COMPREHENSIVE TOMATO FARMING GUIDE

Introduction

In the recent past demand for tomatoes in the region has increased tremendously. This demand can only be met by increasing production area and yield. Better production methods, high-yielding and disease-resistant varieties will play a key role keeping up with the market demand.

Growing requirements

Tomatoes thrive in well-drained, deep, uniform clay or silty loams. They are very sensitive to water logged soils and prefer a soil pH of between 6.0 -7.5. They do best in temperatures of between 20°C – 27°C. Tomato production can be adversely affected when the temperatures get below 10°C or exceed 30°C, as fruit setting is affected. When choosing the field ensure tomatoes or a related crop (Solanaceous family) has not been planted in the field for at least 2 years to avoid high diseases presence in the soil.

Choosing a variety

The various tomato varieties that are available possess different benefits which include high yields, resistance to diseases and long shelf-life. It is up to growers to choose those that will meet needs and are also suited to climate where they are to be grown. No single variety will combine all the best features.

Common Tomato varieties in Kenya

VARIETY	COMPANY	OPENDOOR/GREENHOUSE
Assila F1	Monsanto	Hybrid Opendoor
Eden F1	Monsanto	Hybrid Opendoor
Milele F1	Freshco	Hybrid Opendoor
Africa Revolution F1	George Holland	Hybrid Opendoor
Rambo F1	Royal seeds	Hybrid Opendoor
Kilele F1	Syngenta	Hybrid Opendoor
Shanty Improved	Amiran	Hybrid Opendoor
Star 9065	Stark Ayres	Hybrid Opendoor
Commando F1	Continental seeds	Hybrid Opendoor
Eva F1	Amiran	Greenhouse
Steve F1	Continental seeds	Greenhouse
Tylka F1	Syngenta	Greenhouse
Anna F1	Monsanto	Greenhouse
Corazon F1	Amiran	Greenhouse
Bravo F1	Royal seeds	Greenhouse
Chonto F1	Royal seeds	Greenhouse
Prostar F1	Simlaw seeds	Greenhouse

Consider the following when choosing a variety

Resistance to Diseases: Farmers need to select varieties that are resistant to diseases. Varieties that are resistant to Verticillium wilt (Vd), Fusarium wilt (Fol), Fusarium Crown and Root Rot (Fol) Nematodes (N), Alternaria solani (As) and Tomato Yellow Leaf Curl Virus (TYLCV)

Shelf life: The variety must guarantee that the fruit will remain fresh through the chain and especially during transportation.

Hybrids: Compared to open pollinated varieties (OPVs), hybrids produce higher yields, uniform fruits and possess other preferred quality attributes such as disease resistance and pest tolerance. It is better for the farmer to spend a little more money for Hybrid (F1) seeds but be assured of optimal production.

Nursery Establishment

Because of the small nature of tomato seeds, the seedlings are first raised in the nursery then transplanted into the main field. Though some farmers carry out direct planting, it is usually difficult to maintain planting depth as well as moisture levels, leading to poor germination. In the nurseries proper care of the seedling is made possible avoiding the harsh environmental conditions that the seedlings might face if directly seeded. Seed beds also help the farmer ensure that only healthy and strong seedlings are transplanted; translating to better and uniform plants and high production. Another plus for nursery beds is that less seeds are used -80-100gms/acre for the Nursery, compared to 250-500gms/acre for direct seeding.

***Location*:** The nursery should be located in a flat area that is secure and accessible, to allow close monitoring. It should be established near a source of clean usable water and on well-drained soils. The area should be exposed to the sun, well-aerated, protected from strong winds and strategically located to avoid exposure to pests.

Sowing lines*:* Seeds should be sown at a 1cm depth marked with a finger, with 10-15 cm spacing between the sowing lines. Keep the nursery well irrigated and free of weeds; loosen soil to allow water percolation.

Transplanting

Proper field preparation is essential for optimum performance. Recommended spacing for transplanting is 60cm by 60cm. The seedlings are hardened before transplanting by reducing water application and directly exposing them to sunlight 6-9 days before transplanting. This is done to prepare them for the harsh environment they will face in the main field. A good seedling that is ready for transplanting is usually in its fourth or sixth leaf stage (about 4 weeks old) and is vigorous and stocky. Thoroughly water the seedlings about 12 hours before transplanting to the field. Transplanting late in the evening is recommended to allow the seedling longer cooler hours to increase chances of survival.

Irrigation

Tomatoes must be regularly watered especially during critical periods like flower-setting and growth of the fruits. Watering should be reduced towards the end of a crop. Excess moisture on the leaves can lead to diseases especially early blight.

Weed management

Depending on the type of weeds and growth stage of both the weeds and the crop, appropriate control measures can be adopted. Manual weeding can be done on small fields but use of herbicides can be considered in extensive farming.

Plant Nutrition

To optimize performance, soil nutrition amendment is necessary. It is a requirement that farmers do a soil analysis which will serve as a base for coming up with a fertilizer program. Apply farmyard manure at a rate of 8 tonnes per acre during land preparation to improve soil structure.

