Bacillus Thuringiensis applied as a spray

Dennis Ring
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Bacillus thuringiensis (*Bt*) is a species of bacterium found in the soil. It was isolated in 1901 and named in 1911. It was used as a commercial biological insecticide for the first time in the United States in 1958. *Bt* kills caterpillars, some fly larvae, and some beetle larvae but does not kill other organisms. A few strains of *Bt* are available in products used in the United States. *Bt* var. *kurstaki* is toxic to lepidopteran (butterfly, skipper, and moth) larvae. *Bt* var. *aizawai* is toxic to wax moth larvae. *Bt* var. *israelensis* is toxic to mosquitoes, midge, fungus gnats, and blackfly larvae. *Bt* var. *galleriae* is toxic to larvae of May or June beetles (white grubs). *Bt* var. *tenebrionis* (or var. San Diego) is toxic to Colorado potato beetle, elm leaf beetle, and willow leaf beetle larvae. However, it does not kill all leaf beetles.

Because this insecticide kills larvae of butterflies, moths, and skippers (lepidopterans), care should be taken so that nontarget plants are not treated and drift on other plants does not occur. If the product drifts to a nontarget plant with larvae of lepidopterans on them and is eaten by the larvae, then it will kill them. Monarch butterflies feed only on milkweed plants, so they will not be harmed if the insecticide does not come in contact with milkweed plants.

Bt strains are specific to the insects they kill; therefore, identifying the injurious insect is extremely important. The correct strain must be applied to susceptible insects. Applications of *Bt* to insects that are not susceptible will not kill them. It does not kill predators, parasites, or bees. *Bt* is most effective against young larvae and usually does not kill insects in the adult or other growth stages. Thus, inspections should be made frequently and applications made while larvae are small. Insects must eat *Bt* for it to be effective, and good coverage of the plant is important. Some insects do not eat the outside of the plant part they attack, so applications of *Bt* on the surface of the plant will not kill them. For example, the pecan nut casebearer (a moth) bites the outside of nutlets and spits them out. This insect eats the inside of nutlets and does not eat the *Bt*.

Bt as a biological insecticide applied to plants is not systemic (moving throughout the plant) or translaminar (moving throughout the leaf) and does not kill on contact. It is not toxic to predators, parasites, or pollinators and is listed as an organic insecticide. It is placed in a group of microorganisms that disrupt the midgut membranes of specific insects.

Bt is rapidly deactivated by ultraviolet sunlight. Applications made in the evening and on cloudy or rainy days last longer. However, heavy rains can wash *Bt* off a plant. Applications become inactivated in one to a few days and may need to be reapplied in three to seven days. Applications for leaf beetles may be effective for only one day. Applications of *Bt* do not result in continuous or long-term insect management, and *Bt* is applied similar to chemical insecticides. Once a solution of *Bt* is prepared, it should be used immediately, especially if the water used to make the solution has a pH greater than 7 (basic).

The effectiveness of *Bt* may be reduced after two or three years of storage. Dry formulations last longer than liquid formulations. *Bt* products should be stored out of sunlight and in cool, dry conditions.

A crystalline toxin and spore are usually produced by *Bt* cells. The toxin is called a delta endotoxin. *Bt* products usually, but not always, contain the toxin and spores of the bacterium. Spores may become bacterial cells inside the insect. Once the insect eats the *Bt,* the delta endotoxin is activated in the insect's gut by enzymes and alkaline conditions of the gut. The endotoxin disrupts the cell walls of the gut, and bacterial cells enter the insect's body. Infected insects stop feeding in a few hours and die in a few hours to weeks — frequently two to three days. Different strains of *Bt* have different endotoxins and kill different insects. The endotoxin is not activated in the gut of humans.

Commercial Applications of *Beauveria Bassiana*

Lori Moshman, Rodrigo Diaz, and Dennis Ring

Beauveria bassiana (Hypocreales: Clavicipitaceae) is an entomopathogenic fungus that occurs naturally in soil. Many strains exist and can vary in host range, pathogenicity (ability to infect a host), and virulence (ability to multiply in the host). The fungus was first isolated in 1835 by Italian scientist Agostino Bassi, who found that it killed and mummified silkworm larvae in what was called muscardine disease. The first commercial formulations of *B. bassiana* were developed in 1995 using the strains GHA and ATCC 74040, which are mass-produced by fermentation and sold under the trade names BotaniGard, Mycotrol, and Naturalis. Another strain, ANT-03, was isolated in 2000 and marketed in 2013 under the name BioCeres. Additional strains are available commercially for a variety of insect pests.

Beauveria bassiana is a contact insecticide, meaning its spores must physically contact the insect cuticle to be effective. It is therefore important to ensure thorough and even coverage when making applications. The insect doesn't need to ingest *B. bassiana*, as the fungal spores adhere to the insect and penetrate the body cavity when they germinate. Once inside, secondary metabolites (chemicals) are produced, including the toxin beauvericin and the antibiotic oosporein, which weaken the host's immune system and outcompete intestinal bacteria. White mold may grow out of the insect's body after it has died, but mold growth is not required to achieve control.

As a generalist feeder, *B. bassiana* controls all life stages of leaf-feeding insects, including common pests such as aphids, thrips, whiteflies, mealybugs, caterpillars, beetles, and others. Immature stages tend to be more susceptible than adults. Spray formulations can be applied in greenhouse or field settings and on ornamental or edible crops. Efficacy is dependent on climatic conditions; the greatest control occurs within 68 F-86 F and above 60% relative humidity. *Beauveria bassiana* is a slow-acting insecticide because spores require time to germinate and penetrate insects. In greenhouses, control may be reached in three to seven days, but it is not uncommon for control to take seven to 10 days in field settings. Repeat applications are recommended every five to seven days until a desired level of control is reached.

A commercial suspension of *B. bassiana* spores has a shelf life of one year when stored at room temperature and longer when stored in the refrigerator. The product should not be stored below 0 F or above 85 F. Spray mixes should be applied as soon as possible after mixing, as spores cannot survive in water for more than 24 hours and are susceptible to degradation from UV light. Spores remain viable for longer when applied to leaf undersides or in the evening because of reduced sunlight exposure.

Beauveria bassiana as a biological insecticide is generally not considered systemic (moving throughout the plant) or translaminar (moving throughout the leaf), but in some crops such as corn and cotton the fungus can inhabit the plant as an endophyte (living inside the plant tissue without causing disease). In corn, *B. bassiana* has been found to move internally in the plant and provide extended control of European corn borer caterpillars throughout the season.

Beauveria bassiana is considered safe for beneficial insects, although avoiding spraying directly in areas where bees are actively foraging is recommended. If bees are contacted directly, they can bring fungal spores back to the hive and infect the susceptible brood. *B. bassiana* has no reported phytotoxicity effects and has a zero-day preharvest interval (PHI). The reentry interval (REI) is four to 12 hours depending on the product formulation. Some formulations of *B. bassiana* are approved by the OMRI (Organic Materials Review Institute) for organic pest control. According to label regulations, *B. bassiana may be tank-mixed with other insecticides* but should never be mixed with fungicides.

