

Pineapple: Versatile Multiple Fruit

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Introduction: -

The pineapple [*Ananascomosus*] is one of the leading commercial fruit crops of the tropics. Pineapple is also a commercially important fruit crop of India with around 90,000 ha area under this crop, 15.27 lakh tonnes annual production and 15.3 tonnes /ha productivity (Anonymous, 2013). It is one of the most important tropical and subtropical fruit which is said to have been introduced into India as early as 1548. Pineapple is found in different parts of the world are Malaya, South Africa, Hawaiian Islands, Queensland, Ceylon. Among them, the pineapple industry has been well developed in Hawaii.

It is one of the choicest fruits all over the world because of its pleasant taste and flavour. Pineapple is a good source of vitamin A and B and fairly rich in vitamin C and minerals like calcium, magnesium, potassium and iron (Table 1). It is also a source of bromelin, a digestive enzyme. In addition to being eaten fresh, the fruit can also be canned and processed in to different forms.



Table 1: Nutritional value of Pine apple (per 100 g)

Energy	48 kcal
Carbohydrates	12.63 g
Sugars	9.26 g
Dietary fiber	1.40 g
Fat	0.12 g
Protein	0.54 g
Thiamine (vit. B1)	0.079 mg
Riboflavin (vit. B2)	0.031 mg
Niacin (vit. B3)	0.489 mg
Pantothenic acid (B5)	0.205 mg
Vitamin B6	0.110 mg
Folate (vit. B9)	15.00 µg
Vitamin C 3	6.20 mg
Niacin (vit. B3)	0.489 mg
Pantothenic acid (B5)	0.205 mg
Vitamin B6	0.110 mg
Folate (vit. B9)	15.00 µg
Vitamin C 3	6.20 mg
Calcium	13.00 mg
Iron	0.28 mg
Magnesium	12.00 mg
Manganese	0.90 mg
Phosphorus	8.00 mg
Potassium	115.00 mg
Zinc	0.10 mg

Source: USDA Nutrient database 2 Pineapple-a profitable fruit crop for Goa

It is an herbaceous perennial. Throughout the length of the stem, it is surrounded by thickly with leaves. From the axils of the basal leaves, branches with close arranged leaves arise, which are capable of reproduction of new plants. These are called suckers. Just below the inflorescence, from the peduncle (fruit stalk) small branches with close arrangements of



leaves arise and these are called “slips. The inflorescence is a compact spike with 100-200 flowers. Flowers are hermaphrodite with functional pollen and ovule but there is self-incompatibility, hence the fruit set takes place parthenocarpically. Fruit is sorosis. The edible part of the fruit develops from outer zone of the axis tissue (penducle), the ovaries, fused bases of the sepals and the bases of the bracts.

Soil and climate:-

The best soil for pineapple culture is a well-drained, sandy loam with a high content of organic matter and it should be friable for a depth of at least 2 ft (60 cm), and pH should be within a range of 4.5 to 6.5. Soils that are not sufficiently acid are treated with sulfur to achieve the desired level. If excess manganese prevents response to sulfur or iron, as in Hawaii, the plants require regular spraying with very weak sulfate or iron. The plant cannot stand waterlogging and if there is an impervious subsoil, drainage must be improved. Pure sand, red loam, clay loam and gravelly soils usually need organic enrichment. Filter presscake from sugar mills, worked into clay soils in Puerto Rico, greatly enhances plant vigor, fruit yield, number of slips and suckers.

Pineapple adapts well to sub-tropical regions to tropical regions having humid climate (75-78%), it performs well in places receiving rainfall ranging from 10-150 cm. It requires an optimum temperature range of 21.0°C to 23.0°C. It can be grown up to an elevation of 1100 m from sea level. The amount of sunshine plays an important role in plant growth and quality of the fruit. Large number of cloudy day retards growth and results in small sized fruits of poor quality. On the other hand, too much of sunshine causes sun-burning of mature fruits. However, shading could be provided to overcome this defect.

Ideally, rainfall would be about 45 in (1,143 mm), half in the spring and half in the fall; though the pineapple is drought tolerant and will produce fruit under yearly precipitation rates ranging from 25 to 150 in (650-3,800 mm), depending on cultivar and location and degree of atmospheric humidity. The latter should range between 70 and 80 degrees.

Varieties: -

In international trade, the numerous pineapple cultivars are grouped in four main classes: 'Smooth Cayenne', 'Red Spanish', 'Queen', and 'Abacaxi', despite much variation in the types within each class.



