

GROWERTALKS

Cover Story

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More Rotation, Less Frustration

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When we think about rotating fungicides, many of us think about resistance management, but it can also be a great tool to manage costs and minimize negative effects like residue, long re-entry intervals and phytotoxicity. Many of our newest products are actually premixes; two of the most recent are Pageant (from BASF) and Palladium (Syngenta). Pageant is a combination of two active ingredients in separate MOA (mode of action) groups (boscalid and pyraclostrobin) and Palladium is a combination of two other MOA groups (fludioxinil and cyprodinil). In the agricultural or “crop” world, rotating these two premixes is common on some crops and is an excellent way to keep resistance at bay while achieving excellent control of many foliar diseases especially.

I'll cover a few issues that should be considered before addressing which products make good rotation partners. Philosophically, I don't think broad scale spraying with tank mixes of everything-but-the-kitchen-sink is an acceptable means of producing a sustainable plant product. This approach inevitably stresses the plant, leaves a lot of residue, can be costly and, of course, doesn't target the real problem, except by accident. Not all crops need fungicides, especially if they're grown using at least some cultural tools to minimize disease.

First things first

The most important control method is to do everything in your power to reduce disease pressure: practice IPM. If you do nothing but spray fungicides, you're placing too much strain on them and they certainly are more likely to fail. Even the best fungicides work poorly if the cultural and environmental controls of IPM are ignored.

Very few growers accurately identify all diseases without input from a lab or consultant. Guessing usually leads to crop damage due to use of ineffective products from either phytotoxicity or additional disease damage; you can't simply pick a product and hope for the best. In addition, not all fungicides are created equal. Choosing the most effective products can often give the best results with less cost in the long run since re-treatment is minimal.

Don't wait—be preventative when necessary. Downy mildew and some bacterial diseases aren't easy to control (sometimes impossible to control) when preventative applications aren't made. Use products according to their labels. And learn more about important diseases of your crops so you can find their Achilles heel. For example, Botrytis can be controlled without any fungicides if humidity and temperature are

firmly under your control, which is possible in some greenhouses.

Minimizing resistance

Most studies have shown that both tank-mixing and rotation are effective for resistance management in fungal pathogens. I prefer rotation to tank-mixing because it can be less costly and more effective and teach you to be a better grower. You don't need to know everything about fungicide classes to use them effectively. Using only two products (in different MOA classes) in an alternating routine can go a long way to avoiding resistance development. Rotation also allows you to figure out what happened. If the application worked or failed or caused phytotoxicity, at least you can interpret it. In tank-mix situations, one never really knows which product, or even if the combination, is responsible for the reaction. In the end, it's a matter of your preference whether you choose tank-mixing or rotation, but at least choose one of them.

Down to the nitty-gritty

What are some of the effective rotations that work? I've included a few suggestions for some of the most common diseases. The first criterion I used was efficacy and the second was MOA grouping (usually in parentheses after the active ingredient or chemical class). I also tried not to include products that have significant residue and/or phytotoxicity concerns. I haven't stuck just to the newer products either since many of the older ones remain excellent rotational partners. The first rotation I discuss under each disease is the most effective based on our trials. Alternative products are listed later as they can also be effective.

Alternaria Fungicide Rotation

This is an example of a disease that can be controlled with many different fungicides. Some of the oldest fungicides, including chlorothalonil and mancozeb, can give excellent control of *Alternaria* leaf spot. However, they both leave significant residue that's sometimes unacceptable. The most effective products in our trials have been strobilurins (11—like Compass O or Pageant), fludioxinil (12—Medallion), iprodione (2—Chipco 26019) and triflumizole (3—Terraguard). Thus, you could choose a rotation of Compass O and Medallion or Chipco 26019 and Pageant.

Bacterial Leaf Spot Rotation

This is unfortunately a simple answer since very few products work well on bacterial diseases. If you have *Xanthomonas* or *Pseudomonas* you can alternate a copper-containing product (M1—like Phyton 27 or CuPro) with one containing streptomycin sulfate (antibiotic—like AgriStrep) or *Bacillus subtilis* (biological agent—Cease). Copper has always been most effective on these fungi, but streptomycin sulfate and Cease are also pretty effective (especially preventatively). If, however, you have *Erwinia* soft rot or fire blight (*Erwinia amylovora*), streptomycin works best and can be alternated with a copper. Cease hasn't been very effective on *Erwinia* diseases. There aren't any other products that are particularly effective on bacteria—and indeed many of you will decide the ones I listed above are not very effective either—but they're the best.

Botrytis Fungicide Rotation

Resistance is very common in *Botrytis* populations and has been reported to resist chlorothalonil (M5—Daconil Ultrex), iprodione (2—Chipco 26019) and very recently fenhexamid (17—Decree). The most effective rotation would encompass as many MOA groups as possible and therefore I suggest alternating Pageant (7 and 11) and Palladium (9 and 12). You can also successfully use any two of the following in rotation: chlorothalonil, iprodione, fenhexamid and fludioxinil (12—Medallion). Other fungicides may be helpful at

times, but these are the best.

