

Introduction

Tomato is one of the most important vegetable crops of India, grown in 789.20 thousand ha area with 25.00mt/ha productivity. Pests and diseases are biotic constraints to tomato production. In recent past, with changes in the cropping pattern, ecosystems and habitat, climate and wider use of high input intensive vegetable varieties/hybrids, there has been a paradigm shift in infestation of pests in time and space. These pests cause huge losses depending upon the infestation severity. If we look at the severity of damage, tomato fruit borer *Helicoverpa armigera* alone causes 85-93.7% loss, South American tomato pinworm *Phthorimaea (Tuta) absoluta*, 60.08% to 82.31%, Early blight (*Alternaria solani*) up to 78%, Wilt (*Fusarium oxysporum* f. sp. *lycopersici*) 10 - 60%, Begomoviruses 100%, root knot nematode (*Meloidogyne* spp.) 27.20 % damage to tomato. According to base line survey conducted by ICAR – NCIPM, New Delhi, farmers spray 25-30 rounds of cocktail chemical pesticides in a season leading to various adverse effects. The only alternative to overcome the problems due to sole dependence on pesticides is to adopt Integrated Pest Management (IPM) practices as explained below to manage the pests and diseases. This will besides guiding the farmers to reduce the over reliance upon chemical pesticides will help them to grow the tomatoes according to Good Agriculture Practices (GAP).

Economically Important pests of Tomato

1. South American tomato pinworm, *Phthorimaea (Tuta) absoluta* (Lepidoptera: Gelechiidae): The larvae are whitish to yellowish in first instar and later on turns greenish with a black band behind the head. They mine inside the leaf, stem or fruits. The most distinctive symptoms of damage are blotch shaped mines on the leaves where larvae only feed on mesophyll tissues, leaving the epidermis intact. In case heavy infestation, leaves die off completely. Larvae also prefer stem and fruits. Fruits are infested as soon as they are formed but the larvae only feed on green fruits. Fruits show small pin holes on the surface and larval tunnel / mine in the endocarp region. Damage due to larvae on fruits causes malformations and allows fungal diseases to enter, leading to rotting fruit before or after harvest.



2. Tomato Fruit borer, *Helicoverpa armigera* (Lepidoptera: Noctuidae): Neonate larvae scrap and feed on tender foliage while, the subsequent stage larvae which are apple green in colour with longitudinal stripes bore circular holes on the fruits and thrust part of their body inside the fruit and eat the internal content of fruit.



3. Serpentine leaf miner, *Liriomyza trifolii* (Diptera: Agromyzidae): Minute orange yellowish apodous maggots mines into leaves and cause serpentine mines leading to drying and drooping of leaves. Yellowish brown pupae are noticed very often within the leaf mines.



4. Whitefly, *Bemisia tabaci* (Hemiptera: Aleyrodidae): Both Nymphs and adults suck the plant sap from the ventral surface of leaves due to which chlorotic spots, yellowing, wrinkling and curling of leaves is commonly noticed. Whiteflies also act as a vector of tomato leaf curl disease.



5. Early blight, *Alternaria solani*, *A. alternata* f.sp. *lycopersici*: Also known as target leaf spot disease. The disease produces a wide range of symptoms and the symptom on leaves is termed as early blight and symptoms on stems, seedlings and fruits are termed as stem lesions, collar rot and fruit rot. Initial symptoms of disease appeared as small, dark necrotic lesions on the older leaves which subsequently spread upward as the plants become older. In later stages, the lesions enlarge and they generally resulted in concentric rings like a target board appearance which are often surrounded by a chlorotic zone.



6. Late blight, *Phytophthora infestans*: Disease symptoms of late blight may be noticed on any aerial parts of the tomato plant. Infected leaves typically have small, water-soaked areas that rapidly enlarge to form purple-brown, and appear greasy. On the lower side of leaves or on lower stem, rings of grayish white mycelium and spore-forming structures may appear around the blotches. On stem and petiole, lesions later on appear brown in colour. Discoloration may also occur on the flowers, causing them to drop off. Infected fruits appear mottled, often with golden to dark brown, firm, sunken surfaces. White, fuzzy mycelial growth can also be found in association with the fruit lesions. Persistent moist weather condition favours disease incidence and further spread.



