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VANILLA

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Introduction

Natural vanillin is extracted from the dried and cured pod like fruits known as 'beans' of the vanilla plant. Vanilla, a native orchid of Mexico, was introduced to India as early as 1835. The important vanilla growing countries are Madagascar, Java, Mauritius, Tahiti, Seychelles, Zanzibar, Brazil, Jamaica, Guatemala, Reunion Islands and West Indies. At present, Madagascar accounts for 80% of the world production of vanilla beans. The estimated area under vanilla in India is only about 30 acres, largely confined to Wynad and Nilgiri districts of Kerala and Tamil Nadu respectively.

There are three important species of vanilla viz. *Vanilla fragrans* Salisb. syn., *V. planifolia* Andr. (the Mexican vanilla), *Vanilla pompona* Sch. (the West Indian vanilla) and *Vanilla tahitensis* J.W. Moore the Tahitian vanilla) V. *pompona* has large and broad leaves as well as fleshy large flowers as compared to *V. fragrans*. The petals and sepals of *pompona* is greenish yellow with bright green colour at the tips whereas the petals and sepals of *fragrans* are pale green. *Vanilla fragrans* also have short, thick and obscurely three angled pods. *V. tahitensis* is less robust than *V. fragrans* and this species is predominantly cultivated in Hawaii. All the three species are diploid (2n=32).

Vanilla is a climbing orchid having sessile leaves, oblong in shape with succulant green stems. At the nodes aerial roots (velamen roots) are produced. Flowers appear in raceme which are large and showy, borne on 4-5 cm long stalks. The inflorescence consists of 15-20 flowers produced in leaf axils. There are three sepals and petals each. There is a central column in the flower in which stamens and pistil are united with one of the petals modified to form a 'lip' or 'rostellum'.

Climate and soil

Vanilla requires a humid tropical climate with an annual rainfall of about 250 cm and grows from almost sea level to 1500 metres above HSL. Places with the above elevational range in Wynad and Idukki districts of Kerala, Coorg, North and South Kanara districts of Karnataka are suitable for growing vanilla. High humidity is an important prerequisite for vanilla cultivation. A warm moist weather with temperature ranging from 21-32°C is ideally suited for the plant. The rainfall should be well distributed for a period of nine months and there should be a dry period of three months for flowering. However, the plant cannot survive under excessive dryness and sea winds.

Vanilla is adapted to a wide range of soil types rich in humus and having good drainage. The humus rich forest soils of Western Ghats is ideally suitable for the cultivation of vanilla. Vanilla can also be grown in arecanut or coconut gardens having good drainage. Stiff clay soils and water logged areas are not suitable for the plant.

Preparation of land

It is preferable to open new land for vanilla cultivation. The land may be cleared by cutting down all shrubs and unwanted trees. Vanilla can also be cultivated in open and non virgin land with shade plants such as banana. A gentle slope is ideal. Open land may be prepared by two rounds of ploughings or diggings followed by levelling. It is advisable to incorporate green leaves and top forest soil in the land.

Propagation, Planting and Aftercare

Vanilla is generally propagated by stem cuttings. Vines 60-120 cm long are selected as planting material. The vanilla stem cuttings after collection should be dipped in 1% Bordeaux mixture or copper oxychloride for killing the pathogenic fungi, if any. Then the cuttings are stored in a cool shaded place for 2-3 days for partial loss of moisture, a process which enhances rooting. The cuttings can also be stored for 2-10 days if required and can withstand long distance transportation. Plants raised from lengthy cuttings commence early flowering and are superior in growth and yield as compared to plants raised from shorter cuttings. Use of vines with less than 5-6 nodes and less than 0.5 m length are not recommended for planting in the vanilla growing countries. Usually about one metre long vines are preferred for planting. The vines are coiled around and the base portion is buried in the soil. The portion above the ground should be tied to the standard until the aerial shoots have obtained a firm grip. Cuttings are usually planted directly in the field but they can be raised initially in nursery, if required. The vines can be trained on trellis or on trees such as

Plumaria alba, jack *Erythrina*, cashew, Glyricidia, *Casurina equisettifolia*, Indian almonod (*Terminallia cattappa*) etc. The standards have to be planted well in advance. Approximately 1600 to 2000 standards can be accommodated in a hectare. In any case, the vanilla plants after trailing to a height of 1.5-2 m should be allowed to train horizontally on poles tied to trees.

