Surflan® from seed but Devrinol® is less effective. This weed is often a problem in containers due to its presence in liners. Once established, neither of these two herbicides will control it. Common groundsel (*Senecio vulgaris*), one of the most composite weeds, which is a frequent problem in container-grown plants, is controlled from seed to a reasonable degree with Devrinol® and stunted severely or reduced with Surflan®. Both are highly effective in controlling many annual grasses. As the labels indicate, they do not control all weeds. Those weeds that escape control should be hand-pulled before any seed is produced to minimize their becoming a problem from the standpoint of competition and increase. Even if the weeds are not eradicated, they are usually stunted and much easier to remove by hand weeding.

Neither Surflan® nor Devrinol®, at suggested label rates and use directions, have caused any serious adverse effects on the ornamental species evaluated.

Pre-emergent herbicides, when properly used, are a major aid in maintaining a weed-free nursery. Supplementing them with some hand weeding can accomplish that weed-free nursery at reduced costs and provide a clean product for the customer. The label is an important guide in using pre-emergent herbicides in your program. Read it.

INSECT PEST MANAGEMENT ON NEWLY ESTABLISHED PLANTS

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The management of pest populations on propagation plants is similar to that utilized on all ornamental plants. There are characteristics of newly rooted plants that do isolate them from the control methods which are used on more established plants. One of these characteristics of the newly rooted plant is it has greater sensitivity to some chemicals because of the lack of an established root system. But basically the approach to insect and mite control is the same. The demand for insect-free and damage-free plants has resulted in the utilization of stringent control programs relying primarily on the use of chemicals. An ornamental plant is purchased by the consumer because of its aesthetic qualities and any reduction in that quality results in a

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product which is hard to market. As a result, pesticides have been the easiest and most effective tool in keeping anthropod pests in check and they will continue to play an important role in pest management in the future. Effective insecticides are not as plentiful as they were in past years and there is not a large group of new compounds setting on the horizon waiting for approval of EPA for registration. Already we have some insect pests of ornamentals which are very difficult or even impossible to control. The picture is not entirely bleak. We do have some effective materials available for most pests and there are new materials which show promise in controlling insect and mite pests of ornamentals. I do feel though that we should take advantage of everything that we know to try to maintain our plantings as free of insect and mite infestations as possible, so that our reliance on chemicals can be held to a minimum.

CULTURAL CONTROL

The first approach to pest control is good cultural and management practices which keep the chances of developing damaging pest populations to a minimum. This is especially important on propagation plantings because insect and mite populations which are present can be passed on to growers and to consumers causing control problems at a later date. By maintaining pest-free plants at this stage we can prevent spreading pests to our customers and expanding the need for control at that level.

There are several things which can be considered in maintaining a good environment and monitoring pest build up. First, pests are not present in the greenhouse or other growing area naturally, but they must gain entry to these structures to infest the plants maintained there. If we can eliminate or inhibit this entry we will greatly reduce the need for control measures. Pests gain entrance into greenhouses in many ways. Vents and doors offer the easiest access and often pests enter these access points either independently or with the aid of personnel entering the structure. For example, moths are attracted by lights at night and readily enter vents if open at this time. Man is just as guilty in the introduction of pests as the natural habits of the pest. Some pests, such as mites, will hitchhike from one area to another on the clothing of workers. Also pests are brought in on plants which are moved from one area to another or on plants exchanged between growers. It is important that propagated plants be kept clean because exchanging plants is an excellent source by which pests can be distributed among other growers who purchase these plants. In addition, pests can enter the greenhouse in the soil, mulching material, or equipment which is brought in from outdoors and care should be taken to eliminate this source.

Poor quality cutting material is another common source of pest problems. This is an important reason to keep the mother plants clean before taking cuttings. The earlier the pest control can be achieved in the growth process, the smaller the area which must be treated. Also weeds often attract pests which subsequently reproduce and build their population on weeds. If weeds are allowed to grow around the periphery of houses, pests are close at hand and take advantage of any opening to the greenhouse to extend their feeding to plants housed within. By keeping the area around the houses clean, insects and mites do not have this attraction to frequent the premises around the greenhouses. Weed control in the houses is also important; weeds and algae under greenhouse benches provide a place for insects to hide and reproduce. Once they have established on weeds under benches they can easily move up to the plants on the benches.

