Fungicide control of apple scab
2013 field trial

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University of California Cooperative Extension,
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University of California, Davis, October 2013

Published 2013 at: http://plantpathology.ucdavis.edu/Cooperative_Extension/

Summary

Apple scab, caused by the fungal pathogen *Venturia inaequalis*, is a significant fruit and foliar disease worldwide (Jones and Sundin 2006). Apples grown in regions of California characterized by spring precipitation or damp microclimates are subject to infection. Initial pathogen colonization of green tissue occurs when water stimulates ascospore release from pseudothecia located in overwintering leaf litter, followed by dispersal to leaves, flowers or fruit. Asexually-produced conidia from the primary sites of infection on the host can also colonize new tissue if spores are transported in the air or by water splash (Jones and Sundin 2006). In California, periodic applications of synthetic or organic fungicides from approximately March to June are required to control apple scab; the timing of fungicide applications is dependent on season to season patterns in precipitation (Gubler 2006). Based on research in other apple producing regions, additional control measures such as post-harvest fungicide applications at the time of leaf fall to reduce inoculum for the following growing season (Beresford et al. 2008), leaf litter removal (Gomez et al. 2007) or use of cultivar mixtures in an orchard (Didelot et al. 2007) may effectively reduce disease impacts.

We conducted a field experiment near Camino, El Dorado County, California (elevation 3200 ft) to test the effects of several registered and experimental fungicides on control of apple scab in mature Golden Delicious Trees. Four applications were made from early March (green tip) to late April 2013 (petal fall). We compared disease levels obtained on foliage and fruit in untreated trees with disease control exhibited by various products in combination, with and without adjuvants, and in alternation with other products.

Figure 1. Apples at disease evaluation. A) Untreated Control B) Treated with Sovran.

Materials and Methods

A. Trial layout

Experimental unit	1 tree = 1 plot			
Row and tree spacing	16 ft (row) and 10 ft (tree)		Plot unit area	160 ft^2
Area/treatment	640 ft^2 or 0.0147 acre/treatment (4 replicate trees = 1 treatment)			
Fungicide applications	A	green tip	18 March	150 gallons/acre	2.2 gallons/4 replicates
	B	red bud	28 March	150 gallons/acre	2.2 gallons/4 replicates
	C	full bloom	11 April	150 gallons/acre	2.2 gallons/4 replicates
	D	petal fall	29 April	150 gallons/acre	2.2 gallons/4 replicates

B. Trial Map

● = untreated tree

●	●	●	●	●	●
●	●	●	●	●	●
●	●	●	●	●	●
●	●	●	●	●	●
●	●	●	●	●	●
●	●	●	●	●	●
RKC	RKC	●	●	●	●
W	RKD	●	●	●	●
YKD	GKC	●	●	●	●
KD	GD	●	●	●	●
GKC	W	●	●	●	●
RKD	YKD	●	●	●	●
GD	KD	●	●	●	●
RKD	GD	●	●	●	●
GKC	KD	●	●	●	●
RKC	W	●	●	●	●
KD	YKD	●	●	●	●
YKD	RKD	●	●	●	●
GD	RKC	●	●	●	●
W	GD	●	●	●	●