Studies conducted at Ambalavayal (Kerala) have shown that trailing vines on dead wood posts to a vertical height of 1.5-2 m and then training them horizontally on wooden trellis is better than trailing vines on Plumaria standard to a height of 1.5 m and then training them horizontally or looping horizontally on wooden trellis. The above method also facilitates hand pollination and harvesting. Flowering will not occur as long as the vines climb upward. If dead standards are used shade should be provided to the vines initially by planting banana.

Cuttings are usually planted at a distance of about 3 m, in rows of 2.5-3 m apart at the foot of the standards. Spacings of 1.2-1.5 m within rows and 2.5-3 m between rows are also recommended. Cuttings are planted in shallow pits. The pits are best filled with humus and mulch and should be raised above the soil surface to avoid water stagnation. The cuttings should be planted horizontally with two nodes below the soil surface and at the rate of two cuttings/standard. The basal portion of cuttings should be kept just above the soil to prevent rotting. It is advisable to provide shade to the planted cuttings with twigs etc. In dry soil water should be sprinkled. Within 4-8 weeks, the cutting will sprout. A thick mulch of green leaves should be given immediately after planting. Inter-cultivation is not recommended after planting. Clean weeding of the plantation is also not advisable. However, occasional slashing of weeds and other shrubs is beneficial. Regular mulching with leaves combined with watering once in four days during summer increases growth and pod yield from the vines. Spreading a thick mat of dried leaves on the ground is advisable. This will prevent rise in soil temperature as well as weed growth.

The height of the vines should be restricted to facilitate hand pollination and harvesting. Care should be taken not to tear or bruise the leaves, branches or roots of the plant. The top 7.5-10 cm of the vine is pinched off 6-8 months before the flowering season to encourage the production of inflorescence in the vines.

Tissue culture technology is also now perfected for the production and multiplication of vanilla seedlings.

Pruning

Selective pruning of the old vines after flowering is reported to be beneficial even if it carries few flower buds. However, the shade trees should be regularly pruned to maintain a light shade. It is advisable to give an umbrella shape for the supporting trees to provide better shade and protection to the vines. The pruned leaves and branches can be applied as mulch.

Manuring

The quantity of fertiliser to be applied may vary according to fertility status of the soil. However, 40-60 g of nitrogen, 20-30 g of Phosphorous and 60-100 g of Potash should be given annually to each vine. Nitrogen can be given as ammonium sulfate, phosphorous as super phosphate and potash as muriate of potash. Organic manures other than animal manures can also be applied. The organic manure can be applied in May-June and N, P, K in 2-3 split doses during June-September. The manure should be applied 20-30 cm away from the plant. All fertilisers and manures should be applied on the top soil when sufficient moisture is available and kept covered with leaf mulch. As in the case of other orchids, vanilla also respond to foliar feeding. A 1% solution of an N,P,K mixture can be sprayed on the plant once in a month. This boosts up growth and flower production.

Flowering and Fertilisation

Vanilla usually starts flowering in the third year of planting, the time depends on the size of the original cutting. The maximum production of flowers is in the 7-8th year. In Mexico, replanting is done after 9-10th year. The usual flowering season is from December-March and sometimes in October-November. The flowering period may extend for two months but each flower lasts for a day only from early morning to late evening. Flowers require to be artificially pollinated (hand pollination). Only 6-8 flowers on the lower side of the raceme should be retained and pollinated. Pollination must be done early in the morning. Usually only about 10-12 inflorescences in a vine are pollinated. In hand pollination method, a pin or needle or small piece of pointed wood (a wooden tooth pick is ideal) is employed to apply pollen on the stigma of the flower. The pollen of the vanilla flower is produced in a mass called pollinia, and is covered by hood or anther cap. The stigma is protected with a lip known as 'rostellum' or 'labellum'. For pollination the stamen cap is removed by a needle exposing the pollinia. Then the flap like rostellum is pushed up and the pollinia are brought into contact with the stigma. Following successful fertilisation pods develop. The highest percentage success by hand pollination is 85-100, if done between 6 AM and 1 PM. An efficient worker can pollinate 1000-1500 flowers a day.

