Proceedings of the

Cumberland-Shenandoah Fruit Workers Conference

87th Annual Meeting

December 1st and 2nd, 2011

Hampton Inn and Conference Center

Winchester, VA

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Conference Chair

Greg Krawczyk

Penn State University

Fruit Research and Extension Center

Biglerville, PA

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ENTOMOLOGY

List of Participants

Name	Affiliation
Agnello, Arthur	NYS Agri. Expt. Station
Amarasekare, Kaushalya	Oregon State University
Atanassov, Atanas	Rutgers University
Aukett, Warren	CPS
Basnet, Sanjay	VA Tech
Behling, George	Nob Hill Orchard
Bergh, Chris	VA Tech
Biddinger, David	Penn State University
Biggs, Alan	WVU KTFFREC
Breth, Deborah	Cornell University
Brown, Preston	Oregon State University
Butler, Bryan	University of Maryland Cooperative Ext.
Carbaugh, David	VA Tech
Clarke, Jim	
Collier, Judy	
Combs, David	Cornell University
Cox, Kerik	NYSAES, Barton Lab
Cullum, John	USDA
David, Paul	Gowan Co.
DeMarsay, Anne	The Fruit Doctor
Dimock, Mike	Certis USA
Ellis, Katie	PSU Extension
Ellis, Nic	Penn State University
Engelman, Jean	VA Tech
Enyeart, Travis	Penn State University
Estes, Tony	Uniphos
Ganske, Don	DuPont
Haas, Tom	Cherry Hill Orchards
Halbrendt, Noemi	Penn State University
Hancock, Torri	USDA
Hannig, Greg	DuPont
Harper, Jay	Penn State University
Hed, Bryan	Lake Erie Reg. Grape Res
Hickey, Ken	Penn State University
Hull, Larry	Penn State University
Jones, Taylor	VA Tech
Jordan, Tim	VA Tech
Joseph, Shimat V.	VA Tech
Joshi, Neelandra	Penn State University
Kirfman, Gary	Valent
Krawczyk, Greg	Penn State University
Lalancette, Norman	Rutgers University
Laub, Curt	VA Tech
Leahy, Kathleen	Polaris Orchard Mgmt.
Lee, Doo-Hyung	USDA

Lehman, Brian	Penn State University
Leskey, Tracy	USDA
Love, Kenner	VA Tech
Mackintosh, Bill	CPS
Marine, Sasha	AHS AREC
Mays, Ryan	VA Tech
McArtney, Steve	North Carolina State University
Ngugi, Henry	Penn State University
Nita, Mizuho	VA Tech
Olinger, Matt	Bayer
Olson, Brian	Dow AgroSciences LLC
Paddock, Randall	
Peck, Greg	VA Tech
Pfeiffer, Doug	VA Tech
Pulig, Cassandra	Penn State University
Reissig, Harvey	Cornell University
Rijal, Jhalendra Prasad	VA Tech
Ritz, Amanda	Penn State University
Rodriguez-Saona, Caesar	P. E. Marucci Center
Rosenberger, David	Cornell's Hudson Valley
Rouse, Bob	Agriculturist LLC
Rucker, Ann	Rutgers University
Schmitt, Dave	Rutgers RCE
Scorza, Cameron	USDA
Shannon, Mark	Suterra LLC
Shearer, Peter	Oregon State University
Short, Brent	USDA
Smith, Charles	
Soergel, Deonna	Penn State University
Sorensen, Monte	Bayer
Stamm, Greg	CBC Americas
Steffel, Jim	LABS
Surcica, Alex	Franklin Co. Ext.
Travis, Jim	Penn State University
Tworkoski, Tom	USDA
Villani, Sara	NYSAES, Barton Lab
Walgenbach, Jim	MHCREC
Webb, Mike	Bayer
Webb, Patti	Dow
Wiles, Sean	USDA
Wise, John	Michigan State University
Wright, Starker	USDA
Yoder, Keith	VA Tech

87th Annual Cumberland-Shenandoah Fruit Workers Conference
December 01-02, 2011
Hampton Inn and Conference Center, Winchester, VA

CONFERENCE AGENDA

Thursday, December 1st

8:00 - 9:00 AM	**Registration** - *Pre-registration Room*
9:00 - 9:05 AM	**Call to order** - 87th Cumberland-Shenandoah Fruit Workers Conference; *Washington Room*
9:05 - 10:00 AM	**Call of the States**
10:00 -10: 30 AM	**An overview of the spotted wing drosophila, *Drosophila suzuki*, in western USA.** Peter W. Shearer, OSU, MCAREC, Hood River, OR.
10:30- 10:45 AM	Break
10:45 - 11:15AM	**Grower experience with management of brown marmorated stink bug in Mid-Atlantic region during 2010 and 2011 seasons.** Tom Haas, Cherry Hill orchards, Lancaster, PA; George Behling, Nob Hill Orchards, Arden, WV; and Bill Mackintosh, CPS Field Consultant
11:15-12:00AM	Feature presentation: **Arthropod IPM research on tree fruit in Pennsylvania: historical and future perspectives.** Larry Hull, PSU FREC, Biglerville, PA
12:00 - 1:00 PM	*Lunch*
1:00 - 5:00 PM	**Concurrent Sessions** Entomology – *Washington Room* Horticulture – *Madison Room* Plant Pathology – *Jefferson Room*
5:30 - 7:15 PM	**Industry sponsored mixer** *(Sponsored by Bayer CropScience, CBC America, Certis, Dow AgroSciences, DuPont, Nichino America, Syngenta, United Phosphorus, and Valent)*

Friday, December 2nd

8:00 - 9:00 AM	**Business Meeting** – *Washington Room*
9:00 - Noon	**Concurrent Sessions** (Entomology and Plant Pathology)

CONCURRENT SESSIONS AGENDA

Horticulture – *Madison Room* **Thursday, December 1st**

Moderator: Greg Peck, VT.

1:00 - 1:20 **Current status of organic apple production in the Eastern U. S.: production, research, and extension.** G. Peck, Virginia Tech, Winchester, VA

1:20 - 1:40 **Effects of the PSII inhibitor metamirtron on apples and peaches.** S. McArtney, J. D. Obermiller, North Carolina State University

1:40–2:00 **Physiological processes of size-controlling rootstocks in apple.** T. Tworkoski, G. Fazio, USDA-ARS, Kearneysville, WV

2:00 – 2:20 **Activity of ACC as an apple thinner.** S. McArtney, North Carolina State University

2:20 - 2:40 **Quantifying the efficacy of native bees for apple pollination in Pennsylvania.** A. Ritz, D. Biddinger, J. Schupp, E. Winzeler, E. Rajotte, N. Joshi, H. Sahli. Penn State University, Biglerville, PA and University Park, PA

2:40–3:00 **A survey of apple pollination practices, knowledge, and attitudes of fruit growers in Pennsylvania and New York.** N. Joshi, D. Biddinger, E. Rajotte, M. Park, B. Danforth, Penn State University.

3:00 – 3:15 BREAK

3:15–3:35 **Bloom thinning by lime sulfur and other disease control agents.** K. Yoder, G. Peck, Virginia Tech, Winchester, VA

3:35 - 3:55 **Efficacy of SmartFresh treatments on late-harvested fruit.** S. McArtney, North Carolina State University

3:55 – 5:00 **Additional presentations**

Plant Pathology – *Jefferson Room* **Thursday, December 1st**

Moderator: Henry Ngugi, PSU

1:00 - 1:15 **Summary of 2011 Fungicide Tests.** K. Yoder, Virginia Tech, AREC, Winchester, VA

1:15 - 1:30 **Management of apple diseases with existing and new apple fungicides in PA, 2011.** N. O. Halbrendt, H. Ngugi, Penn State University, Fruit Research and Extension Center, Biglerville, PA

1:30 - 1:45 **New options for controlling postharvest diseases and disorders of apples.** D. Rosenberger, A. Rugh, L. Sudol, F. Meyer, L. Rosario, Cornell Hudson Valley Lab, Highland, NY

1:45 - 2:00 **Performance of Fontelis for early season apple diseases in two large block trials.** A.R. Biggs, KTFREC, WV University, Kearneysville, WV

2:00 - 2:15 **Influence of canopy location and microclimate on SI fungicide resistance in *Venturia inaequalis* populations.** S. Marine, E. Stromberg, K. Yoder, Virginia Tech, AREC, Winchester, VA

2:25 - 2:30 **Implications of off-season applications for selection of fungicide resistance in *Venturia inaequalis*.** S. M. Villani, H. K. Ngugi, K. D. Cox, Penn State University, Fruit Research and Extension Center, Biglerville, PA, NYSAES, Geneva, NY

2:30 - 2:45 **Qualitative and practical resistance to QoI fungicides in *Venturia inaequalis* populations in the northeastern U.S.** S. M. Villani, K. D. Cox, NYSAES, Geneva, NY

2:45 - 3:00 **Capabilities and limitations of SDHI fungicides in apple disease control programs.** D. Rosenberger, A. Rugh, L. Sudol, F. Meyer, Cornell Hudson Valley Lab, Highland, NY

3:00 - 3:15 BREAK

3:15 -3:30 **Summary of 2011 fungicide and bactericide trials on peach.** N. Lalancette, K. McFarland, Rutgers University, NJ.

3:30 - 3:45 **Fungicide trials for management of brown rot on peach and nectarine in PA, 2011.** N. O. Halbrendt, H. K. Ngugi, Penn State University, Fruit Research and Extension Center, Biglerville, PA

3:45 - 4:00 **Prevalence and management challenges of brown rot pathogens in the northeastern U. S.** S. Villani, J. Freier, K. D. Cox, NYSAES, Geneva, NY

4:00 - 4:15 **Fungicide performance trials for wine grapes: downy mildew and Botrytis, 2011.** M. Nita, AHS AREC, Virginia Tech, Winchester, VA

4:15 -4:30 **Progress in bunch rot control of grapes in Pennsylvania through the integration of non-chemical strategies.** B. Hed, H. K. Ngugi, N. O. Halbrendt, Penn State University, Fruit Research and Extension Center, Biglerville, PA

4:30 - 4:45 **Lessons on the use of summer students to assess severity of bacterial spot of stone fruits.** H. K. Ngugi, S. Bardsley, Penn State University, Fruit Research and Extension Center, Biglerville, PA

Plant Pathology – *Jefferson Room* **Friday, December 2nd**

Moderator: Henry Ngugi, PSU

9:00 - 9:15 **Fungicide performance trials for wine grapes: powdery mildew 2011.** M. Nita, AHS AREC, Virginia Tech, Winchester, VA

9:15 - 9:30 **Limited effects of foliar insecticidal treatments on the control of mealybugs on grape.** M. Nita, T. Jones, AHS AREC. Virginia Tech, Winchester, VA

9:30 - 9:45 **Update on fungicide testing on wine grapes in PA, 2011.** N. O. Halbrendt, H. K. Ngugi, Penn State University, Fruit Research and Extension Center, Biglerville, PA

9:45 - 10:00 **Factors affecting spread of fire blight during summer.** D. Rosenberger, A. Rugh, F. Meyer, L. Sudol, L. Rosario, Cornell Hudson Valley Lab, Highland, NY

10:00 - 10:15 **Evaluation of bactericides for management of the blossom and shoot phases of fire blight, 2011.** B. L. Lehman, N. O. Halbrendt, H. K. Ngugi, Penn State University, Fruit Research and Extension Center, Biglerville, PA

10:15 - 10:30 **Effectiveness of Kasumin for fire blight control.** K. Yoder, Virginia Tech, Winchester, VA

10:30 – noon **Additional presentations**

Entomology – *Washington Room* **Thursday, December 1st**

Moderator: Greg Krawczyk, PSU

1:00 - 1:15 **First detection and phenology of spotted wing drosophila in Pennsylvania.** D. Biddinger, K. Demchak, A. Surcica, N. Joshi, E. Rajotte, B. Butler. Penn State University, Fruit Research and Extension Center, Biglerville, PA

1:15 - 1:30 **Spotted wing drosophila: A new invasive fruit pest moves north through Virginia.** D. Pfeiffer, L. M. Maxey, C. A. Laub, E. R. Day, H. J. Burrack. Virginia Tech, Blacksburg, VA

1:30 - 1:45 **The discovery and rearing of a parasitoid, *Pachycrepoideus vindemiae* (Hymenoptera: Pteromalidae) associated with spotted wing drosophila, *Drosophila suzukii* (Diptera: Drosophilidae), in Oregon and British Columbia.** P. H. Brown, P. W. Shearer, J. C. Miller, Oregon State University, M. A. Howard, Agric. and Agri-Food Canada, North Summerland, BC, Canada

1:45 - 2:00 **Management of spotted wing drosophila with spinetoram and spinosad.** B. Olson, B. Hopkins, J. Mueller, J. Dripps, B, Bisabri, J. Richardson, H. Yoshida, Dow AgroSciences, Geneva, NY

2:00 - 2:15 **Lethal and sublethal effects of insecticides on the green lacewing *Chrysoperla carnea*.** K. G. Amarasekare, P. W. Shearer, Oregon State University.

