FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

INTEGRATED PEST MANAGEMENT INNOVATION LAB

tomato package

This photo shows Simon Ndambiri, a farmer working with the IPM Innovation Lab in Mwea, Kenya, grafting tomato plants. He is using MT-56 root stock with a variety called Anna. MT-56 is resistant to bacterial wilt disease, which is a problem in the area. Farmers have seen the promise of grafting and have started to adopt it eagerly.

The tomato, Mesoamerican in origin, has been distributed throughout the world since the 1950s. In 2010, over 145 million metric tons of tomato were produced globally.

Tomatoes are widely grown in subsistence agriculture — mostly in outdoor environments in the tropics and in greenhouses in temperate regions — and used as a key part of local diets. Because the tomato (*Solanum lycopersicum*) is an affordable source of vitamins, micronutrients, and fiber for people throughout the tropical world, it is an extremely valuable crop.

Pest management is a challenge in subsistence agriculture. Due to damage from bacteria, fungi, insects, mites, nematodes, viruses, and weeds, yield loss in tomatoes is high: 40%. This situation prevails in spite of intensive and widespread pesticide use — to the point of chronic misuse — to manage these pests.

This brochure details successful **IPM Innovation Lab (IPM IL)** approaches that have been tested by scientists, researchers, and farmers to manage tomato pests. Following the techniques and recommendations section, photos and descriptions of key plant pests of tomatoes are provided.

WHAT IS **IPM?**

Integrated pest management (IPM), an environmentally-sound and economical approach to pest control, developed in response to pesticide misuse in the 1960s. Pesticide misuse has led to pesticide resistance among prevailing pests, a resurgence of non-target pests, loss of biodiversity, and environmental and human health hazards.

WHAT ARE **IPM PACKAGES?**

The **IPM Innovation Lab** has developed and tested robust IPM packages, holistic suites of IPM recommendations and practices for the production of vegetables and other crops. Farmers who use IPM packages in planting, production, and throughout the supply chain see enhanced profitability in their crops. The recommended practices in IPM packages cover economically significant pest species over a wide range of cropping systems across the tropical world, with resulting benefits to human health and the environment.

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Feed the Future Innovation Lab Integrated Pest Management

tomato

Integrated Pest Management Innovation Lab (IPM IL)

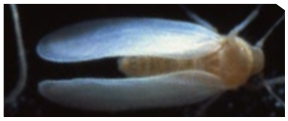
IPM PACKAGES FOR CROP HEALTH

tomato pests and diseases

identification, descriptions, and images









Photos

(clockwise from far top left):

- Tomatoes displaying symptoms of *Peanut bud necrosis virus*
- Tomato on the vine with late blight
- *Helicoverpa armigera*
- *Spodoptera litura*
- A *Bemisia* whitefly
- *Tuta absoluta* larva
- Thrips on a tomato leaf
- Lower stem of a tomato plant showing symptoms of bacterial wilt
- A tomato plant showing symptoms of *Tomato yellow leaf curl virus*

Diseases

Peanut bud necrosis virus (PBNV)

(Genus *Tospovirus*; Family *Bunyaviridae*) | South and Southeast Asia

PBNV has a wide host range and is transmitted by thrips species. It may cause serious economic damage to vegetables, legumes, and ornamental crops. This virus causes tomato yield reduction in both quantity and marketability, reduces nutritional quality of fruits, and reduces shelf life.

Tomato yellow leaf curl virus (TYLCV)

(Genus *Begomovirus*; Family *Geminiviridae*) | Worldwide

One of the most devastating tomato virus diseases, TYLCV is primarily transmitted by the *Bemisia tabaci* whitefly. Infected tomato plants show leaf yellowing, cupping, and stunting. TYLCV can cause reduction in leaf size, can cause flower and/or fruit drop, and can wipe out fruit production if plants are infected at an early age.