7. Tomato leaf curl disease, Tomato leaf curl virus (ToLCV): One of the major diseases transmitted through whitefly, *Bemisia tabaci*. Plants infected by the virus have reduced internodes and the growth of the plants appears stunted. The new leaves are also greatly reduced in size and wrinkled, are yellowed between the veins, and have margins that curl upward, giving them a cup-like appearance. The older curled leaves become leathery and brittle. Flowers may appear but usually will drop before fruit is set



Table 1: Other important insect and non-insect pests of Tomato

Common Name	Scientific Name
Insect Pests	
Leaf eating caterpillar	<i>Spodoptera litura</i> (Lepidoptera: Noctuidae)
Fruit fly	<i>Zeugodacus cucurbitae</i> / <i>Bactrocera cucurbitae</i> (Diptera: Tephritidae)
Thrips	<i>Thrips tabaci</i> ; <i>Frankliniella schultzei</i> (Thysanoptera: Thripidae)
Aphids	<i>Myzus persicae</i> and <i>Aphis gossypii</i> (Hemiptera: Aphididae)
Mealy bugs	<i>Maconellicoccus hirsutus</i> , <i>Phenacoccus solenopsis</i> and <i>Paracoccus marginatus</i> (Hemiptera: Pseudococcidae)
Non-Insect Pests	
Red spider mite	<i>Tetranychus</i> spp. (Acarina: Tetranychidae)
Root Knot Nematode	<i>Meloidogyne</i> spp. (Tylenchida: Heteroderidae)
Reniform nematode	<i>Rotylenchulus reniformis</i> (Tylenchida: Hoplolaimidae)

Table 2: Other important diseases of Tomato

Name of the disease	Causal Organism
Fusarium wilt	<i>Fusarium oxysporum</i> f. sp. <i>lycopersici</i>
Bacterial wilt	<i>Ralstonia solanacearum</i>
Damping off	<i>Pythium aphanidermatum</i>
Bacterial fruits and leaf spots	<i>Xanthomonas campestris</i> sp. <i>vesicatoria</i>
Bacterial stem and fruit canker	<i>Clavibacter michiganensis</i> sub sp. <i>michiganensis</i>
Septoria leaf spot	<i>Septoria lycopersici</i>
Powdery mildew	<i>Oidium</i> sp. and <i>Oidiopsis</i> sp.
Tomato mosaic disease	Tomato mosaic virus
Tomato spotted wilt disease	Peanut bud Necrosis Virus (PbNV) TSWV

Integrated Pest Management practices in Tomato

- ❖ Avoid growing tomato crop in the same field season after season. Follow crop rotation with non-host crops such as cereals and legumes. Avoid growing of solanaceous crops such as chili and brinjal, after tomato to avoid the carry-over of pests and diseases from one season to the other (e.g. bacterial wilt, early blight and nematodes)
- ❖ Deep summer ploughing to expose soil borne pathogens and insect pupae to sunlight and natural enemies.
- ❖ Seed treatment with Organic Formulation (talc formulation of *Pseudomonas fluorescens* + *Trichoderma harzianum*) @ 15- 20 g/kg of seeds shade dried for half an hour before sowing against soil and seed borne fungal diseases and nematodes
- ❖ Use of 100-mesh nylon net in nursery beds to avoid entry of whitefly and transmission of leaf curl disease in tomato
- ❖ Seedlings treatment with *Trichoderma asperellum* / *Pseudomonas fluorescens* @ 5g/1 for 10-15 minutes before transplanting.
- ❖ Application of well decomposed enriched Farm yard manure @ 2t/ha, enriched with Organic Formulation (*Pseudomonas fluorescens* + *Trichoderma harzianum*) or *Trichoderma asperellum* or *Pseudomonas fluorescens* @ 2 kg/t of well decomposed FYM against fungal diseases and nematodes
- ❖ Soil application of 500 kg of Neem cake against bacterial wilt, serpentine leaf miner and root knot nematodes and 1 tonne of vermin-compost per hectare to the main field before transplanting (induced resistance against biotic stress – pest incidence)
- ❖ Plastic mulching to reduce pupation in the soil, repels whiteflies in case of silver coloured sheets and also avoids weed growth. Polythene sheets of 25-30 micron thickness (black or silver colored) should be spread on the raised beds as mulch before transplanting. Round holes should be made as per the recommended spacing (4 ft x 1.5 ft or 120 cm x 45 cm) using a punch or a large diameter pipe and a hammer and the seedlings should be placed in the holes