2:15 - 2:30 **Economic comparison of ICM and standard insect spray programs for New Jersey blueberries, 2009 and 2010.** J. K. Harper, Penn State University, University Park, PA. C. Rodriguez-Saola, D. Polk, F. Zaman, P. Oudemans

2:30 - 2:45 **Trunk injection to deliver insecticides for apple pest management.** J. C. Wise, A. VanWoerkom, C. VanderVoort, Michigan State University

2:45 -3:00 **Preliminary survey for overwintering sites of the brown marmorated stink bug.** Doo-Hyung Lee, S. E. Wright, B. D. Short, T. J. Hancock, J. P. Cullum, S. A. Wiles, C. E. Scorza, T. C. Leskey, USDA-ARS, Kearneysville, WV

3:00 - 3:15 BREAK

3:15 – 3:30 **Initial observations on brown marmorated stink bug diurnal and nocturnal activities.** D. C. Soergel, G. Krawczyk, Penn State University, Fruit Research and Extension Center, Biglerville, PA

3:30 - 3:45 **Investigations of factors influencing *Halyomorpha halys* feeding preferences among Pennsylvania apples.** N. H. Ellis, G. Krawczyk, J. R. Schupp, H. E. Winzeler, T. Kon, Penn State University, Fruit Research and Extension Center, Biglerville, PA

3:45 – 4:00 **Effects of late season feeding by brown marmorated stink bug on post-harvest injury expression on apples.** S. V. Joseph, B. D. Short, J. C. Bergh, T. C. Leskey, USDA-ARS, Kearneysville, WV

4:00 - 4:15 **Laboratory and field evaluations of insecticides for control of brown marmorated stink bug.** S. E. Wright, B. D. Short, E. C. Scorza, B. R, Butler, J. P. Cullum, T. J. Hancock, S. A. Wiles, R. B. Posa, T. C. Leskey, USDA-ARS, Kearneysville, WV

4:15 - 4:30 **Residual insecticide efficacy on adult brown marmorated stink bugs.** B. D. Short, T. C. Leskey, USDA-ARS, Kearneysville, WV

4:30 - 4:45 **Insecticide trials targeting brown marmorated stink bug.** C. Bergh, S. V. Joseph, AHS-AREC, Winchester, VA

4:45–5:00 **Surround vs. the stink bug: A demonstration project for direct market growers.** B. Butler, University of Maryland. Westminster, MD

Entomology – *Washington Room* **Friday, December 2nd**

Moderator: David Biddinger

9:00 - 9:15 **Feeding injury and management of brown marmorated stink bug (BMSB) in vineyards and raspberry plantings.** S. Basnet, Virginia Tech, Blacksburg, VA

9:15 - 9:30 **Insecticide bioassays with brown marmorated stink bug.** G. Krawczyk, T. R. Enyeart, L. A. Hull, Penn State University, Fruit Research and Extension Center, Biglerville, PA

9:30 - 9:45 **A third generation electronic trap for automated monitoring of lepidoptera in orchards.** B. L. Lehman, L. A. Hull, J. Park, G. Holguin, H. Medeiros, T. J. Smith, C. C. Baker, V. Jones, Penn State University, Fruit Research and Extension Center, Biglerville, PA

9:45 - 10:00 **Performance of Isomate TT, Isomate rings and Isomate flex for management of codling moth and oriental fruit moth.** J. Walgenbach, S. Schoof, MHCREC, North Carolina State University

10:15 -10:30 **Mating disruption plus novel barriers for dogwood borer control.** A. Agnello, D. Kain, NYS Agric. Experiment Station, Geneva, NY

10:30 -10:45 **It's here: mating disruption for dogwood borer – Isomate® DWB.** G. Stamm, CBC America.

10:45 - 11:00 **Apple maggot trials year 2: Can newer insecticides control them?** D. Combs, W. H. Reissig, Cornell University, Geneva, NY

11:00 - 11:15 **Development of a multi-life state management strategy for plum curculio in apple orchards.** T. C. Leskey, T. J. Hancock, S. E. Wright, D. I. Shapiro-Ilan, USDA-ARS, Kearneysville, WV

11:15 - 11:30 **Purity and efficacy of commercial pheromone lures for monitoring *Paralobesia viteana* in vineyards.** T. Jordan, A. Zhang, D. Pfeiffer, Virginia Tech, Blacksburg, VA

11:30 - 11:45 **Behavioral response of grape root borer larvae to grape root stimuli.** J. Rijal, J. C. Bergh, AHS-AREC, Virginia Tech, Winchester, VA

11:45: 12:00 **Additional presentations**

CALL OF STATES

Call of the States – New York 2011

Art Agnello and Debbie Breth
Cornell University, NYS Agric. Expt. Sta., Geneva, NY

Entomology

The year's spring weather was messy and unsettled. As always when the spring months are cold and wet, insect pests didn't do well while disease pathogens flourished. During April and May, first pollination and then thinning became added challenges for growers. The early season mites and insects were largely in the background, aside from some **plum curculio** activity that almost became entrenched until the warm weather kicked in around Memorial Day, bringing it to a close by the second week of June.

As is often the case during equivocal springs, **internal leps** got off to a straggled and indecisive start. **Oriental fruit moth** biofix was generally around the 1st of May in the Hudson Valley, and May 10–15 in western NY; codling moth varied from May 16 (Hudson Valley) to either May 23 or 30 in WNY, probably depending on subtle regional temperature differences. Flight numbers for both species were generally on the moderate side this year. **Oblique banded leafroller** made a strong showing with respectable trap numbers during the 2nd and 3rd weeks of June. Weekly fruit inspections indicated very low level damage readings, so most growers were evidently able to handle populations of both classes of these pests with the newer selective insecticides available to them. The main WNY processor reported 225 truckloads with internal worms detected, down somewhat from 2010 levels (240 truckloads); no load rejections were reported.

July weather was uniformly hot and dry; **European red mites** threatened to take off in a few orchards, and **woolly apple aphids** were evident in quite a few more. **Japanese beetles** made a cursory appearance, but didn't seem destined to make the large splash as they have commonly done in recent years. **Apple maggot** was almost nowhere to be found until we started getting rain again in August, but made up for its late appearance with some impressive trap numbers, which continued well into the harvest period.

The no-show category this season must include the two long-anticipated and potentially troublesome invasives that have been keeping most of our neighboring states very busy, **Brown Marmorated Stink Bug** and **Spotted Wing Drosophila**. Each of these pests are known to be more common later in the season, and we did capture a single SWD specimen on Sept. 29 near a fall-bearing raspberry planting. Nonetheless, dozens of traps out for both of these insects throughout the summer (additionally conducting beating and sweep samples for BMSB) resulted in little to show for it. We certainly regard this as another non-representative season, and expect that both of these species will become a greater pest concern to fruit growers in the coming years.

Call of the States – Pennsylvania 2011

Krawczyk, G., R. M Crasweller*, N. O. Halbrendt, L. A. Hull, and H. K. Ngugi.
The Pennsylvania State University
Fruit Research and Extension Center, Biglerville, PA
*Department of Horticulture, State College, PA

Horticulture: There were no extreme cold temperatures during the winter of 2010 – 2011 so there was little winter injury. We did not have any unusually warm temperatures in the late winter or early spring that we typically experience that lead to a loss of winter hardiness. Bloom was about normal. The early spring was notable for the considerable amount of rain. Total rainfall for the growing season (March through October) was 64.05 inches; with nearly 23 inches falling in March through May. There was a ten day period May 4th through 14th without any rain. While overall May had nearly normal rainfall most of that rain fell in a four day window of May 16th through the 20th. Because of the unevenness of rainfall coupled with high temperatures growers applying thinners during the week of May 9th and May 23rd experienced greater thinning response than grower applying thinner either before or after those two weeks. There were also extended dry periods in early and late June and mid-July Initially, harvest seemed to be about 7 to 10 days later than normal but this difference disappeared by the middle of September. The early warm temperatures shortly after bloom promoted a large amount of cell division and hence fruit size at harvest was abnormally large. This was bolstered by nearly 16 inches of rain in September. However, the overall crop in PA on a statewide basis was down about 1 million bushels from previous years.

Entomology: The 2011 season was also a very interesting year form the entomology perspective. The biofixes for our normal fruit pests happened almost perfectly at the normal dates: for OFM (April 19), STLM (April 06) CM (May 07), TABM (May 11) and OBLR (May 29).
The brown marmorated stink bug became fully established in all fruit growing regions of the state, although the most severe injuries were observed in south-western part of the state. Increased usage of broad spectrum insecticides directed against BMSB resulted in higher than normal populations of European red mites. At the same time, during the season, we did not see any unexpected level from our traditional fruit pests. Internal fruit feeders and leafrollers still posed some control challenges in isolated orchards (high numbers of TABM in traps) resulting again in rejections of fruit by fruit processors 110 rejections, 65:35 percent CM/OFM split). Other pests causing some control problem were pear psylla, plum curculio, wooly apple aphid and borers but in most cases the challenge was limited to only few, individual orchards.

Plant pathology: This was an unusually wet year during the early and later parts of the crop season with rainfall amounts in April and May at Biglerville totaling 11.4 and 4.3 in, respectively. As a result, the conditions were ideal for apple scab development and a total of 55 infection periods were recorded at Biglerville between March 16 and Jun 15. This is number is more than twice the long-term average and 24 of these events were recorded in May alone. This high disease pressure combined with recently documented loss of efficacy for site-specific fungicides made it very difficult to protect apples with standard IPM programs. Some growers suffered very severe losses with one large grower estimating >$1.5 million in losses. The problem appeared most severe around Adams County but other counties such as Erie also reported heavy losses. Based on 60 respondents from a survey, 52% of the growers had severe apple scab in their orchards.

Fire blight: There were 7 infection periods recorded between April 20 (about late pink stage) and May 10 and 4 moderate infection risk events over the same. Statewide we consider fire blight severity to have been between moderate and high with most reports from growers relating to fire blight on pears.

Powdery mildew: High disease pressure and high incidence observed at Biglerville.

Rust: Moderate pressure was observed.

Summer diseases: Moderate pressure but high incidence was noted in our organic block especially on 'Enterprise'.

Stone fruits: Brown rot – For the first time in the last five years, we got frequent calls from growers with blossom and shoot blight symptoms on peach and apricots. This was not surprising given the wet weather at petal fall. Severe brown rot also affected varieties maturing in late August to early September. Many cherry growers also had severe brown rot which we suspect to be related to resistance to the SI fungicides in the brown rot fungus.

Bacterial spot – Moderate to low pressure for reasons not yet clear to us.

Cherry leaf spot – Severe levels observed near Biglerville but we do not know if this was representative statewide.

Call of the States – Virginia 2011

Keith Yoder
Virginia Tech

Horticulture

The season started out with a fairly typical bloom date for most of the State, but frequent rain showers made early season spray applications challenging. In terms of apple fruit thinning, growers found it difficult to gauge the cloudy weather's potential impact on chemical thinner response and some growers over-thinned their crop. This seemed to be particularly true for Red Delicious.

As spring turned to summer, the weather became hot and dry in the northern part of the State. The sweet cherry crop benefited from the dry weather, and minimal cracking was reported on cultivars that are normally susceptible to rain-induced cracking. The peach crop was reportedly near average and of good quality. By mid August, the USDA Climate Monitor web site listed Frederick County as being under a "Moderate Drought". The lack of precipitation negatively impacted young trees that did not receive sufficient supplemental water, especially those on dwarfing rootstocks. The dry weather ended when Hurricane Irene (27-28 Aug) and Tropical Storm Lee (8 Sept) each brought several inches of rain to most of the State, with the eastern regions receiving record-breaking rainfall and severe flooding. Unlike in the north of the State, the central region received more regular precipitation throughout the summer.

Apple harvest was challenged by frequent rains, which delayed picking for many mid-season cultivars. Growers in Central Virginia also reported labor shortages of pickers and in packing houses. Significant fruit drop was reported by a handful of growers, likely the result of the summer drought followed by excessive rain during harvest. Nonetheless, fruit quality appeared to be good throughout the State.

Pathology

2011 was quite typical from a disease perspective. Apple scab ascospores were first trapped March 15-16 and the first infection period occurred Mar 30-Apr 1. Other primary infection periods occurred Apr 8-9, Apr 12-13, Apr 16, Apr 19-20, and Apr 22-23. This could have been a secondary period where trees were not adequately protected Mar 30-Apr 1. Primary or secondary scab infection period: Apr 24-25. Lesions were observed Apr 28. Secondary infection periods: May 1-2, May 3-4, May 12-13, May 13-14, May 14-15, May 15-16, May 16-17, May 17-18, May 18-19 (seven infection periods and 3.89 inches of rain in one week), May 23, May 27, May 28 (12 infection periods in May). In summary, 6 primary and 14 secondary infection periods occurred through the end of May. A definite cedar-apple and quince rust infection period Apr 24-25; possible earlier rust infection periods, but with cooler temperatures, occurred Apr 12-13, Apr 16, and Apr 19-20. Additional infection periods occurred May 1-2 and May 3-4 while some fruit were still susceptible, and May 13-14, May 14-15, and May 15-16 on the foliage only.

Powdery mildew spores were available on infected emerging buds by Mar 23. In 2011 we had 28 dry weather "mildew infection days" in April-May compared to 45 days in2010, but secondary mildew symptoms were common where early control was inadequate. Since 1993, the number of such days from tight cluster to six weeks after petal fall (about third cover) ranged from 24 (in '96 and '03) to 49 (in '99).

Fire blight: Earliest bloom opened at our AREC on Idareds Apr 11 and infection events occurred on ten days: Apr 11 (the day bloom opened), 14, 20 and 24-28, May 3 and 6 (on late bloom). On May 17, hail with varying amounts of damage occurred within two miles of the Winchester AREC and some other areas of Frederick County, but not at the AREC. There was some trauma blight in local areas where there had been earlier blossom blight on Romes (probably late bloom). But much of the hail-damaged area seemed to have come through relatively free of serious blight.

Summer diseases: For purposes of predicting the development of the sooty blotch and flyspeck (SBFS) fungal complex, we record accumulated wetting hours starting 10 days after petal fall. This year's petal fall date was Apr 28 so the start of wetting hour accumulation was from May 8. We reached the 250-wetting hour action threshold for SBFS on June 24, the same week as six of the past seven years. Sooty blotch was observed on untreated trees July 5. As usual, SBFS was more prevalent in blocks at lower elevations. From May to early September there were nine extended wetting periods at temperatures 70º or higher that added to rot pressures where fungicide protection was light and inoculum plentiful. The local areas were short on moisture through much of July and August until the drought was broken by abundant rains from tropical storms Irene and Lee. These storms were more beneficial than harmful to local fruit production, but they did cause some weathering and residue reduction of late season fungicides.

Entomology

Brown marmorated stink bug (BMSB) was the predominant concern for Virginia growers in 2011. In response to the anticipated threat from the large overwintering population from 2010, many, but not all growers began targeting BMSB early in the post-bloom period. Commercially available, black pyramid traps baited with the aggregation pheromone of another stink bug, *Plautiastali*, were ineffective as a monitoring tool for BMSB. Use of broad spectrum products in the post-bloom was common, and many growers applied sprays for protection of late season apples well into September. A Section 18 for dinotefuran use against BMSB in pome and stone fruit orchards was approved in July. Among orchards, BMSB pressure and injury varied substantially, ranging from very light to extreme, particularly in orchards where the bug was not aggressively managed. Asian pears appeared to be especially vulnerable to injury. Overall, injury from BMSB was managed better in 2011 than in 2010. There were some instances of secondary pest flares that were likely associated with product selection for BMSB, but these were not widespread. There were some anecdotal reports that predatory mite populations were not adversely affected by post-bloom pyrethroid sprays. There were also a number of reports that two-spotted spider mites were more abundant than European red mites. Based on grower observations and homeowner reports, the size of the fall population in Virginia was much reduced in 2011, compared with 2010. Reasons underlying this remain speculative, although the effects of heavy rain from the remnants of a hurricane and a tropical storm between late August and early September have been invoked. At the Winchester AREC, large numbers of BMSB began to seek overwintering sites on September 22, after which their numbers were dramatically lower within a few days. Relatively low numbers of bugs were counted on the walls of the AREC though late October.

