

FARMER FACTSHEET – IPM

Tomato

Crop group: Solanaceae (sweet pepper, tomato, eggplant)

Summary

The best insect pest and disease management is prevention and knowledge. Each farm will usually have only a few insect pests and diseases that regularly infest or infect each tomato crop and usually one or two regularly cause major crop loss, unless actively managed. Knowing which are the major insect pests or diseases, early signs of infestation or infection, understanding what conditions favour their growth and what their natural enemies are, lead to specific management practices that will give the best outcomes. However there are some general crop management or “cultural” practices that can be used to reduce chances of bringing pests and diseases into crops in general and once there in minimising the pest spread. Crops that have optimal (not too much or too little) nutrition and water, and growing in environmental conditions that they are suited to will grow more quickly, produce higher yields and in general be more resistant to disease infection and outgrow damage (See the Best Practice Guides for Tomato).

Site selection

Practice crop rotation and choose a site that has not recently grown tomatoes or other solanaceous crops, such as sweet peppers, chillies or eggplants to reduce soil borne diseases. To reduce movement of insect pests or diseases from the older to younger crop do not plant next to, down-wind or down-slope of an older tomato crop.

Land preparation

Waterlogging favours many soilborne diseases, stops plants growing and reduces their chance of resisting infection or infestation so good drainage is important. Raised beds, soil amendments and protected cropping can reduce chances of waterlogging. Make soil more disease suppressive by adding microbial inoculants such as EM, Vermi-compost, chicken dung and other well composted organic matter as soil amendments. Cabbage residues, wild sunflower (*Tithonia diversifolia*) and hagonoy (*Chromolaena odorata*) were proven effective in reducing soil-borne diseases, especially bacterial wilt caused by *Ralstonia solanacearum*. (Note: these plants should only be used if locally abundant. Do not plant in new areas as they are common weeds) If soil pH is acidic, lime should be applied to the soil at a rate of 250 g/m.



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Timing

Avoid planting in dry months if whitefly, aphids, thrips and mites are common pests.

Seedling production

Use certified disease-free seed and clean planting materials, particularly in bacterial wilt prone areas. Clean media for planting seeds (sterilized best), monitor seedlings, grow seedlings away from main production area and net well to prevent pest infestation. Check seedlings are pest and disease free before transplanting (see Best Practice Guide to Seedling Production).

Transplanting

Handle seedlings with care when pricking and transplanting. Extra care should be done to minimise root wounding. Fungicide drenching may be applied to newly transplanted seedlings to protect them from soil-borne fungi. Alternatively, 200 ppm chitosan solution can be applied to the seedlings by root drenching during transplanting.

Vegetative

Monitor plants, especially for fruitworm or cutworm eggs and newly hatched larvae. Check undersides of leaves as most insect pests will be found there, especially next to leaf veins. Where possible squash eggs, aphids and newly hatched cutworm or fruitworm larva. Not all insects or mites that are seen in crops are causing economic losses. Many are 'natural enemies' or 'beneficials' and need to be maintained to assist in managing pest insect populations. Learn to recognise the common natural enemies. Monitor pest and natural enemy populations 1–2 times per week and record numbers per plant to track whether populations are increasing or decreasing. If pest populations are increasing and natural enemies absent, or in very low numbers, an insecticide spray may be needed. Where possible choose insecticides that are specific to the pest group and least toxic to natural enemies and humans. Always read the label and use appropriate personal protection when spraying.

Monitor the plants for disease symptoms, such as wilting, stunting, leaf spots, leaf and shoot blights. Rogue infected plants showing systemic symptoms and carefully prune away infected parts for localized diseases. If pruning needs to be done, sanitary pruning should be done, i.e. disinfect pruning tools after use on every plant. Bacterial wilt and blight can be transmitted via pruning tools. Preferably carry a container for

pruned plant materials (e.g. a plastic bag) when pruning and immediately place the pruned diseased plant parts inside the bag to minimise dispersal of inoculum to healthy plants. Control weeds to minimize alternate reservoir of plant pathogens or vectors of plant diseases.

Regulate moisture. Do not over-irrigate the plots, since a film of moisture in the soil is favourable to bacterial wilt dissemination to other plants. Drain the field quickly after rain by providing drainage canals, especially in open field cultivation. Isolate diseased spots. Prevent water flow in or out of the section and limit the traffic of people and machinery in the infested area. Disease spots can be biofumigated with cabbage residues, *C. odorata* or wild sunflower. More frequent irrigation for a shorter time is less favourable for disease.