N →

Apple Scab – 2013 Experimental treatments

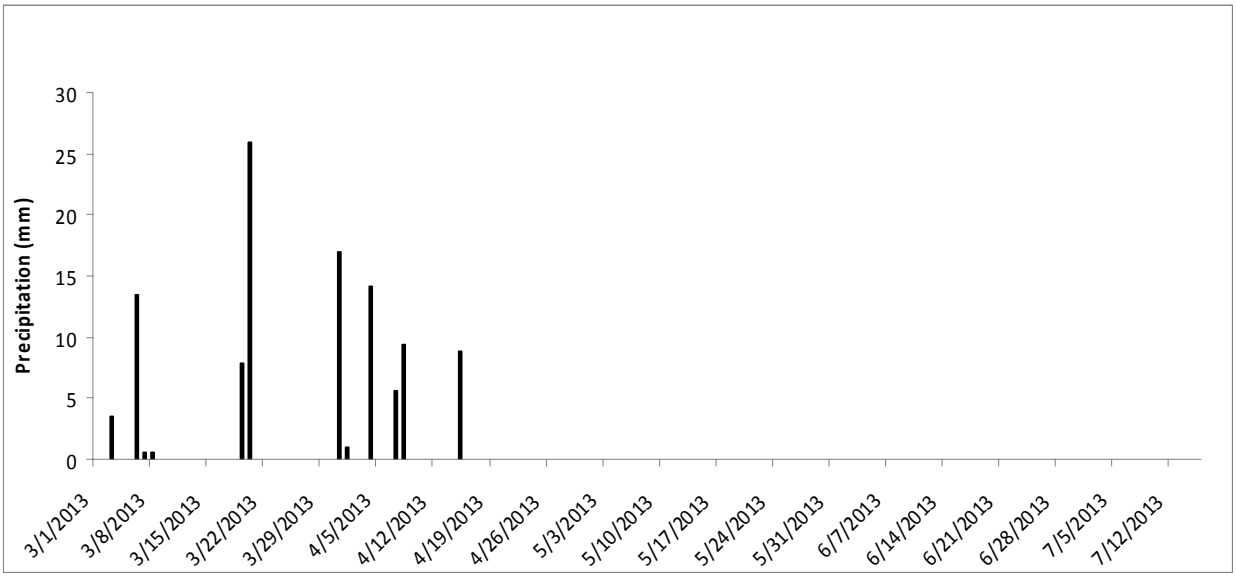
No.	Flag	Product(s)	FP/Acre	FP/Treatment
1	W	Unsprayed control	none	none
2	GD	Pristine + Koverall alt Topguard + Koverall	16.5 oz + 48 oz then 13 fl oz + 48 oz	6.8 g + 20 g alt 5.6 ml + 20 g
3	YKD	Sovran-Chemical Standard	4 oz	1.67 g
4	KD	Phyton 27 AG	40 fl oz/100 gal	26.1 ml
5	RKC	Phyton 27 AG alt Captan 50 WP	40 fl oz/100 gal alt 3 lb	26.1 ml alt 20 g
6	GKC	Manzate Pro-Stick 75 WG + Captan 50 WP then Fontelis + Dyneamic (2x)	3 lb then 3 lb then 20 fl oz + 0.25% (v/v)	20 g alt 20 g then 8.7 ml + 20.8 ml (2x)
7	RKD	Fontelis + Dyneamic (2x) then Manzate Pro-Stick 75 WG + Captan 50 WP	20 fl oz + 0.25%(v/v) then 3 lb + 3 lb	8.7 ml + 20.8 ml (2x) then 20 g + 20 g

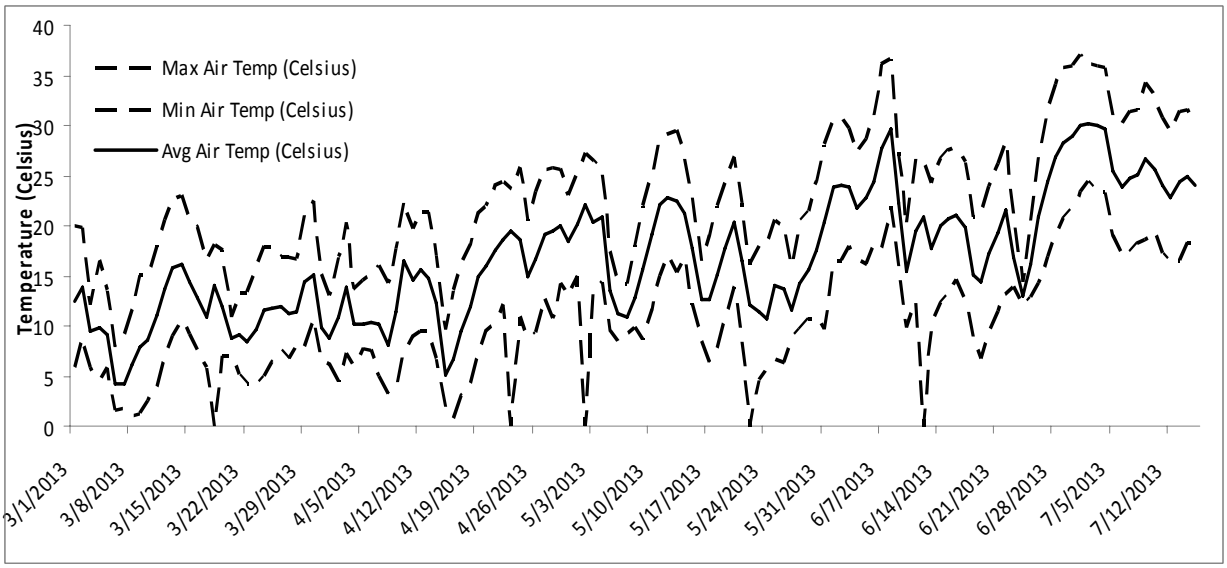
C. Disease and statistical analysis

Disease was assessed on May 8 2013 when fruits were large enough to observe scab lesions. Forty leaves and fruits were randomly selected from each tree. The number of lesions was scored for each leaf and fruit; estimated counts were made when the boundaries of individual lesions could not be easily distinguished. Disease incidence per replicate tree was determined as the proportion of leaves and fruits that were infected by at least one lesion. Disease severity for each plot was obtained as the mean density of lesions on leaves and fruits. Data was analyzed using a one-way ANOVA and means were compared using Fisher's protected LSD test ($\alpha = 0.05$).

