

PINEAPPLE PRODUCTION and POST HARVEST HANDLING



INTRODUCTION

The centre of origin of the Pineapples (*Ananas spp.*) is believed to be in the Parana-Paraguay River drainage basin area in South America where the original seed species still occur wild. Another centre of origin is said to be along the river banks of the most southern areas in Guyana.

It is reported that the Tupi-Guarani Indians were the first people to select and cultivate the pineapple in that area and later took it with them on their subsequent migrations. The records of the early explorers show that the pineapple was widely distributed throughout most of tropical America and later taken to other tropical areas of the world e.g. Africa, Asia, the South Pacific and Australia.

The pineapple is one of the most important fruit crops in Guyana for the domestic and export markets. There are lucrative markets for pineapples in the Caribbean Region. There are also good prospects for extra-Regional exports. The major producing areas are in Administrative Regions 3 and 4 where yields range between 15.0 - 18.0 tons/ha. With improved technology, yields can go as high as 30 tons/ha. The pineapple fruit itself is made up of 100-200 berry-like fruitlets or “eyes” fused together on a central axis or core and is borne on a stem or stalk which is an elongation of the apical meristem.

The pineapple was originally consumed only as a fresh fruit. With the development of the processing industry, the fruit is now prepared and consumed in various forms such as pineapple chunks, slices, juices, syrups, jams, crushed pineapple, diced pineapple etc. also the wastes from processing the fruit are now further processed into sugar, wines, vinegar, animal feed, etc.

In the Philippines and Taiwan, high quality fibres, ideal for the manufacture of luxury clothing, are produced from the leaves of their pineapple varieties. In Brazil, fibres of the wild species are used for making rope and fishing nets. The fibre is also used for making pulp in the paper industry.

VARIETIES

In Guyana, Montserrat is the main variety grown. Other varieties cultivated in small quantities are Sugar Loaf, Smooth Cayenne, and Tiger Head.

Montserrat

This is the principal variety cultivated in Guyana. It has long leaves with stiff serrated edges. The fruit is mainly conical in shape, hardy and delicious. It is pale-fleshed with small pointed “ eyes ” and weighs between 1.5-3.0 kg.

Sugar Loaf

This is a delicate variety with a very short shelf life. The leaves have serrated spiny margins. The fruit is oblong in shape, dark green when mature but acquires a bright yellow colour and a strong aroma when fully ripe. It is yellow-fleshed and averages about 2 kg in weight.

Smooth Cayenne

As the name implies the leaves, unlike those of the Sugar Loaf and Montserrat, have smooth margins. The fruit is almost cylindrical in shape with flat, broad eyes and averages about 2 kg in weight. It is pale fleshed and fine flavoured. It is principally a canning variety.

Tiger Head

This variety is found scattered in the Amerindian Settlements in the Hinterlands areas. It has long, narrow leaves with spiny serrated margins. It bears a long rounded fruit that has a sweet taste and coarse-textured and weighs about 2-3kg.

SOILS AND CLIMATIC REQUIREMENTS

Pineapples grow well in Guyana on a wide range of soils. Some pineapples are grown on the upland sandy soils, but most of the commercially grown pineapples are on riverain silt loams, clay loams and clay high in organic matter, (locally called (Pegasse soils) that have benefitted from improved drainage and water control systems. Soils prone to water logging are unsuitable since they hasten the development of root rot. Best growth is

achieved on well-drained, fertile, sandy loam soils with a pH range of 4.5-5.5.

Although the pineapple plant is fairly resistant to drought, it requires a medium to high evenly distributed rainfall for good growth and the production of healthy fruits. It will grow with an annual rainfall as high as 2,500 mm once adequate drainage is provided

CULTIVATION PRACTICES***Land Preparation***

Where cultivation is to be done for the first time, on forested new lands, the ‘ slash and burn ‘ method of land clearing could be used. This method has the advantage of releasing nutrients to the soil, and destroys or reduces weeds and ants nests in the fields. On the upland sandy soils, little additional preparation is

required before planting.

On the heavier riverain soils, when replanting old pineapple cultivation or using lands previously used for other crops, the area should be ploughed and left to weather for 3-4 weeks. The land is then harrowed and the crop can be planted.

On riverain and potential acid-sulphate soils where water control is critical, a system of raised beds and drains will be required. The width of the beds will depend on whether single or double rows of plants will be used. If single rows are to be used the beds should be made 240 cm (8 ft) wide and for double rows the beds should be 390 cm (13 ft) wide. Drains on either side of the bed should be made 60 cm (2 ft) deep. This will enhance the removal of excess water from the plants' rooting zone. Control of weeds can be initiated at this land preparation stage.

Propagation and Planting Materials.

The pineapple is propagated vegetatively. Planting materials are obtained from various parts of the plant and are identified according to the part of the plant on which they are found.

Ratoon Suckers are shoots produced from ground level and, when used, will produce fruit in twelve to fourteen months after planting. Side Shoots or suckers are shoots produced above ground level and, when used, bear within eighteen to twenty months after planting. Basal suckers known as "slips" (Figure 1) are located at the base of the fruit. They produce fruit within fourteen to sixteen months after planting and are the preferred type of planting material.

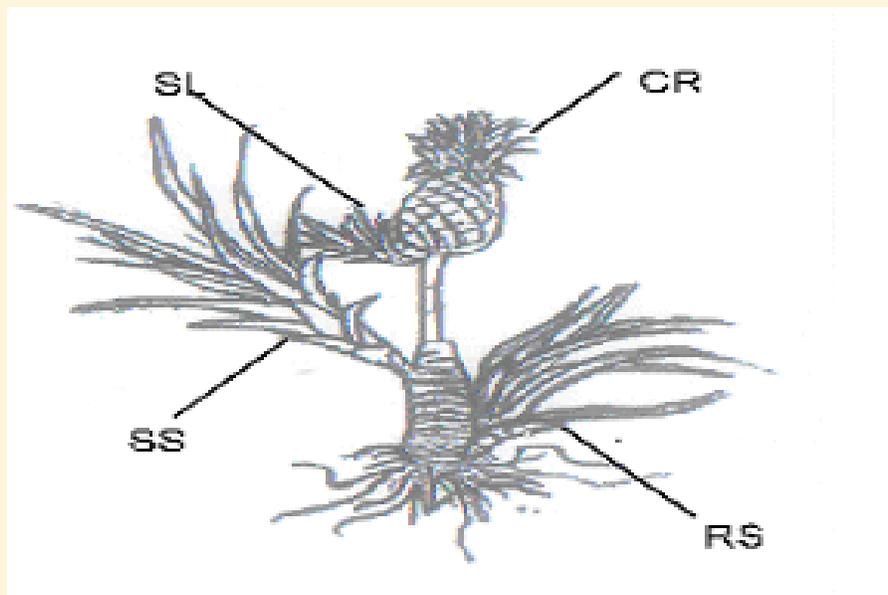


Fig. 1

Plant shoots used for planting material

CR = crown; SL = slip; SS = side shoots or suckers; RS = ratoon suckers

Crowns are situated at the apex of the fruit (fig 1). This type of planting material is not commonly used by farmers, and even when used, they take as long as twenty-four months after planting to produce fruit.

