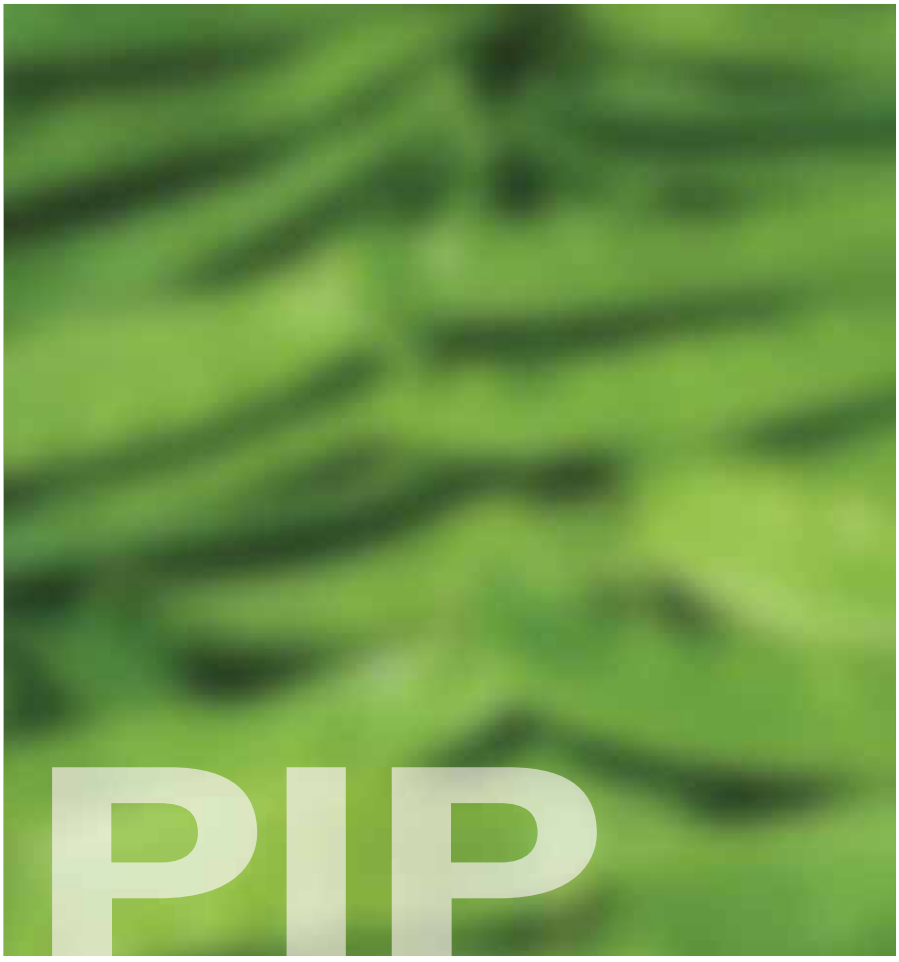

GUIDE TO GOOD CROP PROTECTION PRACTICES

FOR SWEET POTATO (*IPOMEA BATATAS*) IN ACP COUNTRIES

COLEACP is an international network promoting sustainable horticultural trade.

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In accordance with the Millennium Development Goals, the global objective is to: "Maintain and, if possible, increase the contribution made by export horticulture to the reduction of poverty in ACP countries".

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PIP

FOR SUSTAINABLE DEVELOPMENT OF THE ACP HORTICULTURAL INDUSTRY

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Notice

The Guide to Good Plant Protection Practices details all plant protection practices regarding the production of the fruit or vegetables in question and recommends primarily the active substances supported by pesticides manufacturers in the framework of EU Directive 91/414, which must comply with European standards for pesticide residues. Some of these actives substances has been tested by PIP in order to determine the GAP to comply with residues limits on pesticdes residues. Nevertheless, the information given on the active substances suggested is changeable and will be adapted on an ongoing basis in accordance with the new information collected by PIP.

It is, of course, understood that only those products legally registered in their country of application are authorised for use. Growers must therefore check with the local regulatory authorities to see whether the product they wish to use is included on the list of registered products.

The PIP's crop protocols and guides to good phytosanitary practices are regularly updated. For further information, see the PIP website www.coleacp.org/pip

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FOR SUSTAINABLE DEVELOPMENT OF THE ACP HORTICULTURAL INDUSTRY

Table of content

1 Main pests and diseases

This guide is intended for plant protection practices on sweet potato grown for tubers and/or leaves.

1.1 Extent and impact on the quantity and quality of produce

The main pests and diseases that will be discussed in this guide are listed below. This section presents, for each pest or disease:

- the level of economic importance generally observed in ACP countries rated on the following scale: **+ = low, ++ = average, +++ = high;**
- the parts of the plant affected and how they are attacked;
- the resulting types of loss, all of which decrease the yield of marketable produce and consequently end up causing a loss of financial income. The presence of pests and diseases can reduce yield and cause losses at different levels: fewer plants per hectare, lower number of tubers or leaves per plant, smaller size of tubers or leaves, lower quality product.

Quarantine organisms in Europe are followed by the abbreviation "QO".

One should check the status of quarantine organisms on the websites http://europa.eu/scadplus/leg/fr/lvb/f85001.htm and http://www.eppo.org/QUARANTINE/quarantine.htm since regulation can change.

INSECTS						
Significance	Organs affected		Type of losses			
	Leaves	Tubers	Number of plants	Number of tubers or leaves per plant	Size/weight of the tubers or leaves	Quality of the tubers or leaves
Lepidoptera						
***Spodoptera* spp. – Noctuidae** ***Agrius cingulatus* - Sphingidae – Caribbean Islands** ***Agrius convolvuli* – Sphingidae - Africa** ***Acraea acerata* - Nymphalidae - Africa**						
The economic impact level of these pests is related to importance of infestations and phenological stage of the crop at the moment of the attack						
+ to ++	Eaten by caterpillars			Possible reduction if heavy infestation on leaves at early stages of the crop But, if the young plants are healthy and growing well, they can recover. However, damage to the leaves may delay harvest, increasing the likelihood of attack by the sweet potato weevil		Impact on leaves quality only
***Omphisia anastomasalis* – Pyralidae**						
+ to ++	Caterpillars enter into the stems			Possible reduction if heavy infestation on stems Infestation during the establishment phase of the crop can result in yield losses of 30-50% or more		

INSECTS (continued)						
Significance	Organs affected		Type of losses			
	Leaves	Tubers	Number of plants	Number of tubers or leaves per plant	Size/weight of the tubers or leaves	Quality of the tubers or leaves
Coleoptera						
Curculionidae ***Cylas formicarius*** **– Apionidae – Caribbean Islands (Asian origin)** ***Cylas puncticollis*** **- Apionidae - Africa** ***Cylas cyanescens*** **- Apionidae - Africa** ***Exopthalmus*** **sp. - Caribbean Islands** ***Euscepes postfasciatus*** **- Caribbean Islands**						
+++	Holes done by adults on leaves Mines into the stem done by the larvae	Larvae coming from eggs laid on tubers bore galleries Two types of infestation on post-harvest : a primary one through infested tubers at storage and a secondary on healthy tubers				Quality reduction for tubers and leaves Due to the presence of excrements in the galleries, the tuber rots and infects the other ones Roots react to the damage by producing a poisonous substance that has a distinctive smell. This poison can cause damage to the lungs and heart of human beings and livestock
Bostrychidae ***Rhyzopertha dominica*** **- Africa**						
+ to ++		Appear on dry commodities already attacked				Quality reduction for dried tubers
Scarabaeidea ***Phyllophaga*** **sp. (++) - Caribbean Islands**						
++		Galleries done by larvae				Quality reduction for tubers
Chrysomelidae ***Typophorus nigritus viridicyaneus*** **(+++) - Caribbean Islands** ***Diabrotica*** **sp. (+ to ++) - Caribbean Islands** ***Metriona*** **sp. (+ to ++) - Caribbean Islands** ***Chelymorpha multipunctata*** **(+ to ++) - Caribbean Islands** ***Deloyala*** **sp. (+ to ++) - Caribbean Islands** ***Strobiderus aequatorialis*** **(+ to ++) - Africa** ***Aspidomorpha*** **spp. - Africa** ***Systhena*** **sp. - Caribbean Islands**						
+ to +++	Holes done by the adults or larvae for some species	Young roots chewed by larvae for some species		Possible reduction if heavy infestation on leaves The damage on leaves is conspicuous, but generally is not of economic importance		Reduced quality for leaves

INSECTS (continued)						
Significance	Organs affected		Type of losses			
	Leaves	Tubers	Number of plants	Number of tubers or leaves per plant	Size/weight of the tubers or leaves	Quality of the tubers or leaves
Thysanoptera						
Frankliniella schulzei						
+	Bitten by larvae and adults			Possible reduction if heavy infestation on leaves		Reduced quality for leaves
Homoptera						
Bemisia tabaci This pest is mainly dangerous for its capacity to transmit viruses						
+ to ++	Bitten by larvae and adults			Possible reduction if heavy infestation on leaves of young plants		Reduced quality for leaves
Aphis – *Myzus persicae, Aphis gossypii* This pest is mainly dangerous for its capacity to transmit viruses						
+ to ++	Bitten by larvae and adults			Possible reduction if heavy infestation on leaves		Reduced quality for leaves
***Empoasca* sp.**						
+ to ++	Bitten by larvae and adults			Possible reduction if heavy infestation on leaves		Reduced quality for leaves

MITES						
Significance	Organs affected		Type of losses			
	Leaves	Tubers	Number of plants	Number of tubers or leaves per plant	Size/weight of the tubers or leaves	Quality of the tubers or leaves
***Tetranychus* spp.**						
+ to ++	Bitten by larvae and adults			Possible reduction if heavy infestation on leaves		Reduced quality for leaves
***Aceria* sp.**						
+	Bitten by larvae and adults			Possible reduction if heavy infestation on leaves		Reduced quality for leaves

FUNGAL DISEASES on leaves						
Significance	Organs affected		Type of losses			
	Leaves	Tubers	Number of plants	Number of tubers or leaves per plant	Size/weight of the tubers or leaves	Quality of the tubers or leaves
	Alternaria sp. *Phyllosticta* sp. *Septoria* sp. *Cercospora* spp. *Albugo* sp. (white rust)					
+ to ++	Mycelium development on or into the leaves			Usually no impact		Reduced quality of leaves due to presence of spots