- ✚ **Smooth Cayenne** or 'Cayenne', 'Cayena Lisa' in Spanish (often known in India, Sri Lanka, Malaysia and Thailand as 'Sarawak' or 'Kew') was selected and cultivated by Indians in Venezuela long ago and introduced from Cayenne (French Guyana) in 1820. From there it reached the Royal Botanical Gardens, Kew, England, where it was improved and distributed to Jamaica and Queensland, Australia. Because of the plants near freedom from spines except for the needle at the leaf tip and the size-4 to 10 lbs (1.8 4.5 kg)-cylindrical form, shallow eyes, orange rind, yellow flesh, low fiber, juiciness and rich mildly acid flavor, it has become of greatest importance worldwide even though it is subject to disease and does not ship well. Mainly, it is prized for canning, having sufficient fiber for firm slices and cubes as well as excellent flavor.
- ✚ **Red Spanish** grown in Mexico, Puerto Rico and Central America. Red Spanish Pineapples have orange colored skin, are somewhat smaller than Smooth Cayenne **Pineapples**, and their flesh is more fibrous.
- ✚ **Queen** (also called 'Common Rough' in Australia) is the leading cultivar in South Africa, Queensland and the Philippines. The plant is dwarf, compact, more cold-resistant and more disease-resistant than 'Smooth Cayenne'. It matures its fruit early but suckers freely and needs thinning, and the yield is low. The fruit is conical, deep-yellow, with deep eyes; weighs 1 to 2 1/2 lbs (0.45-1.13 kg); is less fibrous than 'Smooth Cayenne', but more fragrant; it is juicy, of fine flavor with a small, tender core. It is sold fresh and keeps well. It is only fair for canning because of its shape which makes for much waste.
- ✚ **Abacaxi** is well known in Brazil, the Bahamas and Florida. The plant is spiny and disease-resistant. Leaves are bluish-green with red-purple tinge in the bud. The numerous suckers need thinning out. The fruit weighs 2.2 to 3 lbs (1-5 kg), is tall and straight-sided; sunburns even when erect. It is very fragrant. The flesh is white or very pale yellowish, of rich, sweet flavor, succulent and juicy with only a narrow vestige of a core. This is rated by many as the most delicious pineapple. It is too tender for commercial handling, and the yield is low. The fruit can be harvested without a knife; breaks off easily for marketing fresh.

Important varieties which are grown in India are Giant kew, Queen and Mauritius. Their distinguishing features are given in Table 2.

Table 2. Distinguishing features of important varieties in pineapple

Characters	Giant Kew	Queen	Mauritius
1. Leaves	Smooth, spiny at tip	Serrated	Short spiny
2. Fruits	Large	Small	Medium
3. Weight	1.6-3.0	0.5-1.0	1.0-2.0
4. Shape of fruit	Oblong, tapering slightly towards crown	Cylindrical	Oblong
5. Colour of ripe fruit	Yellow	Dark yellow	Yellow and red
6. Flesh colour	Light yellow	Golden yellow	Reddish yellow
7. Other characters	Almost fiberless very juicy with pleasant flavours	Sweetest of all varieties, most suitable for dessert	

In India, hybridization work taken up at pineapple research centre of the Kerala Agricultural University.

Propogation:-

Crowns (or "tops"), slips (called nlbs or robbers in New South Wales), suckers and ratoons have all been commonly utilized for vegetative multiplication of the pineapple. To a lesser degree, some growers have used "stumps", that is, mother plant suckers that have already fruited. Seeds are desired only in breeding programs and are usually the result of hand pollination. The seeds are hard and slow to germinate. Treatment with sulfuric acid achieves germination in 10 days, but higher rates of germination (75-90 %) and more vigorous growth of seedlings results from planting untreated seeds under intermittent mist. The seedlings are planted when 15-18 months old and will bear fruit 16-30 months later. Vegetatively propagated plants fruit in 15-22 months.

