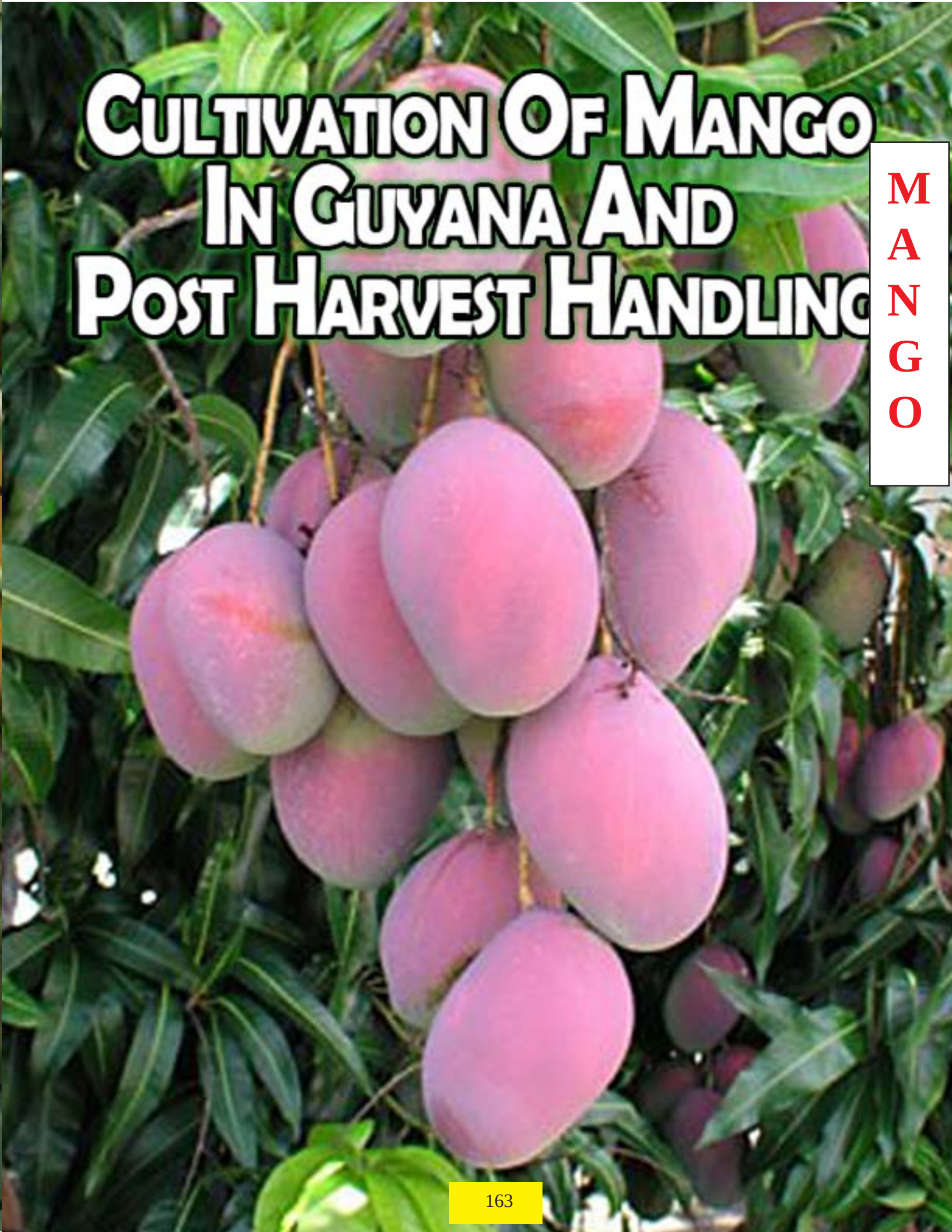
Cultivation Of Mango
In Guyana And
Post Harvest Handling
MANGO

MANGO

INTRODUCTION

The mango *(Mangifera indica)*, which belongs to the family Anacardiaceae is one of the most important fruit crops in Guyana. Mangoes vary in colour (greenish, greenish-yellow, yellow, red, orange and purple) and shape (nearly round, oval and ovoid-oblong).