FUNGAL DISEASES on stems and tubers						
Significance	Organs affected		Type of losses			
	Stems	Tubers	Number of plants	Number of tubers or leaves per plant	Size/weight of the tubers or leaves	Quality of the tubers or leaves
	Pythium sp. *Phoma* sp. *Rhizopus stolonifer* – Caribbean Islands *Botryodiplodia theobromae*					
++	The pathogen can infect stems	These fungus attack the fleshy organs of plants that are rich in sugar or starch Infection occurs through broken ends and abrasions on storage roots				Reduced quality of tubers due to rotting
	Ceratocystis fimbriata – black rot					
++	Enter into the plant trough wounds on roots or underground stems		Death of young plants	Reduction due to rotten stems		Infected tubers produce toxins called ipomeamarone and ipomeamaronol which resist to the cooking

FUNGAL DISEASES on stems and tubers (continued)						
Significance	Organs affected		Type of losses			
	Stems	Tubers	Number of plants	Number of tubers or leaves per plant	Size/weight of the tubers or leaves	Quality of the tubers or leaves
	Fusarium oxysporum f. sp. *batatas*					
++	Enter into the plant trough wounds on roots or underground stems		Death of young plants	Reduction due to stems decay and/or weakened plants		Possible rot on tubers

NEMATODES						
Significance	Organs affected		Type of losses			
	Leaves	Tubers	Number of plants	Number of tubers or leaves per plant	Size/weight of the tubers or leaves	Quality of the tubers or leaves
	Meloidogyne spp. *Radopholus* sp. *Rotylenchulus reniformis* *Pratylenchus* spp.					
+		Larvae enter into the roots	Decline of plants	Reduction if heavy infestation on roots		Distorted tubers

VIRUS						
Significance	Organs affected		Type of losses			
	Leaves	Tubers	Number of plants	Number of tubers or leaves per plant	Size/weight of the tubers or leaves	Quality of the tubers or leaves
	Sweetpotato fearthery mottle virus (SPFMV) QO - Africa, Jamaica Sweetpotato chlorotic stunt virus (SPCSV) - Africa Sweetpotato mild mottle virus (SPMMV) QO - Africa					
++	Virus are transmitted to the plants by insects They then spread in the whole plant			Reduction is important if the photosynthesis is affected by symptoms		Quality of leaves is affected

VERTEBRATES						
Significance	Organs affected		Type of losses			
	Leaves	Tubers	Number of plants	Number of tubers or leaves per plant	Size/weight of the tubers or leaves	Quality of the tubers or leaves
Rats - *Rattus rattus, R. norvegicus*						
+ to +++		Eaten up by rodents		Reduced number of unspoiled tubers		

DIPLOPODA						
Significance	Organs affected		Type of losses			
	Leaves	Tubers	Number of plants	Number of tubers or leaves per plant	Size/weight of the tubers or leaves	Quality of the tubers or leaves
Millipedes						
+ to +++		Gnawed by millipedes mainly if tubers are already with curculinids damages				Reduced quality for tubers

1.2 Identification and damage

This section provides information and illustrations to help with the identification of the main pests and diseases.

INSECTS

Lepidopteran defoliators

Spodoptera spp.

This genus comprises several species, the most important are ***S. exigua, S. frugiperda*** and ***S. littoralis***.
These three species have the same egg-laying characteristic; the eggs are usually laid en masse covered by scales and hairs detached from the abdomen of the female. These masses are easily recognisable.

S. exigua: Widespread around the globe and highly polyphagous. The adult measures approximately 14 mm; the forewings are greyish brown in colour with two characteristic brownish-yellow spots. The caterpillars vary in colour but are generally green during the first instars, subsequently turning brown. Mature caterpillars measure up to 4 cm in length and are generally black, their heads faintly mottled with dark brown spots and with light yellow stripes on their backs.
They are initially gregarious, becoming solitary at a later stage. The damage is characteristic: during the early stages, only the upper epidermis of the leaves is chewed and then the whole leaf is devoured apart from the mid rib. Large numbers of these caterpillars are gregarious, moving around in groups.

S. frugiperda: America, the Caribbean, the West Indies. The adult measures approximately 20 mm; the grey-coloured forewings have irregular white spots. The caterpillar is green during the initial instars before turning dark green with yellow stripes running lengthwise. Non-characteristic damage: defoliation.

S. littoralis: Africa. The adult measures approximately 20 mm. The forewings are narrow with a complex pattern of light buff-coloured lines against a brown background. Neonate caterpillars are bright green in colour with a black head and prothoracic plate. They gradually turn brownish black flecked with white spots and a brownish red median dorsal line. On hatching, the caterpillars remain in clusters on the lower surface of the leaves and eat the parenchyma. They subsequently disperse and are strictly nocturnal, sheltering in cracks in the soil during the day. Highly polyphagous, this is potentially one of the most hazardous pests.

Agrius cingulatus & convolvuli

These are two very similar species. The adult, who measures approximately 40/45 mm, is typical of the sphingidae: powerful body; the forewings, which are much larger than the hindwings, are brownish with numerous lighter coloured patterns. The abdominal segments are reddish. They have very rapid, sustained flying ability. The greenish eggs are laid in isolation on the leaves or stems. The caterpillars are also characteristic of the group with a spur on the last segment. Green during the initial stages, they gradually turn brown. Imposing, they measure between 70 to 80 mm during the last stage. Pupation takes place in the soil.
Caterpillars feed on leaves, causing irregular holes. They may eat the entire leaf, leaving only the petiole. Insect frass can often be found near the infested plant part. One large caterpillar can defoliate a plant on its own. When older caterpillars are present in large numbers they can defoliate a field overnight.

Acraea acerata

Species specific to the ***Ipomea*** genus.
The adult measures 13-15 mm; the wings are orangey with a brown outer border. Black abdomen with circular orange spots.
The pale yellow eggs are laid in piles on the lower surface of the leaves.
Caterpillars are greenish-black and are covered with short-branched spines. Fully-grown caterpillars are about 25 mm long. During the initial stages (two weeks), the caterpillars are gregarious under canvas. They subsequently disperse at the end of the cycle and become nocturnal, sheltering in the soil during the day. In clusters, they devour the upper surface of the leaves. Once solitary, the leaf is destroyed with the exception of the main ribs.

Caterpillars and heavy defoliation

Mature caterpillars crawl up supports such as tall grasses, leaves or walls near the sweet potato field in order to find a site to pupate in vertical position. The pupae are yellowish and hang singly on their support. The total lifecycle takes 27-50 days.

Omphisia anastomasalis

Damage to sweet potato plants results from the caterpillar boring into the main stem leading to the roots. Vines with severe tunnelling show weak growth and poor foliage development; this foliage later yellows and wilts. The distal part of the vine above the damage site often dies. Such plants show poor storage root formation. In some cases caterpillars may bore directly into storage roots.

Stemborer larva inside a stem

Attacks on tubers : Curculionidae

Cylas spp.

The larvae of these species attack the tubers by excavating galleries, which become filled with excreta. These species belong to the ***Ipomea*** genus. The adults perforate the leaves. The adults look like ants: spindly, long legs and a long rostrum.

Adult, larvae and chrysalis

Cylas formicarius: The adult measures 6 to 8 mm and is bluish-black in colour with a reddish thorax, antennae and legs. The female lays its eggs in a cavity excavated on the stem or directly in the tuber. The larvae excavate numerous galleries. Pupation takes place in the tubers or in the soil. At 30°C, the adults can live for 3 months. In the field, two generations can succeed each other on the same crop cultivated for 4 months.

Adult

Cylas puncticollis : The adult measures 7 mm and is black. The female lays its eggs either in a cavity excavated on the stem or in the tuber. The larvae excavate galleries. Pupation takes place in the tuber.

Cylas cyanescens : The adult is black with a more globular appearance. It measures 7 mm. The eggs are laid in the tubers. Pupation takes place in a small cavity excavated in the tuber.

The citrus weevil - *Exopthalmus* sp. (*Diaprepes* sp.)

The adult measures 4 mm and is metallic blue in colour with longitudinal, red stripes on the elytra, which join up at the tip.
The female lays its eggs between two leaves, which are agglutinated by mucous. The eggs are laid in clusters. On hatching, the larvae fall to the ground and penetrate the soil, attacking the root system. Attacks can be intense given the number of eggs laid by one female (5000).

Euscepes postfasciatus

The adult weevil has a stout, compact body and measures 4 mm. Adult weevils are reddish brown to blackish gray, and are covered with short, stiff, erect bristles and scales. Eggs are grayish yellow to yellow. Larvae are white. Pupae are whitish and sedentary.
Adults feed on stems and storage roots, and emerge by chewing exit holes. Larvae feed deep in the plant tissues. Internally, flesh and stem tissues are severely damaged.

Adult

Blosyrus sp.

Adult weevils are blackish or brownish and the surface of the elytra is ridged. This makes them look like a lump of soil. Larvae are whitish and C-shaped. Adult weevils lay eggs underneath fallen leaves. The larvae develop in the soil and pupate there. Adult weevils are found on the ground underneath foliage during the day.
Adult weevils feed on foliage, but the larvae cause greater damage. While feeding under the soil surface, they gouge shallow channels on the enlarging storage roots. When extensively damaged, the skin of the storage root has to be thickly peeled before eating, because the flesh discolours just under the grooves.

Attacks on the root system and tubers : Scarabaeidae

Phyllophaga sp.

The larvae of these pests are commonly known as “white worms”. The adults, who are approximately 6 mm long, are brown to straw-coloured. They are mainly nocturnal. The females lay their eggs in the soil, preferably opting for soils containing a wealth of organic matter. The larvae chiefly attack the roots. They are whitish with a brown head.

Attacks on dry, stored tubers : Bostrychidae

Rhyzopertha dominica

Extremely common, the adult measures 3 mm and is narrow, cylindrical and reddish yellow in colour. They have very big antennae; extremely convex, granular pronotum. Striated elytra with marked punctuations. Appear on dried, previously attacked foodstuffs.

Leaf perforation by the Chrysomelidae

The Chrysomelidae cause characteristic damage: very often circular perforations of the leaf blade. These perforations are numerous and depend on the level of infestation. Some species damage the young stems. As a general rule, these are highly active insects, which either fall to the ground or fly off when approached. They measure between 4 and 6 mm on average, and are often brightly coloured with metallic overtones.

Typophorus nigritus viridicyanerus

The adult, who is metallic bluish green in colour, is oblong and measures 5 mm. Females lay their eggs at the plant base and the light yellow larva measuring approximately 10 mm penetrates the young roots. The adults devour the young leaves. Mostly young plants are attacked.

Diabrotica sp.