In Mexico, vanilla is naturally pollinated to some extent by small bees of the genus *Melapona*. In India, the natural pollinator is absent.

Harvesting and Yield

After about 6-9 months of flowering the beans (or pods) are ready for harvest. The maturity of the beans can be judged by the colour changing from green to pale yellow. At this time, the pods may

be 12-25 cm long with 2.5 cm circumference. It is essential to harvest the pods at the right stage as immature pods produce inferior product and overmatured pods split during curing. The right picking stage is when the free end of the pod starts turning yellow and fine yellow streaks appear on the pods. Daily picking of the mature pod is essential. The pods can be harvested by cutting with a knife. About 6 kg of green pods produce 1 kg of cured beans. Curing should begin immediately after harvesting, but can be stored for 3-5 days.

Field yields are variable. A good vanillery is said to yield about 300-600 kg of cured beans per hectare per year during a crop life of 10 years.

Curing

Green vanilla beans (pods) contain little vanillin and is odourless and flavourless. The process of curing is an important stage in its production as it is during curing that the beans undergo the enzymatic reaction responsible for the characteristic aroma and flavour of vanilla. There are many methods of curing but they all consist of more or less four stages:

(i) **Killing or wilting:** In this stage, further vegetative development of the fresh beans is stopped and the enzymatic reaction responsible for the production of aroma and flavour is initiated. Killing is indicated by the development of a brown colour on the beans.

(ii) **Fermentation:** The temperature of the killed bean is raised so as to promote the desired enzymatic reaction and for a rapid drying to prevent harmful fermentation. During this process, the beans acquire a deeper colouration and can be twisted without split or break. The aroma and flavour of the beans progressively develop from this stage.

(iii) **Drying:** The fermented beans should be dried at ambient temperature under shade until the beans become 1/3 of their original weight.

(iv) **Conditioning or ageing:** The dried beans are stored in closed boxes for a period of 3-4 months or longer to permit the development of desired aroma and flavour.

There are different methods for curing viz. 'Mexican Process', 'Bourbon Process', 'Peruvian Process' and 'Guiana Process'. Details of two processes that can be employed under Indian conditions are given below:

(a) **Mexican Process:**—Store the harvested pods for a week for shrinking. Spread the shrinked beans on a woollen blanket under sun till they become hot and difficult to hold in bare hands. Fold the blanket over the pods, continue drying for the rest of the day, tie them in bundles and keep in a sweating box lined with woollen blanket for overnight. Continue this process until the beans are chocolate brown in colour. After the sweating process, spread the beans on grass mats, dry under sun for 6 days. Every day after drying, they should be packed and kept in the sweat box. After this process, spread the pods in shade until they become completely dry. The beans are then sorted out for conditioning. The beans are straightened by drawing them between the fingers which also helps in spreading the oil, which exudes during the curing process giving the beans their characteristic lusture. The beans are then tied into bundles of 50 and are stored in closed boxes for a period of three months or longer to permit the full development of the desired aroma and flavour. Users prefer well aged beans to freshy cured ones.

(b) **Bourbon Process (Hot water method of curing):** Bourbon vanilla is the name given to the product from the Island of Reunion, formerly known as Bourbon. Production of Bourbon-type vanilla is now dominated by Madagascar, Comoro Islands, Reunion and Seychelles. The process involves the following steps:

(i) **The killing stage:** The harvested pods are processed either the same day or the next day. They are dipped in hot water for a few seconds or they are enclosed in an atmosphere of hot water vapour for some 12 hours. This is to stop the vegetative activity of the pods.

The hot water vapour treatment is safer and produces a more uniform produce. However, the hot water dip is quicker and easier. In this case, vanilla pods are placed in an open basket and dipped into a container of hot water kept at 85-90°C for 10 sec., remove from water and shake the basket once or twice so as to upturn the pods and again dip in the water for another 12-15 seconds. As the process continues, a very low flame may be maintained so that there may not be any considerable rise or fall of temperature. A thermometer (available with any laboratory suppliers) may be used to maintain the optimum temperature. In Madagascar, the hot water treatment is carried out at 60-65°C for 2-3 minutes.

