PAN Germany
Pestizid Aktions-Netzwerk e.V.

Field Guide to

Non-chemical Pest Management

in Sweet potato Production

Pesticide Action Network (PAN) Germany

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for Small Scale Farming in the Tropics and Sub-tropics

Pesticide Action Network (PAN) Germany
Hamburg, 2011

Pesticide Action Network (PAN)

Founded in 1982, the Pesticide Action Network is an international coalition of over 600 citizens groups in more than 60 countries, working to oppose the misuse of pesticides and to promote sustainable agriculture and ecologically sound pest management.

PAN Germany was established in 1984 as part of this global network and has continually been involved in initiatives to reduce the use of hazardous pesticides and to promote sustainable pest management systems on national, European and global levels.

Acknowledgements

First, we want to express our gratitude to the universities and organisations that have given the permission to use their photos for the OISAT project. (For more details see p. 20)

We also wish to thank all the individuals, groups and organizations that have prepared the bases for most of the control measures presented in this field guide, may it have been by preserving traditional experience, on field trials, on field research, or in the lab.

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Prologue

Pesticides worth more than 45 billion US dollar are intentionally released into the global environment every year. A high proportion of these is highly toxic and has immediate adverse effects on human health, wildlife, local food sources such as cattle or fish, beneficial insects and biodiversity. Some of them have chronic effects including cancers, reproductive problems, birth defects, hormonal disruption and damage to the immune system. Impacts come from direct exposure in use, spray drift, washing work clothes used while spraying, home pesticide storage, pesticide dumps, and persistence in the environment.

Overall aim of the international *Pesticide Action Network (PAN)* is to eliminate the use of hazardous pesticides, reduce the overall use, risk and dependence on pesticides, and to increase support for community-based control over a sustainably produced food supply. PAN is committed, in its projects, strategies and campaigns to place pesticide concerns in the broad political and economic context in ways that will advance the fight against rural poverty and enhance pro-poor development and ethical trade. PAN aims to help local communities use the initiatives to benefit their day-to-day lives.

PAN Germany is part of the international Pesticide Action Network. It is supporting non-chemical pest management on tropical crops that are commonly grown by small landholder farmers through the project: Online Information Service for Non-chemical Pest Management in the Tropics, OISAT (www.oisat.org).

OISAT is a web-based information system to distribute information on non-chemical pest management in the tropics and sub-tropics that is easy to read and easy to understand. Information provided via www.oisat.org is relevant to small-scale farmers who intend to produce crops using safer and more affordable non-chemical pest management practices. It provides varied information on how to lower the cost of production based on recommended insect/mites pests, disease, and weeds control methods.

The ‘Field guide to Non-chemical Pest Management in Sweet potato Production’ is an excerpt taken from the website, www.oisat.org. It provides farmers with practical guidelines and alternatives to eliminate the use and their dependence on synthetic pesticides for the management of sweet potato pests. The recommended practices are safer, more affordable, and easy to follow. Most of the farm practices, the farmers can do by themselves and the materials that are needed are found in their backyards or in their kitchens or can be purchased in the local agricultural suppliers.

Carina Weber
Executive Director PAN Germany

How to use this field guide

This field guide is designed to let you grow sweet potato as easy as possible.

It provides you with the suggested appropriate management practices on how to grow sweet potato. In the pest pages, each pest has a brief description of its lifecycle, damage it causes, and its control measures. It is very important to know how the insect/mite pest develops, because the adult does not always cause the damage and sometimes it is not even found where the damage occurred. Included in the control measures are cultural practices, physical control, plant extracts, other homemade solutions, and practical methods. Also, as not to confuse you with the beneficial insects, a separate page with photos of them and their conservation and management is included.

For example, you notice that the sweet potato leaves are having large holes when you're out in the field. What would you do? First, have a closer and careful examination of your plant. If you find the pest and can't identify it, turn the following pages and look at the illustration of an insect and/or the damage or symptom in each pest entry. Once you have identified the pest, look into the corresponding control measures on how to eliminate and/or lessen its population density. You have various options like: cultural practices (e.g. removal of weeds); physical control (e.g. handpicking); plant extract (e.g. neem spray); other homemade solution (e.g. soap spray); other method (use of baits).

