Fungicide Resistance Problems on Glasshouse Ornamentals

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Analysis of fungicide resistance problems in ornamentals is difficult because several factors complicate the picture. In many cases, fungicides seem ineffective because application timing is improper. In other cases, an incorrect diagnosis leads to selection of an inappropriate—and ineffective—chemical. Sometimes, the recommended dosage of a chemical is too low; this is often the case in glasshouse crop production because many people believe lower doses are potentially less toxic to both the glasshouse workers and the crops. Finally, many growers use very poor methods to apply chemicals, and the residue is insufficient to inhibit infection or control disease; this tendency is also common in glasshouse crop production because applying sprays can be difficult and costly in terms of labor and time.

I believe that resistance of a pathogen to a fungicide should not be assumed unless all these complicating factors are ruled out. Also, suspected cases of field resistance must be verified under experimental conditions. If the pathogen from the field site where the original observation was made proves resistant to the fungicide in question under laboratory or highly controlled greenhouse experiments, further consideration is warranted.

Analysis of reported cases of fungicide resistance problems in glasshouse crops reveals a situation paralleling cases of fungicide resistance reported in other segments of agriculture. Apparently, the nature of the fungicide rather than the nature of the cropping or use pattern determines whether a product will encounter a pathogen resistance problem.

Researchers in Greece recently reported that iprodione (Rovral, Chipco 26019) was not controlling *Botrytis* on cyclamen. Cultures of the strain of *Botrytis* isolated from the site in question proved to be resistant to both iprodione and vinclozolin (Ronilan, Ornalin). Japanese workers reported that rust on chrysanthemums could not be managed with oxycarboxin (Plantvax) after repeated use in certain areas. Their observation was verified by highly controlled greenhouse studies of the rust organism.

Many cases of fungicide resistance to benomyl (Benlate) in ornamentals have been reported and involve both outdoor and glasshouse crops. Canadian, Japanese, and other workers have reported the failure of benomyl to properly control *Botrytis* on greenhouse roses. Benomyl's failure to control powdery mildew on greenhouse roses was reported from South America, and its failure to control *Botrytis* on cyclamen was reported from the Netherlands. In some sites in France, *Fusarium* was not properly controlled by benomyl and the other benzimidazoles. Finally, *Botrytis* on chrysanthemums was insufficiently managed with benomyl in California, according to a report several years ago. All these cases of resistance to benomyl were verified in detailed laboratory and greenhouse studies.

A review of the trade literature on management of diseases of greenhouse crops disclosed several possible resistance problems not verified by laboratory or greenhouse studies. Cases involving benomyl include *Botrytis* on bedding plants and on Easter lilies, *Entomosporium* on photinia, and *Phomopsis* on juniper. In a report of failure of triadimefon (Bayleton) to manage powdery mildew on begonia, the writer implied that resistance was at the root of the problem. Fenarimol (Rubigan) has been implicated in a resistance problem in managing powdery mildew on greenhouse roses from several locations in the world. Finally, although no field examples have suggested such situations yet, most ornamentals pathologists are on the lookout for possible resistance of water mold pathogens to metalaxyl (Subdue, Ridomil), of *Botrytis* to iprodione and vinclozolin, and of powdery mildew pathogens to triadimefon, dodemorph (Milban), and triforine.

Several situations in greenhouse ornamentals crops make dealing with resistance problems somewhat unique. Often, the cosmetic nature of the crop dictates a zero disease tolerance goal and thus use of a highly effective fungicide that will not leave a "wild" pathogen population behind. Another danger in the industry is that plant material is moved around the country and cutting material is disseminated from these locations, which could lead to rapid spread of a resistant fungal strain throughout the industry.

The options for countering resistance problems in the greenhouse ornamentals industry are similar to those in other segments of agriculture, although the special dangers mentioned must be kept in mind. For instance, safer fungicides (from the point of view of pathogen resistance) could be used on stock plants. Many growers have an "overkill" approach and apply higher doses than necessary more often than necessary. Some growers are trying to reduce the amount of fungicide used by improving the method and the timing of application.

Fungicides that might lead to resistance problems should be applied only during critical periods in the production of the plant. For instance, a "safe" fungicide could be used in the early stages of plant growth and a more "dangerous" but more effective fungicide used at the end of a cropping cycle. Also, plants being used only for propagation during part of the year could be sprayed under different programs than their counterparts being finished for a salable crop. Another option is to limit the area of treatment. Spraying the entire crop with a particular product may not be necessary when disease is present only in certain areas of the greenhouse or the crop. Combining or rotating use of chemicals can also retard development of resistance; glasshouse crop growers have been using such rotation practices for years to control insects and mites.

Nonchemical control procedures should be emphasized in the production of greenhouse crops. Containerization of crops will go a long way toward managing root diseases without chemicals. Containerized soil mix can be made with amendments that will not promote development and proliferation of root pathogens and diseases, can be easily sanitized before use, and is not recycled through the greenhouse. Environmental control systems that do away with temperature and moisture extremes in greenhouses are also effective.

The approach greenhouse growers should be taking is to integrate nonchemical and chemical control methods, using chemicals only when conditions are quite favorable for disease development. Most chemical companies do not place top priority on developing fungicides and other chemicals for this specialty crop industry. When a chemical *is* labeled for greenhouse crop use, growers have the responsibility to see that it can be used effectively for as long as possible.