

**CHECKLIST  
PEST MANAGEMENT: PROPER USE OF PESTICIDES**

- ✓ Obtain the proper training before mixing pesticides. See section on pesticide licensing.
- ✓ Reduce infestations from outside sources and incorporate non-chemical methods such as biological, cultural and sanitation controls in your pest management program.
- ✓ Limit the frequency of treatments whenever possible, particularly nerve toxins. Evaluate the cost-benefit economics and use scouting and thresholds to justify treatments.
- ✓ Treat small areas as much as possible, and whenever possible, only treat infested plant(s) rather than treating all plants in the greenhouse.
- ✓ Avoid persistent compounds and slow release/encapsulated formulations. Ideally, an effective insecticide should be applied at a concentration high enough to kill all individuals in a population, and then quickly disappear from the environment.
- ✓ Avoid treatments that apply selection pressures on both larval and adult stages.
- ✓ Avoid tank mixes (mixing two or more insecticides together to control a single pest) except in cases where research has demonstrated improved efficacy.
- ✓ Rotate insecticides with different modes of action.
- ✓ Use insecticides with non-specific modes of action whenever possible. The less specific the mode of action of an insecticide, the less likely it is that genetic mutations can be selected.
- ✓ Note that resistance can develop to products other than traditional chemical pesticides. Resistance has been reported in some species to *Bacillus thuringiensis* and to some insect growth regulators.
- ✓ Test the pH of the water and adjust the pH of the water before mixing pesticides.
- ✓ Measure accurately when mixing pesticides. Measure wettable powders by weight using a scale. Measure liquids by volume.
- ✓ After mixing an insecticide with water, spray immediately or within a few hours. Never allow a mixed chemical to stand overnight before applying.
- ✓ Treat according to label directions.
- ✓ Inform your local fire department before using a smoke formulation of pesticide.

- ✓ Apply pesticides during the cooler part of the day, such as the early morning or evening.
- ✓ Add surfactants only when recommended on the pesticide label.
- ✓ Never use a sprayer for insecticides that was previously used to apply herbicides.
- ✓ Apply pesticides only after crops have been irrigated and show no signs of moisture stress.
- ✓ Do not apply pesticides with a fertilizer unless indicated on the label.
- ✓ Never use broad-leaved weed killers and brush killers around the greenhouse.

## PROPER USE OF PESTICIDES

Before using pesticides, obtain the proper training. See section on pesticide licensing.

### **Delaying Pesticide Resistance**

To use fewer pesticides, it is important that pesticides, when used, are effective at killing pests. Pests can become resistant to pesticides making the pesticide ineffective for management. Resistance is genetic in nature, and an insect or mite cannot become resistant or acquire resistance during its life (that is, within one generation). Resistance is stimulated by widespread application of a pesticide but some individual pests survive and pass on genetic factors to the next generation. A chemical cannot adjust in response to genetic changes in the pest population that help the pest survive the chemical application. Thus, the surviving pests can transfer the resistance factor(s) into the population, allowing the population to become resistant over a period of time. Repeat applications with one type of pesticide eventually remove almost all the susceptible individuals from a pest population and leave only those with the resistant gene.

Pests can become resistant to insecticides to which they have never been exposed. This can happen when two insecticides have a similar mode of action. Mode of Action (MoA) is how a pesticide specifically kills a pest. If two (or more) insecticides attack the pest in the same way, a resistance mechanism to one insecticide may also provide resistance to the other, even though the pest may never have been exposed to that second insecticide.

### **Tips for Delaying Pesticide Resistance:**

- Reduce infestations from outside sources and incorporate non-chemical methods such as biological, cultural and sanitation controls in your pest management program.
- Limit the frequency of treatments whenever possible, particularly nerve toxins. Evaluate the cost-benefit economics and use scouting and thresholds to justify treatments.
- Treat small areas as much as possible, and whenever possible, only treating infested plant(s) rather than treating of all plants in the greenhouse.
- Avoid persistent compounds and slow release/encapsulated formulations. Ideally, an effective insecticide should be applied at a concentration high enough to kill all individuals in a population, and then quickly disappear from the environment.
- Avoid treatments that apply selection pressures on both larval and adult stages.
- Avoid tank mixes (mixing two or more insecticides together to control a single pest) except in cases where research has demonstrated improved efficacy. Take precautions when tank mixing. Phytotoxicity problems can occur with a mixture even though no problems were observed with either material used alone.
- Rotate insecticides with different modes of action. Unless otherwise directed on the pesticide label, switch to a pesticide with a different mode of action about every 2 to 3 pest generations or about every 2–3 weeks. Mode of Action (MoA) Classification provides information about pesticides and how they work. The actual length of an insecticide rotation depends on the time of year, as temperatures and season influence the length of insect life cycles. For example, warm temperatures often lead to overlapping generations and various stages of development present at the same time. As a result, more frequent applications and more frequent rotations of insecticides or miticides are needed.

In winter, pest development is slower and insecticides and miticides may not need to be rotated as often.

- Use insecticides with non-specific modes of action whenever possible. Most synthetic and botanical insecticides kill insects and mites by affecting very specific chemical pathways in the pest (interfere with nerve transmission, development, metabolism, digestion, etc.). The less specific the mode of action of an insecticide, the less likely it is that genetic mutations can be selected. Insecticidal soaps and horticultural oils both have broad modes of action and are, therefore, unlikely to allow for the development of resistance.
- Note that resistance can develop to products other than traditional chemical pesticides. Resistance has been reported in some species to *Bacillus thuringiensis* and to some insect growth regulators.

### **Improving Efficacy of Pesticides**

- Test the pH of the water before mixing pesticides. Many pesticides, especially organophosphates, are not effective when mixed in water with a pH greater than 7. If necessary, use a commercially available buffering agent to adjust the pH of water to be neutral (pH 7) or slightly acidic. More information including a list of pesticides and their optimum pH ranges is available at:  
[http://www.umass.edu/umext/floriculture/fact\\_sheets/greenhouse\\_management/ph\\_pesticides.htm](http://www.umass.edu/umext/floriculture/fact_sheets/greenhouse_management/ph_pesticides.htm)
- Measure accurately when mixing pesticides. Use a scale to measure wettable powders by weight. Use a measuring cup to measure liquids by volume. Read labels carefully!
- After mixing an insecticide with water, spray immediately or within a few hours. Never allow a mixed chemical to stand overnight before applying.
- Treat according to label directions. Most pesticide labels now contain information on amounts to be applied to a certain area. This is important for delivering the correct amount of active ingredient for effective control.

### **Preventing Pesticide Damage to Plants (Phytotoxicity)**

- Apply pesticides during the cooler part of the day, such as the early morning or evening. Treatments made in the early morning allow foliage to dry before temperatures reach 85–90°F. Take special precautions when using pesticides containing oil. Treat when conditions allow plants to dry quickly.
- Add surfactants only when recommended on the pesticide label.
- Avoid tank mixes. A mixture of insecticides may increase the chance of injury to plants.
- Never use a sprayer for insecticides that was previously used to apply herbicides.
- Apply pesticides only after crops have been irrigated and show no signs of moisture stress.
- Do not use more than one emulsifiable concentrate in a tank mixture.
- Do not apply pesticides with a fertilizer.
- Never use broad-leaved weed killers and brush killers around the greenhouse.

### **Reference**

Stack, L. Editor. 2009-2010 *New England Greenhouse Floriculture Guide; A Management Guide for Insects, Diseases, Weeds and Growth Regulators*. Northeast Greenhouse Conference:  
<http://www.negreenhouse.org/index.html>