Preparation of Planting Materials

Treatment

Remove dried leaflets found at the base of the suckers and trim the ends with a sharp knife. The slips with leaflets pointing upwards, should be packed in a container, layer after layer. When the container is filled, add a solution of Malathion or Diazinon 0.1 % - 5 ml in 4.5 L water (1tsp/1 gal water) until the slips are fully covered, in order to ensure all pests are killed. Submerge slips for twenty minutes then drain off the solution into another container and store for reuse. Using gloves, remove suckers from the container and pack on ground under shade in an up-right position for seven days.

This treatment is essential for the control and spread of pineapple mealy bug.

Grading

Prior to planting, suckers should be graded according to size. Large and small ones are to be planted separately:

Large suckers (slips) - 15 cm (6 ins) and over

Small suckers (slips) - below 15 cm (6 ins).

For better and faster growth, large suckers are preferred.

Planting

When planting, ensure that the “heart” of the plant is above soil level otherwise rotting will occur, particularly if the soil is wet.

Either the single or double-row system can be used. However, for a more cost-effective land use, the philosophy is to have the largest number of plants per unit area as is practical. This is better achieved by the double row system which accommodates more plants while still permitting some room to manoeuvre between the plants. This double-row system is therefore the recommended system of planting.

Single Row

The rows are spaced 150 cm (five feet) apart and plants spaced 60 cm (two feet) within the row (Figure 2). This allows for a population of 11,000 plants/ha (4,400 plants/ac).



Fig. 2: Single Row Planting

Double Row Planting

Two rows are spaced 70-80 cm (28 -32 ins) apart. The suckers should then be planted staggered 45 - 60 cm (18 - 24 ins) within the rows(Figure 3). The distance between the double rows or every two rows should be 150 cm (5 ft.). This arrangement will give 25,000 - 29,000 plants/ha (10,000 to 12,000 plants/ac).



Fig. 3 Double Row Planting

Fertilizers

The fertilizer recommendations are based on a plant density in the double-row system of 25,000 - 29,000 plants/ha (10,000 - 12,000 plants/ac).

It is important to have the soil analyzed to obtain recommended levels of fertilizers, but on the whole, the pineapple plant requires high levels of fertilizers for satisfactory production.

In the absence of a precise soil analysis, the following general recommendations will suffice.

(1) Sandy Soils

The upland sandy soils are infertile and require a complete fertilizer with added trace or minor nutrients. A general recommendation will be to apply on a per annum basis:

600 kg/ha (532 lb./ac) of 12:12: 17:2
 24 kg/ha (20 lb./ac) of 3:9:30 +FTE (trace elements)

The total amount of nutrients should be applied on equal split applications at two months intervals, i.e. 104 kg/ha of the total mixture is to be applied every 2 months. If 12:12:17:2 is unavailable then it may be substituted by:

Urea -	200 kg/ha (90 lb./ac)
TSP. -	150 kg/ha (80 lb./ac)
M of P -	112 kg/ha (95 lb./ac)
Magnesium Sulfate-	23 kg/ha (5lb./ac)

(3) *Riverain Soils*

Apply half the amounts as recommended for sandy soils but maintain the same times of application.

WEED CONTROL IN PINEAPPLE

Weeds are a major constraint to pineapple production and can incur a significant cost if not managed successfully. Pineapple plants are slow growing and do not cover the ground well enough to suppress weeds from developing in the first six to eight months of its growth. Competition from weeds is much more severe at this stage since the pineapple plants are less vigorous.-This is the critical period for weed control in pineapple since this is the time when the plant needs the conditions that will ensure vigorous growth and establishment. The plants can take “care of themselves” after this stage.

Weeds grow faster than the pineapple and compete with the crop for mineral nutrients, water and sunlight. By so doing they reduce the growth, yields, quality and income to the farmer. Some weeds such as bura-bura, *Solanum stramonifolium*, and congo pump, *Cecropia peltata*, are hosts to the pineapple ant-mealybug complex. This complex is known to be associated with the pineapple scarlet tip disease.

Some weeds commonly found in pineapple fields are:

Imperata brasiliense, Juk grass, Jew grass

Digitaria sanguinalis, large crabgrass

D. iscahaennum, smooth crabgrass

A ciliaris, crabgrass

Phyllanthus urinafia, egg woman, seed underleaf, gripeweed

Caladium bicolor, wild eddo

Croton trinitatis, massalla bush

Solanum caroliniense, horsenettle, wild bura-bura

METHODS OF WEED CONTROL

Weeds can be controlled manually and chemically. The practice recommended is a combination of chemical and manual methods.

Some recommended herbicides for use in pineapple cultivations are:

Karmex (Diuron)

Roundup (glyphosate)

Gramoxone (paraquat)

Gramocil (paraquat + diuron)
2-4D amine
Gesapax (Ametryn)

Weed control before land preparation

Except diuron the other compounds can be used postemergent as “burn down” herbicides before land preparation and tillage. This is an important stage to destroy weeds since they can be difficult to eliminate at later stages.

Roundup, gramoxone, and gramocil must be used at 1.5 L/ha.

Roundup and gramoxone can be tank mixed separately with 2-4D amine for a more even and complete kill. (Roundup/gramoxone at 1.5 L/ha + 2-4D amine at .75 L/ha).

Generally it takes about 8 (eight) CP3 knapsack spraycans to spray an acre.

For Roundup use 5 ounces per spraycan or 10 rum corks per can.

Gramoxone: 3 ounces or 6 rum corks per can.

Gramocil: 3 ounces or 6 rum corks per can.

2-4D 2 ounces or 3 rum corks per can

Weed Control at Planting

Karmex can be used both as pre-emergent and post emergent applications. It is used at planting to kill weeds as soon as they germinate. This compound has a persistence of about 3-4 months after which follow up postemergent applications have to be made. When used pre-emergent, Karmex must be applied at the rate of 2- 2.5 kg a.i/ha. This is 0.5 (half) to 0.75 (three quarters) pounds per spraycan.

Weed Control During Growing Stage

After the first applications of Karmex, hand weeding should follow as soon as weeds are at 4-5 leaf stages. Karmex can also be used as a post emergent (over the top) applications at the rate of 2.5 -4 kg a.i/ ha when late emerging weeds are at the 2 and 3 leaf stages. This is a rate of 0.75 (three quarters) to 1 pound is used per spraycan.

During the growing period, care should be taken in selecting the rates and types of herbicides for use as post-emergent sprays. This will depend on the level of weed infestation as regards grasses or broadleaves.

Non-selective herbicides such as gramoxone and glyphosate must be used with utmost care only in the space between the rows. These herbicides must be applied on a sunny day when the wind is calm. A spray shield may also be used.

