
Sweet Potato
Cultivation And
Post Harvest Handling
SWEET POTATO

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INTRODUCTION

The sweet potato (*Ipomoea batatas* L. (LamK) seemed to have originated in Tropical America, but, the exact location is not known. This crop is now grown throughout the tropics for its edible tubers, which are an important food source in many countries. Guyana is one of the tropical countries in which sweet potato is cultivated. The Regions of highest production in Guyana, are Regions 3, 4, and 9, but it is also grown in Regions 2, 5 and 6.

Sweet potato is primarily used as food. Generally it is consumed directly- the main type of preparation being boiling, baking or frying. In processed form, the tubers can be prepared in many ways for human consumption (canned, frozen, dehydrated or made into flour or starch).

For industrial uses, the tuber is a source of starch, glucose, syrup, vinegar and alcohol. The tuber and plant tops are also a source of animal feed. The tuber is fed directly or in processed form and the leaves are fed to livestock as fresh fodder or in the form of silage.

VARIETIES

There are several sweet potato cultivars in production in Guyana. Some of these are Black Rock, Strong man and Viola.

ENVIRONMENTAL REQUIREMENTS

Sweet potato is adapted to rainfall ranging from 800 – 1000 millimeters per year but it requires good drainage. This crop cannot stand water logging and it will not persist in long periods of drought without irrigation.

This crop can be grown from sea level to elevations of 2000m. It can also be grown on a wide range of soils. In Guyana, sweet potato is mainly grown on soils rich in organic matter, on loamy soils and sandy soils.

CULTIVATION

Land Preparation

Land preparation should be deep enough to accommodate the sweet potato tubers. Since this crop cannot withstand waterlogged conditions, there must be adequate drainage.

The soil should be ploughed and harrowed and adequate drains made. For lighter soils flat planting can be done but heavier soils should be ridged to facilitate drainage.

Planting
Planting material for sweet potato is the slip (stem) of mature plants. The apical portion of the stem should be used.

This apical stem cuttings should be about 25 cm long. In order to control pests during the initial stages of growth, planting material should be treated by soaking in an insecticidal solution for approximately ten minutes. The insecticides recommended are Admire at a rate of 1ml / L of water or Vydate at a rate of 2ml/l of water.

Ridges should be 0.75 m apart and cuttings should be planted 0.3m apart.

MAINTANENCE OF CULTIVATION

General Maintenance
Drains must be properly maintained during rainy periods since sweet potato cannot withstand waterlogging.

Fertiliser Application
As a general rule, before applying fertilizers, the soil should be analysed to determine the types and amounts to be used. If a soil analysis is not done the following fertilizer elements may be applied:

Fertilizer	Rate of Application
Urea	168 kg/ha
TSP	150 kg/ha
MOP	140 kg/ha

Apply the TSP and MOP to the ridges one or two days before planting. Apply all the Urea six weeks after planting, when the vines are turned to prevent formation of small tubes at the nodes (joints) of the stems.

Weed Control
Weed control is important during the early stage of this crop before the vines begin to spread. For a good crop, the weeds need to be controlled during the first six to eight week after planting.

Turning of Vines
It is customary to turn back the vines from time to time to prevent rooting at the nodes of the plant. This is to ensure a more even crop and fewer smaller tubers.

Major Pests and Diseases of Sweet Potato *(Ipomoea batatas)* in Guyana

Sweet potato is the second most widely grown root tuber in Guyana, after yams and cassava. The crop is largely produced under traditional, low input technology and consequently, often suffers poor quality yields. Much of this is due to inadequacies in crop management practices.

Economical damage by diseases, pests and weeds of sweet potato is relatively moderate, although sweet potato weevil can be a menace in some regions, if the problem is not identified early, and remedial action not implemented in a timely manner.

