagation

Under the island condition, no fruit set is seen in this crop, as noticed in the hilly regions in mainland India. Hence, adoption of vegetative propagation is the only means to multiply tejpata here. For this, air layering technique standardized at ICAR-CIARI, Sri Vijaya Puram could be used. Air layering should be done in the identified superior mother plants during monsoon. Terminal shoots of about 25 cm length should be selected, leaves should be removed from this region and two circular cuts should be given about one inch apart to remove the ring of bark using a stainless steel knife. To avoid joining of the wounded region through callusing (tissue deposition without rooting), the wounded region between two cuts should be scraped gently using the knife. The circular cut made towards the tip side of the shoot should then be covered with moistened coir pith compost substrate,

wrapped using a transparent polythene and secured tightly with a thread. Use of rooting hormones is known to promote production of proper roots. About 45 to 50 days are required for complete development of roots which could be seen through the polythene. Rooted layers should be harvested from the plant, substrate should be removed and planted in the polybags filled with equal proportion of soil and farmyard manure. While subjecting the layers for hardening, leaves should be cut to retain 1/4th of its length and hardening should be done in naturally ventilated polyhouse or shade net house with intermittent micro-sprinkler facility. Layers could be used in the subsequent monsoon for planting purpose.

Planting and aftercare

Leaves are the economic part of this crop and harvesting of crop causes pruning of the tree. Thus, a closer spacing of 2 to 3 m between the trees from both sides could be followed in commercial cultivation. Planting could be done at the centre of four arecanut palms spaced at 2.7 to 3.0 m apart. Pits of about 45 cm × 45 cm × 45 cm size should be dug at the identified spots and filled with well decomposed farmyard manure (6 to 8 kg). Air layers should be planted by scooping out soil of polybag size and placing the layer in it. Good contact between the soil and roots is required, which could be ensured by firmly pressing the soil surrounding the plant.

Crop management

Plants grown as intercrop get sufficient shade and hence, provision of shade from all the sides is required only when it is grown under fully open condition. For this,

50% shade net of about 1.2 m height should be secured using wooden poles from all the sides of the plants. This is required to be maintained for about two years to ensure good field establishment and vigorous growth of the plants. Irrigation during the dry period i.e. January to May is required in the islands to protect the crop from drying. Drip irrigation is a viable option that not only saves the water but also improves plant performance.



Planting of tejpata as an intercrop in arecanut plantation with drip irrigation

Pests and diseases

With the emergence of new leaves, occurrence of leaf eating insects is generally noticed but the damage is seasonal and only few leaves get damaged. So, no control is required until the pest causes severe damage. Further, incidence of scales is noticed in the young plants, even in the nursery and spraying of 0.5% neem oil (5 ml/L of water) is recommended. Pruning and destruction of severely infested branches could be followed to reduce

the pest load in plants that are heavily infested, otherwise drying of branch as well as plants could be noticed.

Harvesting and postharvest handling

The plant grows vigorously under the Andaman conditions and thus, harvesting could be done multiple times in a year, provided the terminal shoots have mature leaves and the weather is dry. Branches could be pruned using a sharp sickle/ machete and brought to the processing area, wherein all the diseased/ infested leaves should be removed. Small branches could be separated and air dried in well-ventilated rooms. For this, branches could be hung over the ropes in a room provided with windows and fan. This is required considering the high humidity and extended rainfall in the islands. Alternatively, leaves could be separated from the branches and spread in these rooms over the clean tarpaulin/ mat. Drying of leaves in direct sun could impact the colour as well as aroma of the produce and hence, should be avoided.

The fresh leaves get reduced to about 50-55% after drying, means about 500 to 550 g dry leaves could be obtained from one kg of fresh leaves. From each branch of 1 m length, yield of half kilogram of dried leaves could be obtained. However, use of improved variety could increase the yields drastically. Improper/ incomplete drying may result in fungal incidence on the produce, which could be noticed in the form of black spots. This is a commonly seen issue in the islands and it gets worsened when the produce is not stored properly.