In Guyana, mango is not cultivated on large scale plantings or managed intensively. Almost the entire production comes from landowners who have several trees planted near their residences. Mango is available year round, but the main harvest periods are mid-October to January and May through June. The fruit is widely distributed in the domestic market and small volumes are currently exported to Canada.

VARIETIES

There are two man types of mangoes – Indian and Indo-Chinese. The Indian type has mono-embryonic seeds and are often highly coloured. The Indo-Chinese type possesses poly-embryonic seeds and the fruits often lack attractive colourations.

The principle mango cultivars that constitute almost the entire nation wide production are, Buxton Spice and Long mango. They are selections of materials originally introduced from India, but have been produced in Guyana for decades. Buxton Spice is the leading cultivar grown and produces medium-sized fruit with a golden-yellow skin colour when ripe. The fruits are sweet in flavour and have a relatively low fibre content. The fruits of the Long are slightly larger, more elongated, less sweet and more fibrous than Buxton Spice.

There have been other introductions from India and Florida. Some of these are Haden, Tommy Atkins, Keitt, Kent, Van Dyke, Julie and Sensation.

CULTIVATION

There is always a great demand for Mango plants and the NARI Plant Nurseries are finding it difficult to keep up with this demand. Consequently, the availability of plants at the Plant Nurseries cannot be guaranteed at any time.

There are many seedling mango trees but there is increasing demand for grafted mango plants as this reduces the time taken for bearing, lends a dwarf habit to facilitate easy harvesting, combines the best characteristics of varieties and improves resistance/tolerance to diseases e.g. anthracnose.

Fruits are collected from healthy, vigorous, mature trees and deseeded; the seeds are washed and dried. The tough endocarp is removed and seeds are sown individually in black plastic bags, and covered with not more than I inch (2.5cm) of soil, concave side down. Sowing vertically may result in twisted stems and roots. Seeds may be polyembryonic resulting in several seedlings, which are separated and sown individually.

Grafting is done when plants have attained a height of 1.5ft (.5m). Wedge or cleft grafting is the type commonly used.

The scions for grafting are collected from healthy, vigorous, mature trees having desirable traits e.g. regular and prolific bearing every year to overcome alternate bearing, fruit size, flavour, shape and keeping quality. The graft is wrapped securely and covered with clear plastic until it catches. This is seen if graft sprouts leaves after 2-3 weeks.

During this entire process the plants should be protected from severe sunlight and receive adequate water until transplanting in field.

Mango plants are ready for planting out in field approximately 4-6 months after grafting.

SITE SELECTION

The mango could be planted in a variety of climates or weather patterns but it thrives more in areas that have a marked dry season, which is necessary for flowering and fruiting. A good rainfall is required but heavy rains reduce pollination and fruit set.

Mango can be grown on a variety of soils but wherever the mango is planted there is need for good drainage.

PLANTING

Planting should be done during the wet season while there is an adequate supply of moisture for quick establishment of roots. When planting, the vigour and growth pattern of the trees should be considered. Grafted trees tend to be shorter than seedling trees. Generally, however, plants are spaced 20-25ft apart (6-7.5m) giving approximately 100-75 trees/acre (250-175 trees/ha)

(a) Normal Areas

In areas where there is no waterlogging, planting holes are dug to a size that would accommodate the plant in the bag. The size of the hole is therefore around 1ft (30cm) in length, width and depth.
The roots of bare root plants are more spread out and a larger hole will have to be made to accommodate these plants. The topsoil removed in digging the hole could be mixed with rotted manure and/or some phosphate fertiliser. Some of the soil is then returned to the hole filling about half way up.

The plastic bags are carefully removed to keep the rootball intact and the plants are placed in the holes. The balance of the topsoil is then returned to fill the hole and thoroughly compressed. The plants should then be watered.
After planting, it is recommended to stake the plant to prevent movement by wind.

