

Field Guide to
**Non-chemical
Pest Management**



in Squash Production



Field Guide to

Non-chemical Pest Management in Squash Production

for Small Scale Farming in
the Tropics and Sub-tropics

Pesticide Action Network (PAN) Germany
Hamburg, 2013

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.

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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 32 million 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 Squash 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 squash 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.

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How to use this field guide

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

It provides you with the suggested appropriate management practices on how to grow squash. 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 squash 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 cannot 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 squash 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-up the forms at the end of this manual to have a record of activities each time you grow squash.

Recommended practices

Throughout this field guide, you will find suggestions for stopping or lessening the pests' population before they have control over your squash 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 squash variety that is well adapted to your local conditions.
3. Always select good and disease-free planting materials.
4. Have a healthy soil, but always keep in mind that over-fertilizing is not necessarily better.
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 by appropriate 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 pest-free.
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 squash

Scientific name: Cucurbita spp.

Family: Cucurbitaceae

Four common species are:

Buttercup/Hubbard squash Cucurbita maxima

Butternut squash C. Moschata

Cushaw squash C. mixta

Pumpkin C. pepo

Other names: Calabaza, Pumpkin, Marrow

Uses

Mainly used as vegetable for various cuisines, pies, and pastries; the leaves and flowers are used for salad, as well as vegetables and are found to have medicinal properties; the seeds are processed for oil and also boiled and roasted as snacks.

II. Climatic and soil requirement

The temperature ranges from 25-30°C. Squash can be planted during hot and rainy seasons. However, warm temperature and low relative humidity are more favorable for its growth and fruit setting.

Soil pH ranges from 6.0 - 6.5, well-drained with good aeration.

III. Selection of planting materials

For non-hybrid varieties, select the well-formed, healthy and matured fruit as source of seeds. Remove the seeds and clean them with warm water. Spread seeds on used newspapers to dry for about 3-5 days. Keep in clean container and place in a warm place. For other high yielding varieties, these are available in most agricultural suppliers.

IV. Planting materials requirement

Seed and seedling requirement

Vine types 2.0-5.0kg seeds/ha

Bush types 4.0-6.0kg seeds/ha

Seedling requirement per hectare depends on the distance of planting for the following varieties;

Trailing pumpkins	3,200-5,000
Bush pumpkins	7,400-16,600
Trailing squash	5,000-13,300
Bush squash	7,400-16,600

V. Land preparation

Plow and harrow the field twice before planting to properly remove the weeds and loosen the soil. Make and space the furrows according to the distance of planting to be used.

Another method is to make the holes for planting in zero tillage.

VI. Method of planting

Direct seeding

For direct seeding, place 2-3 seeds per hill/hole. One week after emergence, practice thinning by leaving one healthy plant per hill.

Transplanting

Seedlings are ready for transplanting when they have 3-4 true leaves. Seedlings should be watered thoroughly before transplanting.

Transplanting seedling into the black plastic mulch following the desired planting distance

Spacing distances

Trailing pumpkins

1-1.25m in between hills x 2-2.5m in between rows

Bush pumpkins

60-90cm in between hills x 1-1.5m in between rows

Trailing squash

50-100cm in between hills x 1.5-2.0m in between rows

Bush squash

60-90cm in between hills x 1-1.5m in between rows

VII. Fertilizer and water requirements

Incorporate compost and animal manure on the last harrowing or during the preparation of furrows. Or during transplanting, add a handful of compost into the planting hole.

Another method; as basal fertilizer, place 100g of farm manure or compost mixed with 100 grams of neem cake for each planting hole. One month after, side-dress additional compost or farm manure.

The general recommended fertilizer for squash and some other cucurbits is; 120-150 kg of nitrogen (N), 135 kg of phosphorus (P), and 135 kg of potassium (K) per ha. However, since this is a general guide, soil testing is still highly recommended.

Water is needed by the plant especially on its seedling and vegetative stages. During the flowering stage, water is lessened to avoid blossomed-end rot. Besides, at these stages, the plant is sensitive to continuously wet soil so good drainage is also essential.

VIII. Pest management

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

IX. Weed management

Preventative methods

1. Thorough land preparation
2. During the seedling preparation, make sure that the potting materials are free of weeds.
3. Keep the surroundings of your farm free of weeds, unless they are maintained and intended as habitat for natural enemies

Mechanical and physical practices

Do weeding 2-3 weeks after transplanting. The weeds are easier to control in their early growing period. If possible, do not let the weeds to flower.