Avoid excessive nitrogen fertilization, especially with ammonium forms of fertilizer since they will make plants susceptible to most pests and diseases. Fungicides can be applied to control fungal diseases. Copper-based fungicides can also be applied to protect plants against bacterial leaf spots and blights. Resistance boosters such as chitosan, benzothiadiazole and phosphonates, may also be sprayed to plants if available.

Flowering/Fruit set

Set up fruitfly traps (sticky or baited pheromone) at early flowering. Monitor closely for fruitworm or cutworm eggs and small larvae as they will burrow into fruit soon after hatching. During early flowering monitor for mirid bugs. Control these to prevent premature flower drop. If pest populations are increasing and few natural enemies are present an insecticide spray may need to be applied.

Monitor the plants for the presence of leaf spots and blights because they may also affect the incoming fruit. Monitor also for early fruit drop. If this happens, try to check soil nutrients and inspect the early fruit for possible infections.

Minimize bacterial fruit spots and canker, avoid overhead irrigation and water splashes. Protected cultivation is recommended if feasible. Protectant fungicides may be applied to the fruit and the whole plant at fruit setting to prevent infection by fungal and bacterial diseases that may affect the fruit. Water splashes are major source of fruit infections. This can be minimized by applying mulch on beds around plants, don't put mulch too close to stems as slugs and snails may colonise and damage the stems.

Fruit development

Collect any infested (fruitworm, cutworm or fruit fly) or disease infected fruit and properly dispose of it to ensure no pests can continue to develop or diseases spread.

Continue to monitor the plants for leaf spots and blights because they may also affect the fruit. Monitor for fruit spots, blotch, deformed fruit, fruit rot and blossom end rot. If blossom end rot is present in some fruit, this is a symptom of calcium deficiency usually caused by over or under irrigation. Adjusting irrigation and adding some calcium can help.

Do not apply fungicides when the fruit are about to be harvested. Trellis the plants so that fruit will not get in contact with the soil.

Harvesting

Collect any infested fruit and properly dispose of it to ensure no pests can continue to develop. Do not harvest during rainy days and when conditions are wet. It is important for the fruit to be dry during harvest. Do not let the fruit come in contact with the soil. When it cannot be avoided that the fruit gets wet during harvest, dry it before packing into containers, transporting or storing.

Postharvest

The crop should be removed and ground ploughed as soon as possible after harvest has finished to prevent pest populations continuing.

The tables below provide information on some of the common major diseases or pests that can be found in tomatoes. Refer to the individual disease or pest factsheets for more detailed information.

Proper identification of the problem is a pre-requisite for effective pest and disease management.

Table 1. Major diseases of tomato



Image	Disease name	Damage symptoms	Management strategies
BACTERIAL DISEASES			
	Bacterial canker <i>(Clavibacter michiganensis subsp. michiganensis)</i>	Scorched or “firing” spots/ markings on leaflets and wilting of lower leaves. Infection may advance to vascular system resulting to plant collapse. Brown raised cankers may develop on stem and fruit and later become depressed. May have pale halos around resulting to symptoms called “bird’s eye spots”. Spread with infected seed and contaminated water and soil.	Use clean certified seeds. Practice sanitation in the nursery and farm. Rapidly eliminate plants or prune plant parts that show initial symptoms of the disease. Disinfect hands after handling infected plants. Avoid overhead irrigation. Avoid rain and water splash. Mulching may help or grow plants under protective cultivation.
	Tomato pith necrosis <i>(Pseudomonas spp.)</i>	Small pinpoint water-soaked spots appear on the stems that enlarge. Stem becomes hollow with a rot in the center. Stems sometimes crack. Spread in water and by handling plant. Bacteria enter through wounds. Disease is favoured by too much nitrogen fertiliser.	Use clean certified seeds and healthy seedlings. Practice sanitation in the nursery and farm. Do not apply excessive amounts of nitrogenous fertilizers. Eliminate weeds. Rotate with non-host crops. Copper




