Efficacy of Standard and New Fungicides Against the Sooty Blotch/ Flyspeck Complex and Apple Scab

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The purpose of this project was to look at the effect of different fungicide programs on apple scab and sooty blotch/flyspeck. The difference in fungicides for scab management was fungicide selection, with a captan/mancozeb program compared to early applications of captan/mancozeb followed by applications of Luna Sensation. The sooty blotch/flyspeck program compared a standard calendar fungicide application schedule to one scheduled using a forecast model, and within the forecast model treatments, three different fungicide regimens (Topsin-M, Pristine and Flint).

Methods

A block of 60 mature *Malus* x *domestica* cv. 'McIntosh' apple trees on M.7 rootstock located at the University of Massachusetts Cold Spring Orchard Research and Education Center, Belchertown, MA, were used in the study. This block has a history of heavy disease incidence. Applications were sprayed using a 50-gallon tractor-mounted airblast sprayer calibrated to apply 175 gallons per acre. Treatments were applied to five, single-tree replications for each of five treatments, including a non-sprayed control. Treatment trees were each separated by at least one buffer tree.

The primary goal of the experiment was to compare different fungicides and scheduling options for management of the summer blemish disease complex sooty blotch and flyspeck, with a secondary goal of comparing standard fungicides with Luna Sensation (fluopyram plus trifloxystrobin). During early primary apple scab season, two applications at half-inch green and tight cluster were identical in treatments 1 – 9, a captan plus mancozeb mix (Captan 80 WDG 2 lbs/A plus Penncozeb 80WP 3 lbs/A). For the remainder of primary scab season, two applications of the same mix was applied on treatments 1 – 8, while Luna Sensation (5 oz/A) was applied at the same times to treatment 9. Treatment 10 was an untreated control.

For summer applications, the first application of summer fungicide in treatments 1 – 6 and 9 were determined by a sooty blotch/flyspeck forecast model based on accumulated leaf wetness, with a threshold of 270 accumulated leaf wetness hours starting from the petal fall spray, the NY/New England model. These treatments were divided into two groups. Treatments 1 – 3 used remote weather data from a nearby airport (Westover, Chicopee, MA) and a fuzzy logic model to determine accumulated leaf wetness hours. Treatments 4 – 6 on-site data from a Hobo weather station to measure leaf wetness. Fungicides were also varied in these two groups, where treatments 1 and 4 received Topsin M 70WP 9 oz/A plus Captan 80WDG 2 lbs/A; treatments 2 and 5 received Pristine 38 WP 18.5 oz/A; and treatments 3 and 6 received Flint 50WG 2 oz/A. Treatment 7 was sprayed during primary scab season but was not sprayed with summer fungicides, treatment 8 was sprayed in summer when the orchard manager applied standard covers on production blocks, treatment 9 used the same timing as treatment 8 but used Luna Sensation, and treatment 10 was not sprayed.

Applications were made as indicated in Table 1. For primary scab, all treatments were the same, except treatment 9 received two applications of Luna Sensation instead of the Penncozeb/Captan combination for the pink and petal fall sprays. For summer diseases treatments, the treatments timed using the on-site 170 wet hour threshold received one more summer fungicide application than the treatments that were applied at a 353 wet hr. threshold, three and four applications, respectively. The grower standard treatment, 8, received five summer fungicide applications.

Table 1. Application materials and schedule.