D. Weather and Disease

Weather from CIMIS weather station in Camino, California. Weather for the spray season was somewhat dry with 12 rain events (Mar 1 – July 15) of between 1-26 mm of rain.





Results

The Pristine, Phyton 27 AG treatments (in various combinations) appeared to control severity (and incidence) best. The standard treatment Sovran also did well at controlling severity and incidence. This year some trees fail to bear fruit, therefore fruit severity and incidence were analyzed with missing data.

Table 1. Apple scab leaf and fruit incidence (means). Product names are followed by rate (per acre). Treatment means followed by the same letter are not significantly different according to Fisher's protected LSD test at α=0.05.

Treatment	Leaf Incidence (%)	Fruit Incidence (%)
Sovran, 4 oz	12.5 b	5.00 a
Pristine, 16.5 oz + Koverall, 48 oz then Topquard, 13 fl oz + Koverall, 48 oz	13.13 b	3.66 a
Phyton 27 Ag, 40 oz/100 gal	15.00 b	1.67 a
Fontelis, 20 fl oz + Dyneamic, 0.25% (v/v) (2x) then Manzate, 3 lb + Captan, 3 lb	15.63 b	3.67 a
Phyton 27 AG, 40 oz/100 gal alt Captan, 3 lb	16.25 b	0.00 a
Manzate, 3 lb + Captan 50 WP, 3 lb (2x) then Fontelis, 20 fl oz + Dyneamic 0.25% (v/v)	42.50 a	0.00 a
Unsprayed Control	45.00 a	5.83 a

Table 2. Apple scab leaf and fruit severity (means). Product names are followed by rate (per acre). Treatment means followed by the same letter are not significantly different according to Fisher's protected LSD test at α=0.05.

Treatment	Leaf Severity (lesions/leaf)	Fruit Severity (lesions/fruit)
Pristine, 16.5 oz + Koverall, 48 oz then Topquard, 13 fl oz + Koverall, 48 oz	0.3 a	0.05a
Phyton 27 Ag, 40 oz/100 gal	0.4 bc	0.02a
Sovran, 4 oz	0.4 bc	0.13a
Phyton 27 AG, 40 oz/100 gal alt Captan, 3 lb	0.5 bc	0.00a
Fontelis, 20 fl oz + Dyneamic, 0.25% (v/v) (2x) then Manzate, 3 lb + Captan, 3 lb	0.6 bc	0.04a
Unsprayed Control	1.5 bc	0.09a
Manzate, 3 lb + Captan 50 WP, 3 lb (2x) then Fontelis, 20 fl oz + Dyneamic 0.25% (v/v)	2.7 c	0.00a

Acknowledgements

We thank the Millers for use of their Windmiller Farm orchard.

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Appendix: Products tested

Product	Active ingredient(s) and concentration	Class	Manufacturer
Captan 50 WP	captan (50%)	pthalamide	Arysta Life Sciences
Dyneamic	polyalkyleneoxide modified polydimethylsiloxane, nonionic emulsifiers, methyl ester of C16-C18 fatty acids (99%)	adjuvant	Helena Chemical Co.
Fontelis	penthiopyrad (20%)	carboxamide	Dupont
Koverall	mancozeb (75%)	carbamate	Cheminova
Manzate Pro-Stick	mancozeb (75%)	carbamate	United Phosphorus, Inc.
Phyton-27 AG	copper sulfate pentahydrate (21.27%)	other	Phyton Corporation
Pristine	pyraclostrobin (12.8%) boscalid (25.2%)	QoI + carboxamide	BASF
Sovran	kresoxim-methyl (50%)	QoI	Cheminova
Topguard 1.04 SC	flutriafol (12%)	dimethylase inhibitor	Cheminova

Appendix 1 references: (1) Adaskaveg, et al. 2012. Efficacy and timing of fungicides, bactericides and biologicals for deciduous tree fruit, nut, strawberry, and vine crops 2012, available at http://www.ipm.ucdavis.edu/PDF/PMG/fungicideefficacytiming.pdf.
(2) Bay, et al. 2012. Grape powdery mildew trials, available at http://plantpathology.ucdavis.edu/, under cooperative extension , Gubler lab Fungicide trials 2013. 3) various sources including product labels and/or MSDS, product websites, and personal communications.