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Research Article

Sustainable Approaches to Managing Insect Pests of Tomato (*Solanum lycopersicum* L.)

M.M. Maindargikar, C.D. Ghorband, A.D. Bokharepatil and Saheb L. Shinde*

Department of Botany, Yeshwant Mahavidyalaya, Nanded-431602 (MH), India

*Email: sahebshinde4@gmail.com

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Abstract

Vegetables are an important part of our daily diet because they provide essential nutrients like proteins, vitamins, minerals, and fiber. They also contain beneficial plant compounds, such as flavonoids, that can help prevent diseases. Among these vegetables, the tomato is a very important crop, second only to the potato globally and a staple in the Indian diet. Unfortunately, tomato crops are often damaged by insect pests and diseases. Tomato plants are susceptible to a wide range of pests, both direct and indirect, throughout their entire growth cycle. Tomato plants are directly and indirectly susceptible to a variety of pests throughout their growth cycle. This can lead to significant yield reductions and, in some severe cases, the failure of the entire crop. These include the Tomato fruit borer, White fly, Serpentine leaf miner, Tomato aphids, Tobacco caterpillar, Tomato fruit fly, Tomato mealy bugs and Tomato Thrips. This article explains what causes this damage, how it affects the plants, and how to control it.

INTRODUCTION

India ranks among the largest agricultural countries in the world, where over 60% of the population is involved in farming and related activities (Vanitha, et al., 2013). Globally, tomato is a very popular solanaceous vegetable, second only to potatoes in many countries. Spain has the highest productivity of 66.81 tonnes/ha. Madhya Pradesh leads in total production (2970.64 tonnes), contributing 14.63% to the total state production, while Maharashtra has the highest productivity of 28.20 tonnes/ha (Anonymos, 2017-18). In South America, the tomato (*Solanum lycopersicum* L.), a warm-season crop, is a major economic vegetable of the Solanaceae family. They require both warm and temperate climates for successful production, as adverse conditions can significantly affect plant health (Bihon, et al., 2022). Seed germination, plant development, flower and fruit setting, and fruit quality require various environmental factors such as optimum temperature, humidity, soil composition, etc. (Dube, et al., 2020). Tomatoes are a great addition to a healthy diet, containing sugars, essential amino acids, vitamins, minerals, and dietary fiber. They are particularly rich in vitamins A, B, and C, as well as phosphorus and iron. Tomatoes also contain lycopene, a powerful antioxidant that may help protect against diseases such as heart disease and cancer (Mandloi, 2013). Like other vegetables, tomatoes are susceptible to pests and diseases because their tissues are

particularly tender and soft compared to other crops (Rawat, 2020). Various pests can significantly reduce the quality of tomato fruits at all stages of their growth. These pests use all parts of the plant for shelter, food and reproduction. The most economically damaging pests are leaf miners, aphids, jacids, whiteflies and fruit borers (Reddy and Kumar, 2004).

Material and methods

Major Insect pests of Tomato

1. Tomato fruit borer (*Helicoverpa armigera*):

Nature of damage: During the pre-fruiting stage, the caterpillar eats the tender foliage, including leaves, flowers, and buds. It may also bore holes into tender twigs, giving the crop a perforated appearance. Once the fruit develops, the larvae bore large, clean, circular holes into the fruit and consume the pulp.

Pest management: Treat seeds with *Trichoderma harzianum* at a rate of 4g per kg of seeds. Apply 2-3 sprays of NSKE 4% starting 25 days after transplanting, at a 10-day interval. Erect bird perches at a rate of 50 per hectare to attract insectivorous birds like the black drongo. Install pheromone traps at a rate of 5-7 per hectare for early detection and 12-15 per hectare for mass trapping and mating disruption.

2. White fly (*Bemisia tabaci*):

Nature of damage: Whiteflies are a major threat to crops, as they suck the sap from the leaves, which reduces the plant's vigor. This can cause stunted growth, curling, wrinkling, and severe chlorosis, especially in newly formed leaves. In severe infestations, older leaves can become leathery and brittle. In addition to the direct damage they cause, whiteflies also act as vectors for the transmission of Tomato Leaf Curl Virus, a disease that significantly affects tomato plants.

Pest management: Early detection is important to manage whitefly infestations. Physically remove and burn infected plants to stop their spread. Use Delta or yellow sticky traps to monitor and capture adult whiteflies. In nurseries, cover the beds with fine mesh such as agronet or nylon for 25-30 days after sowing to create a physical barrier. For chemical control, root dipping of seedlings in tetracycline solution 1000 ppm (1gm in 1 lit of water) is effective, followed by 3 spray after 10-12 days. Soil treatment of Carbofuran 3G at a rate of 1.5 kg active ingredient (a.i.) per hectareor or seed treatment with Gaucho at a rate of 3 g per kg of seed also provides systemic protection against whiteflies at the nursery stage.

3. Serpentine leaf miner (*Liriomyza trifoli*):

Nature of damage: Leaf miners create distinctive wavy holes on the upper or lower surface of leaves. These holes, caused by tiny, orange-yellow insects, usually start at the edges of the leaves and spread toward the center. This damage causes the leaves to dry out and fall off. Yellow-brown scales are also commonly found in leaf miners.

Pest management: To manage this pest, you can use 250 kg of neem powder per hectare 20 days after planting. For more control, spray 5% NSKE (Neem Seed Kernel Extract) solution 2-3 times at an interval of 7-10 days, which will be adjusted according to the level of infestation. Alternatively, you can spray 4% Neem Seed Powder Extract or 1% Neem Soap solution 15-20 days after planting. For severe infestation of leaf miners, chemical options include spraying 2 ml of Nuvon, DDVP or Dimethoate per liter of water. This has been found to be effective.

