ATTACKING FROM WITHIN

The latest method of insecticide application in turf reduces surface residues, doesn't require irrigation and may give you better control at a lower rate.

by Will Perry, managing editor

Imagine a day when you get better control of turf insects from an insecticide application you didn't have to water in, apply at a reduced rate and that offers no headaches about surface residues, drift or runoff. That day is today.

The application method is via high pressure surface injection, which has been called a success by university and commercial researchers in warm- and cool-season climates.

The method itself is not new. Injecting polymers for water absorption, nematodes for thatch reduction and low-salt turf fertilizers has taken place for several years. The principle is this: force the pesticide through the surface layer, as deep as soil compaction or thatch levels dictate, and hit the target directly. By doing so you improve the efficacy of the chemical and avoid the problems associated with the residual of pesticides on the turf/soil surface.

Researchers lauditory

"I'm more excited about this technique than anything I've seen in a long time," says Auburn University entomologist Pat Cobb, Ph.D. She is one of eight researchers who recently completed testing of an injection system called Injektaspray, developed two years ago by Cross Equipment Co. of Albany, Georgia. (All of the researchers quoted in this story are recalling their experiences with the Injektaspray system.)

RainSaver, Inc. of Walla Walla, Wash., unveiled the Rain Saver 960 and 360 (formerly the RainSaver Jr.) last month at the annual Golf Course Superintendents Association of America meeting in Anaheim. Both models can be used for high-powered surface injection of insecticides. The units had been on the market as injection applicators of water-absorbent polymers, live microbe formulas and fertilizers.

The machines differ in that the RainSaver units use a series of thin coulter blades set three inches apart on a central shaft, which opens the turf. A nozzle immediately behind the coulter directs the material into the open slit.

The Injektaspray system consists of combined low pressure (30 to 40 psi), low-height topical spray application followed by a high pressure (2,000 psi) ground surface injection. These systems may be operated simultaneously or independently, as needed.

The pesticide is injected directly into the soil using straight stream nozzles through holes in a stainless steel shield pan. The depth of the injection ranges from 1/4 to 1 1/2 inches. Among its most unique aspects is that it doesn't disturb the soil surface, according to the manufacturer.

Harry Niemczyk, Ph.D. at Ohio State University, has been testing both units for Japanese beetle grub control (see related story below). "Subsurface Attack on Grubs").

Mole cricket control

Cobb, Ciba-Geigy senior field research representative Mac Hammond, and field technician Phillip Coburn conducted two extensive tests of the injection process. They used the Injektaspray system with Dursban, Triumph and diazinon in

SUBSURFACE TECHNOLOGY IS PROMISING

OSU research shows it's an idea worth pursuing.

by Harry D. Niemczyk, Ph.D., Department of Entomology The Ohio State University

Soil-inhabiting turfgrass pests, such as grubs and plant parasitic nematodes, are currently controlled by applying pesticides to the turf surface and then irrigating to move the material to the target. Recent research here has shown that the actual amount of pesticide delivered to the site of pest activity is frequently less than five percent of that applied to the surface. This is especially true in turfgrass situations having 1/2 inch or more of thatch. (Immediate post-treatment irrigation generally delivers enough pesticide to control the target pest.)

Because of this disparity, recommended effective rates for pesticides are set higher than that actually needed at the site of pest activity. This compensates for the relative immobility of the material.

What if?

What if the amount of pesticide actually needed to control the pest could

TABLE 1

MOLE CRICKET CONTROL IN BERMUDAGRASS

Treatment	Rate Lb ai/a	Pretreat	Mean Number of mole crickets per flush* (% control) 25 Days Posttreat	50 Days Posttreat
DURSBAN* 50W 350 psi injection	2	3.8	0 (100%)	0 (100%)
DURSBAN microencapsulated	2	5.7	0.2 (9.6%)	1.0 (8.2%)
DURSBAN 50W + Entice	2 + 2 qts	5.3	0.5 (91%)	1.5 (72%)
Oftanol	2	5.2	1.7 (67%)	3.3 (36%)

*Mole crickets flushed in 2′ × 2′ quadrant; two flushes per replicate, three replicates per treatment.