Image	Disease name	Damage symptoms	Management strategies
	<p>Bacterial wilt (<i>Ralstonia solanacearum</i> and <i>R. pseudosolanacearum</i>)</p>	<p>Plants wilt rapidly. Roots form on stems (adventitious roots). Internal stem turns brown. Spread in contaminated water and soil.</p>	<p>Rotate with non-solanaceous plants. Raise healthy seedlings. Graft on to resistant rootstocks. Practice hygiene in the preparation and handling of seedlings, during transplanting and crop maintenance. Avoid excessive irrigation; provide good drainage to minimize water run off during heavy rains. Plant in raised beds and mound plants. Avoid root injuries during cultivation.</p>
	<p>Bacterial spot (<i>Xanthomonas axonopodis</i>)</p>	<p>Dark angular spots on leaves and fruit. Sometimes they have a yellow halo. Severe infections cause premature yellowing and early senescence of plants. Spread with infected seed and contaminated water and soil.</p>	<p>The bacterium is seed-borne, so use certified disease-free seed and clean planting materials. Use new or bleach-sanitized trays in seeding production. Practice sanitation to minimize the risk of pathogen introduction. Avoid overhead irrigation and moving through the garden or field when the plant foliage is wet. Rotate tomato crops with non-host. Plant tomatoes under protective structures, if possible. Properly destroy crop residue. Copper</p>
FUNGAL and FUNGAL-LIKE DISEASES			
	<p>Damping off (various <i>Fusarium</i>, <i>Pythium</i>, <i>Phytophthora</i> . and <i>Rhizoctonia</i> spp.)</p>	<p>Patches of young plants wilt and die. Lower stems become thin and watery. Root systems turn brown and rot. Spread in contaminated water and soil, and by some flies.</p>	<p>Use clean or treated soil/media for seedlings. Remove infected plants and destroy. Fungicides</p>




Image	Disease name	Damage symptoms	Management strategies
	<p>Late blight (<i>Phytophthora infestans</i>)</p>	<p>Dark brown lesions rapidly develop on stems and fruit, causing plant to wilt and die.</p> <p>Greasy brown lesions and rotting of fruit.</p> <p>White mycelia may cover dark lesions during humid weather.</p> <p>Progresses rapidly in moist conditions.</p> <p>Spread by air-borne and water-borne spores.</p>	<p>Practice good crop sanitation.</p> <p>Avoid planting tomatoes during prolonged wet and cool weather.</p> <p>Carefully remove infected plants and plant parts from the garden to minimize source of inocula.</p> <p>Destroy infected plants immediately by burying.</p> <p>Keep stem and branches off the ground.</p> <p>Water plants early in the day, rather than late in the day.</p> <p>Plant tomatoes under protective structures if possible.</p> <p>Fungicides</p>
	<p>Fusarium wilt (<i>Fusarium oxysporum</i> f.sp. <i>lycopersici</i>)</p>	<p>Older leaves turn yellow then dry out.</p> <p>Plants wilt and die.</p> <p>When cut open vascular tissue inside stems is brown. This may extend up to the flower stalks.</p> <p>Spread by spores that survive for years in contaminated soil.</p>	<p>Use clean certified seeds.</p> <p>Practice sanitation in the nursery and farm.</p> <p>Ensure all equipment is free of soil before being brought to a farm or transferred from farm to farm.</p> <p>Apply soil conditioners such as <i>Trichoderma harzianum</i> and sunflower.</p> <p>Avoid planting in infested areas</p> <p>Practice crop rotation.</p> <p>Rapidly eliminate plants that show initial symptoms of the disease and quarantine the area where it is found.</p> <p>Disinfect hands after handling infected plants.</p> <p>Use resistant varieties.</p>
	<p>Sclerotium rot (<i>Sclerotium rolfsii</i>)</p>	<p>Stunted plants will wilt and die.</p> <p>Dense white threads of fungal growth develop around the rotting stem base.</p> <p>Smooth white-brown spherical structures (~1–3 mm in diameter) develop in this fungal growth.</p>	<p>Practice sanitation in the nursery and farm.</p> <p>Ensure all equipment is free of soil before being brought to a farm or transferred from farm to farm.</p> <p>Rapidly eliminate plants that show initial symptoms of the disease and quarantine the area where it is found.</p> <p>Disinfect hands after handling infected plants.</p>




