MULTI-YEAR SUMMARY OF FUNGICIDE EFFICACY ON BOTRYTIS FRUIT ROT AND POWDERY MILDEW

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Introduction

- Botrytis fruit rot (BFR) or gray mold, is caused by *Botrytis cinerea*. It is a devastating fruit rot disease in strawberry production, rendering fruit unmarketable during both pre- and post-harvest stages.
- Powdery mildew (PM) is caused by *Podosphaera aphanis* and affects both the foliage and fruit.
- Both BFR and PM are managed with timely fungicide applications and cultural practices throughout the growing season.
- This poster presents a summary of product efficacy trials conducted at the Cal Poly Strawberry Center from 2014 through 2022.

Materials and Methods

- Results are compiled from 28 experiments over an 8-year period conducted at the Cal Poly Strawberry Center; 16 BFR experiments and 12 PM experiments.

Fig. 1

- BFR studies are conducted in the field with 4 replicated plots of 50 plants/plot.
- Treatments are applied using a handheld backpack sprayer (**Fig. 1**).
- To assess fungicide efficacy, treatments are compared to a non-treated control after 5 weekly applications.

Fig. 2

- There is an at-harvest and postharvest evaluation of BFR
- Fig 2. Example of a BFR postharvest assessment. Plastic tray containing 32 ripe fruit observed at 6 days after harvest in the non-treated plot.

Fig. 3

- PM experiments are conducted in the green house on raised benches with 4 replicates per treatment.
- There are 5 weekly applications and plants are rated weekly for incidence (# infected leaves per plot/# leaves per plot) and severity (% of leaf surfaces colonized).
- Spreader plants (**Fig. 3**) are used to provide inoculum in the trials. Symptoms appear approximately 8 days after exposure to spreader plants.

Results

Rating: 5 = excellent and consistent, 4 = good and reliable, 3 = moderate and variable, 2 = limited and/or erratic, 1 = minimal and often ineffective, 0 = ineffective. NL = pathogen/disease not on label, ND = no data to determine efficacy rating. R = resistant isolates documented in pathogen populations.

Table 1. Relative efficacy of conventional fungicides against BFR and PM

Fungicide trade names	Active ingredient	Resistance risk (FRAC)[1]	Botrytis fruit rot[2]	Powdery mildew
Abound, etc. [3]	azoxystrobin	high (11)	2 (R)	3
Bumper, Tilt etc. [3]	propiconazole	medium (3)	NL	5
Cabrio	pyraclostrobin	high (11)	2 (R)	2
Captan	captan	low (M4)	2	NL
Elevate[4]	fenhexamid	medium (17)	5 (R)	NL
Evito	fluoxastrobin	high (11)	2 (R)	3
Flint Extra	trifloxystrobin	high (11)	2 (R)	4
Fontelis	penthiopyrad	high (7)	5	4
Fungi-Phite, K-Phite, Fosphite, etc.	mono- and di-potassium salts of phosphorous acid	low (P07)	NL	0
Gatten[6]	flutianil	high (U13)	NL	5
Intuity	mandestrobin	high (11)	3	2
Kenja	isofetamid	high (7)	5	3
Luna Sensation	trifloxystrobin; fluopyram	medium (11/7)	4	5
Luna Tranquility	pyrimethanil; fluopyram	medium (9/7)	4	5
Merivon	pyraclostrobin; fluxapyroxad	high (7/11)	5	5
Meteor, Nevado, etc. [3]	iprodione	high (2)	4	NL
Mettle, Perissim, etc. [3]	tetraconazole	medium (3)	NL	5
Miravis Prime	fludioxonil; pydiflumetofen	medium (7/12)	5	5
Ph-D, etc. [3]	polyoxin D zinc salt	medium (19)	3	4
Pristine	boscalid; pyraclostrobin	high (7/11)	5 (R)	4
Procure, etc. [3]	triflumizole	medium (3)	NL	5
Protocol	propiconazole; thiophanate-methyl	medium (3/1)	4 (R)	4
Quadris Top	azoxystrobin; difenoconazole	medium (11/3)	NL (2 (R))	5
Quilt Xcel, Avaris 2XS	azoxystrobin; propiconazole	medium (11/3)	NL (3)	5
Quintec	quinoxyfen	medium (13)	NL (3)	5
Rally, etc. [3]	myclobutanil	medium (3)	NL	5
Rhyme	flutriafol	medium (3)	NL	5
Scala	pyrimethanil	medium (9)	3	NL
Switch	cyprodinil; fludioxonil	medium (9/12)	5 (R)	2
Thiram	thiram	low (M3)	2	NL
Topsin-M, etc. [3]	thiophanate-methyl	high (1)	4 (R)	4
Torino	cyflufenamid	unknown (U6)	NL	5
Velum One[5]	fluopyram	high (7)	NL	3

