SOIL-APPLIED SYSTEMIC INSECTICIDES

These insecticides are a viable alternative to foliar applications, which sometimes raise concerns in the areas of drift and effects on non-target organisms.

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Certain insecticides have the ability to move systemically within the sap stream of plant tissue. These "systemic" insecticides can often provide improved plant coverage. They are also particularly effective for control of insects living within foliage (e.g., leafminers, gall makers, leafcurling aphids). For several plant protection purposes, systemic insecticides are superior to non-systemic insecticides with purely "contact" activity.

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Relatively few insecticides have systemic activity. All those currently used in woody plant protection are limited to the carbamate and organophospate insecticide classes (Table 1). These systemic insecticides are variously applied to foliage, in trunk injections and as soil treatments.

All systemic insecticides are capable of moving systemically within the plant following foliar application. This remains the greatest use of systemic insecticides in landscape plant care since many commonly used insecticides, such as acephate (Orthene) and dimethoate (Cygon) have systemic activity when sprayed on plants. Following foliar applications, these systemic insecticides move within the leaf and often travel upwards in the plant to a limited extent.

A lesser number of systemic insecticides are also capable of being picked up by roots following soil applications.

Many systemic insecticides (e.g., acephate, mevinphos) are decomposed rapidly or are absorbed by soil particles following soil treatment.

Some soil-applied systemic insecticides remain in effective concentration within the soil before root uptake. After uptake, they move in the xylem and are later also diffused more generally through the phloem by radial transfer. Subsequent movement of systemic insecticides within trees is highly dependent on the tree's respiration and growth. Generally the insecticides become most concentrated in more rapidly-growing tissues.

Some remobilization of insecticides may occur, such as from older needles to new needles, but usually herbicide breakdown in the plant is rapid enough to allow maximum effective persistence of a few months.

Soil systemic insecticides can be variously applied, but all require that the material be injected below ground into the root zone. Granular formulations are placed in holes dug around the base of the plant. Solid forms exist as fertilizer/insecticide spikes or as cakes used for root feeder systems.

Liquid formulations are perhaps the most easy to apply. One of the

Table 1.

Characteristics of systemic insecticides used on landscape plants.

Common name	Trade names	Remarks
oxydemetonmethyl	Metasystox-R 2, Inject-A-Cide	Moderately toxic. Available as trunk injection or soil application in liquid formulation. Foliar treatment uses have been eliminated. Recent label improvements have clarified soil application uses.
dimethoate	Cygon, Dimethoate	Moderately toxic. Primarily used as a foliar spray but has soil systemic activity. Soil appliction uses limited to a few states with Special Local Need registration. Liquid formulation.
acephate	Orthene, Isotox, Acecap	Moderate-low toxicity. Primarily used as foliar treatment. Also available as trunk implant. Not effective as soil treatment. Liquid and solid implant formulations.
carbofuran	Furadan	Highly toxic and Restricted Use. National labelling allows soil systemic application use of granular formulation for control of insects of cottonwood, elm, and pine. Some state labelling for use of liquid formulation.
disulfoton	DiSyston	Highly toxic and Restricted Use. Used as soil systemic application in granular formulation. Broadly labelled for use on woody plants.
dicrotophos	Bidrin, Inject-A-Cide B	Highly toxic and Restricted Use. Only available in liquid formulation for trunk injection uses.

Table 2.

Summary of Colorado State University control trial results using soil applied systemic insecticides, 1984-1987.

Target Pest	Insecticide	Degree of Control
Honeylocust pod gall midge	Metasystox-R	Fair-Good
Honeylocust pod gall midge	DiSyston	Poor
Honeylocust spider mite	Metasystox-R	Excellent
Honeylocust plant bug	Metasystox-R	Poor
Honeylocust rust mite	Metasystox-R	Fair-Poor
Honeysuckle aphid	Metasystox-R Cygon/Dimethoate	Excellent Excellent
Ash leafcurl aphid	Metasystox-R	Excellent
Pinyon spindle gall midge	Metasystox-R Cygon/Dimethoate	Fair-Poor Excellent
Pinyon tip moth	Metasystox-R Cygon/Dimethoate	Good Excellent
Hackberry nipple gall	Metasystox-R	Good
Hackberry bud gall	Metasystox-R Cygon/Dimethoate	Poor Good
Elm leaf beetle	Metasystox-R	Poor

simplest application techniques involves use of low-pressure equipment of the Kioritz system which injects the fluid several inches below ground. Regardless of the application technique used, treatments are applied to multiple sites around the tree. To allow insecticide uptake, soil in the treated area must remain moist for several days after treatment.

Recently there has been increased interest and availability of soil-applied systemic insecticides for insect and mite control in landscape plants. This has been largely the result of increased concerns and limitations of foliar applications due to problems with insecticide drift and effects on non-target organisms such as beneficial insects, wildlife and clients.

Also important are recent improvements made in the label instructions of at least one soil-applied systemic insecticide, Metasystox-R2, which clarifies its use in landscape protection.

