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Evaluation of efficacy of various organic fungicides on Gala apple for common storage decay pathogens in Northcentral Washington

Objective: Evaluate the efficacy of different organic materials applied preharvest and at harvest to control postharvest decays of Gala apple in regular atmosphere cold storage.

Methods

Location

Trials were conducted on Gala apple at Washington State University's (WSU) "Sunrise Orchard" in Douglas County, WA and stored at the Tree Fruit Research and Extension Center (TFREC) in Wenatchee, WA.

Treatments

Seven organic treatments were compared against an untreated control and a standard conventional fungicide (Merivon). All treatments were applied five days preharvest (DPH, 08/27/2020) by powered backpack sprayer (Stihl SR430) at the label rates indicated (Table 1). Four replicate trees were used for each treatment.

Table 1. Preharvest (5 DPH) treatments evaluated in this study

Treatment Name	Formulation	Rate/100gal
Untreated Control	Water	Water
Standard Conventional (Merivon)	Liquid	5.5 fl oz
Serenade OPTI	Solid	20 oz
Botector	Solid	10 oz
AVIV 32	Solid	30 oz
Cinnerate 32	Liquid	32 fl oz
Cinnerate 45	Liquid	45 fl oz
Problad Verde	Liquid	45.7 fl oz
Cinnerate 32 + AVIV (tank mix)	Liquid + Solid	32 fl oz + 25 oz

Evaluation

Five days after treatment (09/01/2020), 30 fruits were harvested per replicate/tree, for a total of 120 fruits per treatment. Harvested fruits were placed in perforated plastic liner bags (1 replicate/bag), stored in cardboard bushel boxes (2 replicates/box) and immediately transported to the WSU-TFREC cold storage facility. Fruits were stored at 2°C for 60 days before the first

evaluation, and then evaluated monthly until complete decay incidence (100%) was observed in the untreated control fruits. At each evaluation interval, each fruit was individually inspected for signs of decay caused by an active fungal infection. Other storage conditions (e.g., bitter pit, insect damage, splitting, bruising, etc.) were not considered. Decay incidence was recorded as presence/absence of infection regardless of severity, and primary pathogen causing the infection was visually diagnosed and recorded.

Results

1- Overall decay incidence

Cinnerate applied preharvest as a solo product at 32 or 45 fl oz was the most effective material after 6 and 7 months of storage, although Cinnerate at 45 fl oz/ac was more effective, even compared to Merivon, after 7 months (Table 2). Other products such as Botector and Aviv were effective until 4 to 5 months of storage, then efficacy decreased significantly. The tank-mixture of Cinnerate and AVIV was the least effective treatment at all inspection times.

Table 2. Overall decay incidence on Gala apples from 2 to 7 months of storage

	Overall decay incidence (%) after x month of storage					
Treatment	**2 m**	**3 m**	**4 m**	**5 m**	**6 m**	**7 m**
Control	2	8	13	38	53	100
Standard Conventional (Merivon)	0	0	3	6	23	63
Serenade OPTI	0	14	24	71	100	100
Botector	0	4	8	34	87	100
AVIV 32	0	3	6	18	53	73
Cinnerate 32	0	0	2	3	23	80
Cinnerate 45	0	1	3	10	28	53
ProBlad Verde	0	3	11	33	47	88
Cinnerate 32 + AVIV	0	8	25	77	100	100

2- Incidence of major pathogens by treatment

Blue and gray mold were the two most recorded decay in addition to some other secondary decays such as Bull's eye rot, Speck rot, and Mucor rot. Cinnerate at 45 fl oz and Merivon reduced blue mold the most whereas gray mold was found at lower frequencies in Problad Verde, Cinerate 32 and Botector (Figure 1).

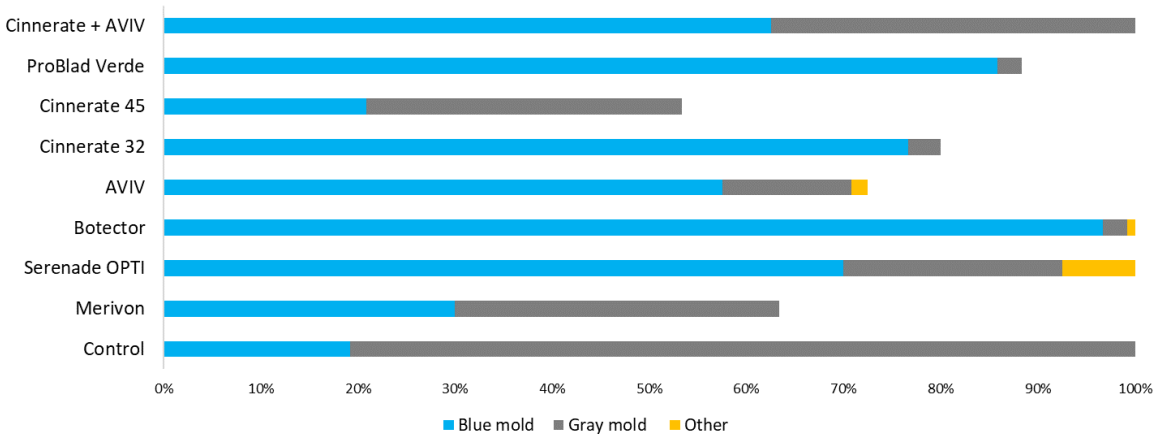

Figure 2. Decay incidence (% of total fruits with decay) and primary pathogen by preharvest treatment on Gala apples after 7 months postharvest storage at 2° C, combined replicates. "Other" pathogen category includes *Mucor piriformis*, *Neofabraea* spp., and *Phacidiopycnis washingtonensis* (Speck rot).

Discussion & Conclusions

Trials were conducted on Gala, an early harvest apple cultivar known to be susceptible to postharvest decay in cold storage. Inspections were implemented following two months in storage at 2°C, but no significant decay was observed in any treatment until the third month. The first treatment to display significant decay incidence (>10%) after three months was Serenade OPTI, followed after four months by ProBlad Verde, Cinnerate 32 + AVIV tank mix, Cinnerate 32 + Botector tank mix, and the untreated control. By the sixth month of storage, the fruits treated with Serenade OPTI and Cinnerate 32 + AVIV tank mix displayed 100% decay incidence and were discarded, while all other treatments showed 23% or greater incidence of decay. The trial was concluded following seven months of storage, when the untreated control and four of the organic treatments displayed over 100% decay incidence (Fig 1, Table 2).

The primary pathogens causing decay in this trial were *Penicillium expansum* and *Botrytis cinerea* (Table 2). *P. expansum* is often associated with inoculum encountered on equipment during transport or storage, and once an infection is present it can spread rapidly by airborne spores or fruit juices, causing significant decay within boxes or bins. Preharvest treatments may be effective in slowing early infection at the orchard, but inadequate sterilization of postharvest transport equipment or storage facilities can easily negate any benefit of preharvest treatments.

B. cinerea can originate within the fruit from as early as the pre-blossom stage, but not lead to visible symptoms until core rot advances to stem bowl, calyx or lenticel lesions after some time in

storage. Therefore, treatment regimens targeting this pathogen may need to be started earlier than what was investigated in this trial. Treatment at five days postharvest may help slow the advancement of decay by *B. cinerea* infections, but once decay is visible in a box or bin it can easily and rapidly spread to adjacent fruits through “nesting”.