Questions and Answers About... INSECTICIDAL SOAPS AND DETERGENTS AS INSECTICIDES

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What are insecticidal soaps?

Many soaps have some ability to control insects. Insecticidal soaps are types of soaps specifically developed and sold for control of insect pests. Several are currently on the market under trade names such as M-Pede, Acco Plant Wash, Safers Insecticide Concentrate and several other Safers-brand products.

How are insecticidal soaps and detergents used as insecticides?

Insecticidal soaps are almost always used as dilute sprays or occasionally as drenches. They are contact insecticides that must be applied to the surface of the target insect pest. Soaps usually are diluted to form a concentration of 1 percent to 2 percent in water. (This is the equivalent of 2.5 to 5 tablespoons of soap in a gallon of water.)

What is a soap?

Soaps are the salts of a fatty acid. Fatty acids are the basic component of fats and oils produced by animals and plants. By reacting these fatty acids with an alkaline or base, soaps are produced. This process is called **saponification**.

Most insecticidal soaps are potassium salts of fatty acids, produced by reacting potassium hydroxide with the soap. Common hard soaps are sodium salts. Fatty acid salts produced by reaction with calcium or magnesium occur when soaps are mixed with hard water. They are insoluble in water.

What's the difference between a soap and a detergent?

All soaps are detergents, but not all detergents are soaps. Synthetic detergents vary considerably in their chemical structure, whereas soaps are a more limited class of chemicals. However, soaps and detergents share the common chemical property of having one water soluble (polar) end and an oil-soluble (non-polar) end.

One important advantage of detergents is that they do not react with calcium or magnesium found in hard water. This is a major reason that detergents have replaced soaps

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for many cleaning purposes. Detergents also produce neutral solutions while soap diluted in water is very alkaline.

Are all soaps insecticidal?

Most soaps have some insecticidal activity. However, the type of fatty acid that the soap is derived from greatly affects insecticidal activity. For the potassium salt soaps, saturated fatty acids containing 10 carbon molecules are most insecticidal. Eight carbon and 12 carbon fatty acids also produce soaps with high insecticidal activity compared to other carbon chain lengths. Safers Insecticidal Soap is derived from oleic acid, a 10-carbon saturated fatty acid.

Salts produced by unsaturated fatty acids are most insecticidal around the 18-carbon chain fatty acid group (18:1).

Another important consideration is how phytotoxic are soaps. Soaps can affect plant cells as well as insect cells. Some soaps have even been selected as herbicides because they are highly destructive to plants. An ideal insecticidal soap for use in plant protection has a high level of effectiveness against insects with minimal effects on plants.

Are detergents insecticidal?

Most detergents used around the home also are insecticidal. However, many also are herbicidal and can not be used on plants without causing injury.

Some liquid dishwashing detergents are effective insecticides as well as fairly plant safe. Ivory Dishwashing Liquid and Dawn are two examples of dishwashing detergents that can be used in a manner (i.e., as a liquid spray, in about a 2 percent dilution) similar to insecticidal soaps.

One caution with detergents is that they are of more variable manufacture and performance and can be irregular. They also tend to be a little more phytotoxic than insecticidal soaps.

What are the advantages of using insecticidal soaps and detergents for insect control?

The primary advantage of soaps and detergents as insecticides involves their safety and selectivity of action. They are essentially non-toxic to humans, mammals and birds. At worst, prolonged exposure to soaps and detergents may irritate skin and if ingested produce stomach upset and perhaps diarrhea.

This selectivity of action also extends to many of the natural enemies of insect and mite pests. Most natural enemies are larger and relatively less susceptible than the pest species to insecticidal soap or detergent treatment. (However, some beneficial species such as predator mites are quite susceptible to insecticidal soaps.) Selectivity also is increased by the non-persistence of the effects from treatment. Once the soap film dries, it does not appreciably affect any insects. This allows natural enemies to rapidly recolonize treated plants. Soap and detergent treatments integrate well with other biological controls.

Insecticidal soaps generally have broad usage labelling that allows their application to essentially all food and non-food plants alike. Furthermore, they can be used up to time of harvest because they do not have a preharvest interval requirement.

What are the legal restrictions of using insecticidal soaps and detergents?

Any product sold for the purpose of controlling a pest is legally classified as a pesticide. They therefore fall under restrictions of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended.

One key provision of this act is that pesticides cannot be used inconsistent with label directions. Perhaps the most important feature is that pesticides, including soaps, cannot be used on crops that are not specified on the label. For example, if use on tomatoes is not permitted on label directions it is illegal to apply the product to tomatoes.

In reality, most insecticidal soaps have label use directions that are broadly stated, allowing use on essentially all plants.

Household detergents/soaps not sold for pesticidal purposes are not regulated as pesticides. Legally they can be used on plants, at the risk of the applicator.

Are all insects susceptible to soaps and detergents?

In general, small soft-bodied insects and mites are susceptible to insecticidal soaps and some detergents. This includes many insects in the order Homoptera such as aphids, whitefly nymphs, leafhoppers, scale crawlers, and mealybugs. Spider mites, nymphs of the 'true bugs' (plant bugs, boxelder bugs, etc.), and thrips are other potential targets for insecticidal soaps. Sometimes eggs or small larvae of beetles, moths, or flies can be killed by insecticidal soaps.

Larger insects, such as beetle grubs, caterpillars, and maggots tend not to be seriously affected by insecticidal soaps. In particular, adult stages of these insects are fairly immune to soap sprays.

It is difficult to generalize about any insect group. For example, insecticidal soaps tend to be effective against aphids. However, they only are marginally effective against the green peach aphid, the common aphid in greenhouses and houseplants. Insecticidal soaps also tend to spare most beneficial insects, although predatory mites are susceptible to the treatments.