In the past, growers preferred plants that supplied abundant basal slips for planting, not recognizing the fact that such plants gave smaller fruits than those without slips or suckers. Also, breeders aim toward elimination of slips to facilitate harvesting. Because of the increased demand for planting material, a new method of mass propagation received wide attention in 1960. During the harvest, plants that have borne single-crowned, superior fruits without basal slips are selected and marked. Following harvest, these plants are cut close to the ground, the leaves are stripped off and the stems—usually 1 to 2 ft (30-60 cm) long and 3 to 4 in (7.5-10

cm) thick—are sliced lengthwise into 4 triangular strips. The strips are disinfected and placed 4 in (10 cm) apart, with exterior side upward, in beds of sterilized soil, semi-shaded and sprinkler-irrigated. Shoots emerge in 3 to 5 weeks and are large enough to transplant to the nursery in 6 to 8 weeks. 'Smooth Cayenne' yields an average of 3 shoots per slice. 'Red Spanish' and 'Natal Queen', 4 per slice.

This use of the stem is a major improvement over the former practice of allowing it to develop suckers high up after the fruit is harvested. If such suckers bear fruit *in situ* they are not strong enough to support it and collapse. They are better removed for planting, but repeated removal of suckers weakens the mother plant.

The butts, or bases, of mother plants, with leaves intact, are laid end to end in furrows in nurseries and covered with 2 to 3 in (5-7.5 cm) of soil. Sprouting occurs in 6 to 8 weeks. The butts give an average of 6 suckers each, though some have put forth up to 25. A one-acre (0.4 ha) nursery of 25,000 butts, therefore, yields between 100,000 and 200,000 suckers. The Pineapple Research Institute in Hawaii has also employed axillary buds at the base of crowns. Each crown segment may develop 20 plantlets. This method has been adopted in Sri Lanka for perpetuating superior strains but not for commercial cultivation because the resulting plants require 24 months or more to fruit.



In India, because of low production of slips and suckers in 'Smooth Cayenne', crown cuttings (15-16 per crown) have been adopted for propagation with 95% success, and this method is considered more economical than the utilization of butts. Vegetative propagation does not assure facsimile reproduction of pineapple cultivars, as many mutations and distinct clones have occurred in spite of it.

Culture: -

The land should be well prepared at the outset because the pineapple is shallow-rooted and easily damaged by post-planting cultivation. Fumigation of the soil contributes to high quality and high yields.

Planting: -

In small plots or on very steep slopes, planting is done manually using the traditional short-handled narrow-bladed hoe, the handle of which, 12 in (30 cm) long, is used to measure the distance between plants. Crowns are set firmly at a depth of 2 in (5 cm); slips and suckers at 3 1/2 to 4 in (9 10 cm). Butts, after trimming and drying for several days, are laid end-to-end in furrows and covered with 4 in (10 cm) of soil.



Double-rowing has been standard practice for many years, the plantlets set 10 to 12 in (25 30 cm) apart and staggered, not opposite, in the common rows, and with 2 ft (60 cm) between the two rows. An alley 3, 5 1/2 or 6 ft (.9, 1.6 or 1.8 m) wide is maintained between the pairs, allowing for plant populations of 17,400, 15,800 or 14,500 per acre (42,700, 37,920 or 33,800 per ha) respectively. Close spacing gives highest total crop weight—e.g. 18,000 plants/acre = 28.8 tons (43,200 plants/ha = 69.12 tons). However, various trials have shown that overcrowding has a negative effect, reducing fruit size and elongating the form undesirably, and it reduces the number of slips and suckers per plant. Density trials with 'P.R. 1-67' in Puerto Rico demonstrated that 21,360 plants per acre (51,265/ha) yielded 35.8 tons/acre (86 tons/ha) in the main crop and 18.9 tons/acre (45.43 tons/ha) in the ratoon crop,



but only one slip per plant for replanting. Some plantings are mulched with bagasse. In large operations, asphalt-treated paper, or black plastic mulch is regarded as essential. It retards weeds, retains warmth in cool seasons, reduces loss of soil moisture, and can be laid by machines during the sterilization and pre-fertilization procedures. Mulch necessitates removal of basal leaves of crowns, slips and suckers and the use of a tool to punch a hole at the pre-marked planting site for the insertion of each plantlet. The mulch is usually rolled onto rounded beds 3 1/4 ft (1 m) wide.

Mechanical planting: -

Research on the potential of machines to replace the hard labor of planting pineapples was begun in Hawaii in 1945. A homemade device was first employed in Queensland in 1953. Early semi-mechanical planters were self-propelled platforms with driver and two men who made the holes in the mulch and set the plants in place. With a 2-row planter, 3 men can set 7,000 plants per hour of operation. Frequent stops are necessary to reload with planting material. With improved equipment, mechanical planting has become standard practice in large plantations everywhere. The most sophisticated machines have attachments which concurrently apply premixed fertilizer and lay a broad center strip of mulch, set the plantlets along each edge, and place a narrow strip along the outer sides. The only manual operation, apart from driving, is feeding of the plantlets to the planting unit. With this system, up to 50,000 plants have been set out per day.