Gesapax 80 WP used at rates of 2 kg/ha at the 3-4 leaf stage of weeds is recommended when there is a heavy infestation of grasses.

This is 0.25 (quarter) pound per spraycan.

When the pineapple has fully canopied and the spaces between the rows are shaded weed control activities would drastically decrease. Economically it is assumed that the yield losses caused by weeds at this stage are not significant to require further costs in weed control.

(1) *During Land Preparation*

This is the best period to destroy weeds that are difficult to eliminate at the later stages.

Post-emergence herbicides such as Round Up that destroy weeds that are already growing, are recommended at this stage. Also recommended is a combination of Gramoxone and Karmex. If only grass weeds are present, it may be more cost effective to use Dalapon.

Since these products take some time to effectively kill the weeds, an interval of 3 -4 weeks after application and before the tilling of the soil should be allowed. The recommended herbicides and dosage recommended during land preparation are shown in Table 1.

(2) *At Planting*

At this stage, the aim is to destroy the weeds as soon as they germinate. Pre-emergent herbicides with long persistence should be used to prevent the development of the weeds over a long period of time. However, these chemicals must not have a detrimental effect on the growth of the pineapple plant. Herbicides such as Gesaprim, Karmex and, Krovar are recommended for use immediately after planting. (Table 2)

(3) *During the Growing Period*

The pineapple plant is most vulnerable to herbicides when it is three to five months old as this is the most active period of growth of the plant.

If chemical weed control cannot be avoided during this stage greatest care must be taken during application. To avoid all phytotoxicity risks therefore, the application of herbicides during the growing period, with few exceptions, should be restricted to the space between the rows.

Herbicides such as Gesapax, Karmex with a surfactant spreader such as Frigate, and Krovar are recommended (Table 3). For certain hard to kill weeds, Gesapax Combi might be used. Also, if there are only grass weeds present, Fusilade could be used and this could be applied as an overall spray over the plants.

Avoid the use of Karmex and Krovar between the flowering and harvesting of the Pineapple as it may cause some phytotoxicity that could affect both quality and yield

Table 1. Recommended herbicides and dosages during land preparation

Trade Name	Chemical	Dose (Per Unit Area)	Dose (Per 20L Spray)
Dalapon 80%	Dalapon	12-18kg/ha 10-16 lb./ac	1-2 kg 2.5-4lb.
Gramoxone 24% Millquat 27%	Paraquat	3-12 L/ha 2-8 Pints/ac	0.250-1L 0.5-2 Pints
Karmex 80%	Diuron	5-7.5 kg/ha 4.5-6.5 lb./ac	0.5-0.75 kg 1-1.5 lb.
Krovar 80%	Bromacil/Diuron	5-7.5 kg/ha 4.5-6.5 lb./ac	0.5-0.75 kg 1-1.5 lb.
Round-Up 42%	Glyphosate	9.5-19 L/ha 6.5-13.5 Pints/ac	1-2 L 1.5-3 Pints

Table 2. Recommended herbicides and dosages at planting

Trade Name	Chemical	Dose (Per Unit Area)	Dose (Per 20L Spray)
Gesaprim 80%	Atrazine	5-7.5 kg/ha 4.5-6.5 lb./ac	0.5-0.75 kg 1-1.5 lb.
Karmex 80%	Diuron	5-7.5 kg/ha 4.5-6.5 lb./ac	0.5-0.75 kg 1-1.5 lb.
Krovar 80%	Bromacil/Diuron	5-7.5 kg/ha 4.5-6.5 lb./ac	0.5-0.75 kg 1-1.5 lb.

Table 3. Recommended herbicides and dosages during during growing period

Trade Name	Chemical	Dose (Per Unit Area)	Dose (Per 20L Spray)
Gesapax 80%	Ametryne	2.5-3.75 kg/ha 2.25-3.25 lb./ac	0.25-0.4 kg 0.5-0.75 lb.
Gesapax Combi 80%	Ametryne/Atrazine	2.5-3.75 kg/ha 2.25-3.25 lb./ac	0.25-0.4 kg 0.5-0.75 lb.
Fusilade Nabu 12.5%	Fluazifopbutyl Sethoxydim	200-250 ml/ha 80-100 ml/ac	20-25 ml
Karmex 80%	Diuron	2.5-3.75 kg/ha 2.25-3.25 lb./ac	0.25-0.4 kg 0.5-0.75 lb.
Krovar 80%	Bromacil/Diuron	2.5-3.75 kg/ha 2.25-3.25 lb./ac	0.25-0.4 kg 0.5-0.75 lb.
Frigate	Surfactant	5 ml/ L 4 teaspoons/gal	100 ml 0.25 pint

SELECTION AND TREATMENT OF PINEAPPLE PLANTING MATERIAL

INSECT PEST MANAGEMENT

The Ant Mealybug Complex

Two insects pose a serious threat to pineapple cultivation. These are the Ant (*Solenopsis* sp or *Araucomyrmex* sp.) and the Mealybug (*Dysmicoccus* spp.). The combination is the Ant Mealybug Complex.

Mealybug colonies are tended by ants, which protect them by making shelters of soil around the mealybug. Initial control should be directed against the ants to ensure success. When the ants are controlled the shelters collapse and control measures can then be directed towards the mealybug.

Control of the ants

Ants can be controlled either by drenching their nests with insecticide or by applying baits.

Drenching- Apply a 0.2% Basudin spray to the nest 10 ml/4.5 L of water (2 tsp. in 1 gal water). Soak nest thoroughly.

Baiting - Use Acoushi ant bait or milk bait.

Using the acoushi ant bait:

To apply the acoushi ant bait, first place a piece of aluminum foil, or plastic near nest. The purpose of this foil is to prevent the bait from absorbing soil moisture. Moist bait is rejected by the ants.

Place bait in any suitable container with the acoushi ant bait on the aluminium foil or plastic.

Cover the container of bait with another piece of aluminium foil. Weight the foil down with stones or pieces of wood. The second piece of aluminium foil protects the bait from rain and sunlight. Disturb the ant nest with a cutlass or any suitable object to arouse the ants for early uptake of the bait.

Finally, cover everything with trash to protect the bait, container and foil from vandals and intruders.

Using the milk bait:

Apply the milk bait by coating the inside pieces of split bamboo, pineapple, leaf or other suitable material. Remember not to touch the bait with your hands.

Place the bait-coated material with the inner surface down, near the nest. As before, disturb the ant nest to excite the ants for early feeding on the bait.

Cover baited material with trash.

Both baits are available at the National Agricultural Research Institute (NARI).

Control of the Mealybug

Spraying the plants in the field after the ants have been eliminated can control the Mealybug. Insecticide application is recommended throughout the plant growing cycle to keep the pest under control. The frequency of these applications depends largely on the level of pest infestation, but are particularly important at the early plant growth stage and during the fruiting season.