Dried produce of tejpatt packed in the food grade packets



MALABAR TAMARIND
(*Garcinia gummi-gutta*)

4. MALABAR TAMARIND (*Garcinia gummi-gutta*)

Introduction

Malabar tamarind is botanically close to the locally grown *kau phal* of the Andaman Islands. Considering the wide diversity of *Garcinia* species in the islands, Malabar tamarind was introduced here. The species was tested for years under island conditions and was found to perform well, thereby opening avenues for its cultivation in the islands. The dried rind of the fruit is conventionally employed as an acidulant in the state of Kerala, especially for non-vegetarian preparations. Rind being a rich source of hydroxycitric acid- an anti-obesity compound, the crop is gaining popularity for cultivation in the mainland. Promotion of its cultivation in the islands could help in diversifying the island agriculture.

Varieties

After perennial evaluation under island conditions, ICAR-CIARI has identified two selections namely, Dweep Agrim and Deep Vishal. Dweep Agrim is characterized by thinner rind (about 5 mm), medium sized fruits and closely arranged shallow ridges. Dweep Vishal is a large fruited, thick peeled and heavy yielder selection.



Bearing in variety Dweep Agrim



Bearing in variety Dweep Vishal

Propagation

Malabar tamarind is dioecious in nature and hence, use of seedlings for planting should be discouraged. Use of seedlings does not ensure fruitfulness in the trees, increases the time taken for fruiting (8-12 years) and the plants turn huge requiring more area for cultivation. Softwood and approach grafting methods have been observed to be successful for mass multiplication of Malabar tamarind in the islands. For both the methods, rootstock of 1-1.5 years age is required. Successful grafts of minimum one year age should be used for planting.

Planting and aftercare

Grafted plants could be planted 5-6 m apart on both the sides. Pits of about 45 cm × 45 m × 45 cm size should be dug out, added with 6-8 kg of well decomposed farmyard manure and filled with top soil. At the time of planting, planting holes of polybag size should be scooped in the center of the pit and root balls of the grafts should be placed carefully inside the hole. Care should be taken to ensure that the graft union is placed at least 4 inches above the soil. Soil around the plant should be pressed firmly and irrigation should be provided immediately after planting to ensure better field establishment. In case of intercropping in coconut, one plant at the center of four coconut palms could be planted following the same method.

Crop management

Grafted plants should be covered with shade net (50%) from all the sides to avoid direct exposure to the sunlight. Sprouts appearing below the graft union must be removed

periodically to avoid failure of grafts. Application of life saving irrigation especially during January to May is desirable under island conditions. Farmyard manure (about 10 kg/plant) should be applied twice during June and October by opening the basins around the plant. The quantity should be increased to 20-25 kg/plant for grown up plants. Use of weed mat (about 130 gsm) in interspaces is advocated as it could reduce the weed incidence as well as manpower required for crop management.

Pests and diseases

No incidence of serious pests and diseases is noticed under island conditions in the crop; however, at times hard scales are noticed in nursery and young plantations. The scales could reduce the vitality of the plants and spray of neem oil (0.5%) on undersurface of leaves should be followed at fortnightly intervals.

Harvesting and postharvest handling

Grafted plants come to bearing within 4-5 years of planting, while seedling plants take 8-9 years under island conditions. Harvesting season coincides with monsoon in the islands. Variety Dweep Agrim starts maturing early in the season i.e. April-May onwards. Fully ripe fruits should be harvested from the trees using a pole. Alternatively, freshly fallen fruits could also be collected from the ground. Weed mat proves advantageous in such cases as it reduces soiling of the fruits. Harvested fruits should be washed with tap water and cut using stainless steel knife. Pulp and seed should be removed and rind should be cut into small pieces to facilitate quicker drying. Considering the rainy season in the islands during harvesting period,

oven drying at 55-60 °C is recommended. This method reduces the moisture content in the produce drastically and the dried produce could then be packed in food grade packaging bags of 90-100 micron thickness. Fresh fruit yield of 130-170 kg/tree/year could be obtained, which upon drying using oven, would yield about 7-10 kg of final produce.