A guideline to fertilizer application will include:

• Basal application of Phosphorus during the early stages for root and shoot development. This can be applied before transplanting.

• Top dressing with Nitrogen based fertilizers such as Urea and CAN for vegetative growth.

• During flowering and fruit formation use of compound fertilizers (NPK) is recommended. Plants require the three primary nutrients; Nitrogen, Phosphorous and Potassium at various levels; fertilizer with high K (Potassium) in formulation will give best results.

• Weekly application of foliar feeds (can be mixed with pesticide sprays) can also foster better plant development.

• Magnesium and Calcium fertilizers can be applied to ensure better fruit development but also when symptoms of blossom end rot manifest.

Staking and pruning

This is done to reduce excess canopy as well as to get rid of old leaves which contribute to high moisture accumulation leading to increased disease incidences. This can be done using sticks and strings to give the plant an upright growth.

Advantages of staking

Increase in the percentage of marketable fruit, easier harvesting and reduced injury to both plants and fruit in harvesting. A farmer may opt not to stake but it's highly recommended

Management of pest and diseases

Major tomato pests include white flies, aphids, thrips, and bollworm. Whiteflies are known to transmit Tomato Yellow Leaf Curl Virus(TYLCV). While major tomato diseases comprise the blights, wilts and rots. Pest and diseases remain the greatest challenge in Tomato production.

The general principles in pest and disease management include:

Disease prevention

Preventing problems is usually easier than curing them. So, here are ten strategies to help prevent diseases and other problems:

1. Although many heirloom varieties have better flavor than newer varieties, they lack disease resistance. Purchasing disease resistant cultivars can help, but keep in mind that disease resistance does not mean immunity. Preventive strategies are still important.

2. Disinfect tools, tomato cages and stakes with a solution of one part bleach to nine parts water.

3. Rotate the planting location every three to five years.

4. Do not plant in cold soils. This weakens plants making them more susceptible to diseases and may stunt them permanently.

5. Do not crowd tomatoes. Good air circulation around plants is vital in keeping the foliage dry and preventing diseases.

6. Remove lower branches, leaving the stem bare up to the first set of flowers and then mulch (straw is a good choice). Many fungal diseases are in the soil or in bits of plant material left over from previous years. When it rains, fungal spores splash up onto the lower leaves, infecting them. The next time it rains, the spores from the infected leaves splash up onto the next set leaves. Unchecked the infection will spread all the way to the top of the plant.

7. Water in the morning to give the foliage time to dry out before nightfall.

8. Remove any diseased looking leaves as soon as possible.

9. If a spray program becomes necessary, use a fungicide (such as, chlorothalonil) alternated with a copper based fungicide to help with bacterial diseases because even an expert can have difficulty distinguishing between fungal diseases and bacterial diseases.

10. At the end of every growing season, remove as much of the plant as possible from the garden and do not compost.

DISEASES

Late blight

Late blight is a very destructive and very infectious disease that affects tomato and potato (not sweet potato). It is the same disease that led to the Irish Potato Famine in the 1840s. It is caused by the fungal-like pathogen, *Phytophthora infestans*. It is prevalent during the rainy season and when there is excess moisture or humidity

What are its symptoms?

Lesions develop on leaves and stems as dark, water-soaked spots. These spots enlarge until the entire leaf or stem turns brown and dies. Dead leaves typically remain attached to stems. The undersides of the lesions may be covered with a white fuzzy growth that contains the spores of the pathogen. On the stems, late blight lesions appear brown to almost black. Infected tomato fruits develop shiny,

dark or olive-colored lesions which may cover large areas and in particular the upper half of the fruit.

How is it different from other diseases with almost similar symptoms?

When diagnosing for late blight examine all parts of the affected plants thoroughly. The late blight pathogen produces most of its spores at night and as a result it is more visible in the morning and these calls for scouting early in the day for the disease. Generally Late blight can affect all parts of the plant whereas some of the 'imitators' cannot. Below are some of the diseases that portray symptoms most similar to LB and how they differ from the latter:

1. Gray mold - This is the disease most commonly confused for late blight because the pathogen causes large leaf spots, stem lesions, and affects fruits. These symptoms are often associated with dead plant tissue (flowers, leaves). The pathogen typically needs to become established on these dead tissues before it can attack living plant tissue. Affected fruit are soft and are not brown. The pathogen growth is fuzzier and gray to brownish, not white as with late blight.

2. Early Blight - Leaf, stem and fruit spots are all smaller than those for late blight and often have a characteristic concentric ring pattern or target-shape appearance.

3. Septoria Leaf Spot - Leaf and stem spots are all much smaller in comparison to those for late blight and often have a characteristic tan center. Fruits are not affected.

4. Buckeye Fruit Rot - Fruit turns brown with white spores forming when moist. Unlike late blight, buckeye fruit rot is most likely on fruit on or near the soil where the pathogen can survive between crops, the fruit stays firm and smooth (not rough) and leaves and stems are not affected. Causal pathogens are closely related to late blight, but don't travel far or fast because their spores move by splashing water and soil, rather than air.