It is also necessary to apply chemical treatment to the plant suckers before planting (refer to section 6.3.1).

Apply any of the following insecticides:

- i. Basudin 60% EC. Apply 0.2 spray. Mix 10 ml/4.5 L water. (2 tsp/1 gal water).
- ii. Malathion 50% EC. Apply 0.1% spray. Mix 10 ml in 4.5 water. (2 tsp/1 gal water).

When spraying, ensure that the nozzle is directed towards the lower parts of the plant where the mealybugs are found.

SELECTION AND TREATMENT OF PINEAPPLE PLANTING MATERIAL

Selection and treatment of planting material are two important activities, especially when it is recognised that such materials develop into plants that produce the final product - the fruits. As such, cultivation of healthy vigorous planting material can result in the production of healthy plants and fruits. There are different types of planting material.

- (a) Slips: These are found at the bases of fruits.
- (b) Suckers: These represent the side shoots of the plant.
- (c) Crowns: These originate at the top of the fruit.

Irrespective of the type used, all planting material should be selected from healthy mother plants.

Fruit Pest

The fruits of the pineapple can be attacked by the larvae of the butterfly, *Thecla basilides*, which is widespread in Latin America but is unknown in the Caribbean Islands north of Trinidad. The attack on the fruit leads to gummosis disease of the fruit.

The control of this pest is achieved by the application, at the time of flowering and during the blooming period, of the same chemicals used to control the mealybug. As such, the timing of the applications could be so co-ordinated to control both pests simultaneously.

Disease Management

THE “SCARLET TIP” CONDITION ON PINEAPPLES

Cause

There is strong evidence that the “scarlet tip” condition on pineapple plants is associated with the presence of a virus. It is believed, that during feeding, the pineapple mealybug (*Dysmicoccus brevipes*) transmits the virus via its saliva to the plant and it is this virus that is believed to be responsible for the development of the “scarlet tip” condition.

In Guyana, nematodes, or very tiny worms which cannot be seen with the naked eye have also been reported to be involved in the development of the condition, but this is yet to be confirmed.

Symptoms

The symptoms of “scarlet tip” are described as seen on the Montserrat pineapple since this “variety” seems to be most susceptible to the condition in Guyana. The symptoms can be described in four stages.

- Stage 1: The first set of symptoms of the condition seems to be the appearance of a pale to pinkish colouration mainly at the middle of the leaves of the 4th whorl. This discolouration spreads outwards towards the leaf margin and upwards towards the leaf tip. Eventually such leaves curl downwards at the margin while the tip remains erect. Irregular spots are sometimes observed on the leaves.
- Stage 2: The pink colouration intensifies and the leaves become bright pink to reddish or bronze. Subsequently, the leaf tips turn yellow and curl downwards and the entire plant begins to wilt. Also, during this stage, older leaves (5th whorl) begin to show the pinkish discolouration.
- Stage 3: The entire plant becomes severely wilted, leaf tips become straw-coloured and begin to die back while older leaves tend to bend over at about midway along the length.
- Stage 4: The plant becomes withered and can be easily uprooted as the roots are severely reduced and rotted. Fruits produced from plants that show symptoms are usually reduced in size, malformed with fibrous, corky and sour flesh.

Development of “scarlet tip”

The causative virus is known to exhibit “**latency**”. This means that even after plants have been infected with the virus by the feeding mealybug, the scarlet symptom may not appear for a period of time, the length of which varies depending upon a number of factors. These include: the nutrient status of the plant, the number of mealybugs feeding on the plant, frequency of feeding of mealybugs on the plant, plant age, and prevailing weather conditions. However, plants of any age have been observed to be affected by “scarlet tip”, but those that have reached 12-15 months seem to succumb to the condition more readily than younger or older plants.

Favourable Weather Conditions

In Guyana, hot, dry, sunny weather conditions seem to favour the development of “scarlet tip”. During these conditions the disease symptoms seem to be most enhanced. With the onset of rains and cooler conditions, some plants may recover from the symptoms.

Control Measures

1. Rogue and burn all diseased plants as soon as they are spotted in the field.

Selection of Planting Material

- (1) Mother plants from which materials are selected should be green in colour. Planting material should not be selected from mother plants showing reddish leaves, for these plants may be infected with “scarlet tip”.
- (2) Mother plants should be free from rots and gums.
- (3) Do not select material from plants infested with mealybugs. Carefully examine, both the inside and outside of leaf bases, for the presence of mealybugs.
- (4) Some plants may show earthen shelters around the plant bases. Do not select material from such plants. These plants are infested with mealybugs that carry the virus germ responsible for “scarlet tip”.
- (5) Planting material should be selected from erect plants showing firm leaves. Plants that are too short (dwarfed), and those showing wrinkled or withered leaves should be ignored.
- (6) In the actual selection of planting materials, these must be carefully examined for mealybugs, rots and gums. Only material free of these should be selected.

Treatment of Selected Material

Selected planting material should be treated the following way, to promote healthy plant growth.

- (1) Trim off old (dry) tissues, especially around the bases of the planting material. This is important in exposing tissues that will develop into roots, so that when the material is planted, roots are in better contact with the soil. This in effect, allows for improved development of plants.

Removing dry material can also expose mealybugs, and therefore allow for more effective control when pretreating the material with an insecticidal solution.

- (2) Treat planting material with a solution of Basudin 0.05% or Malathion 0.1% before planting. This is accomplished by packing the material into a half drum in an upright position. A solution of Basudin 0.05% is then poured into the half drum until the materials are completely submerged. The planting material should remain in the insecticidal solution for 20 minutes. After this time, the material should be removed from the solution and placed on the ground in an upright position for a further 20 minutes. The planting material should then be inverted and allowed to drained. Planting can begin the following day.

The insecticidal solution remaining in the half drum should be used for spraying ant nests in the field. In the absence of ant nests, the insecticide can be used for spraying the soil before planting.

Some Points to Note

- (1) It is preferable that these operations occur under shaded conditions.
- (2) Protective clothing should be worn at all times when treating planting material with an insecticidal solution. For example, wear long boots, long pants, long sleeved shirts, gloves, eye goggles and respirators.

Follow these instructions for the insecticidal mix:

- (1) To prepare Basudin 0.05%, use one “drinks cork” of the chemical to each gallon of water.

**PLANT NUTRITION, WATER RELATIONS AND THE ABILITY OF THE PINEAPPLE
PLANTS TO WITHSTAND THE SCARLET TIP DISEASE.**

The Scarlet Tip condition in pineapple in the Canals Polder is reportedly associated with mealybugs. When they feed on fruits they cause localized deformation and reduced fruit size, but may also be associated with viral transmission. Several factors affect the intensity and development of the symptoms of the condition. This presentation will address two main factors

- plant nutrition and
- soil water

Proper nutrition and irrigation, particularly during the hot dry periods, can reduce intensity of the disease and the ability of the disease to affect the plants. The critical periods for these requirements are

- in the early stages of plant development during shoot development
- and at flowering

Plant Nutrition

Nutrient element requirements are determined by growth and developmental processes and in turn it influences these processes. Pineapple plants need large amounts of nitrogen (supplied by urea and sulphate of ammonia), even larger amounts of potassium (supplied by muriate of potash), a well balanced amount of magnesium (supplied by 12:12:17:2) and relatively small amounts of phosphorous (supplied by TSP).