EARLY DETECTION

Even with the greatest of care, pests will still gain entrance to the growing area. The next area of good pest control management is early detection. If a pest is detected early before it has a chance to spread or increase in numbers it can be easier to control or be removed from the premises. It is important to be constantly conscience of the pests which frequent the particular species or cultivars being grown and to check the plants frequently to make sure they are free of pests. The success of such a program depends on a knowledge of the pests and their habits and biologies so you are aware of what to look for and know what you have once you detect the pest that is causing the problem. Pest detection could be either the sighting of the insect or mite itself or, as if often the case, the detection of injury caused by a particular pest. Very often the damage which is observed is not that easy to identify because a number of pests cause similar damage. But at least the damage will be a key to what to look for and often the pest can be discovered by more diligent searching. It should be remembered that the bottoms of the leaves should be checked. Often pests such as spider mites, can build up significantly before the stippling damage can be detected on the upper surface of the leaf.

When checking a greenhouse for possible pest infestation consider the components of the greenhouse which might result in ideal conditions for pests. Points of access should be considered. Often damage starts near a door, along the main aisle, or near vents because these were the points of entry. Consider the warmer areas of the greenhouse such as over steam pipes or under modine heaters. Also the corners of the greenhouse may be warmer and they are usually isolated. As a result, popula-

tions can reach high levels undetected in corners because conditions are ideal and workers do not frequent them. Early detection of pests can not be overemphasized because early detection not only results in easier control but also limits the amount of damage loss obtained.

CHEMICAL CONTROL

We can reduce many of our pest problems by the use of good management practices but we must still rely on chemical control to keep populations in check. During the past year we have tested insecticides and miticides on the twospotted spider mite (*Tetranychus urticae*), greenhouse whitefly (*Trialeurodes vaporariorum*), and citrus mealybug (*Planococcus citri*), which are major pests of ornamental plants. In these experiments several new compounds were tested and many were effective in controlling troublesome pests of ornamentals.

Twospotted Spider Mite. Twospotted spider mites are probably the most common pest encountered on ornamental plantings in California. They are tiny and develop on the undersides of leaves of most plants making their detection difficult. Most often, they are detected by feeding damage rather than the discovery of the mites themselves. Injury is observed as minute spotting or stippling appearing on the plant leaves.

Miticide effectiveness. Two experiments were conducted this year on the efficacy of miticides for mite control. The first was conducted at the University of California — Riverside greenhouses on *Dracaena*. Treatments consisted of single plants and were replicated five times. Plant were approximately 15 inches high and in six inch pots. Miticides were applied with a hand sprayer, at 75 psi, utilizing an 8003 nozzle. Plants were sprayed to the point of runoff. Samples were taken weekly after application by removing one leaf per plant and counting the number of mites on each leaf to determine the efficacy of each miticide (Table 1). Excellent control was achieved with all compounds for two weeks. During the third weed reinfestation was observed on the Bay KHS 0137-treated plants and numbers of mites continued to increase throughout the test period. Mites were also observed on the Pentac- and Vendex-treated plants at three weeks. In both of these cases, mite observation was a result of a large number of mites on one leaf and could be the result of poor coverage on these leaves because the counts on the following two weeks were low. DPX 3792 and PP 199 treatments were free of mites for a period of at least four weeks.

The second mite control test was conducted in Encinitas, California in a rose range. The plants treated were the 'Forever Yours' rose. Treatments consisted of blocks of six feet of bed 42 inches wide and were replicated five times. Miticides were

applied with a commercial 5 gpm sprayer, at 125 psi, utilizing a 6506 nozzle. One and a half gallons of finished spray were applied to each treatment and plants were sprayed to the point of runoff. Plants were sampled weekly by removing five leaves per replication and counting the number of mites on each leaf to determine the efficacy of each miticide (Table 2).

Table 1. Control of twospotted spider mites on Dracaena in the greenhouse.