Late blight

(Fungal disease caused by *Phytophthora infestans*) | Worldwide

This pathogen survives on volunteer plants or abandoned tomato between growing seasons. The fungus and disease are favored by the combination of cool nights, warm days, and moist weather. Major symptoms include small, water-soaked lesions on leaves that develop into larger lesions and rings; leaves will eventually shrivel and die. Fruit lesions can invade the whole fruit. Decaying fruit and vines may also develop secondary infections such as rot.

Bacterial wilt

(Caused by the bacterium *Ralstonia solanacearum)* | Worldwide

This economically devastating disease of tomato is often lethal to tomato and other crops like eggplant. Symptoms first appear as flaccidity on young leaves and, when conditions are favorable, quickly develop into complete wilt. Other symptoms include brown discoloration of the vascular system, especially near the soil line, and adventitious roots on the lower stems. Infected plants often die, resulting in a severe reduction to yield.

Insects

Helicoverpa armigera

(Tomato fruitworm) | Worldwide

This major pest of food and fiber crops has a wide host range, including tomato, corn, eggplants, crucifers, melons, beans, and others. Most of the damage is caused by fruitworm larvae feeding on flowers, flower buds, and fruits.

Spodoptera litura

(Army worm) | Worldwide

A polyphagous pest that feeds on wide host range of crops including the families *Solanacease*, *Malvaceae*, *Cruciferae*, *Fabaceae*, and others. Early larval instars and caterpillars feed in clusters skeletonizing the leaves.

Bemisia spp. whitefly complex

Worldwide

Responsible for heavy crop losses worldwide, often related to its role in transmitting viral diseases including *Tomato yellow leaf curl virus* (TYLCV).

Tuta absoluta

Worldwide

The tomato leafminer causes damage primarily to tomato but could also affect other crops. Larval feeding on tomato may result in 100% loss of the crop.

Thrips species

Worldwide

Thrips are polyphagous, feeding on a wide host range. Several tospoviruses, such as *Peanut bud necrosis virus* (PBNV) and *Tomato spotted wilt virus* (TSWV), are transmitted by thrips and are responsible for major economic damages to tomato.

tomato ipm **techniques**

Photos from left to right: Grafted tomatoes growing under cover | A tomato plant suffering from bacterial wilt | *Peanut bud necrosis virus* can be managed with roguing, as a rogued plot versus an unrogued plot show

Soil preparation

Preparing the soil before planting results in healthy plants with minimal pest problems. Soil solarization and fertilization combined with compost inoculated with *Trichoderma* spp., neem cake, and vesicular arbuscular mycorrhiza (VAM) fungus improves the nutrients available to the crop, priming the plant's own defenses and reducing the incidence of nematodes, plant diseases, and weeds.

Seed selection

Selecting a high-yielding, locally-preferred tomato variety that is tolerant to insect-transmitted virus diseases caused by *Tomato yellow leaf curl virus* and *Peanut bud necrosis virus* and is free from seed-borne viruses like the *Tomato mosaic virus* and the *Cucumber mosaic virus* is a key decision in raising a healthy crop. These varieties are available from a variety of sources: the World Vegetable Center, national agricultural research institutes, universities, and the private sector.

Seed treatment

Treating seeds with the *Trichoderma viride* fungus and the *Pseudomonas fluorescens* and *Bacillus subtilis* bacteria protects seedlings from fungal, bacterial and nematode attacks, increases seedling vigor, and induces plant defense against pests.

Seedling nursery

Good seedbed preparation is fundamental to the production of healthy plants. The use of seedling trays and blocks reduces contamination. Protecting seedlings from thrips and whitefly vectors by using screens and netting can prevent or delay early virus infections. Irrigation should be monitored to prevent excess moisture, which increases the incidence of fungal diseases.

Seedling selection

All seedlings in the nursery should be examined for symptoms of viral diseases, and suspected seedlings should be removed from the planting material. *Peanut bud necrosis virus* transmitted by thrips is a serious problem on tomatoes in India. Roguing infected seedlings before transplanting will dramatically decrease the incidence of the disease, leading to a higher benefit to cost ratio.

