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A REVIEW OF THE MOST IMPORTANT PEST INSECTS AND ITS INFLUENCE ON TOMATO CULTURE

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INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is a major horticultural crop with an estimated global production of over 120 million metric tons (F.A.O. 2007). The species is the important vegetable crops grown throughout the world and ranks next to potato in terms of the area but ranks first as a processing crop. Tomatoes are the subject to attack by a large number of insect pests from the time plants first emerge in the seed bed until harvest. Aphids, flea beetles, leaf miners, and spider mites threaten young plant-bed tomatoes. In the field, flea beetles, aphids, leaf miners, stink bugs, and fruit worms cause minimal damage to the foliage. All of them do not cause economic damage. A few of them (key pest) may cause damage to that extent where initiation of action becomes essential. However, severe damage may result either from their feeding on the fruit or by spreading certain diseases.

By paying attention to crop rotation and crop residue incorporation, the grower can help prevent population buildup in many pest species. The practice of growing the same crop continuously is an invitation to insect pest and diseases (Fouche, 2000). In the present paper, we survey recent findings in the areas of tomato pest insect attack. Research findings are considered particularly with respect to fruit quality, as reflected in the quality standards of the European Union.

MATERIAL AND METHODS

The objective of this work was to realize a screening of the main pest insect of tomatoes culture. The biological material was represented by *Lycopersicon esculentum* species.

The paper presents a literature review, regarding the pathogen insect attack. The investigated items presented are following:

- main insects
- monitoring of insect attack,
- risk period and damage,
- thresholds of attack,
- control of pathogens.

RESULTS AND DISCUSSIONS

Insects can significantly affect the overall profitability of crops, reducing both yield and seed quality. Insect damage is one of the main reasons for decreasing the harvest. Taking into account the way of attack and the way of feed the insects that attack the tomatoes culture can be classified as follows:

A. Pests that feed on the upper plant

A1. Pests that mine leaves or bore into fruits and/or buds

- **Tomato fruit worm,** presented in figure 1, is active year round, but is usually more abundant in tomato and pepper during warmer months of both the spring and fall. The insect may over summer on volunteer plants and numerous weed species, and migrates into tomato and pepper after the plants begin flowering. Larvae bore deeply into fruit, usually at or near the calyx. Infested fruit are rendered unmarketable and usually rot due to invasion of secondary microorganisms.

Fig. 1. Tomato fruit worm

- **Tobacco budworm** - This caterpillar is similar to the tomato fruit worm except mature worms are somewhat smaller and slightly more slender than tomato fruit worms; in addition, the microscopic spines on the skin of tobacco budworms are more slender, longer, and occur closer to the setae (hairs).
- **Tomato pinworm** - Young yellowish-gray larva only a few millimeters long, making blotch mines in leaves; older yellow, green, or gray, purple-spotted

larva up to 8 mm long, folding leaves and webbing them together, or boring into stems, buds, and fruit; fruits with pinholes and discolored blotches.

- **Vegetable leaf miner** - Colorless to bright yellow maggot, up to 3 mm long, with pointed head; makes serpentine mines in leaves; each mine slightly enlarged at one end.

Cause: Leaf miners are small larvae which burrow in-between the leaf layers. Small puncture marks can be observed on new leaves, caused by the adult females during the feeding and oviposition processes. Sometimes this can also result in a stippled appearance on foliage.

Symptoms: Typically the first signs you will come across are white 'wiggle' marks in the leaves which is the major form of damage by the larvae, and will result in the destruction of the internal leaf mesophyll, see fig. 2. The mine becomes noticeable after about three or four days after oviposition and becomes larger in size as the larva matures. Both leaf mining and the stippling caused by the female adult can greatly reduce leafs ability to photosynthesis. Extensive mining can also cause premature leaf drop.

