

## Less Toxic Insecticides

While a good pest management plan will start with preventative, cultural and other non-chemical methods, these are sometimes not completely effective on their own. In this case a pesticide may be considered. If pesticide use is deemed necessary for control of the pest problem, it is good practice to use the least toxic pesticide that will do the job effectively. Although all pesticides are by their nature toxic in some way to some organisms, there are now a number of "less toxic" pesticide options.

Insecticides may be considered less toxic for several reasons. Generally they should pose less risk to human and environmental health than conventional insecticides. Many break down rapidly and do not accumulate in the body or environment. Some are very pest specific and do little or no damage to other organisms. Still others, such as bait stations, minimize human exposure to the pesticide.

While "organic" insecticides are often less damaging to the environment than conventional insecticides, they are still pesticides. All pesticides should be evaluated before selection for level of toxicity, effectiveness, environmental impacts and costs. Some "organic" pesticides are as toxic, or even more toxic, than some synthetic pesticides.

### Soaps & Oils

Insecticidal soaps and oils have a number of advantages for controlling insects. They are virtually non-toxic to humans and other mammals, and are relatively safe to beneficial insects in the landscape. They control a wide range of common soft-bodied pests including aphids, mealybugs, thrips, whiteflies, mites, and scales. It is difficult for pests to develop resistance to oils and soaps. Soaps and oils are now readily available and relatively inexpensive.

Both soaps and oils can cause damage to plants if applied when plants are water stressed, temperatures are above 90 °F, or high humidity prevents rapid drying. Some plants are sensitive to oil sprays. Read and follow the label.

Since soaps and oils work on contact, an effective application must coat both the upper and lower leaf surfaces as well as stems for best results. Repeated applications may be necessary. Apply soap or oil sprays in the early morning or late evening to reduce drying times for more effective insect pest control.

**Insecticidal Soaps:** Insecticidal soaps damage the protective coat of soft-bodied insects causing them to dehydrate.

Homemade soap recipes are not recommended because they may be more likely to cause foliage burn. Commercial insecticidal soaps are tested on plants and are less likely to cause damage. Some are available as concentrates to dilute before spraying, and some are available as pre-mixed Ready to Use (RTU) bottles. Examples of insecticidal soap products are:

- Bonide Insecticidal Soap Conc. (47%) & RTU (1%)
- Natural Guard Insecticidal Soap Conc. (47%) & RTU (1%)
- Garden Safe Insecticidal Soap Insect Killer Conc. (47%) & RTU (1%)
- Safer Brand Insect Killing Soap Conc. (49.52%) & RTU (1%) OMRI
- Espoma Earth-tone Insecticidal Soap Conc. (47%) & RTU (1%)
- Concern Rose & Flower Insect Killer II RTU
- Bayer Natria Insecticidal Soap RTU (1%)

- Raid Earth Options Insecticidal Soap RTU (1%) OMRI
- Whitney Farms Insecticidal Soap RTU (1%)
- Bayer Natria Insecticidal Soap RTU (1%)

**Horticultural Oils:** Oil products smother soft bodied insects on contact. Oils are formulated as either horticultural or dormant oils. Dormant oils are heavier, less refined oils used on dormant, leafless plants to control overwintering insects (e.g., aphids, spider mites, and scales). Dormant oils will damage plant foliage if used during the growing season. Horticultural oils are also called summer or superior oils, and these are lighter and more refined. They can be applied to both actively growing plants, as well as dormant plants for insect pest control. Do not apply horticultural oil sprays when the temperature is above 90 °F, or if rain is in the forecast within 24 hours.