The adult is elongated and yellowy orange in colour with 3 blackish stripes on the elytra. The adults feed on the leaves and, in some cases, attack the young stems. The females lay their eggs in the soil at the plant base, and the larvae attack the roots: no galleries.

Metriona sp.

The adult is very rounded, golden in colour and measures 5 mm. The elytra and thorax cover the legs. The females lay their eggs on the leaves, which are attacked by the larvae and adult insects.

Chelymorpha multipunctata

The oblong-shaped adult measures approximately 5 mm. Black head, black thorax bordered by a light beige line, light beige elytra with numerous black dots.
The adults perforate the leaves and the larvae attack the young roots.

Deloyala sp.

The oblong-shaped, copper-coloured adult measures approximately 5 mm. The thorax and elytra cover the legs. The adults and larvae attack the leaves.

Strobiderus aequatorialis

This is a small, yellowish beetle, 5–7 mm long occurring in East Africa. The adults perforate the leaves and cause damage similar to that of tortoiseshell beetles.

Holes in a leaf and adult

Aspidomorpha spp.

Adults are broadly oval and shield-like, 6-8 mm long, and may be brightly coloured. They lay eggs singly or in batches on the underside of sweet potato leaves; sometimes the eggs are covered by a papery layer. The larvae are oval, flattened and spiny. Some species of tortoiseshell beetle larvae hold their tails up over their back, usually with excreta and previous cast skins. The pupa is less spiny than the larva, and is fixed to the leaf.
Both larvae and adults feed on leaves. The young larvae scrape on the upper surface of the leaves leaving the lower surface intact, while older larvae and adults eat large round holes in the leaves. Severe attacks can sometimes skeletonise the leaves and peel the stems.

Adult

Biting, sucking insects

This group of pests feeding on sap have an extremely positive reaction under conditions of hydric stress in the sweet potato. Infestation will therefore be substantially increased during periods of drought.

Frankliniella schulzei

The adult measures 1 to 1.5 mm and varies in colour from light brown to black.
The eggs are laid in the foliage tissue. The larvae are contained within the leaves, which curl up as a result of the biting action.
This thrips grinds the epidermis of the leaves, even if they are in the form of buds, thus triggering distortion and patches where the leaf appears to be translucent.

Bemisia tabaci

The adults are small (1 to 2 mm) but can easily be seen on the lower surfaces of the leaves because of their white colour. Very mobile, they rapidly take flight. The eggs are laid in the plant tissues. The larvae are oval and flat. The very short biological cycle (28 to 35 days) accounts for the extremely rapid rise in infestation. Both the larvae and adults feed on sap; the number of bites and the toxicity of the saliva injected distort the foliage, causing the latter to dry out during periods of high infestation. Honeydew can be found on the leaves under heavy infestation.

Empoasca sp.

Leaf hoppers or jassids can jump. They measure between 2 and 3 mm.
The female lays its eggs either in the primary rib or the secondary rib tissues of the leaves. The saliva produced by the larvae and adults is toxic, which triggers colour changes and distortion, chiefly in the tips of the leaves.

MITES

Tetranychus spp.

Adults and nymphs of spider mites suck the sap from the leaves, causing the area around the feeding punctures to become chlorotic and appear as conspicuous whitish to yellowish stippling on the upper surface of the leaf. Under heavy infestation, photosynthesis is greatly reduced and the chlorotic areas may coalesce forming mottled yellowish interveinal patches. The leaves eventually turn yellow and may become brown and scorched and drop prematurely.

Aceria sp.

The mites are minute in size, rather worm-like, and possess only two pairs of anterior legs. Sweetpotato vines and leaves become excessively hairy, beginning at the shoot tip. Young expanding leaves may become distorted or puckered.

Symptoms

NEMATODES

Meloidogyne spp.

Non-specific above-ground symptoms include patchy stunted growth, discolouration and leaf chlorosis, excessive wilting during dry, hot conditions.
On fibrous roots, round to spindle-shaped swellings (galls) are produced together with egg masses on the surface. Large portions of the root system can become necrotic. The storage roots of some varieties react with longitudinal cracking, whereas in others, blister-like protuberances emerge through the epidermis.

Symptoms

Rotylenchus reniformis

Symptoms are not distinctive and can be confused with those caused by other nematodes. Affected plants are stunted because of destruction of fibrous roots. Foliage becomes chlorotic and transitorily wilted.
Fleshy roots, when attacked early, develop cracks that enlarge as the roots grow. In mature roots, deep suberized cracks are the most noticeable symptoms.

Pratylenchus spp.

Affected plants are stunted because of a reduced feeder root system. On fibrous roots, lesion
nematodes produce small, brown necrotic lesions. Affected fleshy roots also show blackish brown lesions that are often invaded by saprophytic fungi and bacteria.

Radopholus sp.

The nematode causes a lesion on the plant's root that forms a canker, and the plant suffers from malnutrition while the nematode completes its life cycle within the root.

FUNGAL DISEASES on leaves

Alternaria sp.

This is mainly observed on old leaves, stems and petioles. Small, round, blackish, clearly demarcated spots appear. These spots then develop into lesions measuring several centimetres, which subsequently crack and have a white centre. These spots can form clusters triggering defoliation and causing the distal sections to dry out by choking the stem.

Drying on stems

Phyllosticta sp.

Appearance of irregularly rounded leaf spots on both surfaces, measuring approximately 5 mm in diameter. The pale brown to whitish centre is surrounded by a reddish brown border. Fructification is often visible in the form of black dots in the centre of the spots.

Spots on a leaf

Elsinoe batatas

Brown to tan raised corky lesions, with purple to brown centers, appear along the stems. Coalescing tiny lesions cover the leaf veins, thus making them shrink and causing the leaves to curl.

Albugo sp.

White rust: On the leaves white pustules appear in the form of leaf curl and filled with chains of sporangia produced under the epidermis of the host.

FUNGAL DISEASES on stems and tubers

Black rot – *Ceratocystis fimbriata*

This disease can be seen both in the field and during storage.
Infected sprouts exhibit a small black lesion near the potato. This lesion will enlarge, often up to the soil surface, girdling the sprout and causing leaf yellowing, stunting and finally sprout death.
Infected potatoes may or may not exhibit lesions at digging. Spots are blackish in color, slightly sunken and circular. Under favourable storage conditions, lesions enlarge. The fungus can be observed as short, dark bristle-like structures within a ½ inch circle in the lesion center. The potato injury may extend to the potato center as black flesh. The fungus will cause the potato to develop a bitter flavour.

Early symptoms: Small, circular, slightly sunken, dark brown or grey spots on the sweet potato surface

Advanced symptoms: Large, circular, sunken, dark brown to black spots on the sweet potato surface

Rhizopus stolonifer

The fungus causes a soft, spongy moist decay in storage or transit. An abundant growth of gray fuzzy mold is usually produced on the surface. When the rotting process is completed, or checked, the parts of the affected potato become shrunken, dry and hard.

Rot often begins at the tips of the sweet potatoes or in wounds

Jack black rot – *Botryodiplodia theobromae*

This rot is firm and moist initially, but storage roots soon become totally blackened and mummified. Rot starts at either or both ends of the storage root and is initially brown, before turning black. Eruptive black stromatic masses that bear pycnidia are a diagnostic feature.

Fusarium wilt - *Fusarium oxysporum* f. sp. *batatas*

Initial symptoms on sweet potato are yellowing of the leaves. Leaves later wilt and fall off, stunting results and eventually death of the plant. Death of the stem vascular bundles occurs with brown to purple discoloration; this may be accompanied by cracking of the stem. The vines may turn tan to light brown. Diseased plants may manage to produce storage roots, but these usually have some discoloured, infected vascular tissues. Rot may follow in storage. Dying vines often have pinkish fungal growth.

Browning of vessels

VIROSES

The two viruses reported most frequently infecting sweetpotato in Africa are Sweetpotato feathery mottle virus (SPFMV), an aphid-borne *Potyvirus* (Potyviridae) and Sweetpotato chlorotic stunt virus (SPCSV), a whitefl y-borne *Crinivirus* (Closteroviridae). The other virus that has been found quite commonly in East Africa is Sweetpotato mild mottle virus (SPMMV), a whitefl y-borne *Ipomovirus* (Potyviridae)

SPFMV by itself causes few or no symptoms on sweetpotato; SPCSV by itself causes a yellowing or purpling of middle and lower leaves, overall stunting of sweetpotato plants, and a noticeable decrease in the production of tuberous storage roots, and SPMMV causes a mild, sometimes transient mottle. However, dual infection with SPFMV and SPCSV is common, causing a very severe disease known as sweetpotato virus disease (SPVD), SPCSV synergizing SPFMV. Plants with SPVD are very stunted, the leaves are small, distorted, and often with either a chlorotic mottle or vein clearing; production of storage roots is generally diminished to 0–30% of that of unaffected plants.

Mottle on a leaf

Feathery mottle on leaves

VERTEBRATES

RATS - *Rattus rattus, R. norvegicus*

Rats and mole rats occasionally feed on sweet potato storage roots either by digging through the ridges or accessing the exposed roots. They often spoil more roots than they actually eat.

Spoiled tuber

DIPLOPODES

Millipedes

Millipedes are also known as "thousand-legged worms" or "Mombasa train". They have many legs (30-400) with a hard-shelled, round segmented body and are up to 30 cm long. They are brown to blackish brown in colour. They move slowly and curl-up when disturbed. Millipedes lay eggs single or in clusters of 20-100 in the soil. They live in moist soil and congregate around the plants in soil that is rich in organic content. They dry out easily and die. Thus, they seek wet places, such as compost piles, leaves and other plant debris, to hide under during the day.

1.3 Appearance of pests and diseases in terms of the phenological stage of the plant

The following tables show the stages of cultivation during which crop enemies are potentially present and the stages during which their presence can do the most harm. It is especially during the latter stages that they must be monitored and controlled if necessary. The purpose is to show that the presence of a pest, disease or pathogenic agent is not always harmful to the crop.
The crop cycle for sweet potato is usually 3 to 6 months. The length depends on the variety, the growing practices and the climatic conditions.