Control: Leaf miner are difficult to control using a contact insecticides as they are pretty much out of reach, protected by the leaf membrane. They can be controlled by a systemic insecticide but is better to avoid the risk eating the crop afterwards. This is one of those cases where it may be best to leave them alone - other than picking off and destroying the worst affected parts of the plant. In fact, tomato plants can have as much as 60% of its foliage affected with leaf miner without affecting the fruit or its growth. After harvesting the crop, is indicate to double digging the soil where the tomatoes grew as the adult leaf miners experience difficulty in emerging if they are buried. Repeating this several times over the winter before re-planting the crops in the late spring can ensure the significant decreasing of attack.

Fig. 2. The leaf miner attack

A2. Chewing pests that make holes in leaves

- **Blister beetles** - Several species of slender, elongate beetles up to 19 mm long; have prominent heads; bodies variously colored but usually black, black with yellow margins, or black and yellow striped; stringy black excrement on heavily infested plants; foliage ragged; plants sometimes stunted. One of the most common of the tomato plants' many invaders, the blister beetle often attacks the plants in swarms, consuming the green foliage in massive amounts. The infestation can leave the crop of pillaged tomato plants.
- **Cabbage looper** - Green caterpillar (fig. 3) with longitudinal white stripes; body up to 30 mm long, tapers toward the head; 3 pairs of legs near head; 3 pairs of fleshy prolegs; young larva on underside of leaf; consumes tender leaf tissue leaving most veins intact. Cabbage loopers rarely cause serious damage. The cabbage looper larva is pale green with two pairs of prolegs in addition to the anal prolegs. It is a foliage feeder, and very rarely directly attacks the fruit. When large populations are present they can lower yields by reducing plant vigor and increasing sun scald of fruit through foliage loss. Typically, insecticides used to control tomato fruit worm keep cabbage looper under control.

Fig. 3 Cabbage looper - larvae

- **Colorado potato beetle** - Yellowish-brown, oval, convex beetle up to 14 mm long with 5 black longitudinal stripes on each wing cover and several black spots on the pronotum (area behind the head); Adults that have overwintered in the soil emerge and migrate into tomato fields and frequently begin their feeding on field margins. The adult and larva feed on the leaves and terminal growth of tomato plants, but typically only cause serious damage to young plants. Once plants reach 20 centimeters, adult or larval feeding, regardless of the apparent severity of damage, does not reduce fruit yield.
- **Flea beetles** - Various species of tiny, darkly colored beetles 2.5 to 4.5 mm long; have solid color body or black body with pale yellow stripe on each wing cover ; tiny round holes in foliage
- **Hornworms** - Green to reddish-brown caterpillars up to 90 mm long with red or black anal horn; body with 7 diagonal or 8 V-shaped marks on each side; round black spiracles along side of body; strips leaves from vines; infrequently feeds on fruit leaving large, open superficial scars

A3. Sap-sucking pests which cause leaf discoloration, leaf or fruit deformation, or defoliation

a) **Aphids** - Soft-bodied, pear-shaped insects with a pair of dark cornicles and a cauda protruding from the abdomen (fig. 4); may be winged or wingless -- wingless forms most common; feed in colonies; cause discoloration or mottling of the foliage; excrete honeydew on which sooty mold grows.
Cause: Aphids are a well known pest insect that can quickly colonise the soft tissue parts of your plant. They damage and weaken the plant by sucking the sap out of pressurized parenchyma cells just below the leaf cuticle.
Symptoms: Clusters of these small insects are readily identifiable, normally at the plants tips or on the underside of their leaves. In severe cases, the infected parts can begin to wither due to the quantity of sap being removed from that area. The foliage can become sticky and may show signs of a harmless black mould called sooty mildew.
Control: There are many chemical treatments available including a number of organic, but all of these must be applied at the first signs of infection to achieve the best results. Try applying contact insecticides such as pyrethrum, derris or soft soap solutions as these are the best option for organic gardeners.