Most horticultural oils are applied at a 1 to 2% mix with water to spray actively growing plants (this would be 2½ to 5 tablespoons of oil with a gallon of water). To use horticultural oil as a “dormant oil” spray to control pests on woody plant bark, they are mixed at 4% with water (this would be 10 tablespoons of oil per gallon of water). Always spray very late in the day to slow drying time, and to get better insect control. Most are available as concentrates made to dilute with water in a sprayer, although some are available as either a Ready to Spray (RTS), which is a bottle to attach to a garden hose for spraying, or as a Ready to Use (RTU), which is a pre-mixed spray bottle. Examples of horticultural oils are:

- Ferti-lome Horticultural Oil Spray Concentrate (80%) & RTS
- Southern Ag Parafine Horticultural Oil (98%)
- Bonide All Seasons Spray Oil Concentrate ((98%) & RTU
- Monterey Horticultural Oil Concentrate (80%) & RTS

## Botanical Insecticides

Botanical insecticides are naturally occurring toxins extracted from plants. There are several advantages to using botanical rather than synthetic insecticides. Plant derived insecticides breakdown quickly in the environment, resulting in little risk of residues on food crops and less risk to beneficial insects. Some

materials can be used shortly before harvest. Most botanicals are rapid acting and most, but not all botanicals are of low to moderate toxicity to mammals. Because most botanical insecticides must be eaten by the insect pest, they are primarily harmful to these pests and do little harm to beneficial insects.

There can also be disadvantages to using these products. Rapid break down, while less risky to health and environment, often creates a need for precise timing or more frequent applications. Several botanical insecticides are quite toxic and should be handled accordingly. Some botanical insecticides can be difficult to find in local stores.

**Neem products:** **Neem oil** is botanical insecticide made from extracts of Neem tree seeds. The active ingredient is listed on product labels as hydrophobic extracts of neem oil. It is used to control a wide variety of insects including leafminers, whiteflies, thrips, caterpillars, aphids, mealybugs, spider mites, scale crawlers, and beetles. Neem oil is most effective against actively growing immature insects. Neem oil sprays kill small insect pests and mites by suffocation as do horticultural oil sprays, but also has some insecticidal properties. Neem oil sprays have some fungicidal activity, but it is typically limited to powdery mildew control. This control is primarily because it is oil. However, a horticultural oil spray generally works better for powdery mildew control.

**Azadirachtin**, the active ingredient in neem extracts, has a very low mammalian toxicity. It has been separated from the neem oil. It acts as an insect feeding deterrent and growth regulator. Azadirachtin does not produce a quick knockdown and kill, but stops insect feeding. The treated insect usually cannot molt into its next life stage and dies without reproducing. It also is an egg-laying deterrent.

Many commercial neem products exist, and these products are labeled for use on ornamentals, foliage plants, trees, shrubs and food crops. Most neem oil products are available as concentrates made to dilute with water in a sprayer, but some are available as either Ready to Spray (RTS), which is a bottle to attach to a garden hose for spraying, or as Ready to Use (RTU), which is a pre-mixed spray

bottle. Examples of neem products for landscape and garden use include:

**Neem Oil:**

- Southern Ag Triple Action Neem Oil Concentrate,
- Ferti-lome Rose, Flower & Vegetable Spray Concentrate,
- Bonide Rose Rx 3-in-1 Concentrate; & RTU,
- Bonide Neem Oil Concentrate; & RTU,
- Natural Guard Neem Concentrate,
- Garden Safe Fungicide 3 Conc.; & RTU OMRI,
- Garden Safe Neem Oil Extract Conc. OMRI,
- Concern Garden Defense Multi-Purpose Spray Concentrate,
- Monterey 70% Neem Oil Fungicide/ Insecticide/Miticide Conc.; & RTS OMRI.

**Azadiractin:**

- Gordon's Azatrol EC Insecticide,
- Safer Brand BioNeem Insecticide & Repellent Concentrate,

**Limonene** (also known as d-Limonene) is produced from citrus oils extracted from oranges and other citrus fruit peels. It is used as a contact insecticide against ants, roaches, palmetto bugs, fleas, silverfish and many other insects. Limonene has low oral and dermal toxicity to mammals, birds and fish, although it can cause skin irritation or sensitization in some people.

Pesticide products containing limonene are used for flea and tick control on pets, insecticide sprays, outdoor dog and cat repellents, mosquito larvicides, and insect repellents. Many products containing limonene are labeled as safe for use in areas near food. Limonene is the active ingredient in Ortho Home Defense Indoor Insect Killer, Concern Citrus Home Pest Control, and in products made by Orange Guard. Safer Fire Ant Killer and Citrex Fire Ant Killer also contain d-Limonene.

