

## Managing Fungicide Resistance in *Botrytis cinerea*

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Fungicide resistance in *Botrytis cinerea* (Botrytis) can occur rapidly after repeated applications of conventional fungicides, resulting in loss of disease control. Implementation of proper management techniques can minimize selection for resistance.



### Characteristics of Fungicides

- Fungicides can be divided into two broad categories. Single-site fungicides have medium to high efficacy but carry high risk of becoming ineffective when used frequently. Multi-site fungicides have low to medium efficacy but can be applied more frequently without increased risk of resistance development.
- Multi-site fungicides mostly inhibit spore germination (not mycelium growth) and do not penetrate into the plant tissue. They are best used before infection occurs.
- Single-site fungicides are most effective when applied before or within 24-48 h after infection. Many are locally systemic.
- Listed below are single-site and multi-site (FRAC M) fungicides available for Botrytis management in greenhouses in the U.S.

Trade Name	Active Ingredient	FRAC	Resistance Risk	Efficacy*
<b>Single-site Fungicides</b>				
Chipco	Iprodione	2	High	Medium
Astun	Isofetamid	7	Medium-High	High
Broadform	Fluopyram + Trifloxystrobin	7+11**	Medium-High	High
Mural	Solatenol + Azoxystrobin	7+11**	Medium-High	High
Pageant	Boscalid + Pyraclostrobin	7+11**	Medium-High	Medium
Orkestra	Fluxapyroxad + Pyraclostrobin	7+11**	Medium-High	High
Palladium	Fludioxonil + Cyprodinil	12+9	Low-Medium	High
Medallion, Spirato	Fludioxonil	12	Medium	
Decree	Fenhexamid	17	Medium	Medium
Affirm	Polyoxin D zinc salt	19	Medium	Low-Medium
<b>Multi-site Fungicides</b>				
Various trade names	Captan, Chlorothalonil, Mancozeb, Thiram, Copper, Sulfur	M01-M04	Low	Medium

\*Efficacy if no resistance is present; \*\* FRAC 11 fungicides only have suppressive action against Botrytis and most Botrytis populations have become completely resistant to FRAC 11 fungicides.

### Fungicide Resistance Principals

- Reduce inoculum through sanitation.
- Use fungicides preventatively.
- Apply appropriate chemical rates (high rates during periods of high disease pressure).
- Rotate fungicides of different FRAC codes.
- Use multi-site fungicides alone or in combination with single-site fungicides when Botrytis pressure is high.
- Reserve an effective FRAC code for post-harvest applications to ensure maximum fungicide efficacy.

### Monitoring Fungicide Resistance

- Laboratory techniques have been developed for testing fungicide resistance amongst spore populations in greenhouses. These tests can help to determine which fungicides will be the most effective. For details about how to develop testing procedures for your business, contact Jim Faust at: [jfaust@clemson.edu](mailto:jfaust@clemson.edu).