Insecticidal Soap

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Insecticidal soap is made when a strong alkali is combined with fatty acid animal or plant oils. They are potassium salts of fatty acids. They are used as an insecticide in some cases. The insecticide resistance action committee does not classify insecticidal soaps. Insecticidal soaps that are produced commercially are versions of liquid dish soap that are highly refined. Insecticidal soap mixtures can also be made by individuals; however, the risk of plant injury is much greater. The additives in clothes washing detergents and dry dish soaps are too harsh to use on plants. Additionally, other detergents and soaps are not effective as insecticides.

Insecticidal soaps are effective on small, soft-bodied insects, but they do not kill many beneficial insects or other insects. These products' modes of action include suffocation of the insect, dehydration, removing waxes from the cuticle of the insect, and disrupting cellular membranes. Thorough coverage of the plant resulting in contact with the pest is important to kill the pest insects. Soaps may remove debris, honeydew, and sooty mold. There is no preharvest interval; they may be used postharvest, and they may have a reentry interval of several hours. There is no residual kill of soaps, and they will not kill insects after they dry. Thus, a repeated application may be needed every three to seven days. Repeated applications may result in a burn of some plants.

Additionally, some plants are sensitive to soaps and will burn. Plants with hairy leaves tend to be more sensitive to burn from soaps than plants lacking hairy leaves. Under drought conditions, plants such as conifers may be sensitive. Soaps should not be applied to the tender new growth of ornamentals. The bluish color may be lost from the waxy leaf coat of some plants when the wax is washed off. Sensitive plants include gardenias, portulaca, nasturtiums, some tomato varieties, lantana, hawthorn, Easter lilies, sweet pea, plum, crown of thorns, cherry, horse chestnut, maidenhair fern, mountain ash, bleeding heart, and Japanese maple. Other plants may be somewhat sensitive, including impatiens, geraniums begonias, azaleas, and fuchsias. If plants show signs of browning of the leaf edge or wilting a few hours after treatment with soap, rinse them with clean water. Plants may be tested for sensitivity. This is done by spraying a small area, waiting for 24 hours, and inspecting the area for burn. Water-stressed plants should not be treated with insecticidal soaps.

Read and follow the label! Insecticidal soaps are usually applied as a 1% to 2% solution (2½ to 5 tablespoons per gallon). Concentrations greater than this will burn plants. Soaps should not be applied in full sun or when temperatures are greater than 85 F. Plants may be more stressed in high temperatures and high humidity, making them more sensitive. Plants may be treated in the early morning or late in the day. Drying conditions will be slower and make the soaps more effective.

It is very important to spray both the upper and lower leaf surface. The effectiveness of insecticidal soaps is reduced when water is hard. Iron, calcium, and magnesium will result in the precipitation of fatty acids out of the solution, making the soap ineffective. The soap and water may be mixed in a glass jar, agitated, and allowed to stand for 15 minutes. The quality of the water is fine for spraying if the mix remains milky and uniform. If scum forms on the surface of the water, then distilled water should be used.

Insecticidal soaps are contact insecticides. They are not stomach poisons, are not systemic, and do not move through the leaf (translaminar). Even though soaps are considered to have low toxicity, the signal word on insecticidal soap 49.52 CF is a warning.

Insecticidal soaps may be used for treating soft-bodied insects. They do not kill many beneficial insects. Coverage of the plant resulting in contact with the pest is extremely important, and there is no residual. Repeat applications may be needed. Caution should be exercised when using soaps because they may burn plants. They may be used with other insecticides and other insect management methods as part of an IPM management plan.

Pymetrozine

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The xylem and phloem are the two types of transport tissues in vascular plants (higher plants). Water and some nutrients are transported in the xylem up the plant to the leaves. Sugars and other products are transported in the phloem down the plant from the leaves. Insects may feed on the phloem or the xylem. Pymetrozine is transported in the xylem and phloem, providing systemic activity against insects feeding in either of these tissues. This article presents some properties of pymetrozine.

The Insecticide Resistance Action Committee places pymetrozine in group 9B (pyridine azomethine derivatives). Pymetrozine interferes with feeding behavior. The muscles that are used to pull food into the mouth are paralyzed. The stylet (feeding tube) of sucking insects is blocked. Sucking insects remove their stylets from the plant and stop feeding in an hour. The affected insects will remain on the plant, starve, and die in two to 10 days. Pymetrozine is active as a systemic in the xylem and phloem, as a translaminar, and if eaten. It has some activity as a contact insecticide. Pymetrozine is rainfast because it easily penetrates the plant.

Sucking insects such as planthoppers, leafhoppers, aphids, and whiteflies are killed by pymetrozine, and all life stages that suck sap from the plant are affected. This insecticide exhibits low toxicity on beneficials (including bees) and mites. It should not be applied to actively foraging bees or flowering weeds.

The translaminar activity of pymetrozine allows the material to move through the leaf from one surface to the other. However, thorough coverage is recommended when an application of pymetrozine is made. Cross-resistance between pymetrozine and neonicotinoids (class 4) has been observed.

In summary, pymetrozine is systemic and is translocated in both the xylem and phloem. It also shows activity when eaten and as a translaminar. It has some contact activity. Pymetrozine is effective against the life stages of sucking insects that are feeding on the plant. This insecticide is useful in insecticide resistance management. Products containing pymetrozine include Fulfill and Endeavor.

Spyrotetramat

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Vascular plants (higher plants) have transport tissues as opposed to nonvascular plants that do not have conducting tissues. There are two types of transport tissues in vascular plants: the xylem and phloem. The xylem transports water and some nutrients up the plant to the leaves. The phloem transports sugars and other products down the plant from the leaves. Insects may feed on the phloem or the xylem. Many systemic insecticides are transported in the xylem to the leaves. Spirotetramat is transported in both the xylem and phloem, providing systemic activity against insects in both the xylem and phloem. This article presents some properties of spirotetramat.

The Insecticide Resistance Action Committee places spirotetramat in group 23 (tetronic and tetramic

acid derivatives). Spirotetramat interferes with fat synthesis and the development of immature insects and is slow acting. It has little activity against adult insects. It is active as a systemic in both the xylem and phloem, as a translaminar, and if eaten. Spirotetramat has limited contact activity.

After the application of spirotetramat to leaves, it penetrates the leaf and is translocated down the plant to the roots and up the plant to developing shoots. This movement allows the insecticide to manage insects that are hiding under plant parts and are difficult to contact with an insecticide. The movement also allows the insecticide to manage feeding below ground on the roots and protect growing plant parts. The translaminar activity of spirotetramat allows the material to move through the leaf from one surface to the other. Thus, good coverage with insecticide is less important but good coverage with insecticide is always recommended.

Spirotetramat is effective against aphids, mealy bugs, psyllids, scales (soft and armored), whiteflies, and some thrips. Cross-resistance to other groups of insecticides is not known. Thus, this insecticide is very useful in managing resistance by rotating groups of insecticides applied to insects.

Spirotetramat is much more active against immature insects than adult insects. It is up to 30 times more active against first-instar nymphs of green peach aphids than adult aphids. However, adult aphids give birth to fewer nymphs. Once immature insects eat spirotetramat they die in two to five days. Spirotetramat should be applied when the numbers of insects are low and in the early stages of infestation. For scales, applications should be made at the crawler stage.

Spirotetramat is harmless to slightly harmful to beneficials such as hoverfly larvae, spiders, predatory bugs, wasp parasites, ladybird beetles, and lacewings. Spirotetramat is potentially toxic to bee larvae, and if exposure to bees occurs, applications should be made only in the early morning or late evening to protect bees. Applications should not be made to bees in the field.