**Capsaicin** is the material that makes chili peppers hot. It can be used on ornamentals outdoors and indoors for control of aphids, spider mites, thrips, whitefly, lace bugs, leafhoppers, and other pests. It is important to note that capsaicin containing products are primarily used to repel insects, rather

than to kill existing infestations, and they appear to be effective at repelling certain animal pests such as rabbits, deer and squirrels. Products containing capsaicin include:

- Bonide Hot Pepper Wax Insect Repellent RTU,
- Bonide Hot Pepper Wax Animal Repellent RTU,
- Bonide Go Away Deer & Rabbit Repellent RTU.

**Pyrethrin:** Pyrethrum is made from the finely powdered flowers of a species of daisy. The word pyrethrum is the name for the crude flower dust itself, and the term pyrethrin refers to the insecticidal compounds that are extracted from pyrethrum. Pyrethroids are not botanical insecticides, but synthetically produced pesticides that are very similar in structure to the pyrethrins.

Pyrethrin is a contact insecticide and must be applied directly to the insect to be effective. Pyrethrum rapidly paralyzes pests, but may not kill them. Pyrethrins are often formulated with another insecticide to ensure that paralyzed insects do not recover and once again become pests.

Because the pyrethrin mammalian toxicity is very low, it can be applied to food crops close to harvest. Pyrethrum has high contact toxicity for common beneficial insects. Pyrethrin's insecticidal activity only lasts a few hours. There are many products with pyrethrin available; some products with pyrethrin alone, and other products combined with another insecticide, such as:

**Pyrethrins:**

- PyGanic Crop Protection EC 1.4 (1.4% a.i.) OMRI,
- PyGanic Crop Protection EC 5.0 (5.9% a.i.) OMRI.

**Neem Oil with Pyrethrins:**

- Ferti-lome Triple Action Plus II with Neem Oil,
- Ferti-lome Fruit Tree Spray Concentrate,
- Bonide Bon-Neem II Concentrate,
- Ortho Tree & Shrub Fruit Tree Spray Concentrate.

### ***Pyrethrins & Piperonyl Butoxide:***

- Southern Ag Natural Pyrethrin Concentrate,
- Bonide Pyrethrin Garden Insect Spray Concentrate,
- Bonide Japanese Beetle Killer RTU,
- Garden Safe (Schultz) Rose & Flower Insect Killer RTU,
- GardenTech-Worry Free Insecticide & Miticide Conc.; RTS; RTU.

### ***Pyrethrins & Sulfur:***

- Bayer Advanced Natria Insect, Disease & Mite Control RTU & RTS,
- Espoma Earth-tone Disease Control Concentrate; & RTU,
- Bonide Citrus Fruit & Nut Orchard Spray Concentrate; & RTS,
- Bonide Tomato & Vegetable 3 in 1 Concentrate; & RTS,

### ***Pyrethrins & Canola Oil:***

- Espoma Earth-tone Insect Control Conc. & RTU,
- Monterey Take Down Garden Spray Concentrate,
- Whitney Farms Outdoor Insect Killer RTU,

**Garlic** is marketed in several products intended to repel insects, much as capsaicin does. Products are labeled to repel a wide variety of pests on ornamental plants, but garlic may also repel nuisance animals. To date there is limited research showing effectiveness of garlic insecticides.

Products containing garlic or garlic oil include:

- Havahart Deer Off Deer, Rabbit & Squirrel Repellent Concentrate; & RTU,
- Sweeney's Deer & Rabbit Repellent Concentrate,
- Captiva Insect Repellent/ Insecticide.

**Rotenone, Sabadilla, Ryania, and Nicotine** are older botanical insecticides that are no longer available due to toxicity to people and/or the environment. Although these insecticides were naturally-derived, they are more toxic or harmful than many commercially produced insecticides.