Source: Wayne Currey, Ph.D.

Mobile and Eufala, Ala., on mole crickets.

Cobb says she got "very satisfactory" control of mole crickets with the injection process. She adds that initial data suggests control with reduced rates of Dursban 2E and Triumph 4E, though additional data is still needed.

"From the environmental standpoint, the fact that you don't need to irrigate these chemicals into the soil is of great importance," says Hammond. "The potential for runoff, leaching and exposure to birds or other animals and humans is virtually eliminated by applying the material by injection."

Hammond adds that pesticides traditionally hampered by being quickly bound to organic matter, such as chlorpyrifos pesticides (Dursban), may perform better when injected.

Hammond expects to conduct future tests with diazinon. Cobb is planning to conduct additional tests of subsurface injection for grub control this spring in Massachusetts.

Wayne Currey, Ph.D., formerly with the University of Florida, tested Dursban by injecting it over an eight-week period at 300 to 400 lbs./psi in Florida with a walk-behind unit at ³/₄ to 1 inch penetration for mole cricket control. "The injection method was the only method tested that gave us 100 percent control of the mole cricket problem," says Currey (see table 1).

Protecting the market

If early indications are correct that subsurface injection of pesticides allows turf managers to use them at a lower rate, several researchers feel the industry will have greater success protecting the chemicals currently on

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be delivered directly to the pest's zone of habitation and activity? Such a system of delivery should result in substantial reductions in the amount of material applied to the surface. At the same time, this would have the effect of reducing surface residues to very low levels.

Two systems for subsurface placement of insecticide for control of grubs were evaluated in 1987. The test insecticides, Triumph 4E and Dursban 4E, were applied at 2 lb. active ingredient/acre to a golf course fairway with no thatch at Canal Fulton, Ohio, and one at Wooster, Ohio, having ½ to 1 inch of dense thatch.

In cooperation with Ciba-Geigy Corp., a high-pressure injection spray unit, the HPI-2000, manufactured by the Cross Equipment Co. of Albany, Ga., was used to apply the two test insecticides. The unit consisted of a dragging boom with 18 nozzles at intervals of 3 inches that delivered 13 gallons of spray per acre at a nozzle pressure of 1,800 psi.

The RainSaver Jr. (RS), manufactured by Clearwater Industries and made available through Rain Saver, Inc., Walla Walla, Wash., was also

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TABLE A

Subsurface placement of insecticides for control of Japanese beetle larvae in golf course turfgrass.

Treatment[1]	Rate lb Ai/A	Method of Application	Post-Treatment Irrigation	Mean % Control Wooster[2] (thatch)	Mean % Control Canal Fulton[3] (no thatch)
TRIUMPH 4E	2	Conv. spray	Yes	76	87
DURSBAN 4E	2	Conv. spray	Yes	5	26
DURSBAN 4E	2	HPI-2000	No	21	40
DURSBAN 4E	2	RainSaver Jr.	No	48	72
TRIUMPH 4E	2	HPI-2000	No	57	82
TRIUMPH 4E	2	RainSaver Jr.	No	69	82

[1] Treatments applied September 9, 1988, replicated 3× and evaluated October 4, 1988 (34 days posttreatment).

[2] Check population = 6.9 grubs/ft²; thatch-mat = 1 inch.

[3] Check population = 24.2 grubs/ft²; no thatch.

Source: Harry Niemczyk, Ph.D.

the market—and perhaps returning products that have been banned.

"It's possible that if we can document the reduced surface toxicity by injecting these materials, it could go a long way toward bringing products like diazinon (which was banned for use on sod farms and golf courses by the Environmental Protection Agency last April) back into the marketplace," says Hammond.

"I think this system may help us keep a lot of the products available today on the market," adds Currey. "I think if we were able get our research under way earlier and got to work with diazinon, we might still be able to use it."