Insect Pests of Sweet Potato *(Ipomoea batatas)* in Guyana

1. Sweet Potato Weevil

(Cylas formicarius)

Among the 300 insect and mite species that feed on sweet potato in the tropics and subtropics, only sweet potato weevil (*Cylas formicarius*) is the most destructive insect pest (Figure 1). No resistant source is available.

A major problem in Guyana.

Sweet potato weevil

Sweet potato weevil damage

Fig 1. Different stages of the sweet potato weevil and damage caused

Cultural Control:

Integrated pest management for this insect is recommended, consisting of the following measures:

- Crop rotation;
- Eradication of Ipomoea weeds;
- Use of clean planting material;
- Deep planting;
- Regular hilling to fill soil cracks around plants; and
- Use of sex pheromone which is effective to trap male weevils;

Chemical Control:

- Pre-plant slip treatment using Triazophos 40%EC; and
- Soil treatment using Basudin 60%EC once monthly.

2. Vine Borer

Symptoms

(Omphisa anastomosalis)

O. anastomosalis adults are white with a brownish-yellow pattern on the wing. They lay slightly domed, greenish eggs with a flat base, on the upper and lower surfaces of the leaf and on petioles. The eggs are usually laid singly and egg incubation lasts for about one week.

Soon after hatching, the larvae bore into the stems and gradually eat their way down the vines. Full-grown larvae are 30 mm long and light purple, although they may also be yellowish-white. The head capsule is brown, the ventral surface and legs are white, and the back and lateral sides have yellowish-brown grooves. (Figure 2).

Fig. 2- Larvae of the vine borer

The larval period usually lasts 30-35 days, but may vary between 21 and 92 days depending upon temperature. Pupation usually takes place in the vine but larvae may also bore into storage roots and pupate when roots are close to the soil surface.

The adults are active at night. Both males and females mate at 1-6 days old.

Cultural Control:

- Integrated Pest Management; and
- Crop rotation

Chemical Control:

- The use of Sevin and/or Decis gives effective control of O. anastomosalis, increasing the yield of treated plants.
- Systemic insecticides such as Carbofuran are applied to the soil in the vicinity of the main stem. The chemical is translocated, killing the insect larvae boring in the stem, but does not come into contact with natural enemies. However, treatment with Carbofuran is barely economical because the price of sweet potato roots in local markets is low.

3. Cricket

Gryllotalpa spp. (Orthoptera: Gryllotalpidae)
Acheta spp. (Orthoptera: Gryllidae)

Mole crickets, which have heavily sclerotised front legs that are adapted for digging, are usually common in sandy soils.

All crickets are nocturnal, feeding at night and secluded by day, under the soil. They feed at or slightly below the soil surface, and can cause considerable damage before being discovered.

Crickets spend their entire life cycle below the soil, which may go through a period of approximately 28 -35 days. They are termed soil insects.

Fig. 3 – Adult Cricket

Sympton

Crickets eat tubers of sweet potatoes. Fully grown crickets are brown in colour and are about 2.5 – 3.5 cm long (Figure 3). The various species of these insects usually live either in the soil, bushes and under decaying crop residues and vegetation.

Cultural control:

- The areas where sweet potatoes are grown should receive full sunlight, kept clean of weeds and all crop residues should be removed and burnt.
- Proper land preparation serves to control weeds, diseases, and soil insects, and also helps in the destruction of large soil clods, which act as hiding places for cricket.
- **Good field sanitation-** rid the field of weeds and plants residues from previous crops.

Chemical control:

- Any approved soil insecticide at the recommended rate may be applied, such as Basudin 60% E.C (Diazinon) or Vydate L 40%E.C at the rate of 10 mls to 4500 mls water to cultivated areas.

4. White Flies

Bemisia tabaci (Homoptera: Aleyrodidae)

These insects are in fact bugs. The adults are white moth-like insects (Figure 4) that fly upwards from the plant when disturbed. They are about 2 mm in length and their wings are covered with a white waxy powder.

