Applying Systemic Pesticides with Subirrigation Systems

Top: Screen cages were used to determine the number of surviving whiteflies on each plant; Bottom: Closeup of silverleaf whitefly on a poinsettia leaf. (Whitefly photo courtesy of Ron Oetting; all other photos courtesy of Marc van Iersel.)

Beyond conserving water, limiting worker exposure to pesticides and eliminating fertilizer run-off, subirrigation can

By Ron Oetting and Marc van Iersel

In elementary school, one teacher taught me that there are two unlimited, renewable natural resources — water and air. Even then that was an exaggeration, and it definitely is today.

We are all concerned about water shortage and pollution of our water and air. This was especially true during 2000 here in our community around the Georgia Experiment Station in Griffin, Ga. With the prolonged drought, we got very close to completely running out of water in early August. But thanks to some timely rains, our water supply will now maintain us until the winter rains come, even though a continued ban on outdoor watering remains in effect.

Water conservation is a part of all phases of agriculture, including greenhouse production. There is much research currently taking place on the efficient use of water and the reduction of runoff.

Subirrigation is widely used in areas of Europe and is growing in popularity in this country. Subirrigation is a closed system, where the growing area — either bench, trough or floor — is flooded with water or fertilizer solution from a holding tank. After there has been sufficient time for the potting medium to absorb water, the flow reverses, and the water flows back into the holding tank. This method of subirrigation recycles the water and fertilizer, reducing water use, nutrient waste and the chance for runoff.

We were interested in finding out how efficient this system would be for the delivery of systemic pesticides, and we set up a series of experiments to test the efficacy. Using subirrigation systems to apply systemic pesticides appears to have several advantages over other methods. It should prove to minimize labor requirements and worker exposure to pesticides during application, result in a uniform application and prevent runoff of pesticides into the environment.

Little information exists today about plant uptake or efficacy of pesticides applied by subirrigation. Systemic pesticides traditionally are applied to the surface of the potting medium, either as a drench or as granules. Water then carries the pesticide down into the pot. Subirrigation works in the opposite direction, delivering the pesticide from the bottom and transporting it by capillary action up to the surface of the potting medium.

There is also little information available on the concentration of pesticide to use and how much of the solution the medium will absorb. Both play an important role in the management of any pest found either on the plant or in the potting medium.

IMIDACLOPRID ON WHITEFLY EXPERIMENTS

The objective of the experiments was to determine whether silverleaf whiteflies (*Bemisia argentifolii* Bellows & Perring) can be controlled with imidacloprid (the active ingredient in

Fig. 1. Applying pesticides with subirrigation systems may be an effective method to treat plants with systemic pesticides. But what is the best time to apply the pesticide? The amount of pesticide solution absorbed by the growing medium increases as the time since the last subirrigation increases, because the drier potting medium can take up more solution. To get the same amount of pesticide solution into the pots as with a standard drench application, we had to wait about two days since the last irrigation.

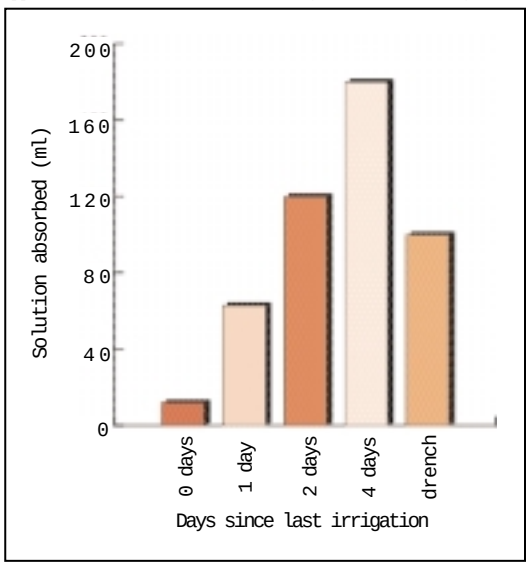
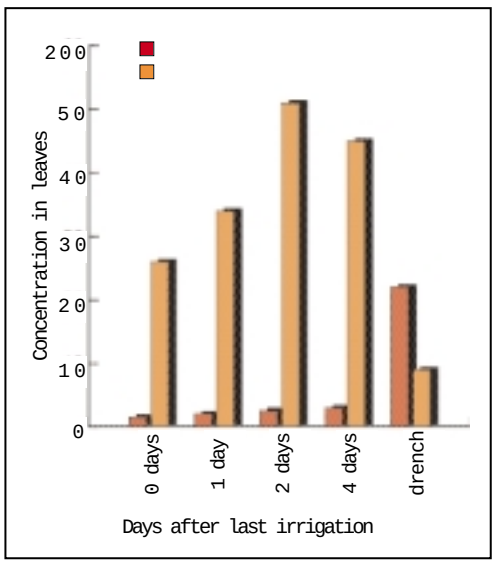