Easier application

"If you have a high pressure injection unit, it pretty much negates the need to water these materials in," says Randy Hudson, Ph.D. at the University of Georgia, who was the first to use and introduce high pressure liquid injection. His data (some of which is presented in table 2) were collected with Ciba-Geigy's Hammond.

"I think the greatest and most important aspect of this application method is the reduced chance for surface exposure after application," says Hudson. "With it we can put a material out there and not have to worry about a child or somebody's pet getting poisoned from pesticide on the surface of the lawn."

Cross Equipment's Injektaspray system has a low-height, low-pressure topical spray followed by a high-pressure ground surface injection.

Tensile strength remains

Ray Dickens, Ph.D. at Auburn University, Cobb, Hudson and Hammond report that their observations are that the Injektaspray system does not damage the tensile strength of sod. "You don't see that you've done anything," says Currey.

Last season one of Alabama's oldest courses, The Country Club of Mobile, became one of the first courses in the country to use high pressure injection of pesticides on its fairways. Shull Vance, course superintendent for 17 years, used Dursban at 2 lb. ai/acre and reported an "excellent" kill with a single application.

"We've tried all the recommended chemicals: diazinon, Dursban, Oftanol and baits, everything. But nothing ever lasted the whole season before. With this system we were able to contract the work out and free up our people," says Vance.

At a cost of $40 an acre, Vance contracted with Hendrix & Dial, Inc. of Tifton, Ga., to inject Dursban on the course's 98 acres of Bermudagrass fairways. The process took three days and did not damage the turf, says Vance. However, the streaks it leaves behind make it impracticable for use on greens for aesthetic reasons, he says.

"The problem with chemicals now is that they break down so rapidly. If the mole crickets don't come up (to the surface) on the night of the application, it's gone. It's like fishing; you don't always catch them," says Vance. "With this system though, you get right at them with a single application."

Only one fairway, which typically undergoes a severe infestation of mole crickets, required a repeat application, says Vance, who used to apply

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used to apply the test insecticides to the above two sites. For the test, the unit's coulters were adjusted so the insecticide depth of $^1/_2$ to $^3/_4$ inch below the surface. The unit was calibrated to deliver a volume of 132 gallons of spray per acre.

The HPI and RS systems were compared to the standard method of applying liquid insecticides for grub control, namely, treatment followed by irrigation. Both Triumph and Dursban were applied at a volume of 4 gallons of spray per 1,000 sq. ft (174 gallons per acre) and immediately irrigated with $^1/_4$ inch of water (i.e., zero time elapsed between application and irrigation).

Residues and control

To compare residues remaining on the grass blades following treatment, samples of grass were collected from each treatment on the day of application. Plots receiving conventional sprays were sampled before and after irrigation, while those treated with the HPI and RS systems were sampled immediately after application. Residues were extracted within three hours after collection and analyzed by gas chromatography within three days.

The RainSaver Jr. opens the turf with coulters before material is sprayed in.

Effectiveness of the treatments for control of Japanese beetle grubs was determined 34 days following treatment.

In areas with no thatch, HPI was best with 69 percent control. The conventional system gave 26 percent control and RS 72 percent control. At Wooster, all three systems registered low control levels. Control with RS was best (48 percent), which was a substantial improvement over the conventional system (5 percent) in turf with thatch.

The conventional method provided better control with Triumph in turf with thatch than either HPI or RS. Control from the conventional method in turf without thatch was 87 percent and 82 percent with HPI and RS.

Thatch penetration

In order to obtain insight into the depth of penetration achieved by the RS and HPI systems, both machines were loaded with a solution of blue dye and application made to the Wooster fairway with thatch. The HPI left clearly visible amounts of dye on the turf surface, while the amount remaining after application with RS was nearly imperceptible.

A cross-section of the turf treated with HPI revealed penetration of only $^1/_4$ inch into the thatch. Examination of the slit made by the RS coulters showed dye distribution to the soil level as well as on the entire depth of the thatch.