In summary, spirotetramat is a systemic insecticide that is translocated in both the phloem and xylem. It is useful in managing hidden insects and those on roots and growing shoots. It also shows translaminar and oral activity. It is most effective against immature insects. Several sucking insects are managed by spirotetramat. It is useful in insecticide resistance management. It is harmless to slightly toxic to predators, and parasites and bees should not be exposed to spirotetramat. Products containing spirotetramat include Kontos and Movento.

Azadirachtin

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Azadirachtin is a naturally occurring chemical found in the seeds of the neem tree *Azadirachta indica*, A. Juss (Sapindales: Meliaceae). Humans have been using it as an insecticide for many years. It does not have an Insecticide Resistance Action Committee number because the mode of action is not known.

Azadirachtin is an anti-feedant. It stops some insects from eating and interferes with egg laying, molting, and mating of some insects, resulting in death. It repels adults and larvae and sterilizes adults. After eating azadirachtin insects may not die for two to seven days. The insect may have a life process interrupted or starve to death. It is systemic and a stomach poison. The systemic activity is less when the pH is greater than 7, and it exhibits low water solubility. This chemical shows activity on gnats, whiteflies, flies, aphids, Japanese beetles, moth larvae, caterpillars, thrips, mealybugs, and mites. The residual activity is seven to 10 days.

Azadirachtin is safe for predators, parasites, and pollinators, but it would be toxic to butterfly and moth larvae eating the leaves. It is not rainfast and should be applied on dry days. This chemical is considered organic. The activity of azadirachtin is best when temperatures are above 70 F.

Flonicamid

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LSU AgCenter

Flonicamid is a synthetic insecticide that was discovered in 1992 by the Ishihara Sangyo Kaisha Ltd. company. Its discovery occurred when it was noticed that some derivatives of trifluoromethylpyridine would kill aphids. Flonicamid is a chordotonal organ modulator in the insecticide resistance action committee group 29. Chordotonal organs are stretch receptors that allow arthropods and insects to detect the position of their antennae. Disruption of these organs interferes with movement, hearing, and balance, causing the insect to stop feeding. Initially, flonicamid was put in insecticide resistance action committee group 9C. However, it was found that flonicamid acts on a different protein than the insecticides in group 9C. Thus, it was placed in its own group. The protein that flonicamid works on is unknown. The flow of potassium into cells is blocked.

After exposure to flonicamid, insects are killed by starvation and dehydration. The insect attaches its head to the plant but is unable to feed on the sap or secrete saliva. Feeding may end in as little as one hour after the insecticide is eaten and death will occur in two to five days depending on environmental conditions, the amount of insecticide eaten, and the plant fed on. Honeydew production is reduced and some aphids stagger in an hour after eating the insecticide.

Flonicamid kills nymphs and adults and is systemic and transported in the xylem and translaminar (moving through leaf tissue). Foliage growing after application of flonicamid will not have insecticide in it and is not protected. This insecticide may kill insects as a stomach or contact insecticide but works faster when it is eaten by the insect.

Flonicamid works on sucking insects including aphids, thrips, mealybugs, whiteflies, leafhoppers, plant bugs, and plant hoppers. It is not known to kill pollinators, bees, caterpillars, predators, or parasites but will kill predatory thrips. It is not effective for chewing insects or mites.

Plants should be sprayed to wetness, and the residual is two to three weeks. This insecticide is not rainfast and should be applied when there is no forecast of rain for 24 to 48 hours, the longer period without rain the better. The preharvest interval ranges from zero to 40 days depending on the plant to which the application is made. Read the label for restricted entry intervals, but it may be at least 12 hours. Read the label to determine distances to maintain away from waterways. Cross-resistance to other classes of insecticides and phytotoxicity has not been reported, and it is not rapidly degraded by UV sunlight. A small number of plants should be sprayed to test for phytotoxicity before applications are made to a large number of plants. Flonicamid is stable at pH levels ranging from 4 to 7 but breaks down when pH is greater than 7.5.

Flonicamid should not be exposed to high temperatures and should be stored at room temperature. It has a long shelf life and may be stored for a long time under cool, dry conditions. The following products contain flonicamid: Aria, Beleaf, Carbine, and Turbine.

Prevent the Movement of Insect Pests by Humans

Dennis Ring
LSU AgCenter

The movement of insect pests by humans is an ongoing phenomenon that is becoming increasingly problematic. New pests are being introduced into the country and then spread by humans unintentionally. To be sure, insects will spread by themselves, but a movement by humans accelerates this process greatly. Insects may be moved by humans when plant material or animals are moved with or without vehicles. Additionally, insects may be moved when products are shipped from county to country.

This is a call for the public and businesses to become more involved in reducing the movement of pests by humans. When any plant is moved, use excessive measures to prevent the movement of pests. Before moving potted plants long distances, drench the soil with products containing a systemic insecticide. That will kill insects in the soil and travel up the xylem into the leaves. It will not go down the phloem in most cases. The xylem transports water and some nutrients up the plant to the leaves. The phloem transports sugars and other products down the plant from the leaves. Spray the plant with malathion or a pyrethroid mixed with insecticidal soap. That will kill insects on the surface of the plant. Make sure all the above-ground parts of the plant are covered with insecticide. If you miss a spot, you have moved the insect. Use caution not to burn the plant with soap.

Spraying a plant even when you don’t see the pest seems to be against integrated pest management practices; however, moving pests to a new area is an even greater violation of integrated pest management practices. Make sure animals are not infested with arthropods before moving them. Follow all quarantine procedures. Remind other people to make sure they are not moving pests. This comes at a cost, but the costs of moving a pest to a new area are vastly greater. For example, the emerald ash borer has been introduced in the United States. This insect is expected to drive all species of ash trees native to North America to extinction. Different insect pests may require different methods to prevent their movement based on their biology. Nurseries must abide by applicable regulations and laws. They must also consider the wishes of their customers when selling plants. Businesses are strongly encouraged to implement procedures to reduce the movement of insects. This will increase costs to businesses but failing to do so will result in greater costs of living with and managing new insect pests that did not previously exist in the country. In summary, this is a call for the public and businesses to become much more involved in preventing the spread of insect pests.

Biological Control of Giant Salvinia Using the Salvinia Weevil

Lori Moshman and Rodrigo Diaz, Department of Entomology

Giant salvinia (*Salvinia molesta*) is an invasive species of aquatic fern native to southeastern Brazil. The plant has light green leaves that bear dense egg-beater-shaped trichomes (leaf hairs) on the upper surface. Giant salvinia does not have true roots, but modified leaves that absorb nutrients from the water column. Thick salvinia mats choke waterways, prevent boat access, and degrade freshwater ecosystems. Fragments of the mat break off and reproduce vegetatively by growing new shoots, which float freely on the water surface. Over time, plant mats affect water quality by reducing sunlight and dissolved oxygen, which negatively impacts native submersed (growing underwater) vegetation as well as fish, arthropods, and waterfowl. Giant salvinia has been spreading throughout Louisiana and other Gulf Coast states since 1998. Currently, it inhabits nearly every parish in Louisiana.