However, with every effort made to provide you with complete information on the pest control in sweet potato growing, the recommendations may vary from location to location. It is highly recommended that you try the various control practices in small scale especially for the plant extracts and other homemade solutions, in order to make adjustments that are adaptable to your local farm conditions before going into large scale application.

Fill in the forms at the end of this manual to have a record of activities each time you grow sweet potato.

Recommended practices

Throughout this field guide you will find suggestions for stopping or lessening the pests' population before they have control over your sweet potato field. To make a plan for you to grow a healthy crop, the following tips are the steps you ought to take:

1. Learn to identify the pests and other causal agents and the natural enemies.
2. Select the proper sweet potato variety that is well adapted to your local conditions.
3. Always select planting materials that are free from insect pests and diseases.
4. Have a healthy soil. Always keep in mind that over-fertilizing may impair your crop..
5. Practice crop rotation by planting in the next cropping season crops of a different family group.
6. If possible, practice intercropping to improve the field's diversity and to encourage natural enemies.
7. Follow the recommended planting distances.
8. Prepare the soil thoroughly with an appropriate soil tillage.
9. Always practice proper field sanitation by removing and pruning infested plant parts, keeping the area free of weeds and other plant residues, and cleaning regularly all farm tools and implements.
10. Monitor your plants regularly.
11. When in doubt, always ask for assistance from your local agriculturists.

When controlling pests using the plant extracts and other homemade solutions, the following are the standard procedures for their preparation and application:

1. Select plants/plant parts that are free of insect pests and diseases.
2. When storing the plants/plant parts for future usage, make sure that they are properly dried and are stored in an airy container (never use plastic container), away from direct sunlight and moisture. Make sure that they are free from molds before using them.
3. Use utensils for the extract preparation that are not used for your food preparation and for drinking and cooking water containers. Clean properly all the utensils every time after using them.
4. Do not have direct contact with the crude extract while in the process of the preparation and during the application.
5. Make sure that you place the plant extract out of reach of children and house pets while leaving it overnight.
6. Always test the plant extract formulation on a few infested plants first before going into large scale spraying.
7. Wear protective clothing while applying the extract.
8. Wash your hands after handling the plant extract.

I. Introduction

About Sweet potato

Scientific name: *Ipomea batatas*

Family: Convolvulaceae

Uses

The true roots (tubers) are cooked as staple food in the tropics and sub-tropics. These are prepared as boiled, baked, or fried. The leaves are used as vegetable. Both the tubers and the leaves are also used as animal feed.

II. Climatic and soil requirement

Temperature: 21-28 °C is the optimum climatic requirement

Soil: Well-drained sandy loam that is moderately fertile

Soil pH: 5.0-6.7 but the ideal is 5.8-6.0 for higher yield and of good quality tubers

III. Selection of planting materials

Select the vine cuttings from young and healthy plants (2-3 months old mother plants) are preferable. The vine cuttings must be 30-40 cm long with at least 5-8 nodes.

IV. Planting materials requirement

Around 30,000 - 85,000 vine cuttings/hectare depending on the distance of planting and the number of cuttings/ hill

V. Land preparation

Plow twice and harrow the field for easy preparation of the ridges, raised beds, or mounds. Prepare the soil two weeks before planting.

VI. Method of planting

The cuttings can be planted immediately on the ridges or mounds. You can also delay the planting by placing the cuttings in a shady and moist area for 3 days to induce rooting. In this case, the cuttings are having better start in the field.

The method of planting is done either on raised beds, ridges, or mounds. The spacing are:

For ridges: the ridge is 20-30 cm width; 8-10cm in height. The distance in between ridges is from 60 - 120cm and the distance of planting within the ridges is 20-30 cm.

For mounds, the distance is 75-100 cm apart.