Fertilization: -

Nitrogen is essential to the increase of fruit size and total yield. Fertilizer trials in Kenya show that a total of 420 lbs N/acre (471.7 kg/ha) in 4 equal applications during the first year is beneficial, whereas no advantage is apparent from added potassium and, phosphorus. Puerto Rican studies have indicated that maximum yields are achieved by urea sprays supplying 147 lbs N/acre (151 kg/ha). In Fruit weight has been considerably increased by the addition of magnesium. Fruit size and total yield have been enhanced by applying chelated iron with nitrogen; also, where chlorosis is conspicuous, by accompanying nitrogen with foliar sprays of 0.10% iron and manganese. Some growers thin out suckers and slips to promote stronger growth of those that remain.

Irrigation: -



Irrigation is desirable only in dry seasons and should not exceed 1 in (2.5 cm) semi-monthly.

Weed Control: -

Manual weeding in pineapple fields is difficult and expensive. It requires protective clothing and tends to induce soil erosion. Coir dust has been used as mulch in Sri Lanka to discourage weeds but it has a deleterious effect on the crop, delaying or preventing flowering. The use of paper or plastic mulch and timely application of approved herbicides are the best means of preventing weed competition with the pineapple crop.

Flower Induction: -

Pineapple flowering may be delayed or uneven, and it is highly desirable to attain uniform maturity and also to control the time of harvest in order to avoid overproduction in the peak periods. In 1874 in the Azores, it was accidentally discovered that smoke would bring pineapple plants into bloom in 6 weeks. The realization that ethylene was the active ingredient in the smoke led to the development of other methods.

As far back as 1936, compressed acetylene gas, or a spray of calcium carbide solution (which generates acetylene) were employed to expedite uniform blooming. Some growers have merely deposited calcium carbide in the crown of each plant to be dissolved by rain. A more advanced method is the use of the hormone, *a*-naphthaleneacetic acid (ANA) or *B* naphylacetic acid (BNA) which induce formation of ethylene. In recent years, *B*-hydroxyethyl hydrazine (BOH) came into use. Treatment is given when the plants are 6 months old, 3 months before natural flowering time. The plants should have reached the 30 leaf stage at this age.

Ethrel, or the more recently developed Ethephon, applied at the first sign of fruit ripening in a field will cause all the fruit to ripen simultaneously. It brings the ratoons into fruit quickly. There is a great saving in harvesting costs because it reduces the need for successive pickings.

Plants treated with naphthaleneacetic acid produce long, cylindrical, pointed fruits, maturing over an extended period of time, ripening first at the base while the apex is still unripe. Ethylene treatment results in a square shouldered, shorter fruit maturing over a shorter period and ripening more uniformly.

Season of Pineapple farming: -

Ideally, pineapples are planted 12-15 months before the flowering season. Flowering season occurs between the months of December and March. It varies between regions. Generally, the planting time depends on the onset of monsoon, its intensity, precipitation, etc. It is planted during April- June period in Karnataka and Kerala while in Assam it is done during August to October months. Pineapple cultivation is avoided during the heavy rainy period. Ideal time for cultivation in different states across India is as below

Name of the State	Time of Cultivation
Assam and other North Eastern States	August to October
Kerala and Karnataka	April to June
Northern parts of West Bengal	October to November
Other parts of West Bengal	June to July

Fruits in pineapple cultivation: -

This is one big challenge of growing pineapples. Pineapples must have the perfect fruit with the perfect oblong shape and the just right 'pineapple' flavor. Else they lose market value. Although infections are uncommon in pineapple cultivation, there are different types of fruit abnormalities that pose a threat to pineapple crop commonly. Some of these are as below:



Abnormalities in Pineapple

Multiple crowns: -



Sometimes, pineapple fruits bear more than one crown (25 crowns in some extreme cases). As a result, the top of the fruits grows broad and flat. The fruits are corky and taste insipid. This is most commonly observed in Kew fruits making it unfit for canning.