Growth stage or summer spray determination method & date	Trts. applied: number	Fungicide and rate per 100 gal.*
1/2" Green 4/8/10	1-9	Pennconzeb 80WP 3lbs/A + Captan 80WDG 2lbs/A
Tight cluster 4/15/10	1-9	Pennconzeb 80WP 3lbs/A + Captan 80WDG 2lbs/A
Pink, 1st bloom	1-8	Pennconzeb 80WP 3lbs/A + Captan 80WDG 2lbs/A
4/22/10	9	Luna Sensation 5 oz./A
95% P.F.	1-8	Pennconzeb 80WP 3lbs/A + Captan 80WDG 2lbs/A
5/3/10	9	Luna Sensation 5 oz/A
Grower standard 5/9/10	8	Pennconzeb 80WP 3lbs/A + Captan 80WDG 2lbs/A
	9	Luna Sensation 5 oz/A
Remote weather,	1	Topsin M 70WP 9 oz/A + Captan 80WDG 2lbs/A
SBFS model	2	Pristine 38WP 18.5 oz/A
6/2/10	3	Flint 50WG 2 oz/A
On-site weather	1	Topsin M 70WP 9 oz/A + Captan 80WDG 2lb./A
plus	2	Pristine 38WP 18.5 oz/A
Remote weather	3	Topsin M 70WP 9 oz/A + Captan 80WDG 2lb./A
SBFS model	4	Topsin M 70WP 9 oz/A + Captan 80WDG 2lb./A
Plus	5	Pristine 38WP 18.5 oz/A
Grower standard	6	Flint 50WG 2 oz/A
6/22/10	8	Topsin M 70WP 9 oz/A + Captan 80WDG 2lb./A
	9	Luna Sensation 5 oz/A
Grower standard 7/8/10	8	Captan 80WDG 3 lbs/A
On-site weather	1	Topsin M 70WP 9 oz/A + Captan 80WDG 2lb./A
plus	2	Pristine 38WP 18.5 oz/A
Remote weather	3	Topsin M 70WP 9 oz/A + Captan 80WDG 2lb./A
SBFS model	4	Topsin M 70WP 9 oz/A + Captan 80WDG 2lb./A
plus	5	Pristine 38WP 18.5 oz/A
Grower standard	6	Flint 50WG 2 oz/A
7/21/10	8	Topsin M 70WP 9 oz/A + Captan 80WDG 2lb./A
	9	Topsin M 70WP 9 oz/A + Captan 80WDG 2lb./A
Final cover 8/11/10	1-6,8,9	Captan 80WDG 2lb./A

* Calculated from per acre rates based on 300 gal/A. Tree row volume was 175 gal/A.

Table 2. Apple scab incidence after primary scab season.

Trt. no.	Treatment Primary scab → summer*	Scab incidence % 20 May** Terminal	Cluster	Fruit
1.	Mancozeb/captan → Topsin/captan	70 ab	31 b	2 bc
2.	Mancozeb/captan → Pristine	54 b	25 b	1 bc
3.	Mancozeb/captan → Flint.....	56 b	27 b	5 b
4.	Mancozeb/captan → Topsin/captan	68 b	27 b	2 bc
5.	Mancozeb/captan → Pristine	56 b	13 b	5 b
6.	Mancozeb/captan → Flint.....	63 b	29 b	8 b
7.	Mancozeb/captan → none	61 b	25 b	3 bc
8.	Mancozeb/captan → standard	51 b	25 b	3 bc
9.	Luna Sensation	30 c	15 b	0 c
10.	Unsprayed check	89 a	75 a	31.3 a

*Refer to Table 1 for treatment details.
**Numbers followed by different letters indicate a significant difference by Tukey-Kramer HSD (*P* = 0.05).

Table 3. Apple scab incidence at harvest.

Trt. no.	Treatment Primary scab → summer*	First summer fungicide timing	Scab incidence % harvest** Terminal
1.	Mancozeb/captan → Topsin/captan	SBFS model, on-site	43 b,c
2.	Mancozeb/captan → Pristine	SBFS model, on-site	21 d
3.	Mancozeb/captan → Flint.....	SBFS model, on-site	20 d
4.	Mancozeb/captan → Topsin/captan	SBFS model, remote	44 bc
5.	Mancozeb/captan → Pristine	SBFS model, remote	49 bc
6.	Mancozeb/captan → Flint.....	SBFS model, remote	52 bc
7.	Mancozeb/captan → none	none applied	56 b
8.	Mancozeb/captan → standard	commercial standard	29 d
9.	Luna Sensation	SBFS model, on-site	24 d
10.	Unsprayed check	none applied	74 a

*Refer to Table 1 for treatment details.
**Numbers followed by different letters indicate a significant difference by Tukey-Kramer HSD (*P* = 0.05).