### **Essential Oils**

A variety of pesticides based on essential oils or components of essential oils have come on the market in the last few years. Essential oils are volatile, highly concentrated substances extracted from plant parts. In 1996 the EPA established that certain ingredients that pose minimum risk to users no longer require EPA approval to be marketed as insecticides. A number of these ingredients are essential oils, including the oils of cedar, cinnamon, citronella, citrus, clove, eugenol (a component of clove oil), garlic, mints, rosemary, and several others. As insecticides, these work most commonly as contact killing agents only, so re-treatment may be needed. Most essential oils used as pesticides work by disrupting an insect neurotransmitter that is not present in people, pets, or other vertebrates.

**Eugenol** is a component of clove oil. It is a fast acting contact insecticide that is effective on a wide variety of household pests such as cockroaches, ants, dust mites, flies, wasps, spiders, crickets, and fleas. It is also used on some ornamental plant pests such as armyworms, thrips, aphids and mites.

Eugenol has little or no residual activity, although the scent of cloves will linger. Products based on eugenol are considered minimum risk pesticides with very low risk of damage to the environment. Eugenol is rapidly absorbed by skin, is toxic to human skin cells, and can cause severe eye irritation. Applicators should wear protective eye wear and water proof gloves for handling and spraying. Often clove oils are mixed with other natural oils, such as rosemary oil, thyme oil, and sesame oil for enhanced control. Products that contain eugenol include:

- Bioganic Safety Brand's Barrier Treatment Indoor/Outdoor Insect Control,
- Bioganic Brand's Flying Insect Killer,
- Bioganic Safety Brand's Lawn and Garden Spray.

### **Microbial Insecticides**

Microbial insecticides contain microorganisms (viruses, bacteria, fungi, protozoa, or nematodes) or their by-products. Microbial insecticides are especially valuable because their toxicity to animals and humans is extremely low.

Insecticidal products comprised of a single species of microorganism may be active against a wide variety of insects or group of related insects (such as caterpillars) or they may be effective against only one or a few species. Most are very specific. Since there is such a narrow range of insects killed, they spare the beneficial insects almost entirely.

***Bacillus thuringiensis*** products are the most widely used microbial insecticides in the United States. They are commonly known as *Bt*. Different subspecies of *Bt* are effective against different groups of insects or their larvae.

The best results will be achieved using *Bt* products by following a few guidelines.

- Make sure the *Bt* product you have chosen lists the specific insect you want to control.
- Make sure the insect is at a stage where it is susceptible to control by *Bt*. In general, *Bt* products are effective against young larval stages, but will not kill adults.
- Spray the parts of the plant on which insects are feeding thoroughly, including the underside of leaves. *Bt* products must be eaten in order to be effective. Liquid formulations are more effective and stay on plants better than dust formulations.
- Treat with *Bt* in late afternoon or evening, or on a cloudy day as *Bt* breaks down in sunlight.
- Be aware that *Bt* does not kill immediately, but the poisoned insects will stop feeding almost immediately.

***Bacillus thuringiensis var. kurstaki (Btk)*** products are toxic only to larvae of butterflies and moths. They are used to safely control many common leaf-feeding caterpillars, including caterpillar pests on vegetables, bagworms and tent caterpillars on trees and shrubs, and European corn borer larvae.

Some caterpillars are not effectively controlled by *Bt*, especially those that live in the soil or bore into plant tissues without consuming a significant amount of the *Bt* applied to plant surfaces.

***Bacillus thuringiensis var. kurstaki*** products include:

- Safer Caterpillar Killer with *B.t.* Concentrate,
- American Brand Thuricide Concentrate,

- Bonide Thuricide *Bt* Concentrate,
- Southern Ag Thuricide *Bt* Caterpillar Control (Concentrate),
- Hi-Yield Thuricide Concentrate,
- Southern Ag Thuricide *Bt* Caterpillar Control Concentrate,
- Tiger Brand Worm Killer Concentrate,
- Monterey *Bt*,
- Organic Laboratories Organocide Worm & Caterpillar Control,
- Ferti-lome Dipel Dust,
- Southern Ag Dipel Dust,
- Safer Brand Garden Dust with *Bt*.

