

The optimum temperature of 95 degrees F would be used as the high temperature for the day when calculating the average temperature for that day.

Biologicals

There are a number of natural products and biological control agents that can be used to manage insect pests of small fruit. Biological pesticides (bio-rational pesticides) are formulated products that use toxins produced by plants (such as rotenone, pyrethrum, sabadilla, ryania, and azadirachtin), or by microorganisms (bacteria, fungi, and viruses).

Rotenone is extracted from the roots of leguminous plants in the genera *Derris* spp. (Far East), or *Lonchocarpus* spp. (Amazon basin, South America). Indigenous people use crude extracts that contain rotenone to kill fish in streams and lakes for harvest, so be careful when using this material around fish bearing waters. *Pyrethrum* is extracted from the flowers of *Chrysanthemum coccineum* and *C. carneum*.

The primary source of pyrethrum today is Kenya. Pyrethrum is a complex of chemicals that attack the peripheral nervous system, and for this reason it is quick acting. *Sabadilla* is extracted from the seeds of the lily-like *Schoenocaulon officinale* plant from Venezuela. The principal ingredients of sabadilla are two alkaloids, cevadine and veratridine.

Ryania is extracted from ground stemwood of *Ryania speciosa*. These botanical insecticides have broad-spectral activity, and are harmful to insect pests and their natural enemies, while azadirachtin is toxic to insect pests and relatively nontoxic to biological control agents. **Azadirachtin** is one of a complex of chemicals (over 20 active ingredients) extracted from the foliage and seeds of the neem tree (*Azadirachta indica*).

There are different strains of *Bacillus thuringiensis* that produce different Cry toxins. These toxins must be ingested to be effective, and are most effective against small larvae, and for this reason timing of applications is critical. Toxins from *B.t. aizawai* (Cry 1C) and *B.t. kurstaki* (Cry 1Aa, 1Ab, & 1Ac) are toxic to Lepidoptera larvae (caterpillars), while the *B.t. tenebrionis* (Cry 3A) toxin is specific to Colorado potato beetle larvae, and a few other leaf feeding beetles that attack trees. Formulated products may contain toxins from one or more strains of Bt. There are other products derived from toxins produced by microorganisms.

Spinosyns are a naturally derived group of chemicals produced by an Actinomycete fungus, *Saccharopolyspora spinosa*, and formulated as **SpinTor**. This product is very effective against a wide range of insect pests, yet relatively harmless to natural enemies. Avermectin B1a (80%) and B1b (20%) are formulated as **Agri-Mek**. The avermectins are derived from another Actinomycete fungus, *Streptomyces avermitilis*. Agri-Mek is very effective against spider mites, and relatively harmless against natural enemies.

Several bio-rational products have been developed by reacting oleic acid with potassium hydroxide to produce potassium oleate, or soap. Potassium oleate used to be available as "Castile Soap." This soap was made from olive oil, while the insecticidal soaps are made from oleic acid extracted from animal fat. The insecticide product is **Safer's Soap**, and the herbicide is **Scythe**.

Natural Enemies and Predators

There are a wide range of insect natural enemies, such as other insects, nematodes, fungi, and viruses that can be used to control insect pests of small fruits. Many of these biological control agents are mass-produced and available for purchase. The cost-effectiveness of using biological control agents varies significantly from one situation to another. Often, inundative releases of purchased organisms are quite expensive and may not "pay-off" if another alternative is available. It is best to take advantage of existing populations of natural enemies and to engage in practices that protect these agents. To this end, it is important to use "soft insecticides," i.e. insecticides that are toxic to the target pest, but relatively nontoxic to natural enemies, or to use other practices that disrupt the pest's biology, such

Warning! Pesticides are poisonous. Read and follow all directions and safety precautions on labels. Handle carefully and store in original labeled containers out of reach of children, pets and livestock. Dispose of empty containers immediately in a safe manner and place. Contact your state Department of Agriculture for current regulations.

as crop rotation, delayed planting, early harvest, etc. However, if a release of a commercially reared natural enemy, predator, parasite, or competitive agent is desired, contact your local Extension Specialist for recommended sources.

Pesticide Safety and Use

All pesticides listed in this publication are registered and cleared for suggested uses according to federal and state regulations in effect on the date of this publication. Follow the current label.

Trade names are used for identification only; no product endorsement is implied, nor is discrimination intended against similar materials.

Label Formulations

The recommendations within this publication list only one formulation of a given pesticide. Growers should be aware of other formulations. The rates to be applied are on the product label.

Before Using Pesticides

Read and post safety rules and list of poison control centers. See instructions on safe storage of pesticides on page 22. You should become familiar with the information on storage and toxicity of pesticides listed in the appendix of this guide. Similar pesticide products may not have the same crop uses. Always be certain the crop is listed on the product label before ordering or using the product.

DO NOT use concentrations greater than stated on the label. DO NOT apply more pesticide per acre or more frequently than the fewest number of days between applications recommended by the label.

Instruct your family, co-workers and farm laborers on the safe use of pesticides, protective clothing and reentry regulations concerning pesticides. See farm worker protection standards on page 20.

DO NOT spray or dust when bees are active in the field. Morning or late evening is usually the best time to spray.

Precautions

- Read and follow all directions and safety

precautions on labels.

- Store pesticides in original containers, out of reach of children, pets and livestock.
- Dispose of empty containers immediately in a safe manner and place. Triple rinse.
- DO NOT contaminate forage, watersheds or water sources.
- Become familiar with life cycles of pests to properly time applications.
- Keep a complete diary of applications: crop, date of planting, pests, weather conditions, materials, date of application and amounts applied.
- Adhere to farm worker protection standards.

Poison Control Centers for the New England states are listed on the back cover. **For an emergency, EPA maintains a 24-hour medical consultation service in case of pesticide poisoning: 1-800-424-8802.** DO NOT use this number on a regular basis; use it only in an emergency! It is set up primarily for consultation with physicians and other health professionals needing assistance in the treatment of pesticide poisonings.

Reentry Period

Be sure all treated areas are posted to keep out unauthorized persons.

Persons must not be allowed to enter the treated area until after sprays have dried or dusts have settled and until sufficient time has passed to insure that there is no danger of excessive exposure. Follow label reentry restrictions. At no time during the reentry period are farm workers allowed to enter the treated area to engage in activity requiring substantial contact with the treated crop. Protective clothing and safety equipment may be needed for all persons, including farm workers, entering the treated areas.

Information About Pesticides

A pesticide is referred to: (1) by a common name or (2) by a trade or brand name (trade names are capitalized in this guide).

Labeled Formulations: The recommendations within this publication usually list only one formulation. Growers should be aware of other formulations. The rates to be applied are on the label.

Note: There may be several products registered with the same active ingredient. Each label is different, and some crops may be listed on some