On May 20, each treatment tree was evaluated by arbitrarily selecting ten terminals, clusters or fruit (depending on the tissue being evaluated) in four quadrants of the tree, corresponding approximately to north, south, east and west. Each tissue type was evaluated for disease incidence on a presence/absence basis. Percent disease in each quadrant was calculated, and treatments were compared using analysis of variance and the Tukey-

Kramer HSD mean comparison test (P = 0.05; JMP 7.0.2, SAS Institute, Inc.). The harvest fruit rating was done similarly on September 2.

Results

Results for primary scab are shown in Table 2. The highest incidence rates for scab were on terminal leaves relative to cluster leaves and fruit. On terminal leaves, the treatment that included two Luna Sensation applications performed significantly better than the treatments that used Penncozeb/Captan combinations exclusively. On cluster leaves, all fungicides treatments had significantly less scab than the unsprayed control, but there were no significant differences between fungicides. On fruit scab at the end of primary scab there were not always significant separations between the Penncozeb/Captan combinations and Luna Sensation, though there were some. This may be related to the overall low rates of primary fruit scab. It is worth noting that scab pressure was low in 2010. Table 5 shows that the most significant infection period in terms of rain came at bud break, and very little inoculum was mature. Later infection periods were light.

Harvest scab results are shown in Table 3. All fungicides performed better than the unsprayed control. Differences between fungicides appear to be related to the number of applications and the type of material used in the summer fungicide program. Treatments that included Luna Sensation, used four applications of either Pristine or Flint, or the five application commercial standard all had significantly less scab than the other treatments which used Topsin/Captan or applied only three applications.

Table 4 shows the incidence of sooty blotch and flyspeck at harvest. The pressure from SBFS was quite low in 2010, as determined by incidence on the unsprayed check. Normally, incidence between 50 and 100% would be seen. This was probably related to dry weather during the summer, and the relatively early harvest on the cultivar used in the test, McIntosh.

All treatments had significantly less flyspeck than the untreated control, with the exception of the standard mancozeb/captan treatment for primary scab followed by no summer fungicides. Both treatments that received no summer fungicide had high levels of flyspeck. There was no significant difference in terms of flyspeck between the no-summer fungicide check and the treatments that received only three fungicide applications as directed by the on-site leaf-wetness model. However, the remote model directed sprays did have significantly less flyspeck (0%) than either check or the on-site directed sprays. There was no difference between the types of summer fungicide within each

Table 4. Sooty blotch and flyspeck incidence at harvest.

Trt. no.	Treatment Primary scab → summer*	First summer fungicide timing	Sooty blotch & flyspeck incidence % harvest Flyspeck		Sooty blotch	
1.	Mancozeb/captan → Topsin/captan	SBFS model, remote	0	c	0	b
2.	Mancozeb/captan → Pristine	SBFS model, remote	0	c	0	b
3.	Mancozeb/captan → Flint	SBFS model, remote	0	c	0	b
4.	Mancozeb/captan → Topsin/captan	SBFS model, on-site	8.8	b	0	b
5.	Mancozeb/captan → Pristine	SBFS model, on-site	1.3	bc	0	b
6.	Mancozeb/captan → Flint	SBFS model, on-site	3.8	bc	0	b
7.	Mancozeb/captan → none	none applied	13.0	ab	0.7	ab
8.	Mancozeb/captan → standard	commercial standard	0	c	0	b
9.	Luna Sensation	SBFS model, standard	0	c	0	b
10.	Unsprayed check	none applied	17.6	a	2.3	a

*Refer to Table 1 for treatment details.