Biofix dates at the Winchester AREC for Oriental fruit moth, codling moth, and tufted apple budmoth were within historical expectations, on April 18, April 26, and May 9, respectively. Internal worms were not a major issue in 2011, and as in recent years, leafroller injury was very light.

HORTICULTURE

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CURRENT STATUS OF ORGANIC APPLE PRODUCTION IN THE EASTERN U.S.: PRODUCTION, RESEARCH, AND EXTENSION

Gregory M. Peck
Virginia Tech, AHS Jr. Agricultural Research and Extension Center
Winchester, Virginia 22602

Organic apple production continues to expand in the Western US, but few growers have adopted the system in the Eastern part of the country. In 2007, more than 13,000 acres of apple orchards were reported to be under organic certification in Washington State (Figure 1). However, in New York, the second largest apple producing state in the country, only 465 acres were under organic management. In Virginia, the sixth largest apple producing state, only 60 acres were reported to be under organic management. The reasons for the disparity in organic production between east and west are well documented (Peck et al., 2010) and include environmental (e.g., humidity and precipitation) and biological reasons. In particular, Eastern apple growers contend with more than 50 direct and indirect arthropod pests, as well as more than 20 plant diseases without the aid of synthetically derived fertilizers and pesticides. Table 1 lists some of the horticultural, entomological, and pathological barriers to organic apple production in the East.

Despite production barriers, Eastern apple growers are still interested in entering the organic market. This is likely due to continued growth in the organic sector. The Perishables Group, a third party market research firm, found that organic apple sales increased 95% from 2006 to 2010 (The Packer, 2011).

In 2011, specialists at the AHS Jr. AREC surveyed the Virginia tree-fruit growers for their input on future research and extension programs. Among the 30 questions in the Horticulture section, growers were asked to rank the importance of the "development of alternative orchard management approaches (e.g., organic, integrated fruit production (IFP), and other "sustainable agriculture" systems). Twenty eight percent of the respondents qualified this research to be "Very Important", and another 44% qualified it as "Important" (n=75). Relative to the other questions asked, this ranked in the middle range of overall importance. While the question asked about more than just organic methods, the fact that 72% of the surveyed Virginia growers consider alternative management approaches important or very important suggests that additional research and extension efforts are necessary.

Currently, several land-grant universities in the eastern US maintain organic apple research orchards, including the University of Vermont, Cornell University, the Pennsylvania State University, Michigan State University, and the University of Arkansas. These orchards are in various stages of development and funding. However, it can be expected that results from these projects will provide additional information to Eastern growers, and perhaps some of the challenges to producing organic apples will be overcome.

Extension efforts towards organic apple production in the East had been lacking for a longtime and there was scant research-based information available for organic growers. This was perhaps due to the lack of organic research. This gap in extension resources was filled by a number of private consultants and organic advocates. Recently, I co-authored *A Grower's Guide to Organic Apples*, with Ian Merwin. The Guide includes seventeen chapters and three appendices that describe organic certification regulations, site selection and orchard design, disease resistant rootstocks and cultivars (nearly 50 disease-resistant apple cultivars are listed), soil fertility and ground-cover management, crop-load management, organically approved pesticides, key pests and diseases, harvest and post-harvest handling, and estimated costs of production. Last winter, New York State Extension educators organized a full day organic apple workshop that was attended by 40 or so current and potential growers. Additionally, it is not uncommon for many of the grower-oriented winter meetings to include presentations about organic fruit production. Many other universities have held similar workshops and field days to highlight their organic apple research programs.

Clearly, the knowledge base and resources for organic apple production are increasing. However, unlike in the Western US, exponential expansion of organic apple production in the Eastern US is still unlikely unless new pest and disease control products become available. Other alternative production systems, such as IFP, should be explored as they allow the use of a greater number of pest control materials and often complement Good Agricultural Practices (GAP) certification schemes.

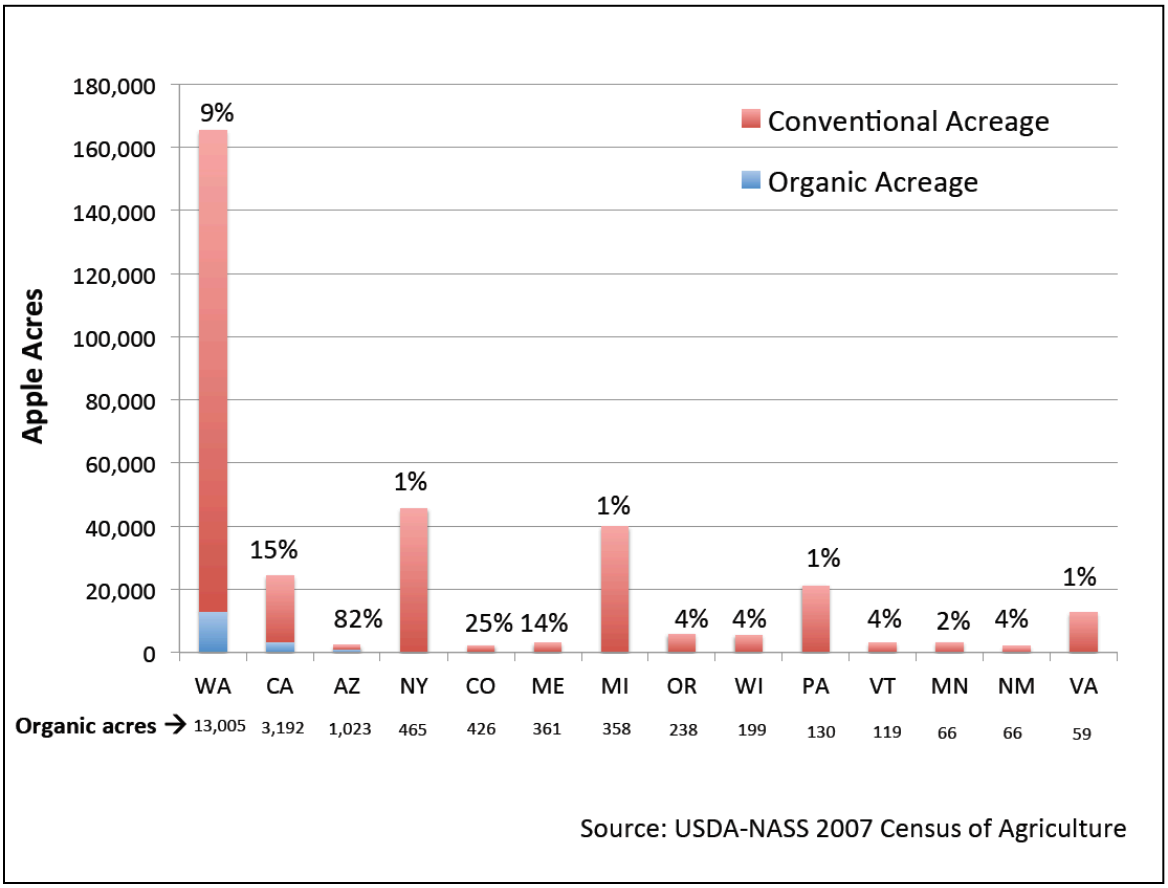

Figure 1. Conventional (red segments) and organically-certified (blue segments) apple acreage in several states. Total apple acreage is the addition of conventional and organic acreage. Organic apple acreage is also reported below the state abbreviations. The percentages above the bars represent the percent of the total apple acreage that is in under organic certification. States are arranged left to right by total organic apple acreage.

Table 1. Barriers to the expansion of organic apple production in the Eastern US.

Barrier	Issue
Crop-load management	• Lime sulfur/oil is phytotoxic and causes fruit russet • Hand thinning is costly • Small fruit size
Weed/ground-cover management	• No effective herbicides for grasses or perennials • Reliance on cultivation • Nutrient competition with trees
Scab	• Marketability of disease-resistant cultivars • Vf gene is losing effectiveness • Reliance on sulfur and liquid lime sulfur
Fire blight	• Possible de-listing of antibiotics by the NOSB
Invasive pests	• Brown marmorated stink bug • Spotted wing drosophila
Markets	• Hard to compete with regions with more favorable climate (i.e., WA& CA) • Low market acceptance for blemished fruit (e.g., sooty blotch/flyspeck; russet; superficial insect damage, etc.)
Costs	• Greater labor costs for thinning and weeding compared to conventional systems • Organic materials tend to be more expensive and need to be applied more often than conventional systems

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PHYSIOLOGICAL PROCESSES OF SIZE-CONTROLLING ROOTSTOCKS IN APPLE

T. Tworkoski[1] and G. Fazio[2]
[1] Appalachian Fruit Research Station, ARS, USDA, 2217 Wiltshire Rd., Kearneysville, WV 25430 and [2] Plant Genetics Resources Unit, ARS, USDA, Cornell University, 630 W. North St., Geneva, NY 14456

Small, efficient trees are critical for early and high yield in high-density plantings of apple. Tree size is controlled by budding scion to size-controlling rootstocks. New rootstocks are needed for both size-controlling efficacy and tolerance of abiotic and biotic stress. Improved knowledge of rootstock-related processes associated with size-control can be an important factor in rootstock breeding. This research was designed to determine the consistency of Geneva and Malling rootstocks for size-control of a variety of scions. Associated with growth, hormone concentrations were examined in xylem exudates from dwarfing and vigorous roots.

Buds from a variety of apple trees, including ‘Gala’ and ‘Fuji’ were grafted to selected rootstocks (G.11, G.935, G.41, G.5087, M.7, M.9, M.27, MM.111) in 2009 and then grown in a greenhouse or the field. Shoot growth, bud break and flowering were measured during 2010 and 2011. A subset of trees was evaluated for hormone concentration in xylem exudate after 1 month of growth in 2011.

In the greenhouse each rootstock had similar relative effects on shoot growth of various scions. For example, one year after budding, ‘Gala’ and ‘Fuji’ shoot growth was generally 20 to 30% less than control on M.9 (dwarfing) than MM.111 (more vigorous). Growth control by rootstocks in the field was similar but less consistent than in the greenhouse. The combination of abscisic acid (ABA) and ABA metabolites were greater in xylem exudate of M.9 than MM.111. Gibberellins (GA) and auxins (IAA) were found in exudate of MM.111 but not M.9. These results indicate that several hormones that move within tree xylem may be important factors associated with size controlling rootstocks.

QUANTIFYING THE EFFICACY OF NATIVE BEES FOR APPLE POLLINATION IN PENNSYLVANIA

A. Ritz, D. Biddinger, J. Schupp, E. Winzler, E. Rajotte, N. Joshi, and H. Sahli
Penn State University
Shippensburg University

Worldwide, honeybees (*Apis mellifera*) have been the most economical option for pollinating most crops and have been the most important pollinator for apples in North America. However, the recent large declines in both feral and domestic honeybee colonies due to mites, viruses, and the recent devastating effects of Colony Collapse Disorder (CCD) have precipitated the need to investigate potential alternative pollinators for fruit trees and other crops. Wild and managed non-*Apis* bee species, including both bumble bees and solitary bees, have long supplemented honeybee pollination in fruit orchards, but little is known about the basic biology of most native bee species, much less their importance for crop pollination. Both bumble and solitary bees show great potential as supplemental pollinators within apple orchards due their high efficacy and willingness to fly under adverse weather conditions. However, reliance on bumble and solitary bees for fruit pollination may be risky depending on the size of the orchard blocks and surrounding habitat due to the limited foraging ranges of many of these bee species in comparison to *Apis mellifera*.

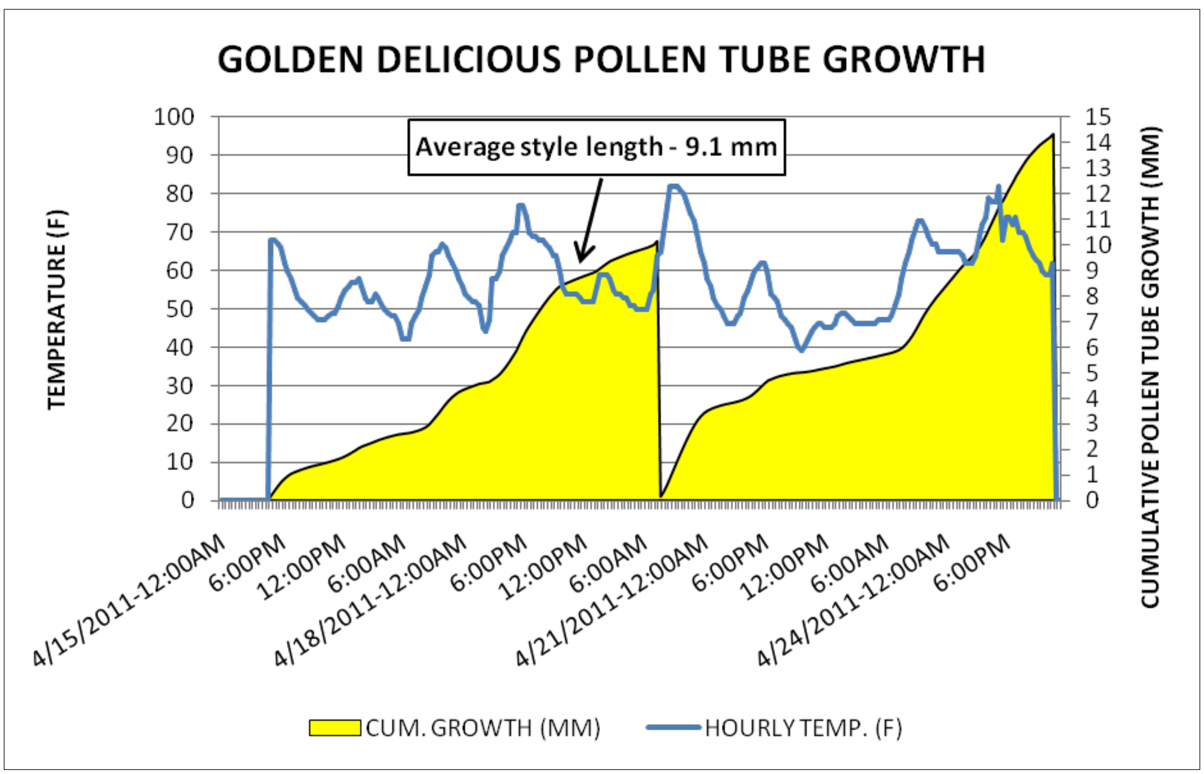
The visitation rate and pollination efficiency of bee species was quantified in six commercial orchards in Biglerville PA. Orchard sites were divided into five zones based on distance from bee habitat (0-200 m) and cultivars sampled included Honey Crisp, Golden Delicious, Ultra Gold, and York. Of the six orchards sampled only the orchard containing Honey Crisp appeared to be pollinator limited as indicated by a significant decrease ($p=0.00$) in the mean number of seed per fruit as distance from bee habitat increased. The five remaining orchards, containing Golden Delicious, Ultra Gold, and York, were not pollinator limited as indicated by no significant decrease in mean number of seeds per fruit in relation to distance from bee habitat. Two minute timed counts of all bees by zone demonstrated that honeybees were present throughout all the orchards with the exception of the Honey Crisp block and may account for the lack of pollen limitation within most of the orchard sites. Additionally, carbohydrate stress brought on by cloudy early season weather may also be a contributing factor influencing fruit yield as indicated by > 7 fruit/cm^2 for all sites and cultivars.

