Making the Change to Integrated Pest Management

Ellen McEnroe Zagory and **Robin Rosetta**
The University Arboretum, University of California, Davis, California 95616

INTRODUCTION

Little information has been written about the use of Integrated Pest Management (IPM) in ornamental nursery production systems. Nursery professionals wishing to establish an IPM program must adapt methods used on greenhouse crops or urban landscapes to their production methods. Nursery IPM is complicated by the fact that the plants do not remain stationary; they move from propagation to liners to gallons and eventually to retailers and the landscape. Mobile host plants make it complicated to track pests and difficult to restrict their spread. It is also harder to establish a balanced system of predators and parasites as is done in greenhouses, orchards, or urban landscapes.

At the University Arboretum the plants produced in our small nursery (approximately an acre) have two general destinations: the campus landscape collections (including the Arboretum) and our annual fund-raising plant sale. Plants destined for distribution to the public are treated much as they would be in a commercial nursery with one exception—all production labor for propagation, repotting, labeling, pruning, and fertilization is provided by a dedicated corps of volunteers. To protect our volunteer work force, some 30 regular volunteers ranging in age from 4 to 75, we needed to eliminate as many hazards to them as possible. This motivated us to seek an IPM program using least-toxic pest control methods.

Information gained in our situation is most applicable to smaller nurseries. Our crop is very diverse with relatively small numbers of each species rather than the large blocks found in larger wholesale nurseries. However, the techniques and treatments we've used, which are the basis of many IPM programs, can be useful regardless of the size of the nursery. From our experience we have learned that to make the change to an IPM program a nursery must make three basic organizational changes in terms of management, personnel, and record keeping.

MAKE THE MANAGERIAL COMMITMENT TO IPM

When converting to an integrated system of pest control, staff must view the crop and production area as a biological system and act not only to eliminate pests but also to protect beneficial insects. This can be achieved by incorporation of physical, cultural, and biological controls into the pest control program. Beneficial parasites and predators will be aided by using least-toxic chemical controls. Accompany good monitoring and use of spot sprays (rather than cover sprays) with selection of insecticides with short residual action. These practices will increase the likelihood of preserving unsprayed refuges for your beneficials and will also decrease the likelihood of development of pesticide resistance in your pest populations. Make sure your tactics are compatible; pesticides should be selected which will have the least affect on predators present. Abandon the "see and spray" method by using your monitoring records to set action thresholds for each pest. Table 1. presents some of the action thresholds we use for pests in our nursery. Decide which pests you have zero tolerance for and which might be tolerable at low levels to provide

food and host species for beneficial insects while causing little damage to the economic value of your crop.

Table 1. Some action thresholds for pest treatment.

Pest	Treatment threshold
Aphids	Presence of alates (winged aphids) and nymphs (zero tolerance on *Dianthus*—viral vectors)
Whitefly	Presence of eggs indicated by waxy deposits.
Thrips	Presence on smaller plants in greenhouse.
Mites	As soon as detected.
Lacebug	Presence of pest.
Mealybug	Presence of pest.
Leafhoppers	Treat only immediately prior to sale.
Plant bugs	Spray only when damage (stippling) becomes obvious
Flea beetles	Spray only when damage (stippling) becomes obvious

ALLOCATE FUNDS FOR TRAINED PERSONNEL

Unless you already have an entomologist on staff you will need to hire a specialist to gather information about the insect pests, predators, and parasites, as well as appropriate pesticides for your crops. This specialist will need to distinguish between the beneficial and harmful insects. Proper identification is essential, as well as knowledge of pest behavior, and the effect of weather, temperature, and pesticides on pest populations. Establishment of monitoring routines can best be done by a professional who has been trained to do so. Monitoring and spot spraying is initially more expensive than calendar cover sprays because monitoring is labor-intensive. However, we have found that careful monitoring and timing of applications will reduce total pesticide usage as well as the number of applications needed and result in future labor savings.

DEVELOP A SIMPLE RECORD KEEPING SYSTEM

Keep careful records of the pests (identification and density), hosts, beneficials, and the date of occurrence. You need to build a body of knowledge useful for prediction under your particular circumstances. We have found this information very useful for catching infestations early before they become difficult to control. We use a simple flat-file database (Wordperfect Notebook) to record the above information as well as comments, the plant location and treatments used.