**Numbers followed by different letters indicate a significant difference by Tukey-Kramer HSD (P = 0.05).

Table 5. Weather data at the UMass Cold Spring Orchard, Belchertown for primary apple scab season, 2009.

Date	High	Low	Wet hours	Scab ascospore maturity	Growth stage	Mills	Cornell
03/29	51.7	42.3	24.0	0		Medium	Infected
03/30	48.8	39.3	18.8	0		Heavy	Infected
03/31	48.8	44.5	16.0	1		Heavy	Infected
04/01	66.3	42.3	4.0	2	GT	Heavy	Infected
04/02	73.9	40.0	0.3	2		None	None
04/03	74.6	44.5	0.0	3		None	None
04/04	71.8	43.7	3.0	4		None	None
04/05	71.1	44.5	0.0	6		None	None
04/06	71.8	48.8	1.3	8	HIG	None	None
04/07	87.4	41.5	0.0	11		None	None
04/08	73.9	49.6	0.8	16		None	None
04/09	51.7	38.5	10.0	18		None	None
04/10	56.6	34.6	0.0	20		None	None
04/11	64.9	42.3	0.0	23		None	None
04/12	57.3	38.5	0.0	26		None	None
04/13	59.4	32.2	0.0	29		None	None
04/14	65.6	31.4	0.0	32		None	None
04/15	67.0	42.3	0.3	35	TC	None	None
04/16	48.1	36.2	11.8	37		None	None
04/17	48.1	36.9	16.3	39		None	Infected
04/18	50.3	34.6	1.0	40		None	None
04/19	57.3	36.9	0.0	43	PINK	None	None
04/20	67.7	37.7	0.0	47		None	None
04/21	69.7	38.5	0.0	51		None	None
04/22	69.7	45.2	5.8	56		None	None
04/23	64.9	38.5	1.0	59	BLOOM	None	None
04/24	69.7	37.7	0.0	63		None	None
04/25	57.3	47.4	4.8	67		None	None
04/26	62.8	44.5	6.8	70		None	None
04/27	50.3	33.0	13.8	72		Light	Infected
04/28	43.0	31.4	5.8	73		None	None
04/29	60.8	34.6	0.0	76		None	None
04/30	74.6	39.3	0.0	80		None	None
05/01	85.9	51.7	0.0	85		None	None
05/02	87.4	60.8	0.0	90		None	None
05/03	78.8	59.4	9.5	94	95% PF	Light	Infected
05/04	78.8	48.8	2.8	96		None	None
05/05	79.5	46.7	0.8	98		None	None
05/06	73.9	51.0	2.5	99		None	None
05/07	70.4	42.3	0.0	99		None	None
05/08	66.3	43.7	11.5	99		None	Infected
05/09	50.3	35.4	0.0	99		None	None
05/10	56.6	32.2	0.0	99		None	None
05/11	59.4	32.2	0.0	99		None	None
05/12	46.7	39.3	10.5	99		None	None
05/13	67.7	32.2	6.8	99		None	None
05/14	73.9	46.7	8.8	99		None	None
05/15	69.7	49.6	1.0	99		None	None
05/16	71.8	43.7	0.0	99		None	None
05/17	76.7	41.5	0.5	99		None	None

