# Fungicide control of apple scab: 2012 field trial

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# 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 pseuodothecia 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 April (green tip) to late May 2011 (petal fall). We compared disease levels obtained on foliage and fruit in untreated trees with disease control exhibited by synthetic, organic and biological 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.

A

B

# Materials and Methods

## A. Trial layout

| | | | |
|---|---|---|---|
| Experimental unit | 1 tree = 1 plot | | |
| Row and tree spacing | 18 ft (row) and 13 ft (tree) | Plot unit area | 234 $ft^2$ |
| Area/treatment | 936 $ft^2$ or 0.0214 acre/treatment (4 replicate trees = 1 treatment) | | |
| Area/treatment (Companion groun spray) | 9466 $ft^2$ or 0.1934 acre/treatment (4 reps = 1 treatment) center tree receives foliar sprays | Plot unit area (Companion grou spray) | 9 trees = 1 rep, 1 rep = 2106 $ft^2$ or 0.0483 acre/rep |
| Fungicide applications | 1 ground spray 9 Apr 180 gallons/acre 8.7 gallons/1 replicates, 4 reps (Exp A treatment only)<br>A green tip 9 April 150 gallons/acre 3.2 gallons/4 replicates<br>B red bud 1 May 150 gallons/acre 3.2 gallons/4 replicates<br>C full bloom 14 May 200 gallons/acre 4.3 gallons/4 replicates<br>D petal fall no spray 200 gallons/acre 4.3 gallons/4 replicates | | |

**B. Trial Map**

● = untreated tree

2012 Trial

| | | | | | | |
|---|---|---|---|---|---|---|
| YKS | YKC | W | PKS | • | • | • |
| • | BC | YKS | GKC | • | • | • |
| W | BD | LG | PKC | • | • | • |
| YKS | P | P | GKS | • | • | • |
| BC | LG | BC | PKC | • | • | • |
| YKC | BC | BD | GKS | • | • | • |
| W | YKC | YKC | PKC | • | • | • |
| BD | P | YKS | GKS | • | • | • |
| P | Y | BD | • | • | • | • |
| LG | • | W | • | • | • | • |
| Y | Y | LG | • | • | • | • |
| YKD | YKD | Y/YKD | • | • | • | • |
| YKD | YKD/GD | YKD | • | • | • | • |
| YKD | YKD | YKD | • | • | • | • |
| YKD | YKD | YKD | • | • | • | • |
| YKD | YKD/GD | YKD | • | • | • | • |
| YKD | YKD | YKD | • | • | • | • |
| YKD | YKD | YKD | • | • | • | • |
| YKD | YKD/GD | YKD | • | • | • | • |
| YKD | YKD | YKD | • | • | • | • |
| YKD | YKD | YKD | • | • | • | • |
| YKD | YKD/GD | YKD | • | • | • | • |
| YKD | YKD | YKD | • | • | • | • |