Remove them from the field before they start to flower. The weed-bearing seeds that are removed should not be placed in the compost pile for the seeds may not be killed in the process of decomposition. The compost might

be the source of the reintroduction of weeds into your fields.

Mulching with dried plant straws or other plant debris, biodegradable black plastic mulch.

Planting squash into the black plastic mulch prevents weed germination in the area immediately near the crop.

The weeds can be killed through shallow cultivation, hoeing, mowing, cutting with a scythe, or hand weeding before the vines start to cover the field.

X. Harvesting

Harvesting starts 40 days after transplanting, depending on the species and varieties. Start harvesting according to the consumer and/or market demands. Harvest regularly for continuous production.

For seed purposes, harvest the fruit when the rind/peel is hard and rough.

To harvest, use a clean knife to cut the fruit from the vine.

XI. Postharvest handling

Store only matures fruits that are free of pests and diseases and wounds due to improper harvesting and handling. The rind must be hard.

Place harvested fruits under shelter or a in well-ventilated storage area.

Insects/Mites

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

Table 1. The squash growth stages and its pests

Growth stages	Insects/mites
0 Stage - Seeds	Ants Seedcorn maggot
Seedling stage - Sprouting seedling - Leaves	Seedcorn maggot Cutworm Aphids
Vegetative stage Leaves - Vines	Squash bug Spider mites Squash bug Squash vine borer
Reproductive - Flowers - Vines - Leaves	Spider mites Squash bug Squash vine borer Spider mites Squash bug
Maturation	

Ants

Damage

Ants take the sown seeds back to their colony and feed on germinating seeds and on young seedlings. These actions result in missing hills, thus loss of plant stand, uneven growth distribution in the field.

Description

Eggs are delicate, soft, white, and are laid in clusters of 75-125 eggs. The larva is grub-like, legless, very soft, and whitish in color. The pupa is whitish and develops inside the ant's nest. It has visible legs and in some cases, wings. The pupa is a transition between the larva and the adult which emerges during the final molt.

An adult ant varies in color, from blackish to reddish-brown depending on its species. It has robust mandibles with strong teeth that can inflict painful bites. It has elbowed-antennae, a thin waist, and if it is winged, the hind wings are smaller than the front wings and have few veins. Ants are also beneficial insects because they prey on termites, eggs, pupa, and caterpillars of other insect pests. Nevertheless, ants should not be introduced into gardens for insect pest control.

Control measures

Cultural practices

Increase the seeding rate and thin the plants 3 weeks after sowing. This practice turns out cheaper than with the use of insecticide.

Spray solution

Ant oil spray
Mix 2 tbsp dish washing soap, 2 tsp vegetable oil, 2 tbsp salt, and a few drops of vinegar into 4 liters of water.

Aphids



Damage

Both the nymphs and the adults pierce the plant tissues to feed on plant sap. The infected leaves become severely distorted when the saliva of aphids is injected into them. Heavily infested ones will turn yellow and eventually wilt because of excessive sap removal. The aphids' feeding on the plant causes crinkling and cupping of leaves, defoliation, and stunted growth.

Description

The eggs are very tiny, shiny black, and are found in the crevices of bud, stems, and barks of the plant.

The nymphs look like the young adults, mature within 7-10 days, and are then ready to reproduce.

The adults are small, 3-4 mm long, soft-bodied insects with two projections on the rear end and two long antennae. Their body color varies from yellow, green, brown, to purple. Females can give birth to live nymphs as well as lay eggs. However, the primary means of reproduction for most aphid species is asexual, with eggs hatching inside their bodies, and then giving birth to living young. Winged adults, black in color, are produced only when it is necessary for the colony to migrate, or there is either overcrowding in colonies, or unfavorable climatic conditions.

Control measures

Cultural practices

1. Control and kill ants. Cultivate and flood the field. This will destroy ant colonies and expose eggs and larvae to predators and sunlight. Ants use the aphids to gain access to nutrients from the plants.

2. Avoid using heavy doses of highly soluble nitrogen fertilizers. Aphids love tender, juicy leaves. Practice split application: during seedling and flowering stage.