Usually, a cutting is planted/hill in the ridge method while 1-2 cuttings/hill in mounds.

VII. Fertilizer and water requirements

Incorporate farm manure and compost during land preparation to loosen the soil.

There is a wide range of fertilizer requirements of sweet potato. Ask assistance from your local agriculturist office.

Water is very necessary during the root development. Sweet potato is a drought tolerant crop and can easily recover from stress when water is available.

VIII. Pest management

See pests/mites, diseases, and beneficial insects information.

IX. Harvesting

Maturity ranges from 3 ½ -4 ½ months after planting depending on the variety. One indication is when the leaves turn yellow and fall. Another is to dig a tuber, cut it and if the cut surface turns white and no other discoloration appears, then it is mature.

X. Yield

from 10-30 tons/ha depending on the crop management, climatic condition, and the variety

XI. Post harvest handling

Remove the damaged and diseased roots. Sort the sizes. Spread them in a well-ventilated and shady area if not marketed immediately.

Storage life is 1-3 months after harvest depending on the variety.

Insect pests

Several pests will infest sweet potato during its growth stages. Table 1 shows the pests that might damage the plant growth.

Table 1. The sweet potato growth stages and its pests

Growth stages	Insects/mites
Seedling stage - Leaves	 Armyworm Cutworm Grasshoppers
Vegetative stage - Leaves - Vines	 Armyworm Flea beetles Grasshoppers Stink bug Whitefly Sweet potato vine borer Sweet potato weevil
Reproductive - Tubers - Vines	 White grub Wireworm Sweet potato vine borer Sweet potato weevil
Maturation - Tubers	 Sweet potato vine borer Sweet potato weevil White grub Wireworm

Armyworm

Damage

The larvae can eat the entire leaves of field crops and grasses. When feeding, they chew from the leaf edges until only the midrib is left. They feed on various crops and grasses during their migration, and often bare crops of tender leaves after passing through. They travel from field to field in great numbers, hence the name "armyworm".

Description

Eggs of armyworms are white and are found in clusters. One egg mass contains 200-300 eggs. These turn yellowish when mature. Hatching occurs in about 2-5 days.

The larva varies its colors according to the species. Sizes vary from 2-4.5 cm long. The larva has 6 small legs just behind the head and 10 fleshy legs at the rear. The larva eats voraciously as it grows. It digs 3-6 cm below the soil surface to pupate.

The pupa is brownish red in color and about 2-3 cm long. Pupation takes about 7-16 days depending on the climatic conditions.

The moth has 3-4 cm wingspan and 1.5 cm long. Colors vary from light green, light pink, tan, to dark brown in color. The tiny white dot in the center of each forewing is an important feature to identify the armyworm moth. The moth is seldom seen because it is active only at night time, either mating or searching for suitable egg-laying sites. The female moths lay eggs on the lower leaves of growing grasses or small grains.

Control measures

Physical method

Plow a deep ditch. Keep it filled with water. This method is helpful, when larvae are found to be moving towards your field from the adjacent fields.

Another method is to dig a deep ditch with vertical sides to trap the larvae and prevent them from crawling out. Dig a hole, a diameter of a fence post, in every 10 meters within the ditch. Larvae are lured to congregate in the holes. Collect and properly dispose the trapped larvae.

Plant extract

Chili and neem leaves extract

Pound 10-20 pieces of chili and 2-2.5kg of neem leaves. Soak into 1 liter of water overnight. Strain. Add 20 liters of water and 2 tbsp of powdered soap. Stir well before application.

Cutworm

Damage

Seedlings are often cut off at ground level. Cutworm larvae can be found in the soil (up to a depth of about 5 cm) near the plant host. They always curl-up when disturbed. Cutworms feed only at night. Generally, they are not found on plants or on the soil surface during the day.

Young caterpillars eat the soft leaves of the plant. The fully grown caterpillars are capable of eating the entire plant. The newly hatched larvae feed from the base towards the tip of the leaf. At this stage, they first feed on the epidermis and may discolor the entire leaf surface.

