CHASE NEWS

Chase Horticultural Research, Inc. Volume 8—Issue 11 November

Mode of Action (MOA) Groups

Understanding the mode of action grouping (MOA) for a fungicide is increasing in importance as we gain more and more fungicides. The definition of MOA code found on the FRAC (Fungicide Resistance Action Committee) website is given below:

"MOA Code—Different letters (A to I, with added numbers) were used to distinguish fungicide groups according to their biochemical mode of action (MOA) in the biosynthetic pathways of plant pathogens."

One of the more important codes for ornamental fungicides is 'M' which denotes multi-site inhibitors and thus a low risk of resistance development. Those fungicides with single site MOA are more likely to result in resistance development. In addition, certain fungi are more likely to develop resistance due to the nature of their reproduction including Botrytis, powdery mildew fungi and Pythium. Many of the active ingredients in ornamental fungicides are marketed to many other crops from apples to grapes and lettuce. If field resistance to a fungicide has been shown in other crops for one fungicide member of a MOA Group, it is most likely but not always true that cross resistance to other fungicides in the group can occur. Cross-resistance simply describes the ability of a fungus resistant to one fungicide to be resistant to closely related fungicides even though it had never been exposed to that fungicide previously.

If you attend seminars or read industry magazines you know that being aware of the MOA group can help avoid development of resistance. Most cases of fungicide resistance occur when a single product or group of similar products is used week after week, month after month and sometimes years on end. This is what has happened in parts of our industry with some *Pythium* spp. resulting in resistance to mefenoxam (Subdue MAXX). There are a number of other important fungicide/bactericides that have been reported to be ineffective in certain crops due to development of resistance (Botrytis resistance to iprodione and thiophanate methyl). Resistance management is based on the fact that the mode of action (MOA) for one chemical class usually differs enough from another chemical class that the fungus or bacterium cannot become resistant to both MOAs simultaneously.

We will be closed December 21 through January 1st for the holidays.

The FRAC risk level does not always match reported resistance development. For instance, copper is listed as low risk based on the fact that these fungicide/bactericides have multiple sites of action which is thought to confer a low level of risk. However, there are many reports of resistance in bacteria such as Xanthomonas and Pseudomonas on vegetables and ornamentals since the 1970's.

Sometimes you can substitute any fungicide sharing the same MOA and obtain equal results but at others this results in unacceptable control. In some cases, the chemical properties are distinct despite have the same MOA and give the product an advantage over others in the same group. This article was originally published in full in GMPro (November 2009). Watch for the new series on MOA in GMPro in 2010.

CONTENTS

I was recently asked to make recommendations on fungicides for two woody ornamental diseases. I started looking into recent work on the pathogens and found nothing reported on fungicides although there were a number of references that summarized the diseases themselves. I therefore resorted to checking fungicide trials on similar pathogens on other crops.

CONTROLLING SEPTORIA LEAF SPOT ON OAKS

The Septoria leaf spot on red oak (*Quercus rubra*) appears to be pretty common in some parts of the country. I could not find anything on any ornamental regarding fungicide efficacy of a Septoria disease. So I started with some web searching and found some trials on controlling Septoria diseases on non-ornamental crops like soybean and celery.

The best control was seen with fungicides like chlorothalonil (Daconil Ultrex) which is very broad spectrum and a good contact fungicide and some of the newer chemistries like strobilurins (especially Heritage) and sterol inhibitors (especially Banner MAXX). All of the work was done with the agricultural equivalents but the active ingredients were the same. One trial by Dr. Mary Hausbeck (Michigan State University) on celery showed best control with alternating Daconil Ultrex and Heritage. Remember to remove any fallen leaves from the previous year to reduce overall inoculum level in the field. If the trees are in the ground this of course is not likely.

Timing is very important so getting three or four applications on as the new leaves emerge and harden-off is critical. I would use the Daconil Ultrex first (due to its longevity and presence on the leaf surface) at the recommended rate (1.4 lb/100 gal) as the leaves are starting to emerge. If the leaves grow very fast then weekly sprays will be needed in parts of the country where spring rainfall is common. If emergence is slower and rainfall minimal, then go to 10-14 in between sprays. Apply the Heritage second (since it is systemic and can help eradicate any infections that might have occurred - 2-4 oz/100 gal) and then go back to Daconil and finish with Heritage if needed based on how long it takes the leaves to harden-off. Keep in mind that you always need to confirm which disease is present since any control strategy must start with an accurate (and current) diagnosis.