Traps

Sticky board traps

Place 1-4 sticky cards per 300 sq m field area. Replace traps at least once a week. To make your own sticky trap, spread petroleum jelly or used motor oil on yellow plywood, 6 cm x 15 cm in size or up. Place traps near the plants but faraway enough to prevent the leaves from sticking to the board. Traps when hung should be positioned 60cm above the plants.

Yellow basin trap

Half-fill a yellow pan or basin with soapy water. Place the pan close to the plant but exposed enough so that aphids will see it.

Botanical pesticides

Ginger rhizome extract

Grind 50 g of ginger and make into paste. Mix with 3 liters of water. Strain. Add 12 ml of soap. Mix well. Ten (10) kg of ginger is needed for 1 ha.

Custard apple leaf extract

Boil 500 g of leaves in 2 liters of water until the remaining liquid is about ½ liter. Strain and dilute the filtrate with 10 -15 liters of water.

Spray solutions

Ammonia spray

Mix 1 part ammonia with 7 parts water. This spray also controls flea beetles.

Soap spray

Mix 2½ tablespoons of liquid soap to a gallon of water.)

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

1. 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.
2. 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.

Seedcorn maggot



Damage

The maggot burrows into the seeds and the seedlings, proceeds into the lateral roots, then tunnels into the taproot, and sometimes bores into the base of the stem. Damaged plants will wilt, stunt, and/or eventually die.

Description

Eggs are elongate and pearly white with a diagonal pattern. They are deposited near the seeds or seedlings, especially those grown in soil with abundant organic matter.

Larvae are small maggots, yellowish-white to dirty-yellow, and legless. They undergo three larval stages. Larval development lasts for about 12-16 days.

Pupae are tan to brown in color. They are situated near the host plant. The pupal stage is about 7-20 days.

The adult flies are grayish-brown and look like small houseflies. The female adults prefer to lay their eggs in newly harrowed fields. They can lay about 100 eggs over a 3-4 week period. Life span is about 1-2 ½ months.

Control measures

Cultural practices

1. Plow-under crop residues immediately after harvest. Plowing destroys the pest and exposes pupae to ground predators and sunlight. Maggots can survive for some time in crop residues.
2. Root flies prefer to lay eggs in the soil that is moist and with high organic matter. Do not plant susceptible crops unless the plant residues are dry and/or completely decomposed.

Physical control

Traps

Sticky board traps

Place 1-4 sticky cards per 300 sq m field area. Replace traps at least once a week. To make your own sticky trap, spread petroleum jelly or used motor oil on yellow plywood, 6 cm x 15 cm in size or up. Place traps near the plants but faraway enough to prevent the leaves from sticking to the board. Traps when hung should be positioned 60cm above the plants.

Spider mite



Damage

Generally, mites feed on the undersides of leaves. They use their sucking mouthparts to remove plant saps. The upper leaf surface has a speckled or mottled appearance while the underneath appears tan or yellow and has a crusty texture. Infested leaves may turn yellow, dry up, and drop in a few weeks. Mites produce large amounts of webbing. Heavy infestation will result in a fine cobwebby appearance on the leaves. Plants die when infestation is severe.

Description

The eggs are tiny, spherical, pale-white, and are laid on the undersides of leaves often under the webbings. Eggs hatch in 4 or 5 days.

Nymph looks similar to the adult but is only the size of an egg. It has only 6 legs. It molts 3 times before becoming an adult.

The adult is also very tiny, maybe yellowish, greenish, pinkish, or reddish depending on the species. It looks like a tiny moving dot. It has an oval body with 8 legs and with 2 red eyespots near the head of the body.

The male is smaller than the female with a more pointed abdomen. A female usually has a large, dark blotch on each side with numerous bristles covering her legs and body.

Spider mite is not an insect.

Control measures

Botanical pesticides

Coriander seed extract

Pound or crush 200 grams of coriander seeds. Boil in 1 liter of water for 10 minutes. Cool and strain. Dilute extract with 2 liters of water. This extract also prevents fungal diseases.

Basil leaf extract

Pound or grind 50 g of basil leaves. Soak it overnight in 2-3 liters of water. Add 8 - 12 ml of soap. Stir well. Spray on infected plants.



Squash bug

Damage

Both nymphs and adults feed on the sap of plants' leaves and vines. Their feeding damage causes 'Anasa wilt' on the plant. The infested plant parts turn black and become crisp and brittle.

The young plants can not tolerate the bugs' damage, and die a few days later. The older plants will have damaged vines, and bear small and malformed fruits or in severe cases, will bear no fruit at all.