The yellowing of the leaves is a typical symptom of Spodoptera when they cause damage to thick-leaf plants.

Description

Eggs are tiny pearl white, round, and have a ridged surface.

The newly hatched Spodoptera larvae are greenish and about 1 mm long. The full-grown larva has a cylindrical body, brown or brownish-black with a tinge of orange. The thoracic segments have one to two dark spots near the base of the legs. The abdominal segments generally have two light brownish lateral lines on each side, one above and one below the spiracles. Above the top lines are broken lines composed of velvet semi-crescent patches that vary in color among cutworms.

The pupa is black or brown in color and measures about 22.5 mm long and 9.2 mm wide.

The adult has dark brown forewings with distinctive black spots and white and yellow wavy stripes. The hind wings are whitish with grayish margins. The total developmental period from egg to adult is about 35-40 days.

Control measures

Cultural practices

1. Removal of weeds in and around fields will reduce egg-laying sites and will help in the prevention of cutworm infestation. Do this at least 2-3 weeks before planting to reduce the incidence of cutworm larvae transferring to newly planted crops.
2. Plow and harrow fields properly before planting. This will destroy eggs and expose larvae to chicken, ants, birds, and other predators.
3. Interplant main crops with onion, garlic, peppermint, coriander, or garlic every 10-20 rows to repel cutworms. Sunflowers and cosmos can also be planted as a trap crop in or around fields.

Physical methods

Protective collars made of plastic or paper cups, plastic drink bottles with ripped-out bottom, sturdy cardboard, and milk cartons. Place the collar around the young plant and push into the soil to prevent the cutworm from attacking the stem.

Sticky substances such as molasses, saw dust, or crushed eggshells placed around the base of each plant. When the cutworm emerges to feed, it will come in contact with the trap, get stuck, harden, and die.

Plant extract

Neem seed powder extract

Add 20 g of finely ground neem kernels into 1 liter of water. Mix by continuously stirring. Steep for at least 6 hrs. Before application, add a drop of liquid soap and stir it again. This is also good for armyworm control.

Spanish needle (*Bidens pilosa*)

Pound one whole plant. Soak in 2 liters of water overnight. Squeeze out the plant sap. Strain. Add a drop or 2 of liquid soap. Stir well.

Flea beetles

Damage

The Flea beetle feeds on seedlings. They usually feed on the undersides of leaves, leaving numerous small round or irregularly shaped holes, although not generally all the way through the leaf. Because the beetle is small and active, it usually does not feed much in one spot.

The larvae are root feeders. They trim the root hairs and make circular pits in tap roots. Its feeding damage is external on the root which can reduce the marketability of radish and turnips. The adults feed on the leaves and stems of emerging seedlings, on green pods, and heads. They chew small holes or pits, usually less than 3 mm in diameter, giving the leaves a characteristic 'shot hole' appearance.

Description

The eggs are ovate, white when freshly laid and gradually become yellowish gray in color. The larva is white with a brown head and three pairs of brown legs near its head. The pupa is white, shaped roughly like adult and pupates in the soil. The adult is small, hard, elongated oval shaped, with enlarged black hind legs and slightly hairy wing covers. It is about 2 mm in size.

Control measures

1. Row covers keep flea beetles away. Put row cover immediately after sowing.
2. White or yellow sticky traps placed every 5-10 m on the rows.
3. Thick mulch in isolated planting interferes with the larva's feeding activities.

Grasshopper

Damage

The feeding damage includes leaf notching and stripping, but as they mature they can consume an entire plant. They can fly and move around easily in search of a wide variety of food sources.

Description

Eggs are white, yellow green, tan, or various shades of brown in color and are elongated, curved, and pod-liked. They are laid beneath the soil surface (also in non-crop areas including ditches, fence rows, and weedy areas) in compact clusters of 35-100 eggs that is covered by a frothy secretion. The froth bubbles, which protect the eggs from drying, are either white or brown, depending on the species. The eggs will hatch in about 1-3 months, depending on the species and environmental conditions.