PHOMOPSIS BLIGHT ON JUNIPERS

Phomopsis blight on juniper is caused by *Phomopsis juniperovora*. The disease has not been worked on or at least I could not find anything published on ornamentals for quite awhile. I did find a few trials on Phomopsis twig blight on blueberry and Phomopsis leaf spot on strawberry.

Phomopsis blight on juniper starts in late spring or early summer when the cankers from the previous infection make spores and they are spread to new shoots via rainfall or overhead irrigation. The first step should be to trim out – clean-up – the plants that are overwintering in your fields. This will reduce the inoculum load that develops in the spring. Long-term you should consider trying to obtain disease-free liners. If you start your own liners, then keeping a healthy batch of stock plants that are sprayed preventatively will be critical. Never use infected cuttings for new production as this merely keeps the cycle going.

When you spray, you should concentrate on the new growth mainly as the older, hardened-off growth is much less susceptible. For the spring and early summer and again in the fall you should probably spray on a 14-21 day interval. In the middle of summer you might be able to space out the spraying. However, if the plants are actively pushing new growth all summer then spraying on the same close schedule will be needed.

Anything you can do to reduce shearing which forces new growth and spreads the pathogen will be a good idea. You could also time fungicide sprays to right before shearing events to make sure that inoculum is at its lowest. You should also reduce nitrogen rates if possible to reduce tissue softness. Finally, if you can space the plants out, it will improve drying and decrease disease and also make effective spraying more likely.

Based on the blueberry trials, the best fungicides we have in ornamentals are been Pageant, Captan and to a lesser degree Heritage. We have had best control of other stem dieback/blights with Pageant.

A similar dieback, Kabatina, can be confused with Phomopsis and fungicide controls cannot be expected to be the same. Get a current diagnosis.

DRECHSLERA LEAF SPOT AND BLIGHT I was recently scanning the web for fungicide work on ornamental pathogens and found a series of trials on Drechslera blight on turf. This pathogen and its relatives are common on some perennials including Helminthosporium head blight on grasses (Pennisetum, middle-left), Heterosporium leaf spot (dianthus, top-left), and Bipolaris and Exserohilum leaf spots (Ensete, bottom-left). These diseases are also found on tropical plants like Calathea, Maranta, ginger, heliconia, bromeliads and palms.

As is often the case, there was no research done on any ornamental recently. So I am resorting to summarizing the turf data so we can see what fungicides might be expected to work on perennials for control of these pathogens. Not all of these products are currently registered for ornamentals but you can see that we actually have quite a selection of products that have worked well on this turf disease. The best product in several trials was Insignia, although the other strobilurins (MOA 11) were very good to excellent as well.

The table is a summary of some of the information presented in three years of trials reported in Plant Disease Management Reports by Uddin and Denelli (Department of Plant Pathology, Penn State University.) As always rotate between different MOA groups to avoid development of resistance.

Fungicide (MOA group)	Degree of Control
2636 (1 and 2)	Some
Banner MAXX (3)	Very good
Chipco 26GT (2)	Very good to excellent
Daconil Ultrex (M5)	Very good to excellent
Disarm (11)	Very good to excellent
Heritage (11)	Very good to excellent
Insignia (11)	Excellent
Medallion (12)	Very good
Protect (M3)	good
Trinity (3)	Very good to excellent

RECENT PERENNIAL SAMPLES FROM OUR DIAGNOSTIC LAB

Pythium root rot on Festuca (left), rust on Veronica (middle) and Fusarium crown rot on dianthus (right).