Stage	Approximative length of development stages	Defoliating caterpillars	Stem borer	Curculionidae	*Phyllophaga* sp.	Leaf eater chrysomelidae	Piercing-sucking insects	Mites	Nematodes	Fungal diseases on leaves	Fungal diseases on stems and tubers	Viruses	Rats	Millipedes
Cutting	/	■	■	■		■	■	■		■	■	■		
From planting to 1st leave	1 to 3 weeks	■	■	■		■	■	■	■	■	■	■		■
Foliar development	depend on varieties	■	■			■	■	■	■	■		■		■
Tubers development to harvesting	depend on varieties			■	■				■		■		■	■
Tubers storage	3 months and more			■	■				■		■		■	

■ Periods during which pest or pathogenic agent is potentially present
■ Periods during which the appearance of a serious infestation can cause the greatest loss

1.4 Importance by country – periods of the year and climate conditions favourable to crop enemies

UGA = Uganda, GHA = Ghana, JAM = Jamaica, DOR = Domenican Republic, KEN = Kenya, MAD = Madagascar, ZIM = Zimbabwe, MAU = Mauritius
0 = no damage
\+ = limited damage
++ = average damage: control necessary
+++ = heavy damage: control essential
X = generally limited damage but evolution of damage level over the year is not known
XX = damage can be average, but evolution of damage level over the year is not known
XXX = damage can be heavy, but evolution of damage level over the year is not known
/ = no information available
N.B. the inventory of pests and diseases has not been conducted exhaustively in all countries. The pest may be present, but has perhaps never been observed in the country on the crop, because it does not cause serious damage.

Agrius convolvui

Favorable conditions: no information.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	X	X	X	X	X	X	X	X	X	X	X	X
GHA	X	X	X	X	X	X	X	X	X	X	X	X
JAM	0	0	0	0	0	0	0	0	0	0	0	0
DOR	0	0	0	0	0	0	0	0	0	0	0	0
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Agrius cingulatus

Favorable conditions: No information.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	0	0	0	0	0	0	0	0	0	0	0	0
GHA	0	0	0	0	0	0	0	0	0	0	0	0
JAM	X	X	X	X	X	X	X	X	X	X	X	X
DOR	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Spodoptera spp.

Favorable conditions: No information.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
GHA	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
JAM	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
DOR	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Acraea acerata

Favorable conditions: Heavy infestations occur during the dry season.
It is found in all sweet potato production areas in Eastern and Central Africa, but is only considered an important pest in relatively dry areas.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
GHA	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
JAM	0	0	0	0	0	0	0	0	0	0	0	0
DOR	0	0	0	0	0	0	0	0	0	0	0	0
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Omphisia anastomasalis

Favorable conditions: No information.
Tropical and subtropical Asia and the Pacific but also a minor pest in West Africa

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Cylas sp.

Favorable conditions: Serious pests especially in drier agroecological zones. Hot, dry weather favors weevil development, because the sweetpotato roots are more easily reached through cracks in dry soil, and the life cycle is faster.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
GHA	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
JAM	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
DOR	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Exopthalmus sp.

Favorable conditions: No information.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
DOR	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Euscepes postfasciatus

Favorable conditions: No information.
Widespread in the Caribbean and South America

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Blosyrus sp.

Favorable conditions: No information.
This weevil is a common pest of sweetpotato in East Africa, and causes serious problems in some localities.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Rhyzopertha dominica

Favorable conditions: None.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	X	X	X	X	X	X	X	X	X	X	X	X
GHA	X	X	X	X	X	X	X	X	X	X	X	X
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Typophorus nigritus viridicyaneus

Favorable conditions: No information.

Month	1	2	3	4	5	6	7	8	9	10	11	12
OUG	0	0	0	0	0	0	0	0	0	0	0	0
GHA	0	0	0	0	0	0	0	0	0	0	0	0
JAM	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
RDO	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Diabrotica sp. , *Metriona* sp., *Systhena* sp., *Chelymorpha multipunctata*, *Deloyala* sp.

Favorable conditions: No information.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	0	0	0	0	0	0	0	0	0	0	0	0
GHA	0	0	0	0	0	0	0	0	0	0	0	0
JAM	X	X	X	X	X	X	X	X	X	X	X	X
DOR	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Strobiderus aequatorialis et *Aspidomorpha* spp.

Favorable conditions: No information.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	X	X	X	X	X	X	X	X	X	X	X	X
GHA	X	X	X	X	X	X	X	X	X	X	X	X
JAM	0	0	0	0	0	0	0	0	0	0	0	0
DOR	0	0	0	0	0	0	0	0	0	0	0	0
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Phyllophaga sp.

Favorable conditions: No information.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
DOR	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Frankliniella sp.												
Favorable conditions: Dry weather.												
Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	X	X	X	X	X	X	X	X	X	X	X	X
DOR	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Bemisia tabaci												
Favorable conditions: Hydric stress.												
Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	X	X	X	X	X	X	X	X	X	X	X	X
GHA	X	X	X	X	X	X	X	X	X	X	X	X
JAM	X	X	X	X	X	X	X	X	X	X	X	X
DOR	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Pucerons – *Myzus persicae, Aphis gossypii*												
Favorable conditions: Hydric stress.												
Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Empoasca sp.

Favorable conditions: No information.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	X	X	X	X	X	X	X	X	X	X	X	X
DOR	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Tetranychus sp.

Favorable conditions: Dry and hot weather.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	X	X	X	X	X	X	X	X	X	X	X	X
DOR	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Aceria sp.

Favorable conditions: Erinose is more pronounced at lower altitude where the climate is hot and dry.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	X	X	X	X	X	X	X	X	X	X	X	X
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Meloidogyne spp.

Favorable conditions: High temperature and high humidity in the soil.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	X	X	X	X	X	X	X	X	X	X	X	X
DOR	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Rotylenchus reniformis

Favorable conditions: This nematode can survive in dry soil and live and infect roots under dry conditions.
In ACP, mainly occurs in western and northern Africa, the Caribbean islands, and some Pacific islands.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	X	X	X	X	X	X	X	X	X	X	X	X
DOR	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Alternaria sp.

Favorable conditions: Cool weather, high relative humidity and splashing rains. Importance increases with altitude.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	X	X	X	X	X	X	X	X	X	X	X	X
GHA	X	X	X	X	X	X	X	X	X	X	X	X
JAM	X	X	X	X	X	X	X	X	X	X	X	X
DOR	0	0	0	0	0	0	0	0	0	0	0	0
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Phyllosticta sp.

Favorable conditions: Wind, splashing water.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	X	X	X	X	X	X	X	X	X	X	X	X
GHA	X	X	X	X	X	X	X	X	X	X	X	X
JAM	X	X	X	X	X	X	X	X	X	X	X	X
DOR	0	0	0	0	0	0	0	0	0	0	0	0
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Albugo sp.

Favorable conditions: No information.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	0	0	0	0	0	0	0	0	0	0	0	0
GHA	0	0	0	0	0	0	0	0	0	0	0	0
JAM	X	X	X	X	X	X	X	X	X	X	X	X
DOR	0	0	0	0	0	0	0	0	0	0	0	0
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Pythium sp. , *Phoma* sp., *Rhizopus stolonifer*

Favorable conditions: High relative humidity.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	0	0	0	0	0	0	0	0	0	0	0	0
GHA	0	0	0	0	0	0	0	0	0	0	0	0
JAM	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
DOR	0	0	0	0	0	0	0	0	0	0	0	0
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Botryodiplodia theobromae

Favorable conditions: No information.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Ceratocystis fimbriata

Favorable conditions: Usually not important in tropical area. Optimal temperatures : 23 to 28 ° C. The disease is favoured by moist soil conditions. In storage, decay progresses most rapidly in moist conditions at temperatures of 14 to 27° C

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Viruses

Favorable conditions: None.

SPVD is the most economically damaging disease of sweetpotato throughout Africa. SPFMV occurs throughout Africa; SPCSV has been reported as far south as Madagascar and Zambia. SPCSV occurs in at least two strains, one found in West Africa and the other in eastern and southern Africa: resistance against the West African strain seems to be ineffective against the East African strain.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
GHA	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
JAM	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
DOR	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Rats

Favorable conditions: No information.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
DOR	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

Millipedes

Favorable conditions: Infestation tends to be severe at the beginning of the long rainy season often causing farmers to plant late.
Millipedes have recently become important pests of sweet potato in some areas of East Africa.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	/	/	/	/	/	/
MAD	/	/	/	/	/	/	/	/	/	/	/	/
ZIM	/	/	/	/	/	/	/	/	/	/	/	/
MAU	/	/	/	/	/	/	/	/	/	/	/	/

2 Main control methods

2.1 Introduction

The sweet potato is a perrenial herbaceous vine grown as an annual crop. Tubers, and some time leaves, are consumed. This short days plant need sunshine and mean temperatures of 24° C. Growth slows down below 20° C.

Planting is done with cuttings put into a deeply ploughed and mounded soil. Fertilisation depends on variety grown. Good weeding is essential during first weeks of the crop. Control of pests (particularly weevils), fungal and viral diseases is done by application of Plant Protection Products and appropriate cultural practices. Crop cycle ranges from 3 months and a half for selected varieties to 8 months for local varieties. Yield of tubers is 40 to 50 tons for selected varieties and 5 to 10 tons per hectare for local varieties. Tubers can be stored for a few weeks to 6 months depending on storage conditions.

From a health/hygiene perspective, cuttings may carry numerous pests and certain viruses and bacteria in particular. The selection and preparation of the planting material is, therefore, extremely important in order to keep crops in a satisfactory, healthy condition. When essential precautions are not followed, a high incidence of pests, mainly viruses and, in some conditions, nematodes or fungal diseases, will soon develop within a few generations.

In traditional, food-producing crop systems, the cultivation methods employed actually minimise the risks of proliferation: slash and burn techniques, substantial fallow periods, long intervals, often several decades, between two crop repetitions, isolation and small-sized fields. Considerable (inter- and intra-specific) agricultural biodiversity, i.e. the cultivation of a combination of several species using several varieties of each species, often with different growing patterns (resistance to disease, cycle, etc.), is generally practised in traditional plots. These conditions halt the proliferation and dissemination of pests and pathogens. However, demographic pressures boosting fallow periods have a tendency to decrease.

When cultivation becomes more intensive with shorter fallow periods, the plantation of larger plots and a lower genetic diversity, the pressure from pests is heightened. If caution is not exercised when selecting and producing planting material, the health of crops may deteriorate to a considerable extent, thus compromising the viability and even the maintenance of such crops. Whereas for potato production, the seeds are subject to a specific, meticulous and clearly separated (including geographically) propagation process aimed at preventing the proliferation of viruses and other pathogens, planting material in the case of the sweet potato is generally produced by the farmers themselves by simply selecting cuttings within their own production system. Under these conditions it is even more important to adopt good agricultural practices (crop rotation, removal of diseased plants, rigorous cutting selection process, preservation of considerable agricultural biodiversity, etc.) in order to minimise health risks.