4. Tomato aphids (*Aphis gossypii*):

Nature of damage: Aphids are a common pest in the early growth stages of tomatoes. Both the adult aphids and their young (nymphs) feed by sucking sap from the underside of new leaves, which causes the leaves to curl and turn yellow. They also excrete a sticky substance called honeydew on which black sooty mold develops, which covers the leaves and inhibits their ability to photosynthesize. In addition to this damage, aphids are also known to transmit mosaic viruses to tomato plants.

Pest management: To manage aphids, you can use yellow sticky traps as they are effective in catching the insects. If the infestation is significant, chemical spraying is recommended. Apply 2 ml Malathion 50 EC per liter of water or 0.3 ml Imidacloprid per liter of water as soon as the insects appear. If necessary, apply again after 10-12 days.

5. Tobacco caterpillar (*Spodoptera litura*):

Nature of damage: Initially, the small larvae feed in groups, stripping the chlorophyll from the leaf surface, giving the leaves a papery white appearance. As they mature, they become voracious feeders, creating irregular holes in the leaves. This feeding can result in complete skeletonization of the leaves, leaving only the veins and stems. In severe infestations, the larvae can completely defoliate the plant and cause irregular holes in the fruit.

Pest management: Summer plowing helps to expose hibernating pupae to natural predators and birds, reducing future populations. Regularly hand pick and destroy egg masses and young caterpillars. In the early stages of infestation, spraying a 5% NSKE solution can be beneficial. Additionally, applying a foliar spray of Bt formulations at 500 g per hectare is an excellent way to control caterpillars. A promising biological control method is spraying Splt NPV at a rate of 250 LE mixed with jaggery (10 g per liter) and a sticker in the evening. Set 25 to 30 pheromone traps per hectare for early identification and mass trapping of adult tobacco caterpillars.

6. Tomato fruit fly (*Bactrocera tau* and *Bactrocera cucurbitae*):

Nature of damage: Adult female flies damage tomatoes and also bore holes in unripe fruits. They lay their eggs into the fruits. These eggs hatch in 7-10 days and the newly emerged larvae begin to tunnel inside the fruits. This internal damage causes the fruit to rot due to secondary bacterial infection. When mature, the maggots emerge from the rotting fruit and pupate in the soil.

Pest management: Deep ploughing your fields during the summer months exposes hibernating pupae to the sun, which kills them, and makes them vulnerable to natural predators. Use Carbofuran 3G granules at the rate of 25-30 kg per hectare during field preparation. Use methyl eugenol traps to effectively kill adult fruit flies, which helps reduce their numbers.

7. Tomato mealy bugs (*Phenacoccus solenopsis*):

Nature of damage: Both the nymphs and adults of this pest feed by sucking sap from plant leaves, causing them to wither and turn yellow. This feeding can also lead to the premature dropping of fruit. If the infestation is severe, it can result in the complete defoliation and even the death of the plant. The excess sap they excrete, known as honeydew, attracts ants and leads to the growth of sooty mold.

Pest management: To manage this pest, start by removing and burning any crop residues from previously infested fields. For chemical control, you can spray one of the following solutions at 15-day intervals: Dichlorvos 76 EC at a rate of 2 ml per liter of water, Chlorpyriphos 20 EC at a rate of 2 ml per liter of water, Imidacloprid 200 SL at a rate of 0.5 ml per liter of water, Malathion at a rate of 2.5 ml per liter of water

8. Tomato Thrips (*Frankliniella spp.*):

Nature of damage: Nymphs and adults of this pest typically feed on flowers, but they can also target flower and leaf buds, as well as leaves. When they feed in blossoms, it can cause the flowers to abort or drop, which prevents proper fruit development and leads to deformed fruit. Feeding on foliage results in a characteristic silvery appearance. Crops are most vulnerable during the flowering and fruit-setting stages. When eggs are laid in the fruit, they cause dimpling, and the infested area may appear white. Thrips are also known to be vectors of Tomato Spotted Wilt Virus (TSWV). Infected plants show dark lesions on their leaves, and the fruit develops distinctive halo-like markings.

Pest management: Regularly remove and destroy weeds, old plant material, and other debris that may harbour thrips. Natural predators such as pirate bugs, lacewing larvae, and ladybirds are effective at preying on thrips and should be encouraged in the field. For more severe infestations, a systemic insecticide can be used. Spraying with imidacloprid, thiamethoxam, or dimethoate 10 days after planting can help reduce thrips population.

Result and Conclusion: Tomato is a major economic vegetable. Tomato crops are highly susceptible to insect pests. Based on the study of tomato pests, it was concluded that eight major pests were studied during this study. Eight major pests including Tomato fruit borer, White fly, Serpentine leaf miner, Tomato aphids, Tobacco caterpillar, Tomato fruit fly, Tomato mealy bugs and Tomato Thrips were studied.

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Table 1. Major Insect Pests of Tomato

Sr. No.	Insect pests of Tomato	Causal organism	Site of damage
1.	Tomato fruit borer	*Helicoverpa armigera*	Leaves, Flowers, Buds
2.	White fly	*Bemisia tabaci*	Leaves
3.	Serpentine leaf miner	*Liriomyza trifoli*	Leaves
4.	Tomato aphids	*Aphis gossypii*	Leaves
5.	Tobacco caterpillar	*Spodoptera litura*	Leaves and Fruits
6.	Tomato fruit fly	*Bactrocera tau* and *Bactrocera cucurbitae*	Fruits
7.	Tomato mealy bugs	*Phenacoccus solenopsis*	Leaves, Stems and Fruits
8.	Tomato Thrips	*Frankliniella spp.*	Flower, leaf buds, Leaves and Fruits