The pinhead size nymphs are oval and flattened and are attached to the leaf surface until maturity. All stages of this pest can be found on the underside of leaves. Nymphs and adults feed by sucking plant sap, resulting in leaves becoming mottled, yellow and brown before dying. Feeding whiteflies excrete honey dew on the leaf surface which encourages the growth of sooty mould, thus hampering photosynthesis. Ants are also attracted to the honey due. This pest is also a vector of viral diseases. The life cycle may be completed in about 28-35 days.

Fig. 4 - Whiteflies

Cultural Control:

- Do not plant a new crop next to one which is mature: The common practice of having mature crops adjacent to newly planted ones makes management of the pest very difficult since the cycle of the pest is never broken.
- An integrated control strategy is necessary for the effective management of this pest.
- Good farm sanitation, including removal of weeds around the cultivation is necessary since weeds serve as hosts for the pests.

Chemical Control:

- Several new generation insecticides are now available for the effective control of white flies. Targeting both nymphs and adults with *soap based products* should be applied very early in the morning or late in the evening. Other chemicals which may be used include Admire, Pegasus and/ or Basudin and Vydate L at 10 mls to 4500 mls water.

Diseases of Sweet Potato *(Ipomoea batatas)* in Guyana

1. Fusarium Wilt

(Fusarium oxysporum)

Symptom

The disease is caused by fungi that persist in the soil for long periods of time. Symptoms include a dark tanned rot that extends into the root and usually has a sharp line separating the rot from the healthy portion of the root. Stem infections appear as swollen areas at the base of the stem that have internal vascular discoloration (Figure 5) .

Fig 5. Field showing signs of Fusarium Wilt

Cultural Control:

- The disease can be avoided by practicing two-year rotations out of sweet potatoes and by using clean planting material.

Chemical control:

- Use Carbendazime, Cuprasan and Rizolex for effective control.

2. Soil Rot

(Streptomyces ipomoea)

Symptom

Roots develop black necrotic lesions which traverse its entire cross section (Figure 6). Usually the necrotic portion of these roots breaks off when the roots are dug, leaving a small portion of the lesion at the broken end of the root. Vine growth may be severely stunted with lower leaves bronzed or yellow and the plants wilted. Lesions on roots are necrotic, black, roughly circular in outline, and often have cracks radiating from the centre.

Fig. 6 – Symptoms of Soil Rot

Cultural Control:

- Phytosanitary measures are important to prevent introduction of *Streptomyces ipomoea* into non-infested soils.
- Cultivating equipment should not be moved from infested fields to non-infested fields and /or should be disinfested before movement into a new area.
- Storage roots from affected fields should not be used for producing transplants.

Chemical Control:

- The use of Banrot, Rizolex, Captan or Mankocide is recommended for effective control. These can also be used as a pre-plant drenches.

3. Black Rot

(Ceratocystis fimbriatum)

Symptom

Tubers with this disease show irregular sunken spots which are dark brown to black in colour. Very often black dots are scattered across the spots (Figure 7). These black dots contain the spores of the fungus causing the disease. Pink masses of the spores are sometimes seen oozing from the black dots.

Cultural Control:

- Use disease free sprouts or tubers for planting;
- Practice crop rotation;
- Use extra care in storage of planting materials- 'slips' and tubers; and
- Practice good farm sanitation.

Chemical Control:

- The use of fungicides such as Captan, Manzeb and Rizolex is recommended.

Fig. 7 – Symptoms of Black Rot

4. Root-knot Nematode

(Meloidogyne spp.)

Symptoms

Underground symptoms are primarily galls on roots, tubers, abnormal formation and function of the root system (Figure 8).

Non-specific **above-ground symptoms** include patchy stunted growth, discolouration and leaf chlorosis, excessive wilting during dry, hot conditions, stunting of whole plants, reduced yield and quality, and sometimes premature death. Root-knot is generally more severe in sandy soils and under adverse environmental conditions.