***Bacillus thuringiensis var. israelensis (Bti)***

formulations kill mosquito, black fly, and fungus gnat larvae. *Bti* is most effective for mosquito or black fly control when it is used on a community-wide basis. For most homeowners, eliminating standing water sources is more effective than applying *Bti* or other insecticides. Floating products sold as dunks or pellets can eliminate mosquito larvae in ornamental ponds and other areas that cannot be drained. *Bti* products that are available commercially include:

- Summit Mosquito Dunks,
- Summit Mosquito Bits,

**Milky Spore** products contain the bacteria *Bacillus popilliae* and *Bacillus lentimorbus*. Milky spore is applied to turf and watered into the soil below to control the larval (grub) stage of the Japanese beetle and, less effectively, some other beetle grubs. If a substantial grub population is present at the time of application, milky spore can survive beneath undisturbed sod for a period of 15 to 20 years. Consequently, lawn applications of milky spore bacteria might not have to be repeated each year. Examples of products are:

- St Gabriel's Milky Spore Powder Japanese Beetle Control
- St Gabriel's Milky Spore Granular Grub Control

**Spinosad** is an insect toxin derived from a soil-dwelling bacterium. It kills primarily by ingestion and is used against fire ants, caterpillars, thrips, leaf miners, and some beetles. It is also used against caterpillar borers of fruit trees. When applied at recommended rates, this product poses less risk than most insecticides to mammals, birds, fish, and

beneficial insects. It is, however, toxic to bees, and should not be applied to plants in flower. Affected pests stop feeding within minutes, but may remain on the plant for up to two days. Always spray plants late in the day to reduce any harmful effect on pollinating insects.

Products containing spinosad are sold as concentrates to spray, or as fire ant baits in granular form. The sprays are labeled for use on ornamentals, lawns, and vegetables; the baits can be used in landscapes and within vegetable gardens. Examples of concentrates and baits are:

#### ***Spinosad Concentrates:***

- Southern Ag Conserve Naturalyte Insect Control Concentrate OMRI,
- Bonide Colorado Potato Beetle Beater Concentrate,
- Bonide Captain Jack's Deadbug Brew Concentrate; & RTS; & RTU,
- Ferti-lome Borer, Bagworm & Leafminer Spray Concentrate,
- Monterey Garden Insect Spray Concentrate,
- Natural Guard Spinosad Landscape & Garden Insecticide RTS.

#### ***Spinosad Fire Ant Baits:***

- Southern Ag Payback Fire Ant Bait,
- Garden Safe Fire Ant Killer Ready to Use Granules,
- Conserve Fire Ant Bait,
- Ferti-lome Come and Get It! Fire Ant Bait,
- Safer Brand Fire Ant Bait Ready to Use.

***Beauveria bassiana*** is a fungus that attacks and kills a variety of immature and adult insects. Insects effected by various formulations include whiteflies, aphids, mites, caterpillars, leaf hoppers, grasshoppers, Colorado potato beetles, Mexican bean beetles, Japanese beetles, boll weevils, cutworms, sod webworms, bark beetles, chinch bugs, fire ants, European corn borers, and codling moths. Beneficial insects, such as lady beetles, are also susceptible.

Products containing *Beauveria* work best when applied at the onset of an infestation. It typically takes three to seven days after application for the spores to germinate, penetrate, and grow throughout the insect, thus killing them. Thorough spray

coverage is essential because fungal spores must contact the insect for infection to occur.

Commercial products contain spores that germinate after application. New formulations do not require high humidity in order to provide effective control. Commercial products containing *Beauveria* include:

- Naturalis L,
- Botanigard 22WP or ES.

**Beneficial Nematodes** Nematodes are microscopic, worm-like parasites. While some species of nematodes are pests of turf grass and other plants, others are beneficial, being parasites of harmful insects. Since beneficial nematodes cannot develop in vertebrate animals, they are very safe for use in pest control.