Mechanical drying of the rind (left) and produce after mechanical drying (right)



CLOVE
(*Syzygium aromaticum*)

5. CLOVE (*Syzygium aromaticum*)

Introduction

Clove (*Syzygium aromaticum*) is a valuable spice of the Myrtaceae family. Clove is indigenous to the Moluccas Island of Eastern Indonesia and was introduced in 1800 A.D. by the East India company to India. It is being cultivated in parts of Tamil Nadu, Kerala, Karnataka and Andaman and Nicobar Islands. Considering the requirement of maritime conditions for cultivation of clove, it could be promoted on commercial scale in these islands. The crop is amenable for intercropping and thus, could be easily incorporated in the well-spaced arecanut and coconut gardens for providing additional returns to the island farmers.

Varieties

There are no released varieties of clove available for cultivation in the Andaman and Nicobar Islands. However, superior mother plants have been identified by ICAR-CIARI for production of quality planting material of clove.

Propagation

Vegetative propagation is quite difficult in clove and hence, seeds are the only viable means of propagation. Regular bearing, high yielding mother plants should be selected for collection of seeds. For collection, the fully ripe fruits which fall naturally on the ground should be collected for better germination. Seeds are extracted from the ripe fruits, soaked in water overnight, de-husked and sown in the nursery. Seeds lose viability rapidly; hence, sowing should be carried out at the earliest possible time. Seeds could be sown in root trainers/pro-trays or sand beds

at about 2 cm depth. The seedlings show very slow growth in the initial stage and the sprouted seeds of about 15 cm should be transplanted in the polybags (25 cm × 15 cm) filled with soil: farmyard manure (1:1, v/v) for hardening for one year and again transplanted for one more year for further hardening. When the plants are about 2 years old, they could be used for field planting.



Healthy seedlings of clove ready for field planting

Planting and aftercare

Clove could be planted as a mixed crop or intercrop with other commercial crops. In case of arecanut, which are appropriately spaced (2.7 m × 2.7 m), clove could be planted at the centre of four arecanut in the first line, and the next clove would be planted leaving one arecanut row empty on both the sides. This means, clove will be planted in every alternate row and column at the spacing of 5.4 m

× 5.4 m in the arecanut gardens. In other cases, spacing of about 6 m could be followed. For planting, pits of 75 cm × 75 cm should be dug at the designated places and filled with well rotten farmyard manure (8 to 10 kg) or vermicompost (2 kg) along with top soil. The pit may be filled and planting hole corresponding to the size of polybag may be opened at the centre of the pit. The root ball is carefully placed in the planting hole after removing the polybag. Soil around the plant is firmly pressed and irrigated. Mulching with *Gliricidia* leaves (8 to 10 kg per plant) would be beneficial. Seedlings must be protected from direct sun by providing shade using shade net or other means.

Crop management

Application of well decomposed farmyard manure (50 kg) in two splits is required in mature plants. For this, shallow trenches should be made about 1 to 1.5 m away from the plants. Application of 500 g/ plant of lime is desirable as most of the island soils in clove grown areas are acidic. Plants are very sensitive to moisture stress and provision of life saving irrigation during dry period is must in clove. Use of live mulches would also be helpful. In undulated terrains, use of gravity fed drip irrigation has shown promising results under island conditions. About 8 litres of water during juvenile stage is desired. During pruning, dried, diseased and criss- cross growing branches are removed from the clove tree. This operation is also done after harvesting of the produce to maintain cleanliness of plants. Keeping the basins weed free is desirable, while slash weeding could be adopted in remaining areas.