Support for this research was provided by a Specialty Crop Research Initiative Grant and a State Horticultural Association of Pennsylvania Grant.

TEST OF THINNING EFFECTS OF LIME SULFUR AND MBI-106020 USING A POLLEN TUBE GROWTH MODEL FOR TREATMENT APPLICATION TIMING

K. S. Yoder, G. M. Peck, L. D. Combs, D. H. Carbaugh, A. E. Cochran II,
W. S. Royston, Jr., S. W. Kilmer and G. Engleman
Virginia Tech Agr. Res. & Ext. Center
595 Laurel Grove Road, Winchester, VA 22602

This test was conducted on to assess effectiveness of lime sulfur and treatments applied for bloom thinning on 11-yr-old Golden Delicious/ M.9 trees, based on a pollen tube growth model. The test was set up in a randomized block design with five single-tree replications. Treatments were applied dilute to the point of runoff with a single nozzle handgun based on a bloom thinning/ pollen tube growth model developed by Virginia Tech in cooperation with Washington Tree Fruit Research Commission. The model graphic is shown below. Treatments were applied 20 Apr, when the model indicated that approximately 10% on king bloom would have been fertilized, and again a late bloom 25 Apr. King bloom flower samples were taken 22 Apr, 48 hr after first bloom thinning application, and 100 styles were sampled using a standard fluorescence microscopy evaluation of pollen tube growth in the styles (Table 1). Carbaryl + Maxcell + Regulaid were applied as a conventional thinner at 5-7 mm fruit size 6 May. Crop load assessments were conducted on two representative limbs 7 Jun; random fruit samples were weighed 14 Jul (Table 2) and excessively set trees were hand-thinned 25 Jul to prevent limb breakage (Table 2). Commercial fungicides and insecticides were applied airblast for general tree maintenance through the season. Fruit were harvested 26 Sep and weighed on a grader, and fruit finish was visually rated on 25 fruit per replicate tree.



There was no significant difference in the amount of pollen tubes on the stigma or penetrating the stigma base, indicating uniform natural pollination of all treatments. Lime Sulfur 2% + JMS Stylet Oil 2% significantly reduced mean pollen tube length on samples taken 48 hr after treatment. Lime Sulfur 2% + JMS Stylet Oil 2% and MBI-106020 2 pt significantly reduced the number of pollen tubes that grew to the end of the style. Significant bloom thinning was achieved by all Lime Sulfur treatments and by the higher rate of MBI-106020.

The 2% lime sulfur rate with either JMS Stylet Oil or Crocker's Fish Oil increased fruit russetting but russetting was less with the 1% rate of Lime Sulfur + JMS Stylet Oil and crop load comparable to the conventional fruitlet thinning application. There were significant rate effects on crop load with Lime Sulfur + JMS Stylet Oil and MBI-106020 giving some optimism that there is room for rate adjustment to improve thinning and/or reduce russetting. It should be noted that these treatment were applied dilute, and that less phytotoxicity might occur if they were applied concentrate, a research effort that should be conducted in the future. Based on crop load and side bloom thinning effects, these bloom thinning application timings were good, although the graph indicates that the second timing might have been a bit later than ideal. If proper airblast application rates and optimal timing can be coordinated, more thinning might be achieved with a minimum of deleterious fruit finish and foliar phytotoxicity. Also, fruit finish effects are of less concern on fruit for processing. Return bloom effects will be recorded next spring.

Table 1. Effect of bloom thinning treatments on pollen tube growth and crop load of Golden Delicious apples, 2011. Virginia Tech AREC.

	Treatment[z], rates per 100 gal dilute	Pollen tubes in stigma (visual rating-0-10)[y]	Mean number of pollen tubes per style penetrating stigma base	Average style length (mm)	Mean length of longest pollen tube in style (mm)	Mean number of visible pollen tubes at end of styles	% fruit set in side bloom, 15 clusters, 11 May 11	Fruit /cm^2 limb cross sectional area (7Jun 11)	Fruit /cm^2 trunk cross sectional area before thinning
0	No Treatment	4.8 a[x]	38.7 a	8.98 ab	4.50 a	1.04 ab	43.7 a	6.56 ab	9.93 a
1	Lime Sulfur 2 gal + Crocker's Fish Oil 2 gal	5.2 a	37.7 a	9.14 a	3.70 ab	0.96 ab	18.7 b	2.12 e	2.24 d
2	Lime Sulfur 2 gal + JMS Stylet Oil 2 gal	4.7 a	37.2 a	8.82 b-d	3.16 b	0.65 b	26.6 b	2.13 e	3.01 d
3	Lime Sulfur 1 gal + JMS Stylet Oil 1 gal	4.9 a	39.2 a	8.93 bc	3.86 ab	1.02 ab	42.0 a	4.06 cd	5.24 c
4	MBI-106020 2 pt + B-1956 8 fl oz	4.9 a	40.0 a	8.71 d	3.72 ab	0.48 b	28.0 b	5.35 bc	8.23 b
5	MBI-106020 1 pt + B-1956 8 fl oz	5.2 a	42.9 a	8.77 cd	4.50 a	1.44 a	45.4 a	7.59 a	9.09 ab
6	Carbaryl 2 pt + Maxcell 4 pt + Regulaid 11 fl oz	--	--	--	--	--	--	2.96 de	5.72 c

[z]Treatments applied 20 Apr and 25 Apr. Maintenance materials applied uniformly to the entire row at other times throughout the season.

[y] King bloom flower samples taken 48 hours after first bloom thinning application (Apr. 22, 2011); 100 styles sampled.

[x]Mean separation within columns by Duncan's New Multiple Range Test ($P \leq 0.05$).

Table 2. Bloom thinning treatments on Golden Delicious, 2011Virginia Tech AREC.

	Treatment[z], rates per 100 gal dilute	Fruit /cm^2 limb cross sectional area, 7 Jun 11	Average fruit length (cm) 14 Jul11	Average fruit diameter (cm) 14 Jul11	Average fruit weight (g) 14 Jul11	Mean no. fruit thinned / tree 25 Jul 11
0	No treatment	6.56 ab	4.92 c	5.10 d	64.6 e	562.0 a
1	Lime Sulfur 2 gal + Crocker's Fish Oil 2 gal	2.12 e	5.72 a	5.90 a	95.6 a	24.2 d
2	Lime Sulfur 2 gal + JMS Stylet Oil 2 gal	2.13 e	5.60 a	5.77 a	87.3 b	66.4 cd
3	Lime Sulfur 1 gal + JMS Stylet Oil 1 gal	4.06 cd	5.25 b	5.42 c	75.8 cd	164.2 c
4	MBI-106020 2 pt + B-1956 8 fl oz	5.35 bc	5.12 bc	5.30 c	70.8 de	313.0 b
5	MBI-106020 1 pt + B-1956 8 fl oz	7.59 a	5.08 bc	5.36 c	71.9 de	416.6 b
6	Carbaryl 2 pt + Maxcell 4 pt + Regulaid 11 fl oz	2.96 de	5.28 b	5.58 b	80.4 bc	115.8 cd

[z]Treatments applied 20 Apr and 25 Apr. Crop load rated on two selected limbs.

[y] Fruit samples taken 14 Jul 2011.

[x]Mean separation within columns by Duncan's New Multiple Range Test ($P \leq 0.05$).

Table 3. Effect of bloom thinning treatments on crop load and finish of Gold Delicious fruit.

	Treatment[z], rates per 100 gal dilute	Fruit /cm^2 trunk cross sectional area before hand thinning [y]	Fruit /cm^2 trunk cross sectional area at harvest (hand-thinned)	Mean single fruit wt (g) at harvest	Russet rating (0-5)[w]	% USDA grade, based on down-grading from russet [w]			fruit russet, % area
						X-Fcy	X-Fcy /Fcy	Utility	
0	No treatment	9.93 a	3.48 bc	146.9 b	1.8 a	67 a	92 a	2 a-c	0 a
1	Lime Sulfur 2 gal + Crocker's Fish Oil 2 gal	2.24 d	2.06 e	170.7 a	3.6 e	5 d	37 e	30 e	10 c
2	Lime Sulfur 2 gal + JMS Stylet Oil 2 gal	3.01 d	2.39 de	169.0 a	2.9 d	21 c	55 d	13 d	7 b
3	Lime Sulfur 1 gal + JMS Stylet Oil 1 gal	5.24 c	3.10 cd	148.1 b	2.3 a-c	53 ab	78 bc	9 cd	0 a
4	MBI-106020 2 pt + B-1956 8 fl oz	8.23 b	4.55 a	144.2 b	2.4 bc	47 b	84 a-c	2 ab	0 a
5	MBI-106020 1 pt + B-1956 8 fl oz	9.09 ab	3.74 a-c	144.6 b	2.1 ab	55 ab	86 ab	1 a	0 a
6	Carbaryl 2 pt + Maxcell 4 pt + Regulaid 11 fl oz	5.72 c	4.24 ab	163.3 a	2.7 cd	43 b	71 c	8 b-d	0 a

z Treatments applied 20 Apr and 25 Apr 2011; Fruit harvested 26 Sep 2011.
y Crop load based on total fruit removed with thinning 25 Jul, other sampling, plus those harvested 26 Sep.
x Mean separation within columns by Duncan's New Multiple Range Test ($P \leq 0.05$).
w Russetting rated on a scale of 0-5 (0=perfect finish; 5=severe russet). USDA Extra fancy, fancy and utility grades after downgrading by russet.

TEST OF DISEASE CONTROL BY LIME SULFUR TREATMENTS APPLIED FOR BLOOM THINNING OF GINGER GOLD APPLE

K. S. Yoder, G. M. Peck, L. D. Combs, D. H. Carbaugh, A. E. Cochran II,
W. S. Royston, Jr., S. W. Kilmer and G. Engleman
Virginia Tech Agr. Res. & Ext. Center
595 Laurel Grove Road, Winchester, VA 22602

This test was conducted to assess disease control by treatments applied for bloom thinning for on 20-yr-old trees. Treatments were applied dilute to the point of runoff with a single nozzle handgun at 300 psi 19 Apr (trt. #1 only, bloom stages pink to petal fall); 20 Apr (trt. #2 only, bloom stages pink to petal fall); 22 Apr (all treatments, full bloom; ahead of a 25-hr wetting period); 27 Apr (follow up for late bloom thinning, all treatments, petal fall). Follow-up cover spray treatments of Rally 1.25 oz per 100 gal dilute were applied as first-fifth cover sprays 12 May, 20 May, 6 Jun, and 21 Jun and 5 Jul. Maintenance sprays, were applied separately with a commercial airblast sprayer, on 19 Mar (Supracide 3 pt + oil 6 gal/A); 6 May (Imidan 3 lb + Provado 6 fl oz/A); 20 May (Delegate 5 oz + Calypso 4 fl oz/A); 6 Jun (Altacor 3 oz + Provado 6 fl oz); 16 Jun (Delegate 6 oz + Calypso 4 fl oz/A); 30 Jun (Imidan 4 lb + Provado 6 fl oz/A); 13 Jul (Imidan 4 lb + Assail 6 oz/A); 28 Jul (Imidan 4 lb + Provado 6 fl oz/A); 16 Aug (Delegate 6 oz + Provado 6 fl oz/A)). Diseases developed from inoculum naturally present in the test area. Foliar data counts were made on ten terminal shoots each of four single-tree reps 17 Jun and represent averages of all leaves or sorted for just the oldest ten leaves on each shoot. Fruit counts are means of 25-fruit samples from each of four single-tree reps on the tree (russet rating), at harvest 16 Jul, or rot assessments after 14 days' incubation at ambient temperatures 70-89° F (mean 79.5° F). Crop load was evaluated by two independent observations before harvest 14 Jul or at harvest 19 Aug. Percentage data were converted by the square root arcsin transformation for statistical analysis.

Disease control: Early season scab and cedar-apple rust pressure was moderate and powdery mildew was heavy. Except for Rally on fruit scab, all treatments gave significant control of all diseases. Supplemental application of Lime Sulfur + Crocker's Fish Oil 19 or 20 Apr and treatments of Stylet Oil (1 or 2%) with Lime Sulfur all gave more foliar scab control than the Rally alone. It is possible that scab control by Rally was affected by SI-resistant scab in the test area. All treatments gave control of mildew, and there were no significant differences among treatments whether considering only terminal shoot leaves 1-10, all leaves or percent area affected of leaves. It is possible that nearly all of cedar-apple rust was controlled by the 12 May Rally cover spray. Compared to non-treated fruit, all treatments gave significant control of the indicated post-harvest rots although the summer cover fungicide was Rally alone.

Thinning effects: Compared to non-treated trees Treatment #2, Lime Sulfur 2% + Crocker's Fish Oil 2%, applied on 20, 22, and 27 Apr did the most thinning, although this treatment was not significantly different from several others in crop load. Greater effectiveness may have been due to warmer weather on 20 Apr (max 82° F) compared to the application made earlier 19 Apr (max 59° F) or those made later (max 43° F). All lime sulfur-related treatments increased the percent of fruits with russet and percent area russetted. Combinations of Lime Sulfur with JMS Stylet Oil tended to have more area russetted than those with Crocker's Fish Oil. The 20 Apr application of Lime Sulfur 2% + Crocker's Fish Oil 2% was the only treatment that resulted in a significantly higher stem end russet rating.

Table 4. Disease control by lime sulfur and oils applied as bloom thinners. Ginger Gold, Block #4, Virginia Tech AREC.

