ered the optimum for the fungus. No difference was found in infection rate in plants incubated at less than 40% relative humidity, or in a saturated atmosphere in a plastic bag. Wounds made by breaking petioles become essentially non-susceptible after only 36 hours, again with no influence of temperature.

From these results it is concluded that relative humidity or available free water is not an important factor in infection of cut stems, and that any fungicide active against *G. cingulata* would provide sufficient protection for the brief period that wounds are susceptible to infection.

APPROACHES TO PLANT PROPAGATORS' INTEGRATED PEST MANAGEMENT

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Lately one only has to pick up the trade journals and find articles discussing integrated pest management (IPM) in the ornamentals industry. Scientists have many interpretations of IPM; it is described as a philosophy, discipline, system, or program. The researchers in agricultural endeavors welcome this as it elevates pest control to a more professional and technological level. The environmentalists look upon it as reducing or eliminating the use of pesticides. The legislators like it as everybody discusses and seems to like it and nobody is vigorously opposed to it. However, when everything has been said and outlined the growers are the people who must decide whether they want it or not. I would like to discuss some of these ideas as I see how and where they would fit into your industry. Every facet of the industry, beginning with the propagators to growers and even the retailers are actually using some of the principles of integrated pest management. First of all, let me give a definition of it by the National Research Council that you can understand. The Council stated, "It is a system of pest control that utilizes all suitable techniques in a compatible way to reduce pest populations and maintain them below the economic injury level."

Let me break this ". . . all suitable techniques in a compatible way to reduce pest populations and maintain them below the economic injury level" down to several categories: (1) Chemical Control, (2) Cultural Practices, (3) Preventive Measures, (4) Host-Plant Resistance, and (5) Biological Control.

CHEMICAL CONTROL

Chemical control of pests (insects, mites, fungi, bacteria, viruses, or weeds) has been the first choice because of its availability for immediate use, ease of application, and quick adequate results. During the past few years the use of pesticides as the primary means of pest control has become less than satisfactory. Pests have shown increasing signs of resistance and/or tolerance to pesticides. Cost for pesticides has risen dramatically over the past few years. Government rules and regulations controlling registrations of new materials, application methods (OSHA regulations on safety during applications) have increased substantially. In particular, methods to protect the environment such as Environmental Impact Reports covering everything from the water we drink and the food we eat to the air we breathe have received the greatest emphasis. Let me give you some examples of the above. There is a situation in the propagation of chrysanthemum cuttings where today, in California, we do not have a commercially legal material that will control the leafminer. Every chemical that we have tested (commercially available and experimental compounds) has shown little or no success on year-'round chrysanthemum potted and cut flowers. The primary source of this leafminer is from rooted cuttings purchased from other states. Flower growers obtaining these infested cuttings have suffered tremendous losses, some have lost as much as 75% or more of their crops.

Last month I was invited to attend a meeting sponsored by the Society of American Florists (SAF) in Florida. The Growers Council of SAF invited entomologists from various state universities working on this particular pest. I discovered that this problem was worldwide and other flower-producing nations are gravely concerned. This is a case where the problem originated with the propagator and continued to the grower. No concrete answers were found at this meeting but all the problem areas were identified and discussed. Considerable basic and applied research must be completed in order to find adequate solutions to the leafminer problem on chrysanthemum.

CULTURAL PRACTICES

The University of California has advocated over the years that good insect control begins with clean cultural practices. This is not to say that clean cultural practices will completely eliminate plant pests but they will help trememdously when the need for pesticides occurs. Here is an outline of the cultural practices that would enhance an IPM program:

1. Weed control around the outside and inside of greenhouse (this is a good source of pests).

2. Algae control under and on the benches and/or around the beds (controls fungus flies).
3. Pasteurization (steam or chemical) of media (controls pathogens, nematodes, insect pupae).
4. Clean and healthy stock plants in mother blocks (prevents the start of disease and insect infestations).
5. Precise fertilization and watering (lessens plant stress; obvious advantages).
6. Discarding of all weak, damaged or dead plants (potential source of disease and insects).
7. Spacing of plants for air circulation and light penetration (makes for healthier plants).