Pests and diseases

Application of neem cake @ 1 kg per plant could help in controlling nematodes in the soil. Scale insects have been noticed to damage the crop in nursery and field condition. Removal of affected branches would help in restricting the spread of insect in other areas. Application of neem oil (0.5%) could help in reducing the insect population. Parasitoids such as *Encarsia* sp. could also cause effective parasitization to the pests. Seedling rot is seen in low lying areas, which could be avoided by providing proper drainage and avoiding planting in such areas.

Harvesting and postharvest handling

Harvesting is the most crucial and labour requiring activity in clove cultivation. In general, plants take about 5 to 8 years for first flowering and as the age increases, the yields tend to increase. Flower buds are produced on young flush and the whole inflorescence is harvested without damaging the branches. Harvesting is done when the buds attain their full size, and a pink tinge is developed on the base of the calyx. If the harvesting is delayed, the bud would open and thereby the produce will lose the quality; whereas if the buds are harvested too early, they give shriveled appearance with limited aroma. Harvesting would require multiple pickings depending on the quantum of produce and the harvester needs to be careful to not to damage the branches, which are very brittle.

The buds are then separated from the harvested flower clusters manually and buds and stem pieces/ pedicels are kept separately. Sorting is also done to separate the fruits



Identification of the correct stage of harvesting (second from left)



Cluster bearing of clove (left) and harvesting of clusters (right)



Separation of buds from pedicel before drying (left) and dried produce (right)

as well as fallen flowers. The buds are spread on the clean drying mat and subjected to sun drying for 4 to 5 days till the stem of the bud changes the colour to dark brown while rest of the bud is light brown in color. Intermittent turning of produce is desirable during drying as it facilitates uniform drying and prevents formation of mould. About 300 to 350 g dried clove could be recovered from each kilogram of fresh buds. Use of electrical or solar dryers could help in efficient drying of the produce and reduce the risk of fungal contamination especially in the wet months.



WOODY PEPPER
(*Piper pendulispicum*)

6. WOODY PEPPER (*Piper pendulispicum*)

Introduction

Woody Pepper (*Piper pendulispicum*) is a wild relative of black pepper distributed naturally in the forests of Middle and North Andaman Islands and Little Andaman Islands. The species has been traditionally consumed by a few members of the Bengali settler communities of these islands. This species is being studied at the ICAR-CIARI, Sri Vijaya Puram for facilitating its domestication as a novel crop from the Islands. DNA barcoding studies have suggested that woody pepper is a new species record for India; that means it is found distributed in the Andaman Islands alone and not in mainland India. Due to this exclusivity, there is good scope for promoting it in the islands as a mono crop as well as intercrop. Studies at ICAR-CIARI have also suggested that the species is a source of antioxidants and biologically active compound – piperine. Due to efforts at ICAR-CIARI, some progressive farmers from different parts of the islands have started growing a few vines of it in their backyards. The unique quality of this species is that the stem pieces of the vine are used as a spice in vegetarian and non-vegetarian cuisines. Plants appear more or less similar to black pepper in morphology; however, it has thickened stem and tufty roots on the nodes.

Varieties

At present there are no improved varieties available in woody pepper. However, a germplasm i.e. INGR-25029 has been registered with ICAR-NBPGR, New Delhi and planting material of the same could be obtained from ICAR-CIARI.



Registered germplasm of woody pepper: INGR 25029

Propagation

The spice could be propagated in two ways- by serpentine layering and stem cuttings, former being the efficient technique. In serpentine layering, the rooted cuttings are planted in the polybag (8 × 6 inch) filled with soil: farmyard manure (1:1, v/v) and should be supplemented with *Trichoderma* sp. or *Pseudomonas* sp. (1 g/kg) to protect it from root rot pathogen. These plants serve as the mother plants, shoot of which is trained over the filled in polybags arranged in front of each mother plant in a series. As and when the shoot grows, the node with cream-white roots is pressed against the substrate of polybag and secured using an inverted ‘v’ shaped clip made up using a coconut leaf midrib. The pressed nodes are then covered with substrate for facilitating quick development of roots. As the vine grows forward, the mother plant and its succeeding plants are detached

from backside and subjected to hardening. The remaining plants are carefully shifted backwards so that the last plant occupies the original position of the mother plant, while the growing end is continued for production of more plants in the next batch. The advantage of this method is that each node gives rise to a plant, unlike stem cuttings which require 2 to 3 nodes.



