EFFECTIVE USE OF MARATHON ON GREENHOUSE CROPS

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Marathon is a systemic insecticide, formulated as a granule containing 1% active ingredient, registered for use against aphids, whiteflies, mealybugs and thrips, on or in indoor and outdoor ornamentals grown in flats, benches or beds and for treatment of containerized flowering and foliage plants. Fungus gnat larvae are expected to be added to the label in the near future.

It is applied to the soil and taken up into the plant via the roots. The active ingredient in Marathon is imidacloprid, which is in a new chemical class among greenhouse insecticides. The importance of this new chemical class (chloronicotinyls) is that the insecticide kills insects by a new mode of action to which significant resistance has not yet developed. Marathon is also an unusual product because it has low mammalian toxicity (oral LD50 greater than 4,800 mg/kg; dermal LD50 greater than 2,000 mg/kg), is easy to use, and provides excellent residual control of aphids and whiteflies for 8 to 12 weeks after a single application. It has a "caution" label, and the Restricted Entry Interval (REI) is 12 hours. The label indicates that it may be applied once per crop cycle. It may also be incorporated into the media mix (3 lbs. Marathon per cu. yd. media) just prior to planting. The Personal Protective Equipment (PPE) for applications and early-entry workers includes coveralls, waterproof gloves and shoes plus socks.

The label directions and reports from the 1994 poinsettia season have provided some important tips on using the product:

1. Do not apply as a broadcast over the foliage of potted crops. Apply pot to pot. Broadcast applications should be reserved for crops grown in beds or flats. For potted crops, the application rates for pots indicated on the label should be followed to avoid applying an insufficient amount of insecticide.

2. The insecticide is only taken up by roots, so the plants should have established roots that are growing into the media. Marathon may leach out of the pot if it is applied too early before the root system can absorb the insecticide. For example, application to newly-stuck poinsettia cuttings should be delayed for 2-4 weeks until the root system is well developed.

3. The insecticide within the Marathon granules on the media surface will not be released unless the granules are watered. Water from drip irrigation emitters or subirrigation systems may not sufficiently wet all the granules on the media surface. If drip or sub-irrigation is in use, the product should be lightly watered-in once by overhead irrigation to be sure all the granules are wetted and the insecticide is released. However, regardless of irrigation system, avoid overwatering and leaching the insecticide out of the pots for the first 7-10 days after application.

4. The insecticide generally does not translocate well to older growth or to flowers. If it is applied too late in the crop, it may not move into the older foliage. Other insecticides or control tactics should be used against established infestations on older foliage.

5. In tests at Cornell, we have seen a decrease in whitefly and aphid infestations after one or two weeks following a Marathon application. Do not expect immediate results. It takes time for the product to translocate in sufficient amounts.

6. The insecticide has shown best results against aphids and whiteflies. Mealybug control has been good. Marathon does not affect mites or caterpillars. Thrips control has only been fair. This is partly because the product does not move into flowers where thrips often occur, although control has also been only fair against thrips on foliage.

7. Insecticide resistance considerations. It is commonly suggested that the product is best used as a preventative application, early in the crop. Early season application is probably the best; most economical strategy **for the short term.** But because Marathon has such long residual control, it puts unusually long-term pressure on an insect population to select for insecticide resistance. Marathon has so many advantages in these days of a dwindling insecticide arsenal and stringent pesticide regulations, that we must look at ways to use Marathon that will keep it around for the long term. It seems obvious that maintaining long-term selection pressure for resistance to Marathon from the beginning of a crop could increase the likelihood of resistance. My colleague at Cornell, Dr. Rick Roush, who is an authority on insecticide resistance management, has assisted in developing some suggestions for managing resistance to Marathon.

Potential for Resistance

Very recent results from two separate research laboratories suggest that resistance to Marathon in silverleaf whitefly populations could develop much sooner than expected. First, a relatively small laboratory population of silverleaf whitefly on cotton has been exposed to imidacloprid as a systemic application for only 20 months (20 generations). Resistance levels have increased nearly each generation, and it now requires roughly 50 times more imidacloprid to kill 50% of the individuals in this selected population compared with the amount needed to kill 50% of an unselected population (N. Prabhaker, U. Calif./ USDA).