Crown and fruit initiation: -

Fasciation makes pineapples totally useless for consumption. A very high soil fertility and warm weather favors boosts vegetative growth resulting in fasciation. Such plants take a longer time than normal plants to flower. In extreme cases, the fruit may be flat and appear twisted with innumerable crowns.

Collar of Slips: -

Presence of an innumerable number of slips arising from the stem near the base of the fruit or sometimes from the fruit directly results in this condition. Owing to the excess slip growth, the resultant fruit is tiny, tapered with knobs at the base. Generally, a high nitrogen fertilization, heavy rainfall and relatively low temperature together result in collar of slips.

Intercultural Operations in Pineapple Plantation: -

Various intercultural operations like earthing, weeding, mulching, removing slips, suckers and crowns and ratoon crops are practiced in pineapple farming. This is especially because pineapples grow on loose soil with shallow roots. Here are the pineapple farming techniques.

Earthing: -

Pineapples have shallow roots. Hence, they are prone to lodging. If plants lodge during fruit development, it would result in uneven fruit development and a lopsided growth. Earthing helps plants get a good anchorage. In earthing, the soil is pushed down from the ridges into the trench.

Weeding: -

Weeding is especially important from the economic point for any cultivation. Nutgrass and hariyali are the most common types of weeds in pineapple. Since hand weeding is a laborious process and cumbersome process, chemical weeding is advisable. Combination of diuron with bromacil as a pre-emergence spray is usually recommended. The pre-emergence spray is 0.6 Kg of diurons with 0.8 Kg of bromacil. It repeated with half the concentration after five months of first application.

Mulching: -



If pineapple is being grown as a rain-fed crop, then this is an essential step. The main aim of mulching is moisture conservation and weed control. Using a black polythene film is the easiest and least laborious way of mulching. However, using a mulch of leaves and straws and spreading them between the pineapple plants in soil is a more organic way of mulching.

Removing Crowns, Slips and Suckers: -

Suckers and slips grow with the emergence of inflorescence and fruit development respectively. Most suckers and slips are removed while only one or two are retained. Since an increased number of slips delay the maturity of fruits, they are removed as soon as they attain the size required for planting. On the other hand, fruit weight increases with increase in suckers. Therefore, desuckering can be delayed. If the farmer intends an early harvest, then the slips are removed as soon as they appear.

Ratoon Crop: -

Pineapples can be retained for upto 3 crops in India. In the next cycle of rotation, the suckers used for cultivation are the ones from the original plant. In order to provide a good anchorage for ratoon crop the plants must be adequately earthened and fertilized.



Diseases and Plant Protection in Pineapple Cultivation: -

Unlike a lot of other crops, pineapples are not dogged by too many diseases in India. In fact, diseases in pineapples are very sporadic. Mealy, scale insects and stem rot are the most likely to occur infection in pineapple cultivation in India. Dipping the suckers in Bordeaux mixture before planting and a good drainage system would take care of stem rot and other fungal diseases.

Harvesting Pineapple:-

It typically takes 2-2.5 years for pineapples to get ready for harvest. They flower after 12-15 months of planting and start fruiting only after 15-18 months. Usually the fruits ripen after 5 months of inflorescence. Fruits cultivated for canning purposes are harvested as soon as a small change at the base of the fruit is noticed. The ones for table purposes are harvested only after they develop a golden yellow color.

To decide the time of fruit maturity, the level of yellow color at the eyes acts as the indicator. They are decided as below:

-  Color Stage (CS) 1: Green eyes with no yellow coloring
-  CS2: 5-20% of eyes turn yellow

- ✚ CS3: 20-40% eyes turn yellow
- ✚ CS4: 40-80% of eyes turn yellow
- ✚ CS5: 90% of eyes turn yellow with 5-20% of them reddish brown
- ✚ CS6: 20-100% of eyes turn reddish brown

The harvested fruits are graded according to their size, color and weight and then sent for storing. On an average, the yield depends on the cultural practices followed and inter-spacing. However, it varies between 20-30 tonnes per hectare.



Storing Pineapple:-

After harvest, fruits with crown can be stored upto 15 days without damage. However, those that are transported must be refrigerated during transportation so as to slow down the ripening process. They can be stored at 10-13°C for 20 days. The optimal storage temperature is 7.2°C with 80-90% relative humidity.

Conclusion:-

Pineapple cultivation is a commercially viable farming business as it gives good return with minimal care. A successful pineapple farm requires good farm management and farming techniques.