	Average Number of Mites per Leaf							
	Weeks Following Treatment							
Treatment and lb ai/100 gal	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Pentac 50WP, 0.25 lb	0	0	6.0	0.2	0.2	10.6	26.2	64.8
Vendex 50WP, 0.25 lb	0	0	7.6	0	0.4	4.6	1.2	0.4
Bay KHS 0137 50%E, 0.25 lb	0	0	4.4	12.8	21.2	27.0	13.6	34.2
DPX 3792 2E, 0.25 lb	0	0	0	0	3.8	5.0	11.8	8.2
PP 199 25%E, 0.125 lb	0	0	0	0	0	0.2	0.4	59.6
Check	14.8	20.8	24.2	25.0	18.4	19.0	39.2	42.8

Table 2. Control of twospotted spider mites on roses in the greenhouse.

	Average Number of Mites per Leaf					
		Weeks Following Treatment				
Treatment and lb ai/100 gal	**pre**	**1**	**2**	**3**	**4**	**5**
Pentac 50WP, 0.25 lb	51.2	0	0	0.1	0	0
Vendex 50WP, 0.25 lb	32.2	0	0	0	0	0
DPX 3792 2E, 0.25 lb	43.8	0	0	0	0	0
DPX 3792 2E, 0.125 lb	37.8	0	0	0	0	0
PP 199 25%E, 0.125 lb	36.3	0	0	0	0	0
Check	—	18.6	90.5	49.0	62.7	74.5

In this experiment all of the test compounds were effective in maintaining mite populations at a very low level throughout the five week test period. In this experiment the chemical treatments were separated from the untreated check plots. This reduced the amount of reinfestation from the untreated checks.

Phytotoxicity. Phytotoxicity was observed from the application of the test formulations of the numbered miticides: DPX 3792, PP 199, and KHS 0137. Damage occurred from applications of all three compounds on *Dracaena*. It was observed the first week after treatment and appeared as yellowish to brown spots on the new leaves. No damage was observed on the old growth or on subsequent new growth. The only phytotoxicity observed on roses was from DPX 3792 at the 0.25 pound rate, and then the damage was not very extensive. In some of the replications, some new shoots were distorted and curled during the first week after application. In subsequent weeks, no damage was observed on any of the treatments.

Greenhouse Whitefly. The greenhouse whitefly is a common greenhouse pest and in California it can also be found in shadehouses and outdoor plantings. California nurserymen re-

port that the greenhouse whitefly is the hardest pest for them to control. These insects can be found on nearly every plant. They are found on the undersides of leaves and often large populations can be established before they are detected. They suck juices from the leaves of the plants, and excrete large quantities of honeydew upon which sooty mold grows. Eggs, nymphs, and pupae are at least partially resistant to most registered insecticides used for their control. As a result, efforts to control this pest results in repeated applications resulting in only partial control.

Insecticides were applied to polka-dot plants (*Hypoestes sanguinolenta*) to test their efficacy in controlling greenhouse whitefly (Table 3). Treatments were replicated eight times with one plant per replication. The plants were approximately 16 inches high in 4 inch pots maintained on raised benches in the University of California-Riverside greenhouses. Foliar sprays were applied to the point of runoff with a commercial 5 gpm sprayer, at 150 psi, utilizing an 8004 nozzle. One leaf per plant was removed weekly, following application, and the number of whitefly nymphs were counted on each leaf and recorded for five weeks after treatment.

Table 3. Control of greenhouse whiteflies on pink polka-dot in greenhouse.

	Average Number of Nymphs per Leaf				
	Weeks Following Treatment				
Treatment and lb ai/100 gal	**1**	**2**	**3**	**4**	**5**
SD 43775 2.4E, 0.1 lb	1.8	1.4	0.1	0.2	0.3
FMC 35171 1.6E, 0.1 lb	1.0	0.0	0.2	1.7	0.3
FMC 45497 0.8E, 0.1 lb	6.7	0.2	0.1	2.7	0.5
FMC 33297 3.2E, 0.1 lb	0.7	0.3	0.0	1.3	1.1
Vydate 2E, 0.5 lb	13.8	2.6	7.1	4.1	4.5
A 47171 2E, 0.5 lb	16.9	8.6	3.6	10.9	4.8
NC 6897 76WP, 1.0 lb	15.8	17.6	8.7	20.3	14.4
Orthene 75S, 0.5 lb	15.0	37.5	34.0	27.9	18.3
Drawin 775 4E, 0.75 lb	34.6	34.0	30.4	33.5	15.4
Check	31.9	68.8	50.0	39.8	62.2

Four pyrethroid compounds (SD 43775, FMC 35171, FMC 45497, and FMC 33297) were the best test compounds in controlling whitefly nymphs. Plants treated with these compounds were protected throughout the test period. Populations of whiteflies on plants treated with the other test materials were also reduced but not as low as those treated with the pyrethroids. Only one application of an insecticide was applied so subsequent applications of some compounds could have resulted in better control.