Curing. The peridermis of the sweet potato is easily damaged during harvesting and handling causing an unpleasant appearance, a high water loss and increasing the likelihood of rotting. The peridermal healing or "curing" process can be accomplished by storing the roots at 25° to 32°C (77°-90°F) with extremely high relative humidity (>90 to 100%) for approximately one week. Curing conditions for the sweet potato are similar to those carried out for other roots and tubers in tropical regions. The producers often fill troughs with hot roots in storage facilities and only switch on the fans to cool by evaporation after approximately one week. This interval prior to cooling establishes the hot, humid conditions needed to cure the wounds.

To reduce weight loss due to dehydration and extends the shelf life of the produce, the tubers can be coated with carnauba-based coating for post harvest application.

2.2 Pest or disease cycle; positioning of control methods and factors influencing the development of the cycle

Based on the stages of development of each pest or disease (first column), the following are the applicable control methods, as well as the effects of natural factors other than those related to climate, which are described in Part 1.4. of this guide. The control methods are then positioned in terms of the plant's development cycle.

The second column of the table shows what actions should be taken to control the different stages of development of the pest or the disease shown in the first column.

In the second column, actions that can be referred to as "cultivation practices" are shown in green boxes, and actions that can be referred to as "application of plant protection products", in orange boxes.

- Cultivation practices
- Application of plant protection product

The third column shows the cultivation stage during which these actions should be taken.

Agrius cingulatus & convolvuli							
Main control methods							
Development stages of the pest	**Action**	**Cultivation stages**					
		Choice of the field	Preparation of the field	Planting	Plant development	Harvest of tubers	Storage of tubers
Caterpillars	Manually remove clearly visible caterpillars.				X		
	Spray a contact insecticide				X		
Chrysalises	Turning the soil over between crops exposes the pupae to predators and to the sun heat		X				

X = action to be taken at the cultivation stage shown in the corresponding column.

***Spodoptera* spp.**							
Main control methods							
Development stages of the pest	**Action**	**Cultivation stages**					
		Choice of the field	Preparation of the field	Planting	Plant development	Harvest of tubers	Storage of tubers
Adults	Remove weeds		X		X		
	Light traps can be hung over basins of water in the field to trap the adults at night				X		
Eggs	Manually remove the egg masses				X		
Caterpillars	Spray a contact insecticide as a matter of priority on gregarious caterpillars in the early stages of development.				X		

X = action to be taken at the cultivation stage shown in the corresponding column.

Acraea acerata							
Main control methods							
These butterflies are capable of flying distances of several kilometres so infestation can come from far source of infestation.							
Development stages of the pest	**Action**	**Cultivation stages**					
		Choice of the field	Preparation of the field	Planting	Plant development	Harvest of tubers	Storage of tubers
Adults	Intercropping sweet potato with onion/ or the silver leaf desmodium (*Desmodium uncinatum*) might reduce the number of eggs laid by the females		X	X	X		
Caterpillars	Monitor the crop on a regular basis and manually remove the nests of young insects				X		
	Spray a contact insecticide as a matter of priority on gregarious caterpillars in the early stages of development				X		

X = action to be taken at the cultivation stage shown in the corresponding column.

Omphisia anastomasalis

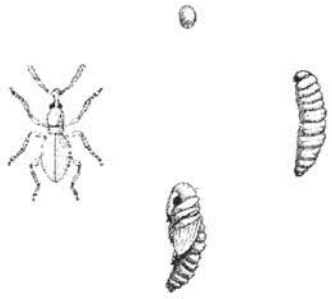
Main control methods

Development stages of the pest	Action	Cultivation stages					
		Choice of the field	Preparation of the field	Planting	Plant development	Harvest of tubers	Storage of tubers
Caterpillars	Handpick caterpillars or attacked vines and destroy them. This is feasible in small plots.				X		
	Spray a contact insecticide				X		

X = action to be taken at the cultivation stage shown in the corresponding column.

Curculionidae
Cylas spp. ; *Exopthalmus* spp. ; *Euscepes postfasciatus* ; *Blosyrus* sp.

Cycle de *Cylas* spp. : The weevil has a life cycle of four stages: egg, larva, pupa and adult. After mating, the female lays its egg on the tuber or on the leaf. After 5-14 days (depending on the environmental conditions), the egg will hatch. Larvae live for 10-35 days before pupating. The pupal stage will last for 7-28 days. The
development of the weevil from egg to adult takes 33 days on average. The adult leaves the root zone searching for mates. High numbers of weevils in the foliage usually indicates that there is a high number in the root zone.



Main control methods

- Ridging and hoeing reduces risks by preventing the tubers from coming into contact with the air.
  Below: poor ridging and hoeing methods leaving cracks in the soil.

- Check that there are no attacks during storage.
- Avoid source of infestation.

Right: damage to tubers on re-emergence in a field that has not been properly cleaned.

Development stages of the pest	Action	Cultivation stages					
		Choice of the field	Preparation of the field	Planting	Plant development	Harvest of tubers	Storage of tubers
Eggs	For *Exopthalmus*: Destruction of "nests" for egg-laying				X		
Adults	Careful ridging and regular hoeing				X		
	Regular irrigation to prevent the soil from cracking				X		
	Do not plant close to existing sweet potato fields	X					
	Use deep-rooted varieties and/or varieties with a short cycle			X			
	Do not leave damaged crops that may regrow in the field and become a source of infestation. Remove and destroy them (incinerate or bury at depth)					X	
	Crop rotation	X	X				
	Remove weeds belonging to the Ipomoea genus over a distance of at least 150 m around the field. For *Exopthalmus*: Do not grow other host plants in the immediate vicinity (avocado tree, citrus, Glyricidia, etc.).	X	X				
	In Kilifi, Kenya, farmers create planting mounds or ridges incorporating a good amount of fresh leaves of *Lantana camara* before planting sweet potatoes. This improves soil organic matter and at the same time serves as a repellent of the sweet potato weevil, thus improving both yield and quality of harvested tubers		X				
	During storage, the sweet potato weevil can be controlled at ambient temperature by processing under low oxygen and high carbon anhydride atmospheres. At 25° C (76° F), storage in 2 to 4% oxygen and 40 to 60% carbon anhydride destroyed adult weevils within 2 to 7 days.						X
	Biological control with *B. bassiana*		X	X			
	Mulches of plastic or rice straw have shown a reduction of weevil damage. The soil surface should be covered soon after planting and the cover should be maintained until harvest. The mulch not only helps to retain soil moisture, but also prevents the weevils from gaining access to roots through soil cracks			X			
	Disposal of attacked tubers					X	
Larvae	Avoid tubers with evidence of attack						X
	Apply an insecticide to the cuttings			X			
	Flood the field for one to two weeks before planting in order to destroy the larvae in the crop debris.	X	X				
	Spray a systemic insecticide on the field and a contact insecticide in the storage facility				X		X

X = action to be taken at the cultivation stage shown in the corresponding column.

Chrysomelidae							
Main control methods							
Development stages of the pest	Action	Cultivation stages					
		Choice of the field	Preparation of the field	Planting	Plant development	Harvest of tubers	Storage of tubers
Adults and larvae	Spray a contact or systemic insecticide.				X		
	Removal of nearby alternative host plants* may reduce the populations or alternatively, planting far away from alternative host plants		X	X	X		

X = action to be taken at the cultivation stage shown in the corresponding column.
* for *Aspidomorpha* sp. : morning glory (flowering plants in the family Convolvulaceae), coffee, potatoes, beets, and various flowers.

Scarabeidae : *Phyllophaga* sp.							
Main control methods							
Development stages of the pest	Action	Cultivation stages					
		Choice of the field	Preparation of the field	Planting	Plant development	Harvest of tubers	Storage of tubers
Adults and larvae	Avoid soils with a high organic matter content	X					
	Spray a systemic insecticide				X		

X = action to be taken at the cultivation stage shown in the corresponding column.

Piercing-sucking insects : *Bemisia tabaci* , *Empoasca* sp. , *Frankliniella* spp.								
Main control methods								
Development stages of the pest	Action	Cultivation stages						
		Choice of the field	Preparation of the field	Planting	Plant development	Harvest of tubers	Storage of tubers	
Adults	Weed the field perimeters		X		X			
	Do not plant near another sensitive crop that has reached the end of its cycle	X	X	X				
	The presence of wind-breakers slows down wind-borne infestations		X					
Adults and larvae	Maintain the water and mineral balance of the crop				X			
	Spray a systemic insecticide or an insect repellent.				X			

X = action to be taken at the cultivation stage shown in the corresponding column.

Nematodes								
Main control methods								
Development stages of the pest	Action	Cultivation stages						
		Choice of the field	Preparation of the field	Planting	Plant development	Harvest of tubers	Storage of tubers	Stockage des tubercules
Multiplication on another crop or weeds	Crop rotation, fallow period.	X	X					
Mobile stage in the soil	Flood the field before planting		X					
	Avoid sandy soils	X						
	Organic amendments such as manure increase the natural enemies of the nematode in the soil and reduce its population		X					
Entering and development in the plant	Application of a nematicide		X					
Dissemination through water or soil move	Avoid the intake of soil or water from an infested area		X	X				

X = action to be taken at the cultivation stage shown in the corresponding column.

Fungal diseases on leaves: *Alternaria* sp. *Phyllosticta* sp., *Coleosporium ipomea, Albugo* sp.							
Main control methods							
Development stages of the fungus	Action	Cultivation stages					
		Choice of the field	Preparation of the field	Planting	Plant development	Harvest of tubers	Storage of tubers
Germination and development on the plant	Choose less sensitive varieties			X			
	Apply fungicides				X		
Conservation in the cuttings	Use cuttings from disease-free plants			X			

X = action to be taken at the cultivation stage shown in the corresponding column.

Roots rots : *Pythium* sp., *Phoma* sp. , *Rhizopus stolonifer, Botryodiplodia theobromae*

These diseases are spread by infested soil, infected storage roots, and contaminated storage boxes, baskets, or tools.

Main control methods

- Timely harvesting can reduce losses.
- The disease is spread by infested soil or air-borne spores that enter wounds. Soft rot (*Rhizopus*) can destroy harvested roots in 48 hours if they are left unprotected under sunlight.
- Avoid damaging the tubers during storage and on harvesting.
- Sort the tubers prior to storage: remove tubers that are damaged, cracked or starting to rot.
- Avoid washing storage roots since this practice is especially conducive to rot.
- The treatment of cuttings and the curing of the peridermis during the post-harvesting stage are the main methods used to control these organisms.
- Use dry, ventilated storage premises after the healing period or preferably store the tubers in a cold chamber at 13°C with a relative humidity of 95 %.
- Some varieties rot faster than others because they are more susceptible.