For the hot water vapour treatment a wooden cask is required. In this about 3000 pods can be arranged on a wire netting/grid placed about 12" from the bottom of the cask. The large pods have to be arranged at the base and the smaller one at the top. Once the pods are arranged, the cask is covered with a wooden lid. Boiling water is poured into the bottom part of the cask to a level of 4" below the gird. Around eight gallons of boiling water is required for treating 3000 pods. The pods are left in contact with the hot water vapour for 12 hrs.

(ii) **Fermentation stage:** This stage consists of wrapping the pods in sacks or in woollen blan-

kets after the first stage. The aim of the wrapping is to conserve the heat and moisture which are essential for fermentation process.

In the hot water treatment, the pods are wrapped, while still hot and moist, in the blanket and are allowed to sweat during the night. The next day they are wiped and kept in wooden trays between the blanket and exposed to sun for 2-3 hours. During the rest of the day they are stored, still covered in blanket inside a room. This process is repeated for 5-6 days.

In the hot water vapour treatment, the pods after removal from the cask are at once placed in wooden trays between woollen blanket and exposed to sun for two to three hours; wrapped and stored. The process of exposing to sun and storing is repeated for 5-6 days.

A few hours after killing, the pods turn to a chocolate brown colour. After a week, the pod starts to loose their turgidity and become wrinkled. During the fermentation stage the pods require utmost attention as there are more chances to get mould attack and loose quality. Any mouldy pod found at any time during curing must be removed and treated separately.

(iii) **Drying stage:** The third stage during which the pods are slowly dehydrated, is carried out in a well ventilated room where the pods are kept exposed in wooden trays for almost thirty days by which the pods acquire a deep chocolate brown colour. After drying for a month, the pods are removed to well-closed containers such as tin trunks with a paper lining and are allowed to mature for 1-2 months. During this time, the pods have to be examined every 4-5 days for any mould growth. Any infected pods should be carefully removed and wiped with a cloth soaked in 70% alcohol and placed back in the cask. In Mexico, the badly infected pods are immersed in hot water for one hour to kill the mould.

In Madagascar, Mexico and other countries, artificial hot air driers are being employed for rapidly drying the hot water treated beans.

Sorting, Grading and Quality

The cured and matured vanilla pods are then sorted and bundled for marketing. The sorting and grading are done mainly based on the length and quality. The producing countries use different systems of grading. Properly cured pods, 5-9 inches in length having good appearance, flavour and without any blemishes are usually graded as the best quality. The second grade consists of pods having inferior colour (having reddish streaks due to immaturity). All the remaining pods are third grade quality. Once graded, the pods are made into bundles of one pound each.

Sometimes, upon storage vanilla 'crystallise'. Fine crystals of vanillin appear on the surface of the pods. They are often called frosted vanilla and fetches a premium price in the market.

The vanillin content of properly cured vanilla is around 2.5%.

Mexican vanilla followed by Bourbon vanilla is considered as the best quality produce in the world. Practically nothing is known about the quality of vanilla produced in our country.

Aroma and Flavour Quality of Vanilla

The quality of cured vanilla beans is primarily due to its volatile constituents of which vanillin is the most important. The aroma and flavour characteristics of the commercial type vanilla are very distinct. For example: Bourbon vanilla (*V. fragrans* from Madagascar, Reunion, Comoro Islands)—has extremely rich aroma, sweet, tobacco like, having a very deep balsamine sweet spicy note. The odour profile is modified by the moisture content. Moist beans give a stronger 'vanillin' character, while dried beans have less intense of this note. Mexican vanilla (*Vanilla fragrans* from Mexico)—has a somewhat stronger and more pungent aroma than the Bourbon type. The aroma of Tahiti vanilla (*Vanilla tahitensis*) is perfumary sweet and is not tobacco like. Guadeloupe vanilla (*Vanilla pompona*) has a floral fragrance of anise, heliotropin-isosafrol type. Indonesian vanilla (*Vanilla fragrance*) has a very heavy woody flavour.

The occurrence of numerous non-vanillin aroma components contribute for the characteristic taste and flavour. Natural vanillin flavour can be easily distinguished from the synthetic vanillin and synthetic blends. Natural vanillin has delicate, rich and mellow aroma while that of synthetic vanillin has heavy, grassy aroma. The after taste of synthetic vanillin is less pleasant than that of natural vanillin.