Second, Matt Cahill at the Rothamsted Experimental Station in England has detected resistance to imidacloprid in a number of strains of sweetpotato/silverleaf whiteflies collected from heavily treated crops (tomatoes, peppers,

eggplant, cucumbers) in southern Spain, where rumors of control problems existed. These two lines of results, coupled with the expected heavy use of Marathon in U.S. greenhouses, strongly suggest that resistance to Marathon is likely to occur rather quickly, especially in the absence of the adoption of resistance management strategies. Currently, serious resistance to Marathon in whiteflies from U.S. greenhouse crops is not yet likely because of the short time the product has been in use. But based on these recent results, it can be reasonably assumed that genes for imidacloprid resistance currently exist, albeit at a low frequency, among our whitefly populations. Add the intense use of this highly-effective, long-term systemic insecticide within an enclosed greenhouse environment that provides no refuge for susceptible individuals but instead increases the likelihood that resistant individuals will find each other to mate and produce resistant offspring, and it is obvious that the selection pressure for these resistance genes will be intense.

When to Use Resistance Management Strategies

Because we rarely know if individuals with resistance genes are in fact present in an infestation, we should always assume that they are, and employ resistance management strategies as a routine practice. The advertising for several popular insecticides suggests that because no resistance has been detected, there is no need to worry about resistance to the produce. However, once scientists can actually measure levels of resistance we are usually well on the way toward control failures. **It makes little sense to wait until insecticide tolerance or resistance is detected before resistance management strategies are used.** For example, as mentioned above, the evidence from California and England suggests that we can strongly suspect that silverleaf whiteflies with genes for imidacloprid resistance already exist in the U.S., although in extremely low, undetectable numbers. The rate at which these individuals increase in frequency is the same whether detectable or not, yet by the time resistance is usually detected, more than 90% of the susceptibility (and number of effective applications) in the population has been used up. Thus, resistance management strategies for Marathon should be developed and employed now, not later.

Suggestions for Resistance Management

We'll use poinsettia production as an example. Although these suggestions are not based on actual experimental data on Marathon (resistance problems in the greenhouse do not yet exist), they are based on the best knowledge available from the entire subject of insecticide resistance management in agriculture. Because the product can select for resistance for such a long period in the plant, **the overall goal is to expose the pest population to Marathon for the briefest period that will still provide control.** In other words, when using Marathon, try to save the best (i.e., Marathon) for last.

Stock Plant and Cutting Production

Avoid the use of Marathon at or near the beginning of the crop, to reduce the time that the whitefly population is exposed to the insecticide. Use screening to exclude whitefly migration from outdoor sources, and biological control or other insecticide(s) as needed for as long as possible. Save Marathon for use at about three weeks before the first cuttings are taken, when the product will be actively taken up by the plant and translocated to the growing tips. Carefully follow label directions and irrigation guidelines.

Christmas Crop Production

Again, do not apply Marathon at the start, but save it for as long as possible, using other control tactics early in the production cycle. Because there is some controversy as to whether poinsettias take up enough insecticide once the plants begin to color, it is currently best to wait no longer than three weeks before color initiation to apply the product. The plant should be actively growing for the best uptake of the product. Again, carefully follow label directions and irrigation guidelines. It is also important to use other insecticides or nonchemical control tactics to keep whiteflies at a low level during the early crop. Do not assume that an application of Marathon just before the bracts color will be all that's needed to provide whitefly-free plants. Research at Cornell is underway to determine how late the product can be applied and still provide control.

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Useful Publications for Insect Management

A Guide to Insects and Related Pests of Floricultural Crops in New England features insects, mites, and related pests of flower crops in the greenhouse. Full-color photographs and line drawings are provided for identification as well as detailed information about life cycles to help develop management strategies. To order, send a check for **$10** made payable to "University of Massachusetts" to: Bulletin Distribution Center, Cottage A, Thatcher Way, Amherst, MA 01003-0051.

All growers must have a copy of ***New England Floricultural Crop Pest Management and Growth Regulation Guide 1995-1996***. This is the latest version of this guide sponsored by the New England Greenhouse Conference. To order, send a check for **$10** made payable to "University of Massachusetts" to Tina Smith, 212 Stockbridge Hall, Univ. of Massachusetts, Amherst, MA 01003.

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