

# Fungicide Resistance Management

Fungicides are important tools for managing many diseases in agricultural and horticultural crops. Fungicides are most effective when applied before fungal infections are established. Because protection by fungicides is temporary, they may need to be reapplied to protect new growth.

Although many factors can contribute to the failure of a fungicide to protect a crop, the development of resistance by the fungal pathogen is the most difficult to overcome. Resistance is a heritable genetic trait that results in reduced sensitivity to a fungicide by a fungal pathogen. Fungicides that disrupt multiple cellular functions (multisite inhibiting fungicides) in the pathogen are less likely to result in resistant pathogen populations than those that target a single cellular function (single site-specific fungicides). Most new fungicides are single site-specific.

Fungal pathogens that are resistant to one fungicide often are resistant to other fungicides that have a similar or same mode of action. This is called cross-resistance. For this reason, the Fungicide Resistance Action Committee (FRAC) developed fungicide group codes, referred to as FRAC codes, to facilitate resistance management. Fungicides with the same FRAC code have a similar mode of action and could exhibit cross-resistance. A full list of the codes for all fungicide common names (active ingredients), their modes of action and the risk level (low, medium or high) for fungicide resistance development can be found at <http://www.phi-base.org/images/fracCodeList.pdf>. **The FRAC codes also are listed on the front of a product label or in the resistance management section.**

Fungicide resistance in a pathogen population becomes important when fungicide-resistant isolates outnumber fungicide-sensitive isolates. **The buildup of resistant isolates is caused by repeated or incorrect use of a fungicide.** Fungicide resistance within a population occurs at different rates and is affected by the mode of action of the fungicide, the genetics of the pathogen and cropping practices.

Strategies for managing fungicide resistance are aimed at slowing down the development of resistance. Therefore, resistance management plans must be implemented when at-risk fungicides become available for a particular use before resistance becomes a problem. The objective of a resistance management program is to minimize the use of at-risk fungicides without compromising disease control. Although specific strategies vary depending on the fungicide FRAC code, the target pathogen and the crop, the general approach is similar. A resistance management program should integrate resistant varieties, good cultural practices and thoughtful and judicious use of fungicides.

**Resistant Varieties:** Whenever feasible, resistant varieties should be selected. The use of resistant varieties lowers the potential for disease incidence and severity and thereby minimizes or eliminates the need for fungicides.

**Good Cultural Practices:** Proper sanitation and crop rotations can lower initial pathogen populations, while proper soil fertility and the use of high-quality water can reduce disease incidence. To decrease the potential for fungicide resistance, avoid sites with a history of disease.

**Fungicide Use:** Fungicides should only be used when alternatives are not available to avoid unnecessary selection of fungicide resistant populations. The following practices should be used when fungicides are necessary:

- Start fungicide applications early in disease development.
- Use low-risk fungicides when possible.
- Use optimal application methods to maximize spray coverage.
- Do not apply fungicides at rates below or above the range specified in the label.
- Do not apply a fungicide more than two times sequentially. Alternate (apply a fungicide at most twice and then switch) fungicides from different FRAC codes.
- Alternatively, tank-mix at-risk fungicides with a protectant fungicide. Refer to product labels to ensure fungicides are compatible or to confirm that the fungicide is not already a pre-mix.
- Refer to product labels for specific resistance management guidelines.
- Do not exceed the number of fungicide applications (or maximum use amount) recommended by the manufacturer.

The fungicide resistance management section was revised October 2019 by Boyd Padgett.