The newly hatched nymph is white in color. After several hours of exposure to sunlight, it assumes its distinctive color and the markings of becoming an adult. Most nymphs immediately look for feeding sites and continue to feed on the same plants until they become adults. The nymphs have wing pads but they cannot fly. This is the reason why most of the damaged plants are concentrated and are found at the edges of the field. They will undergo 4-9 nymphal stages and become adults in about 2-7 months depending on the species and environmental conditions.

Control measures

Physical control

1. Catch the grasshoppers early in the morning when they are less active, using a butterfly net
2. Use floating row covers (fine mesh nets) to protect seedlings and valuable crops.

3. Yellow color attracts grasshoppers. To lure and trap them, make long sticky yellow strips.

Other method

Salty rice bran bait.

Moisten rice bran with salty water. Grasshoppers feed on salty rice bran

Stink bug

Damage

Adults and nymphs suck plant sap from leaves, flowers, bolls, buds, fruits, and from the seeds of a wide array of crops. Feeding on fruits causes scarring and dimpling known as cat-facing. Feeding on the developing grains of rice at the milking stage causes shriveling and empty seeds with brown spots. Feeding on cotton bolls prevents bolls to open or stains the lint or causes bolls to drop.

Description

The eggs are yellow and barrel-shaped. These are laid on the lower surface of the leaves in clusters of 20-130 in 5-8 parallel rows.

The nymph has heterogeneous colors (green, tan, brown or gray). It is oval-shaped, wingless but looks similar to an adult counterpart. The first nymphal instars do not feed. The nymphs form clusters at the natal site. The second and third instars are also found in clusters but they disperse when disturbed. The fifth nymphal instars are sensitive to day length, which also causes the adults to begin diapauses. The nymphal development lasts for about 8 weeks.

The adult is shield-shaped and green, tan, brown or gray in color. Most of the adults are shiny, but some species are spiny and rough-textured. The female starts mating one week after emergence and lives for about 30 days.

Stinkbug emits a foul odor when disturbed, hence the name.

Control measures

Remove and control weeds from fields and also in the adjacent fields. Weeds serve as the pests' alternate hosts.

Plant small flowering plants to attract native parasitic wasps and flies.

Plow-under all plant debris after the harvest to destroy all possible breeding sites.

Parasitoids

Native parasitic wasps

Trichopoda pennipes is a Tachinid fly species that is as big as the housefly. The adult fly is brightly colored with a gold and black thorax and an orange abdomen. It has a fringe of feather-like black hairs on the outer side of the hind legs. The fly develops in the nymph and adult stink bug or squash bug. The female tachinid fly lays its eggs on the body of the bug, completes its cycle inside the bug's body, and the bug dies upon the fly's emergence.

Sweet potato vine borer

Damage

Feeding damage on the vine causes wilting and poor growth. The feeding that occurs on the plant's crown often results in plant death. The accumulation of fecal matter on the soil surface and holes on the vines are signs of larval feeding.

Description

Egg is ovate with a flat base and greenish in color. It is about 0.5 mm in diameter. It is laid singly either on the upper or lower surface of the leaf lamina and on the leaf petiole. An egg hatches in about 7 days.

Larva is light-purple and/or yellowish-white in color. Its head is brown and has brown spots that form prominent stripes along its sides. A fully-grown larva can measure up to 2.5-3.0 cm long. It undergoes 6 larval instars that usually vary from 21-90 days, depending upon the climatic condition.

A pupa is light-brown in color and is about 1.6 cm long. It pupates on the vine where the larva has been feeding, but also on the soil near the roots.

The adult is white in color and has a brownish-yellow pattern on its wings. It has dark-brown forewings and lightly-pigmented hind wings. The female has a broader abdomen than the male, with the latter having clasper-like structures on the last abdominal segment which is not found on the former. Both are immediately fertile upon emergence. A female lives for about 10 days.