Ceratocystis fimbriata							
Main control methods							
Development stages of the fungus	Action	Cultivation stages					
		Choice of the field	Preparation of the field	Planting	Plant development	Harvest of tubers	Storage of tubers
Concervation in the soil	Crop rotation (4 to 5 years without sweet potato)	X	X				
	Treat (fumigate) the soil		X				
Presence in the planting material	Use healthy plant material In places where it is difficult to find healthy mother plants, cuttings should be made 2 cm above the soil line to avoid infected portions of the plant			X			
	Use cuttings rather than parts of tubers on planting			X			
Germination development on the plant	Choose tolerant varieties			X			
	Allow the cuttings to take root in a disinfected soil before planting in the field			X			
	Apply a fungicide to the plant material			X			
Germination and development on the tubers	Avoid damaging the plant on harvesting					X	
	Cure wounds at the start of storage or prior to sale					X	
Spreading through water	Do not wash roots in water after harvest as contaminated water may spread the disease from infected roots to healthy					X	
Presence in the storage facilities	Hygiene						X

X = action to be taken at the cultivation stage shown in the corresponding column.

Fusarium wilt (*Fusarium oxysporum* f. sp. *batatas*)

Main control methods

- Use resistant varieties, if available.
- Use disease-free planting stocks.
- Avoid fields with a history of wilt.
- To reduce infection near transplanting time is to hold transplants for 24 hours at 29°C to promote suberisation of the injured surface, also yield loss can be reduced by planting more than one transplant per hill. Even though the percent of plants affected is not reduced, yield per unit land is maintained because there is less chance that all plants in a hill will be killed and also because productivity is similar for single-plant and multiple-plant hill.

Viruses

Main control methods

- Use cuttings from healthy plots.
- Use resistant varieties.
- Crop rotation.
- Use clean or disinfected tools to take cuttings.
- Isolate new plantings from old plantings.
- Reduce the vector insect population.

Rats

Main control methods

- Rats and mice breed in burrows, destruction of these burrows can help reduce populations.
- Rodents like to hide in vegetation and rubbish, as they do not like crossing open spaces where they may be seen and exposed to predation, keeping the field and surrounding areas clean should reduce damage.
- Traps can be set but care must be taken to ensure they are placed in locations where livestock and children will not interfere or get hurt by them.

Some control methods used by growers

- Some farmers dig a deep ditch around the perimeter of their field to deter rodents from digging tunnels straight into their fields.
- In Western Kenya a mixture of cow dung and pepper is made, placed in the burrows and then burnt to smoke the rodents out.
- Experiments showed that mole rat damage to cassava could be reduced by planting on mounds rather than ridges, and by planting the deep rooted, poisonous shrub *Tephrosia vogeli*i in the field.
- Farmers in Wangige, Kenya chase away mole rats by pouring fermented cattle urine (one week old) into their burrowing holes. They report this method as being very effective.

Millipedes

- They may be a problem when harvesting of sweet potato is delayed, especially if the roots are stored 'in-ground on the plants' during the dry season and harvesting is done at the first rains of the following growing season.
- Millipedes maybe a problem in nurseries located in shady sites (for example under a tree), especially if the nurseries are used for long time.
- In areas where millipedes are a problem, do not rotate sweet potatoes with crops that are also attacked by millipedes, in particular groundnuts, and to a lesser extent cassava and beans.

2.3 Resistant or tolerant varieties

They exist and are often adapted/developed depending on the countries concerned.

In Uganda, “Araka Red” and “Tedo Olooo Keren” are considered tolerant to *Cylas* spp. whereas "Namujuna" is considered resistant to the SPMMV virus.

Some varieties are perceived by farmers in Uganda to have some tolerance to millipede damage: "Araka White","Tedo Oloo Keren", "Latest", "Lira Lira", "Odupa", "Ajara", "Bibi", "Chapananca", "Dyong Bar", "Josi-Josi" and "Acan-Kome-Tek".

2.4 Importance and use of natural ennemies

Cylas spp.

Several natural enemies are known. Wasps such as *Bracon mellitor* Say, *B. punctatus* (Muesebeck), *Metapelma spectabile* Westwood (all Hymenoptera: Braconidae) and *Euderus purpureas* Yoshimoto (Hymenoptera: Eulophidae) have been reared from sweetpotato weevil larvae in the southeastern United States. There have been no studies of parasitoid effectiveness, but these species seem to be infrequent. Among predators, ants (Hymenoptera: Formicidae) seem to be most important. Diseases, especially the fungus *Beauveria bassiana*, have been observed to inflict high levels of mortality under conditions of high humidity and high insect density, but field conditions are rarely conducive for disease epizootics.

Armyworms

Predatory bugs, carabid beetles, spiders and wasps attack the caterpillars, and many parasitic wasps are also known to attack armyworms. Fungal diseases have been observed infecting caterpillars in the field.

Acraea

Caterpillars are attacked by predatory ants, ladybird beetles, lacewings and dragonflies. The fungus *Beauveria bassiana* has been observed on caterpillars in the field during the rainy season.

Whiteflies

Parasitic wasps and predators such as predatory mites, ladybird beetles, and lacewings are important in natural control of whiteflies.

3. Monitoring the phytosanitary state of the crop and intervention thresholds

Cylas spp.

In Japan, the control threshold level of stem injury was estimated to be 5%. Insecticides should be applied when this threshold is reached.
Sweetpotato weevil sex pheromone is produced commercially in several countries. It is produced in a laboratory and applied to small rubber capsules that are placed in traps in the field. The rubber capsules should be placed above the foliage and covered to protect them from rain and sunlight. A container of soapy water is usually placed under the capsule. Male adults that are attracted by the sex pheromone fall into the pail of water and can easily be collected and removed from the field. These traps are useful for indicating how large the weevil population is. In some countries research has shown that mass trapping using sex pheromone traps are an effective means to control the weevil. In Cuba the sex pheromone is often used together with an application of the fungus *Beauveria bassiana*. The fungus is applied on the soil surface beneath the sex pheromone trap or sprayed on the foliage around the trap. Weevils attracted to the sex pheromone will be infected by the fungus and killed after several days. Sex pheromones, however, are not yet widely available at the farm level.

Agrius spp.

Light traps can be used to monitor the population of moths.

4. Active substances and treatment recommendations

Introduction

For each pest or disease, proposals of the strategy for the use of Plant Protection Products (PPP) are indicated below.
A list of active substances is suggested for each pest or disease. When available, the critical GAP (Good Agricultural Practice) is also given for tubers and leaves production.

The PHI (Pre-Harvest Intervals) are indicated for:

- either to comply to the European MRL (for foodstuffs exported to EU) ;
- or to comply to the Codex MRL (for foodstuffs marketed in countries which refer to the Codex MRLs) ;
- or to produce without quantifiable residues and so respond to « 0 » residues requirements of some private standards taking into account the European LOQ.

Any change in one or more elements of these GAPs (increase in the doses, frequency of application and number of applications, last application before harvest not respecting the recommended pre-harvest interval) can result in residues in excess of the MRL in force. These GAPs does not represent a treatment calendar to be applied as such. In practice, the frequency of treatments must take account locally of the severity of attacks and the real risks of damage.

Some GAP (highlighted with yellow boxes in the tables thereafter) was tested in 2009 under tropical conditions by PIP on sweet potato in Mali.
For active substances not tested in ACP growing conditions, when leaves are produced for consumption it is better to not apply PPP on the foliage since the PHI to be respected is not known on this crop.

The list of active substances proposed has been drawn up taking into account the products used by ACP producers and the products registered in ACP countries. It is nevertheless worth noting that there are very few PPP registerd on this crop in ACP countries and that not all the ACP producers contacted provided information on the PPP used. The active substances are classified by resistance risk group (classification and codes of FRAC - Fungicide Resistance Action Committee - http://www.frac.info/frac/index.htm and IRAC - Insecticide Resistance Action Committee - http://www.irac-online.org/. In practice, it is important to alternate active substances belonging to different groups.
The most appropriate development stages of the crop (green boxes) for the application of each active substance are also suggested, taking into account the pre-harvest interval to be respected so as to comply with MRLs, the modes of action of the active substances and the effects on natural enemies.

Defoliating caterpillars

Strategy: In case of heavy infestation not controlled by natural enemies or manual collect an insecticide can be applied on leaves.

Active subsatnce	Recommanded GAP*									Proposed application period			
				Pre-harvest interval (days) for tubers production			Pre-harvest interval (days) for leaves production						
	Dosage g/ha	Maximum number of applications	Minimum interval between applications (days)	EU MRL	Codex MRL	LOQ	EU MRL	Codex MRL	LOQ	Soil preparation	Cuttings	Foliar development	Harvest and storage
Groue 3 – Pyrethroids													
Cypermethrin	70	2	15	15****	15****	15****	**	**	**				
Deltamethrin	12,5	2	15	15	15	15	3	3	**				
Lambda-cyhalothrin	15***	3	30 between 1st and 2nd application ; 15 between 2nd and 3st application	15	15	15	3	30	30				
Group 18 – Ecdysone against/moulting disruptors													
Azadirachtin	150	/	/	2	2	2	/	/	/				
Group 11 – Microbial disruptors of insect midgut membranes													
Bacillus thuringiensis	/	/	/	2	2	2	2	2	2				
Group 5 - Spynosines													
Spinosad	160	2	15	15	15	15	3	3	15				

* The elements of the recommended GAP shown here allow to comply with the harmonised European MRL or the Codex LMR or the LOQ (0 residues)
** the residues obtained don't permit to define the GAP which respect the MRL, so it is preferable to not use this active substance when the plant is grown for leaves production
*** tested with a commercial product formulated with 30 g of thiamethoxam per litre and 15 g of lambda-cyhalothrin per litre
**** extrapolated from trials done on dasheen by PIP in Dominican Republic
/ elements of the recommended GAP not available
n.a. : non applicable

Curculionidae

Strategy: Treat cuttings before planting may provide control for some months. Planting time applications of insecticides can also be made to the soil to prevent injury to the slips or cuttings. Either granular or liquid formulations are used, and systemic insecticides are preferred. Post planting applications are sometimes made on the foliage for adult control, especially if fields are likely to be invaded from adjacent areas, but if a systemic insecticide is applied some suppression of larvae developing in the vine may also occur. Since the cycle of this plant is long, one or more insecticide applications can be done on the plant or on the soil at mid cycle of the growing.