Fig. 4. The aphids attack

- **Green peach aphid**- Pale yellow to green wingless adult up to 2.4 mm long; winged adult with dark dorsal blotch on yellowish-green body; nymph with 3 dark lines on abdomen.
- **Potato aphid** - Adult and nymph both solid pink, green and pink mottled or light green with dark stripe; adult up to 3.5 mm long; long, slender cornicles about twice as long as cauda

b) **Greenhouse whitefly** - White moth-like insect about 1.5 mm long (fig. 5); found in conjunction with tiny yellow crawlers and/or green, oval, flattened, immobile nymphs and pupae; leaves yellow and drop from plant; some plants stunted and unreproductive; black sooty mold often present on leaves.
Cause: Greenhouse whiteflies are a well known pest insect on protected crops and can quickly colonize the soft tissue parts of your plant. They damage and weaken the plant by sucking the sap out of pressurised parenchyma cells just below the leave cuticle.
Symptoms: Like aphids, whiteflies have piercing-sucking mouthparts so the damage caused is very similar to that of aphids. Direct damage to tomato plants can cause deformed new growth and wilting, chlorotic leaves. Whiteflies can also transmit some plant viruses, so if your plant becomes infected, immediately remove and destroy. Also like aphids, whiteflies secrete honeydew, upon which an unsightly, yet harmless sooty mould will grow on. Feeding by whiteflies can also cause deformed fruit and discoloration of your tomatoes.
Treatment: There are many chemical treatments available including a number of organic, but all of these must be applied at the first signs of infection to achieve the best results. Try applying contact insecticides such as pyrethrum, derris or soft soap solutions as these are the best option for organic gardeners.

Fig. 5. The greenhouse whitefly attack

c) **Stink bug** - Green or brown (nymph green with orange and black markings) shield-shaped insect; adult up to 19 mm long; pierces buds and fruit causing buds to drop and fruit to be deformed. Stink bugs have a distinctive shield shape and produce an odor when handled. There are several species of stink bugs that feed on tomato fruit, but the brown stink bug is the most serious. Stink bugs feed with piercing-sucking mouthparts which cause whitish-yellow corky spots underneath the skin of the fruit. This damage is serious for fresh market tomatoes and whole pack processing tomatoes because they render the fruit unmarketable. Adult stink bugs migrate from weedy areas into tomato fields, particularly when the plants begin to decline. On green fruit, stink bug damage appears as a pin prick, surrounded by a light discolored area. This may turn yellow or remain green on ripe fruit and the tissue below these spots is corky.
d) **Silverleaf whitefly** - Adult is slightly smaller (0.96 mm in the female and 0.82 mm in the male), slightly more yellow in color and holds its wings roof-like at about a 45-degree angle; nymphs appear glassy to opaque yellowish and have a flattened and scale-like body with the margin near the leaf surface;

pupa is flattened, dome-shaped and lack setae; plants stunted and nonreproductive with black sooty mold present.

e) **Western flower thrips** - Adult is about 1 mm long, varies from a pale yellow to dark brown and has a rounded, narrow abdomen; larvae are distinctly yellow; plants are distorted and have a silvery appearance; an important vector of spotted wilt virus

B. Pests that feed on roots or lower stems

- **Cutworm** - Fat, basically gray, brown, or black caterpillar 40 to 50 mm long when fully grown; 3 pairs of legs near head; 5 pairs of fleshy prolegs; active at night; young caterpillar climbs on leaves, older caterpillar severs seedling stems near the ground; hides during the day in soil burrows at the bases of plants
- **Southern potato wireworm** - Slender, wire-like cylindrical larva with 3 pairs of short legs near the head and a pair of fleshy anal prolegs; white, cream, or yellow-gray body with red-orange head capsule; about 17 mm long when fully grown; closed notch in last abdominal segment; ragged, irregular holes in roots.