Control measures

After a heavy pest infestation, refrain from planting sweet potato for at least 2 cropping seasons. Always keep your area free of Ipomea weeds to eliminate all the possible food sources of the pests.

Properly select your planting material. Never use cuttings that are taken from infested plants.

Use a row cover when you want to grow sweet potato as your source of planting material. This will protect plants from the pests.

Sweet potato weevil

Damage

The larva prefers to feed on the tuber. An infested tuber is often riddled with cavities as a result of its tunneling activities. It becomes spongy, brownish to blackish in appearance, and has a bitter taste and foul odor. But before tuber formation, it feeds on the vine. A damaged vine is discolored, cracked, or wilted

Description

The egg is laid singly in small cavities on the sweet potato root or vine tissues that is nicely sealed with the mother's fecal material. It is ovate-shaped and creamy-white in color. It is about 0.7 mm in length and 0.5 mm in width.. It hatches in about 5-6 days.

The larva is legless and white in color. It is found feeding on the vine near the base of the plant and goes down to the roots to feed on the tuber. It can reach a length of 0.78 mm. It will undergo 3 larval stages which will last for about 35-56 days depending upon the climatic conditions.

The pupa is white and turns grayish with darker eyes and legs as it further develops. It looks similar to the adult but its head and elytra are bent ventrally. It measures about 6.5 mm in length. The pupal stage lasts for about 7-28 days.

The adult has a black head, orange to reddish-brown antennae, thorax, and legs, and a metallic-blue abdomen and elytra. Its body, legs, and head are long and thin, giving it an ant-liked appearance. It measures 5.5 - 8.0 mm in length.

Control measures

Management and cultural practices

1. Practice proper field sanitation. After harvest remove all plant residues especially the discarded and unharvested tubers.
2. Remove Ipomea weeds, especially the morning glory, as this weed is the weevils' alternate host.
3. Plow the field after harvest to expose the pests to predators. If there is access to irrigation water, submerge the field for at least a day. The weevils do not like being in wet areas and on rotten and decayed materials.
4. Practice crop rotation, if possible, to disrupt the lifecycle of the pest. Rice, sorghum, yam, and edible sunflower are found to be good rotation crops.
5. Properly select your planting material. The tender vine which is about 25-30 cm long is ideal and is usually free from eggs and larvae. The female lays its eggs on the vine near the base of the plant, and the larvae are found feeding on this plant part.
6. Practice hilling-up to prevent soil from cracking. Cracked soil is an entry point for the weevils to feed and reproduce on the tubers.
7. Storage containers and other facilities are possible source of new infestations. Clean and fumigate them.

Complete eradication of the pest is a collective effort among the farmers in a given community (e.g. village, barangay) and involves not planting sweet potato, and removing Ipomea weeds regularly for a period of at least 6 months.

Whiteflies

Damage

Both the larvae and adults pierce and suck the sap of the leaves. This causes the weakening and early wilting of the plant resulting in reduced plant growth. Their feeding may also cause yellowing, drying, premature dropping of leaves that result in plant death. Whiteflies produce honeydews that serve as the substrates for the growth of black sooty molds on leaves and fruit. The mold reduces photosynthesis causing the poor plant growth of the plant. They are the most important carriers of plant virus that cause diseases of fiber crops, vegetables, fruit trees, and ornamentals.

Description

The eggs are tiny, oval-shaped, about 0.25 mm in diameter, and stand vertically on the leaf surface. Newly laid eggs are white then turn brownish. They are deposited on the underside of leaves, sometimes in circle or oval-shaped patterns.

The larvae are transparent, ovate, and about 0.3-0.7 mm in size and they move around on the plants looking for a feeding site upon hatching.

The pupae are dirty-white and surrounded by wax and honeydews. During this stage, the red eyes of the emerging adults are visible.

The adults are about 1mm long with two pairs of white wings and light yellow bodies. Their bodies are covered with waxy powdery materials. They are found feeding on top of the plants. A female can produce as many as 200 eggs in her lifetime and mating is not necessary. It takes about 40 days to develop from egg to adult.