Description

The egg is ovate-shaped and measures 1-1½ mm in diameter in size. It is orange-yellow when newly laid and turns yellowish-brown to bronze in color several days later. The eggs are laid in groups of 7-20, normally on the lower surface of the leaf but are also found on the upper surface, or on the petioles of the leaf. The egg development lasts for 7-9 days.

The nymph is whitish to greenish-gray with black legs. It looks like a tiny spider when newly-hatched. It has red legs and antennae, and a green abdomen. Its colors change as it develops. The nymphal stage ranges from 30-45 days.

The adult is grayish, light-brown or brownish-black in color. It has a flat back and has alternate gold and brown marks on the edges of its abdomen. It emits an unpleasant odor when crushed. It can live up to 130 days.

Control measures

Natural enemies

Parasitoids

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.

Predators include spiders, praying mantis, predatory mites and ground beetles.

Cultural practices

3. Marigold, radish, nasturtiums, mint species tansy, and catnip repel squash bugs. Plant any of these along the field's borders.
4. Practice crop rotation. Rotate cucurbits every cropping season with other crop's families to suppress the supply of their favorite plants.
5. Remove crop debris after harvesting as the squash bugs continue feeding and breeding on abandoned plantings.

Physical control

1. Prune the infested plant parts so as not to attract bacterial and/or fungal disease.
2. Make use of board traps. Place thin boards (or other forms of shelter) on soil around plants to lure the bugs to hide under them. They look for shelter and hide during the day. This is a convenient way of collecting the bugs since they always stay in a group.
3. Hand-pick and place them in a pail of soapy water to drown.

Botanical pesticides

Garlic oil spray

Chop finely 100 g of garlic. Soak the chopped garlic in mineral or vegetable oil for a day. Add 1/2 l of water and few drops of liquid soap. Stir thoroughly to blend. Dilute the filtrate with 10 l of water before spraying.

Squash vine borer



Damage

Attacked plant suddenly wilts. A larva bores into the stem, usually at the lower part, one meter from the plant's base. Damaged vine often rots and becomes wet and shiny. Heavily infested ones die depending on the number of borers and their location.

Description

Eggs are ovoid, flattened, dark-reddish-brown in color, and about 1 mm in diameter. They are laid singly in the vine near the base of the plant but can also be found on leafstalks and underneath the leaves. They hatch in 9-14 days.

The larva is a fat grub-like and whitish caterpillar that has a wrinkled body with a brown head. A fully-grown larva can measure up to 2.5 cm in length. It enters the stem a few hours after it has been hatched, stays and feeds there for 4-6 weeks. It leaves the stem when the vine wilts and/or crawls into the soil when it is ready to pupate.

The pupa is brown and 1.6 cm long, and is contained inside a cocoon that is made of earth-covered black silk. It is found usually 2.5-5 cm deep in the soil. Prior to moth emergence, the pupa moves upward to the soil surface by wiggling its abdomen. It splits behind its head and after 5 minutes, the moth frees itself. In another 15 minutes, the moths' body hardens and is ready to fly. The pupal stage lasts up to 2-3 weeks.

The adult (moth) is colorful and looks similar to a wasp. Its body is black, marked with an orange-red color and with a red abdomen. The hind legs are feathery with black and orange hairs. Its front wings are metallic-green while the hind wings are transparent. It has a wingspan of about 2.5-3.7 cm. The female can lay up to 250 eggs a day. The moths are active during daytime, this differentiates them from the other Lepidoptera, who are active at night. They are found resting on the leaves at night time.

Control measures

1. Do not leave the vines in the field once harvest is over for they may contain larvae that will pupate in the soil to complete their development.
2. Plow the soil to expose pupa to predators and to an unfavorable environment.
3. Do not plant squash, zucchini, pumpkin or any other gourd after harvesting squash. Practice crop rotation as the squash vine borer has only cucurbits as its host plants.
4. Cover vines at their leaf joints (nodes) with soil to encourage more root development and to lessen the impact of the borer's damage to the plant.

Diseases

Damping-off on seedlings

There are 3 causal agents of damping-off, namely: *Pythium* spp., *Rhizoctonia solani*, *Fusarium*

Pythium spp.

The symptoms include dark-brown to black water-soaked lesions that rapidly spread over the entire seedling causing the seedling to wilt and die.