No phytotoxicity was observed from the application of any of the test materials.

Citrus Mealybug. Citrus mealybugs are important pests of ornamental plants. They and other mealybugs injure plants by sucking sap with their piercing-sucking mouthparts. Honeydew is excreted and attacts ants and serves as a medium for growth of sooty mold. This mold and also the masses of wax from the mealybug bodies and cottony egg sacs result in an unsightly and unsalable plant. Mealybugs are capable of locomotion throughout life and a good means of checking your success in controlling these pests is to examine new growth to see if they have survived and moved.

An experiment was conducted to test the efficacy of nine insecticides in controlling citrus mealybug on areca palm (*Areca*). Treatments consisted of single plants and were replicated four times. Plants were approximately 24 inches high and in six inch pots. Insecticides were applied with a hand sprayer, at 80 psi, utilizing an 8003 nozzle with the exceptions of Temik and UC 21865 treatments. Temik is a granule formulation and was applied to the soil and UC 21865 was applied as a soil drench. Observations were made weekly following application by tagging four leaflets on each plant and following the populations on these leaflets throughout the five week test period to determine the efficacy of the test compounds (Table 4).

Temik and UC 21865 were applied to the soil so it took two weeks to obtain good control because of the time required for movement of the material within the plant. After two weeks both compounds yield good results throughout the remainder of the test. Vydate, Cygon, and Orthene treatments resulted in over 90 percent control throughout the test period. Sumithion and Supracide treatments also resulted in good mealybug control throughout the test period with over 90 percent control for four weeks and over 80 percent the fifth week. A second application of some of the test materials could enhance the control of mealybugs.

No phytotoxic responses were observed on any of the plants treated.

In addition to the pests mentioned, many other pests can cause damage to propagation plants. Leaf miners, fungus flies, lepidopterous larvae, and many other pests damage ornamental plants in all stages from propagation to harvest. In every case good cultural practices can reduce the frequency of pest infestation. Early detection can increase the efficiency of control measures utilized and reduce the damage obtained. But chemicals are the main means of controlling pest populations once they are established.

Table 4. Control of citrus mealybugs on palms in the greenhouse.

Treatment and lb ai/100 gal	Corrected Percent Mortality				
	Weeks Following Treatment				
	1	2	3	4	5
Termik 10G, 0.2 g*	80	99	100	99	100
Vydate 2E, 0.25 lb	100	100	100	97	96
Cygon 4E, 0.5 lb	97	99	94	88	94
UC 21865 75WP, 0.5 lb	59	91	91	96	91
Orthene 75S, 0.5 lb	96	98	98	97	98
Sumithion 8E, 1.0 lb	100	91	94	92	89
Supracide 2E, 0.5 lb	99	96	91	91	82
Ambush 2E, 0.1 lb	76	88	87	78	86
SD 43775 2.4E, 0.1 lb	52	49	32	45	56
Check	—	—	—	—	—

* Grams of aldicarb per 6 inch pot.

ENTOMOLOGY IN THE PRODUCTION NURSERY

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Whether a large scale production nursery or a small ornamental plant grower, both parties should have basically the same philosophy in their approach to entomological problems. This philosophy is dictated by the economics of the ornamental plant itself. Most ornamentals are sold on one fact; their eye appeal or their beauty. Ornamental plants must be kept cosmetically clean; hence one could call the control of insect pests in the ornamental nursery cosmetic entomology. It makes little difference if you are concerned in your individual nursery with one particular insect pest or 100 different species. There are some *basic* guidelines one can follow to effect a fairly efficient control procedure which can be applied to almost every insect problem that may occur. Anyone engaged in the elimination of insect pests for an ornamental nursery probably follows the same set of principles I am about to elaborate on, although he may not have stopped to evaluate his own procedures. I have found the degree and expertise which one incorporates into these procedures depends greatly on the desire to build and maintain a pest management program. The procedures: (1) Detection of the pest. (2) Identification of the pest. (3) Analysis or research of literature (life cycles). (4) Implementation of controls. (5) Evaluation of the project.