SUB-SURFACE PLACEMENT OF INSECTICIDES: CAN IT WORK?

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Many turf insects are difficult to control because they spend much of their lives in the soil, below the thatch. As a result, any insecticide which is applied to control the insect pest must penetrate the thatch and reach the soil if it is going to provide any level of control of the damaging insect. This is the reason why most turf insecticides which are directed toward white grubs include instructions to water in the material immediately after application. Even when water is applied after an application, some of the turf insecticides which are currently available commercially are bound, or "tied up," in the thatch quite readily, and may not reach the soil/thatch interface, where the grubs are most active. If techniques could be developed to place interface, where the grubs are most active. If techniques could be developed to place insecticides (and other kinds of pesticides) below the surface of the turf, in or below the thatch, perhaps those materials would perform better against soil-feeding insects or root diseases.

At least two methods of placing pesticides below the turf surface have been developed (actually adapted from previous uses) in the past four or five years. High pressure liquid injection can be used to drive liquid formulations into the turf at very high pressures. Slicing can be used to slice the turf and deliver granular or liquid formulations.

HIGH PRESSURE LIQUID INJECTION (HPLI) equipment uses very high pressures (up to 4,000 psi in some versions) and very small nozzle orifices to deliver liquid formulations. The nozzles normally are directed downward and aligned on a drag bar at 1.5 to 3 inch spacing. The drag bar assures that the nozzles will never be more than 0.5 inch off the ground. The material is driven through the thatch solely by high pressure—there is no slicing with this kind of equipment.

HPLI applications leave very little evidence that an application has been made. There is a small indentation where the material penetrates, but this "dent strip" normally is not visible once the turf has been mowed. I have used HPLI equipment on green, fairway, and rough turf areas and never observed any physical damage to the turf. (There can be a risk of phytotoxicity with any pesticide application, particularly one made with an oil-based carrier on a hot day in the summer on low cut bentgrass, whether the application is made sub-surface or conventionally. However, I have used HPLI under a wide range of conditions and never observed any phytotoxicity.)

I have tested several insecticides for effectiveness against Japanese beetle grubs, applying the materials conventionally or using HPLI for direct comparison. Because I suspected that the technique might improve the performance of the insecticide by placing it closer to the area where grubs are active, I tested the labeled rate and half the labeled rate when using HPLI. There is evidence in my field trials that one insecticide (Triumph™, or isazophos) often can be used at less than labeled rates when applied using HPLI and still provide the same level of control as labeled rates applied conventionally. NOTE, however, that these field data are still considered preliminary, and the current label for Triumph™ does not include reduced rates. For all of the other active ingredients tested (diazinon, Dursban™ or chlorpyrifos, Turcam™ or bendiocarb), we have not seen a statistically significant improvement in performance with HPLI—it works as well as conventional applications, but does not necessarily improve the performance of the material.

There are two basic approaches to HPLI currently being developed. One technology uses a steady stream of liquid and delivers material constantly. The other technique uses a pulsed delivery system. Either approach can be adjusted to deliver material in a pattern which would ensure adequate contact with white grubs, because grubs are relatively mobile as they forage for root material. The depth of penetration can be adjusted by varying ground speed, pressure at the nozzles, or using different diameter orifices. In addition, the pulsing systems can adjust the length of time the jets are open and the period of time between pulses.

The Hydroject™ system, as it was developed by Toro, was not originally designed to handle pesticides (primarily because the materials can be very corrosive as they pass through the delivery system). In addition, the Hydroject™ system was originally intended to provide aerification, which meant that it needed to penetrate several inches into the soil profile to fracture the soil. Penetration to that depth would be much too deep for good grub control—too deep is just as inefficient as too shallow when it comes to placing soil insecticides.

The SLICING technology which is available for pesticide application has been adapted, for the most part, from slicer/seeder technology. Several companies have built equipment which has been adapted to deliver granular pesticides through plastic tubing into the slices which have been cut by solid or notched coulters. Most of the equipment appears to use 1.5 to 2.5 inch spacing. Most of the equipment appears to be adjustable to provide penetration at least 2 inches below the thatch, and can be adjusted to within 1/8 inch of the desired depth. In addition, some of the units have been adapted to deliver liquid formulations at very low pressures (less than 10 psi).

My field experience with the slicing technology includes field trials of Mocap™ (ethoprop), Turcam™ (bendiocarb), Crusade™ (fonofos), and Triumph™ (isazofos). As with HPLI, I have not seen a statistically significant difference between reduced rates of materials applied sub-surface and labeled rates applied conventionally.

However, while sub-surface technology may not enable us to reduce application rates for many active ingredients, there are several other advantages which I see with the technology. First of all, less material remains on the surface following an application made with sub-surface application equipment than one made conventionally. This can be demonstrated visually, especially with granular formulations. In addition, field trials which I have conducted over the past three years have shown that surface residues are 40 to 80% lower in sub-surface plots than conventional plots of the same active ingredient applied at the same rate. If there is less material on the surface, it is reasonable to suppose that the rate of run-off would also be reduced—but the data have not yet been generated to support this hypothesis.

Because the material is being placed below the surface and out of sunlight, materials may not break down as quickly as materials which remain on the surface. This is because there is less penetration of UV sunlight into the plant canopy and thatch, and as a result less breakdown of the insecticide. In addition, some of our field trials using Triumph™ (isazophos) suggest that post-application watering can be delayed (at least a few hours) when the material is applied sub-surface. While I have not tested watering regimes for other insecticides applied with sub-surface application equipment, the same may hold true for some of them as well. The feature alone would make the technology attractive for some lawn care operations.

Several new biological control agents are in the development stage and some will be available in 1994 or 1995. Many of these are living organisms and are subject to desiccation in the turf setting. If these produces (for example, insect-attacking nematodes of fungi) are applied with slicing technology and low pressure, it may enhance their chance of survival.

Meanwhile, sub-surface placement of insecticides will not be the final solution by any means. There are some disadvantages which must be taken into account as well as the advantages which have been discussed. First of all, with the HPLI systems, there can be an issue of operator safety. These units deliver materials at extremely high pressures. Failure to operate the machinery properly could result in a rupture in a low or high pressure hose and potential for direct injury as well as a pesticide spill.

While the reduction of surface residue is considered an advantage, there is also an increased potential for increased leaching. However, preliminary results of studies conducted at Penn State seem to indicate that most insecticides, when applied to established turf in sandy loam or similar soils, do not leach more when applied with HPLI than when applied conventionally. Of course, studies must be conducted on a range of soil and thatch conditions before we can presume that HPLI or slicing applications will not increase leaching rates in established turf.

Most of the sub-surface placement technology which is currently available is notably slower than conventional technology. In some cases turf managers have opted to contract the sub-surface work to a commercial company and leave their own crew available for traditional work assignments. Nevertheless, the technique normally is slower (taking perhaps 50% longer than a conventional application). At this time there are relatively few options available for the lawn care operator who works on small (<10,000 square feet) lawns.

Sub-surface placement technology is progressing rapidly and more options are available every growing season. Environmentally there appear to be several advantages to using the technology, and it warrants experimentation by turf managers who are equipped to do so. However, the bottom line is still that turf insect control must rely on rapid and accurate diagnosis of the problem and a timely response. A poorly timed application of an insecticide, even if it is applied using sub-surface technology, will not control white grubs—or anything else!