

Vanilla Cultivation in Southern Florida

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Scientific Name: *Vanilla planifolia*

Common names: Vanilla orchid

Family: Orchidaceae

Origin: Mesoamerica

Distribution: Globally from latitudes 27°N to 27°S.

Abstract

Vanilla extract is popular around the world as an ingredient in ice cream and various other desserts. The botanical source of vanilla extract is primarily the cured beans of *Vanilla planifolia*. The United States is the world's largest importer of *Vanilla* beans, but domestic production is minimal. Southern Florida has a favorable growing environment for *Vanilla* cultivation. This document includes information relevant to growers interested in establishing a vanillery.

History

Vanilla seed capsules (commonly called beans) have long been appreciated for their distinct aroma and flavor. The major commercial species is *V. planifolia* with *V. x tahitensis* cultivated to a lesser extent. Madagascar leads the world in *Vanilla* production with Indonesia, Uganda, India, Comores, Mexico, and other countries significantly contributing to global production. The United States is the largest importer of *Vanilla* beans that are further processed into vanilla extract. Vanilla extract from *Vanilla* beans is now widely used in ice cream, baked goods, chocolate, cosmetics, and many other products.

V. planifolia spread from its native range in Mesoamerica across the Caribbean islands, into Europe, and globally starting in the late 1500s. Colder climates relied on greenhouses to maintain this tropical species. The vines were not production outside the native range in the absence of natural pollinators. The development of manual pollination methods in 1837 and 1841 by Charles Morren and Edmund Albius, respectively, unlocked the potential of this species for commercial production outside Mesoamerica. This timely development supported expanded production in the 1850s and 1860s in response to supply constraints from Mexico. Today, clonal descendants of the original plants are grown commercially in several countries.

Vanilla has been cultivated in the United States since before the early 1900s in Puerto Rico, Hawaii, and Florida. *V. planifolia* was introduced from Florida into Puerto Rico twice before 1909. A vanilla industry in Puerto Rico included a grower cooperative. The USDA station in Puerto Rico conducted horticultural, breeding, and bean curing research in support of the vanilla industry. The industry in Puerto Rico grew until the 1950s when it declined after World War II as industrialization superseded agriculture. Hawaii received *Vanilla* as part of trade routes before 1900. Hawaii still has *Vanilla* production, but mostly favors tourism business models. Additionally, Florida has four native *Vanilla* species (*V. barbellata*, *V. dilloniana*, *V. phaeantha*, and *V. mexicana*) with naturalized *V. planifolia* (Figure 1). Puerto Rico has seven species growing wild (*V. barbellata*, *V. dilloniana*, *V. poitaei*, *V. pompona*, *V. claviculata*, *V. pompona*, and *V. planifolia*). The native Florida *Vanilla* species are endangered and should not be

collected from natural areas without proper authorization and permitting by regulatory authorities.



Figure 1. Flowers of *V. planifolia* (top left), *V. pompona* (top right), *V. phaeantha* (bottom left), and *V. mexicana* (bottom right) growing in southern Florida. *V. barbellata* and *V. dilloniana* are leafless species that also grow in southern Florida, but flowering has not been observed in our collection.

Importance

Vanilla extract is the second most valuable spice (second to saffron), and is the world's most popular flavor. Natural vanilla extract comes predominantly from the cured beans of *V. planifolia*, which is the major commercial species, and to a lesser extent from *V. x tahitensis* and *V. pompona*. The aroma and flavor profiles vary for each species and from each growing environment. These differences could be useful for a variety of applications including as food ingredients, in cosmetics, and for various other applications.

Description

Plant: *V. planifolia* is a fleshy, perennial vine with green stems. The vines live for many years and some species reach 60 m (200 ft) in length. The stem diameter increases as the plant matures. *Vanilla* is semi-epiphytic meaning it is capable of rooting in the ground and also growing on other plants without direct soil contact.

Leaves: *V. planifolia* has succulent, bright green leaves. Mature leaves can be variable in size ranging from 8-25 cm (3-14 inches) long and 2-8 cm (0.75-3 in) wide. They are lanceolate to oval-shaped with pointed tips and can survive about 3-4 years. Some types of *V. planifolia* have variegated leaves and are usually grown for ornamental purposes.

