

APPLE (*Malus domestica* 'Stayman Winesap', 'Idared')
Scab; *Venturia inaequalis*
Powdery mildew; *Podosphaera leucotricha*
Cedar-apple rust; *Gymnosporangium juniperi-virginianae*
Brooks fruit spot; *Mycosphaerella pomi*
Sooty blotch; disease complex
Flyspeck; *Zygothiala jamaicensis*
Bitter rot; *Colletotrichum* spp.
White rot; *Botryosphaeria dothidea*
Alternaria rot; *Alternaria* spp.

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Evaluation of fungicide mixtures for full season disease control on Stayman and Idared apples, 2017.

Seven combination treatments were tested on 31-yr-old trees in an area where scab and mildew fungus resistance to SI fungicides has been present since 2004. The test was conducted in a randomized block design with four replicates of two-tree sets separated by non-treated border rows. Treatment rows had been used as non-treated border rows in 2016 to stabilize mildew inoculum pressure for 2017. Tree-row-volume was determined to require a 400 gal/A dilute base for adequate coverage. Fungicide treatments were applied to both sides of the tree on each application date with a Swanson Model DA-400 airblast sprayer at 100 gal/A as follows: 5 Apr (OC-P, open cluster-pink); 12 Apr (BL, bloom); 26 Apr (PF, petal fall); 1C-8C (1st-8th covers): 9 May, 23 May, 8 Jun, 22 Jun, 11 Jul, 26 Jul, 4 Aug, 16 Aug. Maintenance materials applied to the entire test block with the same equipment included: Altacor, Assail, Banter, Damoil, Delegate, Imidan, Lannate LV, Sivanto, and Voliam Flexi. Inoculum, placed over each Idared test tree 20 Apr, included cedar rust galls, wild blackberry canes with the sooty blotch and flyspeck fungi, and bitter rot mummies 9 Jun. Other diseases developed from inoculum naturally present in the test area. Foliar data represent averages of counts of ten terminal shoots per tree 29 Jun (Stayman) or 5 Jul (Idared). Post-harvest fruit counts are means of 25-fruit samples picked from each of four paired-tree reps. Idared was sampled 25 Aug, placed in cold storage, moved to ambient storage and first rated 30 Aug, then rated again for rots 15 Sep, after 16 days at 54-81°F (mean 67.4°F). Stayman was sampled 25 Sep, first rated 26 Sep, then rated again for rots 16 Oct, after 21 days at 55-83°F (mean 71.0°F). Percentage data were converted by the square root arcsin transformation for statistical analysis.

Early season scab pressure was light on foliage and moderate on fruit (Table 1). Under these conditions, all treatments gave significant control on fruit, although sulfur (Microthiol Disperss, Trt #7) was significantly less effective than other treatments. Mildew pressure was moderate, with 39 infection days through 21 Jun, and under these conditions all treatments benefitted from inclusion of Microthiol Disperss in the schedule. Combining Captan with Microthiol Disperss (Trt. #6) resulted in significantly greater area infected with mildew than with Microthiol Disperss alone (Trt. #7). Cedar rust pressure was heavy, with ten infection periods and heavy inoculum conditions through May, and there was little suppression under these conditions (Table 2). The 250-hr wetting threshold for sooty blotch and flyspeck (SBFS) activity was reached by 7 Jun, and under heavy disease pressure, all treatments gave significant control (Table 3). Although treatments #5-7 ended with four applications of Captan + Ziram, there were significant differences in control related to the schedule through 3rd cover. Captan or Ziram, combined with Microthiol Disperss (Trts # 5 or #6) were significantly more effective than Microthiol Disperss alone (Trt #7). All treatments gave control of Brooks spot, but Microthiol Disperss was the weakest treatment. Bitter rot pressure was heavy on Idared samples at harvest, and there were significant differences in control related to the schedule through 3rd cover (Table 4). Experimental KFD-269-01 + Captan followed by Captan + Ziram gave excellent control of all rots. Microthiol Disperss followed by Captan + Ziram (Trt #7) was among the weakest of all treatments for rot control. Treatments #2, 4, and 5 significantly increased russet ratings compared to non-treated Idared fruit (Table 5).

Table 1. Scab and mildew control.