In light of the increased interest in soil systemic insecticide applications, a review of advantages and disadvantages of these treatments is in order.

Advantages

Effectiveness on insects and mites. Soil-applied systemic insecticides are highly effective for control of a wide variety of insects and mites that feed on plant foliage. A summary of recent Colorado State University control trials with two systemic insecticides, Metasystox-R2 and Dimethoate 400, is listed in Table 2.

In general, sucking insects appear to be better controlled than chewing insects by these treatments. Control is usually marginal of insects that bore within woody plant parts or of scale insects feeding on bark—presumably because the insecticide does not concentrate at these sites. Persistence of soil-injected systemic insecticides is often superior to that of foliar-applied insecticides.

Drift. A strong advantage of soil-applied systemic insecticides is the elimination of drift associated with spray applications. Soil systemic insecticide applications are limited to the below-ground areas of the plant. They should not drift onto adjacent properties if properly used.

One area requiring research attention is the possible problem of soil-applied systemic insecticides moving into groundwater.

Agriculture-related problems with the highly water soluble insecticide aldicarb (Temik) are well-publicized. Although the insecticides used in soil-applied systemic treatment of landscape plants have not been associated with similar problems, caution is advisable.

Ease of application. Soil-injected systemic insecticides can be substantially easier to apply than foliar treatments. Injection equipment is often portable and capable of being moved easily to hard-to-reach sites. Applications can often be made rapidly and pre-site preparations to cover furniture, fish ponds, etc. can be reduced.

In areas of considerable rainfall, soil injections can be made during periods when foliar sprays are not possible.

Finally, soil injection treatments may be more favorably considered by ordinances which limit or require notification postings of "air-borne" pesticide applications.

Non-target impacts. Soil-injected insecticides that move systemically within plants are often "easier" on benefical insects such as honeybees and insect natural enemies that do not feed on plant tissue. Nesting birds are also not inadvertently treated during application.

Phytotoxicity. Phytotoxicity remains a potential problem for soil-applied systemic insecticides as well as for foliar or trunk injection treatments. Although some buffering of phytotoxic effects does occur when insecticides are applied to the root zone rather than directly to plant tissue, damage can occur. Species sensitivity to the insecticide, insecticide rate, soil conditions and plant physiology all can affect this phytotoxic response. Expanded use and experience with these treatments will help define phytotoxicity risks.

Applicator safety. Relative applicator safety of soil treatments versus foliar treatments is mixed. On the positive side, soil applications should not typically involve the degree of inhalation exposure hazard that occurs during foliar treatments. Also, application equipment for soil applications can be simpler, involving low-pressure, and less susceptible to accidental exposure following equipment failures.

Conversely, use of soil-injected systemic insecticides typically involves the transportation and handling of highly concentrated pesticide in contrast to dilute mixtures used for spraying. Moreover, the relative toxicity of insecticides with systemic activity typically is much greater than commonly-used foliar treatments such as carbaryl (Sevin), malathion or fluvalinate (Mavrik).

Hazards with accidental exposure are greatly increased if high pressure application equipment is used. Additional training, a very high level of attention to equipment maintenance and the use of protective equipment is essential with soil-injected systemic insecticide applications.

Pesticide use rates. The amounts of insecticide used in soil systemic application are extremely high. For example, the amount of Metasystox-R2 used for insect control on a single one-foot diameter tree approach the use rates of equivalent insecticides used on an acre of an agricultural crop. The high use rates have expensive product costs and must cause some pause when considering the amount of pesticides being applied in the environment.

Precautions

Using soil-injected systemic insecticides clearly has strong advantages that will increase their future use in landscape plant protection. However, limitations also exist. It is suggested that certain precautions, preferably included on label directions, be followed.

Labelling. Labelling soil systemic insecticides for use on woody plants is quite limited at present (Table 1). However, there is evidence that many manufacturers are now giving increased attention to ornamental pesticide labelling. In the past, this has been a highly neglected area in marketing plans of many insecticide manufacturers. It is being corrected, due to sluggishness of the traditional agriculture markets and the green industry's increased visibility. Availability of soil systemic insecticide uses can be expected to increase.

Protective clothing needed. Because of the innate toxicity of systemic insecticides and their use in concentrates, full protective clothing should always be required.

Hazards involved in handling and applying soil-injected soil systemic insecticides require special applicator training. By making these products Restricted Use pesticides, use by certified, trained professional applicators is ensured.

Elimination of pressurized application systems. Accidental exposure and injury is greatly increased by application of insecticides under high pressure. Equipment breakage and blowing of pesticide from injection holes are two likely means of inadvertent exposure during application.

Restriction of applications near groundwater sources. The extreme attention and interest in groundwater protection from pesticides and pollutants requires that all pesticide applications be made in a way that eliminates pollution risks. Use of soil injections near wells and low-lying aquifers should be restricted until their safety is demonstrated. **LM**