How do soaps and detergents actually kill insects?

Soaps disrupt the function of cell membranes that surround the cell and enclose cell structures such as mitochondria.

Cell membranes are made of a double layer of lipids. Soaps and detergents pull lipids from the membrane, creating holes in the membrane and destroying its structure. This causes the membranes to leak water and ions needed for cell function.

This loss of normal ion balance affects many cell functions. In particular, the mitochondria that produce ATP and are basic to cellular respiration, can no longer function when the precise balance of ions is disrupted. Once the cell can no longer undertake these basic functions, the cell dies.

The ability of a specific soap or detergent to penetrate outer covering membranes of the insect (e.g., cuticle) and to interact with the lipids of the cell membrane determines its insecticidal activity.

What are the limitations or disadvantages of using insecticidal soaps or detergents for insect control?

Dilute soap sprays act strictly as contact, non-residual insecticides or miticides. In order to be effective, apply directly on the body of the insect that is being controlled. Thus, thorough application coverage is essential when using soaps as insecticides. Furthermore, once the soap film dries, insects that walk over the soap-treated surface are not affected.

Soaps, as with other contact insecticides (e.g., malathion, diazinon, Sevin), also are ineffective against insects that occur within plant tissues and do not make contact with the spray. This includes leafcurling aphids, many gallmakers and leafmining insects.

Phytotoxicity also is a concern. Plant cells can be disrupted by soaps and detergents, causing a burning reaction. Herbicidal soaps are even produced and sold for the purpose of killing plants. However, commercial insecticidal soaps are selected for both plant safety as well as insecticidal activity. Detergent sprays have much higher risk of causing plant injury since they are of variable manufacture and are not developed for use on plants.

Can hard water affect insecticidal soaps?

Hard water can greatly affect performance of insecticidal soaps. Hard water contains calcium, magnesium, iron, or other metallic ions that can chemically react with the fatty acid salts. The byproducts of this reaction are solid precipitates, such as the scum produced by bath soaps reacting with hard water.

In areas of hard water, condition the water (softened) before mixing with an insecticidal soap. This is particularly important if the water/soap mixture is to stand for a long period before use.

If the water hardness is unknown, first test the water by mixing a small amount of soap and check for cloudiness, surface scum or curdling.

Synthetic detergents are not affected by hard water.

Can mixtures of soaps with other pesticides improve performance?

Insecticidal soaps are reported to improve the effectiveness of several pesticides. Such a combination often provides more uniform coverage of the target pest due to the surfactant action of the soap. (Soaps are spreader stickers.)

Uptake of the pesticide through the insect cuticle may also be enhanced by combination with a soap. Some research suggests that reduced rates of soap with the insecticide acts as well or better than full rates.

Can mixtures of soaps with other pesticides adversely affect performance?

Insecticidal soaps are highly alkaline, with a pH above 10. Alkaline conditions can increase the rate at which many insecticides chemically decompose. Highly alkaline-sensitive pesticides, or many pesticides that remain in mixture with soaps for extended periods, will be adversely affected by this mixture.

A few pesticides react chemically with soaps and are incompatible. The EBDC fungicides, such a Maneb or Dithane M-45, are incompatible with soap mixtures. Fertilizers that contain metallic ions of zinc, copper, or iron also are incompatible with insecticidal soaps.

Occasionally, phytotoxicity problems may arise with soap combinations. For example, the mixture of Safers Insecticidal Soap and Sevin was reported by a Colorado applicator to cause defoliation of ponderosa pine.

How can weather factors affect performance?

Insecticidal activity is increased by conditions of slow drying, which allow increased uptake. Cool temperatures are particularly important in increasing activity.

Windy conditions indirectly can affect performance by altering coverage. Since insecticidal soaps and detergents require thorough coverage for effectiveness, reduced coverage will adversely affect performance. Furthermore, winds cause the soap sprays to dry more rapidly, reducing uptake by the insect.

Weather conditions also affect phytotoxicity potential.

How do environmental conditions affect phytotoxicity?

Label directions indicate several precautions regarding phytotoxicity, and most are similar to those that apply to all sprays. Do not apply insecticidal soaps when temperatures are high, above about 90 degrees F, particularly when humidity is high. Plants in direct sunlight under glass also are at greater risk of injury. Plants in poor condition or under stress are more likely to be injured by soaps.

Are any plants particularly sensitive to insecticidal soaps?

The labelling of Safers Insecticidal Soap indicates that some species of plants have been injured in trials. These include:

* Cherry
* Garden pea
* Hawthorn
* Horse chestnut
* Japanese maple
* Mountain-ash
* Nasturtium
* Sweet pea
* Violets

In addition, labels indicate some varieties of the following have shown injury:

* Impatiens
* Geraniums
* Poinsettias

Directions on the M-Pede Insecticide label indicate the product should not be applied to evergreens under drought or when tender new growth is present.

In Colorado State trials involving excessive rates of Safers Insecticidal Soap and Ivory Dishwashing Detergent, phytotoxic injury was observed on the following:

* Alyssum
* Broccoli (some varieties)
* Cornflower

* Dusty miller
* Gaillardia
* Lemonbalm
* Marjoram
* Oregano
* Portulaca
* Tomatoes (some varieties)
* Verbena
* Zinnia (some varieties)

Concurrent comparison trials with Ivory Dishwashing Liquid caused substantially more phytotoxicity to a few more plant species in these trials than Safers Insecticidal Soap.

It should be pointed out that these were greenhouse studies and were conducted under extreme circumstances including high temperature and high light, as well as high concentration of the applied material (usually 8 percent to 10 percent concentration).