Some Principles Of Fungicide Resistance VI: Application Rate And Fungicide Resistance

This is the sixth article in a series.

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This sixth article in this series addresses several practical questions about application rate and the buildup of fungicide resistance. First, it is important to understand the two broad ways that fungicide resistance shows up in fields.

• In quantitative resistance, resistant spores are less sensitive than the wild-type spores, much like an undersized, partially effective shield (compare Figures 1 & 2). If quantitative resistance is present, you may notice you aren't getting the level of control you once did, but that you can still achieve decent control at high rates and short spray intervals. Common examples of this would be cases of resistance to DMI fungicides (=FRAC Code 3, see previous article on FRAC Codes).

• In qualitative resistance, resistant spores are completely insensitive to normal field rates of the fungicide. It is as if a large shield prevented all fungicide from contacting the spores (Figure 3). To the producer, qualitative resistance looks like a complete loss of disease control. In fact, sometimes these resistant spores can actually cause more disease when the fungicide is applied, a phenomenon called "hormesis". (See Table 1 for a real-world example of hormesis.)

If disease pressure is very low, doesn't it make sense to apply a fungicide at a half-rate?

Yes, in a sense, it does. Reducing the application rate of a pesticide benefits one's pocketbook, the environment, field workers, and consumers. However, applying a fungicide at rates below those listed on the label does increase the risk of fungicide resistance. This is especially so for cases of quantitative resistance, such as resistance to DMI fungicides (=FRAC Code 3).

Let's consider a fictional example, called "Blight-Be-Gone". Suppose Blight-Be-Gone is labeled to control a disease at 3-6 oz/acre. However, disease pressure is really low, so we may logically decide that we probably don't need the fungicide. Nevertheless, suppose I decide to include it with a post-emergence herbicide spray, because I am already in the field, and it gives me peace of mind. Since disease pressure is so low, I might spray it at 1.5 oz/acre (which is half the minimum labeled rate). It is seems like sensible plan. However, the risk in using the half-rate is that I am allowing the spores with partial resistance to build up over time. And the more opportunity they have to multiply, the greater the risk that even more resistant spores will emerge.

In cases of qualitative resistance, half-rates probably have little influence on the buildup of resistance. This is because spores that exhibit qualitative resistance thrive even at the highest labeled rate of the fungicide.

Can't I prevent fungicide resistance by using the high, labeled rate of a fungicide?

No, definitely not. If a fungus has the genetic potential to develop resistance to the product we are using, there is no way to prevent fungicide resistance, short of never using the at-risk fungicide. We can only slow down the buildup of resistance. See the first article in this series for more on this.

So, can we slow down the development of resistance using a high, labeled rate? Yes and no. Yes, if the resistance is quantitative, no if it is qualitative.

If resistance in your field is quantitative (Figure 2), high doses can suppress many of the spores, even many of those that have partial resistance. In these cases, higher doses may indeed slow down the buildup of resistant populations.

If resistance in your field is qualitative (Figure 3), high doses essentially have no effect on the fungus. The mutant spores survive even the highest doses, so typically no disease control occurs following the application of even the highest labeled rate.

Bottom line

Fungicide resistance appears as a partial loss of disease control (quantitative resistance) or complete loss of disease control (qualitative resistance). In cases of quantitative resistance, using less than labeled rates is inadvisable, because it may accelerate the buildup of resistance. Use of labeled rates may slow down (though not prevent) the development of quantitative resistance. In cases of qualitative resistance, even high rates don't suppress resistance buildup. Δ

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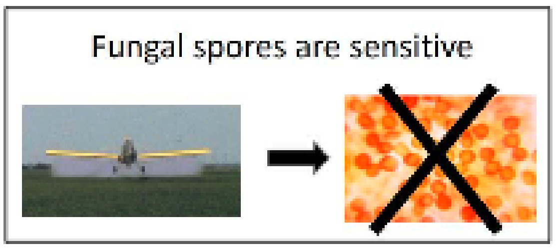

Figure 1. In a population of fungal spores (orange objects at right), sensitive spores are killed by fungicide.

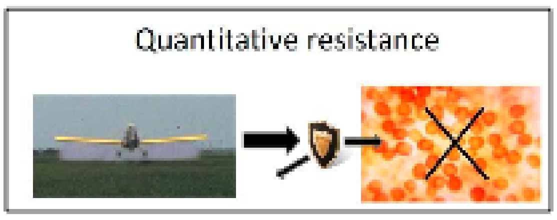

Figure 2. Quantitative resistance: Some spores are partially resistant. It is as if a small, partially effective shield protected some of the spores. Some of them will survive the application, though many will also die. (Image of shield from office.microsport.com)

Figure 3. Qualitative resistance: The large majority of Surviving spores are completely resistant to fungicide. It is as if a large shield prevented fungicide from contacting the spores. (Image of shield from office.microsport.com)

Table 1. Disease enhancement following application of a Q_oI fungicide on perennial ryegrass infected with Q_oI-resistant *Pyricularia oryzae*

Treatment (formulation & amt product/1000 sq ft	% of plot affected[a]
Water	53 b
Thiophanate-methyl + chlorothalonil 90WDG, 8 oz.	2 c
Azoxystrobin 50WG, 0.2 oz.	66 a

[a]Waller-Duncan statistical test, k=100, P~0.05