Fig. 8 – Gall formation due to Root-knot nematode

Cultural Control:

- Practice good farm sanitation;
- Practice crop rotation; and
- Flood fallow

Biological Control:

- Plant marigold flowers, tulsi, neem in and around cultivated areas

Chemical Control:

- Use any approved nematicide

5. Viral Diseases

Symptom

Viral disease on sweet potato is caused by a synergistic combination of sweet potato feathery mottle virus (SPFMV) and sweet potato chlorotic stunt virus (SPCSV).

Chlorotic dwarf virus is caused by the synergistic interaction of three viruses: two potyviruses, SPFMV and sweet potato mild speckling virus (SPMSV), and a crinivirus (SPCSV).

SPVD is transmitted by grafting. The individual viruses are transmitted by their insect vectors.

Symptoms vary with plant genotype but typically include severe stunting of plants, the production of small leaves (Figure 9) which are often distorted, narrow and crinkled and with a chlorotic mosaic and/or vein-clearing, giving affected plants an overall pale appearance.

Fig. 9 – Symptoms of Viral Disease

Whole plant: dwarfing.
Leaves: abnormal colours; abnormal patterns; abnormal forms.
Major vectors:
Aphid and whitefly

Cultural Control:

- Use of disease-free planting material and crop rotation are the most reliable means of controlling these diseases and its insect pest's vectors.
- Use of resistant varieties.

Chemical Control:

- Spraying with insecticides such as Fastac, Decis or Karate on the undersides of the leaves to kill aphids.
- Spraying insecticides such as Vydate L, Newmectin and Admire is an effective control measure for whiteflies.

Harvest Maturity Indices

Sweet potatoes do not mature as fruits do, but continue to grow as long as conditions allow. Harvest time is determined by market price, expected total yield, and root size. Sweet potatoes should be harvested when the majority of roots have reached the desired size for the intended market. This typically requires between 3 to 3.5 months from the time of transplanting. Average root size in a field can be estimated by removing the soil around several randomly selected plants. Sweet potatoes will continue to enlarge if left in the ground, but root diseases and insect damage typically increase with the amount of time the roots remain in the soil.

Harvest Method

The sweet potato vines should be cut off at the soil level prior to the intended harvest date (Figure 10). During the dry season, the vines should be removed three to seven days before digging. During the rainy season, the vines should be left intact until just prior to harvest. Vine removal helps to toughen the skin of the root and facilitates harvesting. The vines can be removed manually with a scythe or machete, or mechanically with a rotary mower.

Fig 10. Vines should be removed before digging to allow the skin to toughen.

After vine removal, the sweet potato roots can be dug by hand or by machine. Manual harvesting of sweet potatoes typically involves the use of a metal spade, pick, or fork which is used to loosen the soil and undercut the roots (Fig 11). Care must be taken to avoid cutting or injury to the roots. The roots are then lifted out of the ground, separated from the main stem, and temporarily left on top of the soil or put directly into a field container.

Fig 11. Manual harvest of sweet potatoes with a hand-made fork.

The roots should be handled gently to avoid skinning and bruising. Freshly dug sweet potatoes have a very thin and delicate skin that is easily removed (Fig 12). Skinned areas of the root surface are open wounds and become entry sites for bacterial and fungal pathogens. Skinning also lowers the appearance and attractiveness of the root. Workers should be advised not to throw or step on the roots. A range of mechanical harvest devices also exists for sweet potatoes.

These include mouldboard plows, middle buster plows, and single or multiple row diggers. Mechanical harvesters require the vines to be removed prior to digging. Mouldboard plows turn the soil and roots over on top of the ground and produce the least amount of physical damage to the roots. However, they leave many roots covered by soil that makes them difficult to recover.

Middle buster plows (usually 30-35 cm size) with broad wings, may be used, although they tend to damage the roots and scatter them on both sides of the row. It is essential to operate the plow accurately on the row, at the proper depth, and at the correct speed.