Serpentine layering in woody pepper

Further, in case of stem cuttings, runner shoots could be used for preparation of two to three node cuttings. Leaves should be trimmed off from the branch leaving behind the petiole on the leaf and such prepared cuttings could be planted in polythene bags filled with the aforesaid substrate. Bags could be maintained in naturally ventilated polyhouse or shade net house. Provision of micro-

sprinklers is required to maintain desired microclimate in the nursery. Cuttings will put forth new leaves and when the leaves turn mature, they could be used for planting during May - June.

Planting and aftercare

The vines are planted on available standard trees such as mango, jackfruit or in arecanut gardens. Selection of site is the most crucial aspect of woody pepper cultivation as it is highly sensitive to water logging. So, the selected site must have good drainage to avoid any issue of moisture stress. In properly-spaced arecanut gardens, about 1,370 plants/ hectare could be planted. For planting, pits of about 60 cm × 60 cm × 60 cm should be dug, leaving one meter distance from the standard trees/ arecanut to avoid overlapping of root systems. The pits should be filled with well decomposed farmyard manure (5 kg), neem cake (1 kg) and top soil. At the centre of the pit, small planting hole could be scooped out considering the size of the polybag in which the plants were raised. After planting, the soil around the plants should be pressed firmly and watering should be done. Providing mulching helps in retention of soil moisture.

Studies at ICAR-CIARI have suggested that the crop could be grown successfully under protected cultivation. For this, metal arches of about 2 m height and 1.2 m wide should be installed inside the shade net house provided with UV stabilized sheet on the top. Use of drip irrigation ensures provision of desirable quantity of water, which could also reduce the incidence of foot rot in the vines. The spaces between the arches could be covered with weed



Growing of woody pepper on jamun (left) and mango (right) as standard



Growing of woody pepper on metal arches inside protected structures

spaces between the arches could be covered with weed mat which could reduce the weed menace inside the structure. The growth of vines in this condition was much vigorous than that observed under outside condition on other standards.

Crop management

For application of manures, basins of about 10-15 cm depth and 30-45 cm radius should be made (depending upon plant age) at the onset and end of monsoon. Well decomposed farmyard manure of (10 kg) mixed with *Pseudomonas* or *Trichoderma* (50 g/vine) should be added to the basins of mature vines. If vermicompost is used, about 1 kg of it should be applied twice a year. Mulching of vines with green leaves @ 5-8 kg/plant is desirable during October onwards to conserve the moisture. Considering the acidic condition of the island soils, application of lime (about 500 g/plant) every alternate year (during April-May) is required to maintain the pH. The granular lime-based *Trichoderma* formulation- Tricholime, developed at ICAR-IISR, Kozhikode could also be used as it not only neutralize the soil acidity, but could also promote the plant growth and protect the plants from soil-borne pathogens. During the drier parts of the year, plants should be irrigated to avoid field mortality. As the plants grow over the standard vine or over the arches, the growing branches of the vine should be tied. Weeds are a major issue in the Andaman Islands that can affect the yields. Hand weeding of the plant basins accompanied by use of brush cutter is required to keep the weeds under control.

Pests and diseases

As the crop is new, not many studies have been conducted in it. However, root/ foot rot is a serious disease-causing death of even up to 100% of plants if appropriate measures are not adapted in time. The disease is very prominent in low lying areas and during the rainy season. Providing proper drainage is must and if cultivated under shade net house, the top of the structure should be covered with UV stabilized sheet to avoid entry of rain water. Further, removal of dead and diseased vines, avoidance of movement of soil and tools from infected vines to other vines is required. As the disease is difficult to control in advance stages, biocontrol agents such as *Trichoderma* spp. is required before onset of monsoon and at regular intervals thereafter. Restricted use of Bordeaux mixture spray @ 1% is advocated to protect the plants from the disease.