	Bloom treatment and rate/ 100 gal;	Bloom	Scab, % infection			Mildew , % inf., leaves			C-a rust, % inf		% post-harvest rots (14 days)*			
	(all trts covered with Rally 12 May-5 Jul)	timing	lvs 1-10	all lvs	fruit	lvs 1-10	all lvs	area	1-10	all lvs	any rot	Bot	bitter	Phomopsis
0	No fungicide	---	29 c	26 d	88 c	48 b	72 b	46 b	12 b	6 b	27 c	17 c	3 b	5 b
1	Lime Sulfur 2% + Crocker's Fish Oil 2%	4/19, 22, & 27	7 a	8 ab	19 ab	21 a	36 a	5 a	0 a	0 a	4 b	4 b	0 a	0 a
2	Lime Sulfur 2% + Crocker's Fish Oil 2%	4/20, 22, & 27	8 a	6 a	18 ab	21 a	32 a	4 a	0 a	0 a	2 ab	2 ab	0 a	0 a
3	Lime Sulfur 2% + Crocker's Fish Oil 2%	4/22 & 27	10 ab	12 bc	33 b	22 a	34 a	5 a	0 a	0 a	4 b	3 ab	0 a	1 a
4	*Lime Sulfur 2% + JMS Stylet Oil 2%*	4/22 & 27	7 a	9 ab	15 a	21 a	33 a	4 a	<1 a	<1 a	0 a	0 a	0 a	0 a
5	Lime Sulfur 1% + JMS Stylet Oil 1%	4/22 & 27	6 a	8 ab	35 b	19 a	36 a	5 a	0 a	0 a	3 ab	3 ab	0 a	0 a
6	Lime Sulfur 1% + JMS Stylet Oil 1% + Rally 1.25 oz	4/22 & 27	6 a	7 ab	24 ab	16 a	28 a	4 a	0 a	0 a	1 ab	0 a	0 a	1 a
7	Rally 40W 1.25 oz	4/22 & 27	18 b	19 cd	77 c	20 a	33 a	4 a	0 a	0 a	1 ab	1 ab	0 a	0 a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four single-tree replications. Treatments applied 19 Apr (trt. #1 only, bloom stages pink to petal fall); 20 Apr (trt. #2 only, bloom stages pink to petal fall); 22 Apr (all trmts, full bloom); 27 Apr (follow up for late bloom thinning, all treatments, petal fall). All treatments covered with Rally 1.25 oz/ 100 gal after 27 Apr, 12 May, 20 May, 6 Jun, and 21 Jun and 5 Jul.

Foliar data counts of ten terminal shoots each of four single-tree reps 17 Jun. Fruit counts are means of 25-fruit samples from each of four single-tree reps on the tree (russet rating), at harvest 16 Jul, or rot assessments after 14 days' incubation.

Table 5. Bloom thinning effects and fruit finish by lime sulfur and oils. Ginger Gold, Block #4, Virginia Tech AREC.

		bloom spray timing	Crop load estimates of % of crop load on tree *				Fruit finish assessments**					
							% of fruits with side russet, on		post-harvest russet ratings			
									% fruit area		stem-end	
	Bloom treatment and rate/ 100 gal	timing	14 Jul		19 Aug		tree 14 Jul		russetted		russet (0-5)	
0	No fungicide	---	96	b	111	b	4	a	0.8	a	1.1	a
1	Lime Sulfur 2% + Crocker's Fish Oil 2%	4/19, 22, & 27	66	ab	61	a	28	b	9.7	bc	1.7	ab
2	Lime Sulfur 2% + Crocker's Fish Oil 2%	4/20, 22, & 27	30	a	44	a	34	b	7.0	b	2.3	b
3	Lime Sulfur 2% + Crocker's Fish Oil 2%	4/22 & 27	78	ab	94	ab	29	b	7.2	b	1.8	ab
4	Lime Sulfur 2% + JMS Stylet Oil 2%	4/22 & 27	66	ab	66	a	30	b	12.8	cd	1.8	ab
5	Lime Sulfur 1% + JMS Stylet Oil 1%	4/22 & 27	73	ab	93	ab	49	b	14.0	d	1.3	a
6	Lime Sulfur 1% + JMS Stylet Oil 1% + Rally 1.25 oz/100 gal	4/22 & 27	120	b	93	ab	45	b	12.6	cd	1.6	ab
7	Rally 40W 1.25 oz/100 gal	4/22 & 27	125	b	114	ab	3	a	0.5	a	1.1	a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four single-tree replications.
*Crop load was evaluated by two independent observations before harvest 14 Jul or at harvest 19 Aug.

**Fruit russet ratings are means of 25-fruit samples from each of four-single tree reps on the tree or after harvest 16 Jul.

Stem russet rated on a scale of 0-5 (5=severe russet).

PLANT PATHOLOGY

EVALUATION OF EXPERIMENTAL FUNGICIDES AND MIXED SCHEDULES ON STAYMAN, IDARED AND GINGER GOLD APPLES

K. S. Yoder, A. E. Cochran II, W. S. Royston, Jr., S. W. Kilmer and G. Engleman
Virginia Tech Agr. Res. & Ext. Center
595 Laurel Grove Road, Winchester, VA 22602

Ten combination treatments directed at fungicide resistance management approaches and broad-spectrum control, including two experimental combination products were tested on 26-yr-old trees in an area where scab fungus resistance to SI fungicides has been suspected since 2004 (Figure 1). The test was conducted in a randomized block design with four three-cultivar replicate tree sets separated by non-treated border rows. Treatment rows had been used as non-treated border rows in 2010 to stabilize mildew inoculum pressure for 2011. 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: 7 Apr (tight cluster, TC); 14 Apr (pink, P); 20 Apr (bloom, Bl); 2 May (petal fall, PF); First-sixth covers (1C-6C): 20 May, 3 Jun, 17 Jun, 11 Jul (last application on Ginger Gold), 28 Jul, and 17 Aug. Maintenance materials applied to the entire test block with the same equipment included Supracide + oil, Assail, Altacor, NAA 10 ppm + Sevin 2 pt + Regulaid, Imidan, Provado, Intrepid, Delegate, and Calypso. Inoculum over each Idared test tree included: cedar rust galls placed 6 Apr and wild blackberry canes with the sooty blotch and flyspeck fungi and bitter rot mummies placed 5 May. Other diseases developed from inoculum naturally present in the test area. Foliar data represent averages of counts of ten terminal shoots per tree 27 May (Idared), 18 Jul (Stayman), or 13 Jun (Ginger Gold). Postharvest fruit counts are means of 25-fruit samples picked from each of four single-tree reps 15 Aug (Ginger Gold). Idared was sampled 20 Sep and rated after 23 days incubation; Stayman sampled 21 Sep and rated after 28 days incubation at ambient temperatures 61-78°F. Percentage data were converted by the square root arcsin transformation for statistical analysis.

Powdery mildew resistance to SIs at Winchester became evident during 2009 (Figure 2). In this test block, control of powdery mildew by Nova (myclobutanil) 4 oz/A, based on percent leaves infected, ranged from 72-98% from 1994-2003. In 2009-10 control by Rally 5 oz/A of percent leaves infected by mildew was only 12%. In 2009, a higher Rally rate (7.5 oz/A) gave only slightly better control than the more typical 5 oz/A, further suggesting mildew resistance to SIs. Also, in the past two years QoI fungicides have not given as effective for mildew control as they were 10-12 years ago. In 2011, mildew conidia were available on infected emerging buds 23 Mar, and 28 days were favorable for mildew infection in April and May. Treatments involving the SIs Rally and Indar or the QoI, Flint, gave significant mildew control compared to no-treated trees but were significantly weaker than treatments involving package mixes of two chemical classes. Merivon, applied in all applications, gave the best mildew control overall, including primary effect, and control of secondary infection on foliage and fruit. Adding Rally to Indar significantly improved mildew control on Idared and Stayman foliage. All treatments gave strong suppression of mildew russetting on fruit. We have seen scab resistance to SIs in this test block since 2004 (Figure 2). Rally + Penncozeb gave 52% control of scab on Stayman foliage, which was similar to 2009-10. QoIs apparently remain effective for scab control (Table 2), as indicated by Flint + Penncozeb (Trt #10). Merivon gave excellent scab control on leaves and fruit. Treatments involving Luna Sensation alternated with Rally + Penncozeb or Indar + Penncozeb with or without Rally were generally intermediate in control between Flint + Penncozeb and Rally + Penncozeb. Under light disease pressure, all treatments gave adequate control of cedar-apple rust on leaves and Brooks fruit spot. Under strong disease pressure, treatments involving Merivon gave superior control. Other treatments, which had Captan + Ziram in the late cover sprays, gave significant control but had some differences that reflected application effects as early as 2nd cover. Under moderate disease pressure, al treatments gave adequate control of post-harvest rots. No treatment deleteriously affected fruit finish compared to non-treated fruit.

Table 1. Powdery mildew control on Stayman, Idared and Ginger Gold apples. Virginia Tech AREC.

			Idared		% leaves or leaf area or fruit infected **																	
			primary		Idared						Stayman						Ginger Gold					
	Treatment and formulated rate/acre	Timing	effect*		leaves		area		fruit		lvs		area		fruit		lvs		area		fruit	
0	No fungicide	---	1.2	e	68	d	40	d	80	c	67	f	52	f	33	c	76	h	55	f	18	c
1	Rally 40WSP 5 oz + Penncozeb 75WG 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb + Rally 5 oz	TC-3C 4C →	4.3	d	38	bc	7	ab	12	b	32	de	5	c-e	0	a	58	g	12	de	2	b
2	Luna Sensation 4.0 oz Rally 40WSP 5 oz + Penncozeb 75WG 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-P, PF-1C Bl, 2C-3C 4C →	6.6	bc	29	ab	4	ab	4	a	23	cd	4	b-d	3	ab	32	c-e	5	bc	1	ab
3	Luna Sensation 4.0 oz + Penncozeb 75WG 3 lb Rally 40WSP 5 oz + Penncozeb 75WG 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-P, PF-1C Bl, 2C-3C 4C →	6.8	bc	30	a-c	5	ab	6	ab	20	c	3	bc	5	ab	28	b-d	3	a-c	0	a
4	Merivon 4 fl oz + Silwet L-77 113.6 ml/100 gal	TC→	7.5	ab	20	a	3	a	6	ab	10	a	2	a	1	ab	12	a	2	a	0	a
5	Merivon 5.5 fl oz + Silwet L-77 113.6 ml/100 gal	TC→	8.3	a	21	a	4	a	4	ab	6	a	1	a	1	ab	16	ab	3	ab	0	a
6	Merivon 4 fl oz + Captan 2 lb + Silwet L-77 113.6 ml	TC→	7.4	ab	20	a	3	a	4	ab	11	ab	2	ab	5	ab	14	a	2	ab	0	a
7	Merivon 4 fl oz + Penncozeb 3 lb + Silwet L-77 113.6 ml Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C→	6.9	a-c	22	a	3	a	4	ab	18	bc	2	ab	0	a	21	a-c	3	ab	0	a
8	Indar 2F 8 fl oz + Rally 40WSP 8 oz + Penncozeb 3 lb + LI-700, 2 pt/100 gal Indar 2F 8 fl oz + Captan 30 oz + LI-700, 2 pts/100 gal	TC-1C 2C→	5.5	cd	29	ab	5	ab	5	ab	25	cd	5	de	9	b	45	e-g	11	de	1	ab
9	Indar 2F 8 fl oz + Penncozeb 3 lb + LI-700, 2 pt/100 gal Indar 2F 8 fl oz + Captan 30 oz + LI-700, 2 pts/100 gal	TC - 1C 2C→	4.6	d	47	c	14	c	11	b	36	e	7	e	6	ab	55	fg	15	e	0	a
10	Flint 50WG 2 oz + Penncozeb 75WG 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C→	4.8	d	38	bc	7	b	3	a	29	de	6	de	3	ab	40	d-f	7	cd	0	a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four reps; ten shoots/tree rated 27 May (Idared), 18 Jul (Stayman), or 13 Jun (Ginger Gold) or harvest counts of 25-fruit samples picked from each of four single-tree reps 15 Aug (G. Gold), 20 Sep (Idared), or 4 Oct Sep (Stayman).

*Apparent suppressive effect rated on six primary mildew shoots / tree, four reps 10 Jun : scale 1-10 (1 = none; 10 = excellent effect)

Treatments applied airblast at 100 gpa to both sides of the row on each date.

Treatment application dates: 7 Apr (tight cluster, TC); 14 Apr (pink, P); 20 Apr (bloom, Bl); 2 May (petal fall, PF); First-sixth covers (1C-6C): 20 May, 3 Jun, 17 Jun, 11 Jul (last application on Ginger Gold), 28 Jul, and 17 Aug.

Table 2. Scab, cedar rust and Brooks spot control on Stayman, Idared and Ginger Gold apples.

			Scab, % leaves infected						Scab, % fruit infected**						% lvs		Brooks spot, %			
			Stay-				Ginger		Stay-				Ginger		c-a rust		Stay-			
	Treatment and formulated rate/acre	Timing	man		Idared		Gold		man		Idared		Gold		G. Gold		man		Idared	
0	No fungicide	---	74	e	9	d	28	f	65	f	52	e	67	d	17	c	10	b	7	c
1	Rally 40WSP 5 oz + Penncozeb 75WG 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb + Rally 5 oz	TC-3C 4C →	35	d	4	c	15	e	6	c-e	6	cd	11	bc	<1	a	0	a	0	a
2	Luna Sensation 4.0 oz Rally 40WSP 5 oz + Penncozeb 75WG 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-P, PF-1C Bl, 2C-3C 4C →	16	bc	2	a-c	5	b-d	11	e	0	a	12	bc	<1	a	0	a	1	b
3	Luna Sensation 4.0 oz + Penncozeb 75WG 3 lb Rally 40WSP 5 oz + Penncozeb 75WG 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-P, PF-1C Bl, 2C-3C 4C →	13	bc	<1	a	2	a-c	3	a-c	2	a-c	15	c	0	a	0	a	0	a
4	Merivon 4 fl oz + Silwet L-77 113.6 ml/100 gal	TC→	8	ab	<1	a	1	a-c	1	ab	2	a-c	1	a	0	a	0	a	0	a
5	Merivon 5.5 fl oz + Silwet L-77 113.6 ml/100 gal	TC→	4	a	<1	ab	1	ab	0	a	1	ab	2	a	<1	a	0	a	0	a
6	Merivon 4 fl oz + Captan 2 lb + Silwet L-77 113.6 ml	TC→	4	a	<1	a	1	a	0	a	4	bc	2	a	0	a	0	a	0	a
7	Merivon 4 fl oz + Penncozeb 3 lb + Silwet L-77 113.6 ml Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C→	10	a-c	<1	ab	2	a-c	3	a-c	0	a	7	a-c	0	a	0	a	0	a
8	Indar 2F 8 fl oz + Rally 40WSP 8 oz + Penncozeb 3 lb + LI-700, 2 pt/100 gal Indar 2F 8 fl oz + Captan 30 oz + LI-700, 2 pts/100 gal	TC-1C 2C→	15	bc	1	ab	5	cd	5	b-d	4	a-c	5	ab	<1	a	0	a	0	a
9	Indar 2F 8 fl oz + Penncozeb 3 lb + LI-700, 2 pt/100 gal Indar 2F 8 fl oz + Captan 30 oz + LI-700, 2 pts/100 gal	TC - 1C 2C→	20	c	2	bc	8	de	8	de	10	d	4	a	<1	a	0	a	0	a
10	Flint 50WG 2 oz + Penncozeb 75WG 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C→	9	ab	<1	ab	3	a-c	2	a-c	0	a	11	bc	2	b	0	a	0	a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four reps; ten shoots/tree rated 27 May (Idared), 18 Jul (Stayman), or 13 Jun (Ginger Gold) or harvest counts of 25-fruit samples picked from each of four single-tree reps 15 Aug (Ginger Gold), 20 Sep (Idared), or 4 Oct (Stayman).