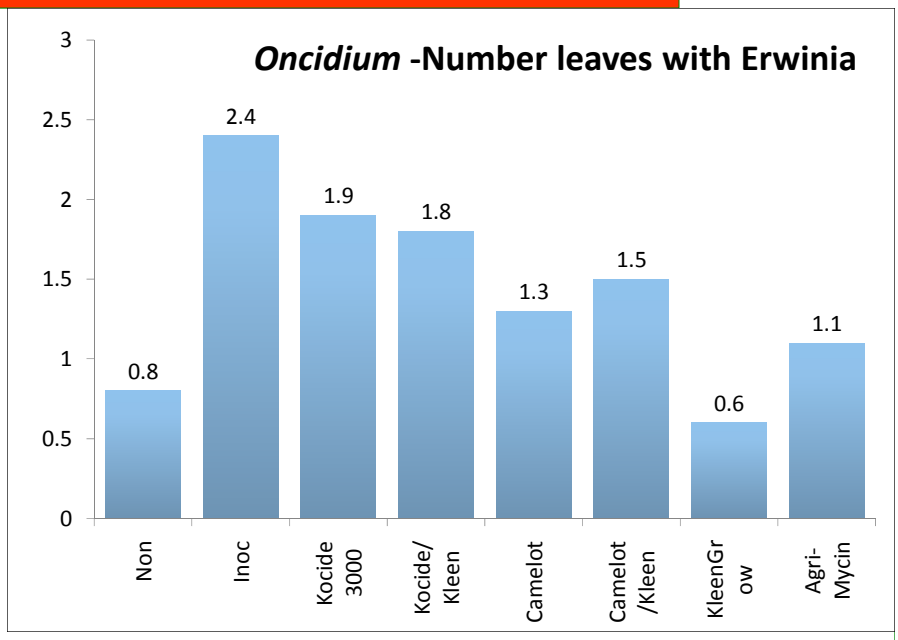
BOTRYTIS AND SCLEROTINIA GALLERY

Botrytis season is officially open for business. I wanted to show you some of the samples we received in our diagnostic lab over the past month. It is interesting that we isolated Botrytis and/or Sclerotinia from each of the samples. The snapdragon flowers (top) were infected with both Botrytis and Sclerotinia (post-harvest). The poinsettia and the rosemary were infected with Botrytis stem rot (middle) and the sunflower was infected with Sclerotinia stem rot (bottom). Mixed infections with these two closely related fungi do mean that you should use products that are effective on both pathogens.

I have summarized left our trials on fungicide control of Botrytis and Sclerotinia. The blanks in the table are due to lack of data on our part. I have left out some of the products which I do not think should be used for Botrytis at all including copper fungicides. You can see that we have not tested many products for Sclerotinia. The best products for both diseases in our trials have been Chipco 26019, Compass O, Daconil Ultrex (can damage flowers), Decree and Pageant (the best on Sclerotinia). Be sure to rotate to avoid resistance development.

Product	Mode of Action Grouping	Botrytis	Sclerotinia
26/36 Fungicide	1 and 2	some/ excellent	
Actinovate	nc	some/good	
Chipco 26019, Chipco 26GT	2	excellent	some/ excellent
Cleary 3336, Fungo, OHP-6672	1	poor/some	
Clevis	3 and M3	poor/very good	
Compass O	11	Very good	Very good/ excellent
Daconil Ultrex	M5	Very good/ excellent	excellent
Decree	17	Very good/ excellent	poor/ excellent
Dithane	M3	good/ excellent	
Endorse	19	Very good/ excellent	none
Fungaflor-TR	3	some/very good	
Heritage	11	fair/good	Very good
Insignia	11	poor/very good	Very good
Medallion	12	Very good/ excellent	
Milstop	nc	some/very good	
Pageant	7 and 11	Very good/ excellent	excellent
Protect T & O	M3	Very good	
Rhapsody, Cease	nc	Some	
Spectro	1 and M5	poor/good	good
Strike	3	good	
Terraclor	14	none	
Terraguard	3	none/very good	
Triact	nc	fair/good	
Veranda O	19	Very good	

For the past two years we have been testing some experimental bactericides. This month I report on the final two trials for 2009. Both trials were conducted with *Erwinia chrysanthemi* with the first on *Oncidium* orchid and the second on poinsettia.



ERWINIA BLIGHT ON *ONCIDIUM*

In the *Oncidium* trial, plants were treated weekly for a total of five weeks. One application was made prior to inoculation with the bacterial pathogen. Disease severity was relatively low due to the late summer-early fall temperatures.

The products tested were two copper formulations—Kocide 3000 (cupric hydroxide) and Camelot (rosin and fatty acids of copper salts). They were used alone or in combination with KleenGrow (a quaternary ammonium fungicide/bactericide from PACE). We also included one treatment of Agri-Mycin (streptomycin sulfate). The rates were: Kocide 3000 (16 oz/100 gal), Camelot (16 oz/100 gal), KleenGrow (6 oz/100 gal) and Agri-Mycin (8 oz/100 gal).

We rated the severity of Erwinia (number of infected leaves) on 20 and 28 October and the graph shows the final data only. The best control was seen with KleenGrow alone. Agri-Strep was also good while the copper products did not do quite as well. The rate of Camelot used was significantly lower than the lowest labeled rate of 48 oz/100 gal. I chose this rate based on previous work with the product. This trial did not indicate any benefit from adding either copper to KleenGrow.