Tables 1 and 2 (Sorensen, 1983, Revised and pesticides added by Joey Williamson, HGIC Horticulture Extension Agent 02/14.) present some insecticides for control of insect pests of tomatoes. Insecticides such as permethrin, cyfluthrin or bifenthrin are effective in controlling stink bugs, leaf-footed bugs, aphids, fruitworms and hornworms. Carbaryl will control cutworms, fruitworms and hornworms.

Bacillus thuringiensis (*B.t.*) products are natural insecticides that contains spores of this bacterium and are used to only control caterpillars (the smaller the better) when they feed on leaves with the spores. *B.t.* products such as Dipel (dust) and Thuricide (liquid concentrate) are effective in the control of hornworms and tomato fruitworms. Sprays give better coverage and stay on the plants longer than dusts.

Spinosad is a natural product for the control of caterpillars and thrips. Pyrethrin is a natural product for the control of aphids and caterpillars. Neem oil extract and insecticidal soap are less toxic options for control of aphids and whiteflies. Adequate coverage of upper and lower leaf surfaces with these insecticides is important for good pest control.

Table 1. Insecticides for Control of Insect Pests of Tomatoes

Insect Pest	Natural, Less Toxic Insecticides	Contact Insecticides for Tomatoes	Contact Insecticides for Cherry Tomatoes
Aphids	insecticidal soap, neem oil extract	permethrin, bifenthrin cyhalothrin, malathion	bifenthrin, cyhalothrin, malathion
Tomato Fruitworms & Hornworms	*Bacillus thuringiensis (B.t.),* spinosad, pyrethrin, neem oil extract	carbaryl, permethrin bifenthrin, cyfluthrin	carbaryl, bifenthrin, cyfluthrin
Leaf-footed Bugs & Stink Bugs	horticultural oil	permethrin, bifenthrin cyfluthrin, alathion	bifenthrin, cyfluthrin malathion
Flea Beetles	insecticidal soap, neem oil extract, horticultural oil, pyrethrin	carbaryl,permethrin bifenthrin, cyfluthrin cyhalothrin	carbaryl, bifenthrin cyfluthrin, cyhalothrin
Whiteflies	insecticidal soap, neem oil extract, pyrethrin, horticultural oil	cyfluthrin, bifenthrin cyhalothrin	cyfluthrin, bifenthrin cyhalothrin
Thrips	spinosad	cyhalothrin	cyhalothrin
Spider Mites	insecticidal soap, horticultural oil	malathion	malathion
Cutworms	protective collars or *B.t.* mixed with molasses & grain as a bait	carbaryl, cyhalothrin	carbaryl, cyhalothrin

