

Alternative approaches to manage pre-harvest Botrytis fruit rot under a scenario of multi-fungicide resistance

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Summary

The effective management of Botrytis fruit rot (BFR) in strawberry relies on the use of effective fungicides. However, repetitive applications of single-site fungicides has selected for resistant populations of *Botrytis cinerea* and represents a major concern. Our recent studies have shown that Switch, Kenja and Luna Tranquility were the only fungicides to which resistance levels were still low. During this season, we monitored the frequency of resistant population of the pathogen to these fungicides and evaluated alternative disease management options such as Zivion, a biofungicide used in the food industry, as well as other biorational products. Resistance frequencies for the three fungicides was higher than those found in the previous seasons which is alarming. Milstop and Botector were the only biofungicides that reduced BFR compared to the non-treated control. However, none of the treatments evaluated were as effective as the conventional chemical standard (Switch/Captan).

Methods

Monitoring *Botrytis cinerea* isolates for fungicide resistance. During the 2017-2018 strawberry season, one hundred and twenty seven *Botrytis cinerea* isolates were collected from commercial farms located in Hillsborough and Citrus County in Florida. Fungicide resistance was determined based on the combination of the number of conidia germinated and germ tube elongation on media amended with fungicides. The assay was conducted twice for all fungicides to determine resistant profiles for each

isolate and obtain the frequency of fungicide resistance.

Evaluation of Zivion and other biorational fungicides.

Zivion and other biorational products were evaluated for the control of BFR as compared to a standard fungicide program on a commercial farm in Plant City, FL. Treatments were arranged in a randomized complete block design with four repetitions. The treatments consisted of non-treated control, Switch 62.5 WG (14oz) during bloom and captan otherwise, and weekly applications of Zivion and other biorational fungicides. Treatments were applied with a CO2 back-pack sprayer calibrated to deliver 100 gal/A at 60 psi through a boom mounted with two hollow-cone T-Jet 8002 nozzles. Fruit were harvested twice a week (5 Dec 17 to 27 Feb 18) to determine yield and BFR incidence. Yield was expressed in pounds of marketable fruit per acre, and BFR incidence was expressed as a percentage of diseased fruit relative to total number of fruit.

Results

Fungicide resistance

Fungicide resistance frequencies of *B. cinerea* isolates to Luna Tranquility, Kenja, and Switch were 47.2, 12.6, and 13.4 %, respectively (Fig.1.). During the season, an increase of resistance was observed for all 3 fungicides compared to previous seasons. Resistance to Switch was not found in past years or it was extremely low, thus these results are a significant concern. The resistance frequency for Luna Tranquility was almost 50% of the sampled population, indicating that its use (as well as other

fungicides in the same chemical group, i.e. Fontelis and Merivon) should be limited to reduce further selection of *B. cinerea* resistant populations.

Effects of Zivion and other biorational for control of Botrytis fruit rot

BFR incidence was analyzed during the peak production period from 23 Jan to 27 Feb, during nine selected harvests when disease incidence exceeded 10% in the non-treated control, and over the entire season. Average percentage of disease during these periods were 15.3, 22.9, and 10.1%, respectively. The standard Switch/Captan treatment significantly reduced BFR incidence compared to the non-treated control during the three periods of evaluation (peak production, disease peak, and whole season). During the peak production period, the only treatments that reduced BFR incidence compared to the non-treated

control were the two conventional treatments with Switch 62.5WG and Thiram SC, and both rates of Milstop. These same treatments in addition to Botector also reduced BFR incidence during the overall season. None of the treatments increased marketable yields compared to the non-treated control. The higher rate of Milstop (3.75 lb/A) and Regalia (52 fl oz) had significantly lower yield than the chemical standards Switch/Captan and Thiram/Captan (Table 1).

Fig. 1. Resistance frequency of Botrytis isolates collected during 2017-2018 strawberry season in Florida.