Active subsatnce	Recommanded GAP*									Proposed application period			
				Pre-harvest interval (days) for tubers production			Pre-harvest interval (days) for leaves production						
	Dosage g/ha	Maximum number of applications	Minimum interval between applications (days)	LMR EU	LMR Codex	LOQ	LMR EU	LMR Codex	LOQ	Soil preparation	Cuttings	Foliar development	Harvest and storage
Group 3 – Pyrethroid													
Lambda-cyhalothrin	15***	3	30 between1st and 2nd application ; 15 between 2nd and 3rd application	15	15	15	3	30	30				
Group 1 – Organophosphate and carbamates													
Chlorpyrifos-ethyl	225	1	n.a.	At planting			At planting			Granule on the soil			
	1st application at planting: 5 ml/ 10 litres of water of a commercial product at 480 g/l 2nd application : 960 g/ha	2	26	70	70	70	70	70	70		Soak cuttings 5 to 10 minutes	Foliar application and around the plants on soil with high volume of water	
Diazinon	3,5 ml/ 10 litres of water with a commercial product at 200 g/l	1	n.a.	70	70	70	70	70	70			Foliar application with high volume of water	
Group 4 – Nicotinic Acethylcholine receptor agonists/antagonists													
Thiamethoxam	30***	3	30 between 1st and 2nd application ; 15 between 2nd and 3rd application	15	15	15	8	8	8				

* The elements of the recommended GAP shown here allow to comply with the harmonised European MRL or the Codex LMR or the LOQ (0 residues)

** the residues obtained don't permit to define the GAP which respect the MRL, so it is preferable to not use this active substance when the plant is grown for leaves production

*** tested with a commercial product formulated with 30 g of thiamethoxam per litre and 15 g of lambda-cyhalothrin per litre

/ elements of the recommended GAP not available

n.a. : non applicable

Defoliating beetles

Strategy: In case of heavy infestation not controled by natural ennemies, an insecticide can be sprayed on leaves.

Active subsatnce	Recommanded GAP*									Proposed application period			
	Dosage g/ha	Maximum number of applications	Minimum interval between applications (days)	Pre-harvest interval (days) for tubers production			Pre-harvest interval (days) for leaves production			Soil preparation	Cuttings	Foliar development	Harvest and storage
				LMR EU	LMR Codex	LOQ	LMR EU	LMR Codex	LOQ				
Group 3 – Pyrethroides													
Cypermethrin	70	2	15	15****	15****	15****	**	**	**				
Deltamethrin	12,5	2	15	15	15	15	3	3	**				
Lambda-cyhalothrin	15***	3	30 between 1st and 2nd application ; 15 between 2nd and 3nd application	15	15	15	3	30	30				
Group 4 – Nicotinic Acetylcholine receptor/antagonist													
Thiamethoxam	30***	3	30 between1st and 2nd application ; 15 between 2nd and 3rd application	15	15	15	8	8	8				

* The elements of the recommended GAP shown here allow to comply with the harmonised European MRL or the Codex LMR or the LOQ (0 residues)
** the residues obtained don't permit to define the GAP which respect the MRL, so it is preferable to not use this active substance when the plant is grown for leaves production
*** tested with a commercial product formulated with 30 g of thiamethoxam per litre and 15 g of lambda-cyhalothrin per litre
**** extrapolated from trials done on dasheen by PIP in Dominican Republic
/ elements of the recommended GAP not available
n.a. : non applicable

Piercing/sucking insects (whiteflies, jassids, aphids, thrips)

Strategy: In case of heavy infestation, a chemical insecticide can be sprayed on leaves alternating with neem aextract, oils or insecticide soap.

Substance active	Recommanded GAP*									Proposed application period			
	Dosage g/ha	Maximum number of applications	Minimum interval between applications (days)	Pre-harvest interval (days) for tubers production			Pre-harvest interval (days) for leaves production			Soil preparation	Cuttings	Foliar development	Harvest and storage
				LMR EU	LMR Codex	LOQ	LMR EU	LMR Codex	LOQ				
Group 3 – Pyrethroids													
Cypermethrin	70	2	15	15****	15****	15****	**	**	**				
Deltamethrin	12,5	2	15	15	15	15	3	3	**				
Lambda-cyhalothrin	15***	3	30 between 1st and 2nd application ; 15 between 2nd and 3rd application	15	15	15	3	30	30				
Group 1 – organophosphate and carbamates													
Dimethoate	400	2	/	/	/	/	/	/	/				
Group 4 – Nicotinic Acethylcholine receptor agonists/antagonis													
Thiamethoxam	30***	3	30 entre 1er et 2ème application ; 15 entre 2ème et 3ème application	15	15	15	8	8	8				

* The elements of the recommended GAP shown here allow to comply with the harmonised European MRL or the Codex LMR or the LOQ (0 residues)

** the residues obtained don't permit to define the GAP which respect the MRL, so it is preferable to not use this active substance when the plant is grown for leaves production

*** tested with a commercial product formulated with 30 g of thiamethoxam per litre and 15 g of lambda-cyhalothrin per litre

**** extrapolated from trials done on dasheen by PIP in Dominican Republic

/ elements of the recommended GAP not available

n.a. : non applicable

Mites

Strategy: Application of a miticide is seldom required.

Active subsatnce	Recommanded GAP*									Proposed application period			
	Dosage g/ha	Maximum number of applications	Minimum interval between applications (days)	Pre-harvest interval (days) for tubers production			Pre-harvest interval (days) for leaves production			Soil preparation	Cuttings	Foliar development	Harvest and storage
				LMR EU	LMR Codex	LOQ	LMR EU	LMR Codex	LOQ				
Group 6 – Avermectines													
Abamectin	21,6	2	7	/	/	/	/	/	/				
Group 23 – Inhibitors of lipid synthesis.													
Spiromesifen	140	2	7	/	/	/	/	/	/				
Group 10													
Hexythiazox	50	2	7	/	/	/	/	/	/				

* The elements of the recommended GAP shown here allow to comply with the harmonised European MRL or the Codex LMR or the LOQ (0 residues)
** the residues obtained don't permit to define the GAP which respect the MRL, so it is preferable to not use this active substance when the plant is grown for leaves production
/ elements of the recommended GAP not available
n.a. : non applicable

Pythium sp. *Phoma*, *Rhizopus stolonifer*, *Ceratocystis fimbriata*

Strategy: It is useful to apply a fungicide on cuttings in area presenting a potential risk in order to avoid to bring the diseases in the field with the cuttings. A post-harvest treatment can be done on tubers to prevent development of the diseases during the storage.

Active subsat-nce	Recommanded GAP*									Proposed application period			
	Dosage g/ha	Maximum number of applications	Minimum interval between applications (days)	Pre-harvest interval (days) for tubers production			Pre-harvest interval (days) for leaves production			Soil preparation	Cuttings	Foliar development	Harvest and storage
				LMR EU	LMR Codex	LOQ	LMR EU	LMR Codex	LOQ				
Group 14													
Dicloran	5 g of a commercial product at 75 % per 10 litres of water. Soak tubers 5 -10 secondes	1 post -harvest***	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a .				
Group M : Multisite activity													
Thiram	1,75 kg of a commercial product at 75 % per 1000 litres	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.		Soak 30 secondes		
Group 1 : MBC fungicides													
Thiabendazole	200 g/100l of water	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.				Soak tubers 2 minutes

* The elements of the recommended GAP shown here allow to comply with the harmonised European MRL or the Codex LMR or the LOQ (0 residues)
** the residues obtained don't permit to define the GAP which respect the MRL, so it is preferable to not use this active substance when the plant is grown for leaves production
*** PIP trial demonstrate that the residues level detected (0,71 and 1,2 mg/kg) don't allow a treatment on tubers produced for consumption because of residues above current MRLs.
./ elements of the recommended GAP not available
n.a. : non applicable

Fungal spots on leaves - *Cercospora ipomoe*, *Albugo ipomea-pandurata* , *Alternaria* sp., *Phyllosticta* sp., *Septoria* sp.

Strategy: It is useful to apply a fungicide on cuttings in area presenting a potential risk in order to avoid to bring the diseases in the field with the cuttings. A foliar treatment can be done if spots on leaves can compromise the quality of leaves for consumption.

Active subsatnce	Recommanded GAP*									Proposed application period			
	Dosage g/ha	Maximum number of applications	Minimum interval between applications (days)	Pre-harvest interval (days) for tubers production			Pre-harvest interval (days) for leaves production			Soil preparation	Cuttings	Foliar development	Harvest and storage
				LMR EU	LMR Codex	LOQ	LMR EU	LMR Codex	LOQ				
Group M : Multisites activity													
Mancozeb	1600	2	14	30	30	30	23	23	23				
	5 g of a commercial product at 80 % per litre of water	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.		Soak 30 secondes		
Chlorothalonil	1500	2	14	30	30	30	**	**	**				

* The elements of the recommended GAP shown here allow to comply with the harmonised European MRL or the Codex LMR or the LOQ (0 residues)
** the residues obtained don't permit to define the GAP which respect the MRL, so it is preferable to not use this active substance when the plant is grown for leaves production
/ elements of the recommended GAP not available
n.a. : non applicable

Sources of GAP validated by PIP trials (boxes highlighted in yellow in previous pages)

Active substance	Commercial product tested	Manufacturer	Trials	
			Year	Country
chlorothalonil	Bravo 500 SC	Syngenta	2009	Mali
chlorpyrifos-ethyl	Dursban 4 EC and Dursban 5 G	Dow AgroSciences	2009	Mali
deltamethrin	Decis 2.5 EC	Bayer CropScience	2009	Mali
dicloran	Botran 75 W	Gowan	2009	Mali
lambda-cyalothrin + thiamethoxam	Eforia 045 ZC	Syngenta	2009	Mali
mancozeb	Dithane M 45	Dow AgroSciences	2009	Mali
spinosad	Laser 480 SC	Dow AgroSciences	2009	Mali

Note : GAPs indicated in previous pages are those corresponding to the PPPs listed above. User of this information should check if the product used by him is equivalent (same concentration and same type of formulation) to the reference product. If it is not the case, the indicated GAP could not be adequate.

Sources of other GAP shown in the previous pages

Active substance	Commercial product	Manufacturer	Source
cypermethrin	Galgothrin 25 EC	Chemotecnica	PIP residues field trials on dasheen in 2009 (Dominican republic)

5. Existing registrations in ACP countries

Remarks : This information should be tailed with the legislation in force locally in each area of production.

Uganda, Dominican Republic, Madagascar, Mauritius and Zimbabwe

No information.

Ghana

Following actives substances listed in part 4 of this guide are included in PPP registered on
- various crop : cypermethrin, deltamethrin, dimethoate, lambda-cyhalothrin, mancozeb ;
- vegetables : chlorpyriphos-ethyl, diazinon ;
- tubers : thiabendazole.