5. Drought Stress - When plants' roots cannot deliver enough water to leaves, large sections of leaf tissue can die. In contrast with late blight lesions, symptoms of drought stress always extend from the leaf edge, they lack a border of wilted tissue, and there is no fuzzy pathogen growth. Also, no symptoms develop on stems or fruit.

What can you do about it?

• Start with disease-free tomato seedlings.

• Scout daily in the morning hours for any symptoms on the crop.

• Rotate tomato fields with non-solanaceous crops. Crop rotation is for the early blight and Septoria leaf spot diseases which are an annual problem, not late blight. The late blight organism requires living tissue to survive; it does not survive in the soil or carry in tomato seed.

• Control tomato volunteer plants as well as solanaceous weeds such as hairy nightshade.

• When late blight is found in small, localized areas, promptly destroy all symptomatic plants plus a border of healthy appearing plants to prevent disease spread.

• Apply late blight specific fungicides in affected fields and nearby fields on a regular basis until tomato harvest is complete. Shorten spray interval when disease pressure is high or environmental conditions remain favourable for the late blight pathogen (cool and wet).

• Alternate fungicide applications among different chemical classes; include a contact (protectant) fungicide in each application (chlorothalonil, mancozeb, or copper). Addition of a protectant fungicide enhances resistance management and fungicide effectiveness; e.g. copper oxychloride, Mancozeb+cymoxanil or propineb+cymoxanil or Metalaxyl+Mancozeb

• Good fungicide coverage is necessary.

• Work in affected field last and clean equipment between fields.

• Disk under the field or kill with herbicide after harvest is complete.

Tomato yellow leaf curl

Tomato yellow leaf curl virus (TYLCV) is a viral disease transmitted by whiteflies; it is one of the most damaging diseases in tomatoes. TYLCV is the most significant tomato virus in areas where whitefly is a big problem. The disease incidence is higher particularly when temperatures are high. Locally, it is known as: *Gathuri* or *ngumi*

Symptoms

• Plants are severely stunted with shoots becoming erect

Leaf symptoms include;

• Small leaves which are cupped, thick and rubbery. Tops of infected plants may look like a head of broccoli.

• Leaflets are reduced in size and puckered

• Leaflets that develop soon after infection curl downwards at the margins; leaves produced later curl upwards, become distorted, and have prominent yellowing along margins and/or intervenal regions

• Flowers wither

• Plants will set very few fruit after infection occurs; when older tomato plants are infected, they produce abnormal growth above the point of infection. Any fruit already on the plant ripens almost normally, but flowers often drop or fail to set fruit. The appearance of the fruit is unaffected

Conditions for Disease Development

• The virus is not seed-borne. It is only transmitted by the whitefly, *Bemisia tabaci*

• The whitefly vector has a very wide host range but it usually does not cause symptoms in these hosts. Most solanaceous plants such as tomato, eggplant, potato, tobacco, and pepper can be infected with TYLCV but remain healthy in appearance. Common bean is also a host and will sometimes display leaf curl symptoms when infected. Many common weeds are also host to the virus and may or may not develop symptoms when infected.

• Hot and dry conditions favor the whitefly, and therefore aid the spread of TYLCV. Whitefly populations decrease after heavy rain showers.

Management

1. Use resistant varieties: Hybrid Tomato Assila from Monsanto is resistant to Tomato Yellow Leaf Curl Virus (TYLCV)

2. Under stress, however, these resistant varieties can lose their protection and develop symptoms of tomato yellow leaf curl. As such, it is important to keep plants healthy by proper irrigation and fertilizer regimes and to keep them free of other pests and diseases.

3. Grow seedlings in an insect-proof net house or in a greenhouse, and maintain good control of whiteflies in these structures in order to prevent early infection of seedlings by whitefly feeding. If non insect-proof nets are used in seedling nurseries, then they should be sprayed with insecticides to control entry of whitefly into the structures.

4. The whitefly vector favors younger plants. To reduce this effect, tomato plants should be about 30 days old at the time of transplanting.

5. Timing of transplanting can also be effective in avoiding high populations of whitefly and therefore reducing or high populations of whitefly and therefore reducing or preventing TYLCV infection. Separate plantings of tomatoes in time and space from plantings of crop hosts which are good sources of whiteflies (i.e. cabbage, cucurbits, potato)

6. Avoid overlapping tomato crops that allow the vector to subsist and develop new populations. Pulling out volunteer tomato and tobacco plants and weed control are also important in reducing sources of virus inoculums.

7. Plant new tomato crops in isolated fields. If possible, plant a tall border crop, such as maize, around the tomato crop.