Control measures

Botanical pesticides

Garlic oil spray

Chop finely 100 g of garlic. Soak the chopped garlic in mineral oil for a day. Add ½ liter and 10 ml of soap. Dilute filtrate with 10 liters of water. Constantly shake the container or stir the extract while in the process of application to prevent oil from separating.

Madre de cacao & neem

Shred 1 kg of Madre de cacao leaves and 1 kg of neem leaves. Soak leaves in 5 liters of water for 3 days. Strain. Add water to make up 20 liters of filtrate. Spraying interval is 4-5 days.

Neem oil extract

Add 15 ml of neem oil into 1 liter of soapy water. Constantly shake the container or stir the extract while in the process of application to prevent oil from separating.

Spray solution

Soap spray

Mix 2 ½ tablespoons of liquid soap to a gallon of water

Potato starch spray

Mix 2-4 tbsp potato flour to 1 liter of water and add 2-3 drops of liquid soap. Shake the mixture and stir thoroughly before spraying.

White grub

Damage

White grubs feed on the main roots of the plants. They cut the main stems and roots of plants below the surface of the soil. They tunnel into tubers of root vegetables and root crops. These feeding habits affect the underground portion of the stems and roots causing the plant to wilt and eventually die

Description

The white grubs are the larvae of Japanese and May/June beetles. They are white or yellowish in color, with tan or brown heads, and with 6 spiny legs. They have fleshy, wrinkled C-shaped bodies. Upon hatching they are quite small but can measure up to 2-4 cm when they mature.

Control measures

Cultural practices

Ensure proper drainage. Grubs love moist soil, especially with decaying organic matter. Female beetles prefer to lay eggs on moist-decaying organic matter.

If heavy infestation occurs, avoid planting the same crops the whole year. Practice crop rotation always. Soybean is found to be resistant to white grubs.

Preventive control

Bacillus popilliae and *B. lentimorbus* are microbial insecticide products that kill grubs and adult Japanese beetles. Infected grubs are filled with a milky white liquid full of bacterial spores. They inoculate the soil as they move. The advantages of using commercial preparations of *B. popilliae* are; they are host specific meaning, only effective against Japanese beetles and their persistence is longer lasting.

Wireworm

Damage

Wireworms attack the stems of newly set plant by boring into the stems near the soil surface. Some plants may wilt and die within a few days or may have stunted growth. Often, the wireworm is found near the damaged or missing plant. Damage is most likely to occur where host plants like cotton, corn, sorghum, and tobacco have been previously planted.

Description

Wireworms are the larvae of different species of Click beetles. Larvae are slender and hard and feel somewhat like wires. Their bodies are segmented and shiny and are usually cylindrical, but flat on the lower sides. There are three pairs of legs close together near the head and no prolegs. Some of the most common species are white, yellowish-brown to reddish-brown, although other species may vary in color.

Control measures

Cultural practices

1. Flood fields for at least a month, during sunny weather, to eliminate wireworms.

2. Control weeds in and around fields, as click beetles feed on weed seeds.

3. Grow Flax (*Linum species*) as a cover crop to kill wireworms. Flax, a tropical herb, is also good for controlling root knot nematodes. White mustard and Buckwheat plants are also found to reduce the wireworm population.

Physical control

Soil baits

1. Corn/wheat seed mixture bait (Rice, 1999).

Procedure:

Soak mixture in water for 24 hours to facilitate germination.

Place 1/2 cup (of a 1:1 corn/wheat seed mixture) in a hole that is 12 cm wide and 30 cm deep.

Cover with soil.

Cover the topsoil with plastic to warm the surface and to speed up germination.

Cover the edges with soil to prevent wind from blowing away the plastic.

Remove the plastic, the soil cover, and the bait.

Destroy larvae trapped in the baits.

This method is also used to monitor white grub population.

2. Potato/carrot bait

Procedure:

Cut potatoes or carrots into chunks.

Remove the potato 'eyes' to prevent from further growing.