Potential growth of the pineapple plant is determined by the amount of available nitrogen and which in turn, determines the potassium requirement. Nitrogen also determines the weight of the fruit, and the amount of slips and suckers formed. All the nitrogen should be applied before flowering as nitrogen applied after may result in reduction in fruit juice acid, less firm fruits and makes the plant lodge easily due to the development of a long weak peduncle. Lodging allows for more mealybugs to get on fruit and slips/suckers and may result in greater sunburning of fruit. Applying artificial floral inductors (tablets) less than six weeks after the last nitrogen application may impair flowering.

When the scarlet tip condition affects young plants, only vigorous and healthy plants renew growth at a sufficiently fast rate under favourable environmental conditions. This developmental reversal occurs only if the plant has the necessary mineral elements at its disposal (in particular, nitrogen) and if it is irrigated in instances of drought. If the condition occurs late in plant development, that is, just before or after flowering, fruit development is affected. However, if sufficient growth occurred before, there may be reserves for better fruiting.

In pineapples, phosphorous is required for floral differentiation and fruit development. A good phosphorous nutrition results in compact fruits with a high percentage of vitamin C. Budding and fruit maturity are positively correlated with phosphorous.

Potassium influences yield especially in soils low in available potassium.

Potassium increases and strengthens the fruit bearing stem of pineapples thereby reducing the risk of lodging. This element also enhances the shell and flesh colour.

Fertilizers may be applied in a row alongside the plant, in a band around the plant or placed in the lower leaf axil. Avoid placing fertilizer into the shoot area as this could kill the plant. Fertilizers NPK in a ratio of 2:1:3, Le 2 parts of nitrogen to 1 part of phosphorus to 3 parts of potassium should be applied to each plant at:

- 3 months after planting
- 6 months after planting and 9 months after planting.

This ratio should work out to 2 parts of urea to 1 part of TSP to 2 parts of muriate of potash. In Guinea about 50 gin (2 ozs) of urea 25 gin (1 oz) of triple superphosphate and 75 gin (3 oz) of muriate of potash is used.

Soil Water

Mealybug infestation and Scarlet Tip condition are more evident during the hot dry seasons. Water requirements far outweigh any other element and must be regularly satisfied. After all, soil water is the medium that contains the mineral elements which the plant uses.

Water-logged conditions causes reduction in the number of roots, and root hairs and therefore affect mineral absorption. In severe cases, root rot may occur. In droughty conditions, there is hardening of the tissue, limited root growth and root activity, fruit growth is affected showing such symptoms as prominent fruitlets, lackluster shell and corky flesh. This weakens the plant and increases ability of the disease to attack the plant.

In some farms in the Canals Polder, growers compromise on good land preparation. Some practise the low cost “juk and plant” method of planting. This practice affects root development which in turn affects shoot development. Water logging also occurs particularly when proper drainage is not provided. In farms where good land preparation and irrigation and drainage are provided, incidence of Scarlet Tip is not as high as in farms where these essential preconditions are not provided.

Some tips for better plant tolerance to Scarlet Tip

1. Prepare land thoroughly and destroy all pineapple residues
2. Irrigate plants during the dry periods and provide proper drainage
3. Ensure good plant nutrition
4. Time planting to avoid critical periods when stage of plant development coincide with greater mealybug activity and excessively dry and wet conditions.

SAFE MOVEMENT OF PINEAPPLE PLANTING MATERIAL FOR THE CONTROL OF SCARLET TIP

This subject focuses mainly on the principles and guidelines for the safe movement of pineapple planting material within Guyana, for the control of Scarlet Tip. The external movement of pineapple planting material i.e. the movement of material from any area of Guyana to another country or from any other country to any area of Guyana is also considered.

Internal movement of planting material and its importance in controlling Scarlet Tip

The internal movement of pineapple planting material involves the movement and or dissemination of crowns (located the top of the pineapple fruit), slips (located around the bottom of the pineapple fruit) and suckers (located at ground level) from one area of Guyana to another for any reason including cultivation or free distribution.

In Guyana, Scarlet Tip, which is a major constraint to pineapple production, is mainly spread by the movement and use of infested and or infected planting material. Hence, in an effort to control the spread of the disease, the movement of pineapple planting material within Guyana must be restricted.

Principles and guidelines for the internal movement of pineapple planting material for the control of Scarlet Tip

- a) Avoid moving pineapple planting material from one area to another, especially from infested areas to “clean” areas. This involves region to region transfer, district to district transfer and farm to farm transfer.
- b) If it is absolutely necessary to move planting material from one area to another, then first seek the advice of either:
 - i) the Agricultural Extension Officer,
 - ii) the Plant Quarantine Service, Ministry of Agriculture
 - iii) any Plant Protection Officer from the Ministry of Agriculture or the National Agricultural Research Institute (NARI).
- c) Only “clean”, healthy looking material should be selected for removal from any farm. (See Section 2.2 for general characteristics of “clean”, healthy looking material). Visibly infected/infested material **SHOULD NOT** be removed.
- d) Material selected for removal must be treated before actual removal from the farm/plot or immediately after removal, as a precautionary measure to eliminate un-detected ants or mealybugs.
- e) Severely infested planting material should not be used for propagation but should be heaped up and immediately destroyed by burning.

General characteristics of “clean”, healthy-looking planting material:-

- Material should only be selected from healthy looking parents (green or fitting the description of the variety, vigorous, thrifty and relatively free of ants or mealybugs).
- Material should be green (or must fit the description of the variety), vigorous, thrifty and sizeable.
- Planting material should be free of mealybugs; (“blight”), ants or ant shelters.

General characteristics of infected planting material:-

- Planting material with mealybugs (“blight”)
Although mealybugs may not always be readily visible on material, it should be thoroughly examined for their presence. This should be done by examining the base of the plant, the area between the leaves, and the heart.
- Planting material with ants or ant shelters
Ant shelters can be seen as clumps of earth found between the leaves.
- Planting material showing leaf discolouration
This includes any form of leaf spot, or abnormal colouration of yellow, pink, red, creamish or white; not fitting the description of the variety.
- Unthrifty planting material.
These are generally pale, wilted, twisted and or undersized.

Preparation of selected planting material for removal/dissemination

Material should be treated, as described before, immediately after selection and harvesting. Planting material should be treated with a solution of a suitable insecticide such as Basudin (diazinon), malathion or Sevin (carbaryl), to kill any ants or mealybugs present.