8. Chemical control methods include the application of systemic insecticides as soil drenches or regular sprays during the seedling stage to reduce the population of the whitefly vector. A second application may be necessary to control adults that have emerged from the egg and nymph stage since the application of the first spray. Rotation of insecticides may be necessary to prevent the development of resistance in the vector. However, chemical control may not be effective in areas where disease incidence is high

9. Symptomatic plants should immediately be carefully removed, bagged, and discarded to prevent the spread of whiteflies on them that may be carrying the virus. Cover plant in plastic bag and tie at the stem at soil line. Cut off the plant below the bag and allow bag with plant and whiteflies to desiccate to death on the soil surface for 1-2 days prior to placing the plant in the trash. Do not cut the plant off or pull it out of the garden and toss it on the compost! The goal is to remove the plant reservoir of virus from the garden and to trap the existing virus-bearing whiteflies so they do not disperse onto other tomatoes.

Buckeye fruit & root rot

Symptoms *On fruit:*

Brown spots appear on green and ripe fruit, often at the blossom end. The spots have bands of dark and light brown rings. A white cottony fungal growth appears under moist conditions. Young green

fruit, when infected, usually become mummified. Fruit touching or near the soil are most likely to become infected

On Root:

Phytophthora can cause a root and crown rot of tomato plants at all ages. Damping-off symptoms occur on seedlings while infections of the roots and crowns of young plants cause rapid wilt. On established plants, brown water-soaked lesions appear on roots, extending into the lower part of the stem. Severely affected roots become necrotic and decayed. The leaves become bronze and later dieback from the tip.

On Stem

The canker that develops is pale green to brown and may extend more than 15 cm. The canker girdles the stem and causes wilting and death

Doses:

1. **Thiophanate methyl**
2. **Carbendazim**

Alternaria stem canker

It appears on stems, leaves, and fruit .Dark brown to black cankers with concentric zonation occur on stems near the soil line or above ground. Canker enlarge girdle the stem, and kills the plant. Dark brown to black areas of dead tissues between leaf veins are caused by a toxin produced by the fungus. Dark brown sunken lesions with characteristic concentric rings develop on green fruit

Doses:

1. **Copper fungicides**
2. **Carbendazim**

Gray mold

Foliage of plants from seedlings to mature plant stage is affected. Brown to black specks appear on both the young and older leaves. The lesions expand slowly into 1- to 2-mm-diameter round spots that remain brown or develop a gray center surrounded by a yellow area.

Early blight (Alternaria solani)

In tomatoes, it causes stem cankers on seedlings and small irregular dark brown spots on the older leaves leading in partial defoliation of the crop. The fungus survives on the crop debris. Infections begin as small brown spots on older leaves that quickly enlarge. The lesions develop a "bulls-eye" pattern of concentric rings that can be seen

.**Fusarium &verticillum wilt**

Both of these fungal diseases are soil-born. Fusarium often causes yellowing on one side of the plant or leaf. Yellowing begins with the older, bottom leaves, followed by wilting, browning, and defoliation. Growth is typically stunted, and little or no fruit develops. Brown, vascular tissue can be found when the infected stem is cut at its base. Infected plants often die before maturing.

Verticillium is less common, usually occurring late in the season when soils are cooler. It begins as a v-shaped blotch on lower leaves, followed by browning veins and dead, chocolate brown blotches. It spreads up the plant. Discoloration of the vascular tissue is limited to the bottom 12 inches of the stem. Look for tomatoes with the resistance letters VF on the plant tag or seed packet, indicating resistance to both verticillium and fusarium wilt.

Lookalikes: all the leaf spot diseases and "bottom-up" diseases

Bacterial cankers (Clavibacter michiganensis)

The symptoms of bacterial canker are brown leaf margins with a yellow border next to the inner green leaf tissue, spreading between the veins (top image). It often affects only one side of a plant. As plants wilt, yellowing leaves usually remain attached to the plant. Unlike the leaves, the petioles remain green. The vascular system shows a yellowish brown discoloration (bottom image). This is a serious infectious disease with no cure and no resistant varieties available. It will kill the plant and is highly infectious, easily spreading to other plants. Infected plants should be removed from the garden immediately and extensive measures implemented for disinfection.

Lookalikes: other foliar diseases, particularly fusarium wilt, viruses

Bacterial wilt (Pseudomonas solanacearum)

The disease causes wilting of tomatoes and potatoes. In tomatoes it is mainly seed borne.

Control: Control is mainly cultural as: - Strict crop rotation, Removal and burning infected plant debris & Planting certified seed.

Damping off

Affected plants usually occur in patches in nursery beds or in low parts of sloped fields. In *pre-emergence damping off, the seeds* fail to emerge after sowing. They become soft, mushy, turn brown, and decompose as a consequence of seed infection. In *post-emergence damping-off, the seedling* emerges from the soil but dies shortly afterwards.

Septoria leaf spots

Septoria leaf spot usually appears on the lower leaves after the first fruit sets. Spots are circular, about one-sixteenth to one-fourth inch in diameter with dark brown margins and tan to gray centers with small black fruiting structures. Characteristically, there are many spots per leaf; they do not

look target-like. This disease spreads upwards from oldest to youngest growth. If leaf lesions are numerous, the leaves turn slightly yellow, then brown, and then wither. Fruit infection is rare.