Fig. 2. The method of applying pesticides can have a great impact on the amount of pesticide that gets into the plants. We applied Marathon by subirrigation at 0, 1, 2, or 4 days after the last subirrigation and compared the uptake by the plants to a standard drench treatment to hand-watered plants. The drench application resulted in much faster uptake of Marathon than any of the subirrigation treatments, as can be seen from the tissue levels at 3 days after the application.



Marathon 60WP) applied by subirrigation. In the first experiment, the objective was to determine if a subirrigation application of imidacloprid is as effective in controlling whiteflies as a surface drench application. In our experiment, the concentration of the imidacloprid solution was 132 mg AI/liter (220 mg of Marathon 60WP per liter, or 3 oz. per 100 gallons).

To determine if subirrigation is an effective means of application, Marathon was applied to poinsettia 'Freedom Red' plants in 6-inch pots by applying the insecticide solution using ebb-and-flow benches. The amount of solution taken up by the potting medium was varied by applying the solution at different intervals after the last watering (shortly after irrigation or 1, 2, or 4 days after the last irrigation). These treatments were compared with untreated control plants and hand-watered plants that were treated with a standard drench application to the top of the growing medium.

The second experiment was conducted to compare imidacloprid concentrations and efficacy in different canopy layers (top, middle and bottom part of foliage) as the result of applications by subirrigation and drench applications. (Note: We only applied the imidacloprid solutions to the plants one time, approximately two weeks after transplanting rooted cuttings. After that, we simply watered the plants with fertilizer solution.)

UPTAKE OF INSECTICIDE

One group of subirrigated plants was sampled approximately every 20 days to determine the level of Marathon in the leaves, and it appears that the peak level of concentration in the tissue occurs about 50 days after application. It is obvious that subirrigated plants take up the pesticide in the potting medium over a longer time period than hand-watered plants receiving a regular drench treatment. As a matter of fact, the concentration of Marathon in subirrigated plants increased during the nine weeks after the application, while the concentration of Marathon in hand-watered plants was much lower at nine weeks than at three days after the application (Fig. 2). This suggests that the Marathon is leached from the potting medium with repeated hand-watering. With subirrigation, the Marathon is not leached from the pots and remains available to the plants for a much longer period of time.

WHITEFLY CONTROL

Although garnering information on concentrations of Marathon in the leaves of the plants for uptake data is highly important, the true test is how well the different treatments kill whiteflies. The effect of the Marathon applications on survival of mature whiteflies and on the emergence and survival of immature whiteflies was tested.

Adult whiteflies were put in little cages on poinsettia leaves to determine changes in activity of Marathon on a weekly basis. The adults were left in the cages for two days before removing them to determine how many had survived. The same area of the leaves was checked three weeks later to