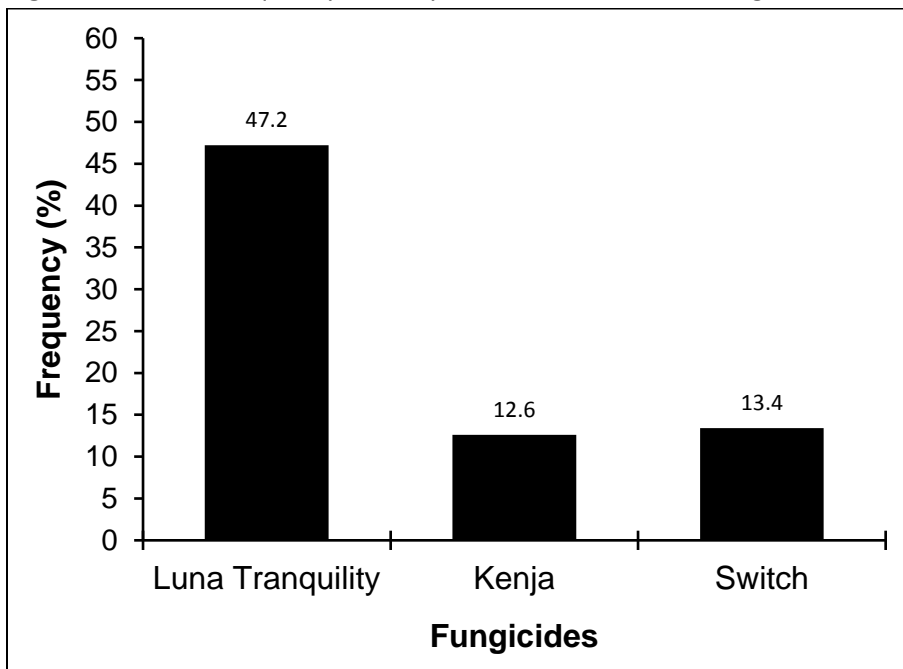


Table 1. Effectiveness of fungicide treatments on the management of Botrytis fruit rot of strawberry for three periods of evaluation during the 2017-18 season.

Treatment (products and rates/A)	Application timing ^w	Yield (lb/A) ^x	BFR incidence (%) ^y		
			Production Peak	Disease Peak	Whole season
Switch 62.5 WG 14 oz	2, 4, 9, and 10	26130.4 ab	4.3 d	5.4 f	2.5 e
Captan Gold 80WDG 1.9 lb	All other weeks				
Thiram SC (2.6 qt) alerts, Captan Gold 80WDG 1.9 lb	2, 4, 9, and 10 All other weeks	26928.3 a	5.2 cd	7.7 ef	3.5 de
Milstop 3.75 lb	weekly	21472.0 abc	9.8 bc	12.2 de	6.3 cd
Milstop 2.0 lb	weekly	22712.2 bc	9.2 bc	13.5 cde	6.6 bc
Botector 7 oz	weekly	23718.4 abc	11.6 ab	14.2 cde	6.9 bc
Actinovate AG 6 oz	weekly	24969.5 bc	14.5 ab	16.9 bcd	8.1 abc
Zivion 26.6 fl oz	weekly	23956.0 abc	14.3 ab	19.2 abcd	8.2 abc
BotryStop 3 lb	weekly	24480.3 abc	13.1 ab	18.4 bcd	8.4 abc
Serenade Opti 1 lb	weekly	22631.9 bc	13.5 ab	21.6 abc	9.2 abc
Actinovate AG 12 oz	weekly	24497.8 abc	17.1 a	20.5 abc	9.6 abc
Zivion 66.5 fl oz	weekly	23882.9 abc	16.7 a	21.3 abc	9.7 abc
Regalia 12 52 fl oz	weekly	21510.6 c	15.8 a	23.7 ab	10.4 ab
Non-treated control	-	23818.8 abc	17.3 a	27.8 a	11.8 a

^w Week of application of products from 1 Dec 2017 to 20 Feb 2018 (12 weeks).

^x Yield from 23 harvests made during the 5 Dec 2017 to 27 Feb 2018 (whole season) period.

^y Average BFR incidence during three periods: production peak (23 Jan 2018 to 27 Feb 2018), BFR incidence peaks (incidence >10% on the non-treated control), and the entire season.

^z Columns with the same letter are not significantly different based on least significant difference (LSD) test ($\alpha = 0.05$).

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