Flowers and Fruit: *V. planifolia* flowers are large and fragrant. Waxy cream-green sepals form on axillary inflorescences. *V. pompona* flowers are diagnostically yellow compared to *V. planifolia*. Flowers can reach about 6 to 8 cm (2.5 to 3in) in length and about 5 to 10 cm (2 to 4in) in diameter. Two of the petals are similar in appearance to the sepals. The third petal is modified into a lip shape. This lip-shaped petal contains two pollinia (pollen masses) and the stigma, mounted on a column. A structure situated between the stigma and pollinia, called the rostellum, effectively prevents autopollination.

The flowers are formed in axillary bunches with a few to many flowers per cluster called racemes. They first appear 2-3 years after planting a new cutting. *Vanilla* tends to flower on larger vines when the diameter reaches 6-13 mm (0.25 – 0.5 in). Usually one, but sometimes up to three, flowers in a cluster can open at a time, usually early in the morning. Flowering usually occurs over a period of about 2 months, once a year, but each individual *V. planifolia* flower lasts for only one day. Flowers of some other *Vanilla* species can remain viable longer than *V. planifolia*.

Following pollination, the ovary swells to produce a long seed capsule (bean) that can reach about 20 cm (8 in) in length and takes between 8-9 months to ripen. *Vanilla* beans contain thousands of tiny black, round seeds. At maturity, the bean will split open along two longitudinal seams, exposing the seeds and ruining the bean for commercial purposes.

Roots: *Vanilla* produces two types of roots including aerial roots and terrestrial (ground) roots. Aerial roots are generally non-branching and are formed on the stem opposite the leaves. Aerial roots primarily function to support the vine's climbing habit and are therefore very effective at adhering to supporting plants or structures. Terrestrial roots are usually found at the base of the vine, are branched, and possess root hairs that are often associated with mycorrhizae. Like other terrestrial roots, the primary role of these roots is the uptake of nutrients and water from the soil.

Pollination

Autopollination of *V. planifolia* flowers is rare to nonexistent in regions where native pollinators (bees and, perhaps, hummingbirds) do not occur. Though not native, the orchid bee *Euglossa dilemma* (Figure 2) has become established in southern Florida and could potentially be a pollinator of *Vanilla* orchids. Otherwise, our observations in natural areas show that native *Vanilla* species will set pods in the absence of manual pollination (Figure 3). One hypothesis is

that a native orchid pollinator in southern Florida could also pollinate *V. planifolia* flowers reducing the need for manual pollination.



Figure 2. *Euglossa dilemma* lured and captured at the University of Florida Tropical Research and Education center. This bee could be a pollinator of *Vanilla* orchids (Photo credit: Daniel Carrillo, University of Florida).



Figure 3. Bean development in the absence of manual pollination for *V. phaeantha* (left) and *V. mexicana* (right) in natural areas.

V. planifolia is generally self-compatible meaning that pollen from one flower can be used to fertilize the same flower and will lead to seed and bean development. Pollination is reportedly low (~1%) in the native Mexican range even when pollinators are present. Thus, commercial *Vanilla* production is heavily reliant on hand pollination.

To pollinate a *Vanilla* flower, the rostellum that separates the pollinia and the stigma needs to be bypassed. Pollinations should be attempted in the morning usually between 6 am and noon. Hand pollination can be accomplished using a toothpick or other narrow implement. Sectioned *V. planifolia* and *V. pompona* flowers are shown in Figure 4 to aid in describing pollination. The lower petal can be torn to expose the anthers with pollen (pollinia), rostellum, and stigmata. The rostellum is gently pushed up and away from the stigmata until the pollinia flap can be pushed towards the stigmata and make gentle contact with the stigmata. If the pollination is successful, the flower will be retained on the plant, otherwise it usually drops off in 2-3 days. Beans will rapidly begin to swell and elongate over a few weeks if successfully pollinated.

For commercial purposes, only the flowers on the lower side of the cluster are pollinated. The beans produced from here will grow into straight beans and command a premium price. If the plant is vigorous, a total of 8-12 flowers on 10-20 clusters can be pollinated. Around 10 beans per cluster is desirable.