Image	Disease name	Damage symptoms	Management strategies
	<p>Leaf mould (<i>Mycovellosiella fulva</i> or <i>Pseudocercospora fuligena</i>)</p>	<p>Early symptoms are light yellowish/brownish leaf spots or moldy lesions on the upper part of the leaf surface of older leaves and usually greyish to blackish mouldy growth on the underside of the surface of the leaves.</p> <p>The infected leaves wither fast, which may cause death of the entire plant.</p> <p>Disease develops later in the season.</p> <p>Spread by air-borne spores.</p>	<p>Use clean seeds and practice sanitation in the nursery and field.</p> <p>Good ventilation in greenhouse –grown tomatoes helps.</p> <p>Provide adequate plant spacing to avoid excessive shading and exercise pruning to encourage air circulation.</p> <p>Avoid splashing the leaves when watering.</p> <p>Do not apply excessive amounts of nitrogenous fertilizers.</p> <p>Biological fungicide</p>
	<p>Septoria spot (<i>Septoria lycopersici</i>)</p>	<p>Small dark circular spots (~1–3 mm) appear on older leaves and stems. These enlarge to 6 mm, turn greyish with dark fungal structures in their centre.</p> <p>Spread with seed and by air and water-borne spores.</p>	<p>Use clean seeds and practice sanitation in the nursery and field.</p> <p>Improve air circulation by proper plant spacing, staking and pruning.</p> <p>Avoid overhead watering.</p> <p>As soon as the first symptom appears, the infected part should be removed and put inside plastic bags to avoid spreading the fungal propagules.</p> <p>Fungicides</p>
	<p>Powdery Mildew (<i>Oidium neolycopersici</i>)</p>	<p>Pale spots first appear on the upper leaf surface.</p> <p>White powdery fungal growth develops on both sides of leaves.</p> <p>Leaves gradually turn yellow, die, and fall off, which can expose fruit to sunburn.</p> <p>Spread by air-borne spores.</p>	<p>Use clean seeds and practice sanitation in the nursery and field.</p> <p>Improve air circulation by proper plant spacing, staking and pruning.</p> <p>Avoid overhead watering.</p> <p>As soon as the first symptom appears, the infected part should be removed and put inside plastic bags to avoid spreading the fungal propagules.</p> <p>Good ventilation in greenhouse –grown tomatoes helps.</p> <p>After harvest, all plant debris should be removed and the field thoroughly cleaned up.</p> <p>Bicarbonates or biological fungicides</p>

Image	Disease name	Damage symptoms	Management strategies
	<p>Target leaf spot (<i>Corynespora cassiicola</i>)</p>	<p>Dark leaf spots with concentric rings looking similar to Target spot (below). May join together forming blighted leaves leading to premature defoliation.</p> <p>Stems and fruit can also be infected.</p> <p>In the earlier stages, may be confused with bacterial spot.</p> <p>Brown lesions may form on stems.</p> <p>In fruit, lesions can also be mistaken as bacterial spot. They are small, light brown freckles with dark margin.</p> <p>Spread by air-borne spores.</p>	<p>Use healthy seedlings.</p> <p>Practice sanitation in the nursery and farm.</p> <p>Eliminate weeds.</p> <p>Rotate with non-host crops.</p>
	<p>Target spot, early blight (<i>Alternaria tomatophila</i>)</p>	<p>Target-like spots on leaves and fruit.</p> <p>Early blight occurs when leaves and stems of young plants are covered in dark lesions. These plants may die.</p> <p>Spread by air-borne spores in hot wet weather.</p> <p>Favoured when plants are low in nitrogen.</p> <p>Not normally serious.</p>	<p>Field sanitation.</p> <p>Ensure plant nitrogen levels are optimal.</p> <p>Crop rotations.</p> <p>Reduce planting density to increase airflow between plants. Do not prune in wet season when disease is present</p> <p>Fungicides</p>
	<p>Anthracnose (<i>Colletotrichum coccodes</i>)</p>	<p>Older leaves turn yellow, then dry out.</p> <p>Plants wilt and die.</p> <p>When cut open vascular tissue inside stems is brown. This may extend up to the flower stalks.</p> <p>Spread by spores that survive for years in contaminated soil.</p>	<p>Use clean seeds.</p> <p>Crop rotation.</p> <p>Stake to allow air circulation and drying.</p> <p>Do not use overhead irrigation.</p> <p>Fruit should not come in contact with the soil and other infected fruit.</p> <p>Remove and properly dispose of infested plant/parts.</p> <p>Keep the fruit cool and dry after picking to reduce fungal growth.</p> <p>Fungicides</p>