Table 2. Relative efficacy of organically certified fungicides against BFR and PM

Fungicide trade names	Active ingredient	Resistance risk (FRAC) [1]	Botrytis fruit rot[2]	Powdery mildew
Actinovate	*Streptomyces lydicus* WYEC 108	unknown (BM2)	0	2
Aleo, etc. [3]	garlic oil	unknown (NC)	0	NL
All Phase	potassium sorbate; sodium lauryl sulfate	unknown (NC)	ND	4
Aviv, etc. [3]	*Bacillus subtilis* IAB/BS03	unknown (NC)	0	3
Botector	*Aureobasidium pullulans* DSM 14940; DSM 14941	unknown (NC)	0	NL
Cinnerate, etc. [3]	cinnamon oil	unknown (NC)	0	ND
Cueva, Camelot O, etc[3]	copper octanoate	low (M01)	ND	ND
Double Nickel	*Bacillus amylo-liquefaciens* D747	unknown (BM2)	0	2
ProBlad Verde, etc. [3]	banda de *Lupinus albus* doce	unknown (NC)	0	3
Howler	*Pseudomonas chlororaphis* AFS009	unknown (BM2)	0	NL
Kaligreen, MilStop, etc. [3]	potassium bicarbonate	unknown (NC)	ND	3
Microthiol Disperss, etc. [3]	sulfur	low (M2)	NL	4
M-Pede, etc. [3]	potassium salts of fatty acids	medium (28)	NL	2
Oso, etc. [3]	polyoxin D zinc salt	medium (19)	3	4
Oxidate, etc. [3]	hydrogen peroxide; peroxyacetic acid	unknown (NC)	0	0
Procidic, etc. [3]	citric acid	unknown (NC)	0	NL
Rango	cold pressed neem oil	unknown (NC)	2	ND
Regalia	*Reynoutria sachalinensis* extract	unknown (P5)	0	2
Serenade ASO, etc. [3]	*Bacillus subtilis* QST 713	unknown (NC)	0	3
Sonata	*Bacillus pumilis* QST 2808	Low (BM02)	NL	3
Stargus	*Bacillus amylo-liquefaciens* F727	unknown (BM2)	0	ND
Serifel	*Bacillus amylo-liquefaciens* MBI 600	low (BM02)	0	2
Taegro	*Bacillus amylo-liquefaciens* FZB24	low (BM02)	0	2
Theia[4]	*Bacillus subtilis* AFS032321	low (BM02)	0	2
Timorex Act	tea tree oil	unknown (BM1)	0	3

[1] Code numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of action (for more information, see http://www.frac.info/).

[2] Efficacy rating determined with fungicide susceptible populations of pathogen.

[3] Generic products may not be all listed and "etc." indicates that other products may be available that have the same active ingredient.

[4] Nonpersistent resistant populations of *Botrytis cinerea* to fenhexamid occur with repeated use of FRAC Code 17 fungicides.

[5] Velum One is a fluopyram formulation for chemigation. Soil applications are designed for nematode management but may also suppress powdery mildew.

[6] Registration pending in California.

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Conclusion

- Results show there are few effective fungicides whose efficacy has not been compromised by resistance in the pathogen population for BFR and PM.
- Overall, biological fungicides show limited control for BFR but several products show moderate efficacy against PM.
- Only 7 fungicides are consistent and effective against BFR and 14 are consistent and effective against PM.

References

Adaskaveg et al. 2022. Fungicides, bactericides, biologicals and natural products for deciduous tree fruit and nut, citrus, strawberry, and vine crops in California 2022 . pp. 81-83