SEAT OF THE PANTS IPM

Our three-year-old program has been developed by the "seat of the pants" technique and is founded on those basic methods, cited above, common to most IPM programs: careful and consistent monitoring, written records, establishment of action thresholds, the use of yellow sticky traps, pesticide baits (for ants), and low-toxicity, low-residual pesticides such as insecticidal soap, *Bacillus thuringiensis*, and pyrethrins. This summer we are testing two new products, Sunspray, a new light oil, and Pyrenone, pyrethrin with a synergist, for efficacy and phytotoxicity. The U.C. Davis graduate program in Plant Protection and Pest Management (PPPM) has supplied the excellent student interns who have provided their expertise and labor setting up our program. We have also been fortunate to have the advice and interest of the staff of the U.C. IPM Education and Publications group. The first season, March through September 1990, was spent developing monitoring forms, recording pest/host occurrence, treating infested plants, and observing the effectiveness of less-toxic pesticide use. A big change we made that year was the abandonment of Dursban for control of ants in favor of Grant's Ant Stakes (an arsenic bait). Also, because of its shorter residual, pyrethrin was substituted for the synthetic pyrethroids previously used. The second season, during the summer of 1991, the recorded data from the previous year allowed us to predict the sequence of pest outbreaks and the expected degree of infestation. We improved our insect identification and reference collection and continued to test the effectiveness of control while limiting ourselves to soaps, pyrethrin, and *Bacillus thuringiensis*.

BENEFICIAL INSECTS

In 1992 we noticed a dramatic increase in naturally occurring populations of beneficial insects such as lady beetles, syrphid flies (sometimes called hoverflies), predatory mites, wasps, and spiders. We believe this to be caused by the elimination of long-residual pesticides, specifically the use of the organophosphate, Dursban, for Argentine ant control. This year, for the first time, we incorporated the use of inundative releases of beneficial insects into our IPM program. Since our early season whitefly problems seem to originate in the greenhouse we made a mid-April release of *Encarsia formosa*. This parasitic wasp has established on some nurse plants and appears to move on to new plants as needed. Larvae of the green lacewing (*Chrysoperla rufilabris*) were released weekly for 8 consecutive weeks from April 1 to May 20th for the control of aphids. The beneficial predatory mite (*Metaseiulus occidentalis*) was released twice, May 28th and July 8th, for the control of two-spotted spider mites. Use of the lacewing larvae coincided with a dramatic reduction in aphids and at the end of the 8-week period we had great difficulty finding any aphids to treat. Our total soap use for April through June dropped from 227 oz in 1991 to 23 oz in 1992, a dramatic effect attributed in part to the reduction in aphids by the lacewing larvae and part to favorable weather conditions. A comparison of insecticidal soap usage for 1991 and 1992 can be seen in Figure 1. The early application (when pest mites were first observed) of predatory mites also appeared successful. Presence of pest mites has remained limited to only a few spots where the predators are still observed. *Metaseiulus* has also been seen around the nursery dining on white flies and thrips.

To attract and encourage beneficial insects to remain we have planted various nectar and pollen plants around the nursery to provide alternate food sources when