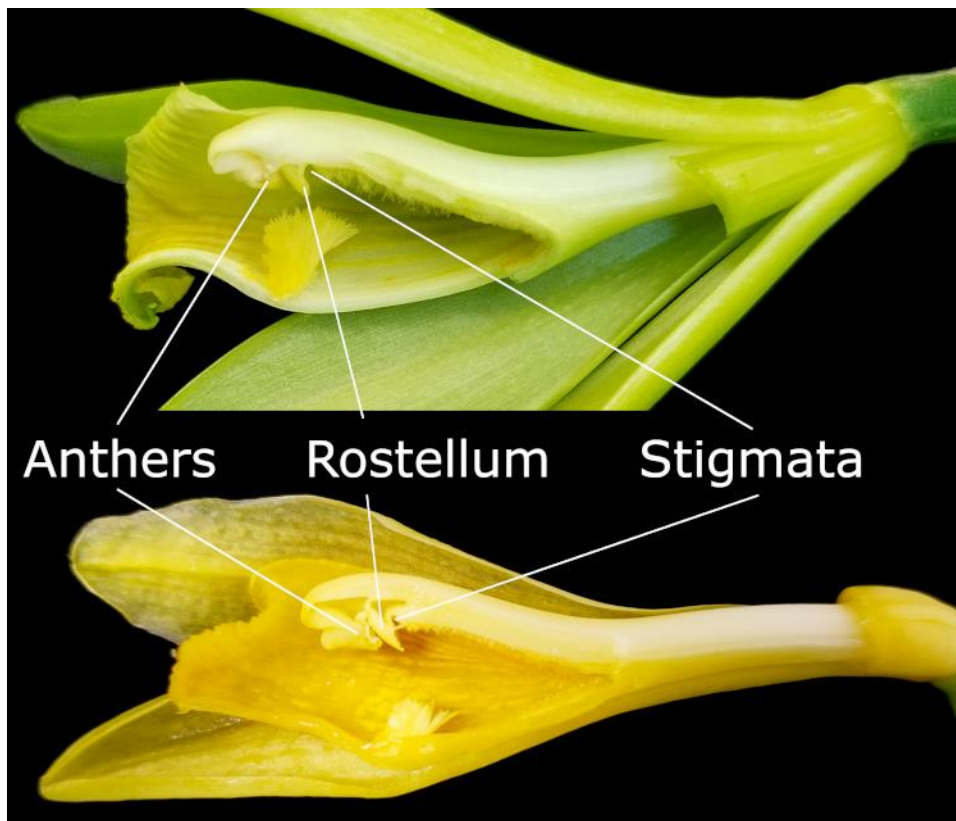


Figure 4. *V. planifolia* (top) and *V. pompona* (bottom) flowers with anthers (pollinia), rostellum, and stigmata. The stigmata are shielded directly behind the rostellum.

Varieties

V. planifolia has not generally benefited from modern plant breeding, so few named cultivars exist. Only a single cultivar, ‘Handa’, has been patented. This variety was developed by researchers from Reunion Island, and the future availability of this material is unknown. Otherwise, a few distinguishable types of *V. planifolia* have been characterized. These include ‘Mansa’ types originating from Mexico and that are commonly cultivated for commercial production. There are also two types of variegated *V. planifolia* generally available online and grown only for ornamental purposes.

V. x tahitensis is the second *Vanilla* type grown on a commercial scale. Our current understanding is that *V. x tahitensis* is mostly *V. planifolia* genetically with a little *V. odorata* (another *Vanilla* species) in its ancestry. The “x” denotes that this is a hybrid and not a separate species. The genetic contribution of *V. odorata* to *V. x tahitensis* seems to be minor, but has major impacts on bean splitting and aroma. The increased anise flavor notes of this type are popular in French desserts. Cuttings claiming to be *V. x tahitensis* can be purchased online but our research has found that many online vendors are unknowingly (hopefully) selling *V. planifolia* as *V. x tahitensis*. Most international sources of verified *V. x tahitensis* are unwilling to share their material. Research is currently underway to verify and distribute verified *V. x tahitensis* to interested growers.

There are also risks associated with purchasing stock plants that have undesirable qualities including sterile, low yielding, or poor quality types. Many of these will produce the classically beautiful vine and flowers, but are not optimal for commercial cultivation. Unfortunately, the sources of these types are difficult to track because of the length of time it takes to obtain a mature, flowering vine. Research is currently underway to identify types that can consistently produce commercial quality beans to reduce the risk to growers.

V. pompona is commonly grown in southern Florida by hobbyists and is also commonly mistaken for *V. planifolia*. *V. pompona* is vigorous, but reportedly produces a lower quality extract. *V. pompona* flowers are diagnostically yellow compared to the cream green color of *V. planifolia* flowers.