Fig 12. Skinned roots are unattractive and susceptible to

Single or multiple row diggers undercut the roots and use a rod conveyor chain to separate the soil from the roots. The roots may be placed back on top of the ground, or conveyed up the chain to a sorting crew riding on the harvester in the sophisticated models (Figure 13). The sweet potatoes are detached from the main stem by hand and graded by size or quality into field containers. Mechanical diggers can cause considerable root skinning in very dry soil or at high operating speeds. The chains should be padded to reduce bruising. A one-row chain-type digger is ideal for harvesting small plots and typically harvests 1 to 1.5 hectares per day at a harvest speed of 1.2 km/hr.

Fig 13. One-row chain type digger capable of harvesting 1 to 1.5 hectares per day.

Roots should be field graded by size and quality at the time of harvest. The rigorousness of grading depends on the demands of the market and the amount of variability in root size and quality. Select out sweet potatoes that are badly bruised, cut, severely mishapened, or insect damaged. Severely damaged or unmarketable roots should be put in a separate field container away from the sound and marketable roots. Roots less than 2.5 cm (1 in) in diameter (strings) are generally discarded. The marketable roots should be gathered off the top of the soil as soon as possible after harvest. Sweet potatoes are highly susceptible to sunburn damage if exposed to intense or direct sun even for periods as short as one-half hour. The damaged areas of the skin remain permanently discoloured and are very susceptible to postharvest decay. In order to avoid sunscald, the harvested roots should be put in field containers as soon as possible and covered with vegetation or stored away from direct sunlight exposure. Sweet potatoes should never be thrown or left in open piles in the field. The roots should be gently dry brushed to remove excess soil prior to curing. Cotton gloves are typically worn to facilitate field cleaning of the roots.

Field Containers

The most common field containers used in Guyana for removing sweet potatoes from the field are nylon sacks, reed baskets or wooden crates. Nylon sacks are the least durable and the least protective to the roots (Figure 14). Considerable root abrasion and skinning occurs during loading, transport, and unloading due to rubbing of the delicate skin against the inside surface of the sack and against adjacent roots. The most desirable field containers are made of smooth wood or durable rigid plastic and are ventilated on the sides and bottom. These containers are sufficiently strong to be stackable and are easily cleaned and sanitized. Their smooth inner surfaces result in minimal root damage. Field containers should not be overfilled with roots above the upper rim, as stacking will cause injury to the top layer of roots. Rectangular crates stack better and allow more efficient use of space in a storage house than do sacks or reed baskets. When properly stacked, rectangular or square crates distribute the weight to the strong points on the crate (the corners and ends) and prevent the roots from bearing the weight load from

Fig 14. Considerable root skinning occurs if nylon sacks are used as field containers.

the container above. When locally made containers have sharp edges or rough inner surfaces, a simple, inexpensive inner liner made from fiberboard can be used to protect the sweet potatoes from damage during handling (Figure 15).

Curing

Roots intended for storage should be properly cured immediately after harvest. The curing treatment should begin within 12 hours or less after digging. Curing is a process in which the skin thickens and new tissue forms beneath the surface of injured areas in the root. The purpose of curing is to heal the skin abrasions and wounds inflicted during harvest and handling, reduce moisture loss during storage, and minimize microbial decay.

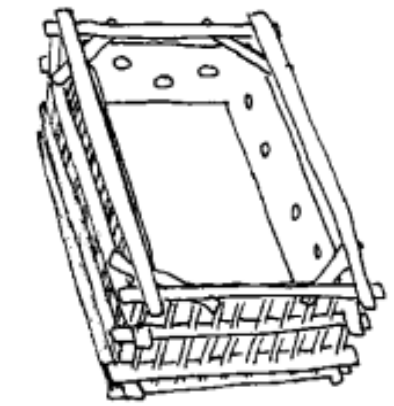

Fig 15. Fiberboard inner liner for locally made field crate.

