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102. Mode of action group m1: copper. Chase, A. R. Greenhouse Management and Production 30(2):26, 28-29. 2010.

By A.R. Chase

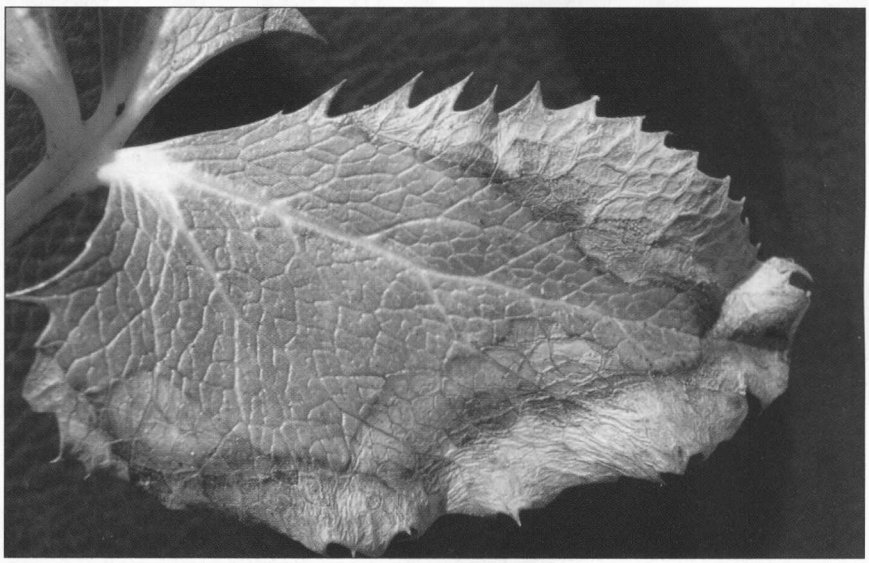
Mode of Action Group M1: COPPER

This is the second of a 6-part series detailing mode-of-action groups for disease control comparing relative efficacy, resistance and phytotoxicity characteristics.

Copper fungicides represent one of the oldest active ingredients developed to fight plant diseases. Some of the first fungicides developed contained copper and were used to combat diseases of vines (i.e., black rot) and fruit (i.e., apple scab).

In the 1800s copper sulfate pentahydrate was formulated with lime into Bordeaux mixture. Many other types of copper products followed with basic copper carbonate and copper ammonium carbonate first used in 1887, copper oxychloride in about 1900 and cuprous oxide in 1932.

Safer and more effective copper fungicides have been developed including copper linoleate (Camelot in 1964) and copper hydroxide in 1968. The copper products now used on ornamental plants are primarily Camelot, Junction, Kocide and Phyton 27. There are other copper products that are used in some portions of the ornamentals market.



Xanthomonas blight on hellebore.

Copper activity

Copper is used in various forms as an algaecide, bactericide, fungicide and water treatment. Copper fungicides are classified as multisite and act by disrupting cellular proteins. For use on ornamentals, copper is often thought of as only a bactericide, perhaps due to the fact that there are very few bactericides in the ornamentals industry.

A solution pH of less than 6.5 increases availability of the copper ion (Cu) which can lead to phytotoxicity. Do not mix copper products with acidic products including Aliette and B-Nine.

Copper is described as unlikely to develop resistance despite the fact that development of resistance in bacterial populations exposed to copper has been demonstrated in crops including ornamentals and vegetables. Using the mode-of-action groups is important but it cannot predict with 100 percent accuracy whether a particular pathogen will become resistant to a specific active ingredient.

In nurseries, copper fungicides are commonly used on leaf diseases due to their relatively low cost. Use on greenhouse crops is less common perhaps due to the higher crop value and the possibility of phytotoxicity which is less tolerable on more expensive flowering crops.

Copper fungicides

Most copper fungicides are applied as foliar sprays although drench applications have been shown to be safe and effective in some situations. Checking the labels for the three most commonly used copper fungicides applied to ornamentals shows some differences in their exact copper source, amount of metallic copper equivalent, reentry interval and approved application method. Only Phyton 27 has extensive labeling for methods used in ornamental produc-

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tion such as dipping (propagation and postharvest), drenching and tree injection. All three products are registered for chemigation.

Diseases controlled

Chase Horticultural Research has been working with copper products, including Phyton 27, for the past 15 years. During this time, the majority of the research work has been done with Phyton 27 so that we know more about its activity and safety than other copper fungicides used in the ornamentals industry.