The salvinia weevil (*Cyrtobagous salviniae*) is a Brazilian beetle that is an effective biological control agent of giant salvinia. The salvinia weevil's host range is limited exclusively to plants in the genus *Salvinia*, making it safe to release. Smaller than a sesame seed, this shiny black weevil spends its whole life associated with giant salvinia plants. Adults feed on growing tips and lay eggs in small crevices on the plant. The larvae feed on all parts of the plant, even burrowing inside the rhizome (underwater stem) to disrupt the flow of nutrients from the “roots” to the growing tips. Feeding injury from the weevil causes salvinia mats to yellow, then turn brown and eventually sink. Once the mat sinks, native submersed vegetation can repopulate the area, restoring the habitat for other freshwater species.

Salvinia weevils are mass-reared by the LSU AgCenter in outdoor ponds and are released annually into public and private waters to manage giant salvinia. Salvinia weevils are a tropical to subtropical species, therefore their distribution is limited to areas with mild winters. In south Louisiana, weevils can control infestations in a period of several months to a year once they reach population densities of 40-60 adult weevils per kilogram of giant salvinia. In northern parts of the state, weevils experience colder winters and suffer high overwinter mortality compared to those in the southern parts of the state. Because of this, weevil population growth is slower and cannot keep up with the growth rate of the giant salvinia plant mat.

Annual weevil releases are frequently necessary to restore portions of the population lost during the winter and to increase the spatial distribution of the weevil. Monitoring is an essential tool for understanding how the weevil population is responding to its environment. Estimating weevil population density by taking periodic samples of the plant mat can inform aquatic plant managers whether the weevils are doing their job, if more releases are necessary or if they need to integrate biological control with other methods, such as mechanical and chemical control. Monitoring can also help managers identify new infestations and take early action before the infestation becomes severe. The best time to release salvinia weevils is in the spring before the plant mat begins to grow vigorously. This helps the weevils maintain spatial control over the plant mat and gives the population the longest amount of time to feed and reproduce before winter approaches.

For more information, see the LSU AgCenter website on giant salvinia.

Special Notice: Chlorpyrifos Registration Loss

The U.S. Environmental Protection Agency (EPA) has taken the step to discontinue the use of the pesticide chlorpyrifos (Lorsban) on food. The final rule by EPA revokes all tolerances to chlorpyrifos. Applications of chlorpyrifos will render any food treated as adulterated and ineligible to be distributed in interstate commerce. EPA will continue to evaluate the non-agricultural, non-food uses as part of the ongoing registration review.

More information can be found at https://www.epa.gov/ingredients-used-pesticide-products/frequently-asked-questions-about-current-status-chlorpyrifos

Host Plant Resistance

The interactions of crop-eating pests with their crop hosts are complex and have many facets. Plants possess many traits that influence these interactions and thereby enable them to defend themselves against the attacks of pests. Plant resistance may be defined as the sum of heritable (inherited by offspring from a parent) plant traits that reduce the negative impacts of plant-eating pests. The defensive traits of crop plants include traits that reduce colonization (initial infestation) of the crop by the pest (antixenotic traits), traits that reduce the ability of the pest to grow and reproduce on the crop (antibiotic traits), and traits that allow the plant to recover and compensate for injury (tolerance traits). Different genotypes (genetic makeups) of crop plants can differ in their inherent resistance to plant-eating pests because they differ in the degree to which they possess these antixenotic, antibiotic, or tolerance traits. Because these traits are heritable, high-yielding crop varieties with greater inherent resistance to pests can be developed through selective breeding. Usually, the resistance expressed by these varieties is not complete — in other words, resistant varieties are usually not immune to (unaffected by) crop pests but rather suffer lower injury than more susceptible varieties under the same numbers of pests. These resistant varieties can serve as very useful components of integrated management programs, not only because they are inherently less susceptible to pests but also because the use of resistant varieties is usually compatible with other management tactics, such as biological control or insecticides. Varieties of many of Louisiana’s most important crop plants with resistance against important insect pests are developed and available for use as components of management programs. For example, sugarcane varieties with partial resistance against stem-boring pests and wheat varieties with high levels of resistance against Hessian fly have been developed. The use of these resistant varieties is highly advisable when available because their use is cost-effective and reduces the amount of insecticide needed to manage pests. The availability and effectiveness of pest-resistant crop varieties are described in various crop-specific production guides issued by the LSU AgCenter.

How to Mix Insecticides

1. **How to mix wettable powder for spraying:**
If you have 50 percent Carbaryl wettable powder and want to make 50 gallons of spray containing 0.5 percent Carbaryl, use the following formula: (water weighs 8.345 pounds/gallon)

$$\frac{Gallons\ desired\ \times weight\ of\ water\ \times desired\ concentration}{\%\ active\ ingredient\ in\ insecticide\ used} = pounds\ of\ wettable\ powder$$

$$\frac{50\ \text{gallons} \times 8.345 \times 0.5}{50} = 4.17\ \text{pounds}$$

4.17 pounds of the 50 percent Carbaryl will make 50 gallons of 0.5 percent Carbaryl.

2. **How to mix emulsifiable concentrate for spraying:**
If you have 50 percent Malathion emulsifiable concentrate and want to make a 2 percent spray, use the following formula:

$$\frac{\%\ insecticide}{Desired\ concentration} = \frac{50}{2} = 25$$

The correct dilution is 1 part of the Malathion to 25 parts of water.

3. **How to mix dusts:**
If you have 25 percent Malathion dust and want to make 100 pounds of dust containing 5 percent Malathion, use the following formula:

$$\frac{Desired\ concentration\ \times Desired\ Weight}{\%\ active\ ingredient\ in\ insecticide\ used} = factor$$

$$\frac{5 \times 100}{25} = 20$$

20 pounds of the Malathion dust should be added to 80 pounds diluents to make 100 pounds of 5 percent dust.

Insecticide Dilution Tables

Table 1. Amount of formulated insecticide materials to use to provide the indicated active ingredient.

Formulation	0.25 pound/ acre	0.50 pound/ acre	0.75 pound/ acre	1.0 pound/ acre	1.25 pounds/ acre	1.5 pounds/ acre	2.0 pounds/ acre
1% Dust	25.0 pounds	50.0 pounds	75.0 pounds	100.0 pounds	125.0 pounds	150.0 pounds	200.0 pounds
5% Dust	5.0 pounds	10.0 pounds	15.0 pounds	20.0 pounds	25.0 pounds	30.0 pounds	40.0 pounds
10% Dust	2.5 pounds	5.0 pounds	7.5 pounds	10.0 pounds	12.5 pounds	15.0 pounds	20.0 pounds
25% WP	1.0 pound	2.0 pounds	3.0 pounds	4.0 pounds	5.0 pounds	6.0 pounds	8.0 pounds
40% WP	2/3 pound	1.25 pounds	1 7/8 pounds	2.5 pounds	3 1/6 pounds	3.75 pounds	5.0 pounds
50% WP	0.5 pound	1.0 pound	1.5 pounds	2.0 pounds	2.5 pounds	3.0 pounds	4.0 pounds
75% WP	1/3 pound	2/3 pound	1.0 pound	1 1/3 pounds	1 2/3 pounds	2.0 pounds	2 2/3 pounds
1 pound/gal. EC	1.0 quart	2.0 quarts	3.0 quarts	4.0 quarts	5.0 quarts	6.0 quarts	8.0 quarts
1.5 pounds/gal. EC	2/3 quart	1 1/3 quarts	2.0 quarts	2 2/3 quarts	3 1/3 quarts	4.0 quarts	5 1/3 quarts
2 pounds/gal. EC	1.0 pint	1.0 quart	3.0 quarts	2.0 quarts	5.0 pints	3.0 quarts	2.0 quarts
4 pounds/gal. EC	0.5 pint	1.0 pint	1.5 pints	1.0 quart	2.5 pints	3.0 pints	2.0 quarts
6 pounds/gal. EC	1/3 pint	2/3 pint	1.0 pint	1 1/3 pints	1 2/3 pints	2.0 pints	2 2/3 pints
8 pounds/gal. EC	0.25 pint	0.5 pint	0.75 pint	1.0 pint	1.25 pints	1.5 pints	2.0 pints

EXAMPLE: You wish to apply an insecticide at the rate of 1 pound (active ingredient) per acre and you purchase an emulsifiable concentrate (EC) formulation containing 2 pounds (active ingredient) per gallon. From the table above, you find that 2 quarts of the formulation are needed per acre to provide the desired dosage.