Make the pieces big enough and put in sticks.

Bury "staked potatoes/carrots" at a depth of 3-6 cm in the ground. The stick serves as the handle to easily pull the baits out.

Bury randomly in the field.

Leave baits in the soil for 2-3 days. Wireworm will feed on the baits.

Dispose the baits and the wireworm properly.

Diseases

Fusarium wilt

The typical early symptoms are the yellowing and wilting of the lower and older leaves and the vines become brownish in color. As infestation progresses, the vines are wilted and pinkish fruiting bodies of the fungi become visible. The infected tubers have discolored vascular tissues which may rot upon storage.

Preventive control

1. Whenever practical, remove and destroy infested plant materials after harvest. However, do not put these into your compost pit or pile. Compost from such materials will contain the fungi.
2. Use resistant varieties.
3. Practice a proper crop rotation strategy. If your soil is severely infested, planting solanaceous and other susceptible crops is not advisable.

Conditions that favor development

1. Infested planting materials
2. Infested soil

Black rot

An infested tuber has sunken brown lesions during the early stage of infestation that continue to enlarge up to 5cm in size. As the infestation continues the spots become black and coalesce and may cover the entire tuber.

Conditions that favor development

1. Infested planting materials
2. Infested soil

Preventive control

Proper selection of planting materials, curing the tubers after harvest, and placing the tubers in a clean and well-ventilated storage area.

Charcoal rot

Charcoal rot is a storage disease. The damaged tuber has lesions which are initially brownish, then turning red or dark-brown and become black at the later stage of the infestation.

A cross-section of an infested tuber will show the outer portion to be blackened due to the presence of the matured fungi spores while the inner part is reddish-brown in color that is slowly decaying.

Preventive control

Make sure that the tubers are not damaged during harvest. Damaged ones are to be discarded.

Curing the tubers after harvest and placing them in a clean and well -ventilated storage area.

Scurf

Early symptoms are tiny brown spots on the tuber. As infestation progresses, the spots turn black and become larger as they coalesce.

Conditions that favor development

1. Infected propagating material.
2. The organic matter content of the soil is too high. The use of animal manure may increase the incidence of scurf.
3. Practice crop rotation
4. Remove all plant debris after harvest.

Sweet potato scab

Small brown lesions are found on the veins of the leaves. As the disease progresses, these lesions become corky that caused the leaves to curl. The stem lesions are slightly raised with rusty-brown spots. Scab-like structures form on the stems as the spots meet.

Conditions that favor development

1. Infested planting materials
2. Infested soil

Preventive control

Proper selection of planting materials, crop rotation with small grains and corn, and practice field sanitation. There are now new sweet potato cultivars that are found to be resistant to the disease.

Beneficial insects

The following are some beneficial insects that are indigenous on your fields and gardens or can be introduced for the control of pests.

Damsel bug

Diadegma

Lacewings

Spiders

Hoverflies

Ground beetles

Ladybird beetles

Tachinid flies

Rove beetles

Conservation of the beneficial insects

Provide hiding sites and alternative habitats such as mulches and other ground covers.
Plant small flowering plants on borders, hedges, and other perennial habitats as source of food and shelter
No indiscriminate use of synthetic pesticides.

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Tables

Table 2. Monthly cropping calendar of activities

Management practices	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Planting material procurement												
Land preparation												
Vine cutting preparation												
Fertilization												
Irrigation												
Pests monitoring												
Pests control												
Harvesting												
Post harvest												

Table 3. Weekly activities

Field activities	- 4	- 3	- 2	- 1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Procurement of planting materials																				
Land preparation																				
Fertilizer application																				
Cultivation																				
Irrigation																				
Weeding																				
Control of insect pests and diseases																				
Harvesting																				

Table 4. Crop lifecycle

Growth stages	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Vine cutting preparation												
Early growth stage												
Vegetative												
Reproductive												
Maturation												

PAN Germany
Pestizid Aktions-Netzwerk e.V.

For more information
on non-chemical pest management see:

www.oisat.org

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