Test rows were used as non-treated border rows in 2010 to stabilize mildew inoculum pressure for 2011. Treatments applied airblast at 100 gpa to both sides of the row on each date.

Treatment application dates: 7 Apr (tight cluster, TC); 14 Apr (pink, P); 20 Apr (bloom, Bl); 2 May (petal fall, PF); First-sixth covers (1C-6C): 20 May, 3 Jun, 17 Jun, 11 Jul (last application on Ginger Gold), 28 Jul, and 17 Aug.

Table 3. Control of sooty blotch and flyspeck, and fruit finish effects by fungicides on Stayman, Idared, and Ginger Gold apples.

			% fruit infected, postharvest counts												Fruit finish ratings (0-5)*							
			Sooty blotch						Flyspeck						Russet				Opalescence			
			Stay-				Ginger		Stay-				Ginger		Stay-		Ginger		Stay-			
	Treatment and rate/A		man		Idared		Gold		man		Idared		Gold		man		Gold		man		Idared	
0	No fungicide	---	100	d	100	d	94	c	73	g	67	c	17	b	2.3	a	1.8	b	1.8	a	1.8	d
1	Rally 40WSP 5 oz + Penncozeb 75WG 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb + Rally 5 oz	TC-3C 4C →	49	bc	30	bc	0	a	7	b-d	1	a	0	a	1.8	a	1.6	ab	1.7	a	1.0	a-c
2	Luna Sensation 4.0 oz Rally 40WSP 5 oz + Penncozeb 75WG 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-P, PF-1C Bl, 2C-3C 4C →	36	a-c	27	bc	3	ab	21	ef	2	a	0	a	2.4	a	1.3	ab	2.2	a	1.4	c
3	Luna Sensation 4.0 oz + Penncozeb 75WG 3 lb Rally 40WSP 5 oz + Penncozeb 75WG 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-P, PF-1C Bl, 2C-3C 4C →	45	bc	14	ab	3	ab	16	d-f	1	a	0	a	2.0	a	1.2	ab	1.8	a	0.8	a
4	Merivon 4 fl oz + Silwet L-77 113.6 ml/100 gal	TC→	28	ab	8	a	0	a	0	a	0	a	0	a	1.7	a	1.3	ab	1.5	a	1.3	bc
5	Merivon 5.5 fl oz + Silwet L-77 113.6 ml/100 gal	TC→	11	a	6	ab	0	a	2	ab	0	a	0	a	2.4	a	1.6	ab	1.7	a	0.8	a
6	Merivon 4 fl oz + Captan 2 lb + Silwet L-77 113.6 ml	TC→	9	a	10	ab	0	a	0	a	1	a	0	a	1.9	a	0.7	a	1.6	a	1.0	a-c
7	Merivon 4 fl oz + Penncozeb 3 lb + Silwet L-77 113.6 ml Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C→	19	ab	11	ab	0	a	4	a-c	0	a	0	a	1.7	a	1.5	ab	1.1	a	1.1	a-c
8	Indar 2F 8 fl oz + Rally 40WSP 8 oz + Penncozeb 3 lb + LI-700, 2 pt/100 gal Indar 2F 8 fl oz + Captan 30 oz + LI-700, 2 pts/100 gal	TC-1C 2C→	59	c	49	c	8	b	23	f	6	b	1	a	2.5	a	2.0	b	2.0	a	1.4	cd
9	Indar 2F 8 fl oz + Penncozeb 3 lb + LI-700, 2 pt/100 gal Indar 2F 8 fl oz + Captan 30 oz + LI-700, 2 pts/100 gal	TC - 1C 2C→	42	bc	43	c	5	ab	13	b-e	1	a	0	a	1.9	a	1.7	ab	1.6	a	0.9	ab
10	Flint 50WG 2 oz + Penncozeb 75WG 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C→	49	bc	27	bc	2	a	15	c-f	1	a	0	a	1.7	a	1.2	ab	1.4	a	1.3	c

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Postharvest counts of 25 fruit samples picked from each of four single-tree reps 15 Aug (Ginger Gold), 21 Sep (Idared), or 4 Oct (Stayman).

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

Table 4. Treatment effect on post-harvest rot development. Ginger Gold. Block #13, Virginia Tech AREC.

			Fruit rot incidence (%), days after harvest incubation period*															
			Harvest + 10 days								Harvest + 15 days							
	Treatment and formulated rate/acre	Timing	any		bitter		Bot		Phomopsis		any		bitter		Bot		Phomopsis	
0	No fungicide	---	18	b	7	c	8	c	10	b	40	b	13	c	23	d	13	b
1	Rally 40WSP 5 oz + Penncozeb 75WG 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb + Rally 40WSP 5 oz	TC-3C 4C →	4	ab	1	ab	2	a-c	1	a	8	a	1	ab	5	bc	2	a
2	Luna Sensation 4.0 oz Rally 40WSP 5 oz + Penncozeb 75WG 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-P, PF-1C Bl, 2C-3C 4C →	1	a	0	a	1	ab	0	a	5	a	0	a	3	a-c	2	a
3	Luna Sensation 4.0 oz + Penncozeb 75WG 3 lb Rally 40WSP 5 oz + Penncozeb 75WG 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-P, PF-1C Bl, 2C-3C 4C →	4	ab	2	ab	2	a-c	0	a	5	a	2	ab	3	a-c	0	a
4	Merivon 4 fl oz + Silwet L-77 113.6 ml/100 gal	TC→	3	ab	0	a	1	ab	1	a	6	a	0	a	3	a-c	2	a
5	Merivon 5.5 fl oz + Silwet L-77 113.6 ml/100 gal	TC→	3	ab	0	a	3	a-c	0	a	4	a	0	a	4	bc	0	a
6	Merivon 4 fl oz + Captan 2 lb 80WDG + Silwet L-77 113.6 ml	TC→	0	a	0	a	0	a	0	a	5	a	0	a	1	ab	1	a
7	Merivon 4 fl oz + Penncozeb 75WG 3 lb + Silwet L-77 113.6 ml Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C→	3	ab	3	bc	0	a	0	a	4	a	3	b	1	ab	0	a
8	Indar 2F 8 fl oz + Rally 40WSP 8 oz + Penncozeb 75DF 3 lb + LI-700, 2 pt/100 gal Indar 2F 8 fl oz + Captan 80WDG 30 oz + LI-700, 2 pts/100 gal	TC-1C 2C→	1	a	0	a	0	a	1	a	2	a	0	a	0	a	2	a
9	Indar 2F 8 fl oz + Penncozeb 75DF 3 lb + LI-700, 2 pt/100 gal Indar 2F 8 fl oz + Captan 80WDG 30 oz + LI-700, 2 pts/100 gal	TC - 1C 2C→	6	ab	0	a	5	bc	1	a	8	a	0	a	6	c	1	a
10	Flint 50WG 2 oz + Penncozeb 75WG 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C→	3	ab	0	a	2	a-c	1	a	4	a	2	ab	2	a-c	1	a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Counts of 25 fruit from four single-tree reps 15 Aug.

*Rot counts following 10 and 15 days' incubation at ambient temperatures. Max/min temperature range for 10 and 15-day incubations were
70-88°F (mean 79.1°F) and 68-89°F (mean 78.5°F), respectively.

Treatment application dates: 7 Apr (tight cluster, TC); 14 Apr (pink); 20 Apr (bloom); 2 May (petal fall); First-4th covers: 20 May, 3 Jun, 17 Jun, 11 Jul.

Table 5. Control of post-harvest fruit rots on Stayman and Idared apples.

			% fruit infected, postharvest counts															
			Any rot				Bitter rot				White rot				Alternaria			
			Stay-				Stay-				Stay-				Stay-			
	Treatment and rate/A		man		Idared		Man		Idared		man		Idared		man		Idared	
0	No fungicide	---	52	c	52	e	31	c	48	c	16	b	12	b	11	b	0	a
1	Rally 40WSP 5 oz + Penncozeb 75WG 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb + Rally 5 oz	TC-3C 4C →	2	a	1	ab	0	a	0	a	2	a	1	a	0	a	0	a
2	Luna Sensation 4.0 oz Rally 40WSP 5 oz + Penncozeb 75WG 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-P, PF-1C Bl, 2C-3C 4C →	8	ab	3	b-d	4	ab	2	ab	1	a	1	a	3	a	0	a
3	Luna Sensation 4.0 oz + Penncozeb 75WG 3 lb Rally 40WSP 5 oz + Penncozeb 75WG 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-P, PF-1C Bl, 2C-3C 4C →	3	ab	0	a	1	ab	0	a	2	a	0	a	0	a	0	a
4	Merivon 4 fl oz + Silwet L-77 113.6 ml/100 gal	TC→	5	ab	2	a-c	3	ab	2	ab	0	a	0	a	2	a	0	a
5	Merivon 5.5 fl oz + Silwet L-77 113.6 ml/100 gal	TC→	3	ab	0	a	1	ab	0	a	0	a	0	a	2	a	0	a
6	Merivon 4 fl oz + Captan 2 lb + Silwet L-77 113.6 ml	TC→	5	ab	1	ab	3	ab	1	ab	2	a	0	a	1	a	0	a
7	Merivon 4 fl oz + Penncozeb 3 lb + Silwet L-77 113.6 ml Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C→	3	ab	0	a	0	a	0	a	1	a	0	a	1	a	0	a
8	Indar 2F 8 fl oz + Rally 40WSP 8 oz + Penncozeb 3 lb + LI-700, 2 pt/100 gal Indar 2F 8 fl oz + Captan 30 oz + LI-700, 2 pts/100 gal	TC-1C 2C→	9	b	4	cd	5	b	2	ab	2	a	0	a	2	a	2	a
9	Indar 2F 8 fl oz + Penncozeb 3 lb + LI-700, 2 pt/100 gal Indar 2F 8 fl oz + Captan 30 oz + LI-700, 2 pts/100 gal	TC - 1C 2C→	2	a	8	d	2	ab	6	b	0	a	1	a	0	a	0	a
10	Flint 50WG 2 oz + Penncozeb 75WG 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C→	3	ab	3	a-d	0	a	2	ab	1	a	1	a	2	a	0	a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Postharvest fruit counts are means of 25-fruit samples picked from each of four single-tree reps. Idared sampled 20 Sep and rated after 23 days incubation; Stayman sampled 4 Oct and rated after 28 days incubation at ambient temperatures 61-78°F.

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

Treatment application dates: 7 Apr (tight cluster, TC); 14 Apr (pink, P); 20 Apr (bloom, Bl); 2 May (petal fall, PF); first-sixth covers (1C-6C): 20 May, 3 Jun, 17 Jun, 11 Jul (last application on Ginger Gold), 28 Jul, and 17 Aug.

Figure 1. 18-yr history of foliar scab control with SI+EBDC
Stayman apple, Winchester, VA

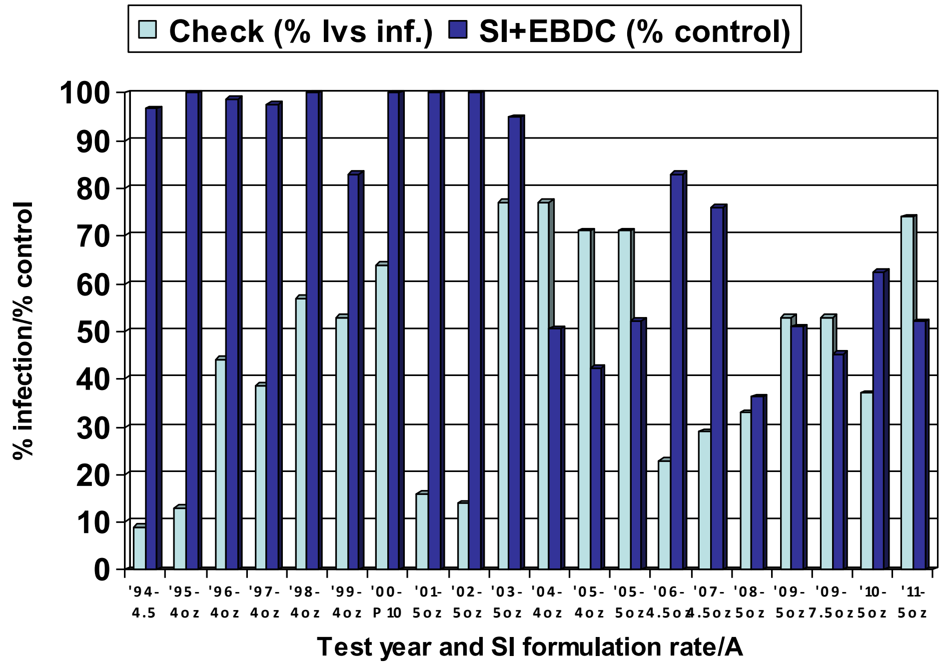
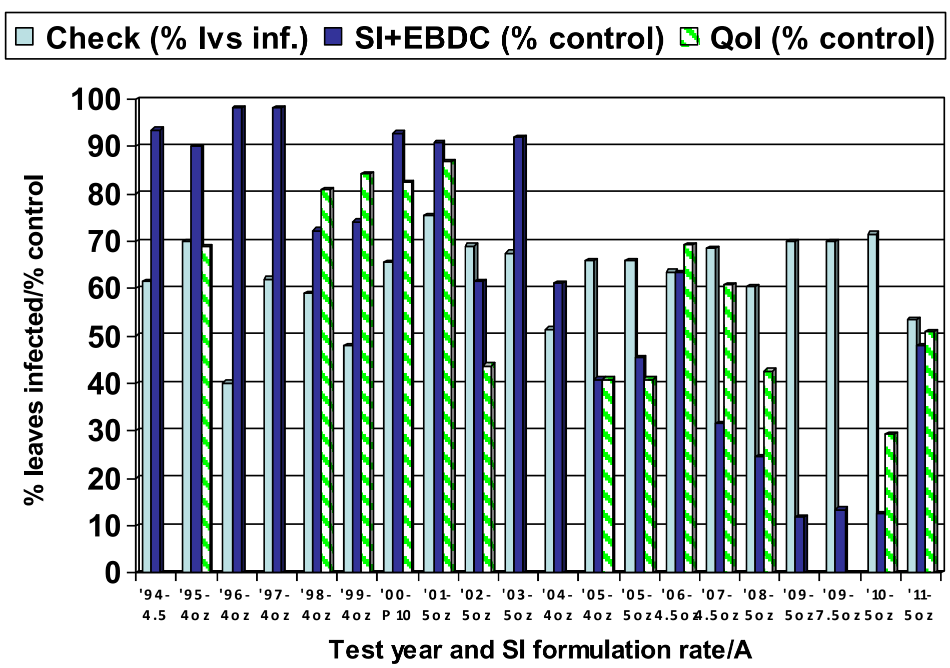