Lookalikes: bacterial leaf spot and speck (no tan centers); and other diseases that progress from the bottom up

Powdery mildew

Leaf symptoms *consist of yellow* blotches or spots on the upper leaf surface. A white powdery growth occurs on the underside of the leaves. This fungus penetrates within the leaf tissue. The older colonies of the fungus may turn a dirty white color with age. The severely affected leaves turn yellow, then brown, and later become shriveled. Generally, the lower leaves are affected first and the disease gradually moves up the plant. Vines may become defoliated under severe infections, leading to lower yields and possible sunburn damage to the fruit.

Bacterial spot and speck

These are two separate but very similar diseases. Symptoms of bacterial spot are small dark brown to black circular spots, initially water-soaked, coalescing and becoming angular, sometimes with a yellow halo.

Symptoms of bacterial speck are tiny, dark brown to black spots with a surrounding yellow halo. Severity of both diseases is increased by wetness of fruit and foliage from sprinklers, rain, or heavy dew. There are some tomato varieties with resistance to bacterial speck but very few with resistance to bacterial spot.

Lookalikes: Septoria leaf spot (tan centers)

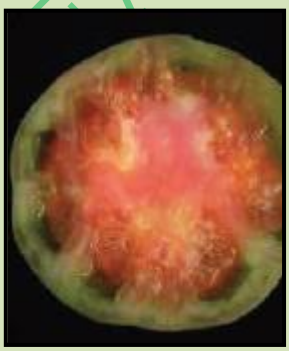
Anthracnose

DISORDERS

Blossom end rot – not a pathological disease, but mainly physiological

This is caused by calcium deficiency. The early sign of the disease is a water soaked spot near the blossom end of the fruit. The surface of the spot becomes dark and leathery but no soft rot develops unless bacteria or fungi invade the spot. Other causes are; Too fast growth during the early stages followed by sudden drought, excessive nitrogen and infrequent irrigation.

Gray wall



sunscald

concentric cracking

Concentric crack **Cat acing**

Catface

Radial cracking

FRUIT ROTS

Gray mold rot

Rhizoctonia rot

Rhizophus rot

Sour rot

Pythium fruit rot

PESTS

Root knot nematodes

These are galls and swellings on the roots causing stunting of the plants and eventual death.

Control:

Good agricultural practices and chemical controls are used. Planting nematode free seedling through application of Nematicides

Tobacco whitefly

Whiteflies are tiny, soft-bodied insects. They are not true flies. They secrete a white waxy substance through special glands on their abdomen. The adults coat their bodies, particularly their wings, with this wax, hence the name "whiteflies." In their immature stages (nymphs) they also secrete wax in various forms.

Damage caused by whiteflies

Like aphids, whiteflies have piercing-sucking mouthparts so the damage caused is very similar to that of aphids. Damage to the crop is usually caused by larvae and adult insects that suck the leaf-tissue and young fruit secreting sticky undigested sap (honeydew) during feeding. It is documented that about 2,000 nymphs can be found on a single leaf; each nymph is capable of producing 20 drops of honey dew in an hour! Sooty moulds grow on the sugary secretions (Cladosporium spp.) hence reducing the photosynthesis area of the leaves and resulting in stunted growth and poor quality produce. Heavy infestations cause decline of plant vigor. Stunting, yellowing of foliage and premature leaf drop are among the symptoms of injury.

Feeding by whiteflies can also cause deformed fruit and discoloration of your tomatoes.

Whitefly adults can also transmit several viruses from diseased to healthy plants including the destructive Tomato Yellow Leaf Curl Virus (TYLCV). If your plant gets infected with a virus, pull it out.

Monitoring

Check the undersides of leaves regularly with a hand lens to monitor for both adults and nymphs. Look for flying whiteflies regularly by knocking tomato leaves. This is an easy way to monitor adult activity and abundance because they are easily disturbed and will flutter away. Monitoring your populations, especially during hot dry weather will help you decide if or how to manage whitefly problems. Generally, tomatoes (and other plants) can tolerate some whiteflies (up to 10-25 nymphs per leaf) but population explosions (50 and up nymphs per leaf) can quickly rob you of your tomatoes

Whitefly Control

Because of the large number of eggs laid by an adult whitefly their population can multiply quickly within a short period of time. Adults mate within 10 to 20 hours of hatching and live between two and three weeks. Control is complicated by the nature of the eggs and the pupae which cannot be killed by contact insecticides as they are covered by waxy substance.

To control whiteflies:

• Use varieties tolerant or resistant to viruses

• Remove Solanaceous plants and weeds which are in the vicinity of the tomato crop.

• Rogue diseased plants and destroy by burning. Ploughing infested crop at night and weed management can help to bring the population below threshold levels.

• Use of oil sprays (DC-tron) helps discourage spread of whiteflies.

• Practice a good crop rotation program.

• A maize crop ‘guard row’ can be planted around the tomato field to reduce the ability of whiteflies to reach the crop.

• Adult whiteflies can be controlled by overhead irrigation with soapy water (sodium based soaps)

• At larval stages system growth regulators such Applaud (buprofezin) can be used

• Biological control options.