The tables below provide a quick reference to determine the amount of insecticide to mix with different amounts of water to obtain the same concentration of spray.

Example: **1 cup** of liquid insecticide in **100 gallons** of water makes **the same spray concentration** as **4 tablespoons** in **25 gallons**.

Table 2. For use with liquid insecticide.

Amount of Water Used	Amount of Liquid Insecticide			
100 gallons	1 cup	1 pint	1 quart	2 quarts
50 gallons	0.5 cup	1 cup	1 pint	1 quart
25 gallons	4 tablespoons	0.5 cup	1 cup	1 pint
2.5 gallons	1.5 teaspoons	2.5 teaspoons	5 teaspoons	10 tablespoons
1 gallon	0.5 teaspoon	1.0 teaspoon	2 teaspoons	4 teaspoons

Table 3. For use with wettable powder insecticides.

Amount of Water Used	Amount of Wettable Powder Insecticide			
100 gallons	1 pound	2 pounds	3 pounds	5 pounds
50 gallons	0.5 pound	1 pound	1.5 pounds	2.5 pounds
25 gallons	0.25 pound	0.5 pound	0.75 pound	1.25 pounds
3 gallons	2 tablespoons	3 tablespoons	5 tablespoons	8 tablespoons
1 gallon	2 teaspoons	1 tablespoon	1.5 tablespoons	2.5 tablespoons

Table 4. Read across from the insecticide formulation you have and down from the concentration of the insecticide you want in the spray. The amount of insecticide to mix with 1 gallon of water to make that concentration is indicated at the point the lines meet.

WETTABLE POWDER (WP)

Insecticide Formulation	The Concentration of Actual Chemical Wanted in the Spray Solution								
	0.0313%	0.0625%	0.125%	0.25%	0.5%	1.0%	2.0%	3.0%	5.0%
15% WP	2.5 teaspoons	5.0 teaspoons	10.0 teaspoons	7.0 tablespoons	1.0 cup	2.0 cups	4.0 cups	6.0 cups	10.0 cups
25% WP	1.5 teaspoons	3.0 teaspoons	6.0 teaspoons	12.0 teaspoons	8.0 tablespoons	1.0 cup	2.0 cups	3.0 cups	5.0 cups
40% WP	1.0 teaspoon	2.0 teaspoons	4.0 teaspoons	8.0 teaspoons	5.0 tablespoons	10.0 tablespoons	1.25 cups	2.0 cups	3.25 cups
50% WP	0.75 teaspoons	1.5 teaspoons	3.0 teaspoons	6.0 teaspoons	4.0 tablespoons	8.0 tablespoons	1.0 cup	1.5 cups	2.5 cups
75% WP	0.5 teaspoon	1.0 teaspoon	2.0 teaspoons	4.0 teaspoons	3.0 teaspoons	5.0 tablespoons	10.0 tablespoons	1.0 cup	2.0 cups

EMULSIFIABLE CONCENTRATE (EC)

Insecticide Formulation	The Concentration of Actual Chemical Wanted in the Spray Solution								
	0.0313%	0.0625%	0.125%	0.25%	0.5%	1.0%	2.0%	3.0%	5.0%
10%-12% EC 1 pound actual/gal	2.0 teaspoons	4.0 teaspoons	8.0 teaspoons	16.0 teaspoons	10.0 tablespoons	2/3 pint	1 1/3 pints	1.0 quart	3.25 pints
15%-20% EC 1.5 pounds actual/gal	1.5 teaspoons	3.0 teaspoons	6.0 teaspoons	12.0 teaspoons	7.5 teaspoons	0.5 pint	1.0 pint	1.5 pints	2.5 pints
25% EC 2 pounds actual/gal	1.0 teaspoons	2.0 teaspoons	4.0 teaspoons	8.0 teaspoons	5.0 tablespoons	10.0 tablespoons	2/3 pint	1.0 pint	1.75 pints
33%-35% EC 3 pounds actual/gal	0.75 teaspoon	1.5 teaspoons	3.0 teaspoons	6.0 teaspoons	4.0 tablespoons	8.0 tablespoons	0.5 pint	0.75 pint	1 1/3 pints

Insecticide Formulation	The Concentration of Actual Chemical Wanted in the Spray Solution								
	0.0313%	0.0625%	0.125%	0.25%	0.5%	1.0%	2.0%	3.0%	5.0%
40%-50% EC 4 pounds actual/gal	0.5 teaspoon	1.0 teaspoon	2.0 teaspoons	4.0 teaspoons	8.0 teaspoons	5.0 tablespoons	10.0 tablespoons	0.5 pint	4/5 pint
57% EC 5 pounds actual/gal	7/16 teaspoon	7/8 teaspoon	1.75 teaspoons	3.5 teaspoons	7.0 teaspoons	0.5 tablespoons	9.0 tablespoons	14.0 tablespoons	1.5 cups
60%-65% EC 6 pounds actual/gal	3/8 teaspoon	0.75 teaspoon	0.5 tablespoons	1.0 tablespoons	2.0 tablespoons	4.0 tablespoons	8.0 tablespoons	12.0 tablespoons	1.5 cups
70%-75% EC 8 pounds actual/gal	0.25 teaspoon	0.5 teaspoon	1.0 teaspoon	2.0 teaspoons	4.0 teaspoons	8.0 teaspoons	5.0 tablespoons	7.5 tablespoons	13.0 tablespoons