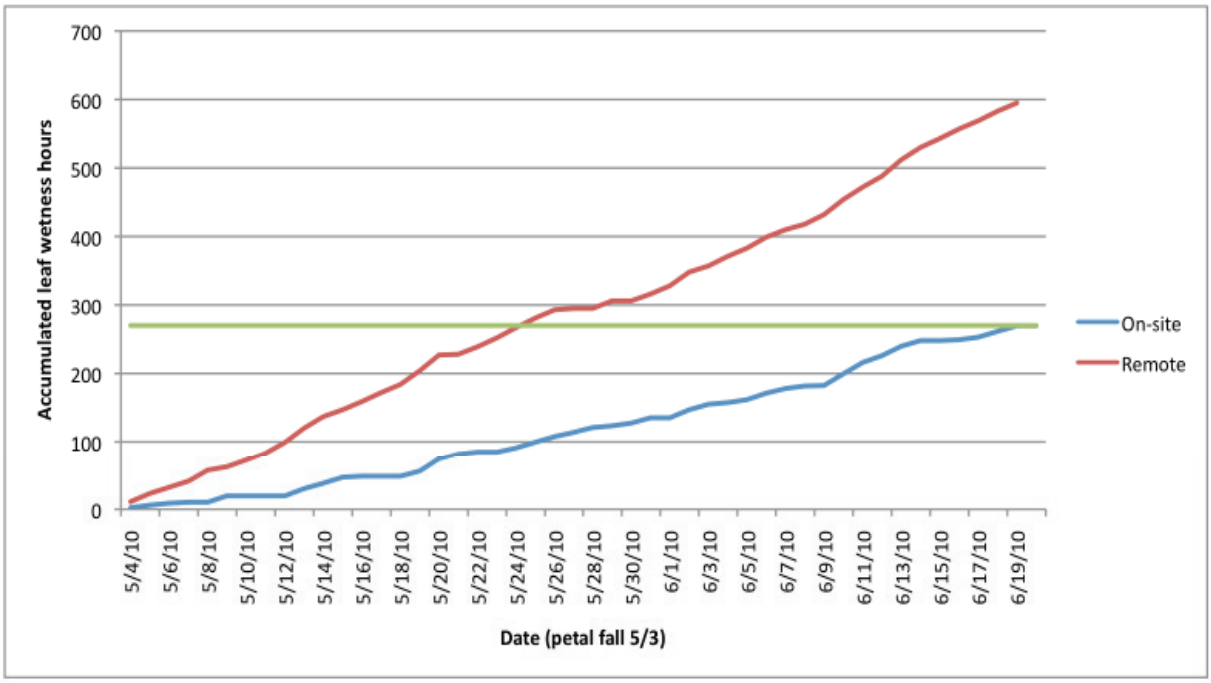

Figure 1. Accumulated leaf wetness hours from petal fall from an on-site weather station with a leaf wetness sensor (Hobo, Onset Computer Corp., Pocassett, MA) and a remote data source (Westover Air Base, Chicopee, MA) using a fuzzy logic model to estimate leaf wetness. The horizontal line indicates 270 ALWH.

treatment regimen. Sooty blotch incidence over all treatments was extremely low, and all fungicide treatments showed no sooty blotch.

The difference between the on-site and off-site directed summer sprays was a single spray, applied to remote treatments on June 2. The first on-site monitoring spray was applied on June 22. Figure 1 shows the accumulated leaf wetness hours for each of the two methods, and shows that the two data sources differed significantly. The off-site fuzzy logic model reached a 270 threshold on May 25, while the on-site data did not reach 270 ALWH until June 19, over three weeks later. Note that the off-site fuzzy logic directed application was not made until a week after the threshold, as there was a change in the model made during May, and there were difficulties getting remote data until 1 Jun.

The results indicate that the fuzzy logic directed sprays were conservative in terms of disease management, while the on-site data was not conservative enough. One should not expect the 270 ALWH threshold, developed using on-site string-based equipment, to work with either the on-site electronic sensor or the remote fuzzy logic model. While the data correlate, the absolute values for the thresholds in each case would be expected to be different. Others have found that electronic sensors work well with a threshold of 170 ALWH, and in this work that would have generated an application date for the on-site model of June 6. Based on the efficacy of the June 2 applications, these would be expected to have been very effective. It is not clear what an appropriate threshold might be for the fuzzy logic model. A similar model used by SkyBit has a threshold of 350 ALWH. This issue will need to be addressed next year.