One cultural control practice that is often overlooked is the physical structure of the greenhouses. It may seem trivial to patch or replace torn plastic sheetings or replace a glass pane, but these are the main points of entry for many types of pests. If you can keep one insect out of the greenhouse, that is one pest that will not have to be controlled. It is very important to cover every hole or opening at the base of the greenhouse as these are the points of entry for flying insects. One grower in the Encinitas, California, area was able to cut down the worm damage to carnations by covering the base boards with dirt and by utilizing plastic screening on the sides of the houses

Several years ago, one propagator was having trouble controlling tortrix in his trays of azalea cuttings. Since he was misting the cuttings during the day, there was no way that he could spray during the day and it was simply not economical for him to treat at night. A system was devised to apply the pesticide in combination with the last misting of the day by injecting the pesticide into the mist system The mist nozzles were replaced with ones that had lowered gallonage output and produced finer particles which effectively controlled the tortrix. In addition, by utilizing less water he was able to cut down on the dying-back of his cuttings

Several of the growers are now using hydrated lime on the greenhouse floor to control algae and weeds which, in turn, will control the fungus flies by removing their primary breeding site. With lime on the floor, the greenhouses have a very clean appearance. Some growers are also experimenting with copper sulfate to control algae and this material appears to hold considerable promise.

In the late 1960s, many growers were using wood shavings as the base for flats and pots. However, it was subsequently discovered that many of the disease and soil-infesting insect problems originated from this practice. The problem began when the me-

dia started to break down. Initially, it was thought that arthropods were the cause of the breakdown, but it was discovered that heavy fertilization of the cuttings and plants was the real culprit.

PREVENTIVE MEASURES

There are many day-to-day local problems but we face another grave situation. As growers import seeds and plants from foreign countries, the control of exotic pest species that come in with these products becomes a potentially serious problem. Quarantine, eradication, and transport programs play a very important role in IPM by detecting and eliminating problems before they get a foothold. Quarantine inspections and programs are definitely important and nursery inspections in California aid considerably in the efforts of all involved in pest control. However, these rules should not be inflexible. They should be subject to modifications based on the particular commodity and grower's needs. I am currently involved in updating an obsolete system which has been in operation for many years so that it can accommodate the needs of the young bromeliad industry in California. The current practice is to fumigate a shipment of bromeliads with methyl bromide when insects are found on the plants. The source of these plants is South America and the need to control insect pests on the plants before they are brought into California is obvious. Unfortunately, methyl bromide kills 30 to 50% of the bromeliads and this is of great concern to the industry. I am already looking at other chemical materials to control the incoming pests which will be less harmful to the plants.

HOST-PLANT RESISTANCE

Host-plant resistance is always included in an IPM scheme but in the ornamentals industry this will not be easy. With *thousands of species of plants, I believe the responsibility for this* type of work should be assumed by the basic producers of plants. Most propagators do not have the time to research the background information necessary to develop this type of program. Also the time and money involved would be tremendous.

BIOLOGICAL CONTROL

Biological control [defined as "controlling arthropods (insects and mites) or pathogens (fungi, bacteria, etc.) with other beneficial arthropods and biological agents"] as a part of an IPM program has been incorporated into models at many institutions all over the world. In particular, biological control of mites and whiteflies with predators and parasites has received the greatest attention. However, IPM is generally crop-specific, as in the case of cotton, alfalfa, corn, and others. In the ornamentals industry a majority of the plants are grown together and each species has its

complex of pests.

With several pests being present at any one time, the control of the other pests present will necessitate the use of chemicals. For example, effective control of mites with predators and without pesticides may allow other pests, such as aphids and worms, to develop to the point where chemicals are needed to control them. These chemicals, in turn, will destroy the beneficial mite predators unless careful attention is given to their selection and proper timing of application. In general, it is more difficult to develop a successful biocontrol program on a crop such as ornamentals with such a diverse complex of pests.

The predators and parasites will not control 100% of the pest population as there must be a small population of pest present to maintain these beneficials.

Utilization of parasites and predators for control of pests is slow when compared to pesticides. Materials such as *Bacillus thuringiensis* do not kill quickly and there will be a great amount of damage before the materials start to take effect.

To establish a good biological control program, a qualified person knowledgable in the priniciples of biological control must be contracted to initiate the program. If a grower commits himself to the principle and starts on the project, he must follow through with the entire program. He should expect that it may take some time before any results are observed.

IPM is an all-inclusive approach to pest control and at the present time I do not believe that with the resources we have the industry can accept the concept wholly. However, there are many features in the concept the grower can take and put to good use.

PROPAGATION OF GIANT SEQUOIA BY ROOTING CUTTINGS

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Several years ago, in a paper on the advantages of reforestation with vegetatively propagated trees, Bill Libby wrote: "The genetic leverage available with vegetative propagation makes reforestation using rooted cuttings . . . (an) attractive new management technique . . .". Since that time, the use of vegetative propagation in forestry has increased, and several countries, including