Trade Names Used in Guide

Common Name	Trade Name	Chemical Name	IRAC Classification	Company
abamectin	Abba Abathor Affirm Agri-Mek Avid CAM-MEK Dynamec Epi-Mek Reaper Timectin Vertimec Zephyr	a mixture of avermectin B1a (10E,14E,16E,22Z)-(1R,4S,5′S,6S,6′ R,8R,12S,13S,20R,21R,24S)-6′-[(S)-sec-butyl]-21,24-dihydroxy-5′,11,13,22-tetramethyl-2-oxo-(3,7,19-trioxatetracyclo[15.6.1.14,8.020,24]pentacosa-10,14,16,22-tetraene)-6-spiro-2′-(5′,6′-dihydro-2′H-pyran)-12-yl 2,6-dideoxy-4-O-(2,6-dideoxy-3-O- methyl-α-L-arabino-hexopyranosyl)-3-O-methyl-α-L-arabino-hexopyranoside and avermectin B1b (10E,14E,16E,22Z)-(1R,4S,5′S,6S,6′R,8R,12S,13S,20R,21R,24S)-21, 22-dihydroxy-6′-isopropyl-5′,11,13,22-tetramethyl-2-oxo-(3,7,19-trioxatetracyclo[15.6.1.14,8.020,24]pentacosa-10,14,16,22-tetraene)-6-spiro-2′-(5′,6′-dihydro-2′H-pyran)-12-yl 2,6-dideoxy-4-O-(2,6-dideoxy-3-	6	AMVAC Parsons Pest Man. Sunwell Syngenta Syngenta CAM CO. Syngenta Syngenta Loveland Tide International Syngenta Syngenta
acephate	Orthene Surrender FateSystemic Insect Con.	O,S-Dimethyl acetylphosphoramidothioate	1B	AMVAC Martin's Future Crop Sci. Bonide LoveLand
acetamiprid	Assail Intruder Tristar	N-[(6-chloro-3-Pyridy) methyl] –n2-Cyanogen -n- methylacetamidine	4A	United Phos. AgNova Nufarm
allethrin	Pynamin	(RS)-3-allyl-2-methyl-4-oxocyclopent-2-enyl(1RS)-cis-transchrysanthemate; also referred to as allyl homolog of cinerin I.	3A	Sumitomo Chemical Co. Ltd.
amitraz	Taktic	N-methylbis(2,4-xylyliminomethyl)amine	19	InTerveT, Inc.
aluminum phosphide	Phostoxin	aluminum phosphide (AIP)	24A	Degesch America
Bacillus sphaericus	VectoLex	Serotype (H-5a5b)	11	Valent BioSciences Corp.
Bacillus thuringiensis	Biobit Condor Crymax DiPel Javelin Thuricide XenTari	Spores and crystalline delta-endotoxin as A.I. which are produced by *Bacillus thuringiensis* spp. k*urstaki*, Serotype H-3a3bin fermentation.	11A	Valent USA Certis USA Certis USA Valent USA Certis USA OHP Inc. Valent USA
Bacillus thuringiensis	VectoBac	Crystalline delta-endotoxin as A.I. (produced by fermentation of *Bacillus thuringiensis* spp. *israelensis*, Serotype H-14)	11	Valent BioSciences Corp.

Common Name	Trade Name	Chemical Name	IRAC Classification	Company
beta-cyfluthrin	Baythroid Tempo Ultra	cyano(4-fluoro-3-phenoxyphenyl)methyl 3-(2,2- dichloroethenyl-2 2-dimethylcyclopropanecarboxylate (CAS 9CI)	3A	Bayer Corp. Bayer Corp.
bifenazate	Floramite	hydrazine carboxylic acid, 2-(4-methoxy-[1'1-biphenyl]-3-yl)-1 methylethyl ester (CA)	25	OHP Inc.
bifenthrin	Brigade Capture Discipline Fanfare Talstar	[1α,3α-(Z)]-(±)-(2 methyl[1,1'-biphenyl]-3-yl)methyl 3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethyl- cyclopropanecarboxylate(CAS)	3A	FMC FMC AMVAC Adama FMC
bifenthrin + imidacloprid	Brigadier	(2-methyl[1,1'-biphenyl]-3-yl)methyl (1R,3R)-rel-3-[(1Z)-2-chloro- 3,3,3-trifluoro-1-propen-1-yl]-2,2-dimethylcyclopropanecarboxylate and (2E)-1-[(6-chloro-3-pyridinyl)methyl]-N-nitro-2-imidazolidinimine	3A + 4A	FMC
buprofezin	Applaud Talus	2-tert-butylimino-3-isopropyl-5-phenyl-1,3,5-thiadiazinan-4-one	18	Corteva SePRO
carbaryl	Sevin	1-napthyl methylcarbamate	1A	GardenTech
chlorantraniliprole	Acelepryn Coragen Prevathon Vantacor	3-bromo-N-[4-chloro-2-methyl-6-[(methylamino)carbonyl] phenyl]-1-(3-chloro-2-pyridinyl)-1H-pyrazole-5-carboxamide	28	DuPont Dupont FMC Corp FMC Corp
chlorfenapyr	Intrepid Phantom Pylon 2SC	4-bromo-2-(4-chlorophenyl)-1-(ethoxymethyl)-5- (trifluoromethyl)-1H-pyrrole-3-carbonitrile	13	BASF
chlorpyrifos	Dursban Pro Lorsban Nufos	O,O-diethyl O-(3,5,6-trichloro-2-pyridinyl)phosphorothioate	1B	Corteva Corteva FMC Corp
clothianidin	Arena Belay Poncho	(E)-1-(2-chloro-1,3 thiazo)-5-ylmethyl)-3-methyl-2 nitroguanidine	4A	Valent Valent Bayer
coumaphos	Co-Ral	O,O-diethyl O-(3-chloro-4-methyl-2-oxo2H-1-enzopyuran 7-yl-phosphorothioate	1B	Bayer Corp.
coumpahos + diazinon	Co-Ral Plus	O,O-diethyl O-(3-chloro-4-methyl-2-oxo2H-1-enzopyuran 7-yl-Phosphorothioate + O,O,Diethyl O-(2-isopropyl-6-methyl-4-pyrimidinyl)	1B	Bayer Corp.
cyromazine	Citation	N-cyclopropyl-1,3,5-triazine-2,4,6-triamine	17	Syngenta
diazinon	Optimizer Patriot	O,O,Diethyl O-(2-isopropyl-6-methyl-4-pyrimidinyl)	1B	Y-Tex Corp. Bayer Corp
diazinon + chlorpyrifos	Warrior (ear tag)	O,O,Diethyl O-(2-isopropyl-6-methyl-4-pyrimidinyl)	1B	Y-Tex
dichlorvos	Nuvan Vapona	2,2-dichlorovinyl dimethyl phosphate (IUPAC)	1B	AMVAC Bayer Corp