Copper products are most effective for bacterial diseases including Erwinia soft rot (calla, orchid and poinsettia), Pseudomonas leaf spots (bedding plants) and Xanthomonas leaf spots (geranium, ranunculus and zinnia). The majority of our trials resulted in good control (Camelot and Kocide) or very good to excellent control (Phyton 27). Despite being labeled as low resistance, copper products must be alternated with another mode-of-action group when treating bacterial diseases or resistance to copper will most likely develop.

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Controlling some diseases like Erwinia on calla can depend on how products are applied. The Phyton 27 label indicates that tubers can be dipped or sprayed. Discussions with growers have indicated that one of the best ways to

Table 1. Comparison of copper fungicides labeled for ornamentals.*

Fungicide	Manufacturer	Active ingredient	Metallic copper equivalent	Application method	REI hours
Camelot	SePRO	Copper salts of fatty and rosin acids 58%	5.14%	Spray	12
Kocide 3000	Dupont	Copper hydroxide 46.1%	30%	Spray	24
Phyton 27	Phyton	Copper sulphate pentahydrate 21.36%	5.5%	Spray, dip, drench, trunk injection, post-harvest dip	24

** Based on label descriptions.*

Table 2. Summary of efficacy of some copper fungicides for ornamental diseases.*

Disease/pathogen	Camelot	Kocide	Phyton 27
Alternaria	Good		Fair to excellent
Botrytis	Fair	Fair	Poor to good
Cercospora		Some	Some to excellent
Colletotrichum	Good		Very good to excellent
Cylindrocladium	Some	Some	Poor to good
Downy mildew	Poor to very good	Poor to very good	Very good
Erwinia		Good	Very good to excellent
Fusarium			None to very good
Myrothecium			None to very good
Phytophthora	Poor to good		Poor to very good
Powdery mildew	Poor to very good		Good to excellent
Pseudomonas	Good	Good	Very good to excellent
Pythium	Some	Fair to very good	Fair to good
Rhizoctonia	Poor to some	Some	Poor to good
Rust	Poor to good	None	Poor to very good
Scab (Sphaceloma)	Very good to excellent		Fair to excellent
Sclerotinia	None		None
Thielaviopsis			Fair
Xanthomonas	Good	Good	Very good to excellent

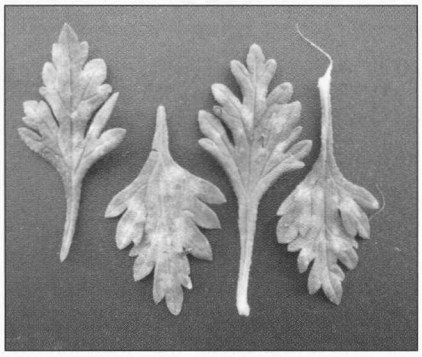
** Research performed at Chase Horticultural Research Inc., 1996-2009.*

minimize Erwinia soft rot losses is to spray tubers laid out on a bench. The tubers can then be allowed to dry before planting. We found in one recent test that a single drench at planting was most effective in controlling losses due to disease.

Some of the best targets for copper fungicides have been leaf spots (Alternaria, Cercospora, Colletotrichum and Sphaceloma), powdery mildew and rust. We have also seen fair to very good results in some Pythium root rot trials when the products were applied as a drench.

Our research would probably not support use of copper fungicides for Botrytis control. The tendency of these products to cause phytotoxicity during the winter when spray applications dry slowly causes Botrytis infection to be sometimes worse after a copper spray than before application. The closely related Sclerotinia blight has not been controlled by copper in our trials.

Other pathogens that seem ill-advised for control with copper include Phytophthora, Rhizoctonia and Thielaviopsis.



Powdery mildew on verbena.

The results in our trials have been quite variable. For instance, control of downy mildew can be poor to very good depending on the plant, the level of disease infection, when treatment begins and the safety of the specific copper product to the crop. This may indicate that unless treatments are preventive they might not be effective. It is also important to note that treatment interval can be critical. Copper fungicides are thought to remain on the leaf surface one to two weeks depending on rainfall or overhead irrigation. Therefore, less frequent treatments may result in poor disease control.

Remember to rotate between active ingredients to minimize resistance development. Be sure to read labels for use sites and rates. Only Phyton 27 is labeled for drench applications.

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