Harvesting and postharvest handling

The price of the woody pepper produce in the local markets depends on the thickness of the stem that is being sold. Thicker stems fetch much higher prices of up to Rs. 1,000/- per kg than the thin stems (about Rs. 300 to 500/- per kg). The harvestable stems of the vines are selected and cut from the main plants without damaging the vines. Under good management practices, about 5 years would be required for getting branches of good thickness and this period would be much shorter when grown under protected conditions. After harvesting of the branches, the leaves are removed and stems are made into small segments and sold in the local markets. The yield of commercial fresh stem pieces ranges from 8 to 10 kg from 12 to 15 feet long harvested stem. Yield; however, vary with the age and vigour of the vines.



NUTMEG
(*Myristica fragrans*)

7. NUTMEG (*Myristica fragrans*)

Introduction

Nutmeg (*Myristica fragrans* Hoult.) is an important tree spice, native of Moluccas islands in the Indonesia. It has been commercially cultivated in the tropical countries including India. A number of wild nutmeg species of genus *Myristica*, *Knema* and *Horsfieldia* have been reported from Andaman and Nicobar Islands, which suggests high potential of cultivating nutmegs in these islands. Compatibility with plantation crops as an intercrop is also an additional advantage of promoting nutmeg in the islands. Some farmers are cultivating the crop in their gardens; however, large scale cultivation is not yet practiced here.

Varieties

Though several improved varieties have been developed in mainland India, so far no varieties have been developed for cultivation in the islands. However, superior mother plants having more than 500 fruits per tree, bold nut size, higher mace recovery etc. could be used for propagation.

Propagation

Nutmeg trees are normally dioecious producing male and female tree separately. Hence, seedling plant should be discouraged as it would result into segregation of male and female plant, which will be known after 8-10 years of age. Soft wood grafting and approach grafting should be done during monsoon period using nutmeg seedlings as rootstock. For raising rootstocks, freshly harvested seeds which were collected from mature fruits are used. Bold

nuts should be dried for a day before sowing in sand beds in the nursery or polybags. If sown in beds, the seedlings with 15 cm shoot should be transplanted to polybags (8 × 6 inch), and seedlings of about one year age could be used for grafting. For approach grafting, a curved cut of about 1 to 1.5 inch is made on the rootstock and on the branch of similar thickness on mother plants. Grafted portion is then tied with a polythene tape and protected from the moisture. This method is difficult as the polybag containing rootstock needs to be tied to the mother plant or should be kept on the platform till the graft attachment takes place. After about 3-4 months, the grafts are separated and hardened for one season before they could be used for planting.

In case of soft wood grafting, scions of about 0.4 cm thickness are grafted on rootstocks of similar thickness and by giving 'v' shape cut and tying with the grafting tape of 300 gauge. The grafted plants should be covered with grafting tube for facilitating graft-take and once the scion show sprouting, the polytube could be removed. After the new leaves get matured on the scion, the graft is considered successful, and could be hardened for one season before the field planting.

Planting and aftercare

Nutmeg is a profitable intercrop under well-spaced coconut gardens. It could also be grown under open conditions. Seedlings grow as huge trees and hence, a spacing of 10 m is required. For grafts, 5 to 6 m spacing could be adopted depending on the soil fertility. In coconut gardens, one nutmeg is generally planted at the

centre of the four palms. Pits of about 75 cm × 75 cm × 75 cm size should be dug out at the desired spacing and about 8-10 kg of well decomposed farmyard manure should be added along with *Azotobacter* and *Azospirillum* (5 g/kg) and filled with top soil. These biofertilizers have been reported to improve the growth of nutmeg, as per the study conducted at Kerala Agriculture University, Vellayani, Thiruvananthapuram. At the time of planting, planting holes of the polybag size are scooped in the center of the pits and the grafts are carefully placed in the hole in such a way that the graft union is placed at least 10 to 15 cm above the soil. Soil around the plant should be pressed firmly and irrigation should be provided immediately after planting to ensure better field establishment.