Common Name	Trade Name	Chemical Name	IRAC Classification	Company
dicofol	Kelthane	2,2,2-trichloro-1,1-bis(4-chlorophenyl)ethanol(IUPAC)	3	Corteva
dicrotophos	Bidrin	(E)-2-dimethylcarbamoyl-1-methylvinyl dimethyl phosphate (IUPAC)	1B	AMVAC
diflubenzuron	Vigilante	N-[(4-Chlorophenyl)amino]carbonyl-2,6-Difluorobenzamide	15	Chemtura Corp.
dimethoate	Cygon Cygon 2E	O,O-dimethyl S-(N-methylcarbamoylmethyl	1B	Bonide Hi-Yield
dioxathion	Del-Tox	2,3-p-dioxanedithion-S,S-bis-(O,O-diethyl phosphrodithioate)	1B	AgrEvo
disulfoton	Di-Syston	O,O-diethyl S-[2-(ethylthio)ethyl]phosphorodithioate (CAS)	1B	Bayer Corp.
endosulfan	Phaser	6,7,8,9,10,10-herachloro-1,5,5a,6,9,9a- hexahydro-6,9-methano-2,4,3-benzodioxathiepin 3-oxide (IUPAC)	2A	Aventis CropScience
eprinomectin	Eprinex	(4’’R)-4”-(Acetylamino)-4”-deoxy-avermectin B1	6	Merck Agvet
esfenvalerate	Asana XL	(S)-α-cyano-3- phenoxybenzyl) (S)-2-(4-chlorophenyl)3- methylbutyrate (IUPAC); (S)-cyano(3-phenoxyphenyl)methyl (S)-4-chloro-α(1-methylethyl)benzeneacetate (CAS)	3A	Dupont
etoxazole	Zeal	2-(2,6-difluorophenyl)-4-[4-(1,1-dimethylethyl)-2-ethoxyphenyl]-4,5-dihydrooxazole	10B	Valent USA
fenbutatin-oxide	Vendex	hexakis(2-methyl-2-phenylproply)distannoxane(CAS)	12B	UPI
fenoxycarb	Award Logic	(ethyl [2-4 phenoxyphenoxy ethyl] carbamate)	7B	Syngenta Syngenta
fenthion	Spotton	O,O-Dimethyl O-[3-methyl-4-(methylthio)phenyl]phosphorothioate	1B	Bayer Corp.
fipronil	Ceasefire Chipco Choice Regent Over ‘n Out Termidor Top Choice	[5-amino-1-(2,6-dichloro-4-trifluoromethyl)phenyl-4-(1,R,S)-(trifluoromethyl)su-1-H-pyrasole-3-carbonitrile]	2B	Bayer BASF
flonicamid	Carbine	N-cyanomethyl-4-(trifluoromethyl) nicotinamide	9C	FMC
gamma-cyhalothrin	Prolex	Cyclopropanecarboxylic acid, 3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethyl,cyano(3-phenoxyphenyl) methyl ester	3A	Pytech
halo fenozide	Mach 2	N-tert-butyl-N'-(4-chlorobenzoyl)benzohydrazide; benzoic acid,4-chloro-2 benzoyl-2-(1,1-dimethylethyl) hydrazide	18	Corteva
hydramethylnon	Amdro	Tetrahydro-5, 5-dimethyl-2 (1H)-pyrimidinone[3-[4(trifluoromethyl) phenyl]-1-[2-[4-(trifluoromethyl)phenyl]etheny]-2-propenylidene]hydrazone	20A	AMBRANDS

Common Name	Trade Name	Chemical Name	IRAC Classification	Company
imidacloprid	Admire Gaucho Marathon Merit Premise	1-(6-chloro-3-pyridin-3-ylmethyl)-N-nitroimidazolidin-2- ylidenamine (IUPAC)	4A	Bayer Corp Bayer Corp OHP Inc. Bayer Corp Bayer Corp
imidacloprid + beta-cyfluthrin	Leverage	(2E)-1-[(6-chloro-3-pyridinyl) methyl]-N-nitro-2-imidazolidinimine + cyano(4-fluoro-3-pheno xyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethyl cyclopropanecarboxylate	3A + 4A	Bayer Corp
insecticidal soap	M-PEDE Safer	potassium salts of fatty acids	unknown	Gowan Safer
indoxacarb	Advion Steward	(S)-methyl 7-chloro-2,5-dihydro-2-[{(methoxy-carbonyl){4trifluoromethoxy)phenyl}amino}-carbonyl}indeno{1,2-e}[1,3,4}oxadiazine-4a-(3H)-carboxylate	22A	DuPont FMC Corp.
isofenphos	Oftanol	1-methylethyl 2[(ethoxy)(1methylethyl)amino]phosphinothioyl oxy benzoate (CAS)	1B	Bayer Corp.
lambda-cyhalothrin	Battle Commodore Karate Z Saber Warrior T	α-cyano-3-phenoxybenzyl 3-(2-Chloro-3,3,3- trifluoroprop-1-enyl)-2,2-dimethylcyclopropane-carboxylate	3A	Lesco Syngenta Syngenta Merck Syngenta
lambda-cyhalothrin + PBO	Saber Extra (ear tag)	α-cyano-3-phenoxybenzyl 3-(2-Chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropane-Carboxylate	3A	Merck
lambda-cyhalothrin+ thiamethoxam	Endigo	Combination of lambda-cyhalothrin and thiamethoxam (premix): [1α(S),3α(Z)]-(±)-cyano-(3-phenoxyphenyl)methyl-3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethylcyclopropanecarboxylate and 3-[(2-chloro-5-thiazolyl)methyl]tetrahydro-5-methyl-N-nitro-4H-1,3,5-oxadiazin-4-imine	3A + 4A	Syngenta
malathion	Fyfanon	diethyl (dimethoxythiophosphorylthio)succinate	1B	Cheminova, Inc.
mancozeb	Dithane	coordination product of zinc ion, manganese ethylene bisdithiocarbamate related to both maneb and zineb	M3	Corteva
methidathion	Supracide	S-2,3-dihydro-5-methoxy-2-oxo1,3,4-thiadiazol-3-ylmethyl O,O-dimethyl-phosphorodithioate(IUPAC)	1B	Gowan Company
methiocarb	Slugger	3,5-dimethyl-4-(methylthio)phenyl methylcarbamate (CAS)	1A	OR-CAL
methomyl	Lannate	S-methyl N-[(methylcarbamoyl)oxy]thioacetimidate (CAS 8CI)	1A	DuPont
methoxyfenozide	Intrepid	Benzoic acid, 3-methoxy-2-methyl, 2-(3,5-dimethylbenzoyl)-2-(1,1-dimethyethyl) hydrazide	18	Corteva
mineral oil	TriTek	mineral oil	unknown	Brandt

Common Name	Trade Name	Chemical Name	IRAC Classification	Company
naled	Dibrom Trumpet	1,2-dibromo-2,2-dichloroethyl dimethyl phosphate	1B	AMVAC AMVAC
novaluron	Diamond	*N*-[[[3-chloro-4-[1,1,2-trifluoro-2-(trifluoromethoxy)ethoxy]phenyl]amino]carbonyl]-2,6-difluorobenzamide	15	Adama
oxamyl	Vydate	S-methyl N' N'-dimethyl-N-(methylcarbamoyloxy)-1-thio-oxamimidate(IUPAC)	1A	Corteva
permethrin	Ambush Astro DeLice Permanone Pounce	3-phenoxybenzyl (1RS)-cis, trans-3-(2,2- dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate (IUPAC)	3A	Syngenta FMC Coopers Bayer Corp FMC
phorate	Thimet	O,O-Diethyl S-[(ethylthio)methyl]phosphorodithioate (CAS)	1B	Amvac Chemical
phosmet	Imidan	S-[(1,3-dihydro-1,3-dioxo-2H-isoindol-2-yl)methyl]O,O-dimethyl phosphorodithioate(CAS 9CI)	1B	Gowan Company
propargite	Comite	sulfurous acid,2[4(1,1-dimethyl-ethyl)phenoxy]cyclohexy1-2- propanyl sulfite (CAS 9C1)	12C	Uniroyal Chemical/ Crompton Corp.
propoxur	Baygon	2-(1-methylethoxy)phenyl methylcarbamate(CAS)	1A	Bayer Corp.
pyriproxyfen	Distance	(2-[1-methyl-2-(4-phenoxyphenoxy)ethoxy]pyridine)	7C	Nufarm
pyrethrin	Pyrethrin	Pyrethrin (natural product)	3A	several
s-methoprene	Altosid Extinguish	isopropyl (E,E)-(RS)-11-methoxy-3,7,11-trimethyl-dodeca-2,4- dienoate (IUPAC)	7A	Wellmark International Phoenix Environmental Design
s-methoprene, + hydromethylnon	Extinguish Plus	(s)-methoprene[isopropyl (2E, 4E, 7S)-11-methoxy-2,7,11-trimethyl-2,4-dodecadienoate] + tetrahydro-5, 5-dimethyl-2 (1H)-pyrimidinone [3-[4(trifluoromethyl)phenyl]-1-[2-[4-(trifluoromethyl)phenyl]etheny]-2-propenylidene]hydrazone	7A	Phoenix Environmental Design
spinetoram	Radiant	Mixture of spinetoram-J and spinetoram-L	5	Corteva
spinosad/spintor	Conserve SC Entrust Success Tracer	Spinosyn A and Spinosyn D	5	Corteva
spiromesifen	Forbid 4F Oberon	2-oxo-3-(2,4,6-trimethylphenyl)-1-oxaspiro[4,4]non-3-en-4-yl3, 3 dimethylbutanoate	23	Bayer Corp Bayer Corp
tebufenozide	Confirm Mimic	N-tert-butyl-N'-(4-ehylbenzoyl)-3,5-dimethylbenzo-hydrazide (IUPAC);3,5-dimethylbenzoic acid 1-(1,1-dimehtylethyl)-2-	18	Corteva Bayer
tefluthrin	Force	(2,3,5,6-tetrafluoro-4-methylphenyl)methyl-(1a,3a)-(Z)-3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethylcyclopropanecarboxylate	3A	Syngenta