(b) Areas Prone to Waterlogging

In areas where waterlogging is suspected, the same system is used except that planting is done on mounds.

AFTERCARE

Training and Pruning

Mango plants should be pruned to encourage branching to ensure a good framework. Afterwards, pruning should be practiced after harvest to remove dead wood, as well as maintain the framework of the tree. It is advisable to plant wind breaks in windy areas or where there are heavy, salty sea sprays.

Fertilizing
Fertiliser needs are directly related to the type and nutrient status of the soil. It is essential therefore that a soil analysis be conducted to determine these factors for he particular location.

However, in the absence of a precise soil analysis, the following might suffice:
Clay Soils - Compound Fertiliser 12:12:17:2 at the rate of 1/21b (227g) to 2lbs (0.9kg) depending on the age and size of the plant, applied twice per year usually at the beginning of each wet period.

Sandy Soil - the above is to be used at the higher rate as well as 9:27:9 +FTE at the rate of 1/41b (113g) to 1/21b (227g) per plant once per year. Organic matter such as manure may be added for the first four - five years.

WEED CONTROL
At the time of planting it is important to remove weeds, which serve as competition for the young plants as well as provide conditions for the development of unwanted pests and diseases.

Weeding around the plant is usually done manually, while between the rows weed control could be accomplished by the following, singly or in combination:

- Chemically
- Mechanically by the use of brush cutters or mowers.

For chemical control, Glyphosate (Round Up) or Paraquat (Gramoxone, Miliquat) at a rate of around 2 pints/acre (2.8 litres/hectare) or 0.5 pints (284.13mls)/5 gallon (20L) sprayer could be used. In applying these herbicides, care should be taken to avoid “spray drift” onto the plants or severe damage might occur. To minimise the risk of drift, it is recommended that a “spray shield” be used and the spraying of very tall weeds be avoided. However, where only grass weeds are present, the herbicide Fusilade (Fluazifopbutyl) or Nabu (Sethoxydim) can be used at a rate of I pint/acre (1.4 litres /hectare or 0.25pints (142.07mls)/5 gallon (20L) sprayer without a shield, as only grasses are affected.

PEST OF MANGO
There are no major pest problems of Mango.

- It should be noted that the occurrence of any unusual pest or disease must be reported to the Crop Protection Section’ at NARI for investigation.

DISEASE OF MANGO
In Guyana, the main disease affecting Mangoes is **Anthracnose**, caused by the fungus ***Colletotrichum gloespoiroides***. It is prevalent in high humidity areas and leads to low fruit-set. The infection commonly takes place between blossom time and when fruits are half their full size.

Fig 1. Symptoms of Anthracnose

Symptoms:

This disease causes leaf spot; wither tip, blossom blight, fruit rosetting/staining and fruit rot. The affected young leaves and branches dry out from tip downwards resulting in excessive leaf fall. Young infected fruits wither, turn brown and fall off; older fruits have black slightly sunken spots which grow together covering the entire fruit (**Figure 1**).

Some fruits may appear healthy but there could be a latent infection, which shows up when fruits ripen and could lead to extensive rot within a few days.

Control:

Where there is severe leaf infection, trees are sprayed before the inflorescence appears. If little or no infection is present trees are sprayed at blossom time. Benlate may be used at a dose of 80gm/5gallon (20L) sprayer. Alternatively Kocide or Cupravit Blue may be used at a dose of around 2.5lbs/ acre (2.80Kg/hectare) or 0.63lbs (283.50gm) / 5 gallon (20L) sprayer.

Harvesting

Harvest Maturity

Various non-destructive indices can be used to determine mango fruit harvest maturity for the fresh market, including external color, size, changes in appearance in the fruit shoulder area, and waxiness of the skin. Destructive indices used for determining harvest maturity include internal pulp color and % soluble solids content. Grower experience, which uses a combination of these indices, is also a reliable way to determine when to harvest.