Rhizoctonia solani

The symptoms include reddish-brown lesions on stem and death of growing tips. The lesions are also found on roots and stem near the soil line that cause the seedlings to wilt and eventually die.

Fusarium species

The symptoms include dark-brown lesions on the stem and dark-brown lesions on roots and stems at or near the crown, killing the seedlings. The root lesion is soft and water-soaked.

Conditions that favor development

1. High soil moisture and/or compaction
2. Overcrowding
3. Poor ventilation
4. Cool, damp, cloudy weather.
5. Water-splashing moves infested soil from diseased to healthy plants.

Preventive control

1. Improve the drainage and regulate soil moisture to prevent soil saturation.
2. Seed treatment.
3. Rotation to cereal crops .
4. Soil fumigation or solarization may reduce damping-off in the field.
5. Use pasteurized soil mixes in nurseries.

Downy mildew

Small yellowish spots occur on the upper surface of the leaves. In the later stage of infection, the colorations become brilliant-yellow with the internal parts of the spots turning brown. Usually, the spots are angular as they are somewhat restricted by the small leaf veins. When the leaves are wet, a downy white or gray to light-blue fungus growth can be seen on the

underside of individual spots. Downy mildew infects only the leaves on cucurbits.

Conditions that favor development

1. Cool moist and warm moist weather conditions
2. Weeds found in between the crops
3. Infected leaves that are left to rot in the field
4. Poor plant aeration

Preventive control

1. Select and use only diseased-free seeds for sowing. If possible, procure seeds that are resistant to downy mildew.
2. Transplant only healthy seedlings.
3. Proper land preparation to make sure that your soil is well drained.
4. Provide adequate plant spacing, between the rows and the hills, to reduce the density of the canopy and minimize humidity. Pruning of new growth also helps proper plant's aeration.
5. Remove infested plants and prune infested shoots. However, do these sanitation practices when the plants are not wet to prevent further spread of the disease. Properly dispose collected diseased-parts either by burning or burying them.
6. Avoid overhead watering. It lengthens the duration of leaf wetness and favors further development of the disease.
7. After harvest, plow-under all the plant debris.
8. Practice crop rotation. Make a list of the crops that are susceptible to downy mildew. Rotate these with resistant ones.

Powdery mildew



Powdery mildew is characterized by a dusty-white to gray coating and talcum powder-like growth commonly infecting plant's leaves. It begins as circular, powdery-white spots that turn yellow-brown and finally black. In most cases, the fungal growth can be partially removed by rubbing the leaves.

Powdery mildew is commonly found on the upper side of the leaf. It also infects the underneath surface of the leaf, young stem, bud, flower, and young fruit. The infected leaf becomes distorted, turns yellow with small patches of green, and falls off prematurely. Infected buds fail to open. Other injuries include stunting and distortion of leaves, buds, growing tips, and fruits. Infected seedlings will eventually die.

Conditions that favor development

1. Warm and dry climate with high humidity
2. Infected seeds and planting materials
3. Overcrowded plants

Preventive control

1. Plant resistant cultivars when available
2. Practice a wider spacing between the hills and the rows to increase air flow among plants, and light penetration
3. Practice crop rotation
4. Remove infected plant materials and alternative hosts
5. Prune overcrowded plants to increase air circulation, reduce the relative humidity, reduce infection, and increase the light penetration

6. Plow under all plant residues or remove plant residues after harvest. Do not place infected plant materials on the compost pile.

Verticillium wilt

The symptoms are stunted and wilted plants.

The initial symptom is yellowing of the leaf margins which later turn brown and cause the plant to wilt. A lengthwise cut of the infected stem shows dark-brown discoloration in the vascular tissue.

Preventive control

1. Use pasteurized soil mixes in nurseries.
2. Seed treatment
3. Soil sterilization, soil fumigation.
4. Crop rotation with non-Solanaceous crops are recommended.
5. Grafting eggplants on suitable rootstocks also minimizes the disease infestation.
6. Use of verticillium wilt resistant varieties.

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



Lacewing



Spider



Hoverfly



Ground beetle



Ladybird beetles



Tachinid flies



Rove beetles



Trichogramma



Braconid

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
Seed procurement												
Land preparation												
Seedling 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
Care of seedlings																				
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
Seedling preparation												
Early growth stage												
Vegetative												
Reproductive												
Maturation												



For more information
on non-chemical pest management see:

www.oisat.org

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