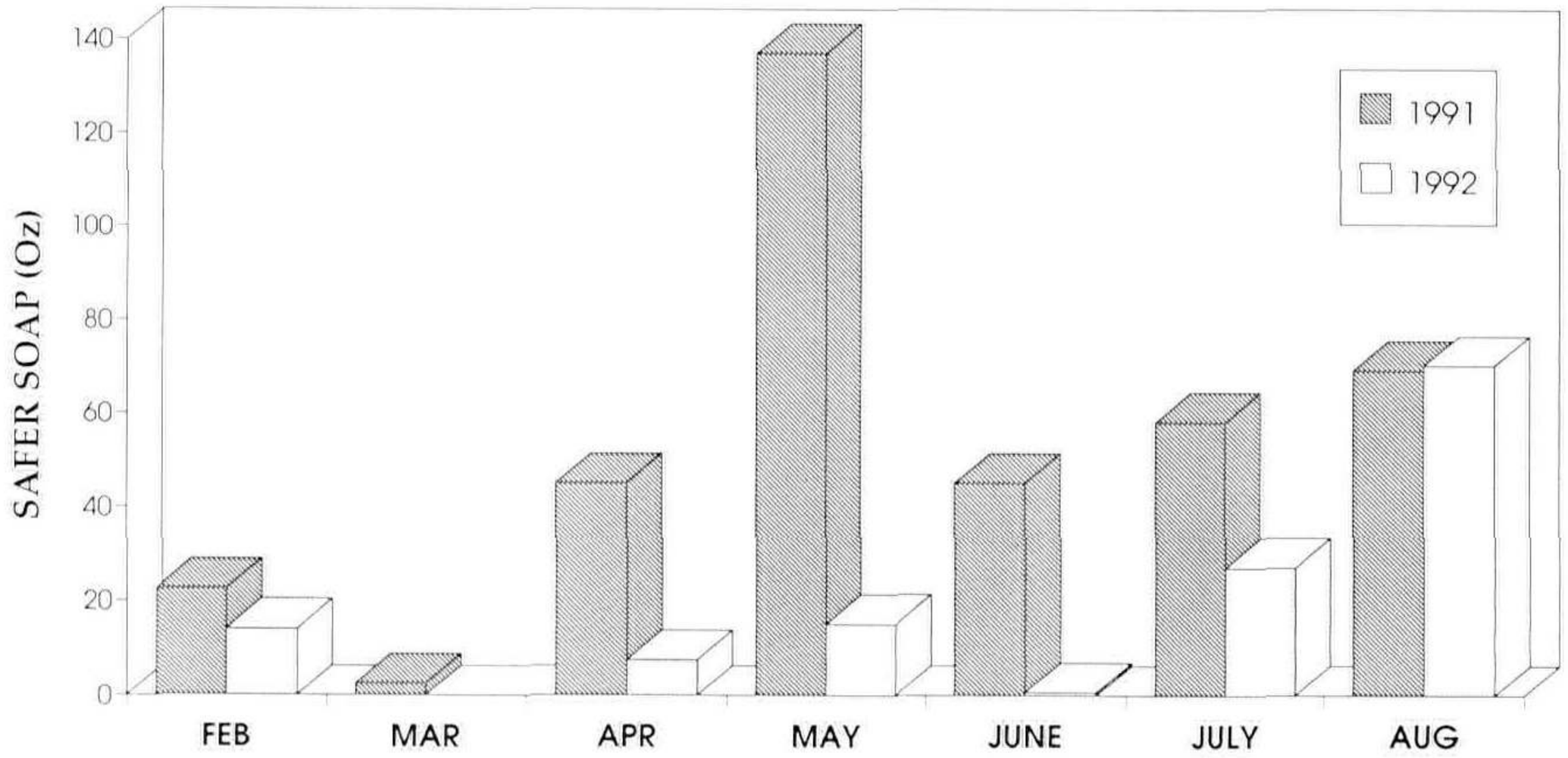

Figure 1. Total safer soap applied to arboretum nursery.

pest populations are low. Growing around the nursery are some shrubby native buckwheats, *Eriogonum giganteum* and *E. fasciculatum*; coffeeberry, *Rhamnus californica*; bronze fennel, *Foeniculum vulgare* 'Purpureum'; candytuft, *Lobularia maritima*; and the Chilean soapbark tree, *Quillaja saponaria*. An existing willow, *Salix bonplandiana* [syn. *S. laevigata*] at the nursery serves as an insectary plant when it becomes infested with the giant willow aphid, a pest specific to willow which does not spread, and which also serves as an alternate food source for beneficials. A commercial preparation of yeast, sugar and water (Bugpro™) was also applied to increase food availability when populations of adult lacewings were high.

REMAINING WORK

The changes we have made in pesticides have resulted in resurgence of some pests. A summary of major pests and control treatments can be found in Table 2. Attempts to control the obscure mealybug on species and cultivars of the genus *Heuchera* with the predatory mealybug destroyer (*Cryptolaemus*), soaps, and light oil have so far been unsatisfactory. Pyrenone, a pyrethrin with synergist, is currently being tested for efficacy against this pest and for possible phytotoxicity. Also, we are hoping to retest the application of *Cryptolaemus* for control, doing it earlier in the season next year. Lacebugs, leafhoppers, and flea beetles have proven resistant to our preliminary control efforts using soap and are also candidates for treatment with oil and pyrenone. These pesticides are under trial until we can incorporate more follow-up evaluation of control efficacy. Our methods have provided us with excellent control of aphids and mites, but we want to fine tune early season control of whitefly in the hope we can avoid high spray use in August and September. Next year we hope to explore the use of degree-day calculation in predicting pest outbreaks so we can better schedule the timing of pesticide sprays and release of beneficials. We also believe it worthwhile to try a release of the predator, *Thripobius luteus*, which attacks thrips to reduce the spraying necessary in the greenhouse.

Table 2. Major pests, treatments used, and evaluation of control.

Pest	Treatments used (in order of importance)	Control	Comments
Ants	Ant stakes	Acceptable	Stakes need periodic replacement, spot spray required late in season.
	Tanglefoot barriers		
Aphids	*Chrysoperla* larvae insecticidal soap	Excellent	Natural parasitism evident
Mealybugs	*Cryptolaemus* Pyrethrin Horticultural oil Insecticidal soap	Poor	Soap ineffective, others experimental
Thrips	Horticultural oil Pyrethrin Insecticidal soap	Acceptable	Soap reduced numbers only, others needed for good control
Whiteflies	Insecticidal soap Horticultural oil Yellow sticky traps	Acceptable	Eggs not effected by soap, earlier spray needed
	Encarsia formosa		In greenhouse only

Excellent=applications result in control.
Acceptable=repeat applications necessary for control.
Poor=control not achieved with listed method(s).

CONCLUSIONS

We feel that our IPM program works for us and hope that some nurseries may be able to apply the information here to their own production systems. The most important work that we have left undone is an economic analysis of our methods compared to more traditional pest control. Many nurseries will resist the change to IPM until it has been demonstrated to them that these practices will increase the net on their balance sheet. But regulatory withdrawal of some pesticides, increased costs of liability insurance, and stricter environmental regulations concerning offsite pollution are putting pressures on all in the industry to reduce highly toxic pesticides whenever possible. We believe it is worth a look and that nursery professionals who develop IPM programs will find that it pays off in the future.