Roguing

Within the first 45 days after transplanting, monitor crops and remove and dispose of *Peanut bud necrosis virus*-infected plants. This prevents disease spread by thrips within the field.

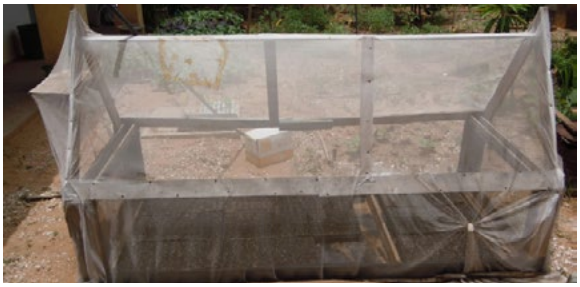
Grafting

By grafting high-yielding tomato scions on disease-resistant rootstock of wild solanums, healthy tomatoes grow in soil known to be infected with *Ralstonia solanacearum* that cause bacterial wilt disease. Grafting increases the yield and robustness of plants.

Fertilization

Neem cake or mustard oil cake alone, or in combination with compost inoculated with *Trichoderma* spp., is effective against soilborne diseases. Using neem and mustard oil cakes reduces the incidence of nematodes in vegetable crops. Additionally, they contribute to the build-up of beneficial soil microbes that assist in nutrient absorption by the plants.

tomato ipm **techniques**



Photos from left to right: Tomato seedlings under cover are protected from pests |A pheromone trap to attract pests| A researcher holding a sticky trap filled with *Tuta absoluta* moths from a tomato field in Senegal

Mulching

Mulching conserves moisture, harbors natural enemies, and reduces insect pest and disease incidence.

Sticky traps

Setting up large, yellow sticky sheets in fields helps to reduce pest populations such as aphids, thrips, and whiteflies.

Host-free period

Keeping an area free of tomato and pepper crops for two months before planting a tomato crop reduces the incidence of the *Tomato yellow leaf curl virus* transmitted by the whitefly *Bemisia tabaci*.

Staking

Staking tomatoes in the field increases proper aeration and exposure to sunlight and prevents shoots and fruits from touching the soil. This also reduces late blight infection and fruit rot.

Biological control

Inundative release of parasitoids such as *Trichogramma* spp. and *Bracon* spp. controls caterpillar pests such as *H. armigera*, *S. litura, T. absoluta,* and the semilooper *Trichoplusia ni*.

Pheromone traps

Sex pheromone traps for the tomato fruit worm *Helicoverpa armigera* and the army worm *Spodoptera litura* should be set up in the field. Pheromone traps for the tomato leafminer *Tuta absoluta* should be set up in Senegal where this pest has recently been introduced. Once pests are found in the traps, the field should be monitored, and a specific biopesticide should be used if necessary.

Microbial biological control agents

In addition to the use of nuclear polyhedrosis viruses (NPVs) against specific insect pests, formulations of the fungi *Verticillium, Paecilomyces, Metarhizium*, and *Beauveria* species and formulations of beneficial nematodes such as *Heterorhabditis* sp. and *Steinernema* sp. may be used for the control of whiteflies, thrips, and leafminers.

Microbial control agents have little or no impact on parasitoids and predators of pests. For this reason, natural enemies will continue to serve as effective regulators of a variety of pests. By using these biopesticides, one may totally eliminate the use of synthetic pesticides and thus produce pesticide-free crops for consumers.

FOR MORE INFORMATION

The **Integrated Pest Management Innovation Lab** (IPM IL, formerly the IPM CRSP) develops sustainable and economical pest control methods to improve livelihoods for farmers worldwide. Our eight projects in seven countries work with scientists, extension agents, students, and farmers in the tropical and subtropical world.

We are funded by USAID and housed at Virginia Tech in Blacksburg, Virginia.

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