Beneficial nematodes can be used to control a variety of plant pests, including larvae of black vine weevil, clearwing borers, cutworms, sod webworms, mole crickets and white grubs. It is important to select the proper nematode species when trying to control a particular pest.

Nematodes can be difficult to use for most home gardeners. They must be shipped, stored and used under specific temperature and moisture conditions, and generally must be used very soon after shipping. For this reason, they are best ordered from suppliers immediately after a pest problem is observed.

A number of nematode products are available by mail order. Be sure the product you are ordering is specified for the pest you have and that you are able to provide proper environmental conditions for the nematodes. In general, nematodes require moist conditions, high humidity, and temperatures between 55 and 90 °F with little direct sunlight.

#### **Minerals**

**Diatomaceous Earth** is a nontoxic powder composed of fossilized, one-celled organisms called diatoms. It is used to control slugs, millipedes, sow bugs, cockroaches, ants and soft-bodied insects like aphids. It has low mammalian toxicity. Use the "natural grade," not the type used as a filtering agent in swimming pools.

Prolonged exposure to diatomaceous earth will irritate lungs and other tissues of people or pets.

Because it also kills honeybees, avoid applying the product to crops in flower. Diatomaceous earth products include:

- Concern Diatomaceous Earth,
- Natural Guard Diatomaceous Earth,
- Bonide Diatomaceous Earth Crawling Insect Killer,
- Natural Guard Crawling Insect Control Containing Diatomaceous Earth,
- Safer Brand Ant & Crawling Insect Killer.

**Kaolin Clay** products act as a barrier that irritates insects and disguises the host plant by coating it with a ghostly white film. Insects are apparently unable to recognize plants treated with kaolin. It is most commonly used against a wide variety of pests on apple and pear trees. Also, kaolin can be used to control Japanese beetles, tarnished plant bugs, thrips, leafhoppers, cucumber beetles and Colorado potato beetles on vegetable crops. Kaolin must be applied as a preventative to be effective and cannot control a pest that is already established.

Kaolin clay can be applied up to the day of harvest and is non-toxic. Kaolin is sold as Surround Crop Protectant.

**Boric Acid** is derived from boron, a naturally occurring mineral. It acts as a stomach poison and causes insects to die from starvation. Boric acid is available in powder, paste, aerosol, tablet, and liquid forms for use against cockroaches, ants, and other insects. It should not be applied around plants in the landscape because, although boron is a necessary plant micro-nutrient, larger than trace amounts are toxic to plants. Most boric acid products are available as ready-to-use products. Boric acid (labels may list this as orthoboric acid or sodium tetraborate) is sold under a number of brand names, including:

- Terro Outdoor Liquid Ant Baits,
- Pic Boric Acid Roach Killer Gel,
- Pic Ant Killing System (Bait),
- Terro Multi-Purpose Insect Bait,
- Amdro Kills Ants Liquid Ant Killer.

**Silica Gel** is an inert, nonabrasive material that is very effective in absorbing moisture. It absorbs the waxy coating on the insect's body and causes death by dehydration. Silica gel products are often used by professional pest control operators to control

cockroaches, silverfish, and other pests. Examples are BASF Tri-Die and Bayer Drione Insecticide. These contain 40% amorphous silica gel and 1% pyrethrins.

**Sulfur** is probably the oldest known pesticide in current use. It can be used as a dust, wettable powder, paste or liquid, and is primarily for disease control. However, mites, psyllids and thrips are also controlled by sulfur. Sulfur is nontoxic to mammals, but may irritate skin or especially eyes.

Sulfur is also used as a fungicide to control powdery mildew, rusts, brown rot and leaf spots on fruits, vegetables and ornamentals.

Sulfur has the potential to damage plants in hot, dry weather. It is also incompatible with other pesticides. Do not use sulfur within 20 to 30 days of applying spray oils to plants as it reacts with the oils and is more likely to cause damage to foliage. Do not apply sulfur when temperatures are above 80 °F. Examples of products containing sulfur are:

#### ***Sulfur:***

- Hi-Yield Wettable Dusting Sulfur,
- Safer Brand Garden Fungicide Concentrate; & RTU OMRI,
- Southern Ag Wettable or Dusting Sulfur,
- Bonide Sulfur Plant Fungicide (dust or spray),
- Ferti-lome Dusting Sulfur.