• Perhaps the most common is the use of whiteflies natural predator Encarsia formosa. This parasitic wasp attacks the whitefly by depositing an egg within the host body then, after about 10 days, the parasitized host will turn brown as wasp pupation occurs. After another 10 days the emerging adult wasp will appear and will, in turn, parasitize more whitefliesand Entomopathogenic fungi such as Beuaveria bassiana and Verticillium lecanii.

• Effective insecticides for control of whiteflies include Pyrethroids and other contact insecticides.Imidacloprid, Azadirachtin, Dimethoate, Lambda- Cyhalothrin, Deltamethrin, Acephate,

Pyrethrin and Thiacloprid among others. Farmers MUST adhere to the recommendations on the product label and observe the Pre-Harvest Intervals as advised on the product label.

Red spider mites

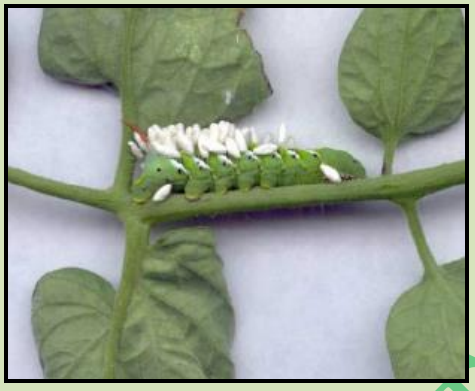

The minute, spider like animals are visible by the naked eye and feed on sap from the underside of the leaves. They cause speckling and tarnishing of the leaves turning yellowish to whitish. The pest has wide host range including wild e.g. sodom apple and cultivated plants such as cassava, maize

American boll worm (Heliothes armigera)


The caterpillars bore into fruit and feed on the inner of the fruit releasing plenty of excreta which is noticeable.

Tuta absoluta


Hornworm



Hornworms are the larval stage (caterpillars) of sphinx moths. They are called hornworms because of the tell-tale horn or spike on their tail end (top image). These caterpillars have voracious appetites and can consume entire leaves and small stems in a short time. Hornworm damage is obvious when the infestation is moderate to heavy because of the large amount of defoliation. Search for the large caterpillars and the large, black droppings on the leaves or ground beneath the plant.

Hornworms that are not feeding should be left on the tomato plant. They may have been infected with Bt, an organic pesticide that only attacks caterpillars, or they may have been parasitized (bottom image). The tiny white cocoons sprouting from the hornworm are the pupal cases of tiny wasps that have eaten the hornworm from the inside out. If left alone, the adults will emerge and fly off in search of other caterpillars to parasitize and kill.