The most obvious index of fruit maturity is external skin color. As the fruit matures, the skin color will change from green to yellow. Normally sized fruits which have started to turn yellow are ripe and ready for immediate harvest. However, fruits showing some yellow color on the tree are generally too ripe for long distance marketing. They will bruise easily and soften during transport and distribution. Yellow fruits typically have a shelf life of only a few days and must be sold in the local market. If the intended market is for export, the fruit should be picked when firm and at the mature green color stage, using a combination of fruit size and appearance to determine maturity. The fruit should arrive at the destination market at some predetermined stage of color development

(usually more yellow than green). There is a range of maturity levels within which green fruit will develop acceptable ripe fruit attributes. The rate at which ripening occurs depends upon the degree of maturity at the time of harvest. More mature fruit will ripen sooner than less mature fruit. Fruits harvested too immature green will not ripen properly, will not taste good, and will shrivel prematurely. The Buxton Spice mango ripens quite

rapidly after harvest and if picked at the mature green stage will begin to turn yellow within 3 to 5 days at ambient temperature.

Mango fruit is ready for harvest when the shoulder area swells or broadens and rises above the stem end. This is accompanied by the stem end sinking and forming a small pit around the pedicel (stem). Another external characteristic which is correlated to harvest maturity is the appearance of the skin. A dulling in the shine or waxiness of the fruit surface occurs when mangoes become mature and are ready for harvest. Internal pulp color and % soluble solids (sugar content) are additional indices for determining harvest maturity, but both involve cutting the fruit open with a knife and therefore are destructive tests. However, they are often used on a few randomly selected fruit to establish a correlation between fruit size and maturity. The pulp of Buxton Spice fruit at maturity changes in color from light yellow to deep yellow or yellowish-red (Figure 2).

The soluble solids content of mature fruit will be at least 10%, and can be determined by placing several drops of juice on a hand-held refractometer (Figure 3). In addition to the fresh market, mango fruit may be harvested at an immature stage and used as a component of processed foods (i.e. chutney, achar, preserves, etc.). In this case, the above indices of fresh market harvest maturity do not apply.

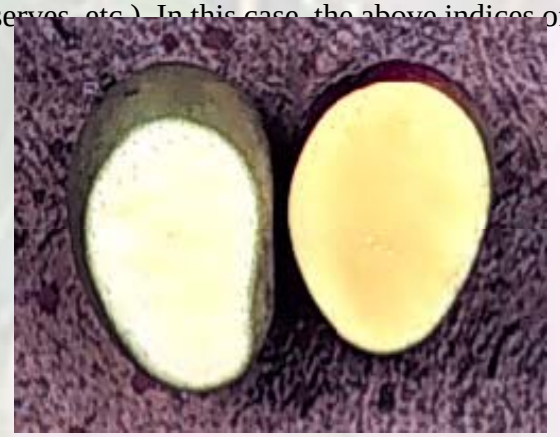

Fig 2. Immature fruits with light yellow pulp (left) versus mature fruits with deep yellow pulp (right).

Fig 3. Hand-held refractometer for determining fruits maturity.

Principal Postharvest Diseases

Anthracnose

Anthracnose, caused by the fungus *Colletotrichum gloeosporioides*, is the worst postharvest disease of mangoes. It makes the fruit unsightly and in many cases unmarketable. Typical symptoms include small black spots and/or larger black lesions on the surface of the skin (Figure 4). The lesions may coalesce and penetrate deep into fruit, resulting in extensive fruit rotting.

Fig 4. Mango fruit with anthracnose lesions.

Mature fruit may also exhibit tear stains, in which the anthracnose spores wash along in spore-laden water droplets falling from infected twigs and panicles above the fruit. This results in a vertical spotting pattern (Figure 5).

Fig 5. Tear staining symptoms of anthracnose infected mango fruits.

Ripe yellow colored fruits are much more susceptible to anthracnose than mature green fruits. However, the infection process generally begins on the tree when the fruits are green. The fungal spores often remain dormant on the surface of the mature green stage fruit, but rapidly develop and penetrate the surface of the weaker and softer yellow skin as the fruit ripens. Anthracnose is always more severe during the rainy season. Buxton Spice fruit is highly susceptible to anthracnose. Long fruits are also susceptible, but are generally less severely affected because of their tougher skin.