Cercospora Fungicide Rotation

Cercospora leaf spot has always been effectively controlled with thiophanate methyl (3) and strobilurins (11). Thiophanate methyl products like OHP-6672 and Cleary's 3336 can be rotated with a strobilurin like Heritage or Insignia.

Colletotrichum Fungicide Rotation

Anthracnose caused by Colletotrichum can be controlled effectively with copper (M1—like Phyton 27), mancozeb (M3—residue issues), chlorothalonil (M5—residue issues) and finally Pageant (combination of MOA groups 7 and 11). Using a rotation of Phyton 27 (only when the sprays can dry quickly or copper burn can happen) with Pageant should give good control without excessive residue.

Cylindrocladium Fungicide Rotation

Cylindrocladium has been very hard to control even when fungicides are applied preventatively. The best products overall have been triflumizole (3—Terraguard), fludioxinil (12—Medallion) and azoxystrobin (11—Heritage). Unfortunately, the first two products can delay rooting on some cuttings, so using azoxystrobin first might be advisable if azaleas, roses and myrtles are being rooted. For such a tough disease, I wouldn't resort to less effective products.

Downy Mildew Fungicide Rotation

There are really quite a lot of very effective products for prevention of downy mildew and also some that are pretty effective in a curative manner. Three very effective newer products include Adorn (43—must be tank-mixed according to label directions), FenStop (11—not a strobilurin, but same MOA grouping) and Segway (21). Based on research trials and grower reports, the best curative effects are with Subdue MAXX (4—must be tank-mixed for this use), phosphonates (33—like Aliette) and Stature (40). Many other fungicides are effective as well, including strobilurins (be sure not to alternate with FenStop).



Fusarium Fungicide Rotation

This is one of the toughest pathogens to control. However, the best products include strobilurins (11), triflumizole (3) and fludioxinil (12). Don't expect miracles with Fusarium control.

Phytophthora Fungicide Rotation

The best products for Phytophthora are roughly the same as the best ones for downy mildew. Stature (40), Adorn (43—must be tank-mixed according to label directions), FenStop (11—not a strobilurin, but same MOA grouping), Segway (21) and phosphonates (33—like Aliette) are each very good. Pick any two of them and rotate being sure to follow label directions concerning rates, intervals and tank-mixing.



Powdery Mildew Fungicide Rotation

There's a rather long list of products for powdery mildew prevention and eradication. The best powdery mildew fungicides usually fall into the strobilurin (11) or sterol inhibitor (3) groups. One pretty significant exception is using strobilurins for rose powdery mildew, which can be unsatisfactory. Copper products (M1—like Phyton 27 and Camelot) can be very effective with minimal residue. Myclobutanil (3—Hoist) tends to have the lowest PGR activity of the sterol inhibitors. Some of the “green” products can be effective in powdery mildew

rotations including Cease (biological), MilStop (potassium bicarbonate—can leave objectionable residue) and oils (can be phytotoxic).

Pythium Fungicide Rotation

The products that work best for Pythium include Subdue MAXX (4—resistance is a big concern), etridiazole (14—like Terrazole) and Segway (21). Some of the other newer products are labeled for Pythium, but our trials haven't yielded enough control for me to include them in a rotation. Phosphonates have been used for Pythium control for many years, but our trials have shown efficacy against Pythium only 50% of the time. Finally, if you're biologically minded, you should know that *Trichoderma harzianum* (PlantShield) has been very good for Pythium in many of our trials as long as they are used preventatively.

Rhizoctonia Fungicide Rotation

The single best product for Rhizoctonia in our trials during the past 20 years is fludioxinil (12—Medallion). It can be rotated with a strobilurin (11—like Heritage) or thiophanate methyl (3—like OHP-6672 or Cleary 3336). You can also successfully use *Trichoderma harzianum* (PlantShield) for Rhizoctonia root rot, but it won't be very effective for stem rot or aerial blight since it works most effectively in the soil/potting medium.

Rust Fungicide Rotation

The best rust fungicides usually fall into the strobilurin (11) or sterol inhibitor (3) groups. Unfortunately, sterol inhibitors are sometimes effective as plant growth regulators, so rotation is especially important when trying to minimize PGR effects as well as control disease.

Thielaviopsis Fungicide Rotation

Thiophanate methyl products like OHP-6672 and Cleary's 3336 can be rotated with Veranda O (19). These have been the best in our trials. Less reliable products include azoxystrobin (11), triflumizole (3) and fludioxinil (12). This disease really should be controlled through use of pathogen-free plugs or cuttings and maintaining the potting medium pH below 5.5. Growing plants under stressful conditions can make this disease worse.

Conclusions

There are probably as many effective rotation programs for diseases as there are successful growers. Remember that you need to know what you're trying to prevent, practice IPM, and rotate. If you have a program that works for you there's really no reason to change it. However, it never hurts to learn something new. Finally, be sure to do small tests for safety—at least when trying a new product. And always follow the label. **GT**

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