Storing of material after treatment

Ideally, planting material should not be stored for more than 3 weeks even after treatment, as this encourages build up of mealybug populations and subsequent re-infestation. However, if material is stored for longer periods (more than 2 weeks), then it should be treated again as described above.

External Movement of Planting material

In general, the international transfer of pineapple planting material is prohibited. Countries requiring planting material can only obtain such for scientific purposes. This means that any external movement of pineapple planting material (other than for scientific use) is considered illegal and the person or persons involved can be subject to prosecution.

General principles and guidelines for the external movement of pineapple planting material for scientific use

- a) The external movement of pineapple planting material must comply with regulatory requirements of Guyana and the importing country.
- b) In addition to a phytosanitary certificate, a germplasm health statement indicating which tests have been performed to assess the health status of the material should accompany the germplasm.
- c) Planting material should be transferred as sterile, pathogen-tested plantlets grown as tissue cultured material.
- d) Meristem-tips should be cultured in the country or at an intermediate quarantine centre.
- e) For the movement of in vitro cultures, neither antibiotic nor charcoal should be added to the medium.
- f) Cultures should be checked for systemic bacterial and fungal contamination and other pests before dispatching after removal.
- g) Plantlets should be tested for viruses in the country of origin, in an intermediate quarantine station or in post-entry quarantine. Only materials tested and found free of viruses of concern should be released.
- h) Once in the region of determination, the material should be multiplied in field conditions under observation for a period 18 months in agreement with the quarantine authorities of that region. Plants suspected to be infested should be destroyed.

Wilt Disease:

The most common Wilt Disease is caused by a virus/toxin associated with the Mealybug. This disease occurs throughout the world and is present in Guyana.

The most visible symptom is a bright bronze to red coloration of the leaves of the young plant or a pinkish and/or yellowish coloration of the older plants. If the plants continue to grow, the leaves lose turgidity and curl outwards. Any fruit produced by these plants is usually small and/or distorted.

Control is effected by taking the measures to control the mealybug previously described, starting with the selection and treatment of healthy suckers for planting. This is followed by the eradication of the ants associated with the mealybug and the routine treatment of the plants to control the pest.

Also, all infected plants should be removed from the plant site and destroyed by burning as these plants are a source of infection.

Gummosis Disease of the fruit:

This disease follows the attack of the fruit by the *Thecla* butterfly and is characterized by the exudation of an amber coloured resinous material or gum from the wound. Control of the disease is directed at controlling the *Thecla* butterfly previously described.

ARTIFICIAL FLOWER - INDUCTION

Artificial flower-induction is a procedure that utilizes synthetic hormones to induce plants to flower. It permits better scheduling of the harvest as it takes five months from the time of induction to full maturity of the fruits. The process works best when the following criteria are fulfilled:

The plants in the block to be treated should be homogeneous in size and not less than 12 months old or possess less than 25 leaves (Figure 4). Young and unhealthy plants should not be induced to flower since they will produce small fruits, (unless small fruits are specifically required for a particular market). Treatment should take place in the cool of the day, early morning or late afternoon, with preference for the latter. The main products used to induce flowering are Naphthalene Acetic Acid (NAA) and Ethrel. The NAA is available in tablet form (0.5 mg active ingredient per tablet) and treatment is achieved by placing one or one-half a tablet into the whorl of each suitable plant. Ethrel is a liquid and is used as a 0.1-0.2 %



Fig 4. Artificial flower-inducti

spray solution. To enhance its performance, it is recommended that Urea be added to the solution to the level of 2 %.

In practice this is 20-40 mls of Ethrel + 400 gms of Urea per 20 L Sprayer or approximately 1.5-3 Tablespoons of Ethrel + 1 lb. Urea per 5 gal. Sprayer. The application is made to the centre of the whorl delivering about 30 mls (2 tablespoons) of the mixture per plant.

It must be remembered that the use of the herbicides Karmex and Krovar are to be avoided during this blooming period. If these herbicides are being used around this time, then the application should be so scheduled to conclude before floral induction commences.

HARVESTING

The time of harvesting the Pineapple depends on whether the fruits are for the domestic or overseas market. Fully ripe fruits are suited more for local markets while unripe but mature fruits can be shipped overseas.

The Montserrat pineapple has excellent quality when optimum ripeness is reached. As a fresh fruit, however, it has two (2) undesirable features:

1) After picking, it does not ripen or improve in eating quality and consequently the fruit must be harvested at the optimum ripeness to suit the particular market.

2) In some cases, there may be a difficulty in estimating the internal quality of the fruit based on external or skin colour and other means will have to be employed.

Assessing Maturity

Fruit maturity is evaluated on the extent of fruit eye flatness and skin yellowing. Generally, the colour stages are categorized as follows:



Code:
CS1

Eye Colour:
All Green Eyes

Average Brix:
Top – 10



Code:
CS2

Eye Colour:
5-20% Eyes Yellow

Description:
Green Mature

Average Brix:
Bottom – 12

P
I
N
E
A
P
P
L
E



Code:
CS3

Eye Colour:
20-40% Eyes Yellow

Description:
Intermediate Green
Green Mature/Fully Ripe



Code:
CS4

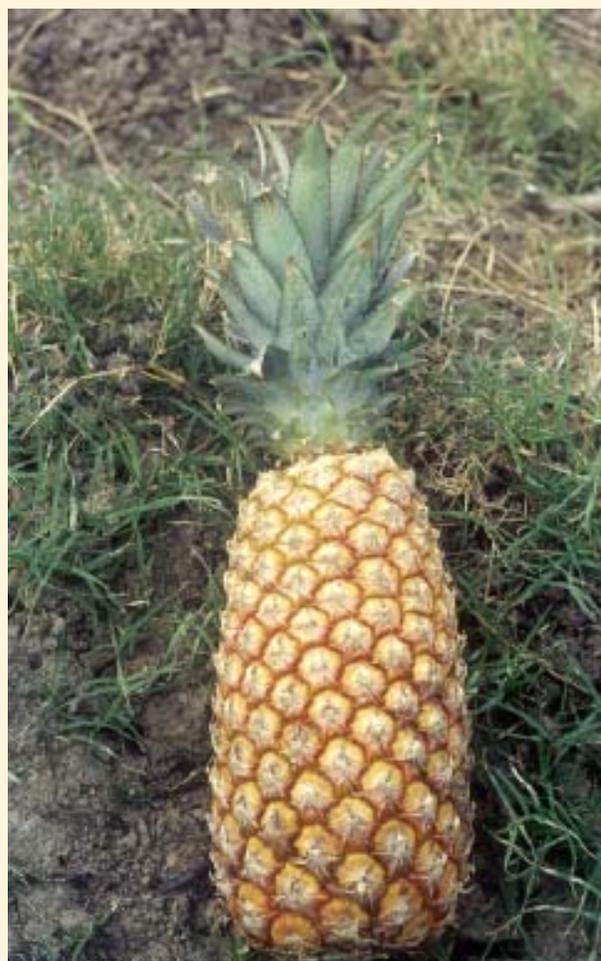
Eye Colour:
40-80% Eyes Yellow

P
I
N
E
A
P
P
L
E



Code:
CS5

Eye Colour:
90% Eyes Yellow
5-20% Reddish Brown



Code:
CS6

Eye Colour:
20-100% Eyes Reddish Brown

Description:
Fully Mature

Average Brix:
14-15

Observing the flesh condition can also assess fruit maturity. Random samples of fruit can be taken and sliced horizontally at the point of the largest diameter. Where more than half of the area is translucent, the fruit is considered beyond optimum maturity. If the facilities are available, the sugar content or Brix measured by a portable refractometer could be determined. The minimum Brix required is 10% at the top and 12 % at the bottom for the green mature pineapple. Also a brix; acid ratio measurement of 2.0 at the top and 2.75 at the bottom of the fruit may be used but this will also depend on market requirements.