Production and Trade

Madagascar dominates in vanilla production and trade followed by Tahiti, the Comoros, Mexico, Reunion, Guadeloupe and other minor producing countries (Indonesia, Guatemala etc.). The world trade in vanilla beans is controlled by the Vanilla Alliance an association of producing and importing countries. Vanilla Alliances has evolved a rigorous system of production control involving export quotas and price control.

Vanillin and Health

Vanillism, a toxicity problem, is an important hazard encountered by people engaged in vanilla industry. Vanillism is caused by the poisoning due to vanillin. It is characterised by headache, gastric trouble and rashes over the body.

The juice of vanilla plant can cause severe allergic reactions such as itching and rashes over the body

and inflammation. This is due to the calcium oxalate crystals present in abundance in the juice of the plant.

Pests and Diseases of Vanilla

The major diseases of vanilla are the root rot caused by *Fusarium* and the anthracnose caused by *Calospora vanillae*.

In many countries, the root rot caused by *Fusarium batatis* var *vanillae* is the most serious problem limiting the production of vanilla. The pathogen affects the roots causing first a browning and later death of the roots as well as the underground part of the stem. The plant ceases to grow, stems and leaves become flaccid and the stem begins to shrivel, leading to ultimate death. Not much information is available on the control of this disease. Drenching and irrigating the vines with 0.1% bavistin should help in controlling the disease.

At Ambalavayal (Wynad, Kerala), *Fusarium oxysporum* was found to cause wilting of vanilla. The affected plants wilt. The wilt is characterised by gradual yellowing, withering and drying of the stem. The stem when cut open shows the typical vascular browning. A warm humid weather followed by monsoon showers is reported to aggravate the disease. Good sanitation, mulching and drenching the soil around the base with 0.1% bavistin can check the disease.

Anthracnose caused by *Calospora vanillae* is a very serious disease in many countries. The pathogens attack the stem apex, leaves and roots and results in wilting and falling of the beans which turn black at the end and middle and fall off in one or two days. The disease is aggravated by excess of moisture, prolonged rainy weather, excess shade and overcrowding. Phytosanitation, removal of excess shade, avoiding overcrowding coup'ed with 0.1% bavistin spraying can help to control the disease.

No serious insect pests are known to occur in India.

Spoilage of Vanilla

Vanilla beans are quite susceptible to mould infestation *Penicillium* spp. and *Aspergillus* spp. are the common mould infecting vanilla beans during conditioning and subsequent storage periods. Mould attack leads to very disagreeable odour and this results in very poor market value. The immature beans are more susceptible to mould infestation. Improper killing and inadequate drying and the presence of moisture are the major factors leading to mould infestation. Mould infestation can be prevented by proper curing and drying and by hygenic conditions during processing. If mould attack becomes severe, the curing room should be painted and then disinfected by spraying formaldehyde solution (1:1000). The beans should be inspected regularly for any mould attack and the mouldy beans should be promptly removed and attended to.

Vanilla beans are prone to attack by mites (*Tyrophiagus* spp.) resulting in a disagreeable odour, Mite infestation can be detected by the small holes they produce on the beans. Mild infestation can be controlled by spreading the bean in open sunlight for a few hours. Fumigating the curing room by burning sulphur is useful for preventing mite attack.

Creosoted vanilla (vanilla beans having creosote like aroma) having off flavour is of poor quality and is the result of poor handling and curing practices. Storing of harvested beans in well ventilated small piles and timely handling and curing of the harvested beans reduce this problem.

Uses of Vanillin

Vanillin is a well known food flavouring substance all over the world. Over half the total ice cream output in the western world is flavoured by vanilla though natural vanillin is used in less quantity as compared to the synthetic one. Natural vanillin is also used in chocolate, biscuits and confectionary besides in perfumery and pharmaceuticals. Of course, the advent of cheap synthetic vanillin affected the market of natural vanillin to a great extent. But of late, consumers have started preferring natural vanillin especially in the western countries. Thus, the demand for natural vanillin is likely to increase in the years to come.

Employment Potential

Vanilla industry can provide employment opportunities to women especially in the pollination work.