Environmental Conditions

Southern Florida with its hot, humid climate is suitable for *Vanilla* cultivation. *Vanilla* is sensitive to cold temperatures including freezing. Therefore, a location with reduced risk of freeze events should be selected for *Vanilla* cultivation. Optimal rainfall for *Vanilla* has been reported around 170 to 280 cm per year (67 to 110 inches/year). *Vanilla* requires about two months of a dry season to initiate flowering. Excessively wet conditions during capsule ripening can lead to bean rot. Supplemental irrigation can be useful for establishing new cuttings and potentially for frost protection. Figure 5 shows average monthly rainfall and temperatures as recorded by the FAWN weather station at the University of Florida’s Tropical Research and Education Center.

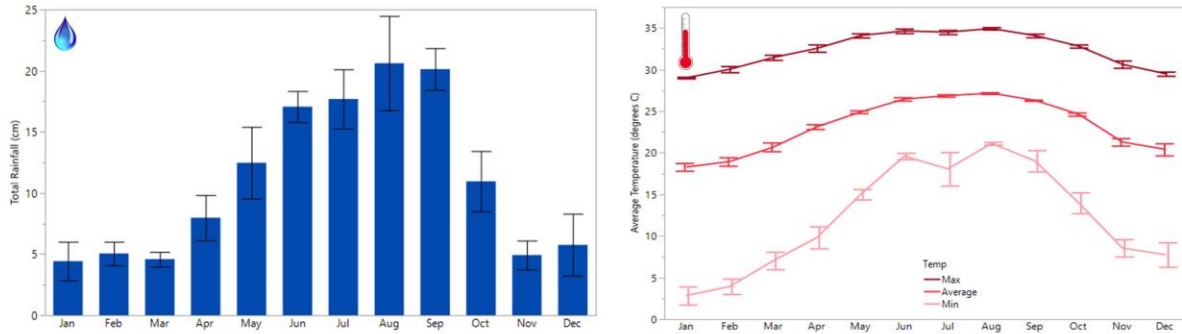


Figure 5. Average monthly rainfall and max, average, and min temperatures for Homestead, FL. Data are averages from 10 years spanning 2006 to 2016.

Propagation

Vanilla is primarily propagated by cuttings. It is important to let cut sites heal prior to planting by leaving fresh cuttings at room temperature under low light for 1-2 days. All other factors being equal, the longer the cutting the more quickly the vine will establish and begin to flower. Cuttings that are 30 cm (12 in) long will generally require 3 to 4 years to flower while meter long cuttings should flower in 2-3 years.

Cuttings can be placed directly on top of the growth substrate (usually mulch) as soon as the cut sites have healed. Misting will help vines retain leaves and support the rapid development of new roots and shoots. The apical end of longer cuttings can be tied to a support post with only the distal 1-2 nodes in contact with the substrate. Leaves should be removed from nodes that are in contact with the growing substrate.

Tissue culture *V. planifolia* plants are available from a few companies. Tissue culture plants are attractive as a clean source of starting material, but will take 3 to 4 years to mature and flower. Tissue culture plants received in enclosed containers will need to be hardened in soilless mix under humidity domes and bright indirect light for a few weeks to months before they can survive in an environment with lower humidity and free-flowing air. Regular, light misting will increase the survival of young tissue culture plants.

Vanilla is not commonly propagated by seed due to germination challenges. The thick, highly lignified seed coat prevents timely germination and takes significantly longer to grow into mature plants than cuttings. In addition seed germination is likely reliant on associations with fungi or other microorganisms. Such constraints have supported the use of cuttings as the primary propagation method.

Production Methods

Vanilla vines require trellising to maximize production. Two major production methods are used. One uses “tutor” trees to provide both shade and a suitable structure on which the vines can climb. Tutor trees can be selected based on hardiness in a given location, availability, and co-cultivation considerations. This type of cultivation can be less expensive in some areas, and also naturally reduces the risk of vine death by *Fusarium* by increasing the distance between plants.

Growers in southern Florida should consider *Vanilla* as a secondary crop on existing fruit trees. Figure 4 shows *V. pompona* growing on an avocado tree. Any agricultural inputs will have to be compatible with both species under the intercropping model.



Figure 4. *V. pompona* growing on an avocado tree. Vines were received as ~1 meter long cuttings. Growth is after one year without supplemental irrigation.

More intensive cultivation under shade structures can increase yields. This system requires more initial investment for infrastructure, but allows for increased planting density and yield potential. Trellis support systems vary greatly, but are generally made of vertical wood or concrete supports with wire running between them. Supports vary in height but are usually no more than 2 m (6 ft) tall to facilitate pollination once vines mature. The post and wire system allows for greater control over vine spacing compared to tutor trees. Vines will need to be maintained on 15-20 cm (6-8 inches) of a mulch substrate.