Management and control of anthracnose decay begins in the field. Proper cultural practices are necessary to avoid the build-up of high levels of inoculum responsible for postharvest decay. These practices include proper tree spacing to avoid crowding, periodic pruning to allow more air movement through the canopy, monthly foliar fungicide applications (i.e. mancozeb, benomyl, iprodione, propiconazole, and/or copper fungicides), and removal of fallen leaves under the tree. Manipulation of the time of flowering (i.e. using KNO_3 foliar sprays) so the fruit ripens during the drier months is another way to reduce anthracnose decay.

Several postharvest decay control methods are useful in reducing the severity of anthracnose fruit rot. They are effective in eradicating quiescent infections of the fungi that have become established on and beneath the cuticle and within the pedicel. Treatment effectiveness varies with infection level and storage temperature. The first decay control method involves submerging the fruit for 2 to 5 minutes in 50°C to 55°C (122° F to132° F) water or 5 minutes at 48° C to50°C (118° F to122° F) water. Control of the water temperature and the length of submergence are critical for effective anthracnose control. If either the temperature or duration of submergence is exceeded, fruit injury will result. On the other hand, if the temperature is too low and/or the duration of submergence inadequate, the treatment will be ineffective. The second method

involves the same hot water submergence treatment with 500 ppm thiabendazole or imazalil fungicide added to the hot water. This provides a more effective level of anthracnose control than just the hot water alone, but would not be appropriate for use if the intended market was the organic trade. Also, before use, it is necessary to determine the acceptability of any postharvest pesticide in the final market destination.

Stem End Rot

Stem end rot, caused by several different fungi (*Dothiorella* spp., *Lasiodiplodia theobromae, Phomopsis mangiferae*), is another principal postharvest disease of mangoes. This disease usually begins with the fungus attacking the stem of the fruit prior to harvest, where it remains quiescent until the fruit ripens. The initial symptom of stem end rot on harvested mature fruit is a darkening of the skin around the base of the pedicel. The infected area may enlarge rapidly to form circular brownish-black areas of watersoaked tissue which can extend over the whole fruit within several days (Figure 6). Once the fungus enters the stem end of the fruit, the whole fruit will rot within several days.

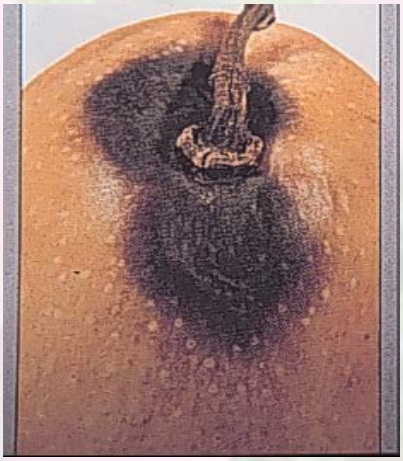

Fig 6. Stem end rot of mango fruits.

Control of stem end rot can be obtained by following several different pre- and postharvest sanitation practices. First of all, the inoculum level of the fungus on the tree prior to harvest can be reduced by removing the contaminated leaves and debris on the ground, coupled with regular foliar fungicide sprays. Postharvest control is obtained using the same hot water submergence protocol as described above for combating anthracnose.

Alternaria Rot

Alternaria rot, caused by the fungus *Alternaria alternata*, can become serious when anthracnose and stem-end rot are well controlled. Alternaria infects the mango fruit through the lenticels on the skin. After infection on the tree, the fungal hyphae remain dormant until fruit ripening, when it starts to grow intercellularly. The symptoms include small black circular spots, 0.5 to1.0 mm in diameter, which develop around the lenticels.

The fungus develops in the lenticels and penetrates the fruit, resulting in a darkening of the intercellular spaces and cell collapse. Initially, spots are concentrated around the stem end of the fruit where high numbers of lenticels are present. The spots grow and coalesce to become a single spot that can cover half the fruit. Later, the disease progresses into the flesh which darkens and becomes partially soft.