SOME COMMON PEST AND DISEASE IN TOMATOES

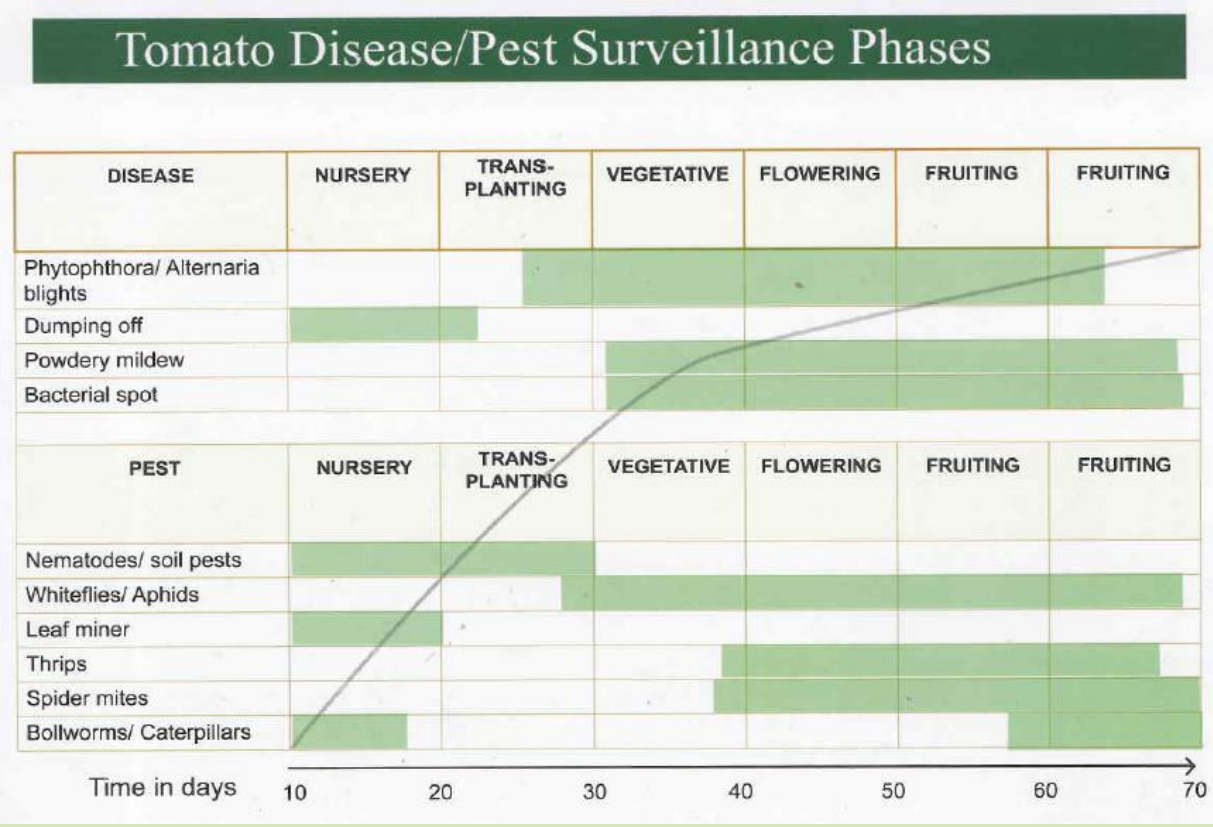


TABLE OF COMMON PESTS AND DISEASES AND THEIR MANAGEMENT

PEST/DISEASE	PEST STAGE	AFFECTED PART	PRODUCTS TO USE
Whiteflies	Adults	Leaves	Synthetic pyrethroids,chlorpyrifos,dimethoate,thiocyclam hydrogen oxalate
	Larvae	Leaves	Abamectin,thiacloprid
Leafminer	Adults	Leaves	imidachloprid,acephate,dimethoate,thiacloprid,azadirachtin
	Larvae	Leaves	abamectin,spinosad,cyromazine
Tuta absoluta	Adults	leaves	dimethoate,thiocyclam hydrogen oxalate
	Larvae	leaves,fruits	chlorantraniliprol,abamectin,emamectin benzoate,flubendiamide
Spidermites	All stages	Leaves&stems	synthetic pyrethroids,abamectin
Aphids	Adults	Stems,leaves&flowers	lambdacyhalothrin,dimethoate
Thrips	pupa,adults	Flowers&leaves	spinosad,lambdacyhalothrin
Caterpillars	Larvae	Leaves&fruits	synthetic pyrethroids
Nematodes	All stages	Roots	Azadirachtin,othoprophos,metamsodium
Late blight		leaves&stems	Azoxystrobin,mancozeb,propineb,chlorothanonil,metalaxyl,copper oxychloride
Early blight			chlorothalonil,azoxystrobin,mancozeb,metalaxyl
Bacterial wilt			Copper oxychloride, copper oxide
Rootrot	Fusarium		chlorothalonil,metalaxyl
	Pythium		chlorothalonil,metalaxyl
	Rhizoctonia		chlorothalonil,metalaxyl
Powdery mildew			Tebuconazole,azoxystrobin,mancozeb,chlorothanonil,metalaxyl
Downey mildew			Propineb, chlorothalonil,metalaxyl,azoxystrobin,mancozeb
Bacterial speck			Copper oxychloride, copper oxide
Viral infections			uproot and control vector

Harvesting and handling tomatoes

Since tomatoes are perishable, proper after-harvest handling is very crucial for maintaining quality and increasing shelf life.

Cleaning

Tomatoes should be washed in clean water to sufficiently remove dust and foreign material, then wiped dry with a clean soft cloth. To eliminate the problems with disease build-up that normally occur, wash water should not be reused. When washing ensure the wash water is several degrees warmer than the pulp temperature of the tomatoes to avoid drawing water and disease organisms in the fruit

Grading

During grading of fruits, damaged, rotten and cracked fruits should be removed. Only healthy, fruits should be selected. The grades are mostly based on the condition and the quality of the fruits and not specifically on their size. However, on the basis of the size, three grades are formed: small (less than 100 g), medium (100-255 g) and large (over 255 g). Retailers normally do size grading for the local market

Storage: Temperature and Humidity Management

Immediate and thorough postharvest cooling to remove excessive field-heat aids greatly in maintaining quality and substantially lengthens the shelf-life of tomatoes. Cooling and washing can reduce the effects of dehydration and minimize decay. Though postharvest cooling is essential for maintaining quality, it will not improve the quality of a poor product. Pink or light red tomatoes destined for distant markets should be cooled immediately after harvest to avoid becoming overripe before reaching the consumer. Placing containers of warm tomatoes in a refrigerated space, known as room cooling, is recommended. To aid room cooling and prevent the buildup of respiration heat, containers of tomatoes should be loosely stacked with space between the containers to allow for sufficient air circulation.

Tomatoes are very sensitive to chilling injury. The recommended storage temperature varies with the maturity of the fruit (for mature green, 14°C; for pink, 10°C). Proper temperature control is critical to quality and shelf-life. Mature green tomatoes should not be held at temperatures that delay ripening. When they are stored for several weeks at 12.7°C, they often fail to ripen properly instead developing decay due to Alternaria. Chilling injury is cumulative and is a function of both temperature and exposure time. The optimum temperature for ripening mature green tomatoes is from 18°C to 21°C. At temperatures above

26.7°C, mature green tomatoes will appear to ripen but may not have the best eating qualities. A temperature of 14.4°C to 15.6°C is best for slowing the ripening of mature green tomatoes and preventing existing decay. Light red tomatoes can be stored for two weeks or longer at10°C. Longer storage may result in reduced retail shelf-life. Ripe tomatoes may be stored at lower temperatures than mature green tomatoes. Several days at 4.4°C may be acceptable, but longer storage at this temperature will result in loss of color, firmness, shelf life, and especially taste. Under extreme circumstances, firm yet well-ripened tomatoes may be stored for as long as three weeks at 0.6°C to 1.6°C. Pink to firm-red greenhouse grown tomatoes may be stored at temperatures of 10°C degrees to 12.7°C.Less mature tomatoes should be ripened at 21°C before being stored at 10oC to 12.8°C.