Spacing and Planting

An estimated 1,000 plants per acre is often used for establishing a commercial vanillery. Spacing recommendations are to plant vines 1-3 m (3 to 10 ft) apart with and 2.5 to 3 m (8 to 10 ft) between rows.

Soils

Vanilla can be grown in a wide range of soil types but thrives in light soils with plenty of organic material. For the tutor tree method, a slight slope may be beneficial to reduce the incidence of standing water and incidence of disease. Dry soils will require additional irrigation to maintain adequate soil moisture. Under more intensive cultivation systems, soil moisture can be regulated by managing the height of raised mulch beds.

Mulch is a popular substrate for *Vanilla* cultivation. The particular type of mulch is not as important as its ability to provide a slow release of nutrients and retain an optimal level of moisture for roots. Some areas rely on aged coconut husks to mulch vines. Mulch will need to

be reapplied every 6 to 12 months to replenish the source of nutrients and suppress weeds. Much can be applied directly on top of the resident soil without the need for incorporation into the soil.

Pruning and Training

Vines are trained to facilitate hand pollination and harvesting in a process called looping. Vines should be looped around supporting trellises or branches as they grow. Looping vines to the ground will stimulate terrestrial roots to form, especially if they are covered in mulch, leading to stronger vines.

Looped, healthy vines from mature plants can be tipped (apex removed) to induce flowering. Vine tips are cut about 15 cm (6 inches) from the end (above the soil line) right before the dry season. These vines will be primed to flower in the coming months.

Irrigation

The natural rain cycles of Florida are favorable for *Vanilla* production. The rainy season, along with the high summer temperatures stimulates rapid growth. The drier season induces a rest period needed prior to flowering. As a result, established *Vanilla* plants sometimes may not require supplemental irrigation except during extremely dry periods. *Vanilla* plants are tolerant of short periods of desiccation. Irrigation is more critical for commercial production than in the home landscape.

Fertilization

Vanilla cultivation relies on the slow release of nutrients from decomposing organic material. Supplemental foliar nutrition can be applied, but scientifically-validated tests to justify this additional input are still lacking.

Pests

Insect pests generally do not typically cause serious damage. Snails and slugs, however can sometimes be problematic if not controlled. We have noticed larval feeding on young plants, but manually removed the pests.

Diseases

A major limitation to *Vanilla* production in many regions is root and stem rot disease caused by *Fusarium oxysporum*. *Fusarium* is a ubiquitous soil-borne fungus that causes rot in many species. One specialized type (*Fusarium oxysporum* f. sp. *radices-vanillae*) causes rot in *Vanilla* in all major producing areas by penetrating roots and spreading throughout the plant. Typical symptoms include browning and wilting, eventually leading to death of vines. The disease can be partially controlled by good horticultural practices including the avoidance of excessive waterlogging. Fungicides and biocontrol agents can have some benefit under certain conditions. Other potential fungal diseases include anthracnose and mildew.

Harvesting and traditional curing

Beans begin to yellow at the blossom end when fully mature. Care should be taken not to harvest beans prematurely as this negatively impacts the quality of the resulting extract. *V. planifolia* beans that are left on the vine for too long have a higher propensity to split or mold eliminating their economic value. The exception to this is *V. x tahitensis* that does not display the bean splitting trait and can be left on the vine until completely brown. Individual beans should be carefully removed from the raceme in order to avoid damaging the beans.

Vanilla beans must be cured in order to develop the characteristic vanilla aroma and flavor. Curing outcomes vary greatly by location and are heavily influenced by the growing environment, plant genetics, and the maturity of beans. The curing of *Vanilla* beans remains somewhat of an art with many variations being used in different parts of the world. In general, curing includes a few major steps: sorting, killing, sweating, gradual drying, and conditioning.

Sorting: Beans are sorted into classes including beans 16 cm and longer, beans 12-16 cm, and small/split/reject beans. Sorting beans by size is important for the heat kill step of curing.

Heat Kill: Heat is applied at a temperature that is high enough to kill the plant cells, but not so high that the enzymes required to produce the desirable vanilla flavors would be destroyed. Water killing at 63-65°C is required to arrest cell development and start the curing process. Long beans (>16 cm) should be heated for 3 minutes, with 12-16 cm beans heated for 2.5 minutes. Smaller beans can be water-killed for 2 minutes depending on the needs for the final product. After heat killing, the beans are packed into plastic bags for sweating.