Planting of nutmeg at the centre of four coconut palms

Crop management

Pruning is not required in nutmeg; however, removal of polythene of grafted plants after few months of establishment in the field is a must. Further, any sprouts arising from the rootstocks should be removed to avoid drying of scion portion. As nutmeg is sensitive to water stress, provision of irrigation during the drier period of the year is required to save the crop. Provision of shade using 50% agrosshade net around the plants would help in protecting the young plants from scorching sun in dry months. Green leaf manures such as *Gliricidia* could be applied in the basins of each plant @ 10 kg/plant. The nutmeg responds well to manuring and application of 10 kg farmyard manure per plant is required to be applied in two splits, while it should be increased to 50 kg per plant in mature tree of 10 years and above.

Pests and diseases

Nutmeg is not affected by major pests or diseases in the islands. Seasonal incidence of scales is noticed in some cases, which could be controlled by spraying of 0.5% neem oil (5 ml/L of water). Pruning and destruction of severely infested branches could be followed to reduce the pest load in plants that are heavily infested, otherwise drying of branch as well as plants could be noticed. Further, die back disease, which is characterized by the drying of the branches from tip downwards is noticed in some plantations. Such infected branches should be cut and the cut ends should be pasted with Bordeaux mixture (restricted use) in severe cases.

Harvesting and postharvest handling

Seedlings take 10-12 years for fruiting, while grafted plants come to bearing after 4-5 years of planting. Fruits take about 7-9 months from flowering till harvesting. When the fruits ripe, the pericarp splits open at its natural suture revealing scarlet red aril. Such fruits fall down naturally and they could be picked from the ground. The fruits are split opened and nuts are separated from the outer rinds. After removal of the pericarp, nuts with mace are taken out and mace is manually separated from the nut and flattened out. The nut and mace are dried separately in the sun in a drying yard. Nuts should be dried on a clean platform under the sun till the nuts start producing rattling sound upon shaking. Nutmeg harvesting is usually done in the rainy period and hence, drying in sun gets difficult at times under island conditions. In such cases, drying in hot air oven could be practiced.



Fully grown fruit of nutmeg (left) and split-opened fruit upon ripening showing mace and nutmeg (right)



CULANTRO
(*Eryngium foetidum*)

8. CULANTRO (*Eryngium foetidum*)

Introduction

Culantro or broad dhaniya (*Eryngium foetidum*) is an economically important species of the Apiaceae family that is cultivated for its green coriander (cilantro) like aroma. Culantro is quite popular in the Andaman Islands as well as Northeastern states; although it is reported to occur in wild in the southern states of India. It is cultivated on commercial scale by some farmers in South Andaman, while in North and Middle Andaman, it is rarely cultivated. Produce is available in the local markets of South Andaman in good quantity. Many people also grow this herb in their garden on homestead scale.

The warm and humid climate and well drained soils of these islands are suitable for its cultivation. Culantro has multiple benefits to the grower as well as consumers. From farmers' point of view, the herb is hardy in nature, can tolerate high rainfall to a great extent and performs well under shaded conditions. Shelf life of the produce is much higher than the commercial coriander/ cilantro, especially as the crop is harvested and sold in the markets with roots. The superior shelf life is advantageous to both farmers as well as consumers. The crop is cultivated in isolated pockets in the islands and no exact data on its area under cultivation is available. The produce is regularly being sold at premium prices (₹ 300 to 500/- per kg) in the island's urban and suburban markets. Due to good demand of the herb by the settler communities of the islands and increasing tourism activities, there is ample scope for promotion of this underutilized spice in the islands.