Treatment and rate/A	Timing	Scab infection (%)				Mildew infection (%)					
		Stayman		Idared		Stayman			Idared		
		leaves inf.	fruit inf.	leaves inf.	fruit inf.	leaves inf.	leaf area	fruit inf.	leaves inf.	leaf area	fruit inf.
0 No fungicide	--	9 a*	19b	1 a	20c	54 b	24.9 c	2 a	57 c	32.8 c	46b
1 Manzate 75DF 3 lb + Captan 80WDG 2.5 lb + Microthiol Disperss 80% 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	3 a	0a	1 a	1 ab	38 a	6.4 ab	0 a	52 bc	12.9 b	18 a
2 KFD-269-01 75DF 3 lb + Captan 80WDG 2.5 lb + Microthiol Disperss 80% 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	5 a	1 a	1 a	1 ab	36 a	6.1 ab	0 a	55 bc	12.4 b	10 a
3 KFD-314-01 76DF 6 lb + Microthiol Disperss 8 lb	OC-8C	5 a	3 a	1 a	0 a	38 a	6.3 ab	0 a	44 a	5.8 a	8 a
4 Ziram 76DF 6 lb + Microthiol Disperss 80% 8 lb	OC-8C	3 a	0 a	2 a	2 ab	40 a	5.4 a	2 a	42 a	5.7 a	14 a
5 Manzate 75DF 3 lb + Microthiol Disperss 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	4 a	0 a	2 a	0 a	35 a	6.8 ab	0 a	44 a	6.7 a	12 a
6 Captan 80WDG 2.5 lb + Microthiol Disperss 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	6 a	4 a	1 a	1 ab	42 a	10.0 b	2 a	50 ab	11.1 b	7 a
7 Microthiol Disperss 80% 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	8 a	3 a	1 a	7 b	35 a	4.5 a	0 a	42 a	6.6 a	20 a

*Mean separation by Waller-Duncan K-ratio t-test (p=0.05).

Table 2. Cedar-apple control and “leaf spot” incidence.

Treatment and rate/A	Timing	Cedar-apple rust				“Leaf spots”**			
		Stayman		Idared		Stayman		Idared	
		% leaves inf.	lesions/leaf	% leaves inf.	lesions/leaf	% leaves affected	lesions/leaf	% leaves affected	lesions/leaf
0 No fungicide	--	26 a*	2.2 ab	18 a	0.8 a	22 a	0.6 a	14 ab	0.2 ab
1 Manzate 75DF 3 lb + Captan 80WDG 2.5 lb + Microthiol Disperss 80% 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	27 a	1.7 ab	27 a	1.1 a	20 a	0.5 a	6 ab	0.1 a
2 KFD-269-01 75DF 3 lb + Captan 80WDG 2.5 lb + Microthiol Disperss 80% 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	25 a	1.6 ab	27 a	1.5 a	15 a	0.4 a	6 a	0.1 a
3 KFD-314-01 76DF 6 lb + Microthiol Disperss 8 lb	OC-8C	28 a	2.3 b	21 a	1.0 a	22 a	0.5 a	7 ab	0.1 a
4 Ziram 76DF 6 lb + Microthiol Disperss 80% 8 lb	OC-8C	25 a	1.1 a	25 a	1.0 a	14 a	0.3 a	10 ab	0.2 ab
5 Manzate 75DF 3 lb + Microthiol Disperss 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	24 a	1.7 ab	31 a	1.7 a	17 a	0.6 a	16 b	0.4 b
6 Captan 80WDG 2.5 lb + Microthiol Disperss 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	29 a	2.7 b	26 a	1.5 a	23 a	0.6 a	5 a	0.1 a
7 Microthiol Disperss 80% 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	21 a	1.5 ab	24 a	1.2 a	25 a	0.7 a	8 ab	0.2 ab

*Mean separation by Waller-Duncan K-ratio t-test (p=0.05).

** “Leaf spots” refers to an unidentified symptom; could be inhibited cedar-apple rust, frog-eye leaf spot or an injury response.

Table 3. Control of sooty blotch and flyspeck and Brooks spot.