Figure 2. Control of % leaves infected with mildew by SI+EBDC and QoI
Stayman and Idared apples, 1994-2011, Winchester, VA



CONTROL OF POWDERY MILDEW AND OTHER DISEASES BY EXPERIMENTAL FUNGICIDES AND MIXED SCHEDULES ON IDARED APPLES

K. S. Yoder, A. E. Cochran II, W. S. Royston, Jr., S. W. Kilmer and G. Engleman
Virginia Tech Agr. Res. & Ext. Center
595 Laurel Grove Road, Winchester, VA 22602

Sixteen experimental and registered combination treatment regimes were directed at powdery mildew control in an area where SI fungicide effectiveness is declining. The test was established as four randomized blocks on 30-yr-old trees using single-tree replications with border rows between treatment rows. Treatment rows had been used as non-treated border rows in 2010 to stabilize mildew inoculum pressure for 2011. 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: App. #1- 14 Apr (pink); #2- 22 Apr (bloom); #3- 2 May (1C); #4- 11 May (2C); #5- 20 May (3C); #6- 3 Jun (4C); #7- 17 Jun (5C); #8- 1 Jul (6C); #9- 28 Jul (7C); #10- 11 Aug (8C). Maintenance materials applied to the entire test block with the same equipment included Lorsban + oil, FireWall, Altacor, Assail, Imidan, Provado, Intrepid, Delegate and Calypso. All diseases developed from inoculum naturally present in the test area. Foliar data represent averages of counts of ten terminal shoots per tree 24 May. Apparent suppressive effect on appearance of primary mildew was rated on six primary mildew shoots / tree, 13 Jun using a scale of 1-10 (1= none; 10= excellent effect). Quince rust counted on 50 fruit per tree 19 Jul. Postharvest fruit counts are means of 25-fruit samples picked from each of four single-tree reps 22 Sep and placed in cold storage until evaluation 17 Nov. Percentage data were converted by the square root arcsin transformation for statistical analysis.

The possibility of powdery mildew resistance to SIs in this test block became evident during 2009-10. In 2009 control of powdery mildew by Nova (myclobutanil) 4 oz/A, based on percent leaves infected, ranged from 75-95% but in 2010, control by Rally (myclobutanil) 5 oz/A of percent leaves infected by mildew was only 8%. In 2011, mildew conidia were available on infected emerging buds 23 March, and 28 days in April and May were favorable for mildew infection. Qualitative assessment of treatment effects (first data column, 6) on primary powdery mildew development showed excellent effects by Topguard (Trt. 5) and Luna Sensation/Topguard (Trt. 7). Generally, these treatments also gave the best mildew control of secondary infection as indicated by percent leaves and percent leaf area infected. Flint or Flint combined with Microthiol Disperss, Regalia or JMS Stylet Oil also gave strong suppression of secondary mildew although their primary effect was not as strong. Based on percent leaves and percent area infected, all treatments gave significant control under heavy disease pressure. The combination of Rally + sulfur (Trt. 2) gave significantly better control than either Rally (Trt. 1) or Sulfur (Trt. 15) separately. Under extremely heavy pressure, all treatments gave significant control of percent fruit and fruit area affected, with Luna Sensation/Topguard (Trt. 7) providing outstanding control. Most treatments gave significant control of scab which was very light on foliage but more prevalent on non-treated fruit. Treatments involving Penncozeb or Flint generally gave the best fruit scab control. Although most of the treatment schedules received Captan + Ziram in the last two applications, effects from Penncozeb in the earlier applications was evident in sooty blotch, flyspeck and rot control (Tables 7-8). Regalia and JMS Stylet Oil, applied in the late covers sprays, were significantly weaker than other treatments for summer disease and bitter rot and white rot control, but they did provide significant control compared to non-treated trees. Apart from russetting that were presumed to be caused by mildew, there was no significant increase in either russet or opalescence compared to non-treated fruit (Table 8), and several treatments significantly improved fruit finish.

Table 6. Powdery mildew control on Idared apples. Block #15. Virginia Tech AREC.

			Primary		Mildew infection							
			mildew		% leaves				% fruit infected			
	Treatment and rate /A	Timing	effect*		% lvs		% area		% fruit		% area	
0	No fungicide	---	1.4	f	61	g	33	c	96	g	22	f
1	Rally 40WSP 5 oz + Penncozeb 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1-8 #9 →	3.5	bc	47	f	8	b	74	f	11	a-c
2	Rally 5 oz + Microthiol Disperss 80DF 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1-8 #9 →	3.5	bc	26	a-c	3	a	41	b-d	5	a-c
3	Flint 50WG 2 oz + Penncozeb 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1-8 #9 →	3.0	c-e	21	ab	3	a	27	ab	3	ab
4	Flint 50WG 2 oz + Microthiol Disperss 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1-8 #9 →	3.4	b-d	18	a	3	a	26	a-c	3	bc
5	Topguard 10 fl oz + Microthiol Disperss 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1-8 #9 →	6.2	a	24	a-c	3	a	45	cd	5	bc
6	Flint 50WG 2 oz + Koverall 75DF* 3 lb Topguard 125SC 13 fl oz + Koverall 75DF* 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1,3,5,7 #2,4,6,8 #9 →	4.0	b	22	ab	3	a	38	b-d	4	cd
7	Luna Sensation 500SC 4 fl oz+ Penncozeb 3 lb Topguard 125SC 10 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1,3,5,7 #2,4,6,8 #9 →	6.4	a	17	a	2	a	17	a	1	a
8	Flint 50WG 2 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1-8 #9 →	2.9	c-e	22	ab	3	a	49	de	5	b-d
9	Regalia SC 2 qt	#1→	2.3	e	45	ef	9	b	66	ef	9	de
10	Regalia SC 2 qt Flint 50WG 2 oz + Regalia SC 1 qt Captan 80WDG 30 oz + Ziram 76DF 3 lb	1,3,5,7,9,11 #2,4,6,8 #10	2.4	e	39	d-f	7	b	71	f	10	cd
11	Flint 50WG 2 oz + Regalia SC 1 qt Ziram 76DF 3 lb + Regalia SC 1 qt	#1-8 #9 →	2.5	de	29	b-d	4	a	46	cd	4	cd
12	JMS Stylet Oil 1.5 gal	#1→	2.3	ef	45	ef	11	b	78	f	10	e
13	JMS Stylet Oil 1.5 gal Flint 50WG 2 oz + JMS Stylet Oil 3 qt Ziram 76DF 3 lb + JMS Stylet Oil 1.0 gal	1,3,5,7,9,11 #2,4,6,8 #10	2.6	de	26	a-c	4	a	70	f	10	bc
14	Flint 50WG 2 oz + JMS Stylet Oil 3 qt Ziram 76DF 3 lb + JMS Stylet Oil 1.5 gal	#1-8 #9 →	2.9	c-e	19	ab	3	a	49	de	5	cd
15	Microthiol Disperss 80DF 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1-8 #9 →	2.4	e	44	ef	8	b	71	f	11	cd
16	Microthiol Disperss 80DF 8 lb Flint 50WG 2 oz + Microthiol Disperss 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1,3,5,7 #2,4,6,8 #9 →	2.9	c-e	34	c-e	4	a	41	b-d	5	a-c

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four reps; ten shoots/tree rated 24 May.
* Koverall was used 11 May and later applications; Penncozeb in earlier apps.
Treatment rows were used as non-treated border rows in 2010 to stabilize mildew inoculum pressure for 2011. Applied airblast at 100 gpa to both sides of the row on each application date.
** Apparent suppressive effect rated on six primary mildew shoots / tree 13 Jun: scale 1-10 (1= none; 10= excellent effect).

Table 7. Early season and summer disease control on Idared apples. Block #15.

							Quince		% fruit infected			
			Scab infection				rust, on		Sooty		Fly	
	Treatment and rate /A	Timing	% lvs		% fruit		tree**		blotch		speck	
0	No fungicide	---	2.3	d	17	d	16	e	85	f	53	d
1	Rally 40WSP 5 oz + Penncozeb 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1-8 #9 →	1.5	cd	5	bc	0	a	5	a-c	0	a
2	Rally 5 oz + Microthiol Disperss 80DF 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1-8 #9 →	1.0	b-d	7	bc	0	a	16	a-c	7	bc
3	Flint 50WG 2 oz + Penncozeb 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1-8 #9 →	0.3	ab	0	a	0	a	2	ab	0	a
4	Flint 50WG 2 oz + Microthiol Disperss 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1-8 #9 →	0.3	ab	1	ab	0	a	17	bc	3	ab
5	Topguard 10 fl oz + Microthiol Disperss 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1-8 #9 →	0.6	a-c	5	bc	1	ab	22	bc	6	ab
6	Flint 50WG 2 oz + Koverall 75DF* 3 lb Topguard 125SC 13 fl oz + Koverall 75DF* 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1,3,5,7 #2,4,6,8 #9 →	0.6	a-c	0	a	0	a	19	cd	2	ab
7	Luna Sensation 500SC 4 fl oz+ Penncozeb 3 lb Topguard 125SC 10 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1,3,5,7 #2,4,6,8 #9 →	0.2	ab	0	a	1	ab	0	a	0	a
8	Flint 50WG 2 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1-8 #9 →	0.1	a	3	a-c	3	a-c	23	b-d	2	ab
9	Regalia SC 2 qt	#1→	0.4	a-c	7	cd	4	d	44	de	15	c
10	Regalia SC 2 qt Flint 50WG 2 oz + Regalia SC 1 qt Captan 80WDG 30 oz + Ziram 76DF 3 lb	1,3,5,7,9,11 #2,4,6,8 #10	0.8	a-c	9	cd	5	d	25	cd	1	ab
11	Flint 50WG 2 oz + Regalia SC 1 qt Ziram 76DF 3 lb + Regalia SC 1 qt	#1-8 #9 →	0.8	a-c	2	a-c	2	bc	26	cd	4	ab
12	JMS Stylet Oil 1.5 gal	#1→	0.3	ab	2	a-c	4	d	60	e	42	d
13	JMS Stylet Oil 1.5 gal Flint 50WG 2 oz + JMS Stylet Oil 3 qt Ziram 76DF 3 lb + JMS Stylet Oil 1.0 gal	1,3,5,7,9,11 #2,4,6,8 #10	0.2	ab	4	a-c	5	d	23	bc	6	ab
14	Flint 50WG 2 oz + JMS Stylet Oil 3 qt Ziram 76DF 3 lb + JMS Stylet Oil 1.5 gal	#1-8 #9 →	0	a	3	a-c	4	cd	26	cd	1	ab
15	Microthiol Disperss 80DF 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1-8 #9 →	0.7	a-c	4	a-c	6	d	28	cd	4	ab
16	Microthiol Disperss 80DF 8 lb Flint 50WG 2 oz + Microthiol Disperss 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1,3,5,7 #2,4,6,8 #9 →	0	a	2	ab	6	d	11	a-c	1	ab

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Foliar counts based on 10 shoots from each of four single-tree replications rated 24 May or 25 fruit per replication harvested 22 Sep and placed in cold storage until evaluation 26 Oct.

Treatment rows were used as non-treated border rows in 2010 to stabilize mildew inoculum pressure for 2011. Applied airblast at 100 gpa to both sides of the row on each application date.
* Koverall was used in 11 May and later applications; Penncozeb in earlier apps.
** Quince rust counted on 50 fruit per tree 19 Jul.

Table 8. Postharvest storage rots and fruit finish of Idared apples. Block #15.