It is clear therefore that the stage of maturity at harvest is, however, dependent on the storage life and distance to the particular market. Fully ripe fruits are unsuitable for transporting to distant markets and less mature fruits are selected in this case. Immature fruits are not shipped since they do not develop good flavour, have low brix and are more prone to chilling injury. Generally, for export CS1 and CS2 are used.

Harvesting and Field Preparation

The Pineapple is hand harvested with the pickers being directed as to the stage or stages of ripeness required. It is harvested by breaking or cutting the stalk a few centimeters below the fruit. The harvested fruit is packed either in the field or at a central packing shed. While in the field it should be placed in shaded conditions. From the collection in the field and from field to Pack house, polyethylene sacks or bags should not be used for packing and transport, as this will cause a high level of mechanical damage and eventual losses in quality. The fruit should be placed in field crates for transport to the packing shed. In the field, a preliminary grading exercise can be conducted. Undersize, oversize, overripe, under ripe, damaged, bruised, insect and fungal infested fruits should be rejected.

Transport

Fruit should be transported in such a way as to avoid unnecessary damage. The transporting vehicle should allow for good air circulation and protection of the produce from sunlight. Transport of fruit should be done in the cool periods of the day and on roads / dams that allow for smooth traveling.

Preparation for Market

Cleaning

Pineapple fruits are quite perishable and should ideally be packed for market within a day of harvest. The initial step in preparation for market involves cleaning of the outside of the fruit. For the domestic market, this generally involves trimming of the stem at the base of the fruit to a length of 1-2 cm, removing any damaged or unsightly leaves in the crown, and a gentle dry brushing of the fruit surface to remove dirt and dust. A similar protocol should be followed for the export market, with more emphasis placed on fruit uniformity and quality. Depending on the export market requirements, all fruits which are undersized, oversized, over-ripe, under-ripe, damaged, bruised, or show fungal or insect damage should be discarded.

The Barbados market requires a specific protocol to be adhered to. The stem must be trimmed very close to the base and the crown has to be cut back to a length of 10 cm. Then the fruit has to be washed in a soap solution and thoroughly scrubbed on the outside with a brush to remove all live insects (Figure 6). The wash water should be properly chlorinated (150 ppm free chlorine) and maintained at a pH of between 6.5 to 7.0. In addition, an approved postharvest fungicide should be added to the wash solution to reduce decay. Bayleton and benomyl are two postharvest fungicides commonly used in other countries. After washing, the fruit must be dried and inspected by a trained and certified Guyanese Ministry of Agriculture (Plant Health Unit) inspector. Fruit approved for export by the inspector can then be packed.



Fig 6. Washing and brush scrubbing of pineapple fruit to remove mealybugs.

Waxing

For maximum potential shelf life, pineapple fruit should be waxed after cleaning and drying. Several types of food-grade waxes are appropriate for pineapples, and they can be applied by dipping or spraying. The most commonly used waxes for pineapples are mixtures of carnauba and paraffin or polyethylene and paraffin. The type of wax chosen must be approved by the importing country, if the market destination is for export. The wax should be applied only to the fruit surface and not the crown, as many waxes cause injury to the crown. Beneficial effects of waxing include a reduction in fruit internal browning, less moisture loss, and a shinier external appearance.

Sorting

Regardless of the market destination, the fruit should be sorted according to size, shape, firmness, external color, insect damage, and decay. Visibly damaged fruit should be rejected. Different markets have different quality requirements and the fruit should be graded to conform to the individual market standards (Figure 7). However, there are certain minimal requirements for pineapple fruit intended for any market. The fruit should:

- be clean and free of dirt or stains
- be mature and firm
- be well shaped and have fully developed eyes (fruitlets)
- be free of punctures, wounds, and cuts
- be free of sunburn, insect damage and decay
- have a well cured butt
- have a single crown

In addition to the above general requirements, the Guyanese market standards (Guyana National Bureau of Standards) stipulate that:

- 80% of the fruit surface should exhibit the color typical of the variety at maturity
- the stem should be trimmed near the base of the fruit, with 4 bracts remaining
- large-sized fruit is 2.1 kg, medium-sized fruit ranges from 1.2-2.0 kg, and small-sized fruit ranges from 0.7-1.1 kg
- packages should contain 6 or 9 fruits, which can be oriented horizontally or vertically

Pineapple fruit destined for Barbados require the crown be trimmed back to a length of 10 cm. On the other hand, fruit destined for U.S. and Canadian markets must have an intact crown > 10 cm in length. No more than 10% of the crown leaves should be discolored. Mechanical damage must be confined to < 5% of the fruit surface area and any bruise must not exceed 3.75 cm in diameter or be deeper than 0.6 cm.

Packing

All fruit packed in the same carton or container should be uniform in size, shape, and external color. Immature or over mature fruit should not be packed for export. It is important that the carton be properly ventilated and be of sufficient strength to withstand the rigors of distribution without collapsing. Weak cartons do not have sufficient physical strength to be stacked and result in major losses of the fruit upon arrival in the destination market. Inferior packaging is a constraint facing Guyanese exporters .



Fig 7. Uniform sized and shaped fruit destined for U.S. market.

A carton with at least 275 lb/in² bursting strength should be used to avoid damage to the product during transport and handling. A commonly used package in the international trade of pineapples is a full-telescopic two-piece corrugated fiberboard carton. Top and bottom ventilation, in addition to side vents are required, particularly where seashipments are used. Typical carton inside dimensions are 30.5 cm wide x 45 cm long x 31 cm deep (12 in x 17.7 in x 12.2 in).

The preferred method of packing is to place the fruit vertically on the base, and then to place dividers between the fruits to prevent rubbing and movement. With some cartons, this is not possible and fruit are laid horizontally in alternating directions; where two layers of fruit are packed, a divider is required between the layers. Another commonly used export carton for pineapples is a single-layer corrugated fiberboard carton.



Fig 8. Typical corrugated fiberboard carton used for exporting pineapples.

The Barbados market requires the fruit be packed in corrugated containers (Figure 8). The fruit may be oriented vertically or horizontally inside the carton. Typically, about 40 ±5 lb. of fruit are put in each carton.