The RS and HPI were loaded with water and application made to two bentgrass putting greens at Canal Fulton. Both systems left only thin lines of penetration on the green, leaving the surface virtually unchanged for putting.

Irrigation following the conven-

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tional application reduced grass residues of Triumph 43 percent (from 47.3 to 26.8 ppm) and Dursban 51 percent (from 78.8 to 38.8 ppm). HPI reduced Triumph residues 63 percent (26.8 to 10.1 ppm) and Dursban 38 percent (38.8 to 24 ppm) over the amount remaining after irrigation of the plots treated with these insecticides using the conventional method. Residues of both Triumph and Dursban were reduced 95 percent (to less than 1.4 ppm) by the RS application, confirming that the RS system resulted in the lowest grass residues.

Grub control with HPI was poor in thatch because of inadequate penetration. Control with RS was better but not as good as that from the conventional application of Triumph, and less than expected from Dursban at both test sites.

Application of the dye showed the probable reason may have been that the insecticide (like the dye) was distributed along the face of the thatch or soil in the slit made by the coulter instead of being deposited directly to the zone of grub habitation at the bottom of the slit. This is easily corrected. With such modification, the coulter principle appears to have the best potential for direct delivery of materials and near elimination of surface residues.

The deep penetration of blue dye into this turf following application by the RainSaver Jr. shows the advantage of subsurface injection.

TABLE B

Residues on grass blades following attempts at subsurface placement of insecticides for control of Japanese beetle larvae in gold course turfgrass.

Treatment	Rate lb AI/A	Method of Application	Irrigation	Mean ppm Residues Canal Fulton[3]	Mean ppm Residues Wooster[4]
TRIUMPH 4E	2	Conv. spray	Before[1]	47.3	
TRIUMPH 4E	2	Conv. spray	After[2]	26.8	
TRIUMPH 4E	2	HPI-2000	None	10.1	13.2
TRIUMPH 4E	2	RainSaver Jr.	None	1.4	1.3
DURSBAN 4E	2	Conv. spray	Before[1]	78.8	
DURSBAN 4E	2	Conv. spray	After[2]	38.8	
DURSBAN 4E	2	HPI-2000	None	24.0	11.1
DURSBAN 4E	2	RainSaver Jr.	None	1.3	1.5

[1] Sample collected after application dried but BEFORE POSTTREATMENT IRRIGATION (ca. 1 hr.)

[2] Samples collected AFTER IRRIGATED GRASS DRIED (ca. 1 hr. after irrigation and 2 hr. after treatment).

[3] Mean residues based on separate GC analysis of 5 pooled 1 ft^2 samples of grass blades from each of 3 replicates.

[4] Means residues based on separate GC analyses of 8 pooled 1 ft^2 samples of grass blades from each of 2 replicates.

Source: Harry Niemczyk, Ph.D.

Looking good

The RS and HPI subsurface placement systems showed sufficient potential to warrant further research and development. The HPI may have limited application in cool-season areas where thatches are often too dense to permit delivery of materials to the soil level. However, this system may have further application for control of insects such as mole crickets in warm season areas where thatch may be less dense.

Further research on subsurface placement of insecticides is planned for 1989. A new "riding" version of the RainSaver Jr. modified to directly place materials to the bottom of the slit made by the coulter will be made tested here. In addition, several pieces of overseeding equipment with coulters will soon be modified and evaluated for their potential to place granular products beneath the turf surface.

Other applications

Potentially, the subsurface placement principle could be used to deliver many materials, such as certain fungicides, herbicides, nematodes parasitic on insects, and others.

With modification, these systems should more accurately deliver materials directly and only to the subsurface target zone at rates only a fraction of those currently needed. In addition, other materials, now ineffective because of immobility in thatch and/or soil, may show effectiveness when placed directly in the zone of pest activity.

The placement of pesticides under the soil in turfgrass without thatch, or at the soil surface under thatch, increases the potential for these materials to move downward through the soil. However, this potential should be at least substantially reduced if not negated by greatly reduced application rates.

Research here will contiune to focus on the dissipation and mobility of test materials. **LM**