Treatment and rate/A	Timing	% fruit or fruit area infected, harvest counts								Brooks spot, Idared fruit
		Sooty blotch				Flyspeck				
		Stayman		Idared		Stayman		Idared		
		fruit	area	fruit	area	fruit	area	fruit	area	
0 No fungicide	--	89c*	8.3c	85d	7.9d	46d	3.0d	42b	3.4b	7c
1 Manzate 75DF 3 lb + Captan 2.5 lb + Microthiol Disperss 80% 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	12a	0.9ab	14ab	1.0ab	8a-c	0.4a-c	3a	0.2a	0a
2 KFD-269-01 75DF 3 lb + Captan 2.5 lb + Microthiol Disperss 80% 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	6a	0.3a	4a	0.2ab	5ab	0.3ab	2a	0.1a	0a
3 KFD-314-01 76DF 6 lb + Microthiol Disperss 8 lb	OC-8C	17a	1.0a	3a	0.2a	6ab	0.3a-c	2a	0.2a	0a
4 Ziram 6 lb + Microthiol Disperss 80% 8 lb	OC-8C	4a	0.2a	5a	0.3ab	1a	0.1a	0a	0a	0a
5 Manzate 3 lb + Microthiol Disperss 8 lb Captan 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	16a	0.8a	15bc	0.9bc	8a-c	0.4a-c	2a	0.1a	0a
6 Captan 2.5 lb + Microthiol Disperss 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	10a	0.5a	11ab	0.6ab	14bc	0.8bc	4a	0.3a	0a
7 Microthiol Disperss 80% 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	39b	2.2b	35c	2.9c	21c	1.1c	5a	0.3a	2b

*Mean separation by Waller-Duncan K-ratio t-test (p=0.05).

Table 4. Control of post-harvest fruit rots.

Treatment and rate/A	Timing	% bitter rot at harvest		% fruit infected, post-storage counts							
				Any rot		Bitter rot		White rot		Blue mold, Alternaria, Stayman Idared	
		Stayman	Idared	Stayman	Idared	Stayman	Idared	Stayman	Idared	Stayman	Idared
0 No fungicide	--	2a*	89e	37d	92e	29c	92e	10c	0a	3a	0a
1 Manzate 75DF 3 lb + Captan 2.5 lb + Microthiol Disperss 80% 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	0a	11a-c	5ab	15ab	0a	15ab	3ab	0a	2a	0a
2 KFD-269-01 75DF 3 lb + Captan 2.5 lb + Microthiol Disperss 80% 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	0a	1a	1a	5a	0a	5a	1a	0a	0a	0a
3 KFD-314-01 76DF 6 lb + Microthiol Disperss 8 lb	OC-8C	0a	29cd	8bc	37b-d	7b	36b-d	1a	1a	1a	0a
4 Ziram 6 lb + Microthiol Disperss 80% 8 lb	OC-8C	0a	19bc	12c	25a-c	6b	24a-c	5bc	1a	1a	0a
5 Manzate 3 lb + Microthiol Disperss 8 lb Captan 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	0a	4ab	7bc	19a-c	5b	14ab	2ab	1a	0a	4b
6 Captan 2.5 lb + Microthiol Disperss 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	1a	34cd	12bc	48cd	5ab	45cd	5bc	1a	2a	0a
7 Microthiol Disperss 80% 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	0a	55d	4a-c	60d	4b	59d	0a	3a	0a	0a

*Mean separation by Waller-Duncan K-ratio t-test (p=0.05).

Table 5. Fruit finish effects.

Treatment and rate/A	Timing	Fruit finish ratings (0-5)**			
		Russet		Opalescence	
		Stayman	Idared	Stayman	Idared
0 No fungicide	--	1.2 a*	0.8 a	0.9 a	0.7 a
1 Manzate 75DF 3 lb + Captan 2.5 lb + Microthiol Disperss 80% 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	1.2 a	1.0 a-c	1.3 a	0.6 a
2 KFD-269-01 75DF 3 lb + Captan 2.5 lb + Microthiol Disperss 80% 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	1.4 a	1.3 d	1.2 a	0.8 a
3 KFD-314-01 76DF 6 lb + Microthiol Disperss 8 lb	OC-8C	1.1 a	1.0 a-d	1.0 a	0.8 a
4 Ziram 6 lb + Microthiol Disperss 80% 8 lb	OC-8C	0.9 a	1.1 b-d	0.9 a	0.8 a
5 Manzate 3 lb + Microthiol Disperss 8 lb Captan 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	1.2 a	1.2 cd	1.0 a	1.0 a
6 Captan 2.5 lb + Microthiol Disperss 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	1.4 a	0.8 ab	1.2 a	0.6 a
7 Microthiol Disperss 80% 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-3C 4C-8C	0.9 a	0.9 a-c	1.1 a	0.7 a

*Mean separation by Waller-Duncan K-ratio t-test (p=0.05).

** Fruit finish rated on a scale of 0-5 (0=perfect finish; 5=severe opalescence or russet, presumed not to be mildew).