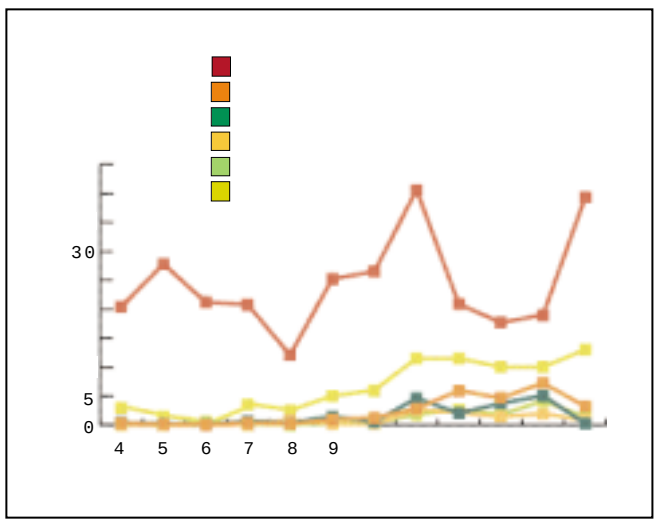


Fig. 3. The method of applying systemic pesticides affects their activity. We applied Marathon by subirrigation (at 0, 1, 2 or 4 days after the last irrigation) and compared these treatments to untreated control plants and hand-watered plants treated with a standard drench. To determine how effective the different treatments were, we determined how well silverleaf whiteflies could reproduce on the plants. As expected, the untreated control plants always had a lot of immature whiteflies. Although all Marathon treatments reduced the number of immature whiteflies, the drench application was not as effective as any of the subirrigation treatments. This difference was especially clear near the end of the growing season and probably occurred because the Marathon was leached out of the drenched pots, which were hand-watered. When plants are grown in a subirrigation system, leaching does not occur and more of the pesticide is taken up by the plants, resulting in better whitefly control.

determine how many immature whiteflies were present.

EFFECT ON ADULT POPULATION

Throughout most of the experiment, adult whitefly survival was over 75 percent in the untreated plants and less than 20 percent in the different Marathon treatments. Twelve weeks after the Marathon application, however, there was an increase in survival rate in most of the treatments, suggesting that the Marathon residues were no longer sufficient to kill adult whiteflies.

Although it is clear that all Marathon treatments provided control of adult whiteflies, inhibition of reproduction is more important than their control. After all, a few adult whiteflies won't cause much damage, but if they can reproduce rapidly, populations can quickly build to a serious infestation problem.

Overview of the experiment in the greenhouse. Whiteflies were placed on the plants weekly, and the survival and reproduction of the whiteflies was monitored.

EFFECT ON IMMATURE POPULATIONS

There were fluctuations in the population of immature whiteflies from 10 to 40 per leaf cage in the untreated control treatment. These fluctuations in numbers may be the result in changes in the greenhouse environment or the age of the adult population used to infest these plants. All of the Marathon-treated plants had much fewer immature whiteflies than the untreated control. This indicates that Marathon provided good control of whiteflies with all of the treatments.

The number of immature whiteflies on the treated leaves generally increased throughout the experiment. This suggests that the efficacy of the Marathon treatment slowly decreased during the experiment. Surprisingly, all plants treated by subirrigation had fewer

Little screen cages containing approximately ten whiteflies were placed on the bottom of poinsettia leaves once a week. After two days, the number of surviving whiteflies was determined, while the reproduction was determined by counting the number of immature whiteflies three weeks later.

immature whiteflies than the drenched plants throughout most of the experiment, and this difference became more pronounced later in the growing season.

A LITTLE NOW, A LITTLE LATER

All of the subirrigated plants treated with Marathon contained enough pesticide in the leaf tissue to control both adult and immature whiteflies. There was very little Marathon solution absorbed by the potting medium that was watered the same day as the application. These plants contained little Marathon at three days after the application. However, the plants took up additional pesticide during the growing season and got enough Marathon in the leaf tissue to provide excellent control of whiteflies.

Lack of leaching appears to be the key factor in making the pesticide applications by subirrigation so effective. The pesticide either is taken up by the plants, or remains in the potting soil so it can be taken up by the plants later in the growing season.

The drenched plants had more Marathon in the plant tissue during the first few days after the application, but the pesticide in the potting medium was probably leached out with subsequent irrigations. As a result, there was less Marathon in new leaves that developed later in the growing season. This resulted in higher populations of immature whiteflies on the drenched plants from the third week after the application until the end of the experiment.

CONCLUSION — SUBIRRIGATION WORKS

Using the subirrigation system to apply Marathon to subirrigated poinsettias provides excellent control of whiteflies. This control is actually quite a bit better than what can be achieved by drench applications. As a result, subirrigation of Marathon appears to be an effective means of delivering this systemic compound to subirrigated poinsettias.

However, in subsequent experiments, it was observed that there is an important relationship between how the Marathon is applied to the pots and how the pots are watered. For example, when the Marathon is applied as a drench, the control of whiteflies is better on drip-irrigated plants than on plants watered by subirrigation.

The bottom line is — to get optimal control of whiteflies, Marathon should be applied the same way that the water is applied during normal irrigations: drench drip-irrigated plants and use subirrigation to apply Marathon to subirrigated plants. The possibility of applying other systemic pesticides by subirrigation needs investigating.

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