ERWINIA BLIGHT ON POINSETTIA

Treatment	Rate/100 gal.	Disease severity
Water noninoculated	-----	1.2 ab
Water inoculated	-----	2.3 c
Actigard	0.75 oz	2.2 bc
Citrex	1.5ml per liter	2.1 abc
Physpe-G	14.4 oz	1.5 abc
Kasugamycin	45 oz	1.6 abc
SP2015	12 oz	1.4 abc
SP2015/CuPRO	8 oz/2 lb	1.6 abc
Taegro	3.5 oz	1.1 a
CuPRO	2 lb	1.4 abc
Rezist/Sett	16 oz/32 oz	1.5 abc
Rezist/Sett	32 oz/32 oz	1.2 ab
Rezist	32 oz	1.4 abc

The second trial was conducted for the IR-4 program and employed poinsettias. Although, Erwinia blight on poinsettia is primarily a disease of the cuttings, we did the trial on larger plants. Once again, plants were sprayed before inoculation (twice this time). A total of four weekly sprays was made. Products and rates are given in the table to the left. All products were applied as sprays with the exception of Taegro which was applied as a drench alternated with a spray. Numbers in the disease column followed by the same letter are not statistically different.

The best prevention of Erwinia blight was achieved with the Taegro treatment. Taegro is a biological agent (bacterial) being developed for ornamentals by Novozymes. The second most effective treatment was Rezist combined with the adjuvant, Sett (each at 32 oz/100 gal). Rezist is a product of Stoller Enterprises and worked pretty well with or without the Sett. Of the remaining products, only Citrex and Actigard provided no reduction of Erwinia blight on poinsettia.

Since, IR-4 has decided to continue their focus on bacterial diseases in the next two years, we will hopefully see more reports of efficacy of these and other new bactericides.

DOES SILICON-BASED FERTILIZER AFFECT MEALY BUGS? Hogendorp, Cloyd and Swiader recently reported on research performed at the University of Illinois on citrus mealy bug. These researchers evaluated the effect of silicon-based fertilizers (such as potassium silicate) on development of this mealy bug on *Ficus lyrata*. Examples of plants that are silicon accumulators include corn and rice, resulting in enhanced insect resistance. The number of eggs laid, size of the mealy bug and developmental time were each studied using a range of rates of silicon from several fertilizer sources. Although silicon was found at somewhat higher rates in leaves of ficus treated with high levels of silicon fertilizer it did not accumulate in high enough levels to affect any of the parameters measured for this mealy bug. The authors conclude that *Ficus lyrata* may be classified as a silicon "rejector" and thus no effect on mealy bug was noted. For a complete report see HortScience 44(6):1616-1621

LETHAL PALM DISEASES COMMON IN THE UNITED STATES Downer, Uchida, Hodel and Elliott reported on the most common diseases of palms in the US that could result in their death. I have summarized the diseases they include in the table below. For a complete report see: HortTechnology 19(4):710-715 (2009).

Disease	Cause	Palms affected	States of occurrence
Canary Island Date Palm wilt	*Fusarium oxysporum* fsp. *canariensis*	*Phoenix*	California Florida
Diamond Scale	*Phaeochoropsis neowashingtoniae*	*Washingtonia*	Southern California
Ganoderma butt rot	Ganoderma zonatum	Many palms	Florida, rarely California
Lethal yellowing	*Candidatus Phytoplasma palmae* subgroup 16SrIV-A	Many palms	Florida
Pink rot	*Nalanthamala vermoeseni* (=*Gliocladium*)	*Archontophoenix Chamaedorea Dypsis, Phoenix Trachycarpus Syagrus Washingtonia*	California Florida Hawaii
Phytophthora bud, stem and collar rots	*Phytophthora (drechsleri, katsurae, palmivora)*	*Cocos Washingtonia*	California Florida Hawaii
Thielaviopsis trunk rot	*Ceratocystis paradoxa*	Many palms	California Florida

Fungicide Efficacy on Artillery Fungus

Polyoxyin-D (Endorse)
Azoxystrobin (Heritage)
Pyraclostrobin (Insignia)
Triademifon (Bayleton)
Propiconazole (Banner MAXX)
Thiophanate methyl (3336)
Triticonazole (Trinity)
Thiram (Spotrete)
Fludioxinil (Medallion)

Sphaerobolus stellatus is the artillery fungus, so named because its fruiting bodies are forcibly discharged like a gun. The sticky spore masses are misidentified as scale insects at times and attach to sides of structures as well as cars. The fungus is becoming rather common in some landscape mulches although including greater than 40% mushroom compost has been found to suppress their sporulation. This saprophytic fungus thrives under cool, wet springtime weather. Fidanza and Davis reported on lab tests of fungicides for controlling this fungus. The active ingredients which were found most suppressive to the fungus are listed in the table to the left (most suppressive listed first).

For a complete report see:

J. Environ. Hort. 27 (3):155-158 (2009).

Chase Horticultural Research, Inc.
Education for Horticulture