#### ***Sulfur & Pyrethrins:***

- Bayer Advanced Natria Insect Disease & Mite Control RTU,
- Bonide Citrus, Fruit & Nut Orchard Spray Concentrate,
- Espoma Earth-tone 3-in-1 Disease Control Concentrate; & RTU.

#### ***Sulfur with Insecticidal Soap:***

- Safer Brand 3-in-1 Concentrate OMRI.

### **Insect Growth Regulators**

Insect growth regulators (IGRs) are juvenile insect hormone analogs. They interfere with egg development and molting of various insect life stages. Because of their mode of action, they are very safe for vertebrate animals. IGRs are among the safest pesticides for application in homes. They are primarily used in homes for flea control. More information is available in [EIIS/HS-2, Flea Control](#).

Two commonly available IGRs are methoprene (Precor) and pyriproxyfen (Nylar). The latter is photostable, and therefore can also be used outdoors. Nylar is sold as Martin's IG Regulator.

## Safer Formulations

**Bait Stations** deliver an insecticide through a sealed plastic or metal chamber that insects enter. This gives bait stations the advantage of decreasing both the amount of insecticide used and the likelihood of exposure to it. Bait stations are particularly suitable for use in situations where the safety of children is a concern, or in areas where food is prepared or stored.

Numerous brands of bait stations are commonly available to control cockroaches and ants. Some of the more effective bait stations have fipronil as the active ingredient, but those with boric acid (it may list this as orthoboric acid or sodium tetraborate) are also available. Examples of products containing fipronil are:

- Terro Liquid Ant Bait,
- Combat Source Kill Max Ant Bait,
- Bayer Maxforce FC Ant Bait Stations,
- Combat Roach Killing Bait,
- Bayer Maxforce FC Magnum Roach Killer Bait Gel.

## Pesticide Safety

**Always** read the pesticide label and follow its directions exactly. You may **only** use the pesticide on sites or crops listed on the label. Be sure to observe all special precautions that are listed on the label. Wear protective clothing or equipment as listed on the label when mixing or applying pesticides. Mix pesticides at the rate recommended for the target site as listed on the label. Never use more than the label says. Follow all label directions for safe pesticide storage and disposal. Always remember to read and heed the six most important words on the label: "**KEEP OUT OF REACH OF CHILDREN.**"

**Caution:** Pollinating insects, such as honey bees and bumblebees, can be adversely affected by the use of pesticides. Avoid the use of spray pesticides (both insecticides and fungicides), as well as soil-applied, systemic insecticides unless absolutely necessary. If spraying is required, always spray late in the evening to reduce the direct impact on pollinating insects. Always try less toxic alternative sprays first for the control of insect pests and diseases. For example, sprays with insecticidal soap, horticultural oil, neem oil extract, spinosad, *Bacillus thuringiensis* (*B.t.*), or botanical oils can help control many small insect pests and mites that affect garden and landscape plants. Neem oil extract or botanical oil sprays may also reduce plant damage by repelling many insect pests. Practice cultural techniques to prevent or reduce the incidence of plant diseases, including pre-plant soil improvement, proper plant spacing, crop rotation, applying mulch, applying lime and fertilizer based on soil test results, and avoiding over-head irrigation and frequent watering of established plants. Additionally, there are less toxic spray fungicides that contain sulfur or copper soap, and biological control sprays for plant diseases that contain *Bacillus subtilis*. However, it is very important to always read and follow the label directions on each product. For more information, contact the Clemson Extension Home & Garden Information Center.

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Pesticides updated by Joey Williamson, HGIC Horticulture Extension Agent, Clemson University, 10/16. Revised by Joey Williamson, HGIC Horticulture Extension Agent, Clemson University, 09/15. Originally prepared by Karen Russ, HGIC Information Specialist, Clemson University. New 08/05.

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