Common Name	Trade Name	Chemical Name	IRAC Classification	Company
temephos	Abate	O,O' -(thiodi-4,1-phenylene) O,O, O' O'-tetramethyl phosphorothioate	1B	BASF Corp.
terbufos	Counter	S-[(1,1-Dimethylethyl thio)methyl]O,O-diethyl phosphorodithioate (CAS)	1B	AMVAC
tetrachlorvinphos	Rabon	2-chloro-1-(2,3,5 trichlorophenyl) dimethyl phosphate vinyl	1B	Bayer Livestock
tetrachlorvinphos + dichlorvos	Ravap	(Z)-2-chloro-1-(2,4,5-trichlorophenyl) vinyl dimethyl phosphate + 2,2-dichlorovinyl dimethyl phosphate (IUPAC)	1B	Bayer Livestock
thiamethoxam	Centric Meridian	3-[(2-chloro-5-thiazolyl)methyl] tetrahydro-5-methyl-N-nitro-4H-1,3,5-oxadiazin-4-imine	4A	Syngenta Syngenta
tralomethrin	Scout X-Tra	(1R, 3S) 3 [(1'RS)(1',2',2',2',-tetrabromoethyl)]-2,2-dimethylcyclopropanecarboxylic acid (S)-a-cyano-3-phenoxybenzyl ester (CAS)	3A	Aventis CropScience
zeta-cypermethrin	Mustang	☐-Cyano(3-phenoxyphenyl)methyl (±)-cis-trans3-(2,2dichloroethenyl)-2,2-dimethylcyclopropane carboxylate (CAS)	3A	FMC Corp
zeta-cypermethrin + bifenthrin	Hero Mustang Maxx	α-Cyano(3-phenoxyphenyl)methyl (±)-cis-trans3-(2,2 dichloroethenyl)-2,2-dimethylcyclopropane carboxylate (CAS) +[1a,3a-(Z)]-(±)-(2 methyl[1,1¢-biphenyl]-3-yl)methyl 3-(2-chloro-3,3, 3-trifluoro-1-propenyl)-2,2-dimethyl-cyclopropanecarboxylate(CAS)	3A	FMC Corp

NOTE: This list is presented for information only. No endorsement is intended for products mentioned nor is criticism meant for products not mentioned.

Biological Control of Crapemyrtle Bark Scale

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Crape myrtles (*Lagerstroemiae* spp.) are one of the most popular ornamental trees in the southeastern United States. This is largely because of their beautiful flowers, bark, climate adaptation, and relatively easy maintenance. However, in the past years a new pest was first detected in Texas, the crapemyrtle bark scale (*Acanthococcus lagerstroemiae* [Hemiptera, Acanthococcidae], hereafter referred to as CMBS). CMBS is native to Asia and can be recognized by white circles along the branches. The first life stage of the scale is called a crawler which is responsible for their spread. Crawlers settle in the branch and will start feeding on the tree's sap. The adults have sexual dimorphism, the males turn into pupae and then hatch as winged small insects. Meanwhile, the females stay as immotile scales. Once they mate, the females produce eggs that stay protected under a layer of wax until they hatch. The scale can colonize different parts of the trees causing direct and indirect injury. Direct injury occurs because of its sucking sap behavior, leading to branch dieback, and indirect is because of honeydew excretion, which provides the substrate to black sooty mold that will cover the leaves. These injuries lead to a reduction in the size of the panicles and the unpleasant appearance of the tree. CMBS can also feed on beautyberry (*Callicarpa americana*), pomegranate (*Punica granatum*), henna tree (*Lawsonia inermis*), narrow-leaf heimia (*Heimia salicifolia*) and winged-lythrum (*Lythrum alatum*).

In Louisiana, several beneficial insects are found on crapemyrtle trees. They are mainly responsible for pollination and biological control. As biological control agents, they eat or parasitize the pests, leading them to death. Parasitoids have been found parasitizing the CMBS in the U.S., but not in Louisiana. Therefore, the key biological control agents against CMBS are predators such as ladybeetles, pirate bugs, and lacewings. However, only pirate bugs and lacewings can be purchased. Avoiding unnecessary pesticide applications will decrease natural enemy mortality and prevent rapid growth of CMBS. To protect the ladybeetles, consider products with low impact to non-targets and follow product's label.

Predators of CMBS are the ladybeetles, *Chilocorus* sp. and *Hyperaspis bigeminata*, the minute pirate bug, *Orius insidiosus,* and lacewings, *Chrysoperla* sp. The *Chilocorus* sp. ladybeetles are black with two orange spots on the wings. Its body size can vary between 0.16 and 0.24 inches long, the larvae are also black with spine-looking structures around the body. The *H. bigeminata* ladybeetle is also black with orange spots on the wings and two other spots on the front part of the body. Its body size can vary from 0.09 to 0.13 inches, and the larvae are pink with a white wax coverage. Both ladybeetles can be observed during the day feeding on the scales from late spring until early fall. The minute pirate bug is small (around 0.08 inches) and black. The nymphs can be from yellow to orange and, as adults, have piercing-sucking mouthparts that can be used to feed on different kinds of pests, including CMBS. Adult lacewings are small (up to 0.8 inches) green or pale, winged, and with long antenna that feed on pollen or honeydew. The larvae are as small as 0.04 inches when they hatch, have long mandibles that resemble pincers and are active predators of several small insects and mites. These natural enemies are largely distributed through the United States and play a key role preventing scale's outbreaks.

CMBS can be managed by washing the trunk and reachable limbs with a soft brush and mild solution of dishwashing soap and water. This will remove many of the female scales and egg masses. Washing will also remove much of the black mold that builds up on the bark of infested trees. However, washing the trees can be time consuming and not feasible in areas with many crapemyrtles. Therefore, studies are being carried out to assess which are the best pesticide products to control the CMBS.

For more information, see the LSU AgCenter crapemyrtle bark scale website (http://www.lsuagcenter.com/crapemyrtle).

For managing resources, see LSU AgCenter crapemyrtle bark scale management updates (http://www.lsuagcenter.com/articles/page1508343389870).