Jamaica

According to the site http://www.caribpesticides.net/ , the following active substances listed in part 4 of this guide are included in PPP registered on sweet potato: dicloran.

Kenya

Following actives substances listed in part 4 of this guide can be used on sweet potato since they are registered on:
- vegetables : abamectin, Bacillus thuringiensis, cypermethrin, deltamethrin, diazinon, dimethoate, lambda-cyhalothrin, spinosad, thiamethoxam
- horticultural crops : chlorpyrifos-ethyl, mancozeb, azadirachtin

6. European regulations and pesticide residues

Status of the active substances in Directive 91/414; European and Codex MRLs in May 2011.

Caution: The information contained in this table is subject to change by future directives of the Commission of the European Communities and Codex.

Active substance	Status in DIR 91/414	European MRLs		Codex MRLs	
		Tubers of sweet potato	Leaves of sweet potato * (spinach and similar)	Tubers of sweet potato	Leaves of sweet potato***
Abamectin	Annex 1	0.01****	0.01****	0.01****	0.01****
Azadirachtin	Annex 1	1	1	/	/
Bacillus thuringiensis	Annex 1	n.a.	n.a.	n.a.	n.a.
Chlorothalonil	Annex 1	0.01****	0.01****	0.01****	0.01****
Chlorpyrifos-ethyl	Annex 1	0.05****	0.05****	/	/
Cypermethrin	Annex 1	0.05****	0.7	0.05****	0.05****
Deltamethrin	Annex 1	0.05****	0.5	/	2
Diazinon	Withdrawn	0.01****	0.01****	/	/
Dicloran	Withdrawn	0.1	0.1	/	/
Diméthoate	Annexe 1	0.02****	0.02****	0.05****	0.05****
Hexythiazox	Annexe 1	0.5	0.5	/	/
Lambda-cyhalothrin	Annex 1	0.02****	0.5	/	/
Mancozeb	Annex 1	0.05****	0.05****	/	/
Spinosad	Annex 1	0.02****	10	0.01****	10
Spiromesifen	New substance	0.02****	0.02****	/	/
Thiabendazole	Annex 1	15	0.05****	/	/
Thiametoxam	Annex 1	0.05****	0.05****	/	/
Thiram	Annex 1	0.1****	0.1****	/	/

* MLRs on « Spinach and similar » apply on leaves of sweet potato.
** Not included in Annex 1 for the time being and the EU Member States have the possibility to maintain authorisations until 31 December 2012
*** MRL of leafy vegetables
**** = LOQ
n.a. Not applicable
/ No MRL specified

Note on the status of active substances in EU

Before a Plant Protection Product can be marketed in EU, its active substance must be approved by the European Commission. Directive 91/414/EEC provides a comprehensive list (Annex I) of active substances that can be incorporated in plant protection products. This Directive and its amendments are available on: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31991L0414:EN:NOT
The status of active substances can be checked on the following web site: http://ec.europa.eu/sanco_pesticides/public/index.cfm.
Regulation (EC) No 1107/2009 concerning the placing on the market of plant protection products replaces Directive 91/414/EEC from June 14, 2011.
http://europa.eu/legislation_summaries/food_safety/plant_health_checks/sa0016_en.htm
It should be noted that if an active substance is not registered in the EU it can still be used in the ACP countries in food items exported to Europe, provided the residue complies with the EU MRL.

Note on MRLs:

The quantities of pesticide residues found in food must be safe for consumers and remain as low as possible.
The maximum residue limit (MRL) is the maximum concentration of pesticide residue legally permitted in or on food or feed.

MRLs in the EU

Pursuant to Regulation (EC) No 396/2005 harmonized Community MRLs have been established.
The European Commission (EC) sets MRLs applying to foodstuffs marketed in the territories of the EU countries, either produced in the EU or in third countries.
Annex I to the Regulation contains the list of crops (Regulation (EC) 178/2006) on which MRLs are assigned, Annexes II and III contain the MRLs: temporary MRLs can be found in Annex III, final MRLs in Annex II. Substances for which an MRL is not required are listed in Annex IV (Regulation (EC) 149/2008). When there is no specific MRL for a substance / crop a default MRL, usually set at 0.01 mg/kg, is applied.
When establishing an MRL, the EU takes into account the Codex MRL if it is set for the same agricultural practices and it passes the dietary risk assessment. Where appropriate Codex MRLs exist, the import tolerance will be set at this level.
EU harmonized MRLs came into force on 1 September 2008 and are published in the MRL database on the website of the Commission http://ec.europa.eu/sanco_pesticides/public/index.cfm
See also the leaflet "New pesticide residues in food" http://ec.europa.eu/food/plant/protection/pesticides/explanation_pesticide_residues.pdf
How are MRLs applied and monitored in EU?

- Operators, traders and importers are responsible for food safety, and therefore for compliance with MRLs.
- The Member State authorities are responsible for monitoring and enforcement of MRLs.
- To ensure the effective and uniform application of these limits, the Commission has established a multiannual Community monitoring program, defining for each Member State the main combinations of crops and pesticides to be monitored and the minimum number of samples to be taken. Member States must report results to the Commission, which published an annual report. At present the reports are published by the European Food Safety Authority (EFSA) http://www.efsa.europa.eu/en/scdocs.htm
- In case of detection of pesticide residue levels posing a risk to consumers, information is transmitted through the Rapid Alert System for Food and Feed (RASFF) and appropriate measures are taken to protect the consumer. The database is accessible on http://ec.europa.eu/food/food/rapidalert/rasff_portal_database_en.htm
  and RASFF publishes an annual report http://ec.europa.eu/food/food/rapidalert/index_en.htm.
- PIP monthly updates on its website a summary of RASFF notification for fruit and vegetable imports from ACP countries.

MRLs in ACP countries – Codex

The Codex Alimentarius Commission was established in 1961 by the Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) with the objective to develop an international food code and food standards. Membership of the Codex Alimentarius Commission is open to all Member Nations and Associate Members of FAO and WHO. More than 180 countries and the European Community are members of the Codex Alimentarius Commission.

The Joint FAO/WHO Meetings on Pesticide Residues (JMPR) is not officially part of the Codex Alimentarius Commission structure, but provide independent scientific expert advice to the Commission and its specialist Committee on Pesticide Residues for the establishment of Codex Maximum Residue Limits, Codex MRLs for pesticides which are recognized by most of the member countries and widely used, especially by countries that have no own system for evaluating and setting MRLs.

The Codex MRL database can be found on the web site: http://www.codexalimentarius.net/pestres/data/index.html?lang=en.

Annexes

1. References and useful documents

Sweetpotato: Major Pests, Diseases, and Nutritional Disorders - T. Ames, N.E.J.M. Smit, A.R. Braun, J.N. O'Sullivan, and L.G. Skoglund - International Potato Center (CIP)

Sweet potato cultivation and post harvest handling – Guyana

Black Rot of Sweet Potato - Disease Cycle and Management - Dr. Scot C. Nelson - Plant Pathology Specialist - University of Hawaii at Manoa - College of Tropical Agriculture and Human Resources - Cooperative Extension Service

Farmers' information on sweet potato production and millipede infestation in north-eastern Uganda. II. Pest incidenceand indigenous control strategies. - E. Ebregt, P.C. Struik, P.E. Abidin and B. Odongo.

2. Useful websites

http://www.infonet-biovision.org/default/ct/126/crops

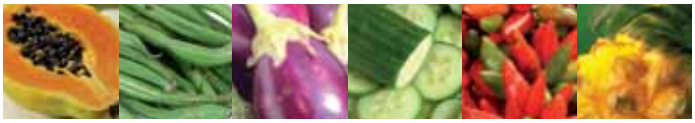
http://keys.lucidcentral.org/keys/sweetpotato/key/sweetpotato%20diagnotes/media/html/FrontPage/FrontPage.htm

CROP PRODUCTION PROTOCOLS

Avocado (*Persea americana*)
French bean (*Phaseolus vulgaris*)
Okra (*Abelmoschus esculentus*)
Passion fruit (*Passiflora edulis*)
Pineapple Cayenne (*Ananas comosus*)
Pineapple MD2 (*Ananas comosus*)
Mango (*Mangifera indica*)
Papaya (*Carica papaya*)
Pea (*Pisum sativum*)
Cherry tomato (*Lycopersicon esculentum*)

GUIDES TO GOOD PLANT PROTECTION PRACTICES

Amaranth (*Amaranthus* spp.)
Baby carrot (*Daucus carota*)
Baby and sweet corn (*Zea mayis*)
Baby Leek (*Allium porrum*)
Baby pak choy (*Brassica campestris* var. *chinensis*), baby cauliflower (*Brassica oleracea* var. *botrytis*), baby broccoli and sprouting broccoli (*Brassica oleracea* var. *italica*) *and head cabbages* (*Brassica oleracea var. capitata* and *var. sabauda*)
Banana (*Musa* spp. – plantain (*matoke*), apple banana, red banana, baby banana and other ethnics bananas)
Cassava (*Manihot esculenta*)
Chillies (*Capsicum frutescens, Capsicum annuum, Capsicum chinense*) and sweet peppers (*Capsicum annuum*)
Citrus (*Citrus* sp.)
Coconut (*Cocus nucifera*)
Cucumber (*Cucumis sativus*), zucchini and pattypan (*Cucurbita pepo*) and other cucurbitaceae with edible peel of the genus *Momordica, Benincasa, Luffa, Lagenaria, Trichosanthes, Sechium* and *Coccinia*
Dasheen (*Colocasia esculenta*) and macabo (*Xanthosoma sagittifolium*)
Eggplants (*Solanum melongena*, *Solanum aethiopicum*, *Solanum macrocarpon)*
Garlic, onions, shallots (*Allium sativum, Allium cepa, Allium ascalonicum*)
Ginger (*Zingiber officinale*)
Guava (*Psidium catteyanum*)
Lettuce *(Lactuca sativa*), spinach (*Spinacia oleracea* and *Basella alba*), leafy brassica (*Brassica* spp.)
Lychee (*Litchi chinensis*)
Melon (*Cucumis melo*)
Organic Avocado (*Persea americana*)
Organic Mango (*Mangifera indica*)
Organic Papaya (*Carica papaya*)
Organic Pineapple (*Ananas comosus*)
Potato (*Solanum tuberosum*)
Sweet potato (*Ipomea batatas*)
Tamarillo (*Solanum betaceum*)
Water melon (*Citrullus lanatus*) and butternut (*Cucurbita moschata*)
Yam (*Dioscorea* spp.)



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