Table 2. Insecticide Products Labeled to Control Tomato Insect Pests

Insecticides & Fungicides	Days PHI	Examples of Brand Names & Products
Notes: The PHI (pre-harvest interval) is time to wait in days between spraying and harvesting, and is listed after each active ingredient above. Apply soaps or oils in the evening or early morning. [1]RTU = Ready to use (pre-mixed spray bottle) [2]RTS = Ready to spray (hose-end applicator)		
Bacillus thuringiensis (B.t.)	0	Green Light *B.t.* Worm Killer Concentrate Hi-Yield Thuricide Concentrate Monterey *B.t.* Concentrate Safer Caterpillar Killer with *B.t.* Concentrate Southern Ag Thuricide Spray Concentrate
Bifenthrin	1	Ferti-lome Broad Spectrum Insecticide Concentrate
Carbaryl	1	Bayer Advanced Complete Insect Killer for Gardens RTU[1] Garden Tech Sevin Concentrate; & RTS[2]; & RTU[1]
Cyfluthrin	1	Bayer Advanced Garden Power Force Multi Insect Killer Conc. Bonide Beetle Killer RTS[2] Bonide Caterpillar Killer RTS[2]
Cyhalothrin	1	Spectracide Triazicide Insect Killer for Lawns & Landscapes Conc.; & RTS[2]
Horticultural Oil	0	Monterey Horticultural Oil Concentrate Southern Ag Parafine Horticultural Oil
Insecticidal Soap	0	Espoma Earth-tone Insecticidal Soap Concentrate; & RTU[1] Natural Guard Insecticidal Soap Concentrate; & RTU[1] Safer Brand Insect Killing Soap Concentrate; & RTU[1]
Malathion	1	Bonide Malathion Concentrate Gordon's Malathion 50% Spray Concentrate Hi-Yield 55% Malathion Insect Spray Concentrate Spectracide Malathion 50% Insect Spray Concentrate Southern Ag Malathion 50% EC
Neem Oil Extract	0	Bonide Neem Oil Fungicide, Miticide & Insecticide Concentrate; & RTU[1] Green Light Neem Concentrate Monterey 70% Neem Oil Fungicide, Insecticide/Miticide Conc.; & RTS[2] Natural Guard Neem Concentrate Southern Ag Triple Action Neem Oil Concentrate Safer BioNeem Insecticide & Repellent Concentrate
Permethrin	1	Bonide Eight Insect Control Vegetable Fruit & Flower Concentrate Bonide Eight Insect Control Yard & Garden RTS[2] Bonide Total Pest Control – Outdoor Concentrate Hi-Yield Kill-A-Bug II Concentrate Hi-Yield Indoor/Outdoor Broad Use Insecticide
Pyrethrin	0	Bonide Garden Insect Spray Concentrate| Lilly Miller Worry Free Concentrate Insecticide & Miticide Southern Ag Natural Pyrethrin Concentrate Spectracide Garden Insect Killer Conc. (with Pipernyl Butoxide)
Spinosad	1	Bonide Colorado Potato Beetle Beater Concentrate Ferti-lome Borer, Bagworm & Leafminer Spray Concentrate Green Light Lawn & Garden Spray Spinosad Concentrate; & RTS[2] Monterey Garden Insect Spray Concentrate Natural Guard Spinosad Landscape & Garden Insecticide RTS[2] Southern Ag Conserve Naturalyte Insect Control Concentrate

CONCLUSIONS

Tomato is one of the most researched of all horticultural crops and considerable progress has been achieved in all the areas including in pest insect attack. Although tomato plants are easy to grow, they are vulnerable to a variety of insect pests. Whether the plants grow in greenhouses or in a field, caterpillars and other bugs can strip the leaves or damage the fruit.

Pest management should be based on the proper identification of pests and knowledge of their biology. Some insects may be more important in some areas than others. Cultural practices are helpful in avoiding many insect infestations. Tomatoes should be planted in well-prepared, fertile beds, mulched and properly watered to promote vigorous growth. Stressed plants tend to attract more insect pests than healthy plants.In a home garden, handpicking and destroying many pests is an effective control measure. In addition, beneficial insects are very helpful in controlling insects such as aphids, leaf miners and hornworms. To avoid killing these beneficials, use insecticides only when necessary.

ABSTRACT

Tomato is one of the most important vegetable crops cultivated all over the world. Because of its value growers often apply pesticides too often in order to protect their investment. This often leads to development of insect resistance, environmental contamination, worker and food safety issues and poor management of pests. The key to any successful pest management program is to develop a regular scouting plan to gain information on insect pest populations that may be used to determine if insecticide applications are needed. Monitoring can consist of sampling groups of 10 plants which are randomly selected at 5-8 different locations in a field. Samples should be distributed throughout the field so that plants near the edges and middle of the field are examined. In recent years there has been a great increase in new control technologies available to growers, this makes management of insect pests in tomatoes an ongoing process. The new insecticides generally act against a narrower range of pest species than the older, broad-spectrum materials. Therefore, it is critical to properly identify the pest to be controlled and to determine its potential for damage. The only way to obtain this information is through routine scouting. The purpose of this work is to serve as a reference for insect pest identification.

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