Image	Disease name	Damage symptoms	Management strategies
VIRAL DISEASES			
	<i>Cucumber mosaic virus</i> CMV	Plants are stunted with distorted and twisted young growth. Leaves have pale green and dark green areas. Leaves can have 'shoestring' appearance.	Spread with infected seed and by aphids. There is no cure to viral infections. Remove infected plants Control aphids (see below).
	<i>Tomato yellow leaf curl virus</i> TYLCV	Plants stunted. Young leaves yellow and curl. Spread by whitefly (<i>Bemisia tabaci</i>).	There is no cure to viral infections. Use TYLCV resistant varieties Remove infected plants. Control whiteflies (see below).
	<i>Tobacco mosaic virus</i> <i>Tomato mosaic virus</i> TMV	Leaves have patches of yellow or white marks. Growth can become twisted and young shoots stunted. Some virus strains cause dark marks to form inside the walls of fruit. Spread by handling plants and in contaminated soil where susceptible plants were previously grown.	There is no cure to viral infections. Remove infected plants. Wash hands and equipment that have been in contact with infected plants.
	Root knot nematode (<i>Meloidogyne incognita</i> and other <i>Meloidogyne</i> species)	Plants are stunted and may wilt during the day. Galls form on roots.	

Table 2. Major pests of tomato









Image	Pest name	Damage symptoms	Management strategies
	Thrips (<i>Thrips tabaci</i> , <i>Frankliniella occidentalis</i>)	Can vector Tospoviruses such as TSWV. Feed on underside of the leaves and in flowers. Cause burning/drying of leaves at high populations. Cause scarring on the fruit. High populations during dry months.	Yellow sticky traps for monitoring. Light coloured bed mulch. Biologicals Pesticides
	Mirid bug (<i>Nisiodiocoris tenius</i>)	Damage stems by inserting their piercing mouthparts into the plants, particularly in vegetative stage. Girdles around the stem and peduncle and causes drying of stem and flowers to drop off.	Pesticides
	Whiteflies (<i>Bemisia tabaci</i>)	Adults suck sap, causing yellowing, mottling of leaves. Most important vector of TYLCV (Kulot).	Yellow sticky traps (for monitoring and control). Intercrop using non-hosts crops. Remove weeds. Removal and destruction of infested crops. Plant tolerant varieties. Pressurized water/soap solution spray. Biologicals Pesticides Spray oils
	Cutworm (<i>Spodoptera litura</i>)	Early instar larvae feed close together causing windowing. Larger larvae separate and chew larger ragged holes in leaves. Chew holes in fruit, depositing frass causing fruit rots.	Hand pick egg mass and larvae. Remove and dispose well infested plant/parts. Plant trap crops such as castor plant. Plough soil to minimise pupae survival between crops. Biologicals Botanicals Pesticides
	Fruitworm (<i>Heliothis – Heliocoverpa armigera</i>)	Chew leaves, stem, flowers. Bore and feed inside fruit, deposits frass causing fruit rots.	Handpick larvae and infested fruit. Plough soil to minimise pupae survival between crops. Biologicals Botanicals Pesticides

Image	Pest name	Damage symptoms	Management strategies
	Fruit fly (<i>Bactrocera cucurbitae</i>)	Flies lay eggs in developing fruit, causing tissue death around puncture marks. Larvae (maggots) feed inside fruit causing fruit rots.	Remove and destroy infested fruit. Use pheromone fruit fly traps for monitoring. Will lead to some control if used area-wide. Fermented solution (ex. vinegar + molasses/ sugar) Biologicals Pesticides Pesticides
	Leafminer (<i>Liriomyza</i> spp.)	Eggs laid by flies within leaf tissue, white/silver trails seen where larvae tunnel inside leaf. Particularly serious in seedlings. Damage serves as entry points for bacterial and fungal infection. Only serious in seedlings	Use yellow sticky traps to reduce adult populations. Prune and bury/burn infested leaves if miners still present. Remove host weeds. Destroy crop residues. Lemon grass extract as adult repellent Biologicals Pesticides
	Leaf-eating lady beetle (<i>Epilachna</i> spp.)	Chew holes in leaves leaving skeleton/windowpane. Remove egg clusters, alternate weed hosts, and crop debris.	Biologicals Pesticides

Refer to the Pesticide table for further information.

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For more information, see individual factsheets and crop best practice guides also produced from this project.
Other information available from www.plantwise.org.

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