Main Road

**Apple Scab – 2012 Experimental treatments**

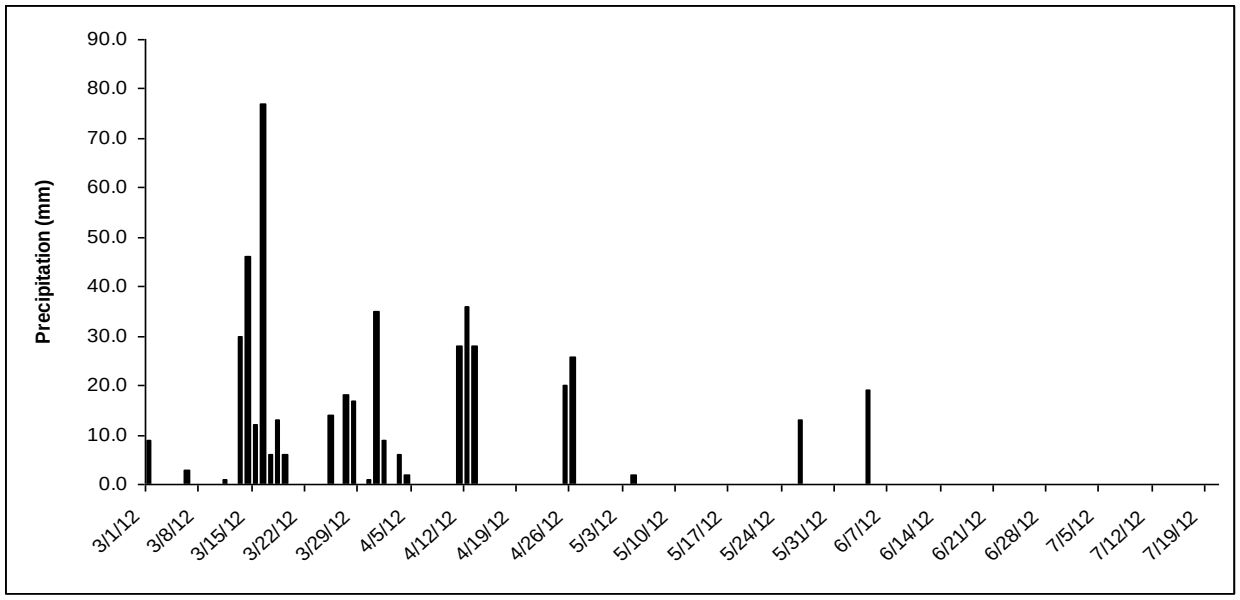
| No. | Flag | Product(s) | FP/Acre | FP/Treatment |
|---|---|---|---|---|
| 1 | W | Unsprayed control | none | none |
| 2 | P | Manzate + Captan (2x) then Fontelis + Manzate (2x) | 3 lb + 3 lb (2x) then 14 fl oz + 3 lb (2x) then 3 lb + 3 lb (2x) | 29.2g + 29.2g then 8.9 ml + 29.2 g then 29.2g + 29.2g |
| 3 | BD | Manzate + Captan (2x) then Fontelis + Captan (2x) | 3 lb + 3 lb (2x) then 14 fl oz + 3 lb (2x) then 3 lb + 3 lb (2x) | 29.2g + 29.2g then 8.9 fl oz + 29.2 g then 29.2g + 29.2g |
| 4 | YKS | Manzate (2x) then Fontelis (2x) | 6 lb (2x) then 20 fl oz (2x) then 6 lb then 6 lb | 58.4 g then 12.7 ml then 58.4 g then 58.4 g |
| 5 | LG | Manzate + Captan | 3 lb + 3 lb | 29.2 g + 29.2 g |
| 6 | YKD GD | Exp A-ground spray (1x) Exp A-regular spray (3x) | 128 fl oz | Ground spray 729 ml<br>Regular spray 81 ml |
| 7 | YKC | Pristine + Koverall then Topguard + Koverall (Repeat 3x, then T+K) | 16.5 oz + 48 oz then 13 fl oz + 48 oz | 10 g + 29.2 g then 8.2 ml + 29.2g |
| 8 | BC | Sovran-Chemical Standard | 4 oz | 2.4 g |
| 9 | PKS | OxiDate 2.0 + Nufilm-P | 1.0% (v/v)+ 0.125%(v/v) | 118 ml + 2.0 ml (150 gal/a) or 157 ml + 2.7 ml (200 gal/a) |
| 10 | GKC | OxiDate 2.0 + Vanguard + Manzate alt<br>OxiDate 2.0 + Fontelis + Manzate | 1.0% + 3.0 oz + 3 lbs alt 1.0 % + 12.0 oz + 3 lb | 118 ml (150 gal/a) or 157 ml (200 gal/a) + 1.8 g + 29.2 g alt 118 ml (150 gal/a) or 157 ml (200 gal/a)+7.6 ml + 29.2 g |
| 11 | Y | Phyton 27 AG+ Hi-Wett | 40 oz + 0.1% | 25 ml +<br>12.1 ml (150 gal/a)<br>16.3 ml (200 gal/a) |

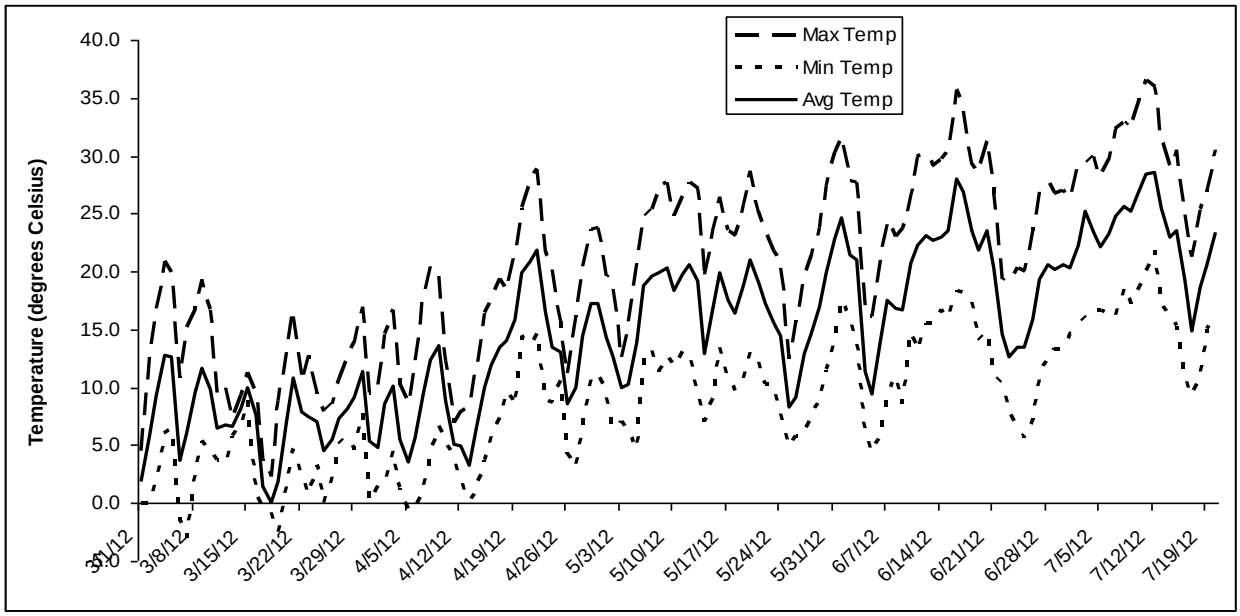
## C. Disease and statistical analysis

Disease was assessed on 20 July 2012 when the threat of infection periods were over. 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 for the spray season was rainy with 25 rain events (Mar 1 – July 19) of between 1-77 mm of rain.