It is important the carton be properly ventilated and be of

The U.S. and Canadian markets prefer either a single layer carton containing 6 to 12 fruits or a double layer carton containing 12 to 20 fruits (Fig 9). The approximate weight associated with the different count sizes is:

6 count - 1.75 kg fruit (3.8 lb)
12 count - 1.25 kg fruit (2.7 lb)
20 count - 0.75 kg fruit (1.6 lb)

Export packages should be labelled with the name and address of the exporter, country of origin, size (grade) of fruit, variety, and net weight of product.

Storage Conditions

Temperature

For maximum postharvest life, pineapple fruit should be cooled to 8°C (47°F) as soon as possible after harvest and maintained at this temperature during transport to market. At this temperature, pineapples harvested at the quarter-yellow stage have a shelf life of approximately 3 weeks. Storage at higher temperatures will result in an abbreviated shelf life, to as short as only a few days at ambient temperature (i.e. 30-32°C). Fruits that are quarter yellow at harvest gain about four additional days of shelf life for every 6°C decrease in storage temperature from 32° to 8°C. On the other hand, pineapple fruits are subject to low temperature breakdown, also known as chilling injury, and should not be stored below 8°C. Sensitivity to chilling injury is related to the ripeness stage of the fruit, with mature green fruit being more susceptible. Internal tissue darkening and postharvest decay are typical symptoms of chilling injury.

Pineapples harvested at more advanced stages of ripeness will have an abbreviated market life. For example, fruit harvested at the half-yellow color stage will have about 10 days of storage life at 8°C followed by an additional week of market life.

Relative Humidity

Pineapple fruits are susceptible to wilting and shrivelling in low relative storage environments. Most of the weight loss occurs through the leaves rate of transpiration and water loss from the fruit becomes increasingly decreasing RH. Ideally, pineapples should be held at 90 to 95% RH.

Transport

Fruit should be transported carefully to market in order to minimize bruise damage and subsequent postharvest decay. Use of strong protective packaging will help to minimize bruise damage. Proper loading and stacking of the cartons in the bed of the transport vehicle is essential to protect the product. Sufficient air circulation through the sides of the cartons is necessary to avoid product re-warming during transport. The pineapple cartons should be covered and never exposed to direct sunlight during transport. This will accelerate the rate of ripening and softening of the fruit, in addition to possible sunburn damage. In the absence of refrigeration, the fruit should be transported during the cooler part of the day.



Fig 9. Single-layer corrugated fiberboard carton used for exporting pineapples.

After treatment, size grading and separation according to stage of ripeness should be carried out. Large is considered to be greater than 1.6kg medium 1.2 to 1.6kg and small less than 1.2kg. The fruit is then packed in special cartons with good ventilation. The preferred method of packing is by placing the fruit vertically or in a standing position in the carton. Dividers or separators are placed between fruits in the carton to prevent the fruit from rubbing together and minimize abrasion and damage.

Fruits are normally packed to a net weight of 10- 15kg but this depends, however, on the carton and the market. Fruits in individual cartons should be the same size which would determine the counts that can be accommodated. Accepted counts are as follows:

- (i) 6 count - over 1.6kg
- (ii) 12 count - 1.2kg
- (iii) 12 count - 1.0kg
- (iv) 20 count – 0.75kg

8.2. Storage

Mature green pineapple should be stored at a temperature of 8-10 °C and at relative humidity of 85-90%. Under these conditions it should have a storage life of 2-3 weeks.

Sensitivity to chilling injury is, however, related to the level of ripeness of the fruit. Storage of green fruit (CS1) below 8°C will result in chilling injury symptoms such as incomplete colour development, wilting and darkening of the flesh, crown and peel.

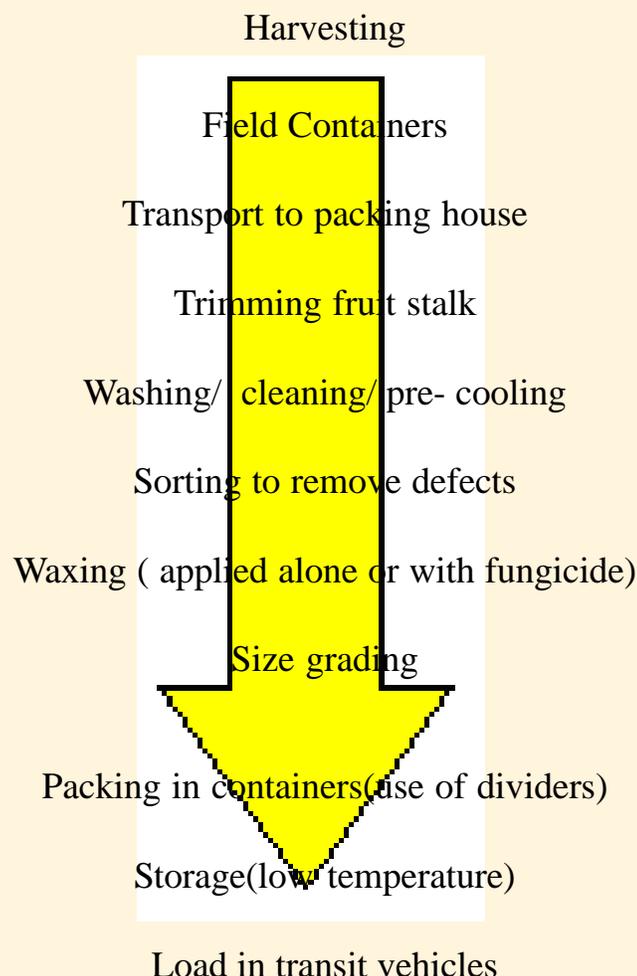
It should be noted that if low temperature storage is used this will have to be maintained throughout the postharvest and marketing chain so as to avoid condensation of the produce which may later cause fungal diseases such as black rot etc. to develop.

8.3. Grading Standards

Pineapple should have the following minimum quality standards to stimulate consumers appeal and increase profits.

- (i) Fruit needs to be mature, firm and well formed.
- (ii) Fruit should be free of surface debris and stains.
- (iii) Fruit should have no wounds, scratches, punctures or bruises.
- (iv) Fruit should have no scars or residues from insects or spray chemicals.
- (v) Fruit should be free of soft rots or surface moulds.
- (vi) The size of the crown and ratio of crown to fruit length should be guided by market requirement.

9. FLOW DIAGRAM OF A POST HARVEST HANDLING SYSTEM OF PINEAPPLES



10. RECORD KEEPING

Record keeping is of vital importance at all stages in the production of pineapples.

Whether it is an estimate of the market demands, the average number of slips needed to plant a bed, the amount and date of the fertilizer application, the number and weight of fruits obtained, a system of records is necessary.

Various recording systems could be developed and maintained. However, if record keeping is considered a burden, just a record of daily operations would be extremely helpful.