Packaging and Transportation

For local markets, the fruits are packed in wooden or plastic crates. The packing should be rigid enough to protect the fruit from being crushed. Plastic crates can be conveniently stacked one on the other as the contoured rim keeps the product safe and allows sufficient air circulation. For exports, the fruits are packed in cardboard telescopic boxes with capacities of not more than 15 kg. Size graded tomatoes are pattern packed in layers to make best use of the box. Tomatoes are highly perishable in nature hence quick means of transportation is necessary.

Cool Chain:

Maintaining a cool chain is essential during the transport of export quality commodity all the way from the farm to the customer. This helps in maintaining the temperature inside the box at the same low level as is found in cold storage.

The various stages of the cool chain are:

1. Cold store at the farm.

2. Refrigerated truck from farm to the airport

3. Cold store at the airport.

4. Building up of the pallet in a cold store at the airport.

5. Loading the aircrafts directly from the cold store in a short time.

6. Cargo aircraft maintains cold store temperature in hold.

7. Off loading direct into a cold store in the receiving country.

8. Refrigerated truck to the customers.

Post Harvest Disease Management

Tomatoes are subject to a large number of postharvest diseases such as alternaria rot (Alternaria alternata), gray mold or botrytis (Botrytis cinerea), rhizopus rot (Rhizopus stolonifer), and sour rot (geotrichum candidum). Although the skin of tomatoes offers some protection against infection, it is easily damaged by rough handling.

Pathogens can enter tomatoes through a variety of openings. Wounds such as punctures, cuts, abrasions, and cracks as well as stems and stem scars provide potential points of entry. The entry of pathogens into a surface injury is nearly a certainty. Therefore, tomatoes with surface injury should be separated promptly from sound fruit and discarded before decay can spread

PRODUCTION SCHEDULE/CROP PLANTING CALENDAR

This is a tool used by farmers to plan for production and ensure that marketing coincides with peak demand

The procedure involves:

Conduct a market survey and determine where there is peak demand which translates to high prices

Work backwards from month when there is peak demand to prepare monthly farm activities preceding the peak period

Use the monthly activities preceding the peak as a procurement plant for farm inputs and a guide to farm operations

December peak season

ACTVITIES/PERIOD	Aug	Sep	Oct	Nov	Dec	Jan
Soil Sampling						
Nursery establishment						
Land preparation						
Transplanting						
Fertilization						
Support						
Pest&disease control						
Harvesting						
Marketing						

May peak season

ACTVITIES/PERIOD	Jan	Feb	Mar	Apri	May	June
Soil Sampling						
Nursery establishment						
Land preparation						
Transplanting						
Fertilization						
Support						
Pest&disease control						
Harvesting						
Marketing						

TOMATO GUIDE

DAY	FUNGICIDE	INSECTICIDE	FOLIAR FEED	FERTILIZER
Sowing day(use Apronstar for seed treatment) Soak seeds for 24hours in DI Grow Green at a dose of 3ml/1 ltr of water				Manure/DAP
Day 7	Ridomil gold	Confidor		
Day 14	Ridomil gold	Evisect	D.I.Grow Green-40ml/20l (15^{th} Day After Sowing)	
Day 21	Ridomil gold	Dynamec		
Day 28	Ridomil gold	Evisect		
Transplanting (Apply well decomposed manure 2 weeks before transplanting)				Manure-4tons DAP-80kgs MOP-20kgs
Week 1	Ridomil Gold	Confidor		
week 2	Milraz	Evisect	D.I.Grow Green (15^{th} Day After Planting)	
week 3	Ortiva	Dynamec		
week 4	Ridomil Gold	Belt	D.I.Grow Green (25^{th} Day After Planting)	CAN-50kgs MOP-20kgs (25 Days After Sowing)
week 5	Milraz	Dynamec	D.I.Grow Red (35^{th} Day After Planting)	
week 6	Ortiva	Evisect		CAN-50kgs (40 Days After Planting)
week 7	Ridomil Gold	Belt	D.I.Grow Red (45^{th} Day After Planting)	
week 8	Milraz	Dynamec	D.I.Grow Red (55^{th} Day After Planting)	
week 9	Ortiva	Evisect	D.I.Grow Red (65^{th} Day After Planting)	
week 10&above	Ridomil Gold	Belt	D.I.Grow Red (75^{th} Day After Planting)	DAP-30kgs CAN-30kgs MOP-15kgs

Compiled by FARMING GURUS-K LTD

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