Sweating: Sweating is the process of maintaining elevated bean temperatures above 45°C for 24-48 hours after heat killing. This can be done using insulated boxes with temperature control or by placing bottles with hot (~60°C) water inside the insulated container. Beans should be dark brown after water killing and sweating.

Gradual drying: Slowly drying the beans to a final moisture content <25% is important for flavor development and control of microbial growth. This is traditionally accomplished over 12-15 days by removing the beans from their plastic bags, exposing them to direct sunlight for a few hours each day, and repacking into plastic bags at the end of sun treatment. This process could be mimicked using spaces that have temperature, humidity, and air flow control. Beans are then placed on open trays to continue drying over ~70 days. Beans are sorted by quality at the end of the drying step. Any moldy beans should be discarded as they are detected.

Conditioning: Conditioning typically takes another 1-2 months. Bundled beans should be conditioned in boxes lined with paper that is impermeable to grease and oil (eg wax paper, parchment paper, grease-proof paper). Beans should not be allowed to completely dry during conditioning.

Making your own vanilla extract

Only extract from two types of *Vanilla*, *V. planifolia* and *V. x tahitensis*, can be sold as “vanilla extract” under the Code of Federal Regulations (Code of Federal Regulations Title 21 CFR169.175 and CFR169.3). The regulation dictates the solvent for vanilla extract to be not less than 35% ethyl alcohol by volume with 13.35 ounces of *Vanilla* beans at 25% moisture content per gallon of solvent. Smaller growers may want to consider forming cooperative ventures to improve curing and storage processes, and to help ensure the uniformity and consistency of the cured *Vanilla* beans.

Basic Economics

Many potential growers would like basic estimates for key inputs when considering the startup of a new vanillery. The available data is from other growing environments and production practices that will not necessarily reflect those of growers in southern Florida. Still, rough estimates can be useful when considering a new growing operation. The following answers to common questions are provided for estimation purposes only, and actual results will need to be empirically determined.

Answers to Common Questions

Q: How many years until a *Vanilla* vine will produce flowers and beans?

A: Meter-long cuttings will produce in 2-3 years, and smaller cuttings and tissue culture plants will take 3-4 years.

Q: How many times does a *V. planifolia* flower per year and when does this occur?

A: *Vanilla* flowers once per year usually in April-May in southern Florida.

Q: How many months does it take for a bean to ripen?

A: About 9 months after pollination.

Q: How many kilograms of green beans can one *V. planifolia* plant produce? How many kilograms of cured beans?

A: One healthy *Vanilla* plant can produce ~2 kg of green beans per plant. Curing is usually about 5:1 or 6:1 kg green bean to cured bean by weight, so each plant can produce around 0.3 to 0.4 kg cured *Vanilla* beans.

Q: How many cured beans do I need to obtain 1 kg of beans?

A: It will take 200-400 cured beans to make 1 kg of beans.

Q: How many plants do I need per acre?

A: Around 1,000 plants per acre is a good estimate, but this depends on the production method with more plants needed for intensive, shade house cultivation and fewer total plants when using tutor trees.

Q: Where can I obtain *V. planifolia* plants?

A: Tissue culture companies in both Florida and outside the USA (eg Costa Rica) can be identified by a quick internet search. Caution should be taken to ensure that these companies are selling *V. planifolia* or *V. x tahitensis* if you plan on selling “vanilla extract”.

Q: How much labor is required during pollination?

A: A general estimate is that one person can pollinate one acre of *Vanilla* vines. This includes monitoring the plants every day during the flowering season to pollinate freshly opened flowers.

Q: Do *Vanilla* flowers really need to be pollinated the morning that they open?

A: Yes, *Vanilla* flowers are only receptive for pollination for a short time. Temperatures can impact flower longevity, but pollinating before noon is usually optimal.

Q: Can I grow *Vanilla* hybrids?

A: Certainly, but the regulatory framework for some hybrids is murky. A grower must consider their buyers and consumers when considering the cultivation of *Vanilla* hybrids that incorporate species other than *V. planifolia* and *V. x tahitensis*. Some hybrids will be more robust and have higher disease resistance than traditional *V. planifolia*.

Q: How many flowers should be pollinated per raceme?

A: Usually no more than 10 beans should be allowed to develop per raceme. More could overly burden the nutritional status of the vine leading to poor vine health the following year.

Q: How long will the *Vanilla* vines stay in production?

A: This depends on the health of the vines, disease, and other cultural practices. You can anticipate vines staying productive for 3-5 years, but regular cycling with new, disease-free vines will aid your operation in sustainably producing beans.

Additional resources

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