# Results

The Manzate, Fontelis and Captan treatments (in various combinations) as well as Sovran and Topguard gave excellent disease controlThe Companion treatment, tested for its effectiveness as a ground spray, was not successful at controlling disease.

**Table 1.** Apple scab 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 | Fruit Incidence (%) |
|---|---|
| Manzate, 3 lb + Captan, 3 lb | 28.3 c |
| Sovran, 4 oz | 30.8 c |
| Manzate, 3 lb (2x) then Fontelis, 14 fl oz (2x) | 31.9 c |
| Manzate, 3 lb + Captan, 3 lb (2x) then Fontelis, 14 fl oz + Captan, 3 lb (2x) | 36.1 c |
| Pristine, 16.5 oz + Koverall, 48 oz then Topquard, 13 fl oz + Koverall, 48 oz | 36.7 c |
| Manzate, 3 lb + Captan, 3 lb (2x) then Fontelis, 14 fl oz + Manzate, 3 lb (2x) | 36.7 c |
| Oxidate 2.0, 1.0% (v/v) + Vanguard, 3.0 oz + Manzate, 3 lb alt Oxidate 2.0, 1.0% (v/v) + Fontelis, 12 o | 37.1 c |
| Phyton, 27 AG, 40 oz + Hi-Wett, 0.1% (v/v) | 64.2 b |
| Oxidate 2.0, 1.0% (v/v) + Nufilm-P, 0.125% (v/v) | 64.6 ab |
| Unsprayed Control | 77.5 ab |
| Exp A, 128 fl oz | 84.2 a |

**Table 2.** Apple scab 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 | Fruit Severity (Lesions/fruit) |
|---|---|
| Manzate, 3 lb (2x) then Fontelis, 14 fl oz (2x) | 0.58 d |
| Manzate, 3 lb + Captan, 3 lb | 0.68 d |
| Oxidate 2.0, 1.0% (v/v) + Vanguard, 3.0 oz + Manzate, 3 lb alt Oxidate 2.0, 1.0% (v/v) + Fontelis, 12 o | 0.69 d |
| Sovran, 4 oz | 0.70 d |
| Pristine, 16.5 oz + Koverall, 48 oz then Topquard, 13 fl oz + Koverall, 48 oz | 0.74 d |
| Manzate, 3 lb + Captan, 3 lb (2x) then Fontelis, 14 fl oz + Captan, 3 lb (2x) | 0.82 d |
| Manzate, 3 lb + Captan, 3 lb (2x) then Fontelis, 14 fl oz + Manzate, 3 lb (2x) | 1.37 cd |
| Oxidate 2.0, 1.0% (v/v) + Nufilm-P, 0.125% (v/v) | 2.25 c |
| Phyton 27 AG, 40 oz + Hi-Wett, 0.1% (v/v) | 2.40 c |
| Unsprayed Control | 3.66 b |
| Exp A, 128 fl oz | 5.21 a |

# Acknowledgements

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# Appendix: Products tested

| Product | Active ingredient(s) and concentration | Class | Manufacturer |
|---|---|---|---|
| Captan 50 WP | captan (50%) | pthalamide | Arysta Life Sciences |
| Exp A | proprietary | proprietary | N/A |
| Fontelis | penthiopyrad (20%) | carboxamide | Dupont |
| Hi Wett | polysiloxane polyether copolymer, polyoxyethylene-polyoxypropylene copolymer & alcohol ethoxylate (100%) | adjuvant | First Choice |
| Koverall | mancozeb (75%) | carbamate | Cheminova |
| Manzate | mancozeb (75%) | carbamate | Dupont |
| NuFilm P | poly-1-p-menthene | adjuvant | Miller Chemical and Fertilizer Corporation |
| Oxidate 2.0% | hydrogen dioxide (27%) | N/A | BioSafe Systems LLC |

| | | | |
|---|---|---|---|
| Phyton 27 AG | copper sulfate pentahydrate (21.3%) | other | Phyton Corporation |
| Pristine | pyraclostrobin (12.8%)<br>boscalid (25.2%) | QoI +<br>carboxamide | BASF |
| Sovran | kresoxim-methyl (50%) | QoI | Cheminova |
| Topguard 1.04 SC | flutriafol (12%) | dimethylase inhibitor | Dow AgroSciences |
| Vangard | cyprodinil (75%) | anilinopyrimidine | Syngenta Crop Protection, Inc. |

*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. 2011. Grape powdery mildew trials, available at http://ucanr.org/sites/plp/Cooperative_Extension/gubler/fungtrials2011/, (3) various sources including product labels and/or MSDS, product websites, and personal communications.