

**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.

**Detection.** Detection of an insect problem is the first step in eliminating it. The sooner one can determine that there is truly an insect problem present, or that an insect problem is developing, the better. Time is of the essence. Early detection will allow some leeway for the time consuming procedures of pest identification and life cycle analysis. In a small production nursery detection of pest problems can be made by actually "walking the field". This method becomes less efficient as the size and scope of the growing area increases. Detection aids must be employed in this later case. The use of blacklights and sticky cards are two widely used aids. Blacklights provide excellent samples of adult moth pests. The detection of the adult forms is particularly desirable since one can control the next generation more effectively in many cases. Sticky cards are cards to which a commercially manufactured glue-like substance is applied which entraps the insect. These cards are placed in areas of known or suspected insect activity. The cards are specifically used for the detection of small insects such as thrips, whiteflies, adult male scale, and aphids. These cards may be used to monitor pest build ups over a period of time, freeing the inspector for other duties. The keeping of accurate records on the detection of pests will be most beneficial in simplifying your detection inspection efforts in the future. You will know what to expect and when. The incorporation of temperature and humidity as well as any other influential factors that can be gathered should also be recorded. This information may be coordinated and patterns found in the research phase.

**Identification.** The accurate identification of an insect pest is essential to the planning of control measures for that pest. You must know what you are dealing with before you can do anything about it. The exactness of the identification should be as near to the species taxon as possible. In many cases it will make very little difference whether you have a particular species of pest but, on the other hand, it may make all the difference. It is a good pest management principle to identify the pest accurately making the research of the life cycle possible. There are outside sources such as the county entomologist or the state taxonomy laboratory which can identify a particular pest for you if no one is available on your nursery staff who is familiar with insect systematics.

**Analysis and Research.** This step is where the pest management aspect is brought into perspective. After identifying the pest one can research its individual life cycle. Some of the important elements that can be learned from this research are optimum point for breaking the cycle, the stage in the life cycle you have detected, calculations on the appearance or disappearance of any stage in the cycle, and an overall estimation of the

proportions of the infestation. Many facts on the duration of individual stages may be of significance in specific cases. The time one expends on this research of the literature is well worth it. The process need only be done once for each pest and is invaluable as a quick reference. This research will also lead to the knowledge of predators and parasites of your problem pest. This may or may not be of assistance to any control measures that might be undertaken. The information you derive from researching literature on an insect pest may be of significant benefit when coupled with facts on the population dynamics you acquire through your inspections. After you have found all that you can from literary sources you should consult others about any particular deviations in the population dynamics of the pest in your locality. Information from literary sources may be only valid in a particular range (locality). Cooperative Extension Services of the Universities and the State and County departments of agriculture are also good sources of information.

**Implementation of controls.** When you have analyzed the research information you can start to see how the pest is employing its particular dynamics in your own nursery. From your research you will have an idea of what to expect from this pest, such as alternate host, number of generations per year, flight patterns, and reproductive capacities. The absorption of this information along with the idiosyncracies of your own nursery operations must be weighted together before you can arrive at a control measure. Chemical controls must be considered for phytotoxicities as well as their effectiveness on the pest. Secondary problems of the host plants, their location in the nursery, surrounding areas, equipment available for application; all of these must be considered. Integrated controls, whereby a population of predators or parasites are released into the pest population and chemical controls are applied after the pest population is reduced sufficiently to effectively eliminate the problem may be the better solution. Whatever is decided upon, the fact still remains that ornamental plants have a very low economic damage level. So your control measures must be as effective as possible with the least amount of damage to the crop. The clearer a picture one can see of the pest problem the more effective a plan can be made to control it with respect to the present and the future.

**Evaluation.** When you have selected a plan of control and tried it you must evaluate it by keeping in mind a number of points. Do you really have the pest under control? Does your program have any drawbacks you didn't foresee? After seeing the program is there a better way? Better does not always mean cheaper. It does mean more effective, quicker or safer. This step is important because it reflects the fruits of your labors in the

preceding steps. This evaluation may be an ongoing process over a number of generations of a pest. Long or short, this part of your overall pest management program is where anomalies can be detected and adjustments made to correct them.

The interrelationship of the steps I have outlined for controlling an insect pest is obvious. Each step is built by the preceding one yielding an overall effect. Hopefully this effect is a scientifically calculated elimination of the insect pest. In the everyday production nursery these procedures are often overlooked in favor of a quick one shot remedy. This stop gap measure must be done sometimes but it should not become a habit. In the long run this kind of control practice will only lead to more complex problems. Whenever possible, think your insect problem through. Your operation will reflect the work you have done with smoothness, efficiency and, most of all, clean insect-free plant material.

J. HAROLD CLARKE, Moderator: Do we have any questions for the speakers?

VOICE: If a pesticide is labeled for use on a particular plant can it also be used on the same plant grown in containers?

WES HUMPHREY: Let me speak to the California situation only; it is my understanding that among the regulatory people in California that if the material is to be used for container-grown plants, it is preferred that it so specify on the label. We are trying to get the chemical companies to develop the label information and to get registration so the label specifically states that it can be used on plants grown in containers.

VOICE: I am curious about any investigations of biological control that might be going on right now.

RONALD OETTING: We have some experiments going on biological control. The most recent is on control of two-spotted spider mite. We are running into problems; conditions here are not the same as they are in Europe. For some reason, we are not getting the results they obtained in Europe. For one thing, we feel that it is temperature. The first experiment that we ran was under greenhouse conditions. We did not get a buildup of the predator and as a result we didn't get the control that was anticipated. It was true that we had a reduction and we did have plants that looked a little better — a little greater growth, so there was some effect but we still had damage and still had the two-spotted spider mite population very high. We tried some other experiments under controlled conditions — one using growth chambers. We got excellent control in the growth chambers by reducing the temperature 10°F, getting a little more uni-

form temperature. In a matter of a week, we could almost wipe out the two-spot population. Now there are other predators and parasites which do feed on pests of ornamentals. We have not started any other programs at this time. First of all, we are going to look at this two-spot program and then expand into some others. I know there are some field programs going on for mealy bug control, with parasites and others, but these are still in the future. Right now we have the program on two-spot mite and that is it.

WES HUMPHREY: As far as I am aware, there is only one major biological control method available for weeds in containers. You are all biological entities, it seems to me. Any time you are out there using my favorite herbicide, dos maños, or have a crew using dos maños, you are going to fall very deeply into the category of biological weed control.