- ❖ Intercropping a tall variety of marigold as a trap crop @ 16:1 ratio. Plant 45 days old marigold seedlings and 25 days old tomato seedlings to synchronize flowering in both the crops. Eggs and larvae are manually collected and destructed from field along with the flowers. This trap cropping system also helps in reducing the root knot nematode infestation
- ❖ Growing 5-6 rows of sorghum or maize all around tomato field at least 2 months before transplanting as a barrier crop against sucking pests like whiteflies, thrips and aphids
- ❖ Install bird percher @ 15-20 bird perches (T shaped) per ha to attract insectivorous birds to feed on different stages of insect pests
- ❖ Staking tomato plants improves fruit quality by keeping plants and fruits off the ground and by providing better spray coverage. Staking tomatoes and using a system of drip irrigation will reduce leaf dampness, as well as allowing enough space for aeration
- ❖ Installation of Yellow sticky traps @ 10 traps /ha, 15 cm above the canopy against white fly and Blue sticky traps @ 10 traps /ha against thrips. Locally available empty tins can be painted yellow or blue / coated with grease / vaseline/ castor oil on outer surface may also be used as yellow/blue sticky traps
- ❖ Installation of specific lures in pheromone traps for South American tomato pinworm, fruit borer and tobacco/leaf eating caterpillar @ 10-12 traps/ha (replace the lures with fresh ones after every 2-3 weeks). Trap should be installed in the field in such a way that the position of the lure is always 2 to 3 feet above the crop canopy. The trapped moth should be collected and killed on regular intervals
- ❖ Installation of indigenously prepared light trap by hanging one incandescent bulb @ one bulb on a tub of water. Such traps may be installed @ 2-3 traps/ha for monitoring and mass trapping of adult moths of South American tomato pinworm
- ❖ Installation of fruit fly traps @ 20-25 traps/ha for monitoring and mass trapping of fruit flies
- ❖ Releasing of egg parasitoids *Trichogramma Achaea* / *Trichogramma pretiosum* / *Trichogrammatoidea bactrae* at weekly intervals @ 50,000/ha for 6 times at an interval of 7 days against South American tomato pinworm
- ❖ Spraying of Entomopathogens like *Beauveria bassiana* / *Lecanicillium lecanii* / *Metarhizium anisopliae* @ 1×10^8 cfu/ml against sucking pests
- ❖ Spraying of *Bacillus thuringiensis* var. *kurstaki* @ 500g/ha against lepidopteran pests
- ❖ Spraying of Ha/SI NPV 250 LE with 1% jaggery at 28, 35 and 42 days after transplanting in the evening hours against fruit borers/leaf eating caterpillars
- ❖ Spraying of 0.50% Neem oil (05 ml/L) or 5% NSKE (50 ml/L) or commercial formulation of Neem (Azadirachtin 05.00% w/w Min. Neem Extract Concentrates) @ 0.50 ml/L is effective against fruit borer, defoliators and sucking pests
- ❖ Mechanical collection and destruction of lepidopteran larvae at periodic intervals (3-4 times) for management of fruit borer and defoliator. Collection and destruction of infected leaves, shoots and fruits to reduce the spread of diseases.
- ❖ Spraying of label claim pesticides as final resort.



Maize/Sorghum as barrier crop Marigold as Trap crop



Plastic mulching and stacking Indigenously prepared light



Sticky trap with a pheromone lure Blue trap Yellow trap



Pheromone traps

Table 3: List of label claim pesticides to be used in Tomato pest management (Source - Central Insecticide Board and Registration Committee)

Name of the Pesticide and recommended dose	Against
Indoxacarb 14.5% SC @ 0.8 ml/lit	South American pin worm and Tomato fruit borer
Chlorantraniliprole 18.5% SC @ 0.25 ml/lit	Tomato Fruit borer
Thiomethoxam 25% WP @ 0.4 g/lit or Imidacloprid 17.80% SL @ 0.5 ml/lit	Whitefly
Cyantraniliprole 10.26% OD @ 1.2 ml/lit	South American pin worm, leaf miner, aphids, thrips, whitefly and fruit borer
Fenazaquin 10% EC @ 2.5 ml/lit or Spiromesifen 22.9% SC @ 1.5 ml/lit	Red spider mite
Copper oxy chloride 50% WP @ 2-3 g/lit	Late & early blight, leaf spot and bacterial wilt
Carbendazim 50% WP @ 1 g/lit	Fusarium wilt, sclerotium rot and powdery mildew
Mancozeb @ 2ml/lit	Leaf spot, early and late blight
Tebuconazole 50% + Trifloxystrobin 25% WG @ 0.75 g/lit	Early blight, leaf spot and late blight

Note: Spray solution required per hectare in tomato crop = 500 litres.

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Integrated Pest Management approaches against major insect pests and diseases of Tomato



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