Even with extreme care in harvesting and handling, a wound often occurs at each end of the root as a result of digging. These wounds and other breaks in the skin create areas where disease-producing organisms can enter the root. Therefore, these wounds must be allowed to heal over as soon as possible. Curing is an indispensable first step in a process that will allow Guyanese growers and exporters to provide a yearround supply of high quality sweet potatoes. Sweet potatoes can be cured outdoors if piled in a partially shaded area (Figure 16). Cut grasses or straw can be used as insulating materials and the pile should be covered with canvas, burlap or woven grass mats (Figure 17). Curing requires high temperature and high relative humidity, and this covering will trap self-generated heat and moisture. The stack should be left for about four days.

Fig 16. Piling of sweetpotatoes in preparation for outdoor curing.

Sweet potatoes can also be cured inside a protected structure at ambient temperature, provided the relative humidity is high in order to provide the warm humid conditions necessary for curing (Figure 18). The most uniform distribution of heat is obtained when heat isintroduced near the floor level of a curing structure. Heaters can be placed on the floor near the bins of produce, or heat can be ducted in from outside the curing room. A high relative humidity can be obtained by wetting the floor or by using an evaporative cooler in the room without introducing outside air. The optimal conditions for sweet potato curing are holding the roots at 26.5°C to 32°C (80°F to 90°F) under high relative humidity (90% to 98%) for 4 to 7 days immediately following harvest. The curing process does not occur at temperatures below 23°C or RH's below 65%. On the other hand, the temperature should not exceed 35°C nor should the RH be so high (i.e. 100%) where moisture condensation occurs on the surface of the sweet potato.

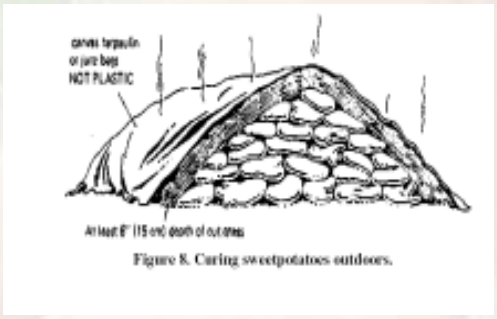

Figure 8. Curing sweetpotatoes outdoors.

Fig 17. Curing sweetpotatoes outdoors.

Uncured roots will deteriorate faster and lose more weight than adequately cured roots. In addition, uncured sweet potatoes lack the visual appeal and eating quality of cured roots. Proper postharvest curing will increase the sweetness and moistness of the roots and enhance the aroma.

Sweet potatoes can be expected to lose between 2 to 5 percent of their weight during curing. It is not unusual to see short (less than one centimeter)
sprout buds develop on a few roots toward the end of curing; however, curing should be stopped before sprouting is widespread. Roots should never be washed prior to curing and/or storage, as this would result in severe decay after several weeks. They should be stored in bins or crates, and washed only prior to packing for market (Figure 19). An ideal curing facility is an enclosed structure with temperature and RH control equipment. Adequate ventilation is also necessary to remove the CO_2 and replenish the O_2 inside the curing facility.

Fig 18. Curing sweetpotatoes inside a temperature-humidity controlled room.

Storage Temperature

Following curing, the sweet potatoes should be moved carefully to a separate well-insulated storage room at 13^{o}C ± 1^{o}C and 90 to 95 percent RH. A storage life of 6-10 months an be expected under these conditions, although sprouting may begin to occur after about 6 months, depending on the cultivar. Temperatures above 15°C (59°F) lead to more rapid sprouting and weight loss. Roots can be stored up to a year without sprouting under optimal conditions (Figure 20). Ideally, sweet potatoes should be stored in well-ventilated crates stacked at least 10 cm off the floor and 15 cm from the wall. Leave 2.5 cm between stacks for air movement.

Fig 19. Sweetpotato roots should never be washed before curing.

Fig 20. Sweetpotato roots can be stored for many months under the proper temperature and relative humidity.