Varieties

ICAR-CIARI, Sri Vijaya Puram has released Dweep Broad Dhania 1 as improved selection from the local population from the islands.

Propagation

Common method of propagation is through seeds, which are born on the inflorescence. However, seeds when harvested and stored, do not show good germination. Hence, naturally fallen and germinated seedlings in the existing mother blocks could be used for planting.

Planting and aftercare

Considering the hilly upland terrain of the plantations in the islands, preparation of terraces across the slope facilitates cultivation of intercrops. Improved varieties such as Samrudhi or Mangala, which are the popular arecanut varieties among island farmers should be used for getting better yields. The island farmers generally take up planting of arecanut too close or naturally fallen seeds are allowed to grow thereby making the plantations too crowded. Following recommended spacing of 2.7 m × 2.7 m for arecanut makes preparation of raised beds of optimum size (two beds of about 75 cm wide and of suitable length on each terrace) possible and facilitates interculture operations of the planted intercrops. Use of well decomposed farmyard manure (10 kg/ m²) and proper mixing of it with the top soil should be done. For planting, 4-leaf-stage seedlings of Dweep Broad Dhania 1 germinated naturally from the mother block of culantro could be collected and planted at 20 cm × 20 cm spacing as seeds do not show uniformity when used for broadcasting.

For urban dwellers with limited availability of space, novel pro-tray cultivation technique viz. Dweep ProDhania has been developed wherein seedlings are transplanted in the 50 cavities pro-trays with 5 cm depth. The pro-trays should be filled with soil and vermicompost (1:1, v/v) and used for growing the crop. This system helps in growing plants in compact spaces and about 250 to 500 g of fresh produce could be obtained from each tray. Similarly, Dweep HanGreens is a hanging structure designed for growing culantro-like herbs in urban areas. Herein users can harvest desired quantity of produce from the structure as and when required for family use.



Growing culantro as intercrop in the arecanut plantations

Crop management

When cultivated under open conditions, exposure of herb to sun results into development of serrations on leaf margins and premature production of inflorescence. Cultivation as intercrop helps in avoiding both these issues as the leaf serrations get reduced drastically and production of inflorescence also gets delayed. Hand weeding is desirable in the initial period to maintain the area weed free especially in the initial period of crop establishment. Addition of farmyard manure after each harvest boosts the production of vigorous plants.



Growing culantro using novel Dweep ProDhaniya method



Growing culantro in Dweep HanGreens

Pests and diseases

Though the species is relatively hardy, incidence of root gall causing nematodes has been noticed in some places in South Andaman Islands. Such infested fields should not be used for taking planting material. Uprooting of infested plants and careful destruction is advocated. Also, some weeds could serve as an alternate host for nematodes, so weed management is desirable. Crop rotation using cowpea and use of marigold as a trap crop could be employed. During summer months, ploughing could help in reducing the nematode population from the soil. Application of neem cake could help in reducing the incidence of nematodes. The biocontrol agent combination of *Paecilomyces lilacinus*, *Pseudomonas fluorescens* and *Trichoderma harzianum* (2 g per kg of farmyard manure) could also be incorporated in soil to reduce the nematode population drastically.

Harvesting and postharvest handling

After about four to five months, when the leaves attain full growth but still soft, plants could be carefully pulled out along with roots. Roots of such harvested plants should be washed in clean water before packing in banana leaves or bamboo baskets for local transport. Few plants in each bed should be allowed to produce inflorescence and set seeds as this serves as new crop and the cycle continues. The yields are generally low in the first harvest as 1 q/ha produce could be harvested from it, while higher yields of about 21 q/ha could be obtained from the second harvest. The yield gets increased in subsequent harvests due to increasing plant population from naturally fallen seeds.

Seedlings germinated could be thinned out and used for planting in areas from where harvesting of plants was done so that the next cycles could continue. Alternatively, foliage could also be cut at the base instead of uprooting the seedlings for harvesting; however, in such cases the yield will go down and shelf life also gets reduced.





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