			Post-incubation rots (%)*								Fruit finish**			
			Any		Bitter		White		Alter-				opal-	
	Treatment and rate/A	Timing	rot		rot		rot		naria		russet		escence	
0	No fungicide	---	59	d	37	c	21	d	7	d	1.4	e	1.8	g
1	Rally 40WSP 5 oz + Penncozeb 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1-8 #9 →	1	ab	0	a	1	ab	0	a	1.1	a-e	1.5	b-g
2	Rally 5 oz + Microthiol Disperss 80DF 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1-8 #9 →	0	a	0	a	0	a	0	a	1.0	a-d	1.6	d-g
3	Flint 50WG 2 oz + Penncozeb 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1-8 #9 →	0	a	0	a	0	a	0	a	1.0	a-d	1.1	a-c
4	Flint 50WG 2 oz + Microthiol Disperss 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1-8 #9 →	3	b	1	a	2	a-c	0	a	1.1	a-e	1.3	b-e
5	Topguard 10 fl oz + Microthiol Disperss 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1-8 #9 →	4	ab	4	a	0	a	0	a	0.9	a-c	1.3	a-d
6	Flint 50WG 2 oz + Koverall 75DF* 3 lb Topguard 13 fl oz + Koverall 75DF* 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1,3,5,7 #2,4,6,8 #9 →	2	ab	1	a	1	ab	0	a	0.8	ab	1.1	ab
7	Luna Sensation 4 fl oz+ Penncozeb 3 lb Topguard 125SC 10 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1,3,5,7 #2,4,6,8 #9 →	0	a	0	a	0	a	0	a	0.8	ab	0.8	a
8	Flint 50WG 2 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1-8 #9 →	1	ab	0	a	1	a	0	a	1.0	a-e	1.4	b-f
9	Regalia SC 2 qt	#1→	16	c	13	b	3	bc	2	bc	1.4	de	1.8	fg
10	Regalia SC 2 qt Flint 50WG 2 oz + Regalia SC 1 qt Captan 80WDG 30 oz + Ziram 76DF 3 lb	1,3,5,7,9,11 #2,4,6,8 #10	14	c	11	b	2	a-c	1	ab	1.3	c-e	1.5	c-g
11	Flint 50WG 2 oz + Regalia SC 1 qt Ziram 76DF 3 lb + Regalia SC 1 qt	#1-8 #9 →	5	ab	3	a	2	ab	0	a	1.0	a-e	1.1	ab
12	JMS Stylet Oil 1.5 gal	#1→	16	c	9	b	4	c	3	c	1.3	c-e	1.7	e-g
13	JMS Stylet Oil 1.5 gal Flint 50WG 2 oz + JMS Stylet Oil 3 qt Ziram 76DF 3 lb + JMS Stylet Oil 1.0 gal	1,3,5,7,9,11 #2,4,6,8 #10	0	a	0	a	0	a	0	a	1.2	b-e	1.4	b-g
14	Flint 50WG 2 oz + JMS Stylet Oil 3 qt Ziram 76DF 3 lb + JMS Stylet Oil 1.5 gal	#1-8 #9 →	0	a	0	a	0	a	0	a	0.7	a	1.1	ab
15	Microthiol Disperss 80DF 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1-8 #9 →	0	a	0	a	0	a	0	a	1.1	a-e	1.3	b-e
16	Microthiol Disperss 80DF 8 lb Flint 50WG 2 oz + Microthiol Disperss 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	#1,3,5,7 #2,4,6,8 #9 →	4	ab	2	a	2	a-c	0	a	1.3	c-e	1.2	a-d

* Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four reps; Data represent postharvest counts of 25 fruit per rep tree sampled 21 Sep and stored 34 days at 39°F then rated after 22 days incubation at ambient temperatures 61-78°F.

** Fruit finish rated on a scale of 0-5 (0=perfect finish; 5=severe russet). USDA Extra fancy and fancy grades after downgrading by russet presumed not to be caused by mildew.

DISEASE CONTROL BY EXPERIMENTAL FUNGICIDES AND MIXTURES ON GOLDEN DELICIOUS, IDARED, AND YORK IMPERIAL APPLES

K. S. Yoder, A. E. Cochran II, W. S. Royston, Jr., S. W. Kilmer and G. Engleman
Virginia Tech Agr. Res. & Ext. Center
595 Laurel Grove Road, Winchester, VA 22602

Seventeen experimental or combination treatment schedules were compared to registered treatments on 11-yr-old trees. The test was conducted in a randomized block design with four replicates separated by non-treated border rows. Test rows had been non-treated border rows in 2010, which allowed mildew inoculum pressure to stabilize on 2011 test trees. Fungicide treatments were applied to both sides of the tree on each indicated application date with a Swanson Model DA-400 airblast sprayer at 100 gal/A as follows: 7 Apr (TC- tight cluster); 14 Apr (P-pink), 25 Apr (Bl-York, full bloom; Golden and Idared, petal fall); 6 May (PF-York, petal fall); 1st-6th covers (1C-6C): 20 May, 3 Jun, 17 Jun, 7 Jul, 28 Jul, 17 Aug. Maintenance applications applied to the entire test block with the same equipment included Supracide, oil, FireWall, Assail, Altacor, Calypso, NAA 15 ppm + Carbaryl, Provado, Imidan, Intrepid, and Delegate. Inoculum placed over each Idared test tree included cedar galls, wild blackberry canes with the sooty blotch and flyspeck fungi, and bitter rot mummies 21 Apr. Other diseases developed from inoculum naturally present in the test area, including cedar-apple rust inoculum from red cedars in the vicinity. Foliar data are from counts of ten shoots per tree from each of four reps: 2 Jun (Idared), 28 Jun (Golden Delicious) or 11 Jul (York). Fruit data represent postharvest counts of 25 fruit per replicate tree sampled: 22 Sep (Golden Delicious), 26 Sep (Idared), or 4 Oct (York). Golden Delicious fruit were harvested 22 Sep, held 27 days in cold storage, then rated after 26 days incubation at ambient temperatures 61-78°F. Idared fruit were sampled 26 Sep and rated after 17 days incubation. York fruit were harvested 4 Oct and evaluated after 24 days incubation. Percentage data were converted by the square root arcsin transformation for statistical analysis.

Mildew pressure was high in this test block with conidia available as early as 23 March, and 28 days in April and May were favorable for mildew infection. Luna Sensation, Merivon and Topguard gave the most suppression of primary mildew (first data column in Table 9), significantly better than all other treatments. Omega/Inspire Super treatments had the least suppressive effect, but were significantly better than non-treated trees. The treatments with the best effect on primary infection also, generally, gave the best control of secondary mildew on leaves, percent leaf area infected, and percent fruit with mildew russet. The higher rate of Fontelis, especially with oil, gave strong secondary mildew control although primary suppression was not as good. Omega, Inspire Super and alternations of them gave the weakest mildew control overall. Early scab pressure was moderate with the first infection period occurring 1 Apr and lesions were observed Apr 28. However, seven secondary infection periods and nearly 4 inches of rain in one week in mid-May resulted in heavier pressure on fruit. Under these conditions, all treatments gave adequate control of scab on leaves (Table 10). There was evidence of some weakness on fruit scab control on some cultivars, but treatments involving Merivon, Inspire Super, and the higher rate of Fontelis gave good scab control on all cultivars. Under moderate pressure, cedar-apple rust control was generally adequate, with the best control by Topguard, Inspire, Indar and the higher rate of Fontelis (Table 11). All treatments gave adequate control of Brooks spot and sooty blotch, which developed late in the season. There were significant treatment differences in flyspeck infection, apparently related to what was applied as early as 2nd cover (Table 12). Fruit treated at 2nd cover with Fontelis, Omega Flint, Luna Sensation or Topguard had more flyspeck than those treated with Inspire Super or Inspire Super + Penncozeb. The most prominent post-harvest rot, bitter rot, was best controlled by Merivon or schedules involving Fontelis, Inspire Super or Indar to 2nd cover, followed by Captan +

Ziram (Table 13). Although there were significant differences in fruit finish, no treatments had more russet or opalescence than non-treated fruit.

Table 9. Mildew control on Idared, Golden Delicious and York apples.

			Idared		Mildew , % leaves, leaf area or fruit infected															
			primary		Idared						Golden Del.				York					
	Treatment and rate/A	Timing	effect*		leaves		lf area		fruit		lvs		lf area		leaves		lf area		fruit	
0	No fungicide	---	2.3	g	63	i	38	f	55	f	41	h	13	h	25	h	5	j	13	c
1	Rally 40WSP 5 oz + Penncozeb 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C →	6.9	b	16	c-e	3	ab	6	b-e	9	cd	2	bc	8	c-e	2	c-f	0	a
2	Fontelis 1.67SC 19.6 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	6.1	bc	11	a-c	2	ab	1	a	5	a-d	1	a-c	5	a-d	1	a-d	2	ab
3	Fontelis 19.6 fl oz + Damoil 2 qt/100 gal Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	5.8	bc	7	a-c	2	a	5	a-e	2	a-c	<1	ab	5	a-d	1	a-e	0	a
4	Penncozeb 75DF 4 lb Fontelis 1.67SC 19.6 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC P-2C 3C →	5.7	c	15	cd	3	ab	6	b-e	8	cd	2	b-e	4	a-c	1	a-d	1	a
5	Fontelis 1.67SC 13.9 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	6.0	bc	23	de	5	b	4	a-d	8	cd	2	b-d	7	c-e	2	d-h	1	ab
6	Omega 4SC 13.8 fl oz Inspire Super EW 12 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC & Bl P,PF-2C 3C →	3.6	f	47	gh	11	d	9	c-e	24	fg	5	fg	21	gh	5	ij	4	b
7	Omega 4SC 13.8 fl oz Inspire Super EW 12 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC&PF #2,3,5,6 3C →	3.6	f	41	fg	11	d	2	a	21	e-g	4	d-g	13	e-g	2	e-i	0	a
8	Omega 4SC 13.8 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	3.9	f	62	hi	28	e	14	e	26	g	5	g	20	gh	4	g-j	0	a
9	Inspire Super EW 12 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	5.4	cd	51	g-i	11	d	4	a-c	22	e-g	4	e-g	17	f-h	3	f-j	0	a
10	Omega 4SC 13.8 fl oz Inspire Super EW 12 fl oz + Penncozeb 3 lb Inspire Super 2.82 EW 12 fl oz	TC-PF 1C-2C 3C →	4.3	ef	50	g-i	14	d	12	de	24	fg	4	fg	19	gh	4	h-j	1	a
11	Inspire Super 2.82 EW 12 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	4.5	d-f	38	fg	9	cd	3	ab	16	d-f	3	b-d	9	d-f	2	c-g	1	a
12	Flint 50WG 2 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	5.3	c-e	14	cd	2	ab	2	ab	7	b-d	2	b-d	6	a-e	2	b-f	0	a
13	Luna Sensation 4.0 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	9.1	a	4	a	1	a	3	ab	1	a	<1	a	3	ab	1	ab	0	a
14	Merivon 4 fl oz + Silwet L-77 114 ml/100 gal	TC →	8.9	a	5	ab	1	a	3	ab	8	a-d	2	a-c	4	a-c	1	a-c	0	a
15	Merivon 5.5 fl oz + Silwet L-77 114 ml/100 gal	TC →	9.2	a	8	a-c	1	a	1	a	1	ab	<1	a	2	a	1	a	0	a
16	Topguard 125SC 10 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	8.7	*a*	13	b-d	2	ab	4	a-d	6	b-d	2	b-d	2	ab	1	ab	0	a
17	Indar 2F 8 fl oz + LI-700, 2 pt/100 gal Indar 8 fl oz + Captan 30 oz + LI-700, 2 pts/100 gal	TC-1C 2C →	6.1	bc	28	ef	5	bc	3	ab	11	de	2	c-f	6	b-e	2	b-e	0	a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four reps; 10 shoots/tree rated: 2 Jun (Idared), 28 Jun (Golden Delicious) or 11 Jul (York). Fruit data represent postharvest counts of 25 fruit per rep sampled: 26 Sep (Idared); or 4 Oct (York).
* Apparent suppressive effect rated on six primary mildew shoots / tree 10 Jun: scale 1-10 (1= none; 10= excellent effect).

Table 10. Scab control on Idared, Golden Delicious and York apples.

			Scab											
			% leaves infected						% fruit infected					
	Treatment and rate/A	Timing	Idared		G.Del		York		Idared		G.Del		York	
0	No fungicide	---	14	f	15	f	14	f	54	f	40	d	26	d
1	Rally 40WSP 5 oz + Penncozeb 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C →	3	b-e	2	c-e	2	de	8	e	1	ab	3	bc
2	Fontelis 1.67SC 19.6 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	1	a-e	<1	b-d	2	de	1	ab	1	ab	0	a
3	Fontelis 19.6 fl oz + Damoil 2 qt/100 gal Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	1	ab	<1	ab	<1	a-e	3	a-d	0	a	0	a
4	Penncozeb 75DF 4 lb Fontelis 1.67SC 19.6 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC P-2C 3C →	1	a-e	<1	a-d	0	a	3	a-c	4	a-c	0	a
5	Fontelis 1.67SC 13.9 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	3	c-e	<1	a-c	3	c-e	3	a-d	0	a	1	ab
6	Omega 4SC 13.8 fl oz Inspire Super EW 12 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC & Bl P,PF-2C 3C →	1	a-e	<1	a-d	2	b-e	2	a-c	2	a-c	0	a
7	Omega 4SC 13.8 fl oz Inspire Super EW 12 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC&PF #2,3,5,6 3C →	1	a-d	<1	ab	<1	a-d	0	a	1	ab	0	a
8	Omega 4SC 13.8 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	3	de	3	de	2	e	6	c-e	3	a-c	0	a
9	Inspire Super EW 12 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	2	a-c	0	a	<1	a-d	1	ab	1	ab	0	a
10	Omega 4SC 13.8 fl oz Inspire Super EW 12 fl oz + Penncozeb 3 lb Inspire Super 2.82 EW 12 fl oz	TC-PF 1C-2C 3C →	1	a-e	<1	b-e	1	a-e	0	a	8	c	1	ab
11	Inspire Super 2.82 EW 12 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	1	ab	0	a	<1	ab	0	a	1	ab	0	a
12	Flint 50WG 2 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	3	a-e	<1	a-c	1	b-e	5	b-e	0	a	0	a
13	Luna Sensation 4.0 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	1	a-c	<1	ab	<1	a-e	2	a-c	4	bc	1	ab
14	Merivon 4 fl oz + Silwet L-77 114 ml/100 gal	TC →	4	a-e	0	a	0	a	1	ab	0	a	0	a
15	Merivon 5.5 fl oz + Silwet L-77 114 ml/100 gal	TC →	1	a	<1	a-c	<1	a-c	0	a	1	ab	1	ab
16	Topguard 125SC 10 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	4	e	3	e	1	b-e	7	de	6	c	4	c
17	Indar 2F 8 fl oz + LI-700, 2 pt/100 gal Indar 8 fl oz + Captan 30 oz + LI-700, 2 pts/100	TC-1C 2C →	3	c-e	1	c-e	1	b-e	9	e	2	a-c	0	a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four reps; 10 shoots/tree rated 2 Jun (Idared), 28 Jun (Golden Delicious) or 11 Jul (York). Fruit data represent postharvest counts of 25 fruit per replicate tree sampled: 22 Sep (Golden Delicious), 26 Sep (Idared), or 4 Oct (York).
Fungicides applied to both sides of the tree on each indicated application date at 100 gal/A as follows: 7 Apr (TC- tight cluster); 14 Apr (P-pink), 25 Apr (Bl-York, full bloom; Golden and Idared, petal fall); 6 May (PF-York-petal fall); 1st-6th covers (1C-6C): 20 May, 3 Jun, 17 Jun, 7 Jul, 28 Jul, 17 Aug.

Table 11. Cedar-apple rust and Brooks spot control on Idared, Golden Delicious and York apples.

			Cedar-apple rust						Brooks	
			% leaves infected						spot %,	
	Treatment and rate/A	Timing	Idared		G.Del		York		Idared	
0	No fungicide	---	16	b	24	c	42	g	11	b
1	Rally 40WSP 5 oz + Penncozeb 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C →	0	a	<1	a	6	a-e	0	a
2	Fontelis 1.67SC 19.6 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	0	a	<1	a	<1	a-c	0	a
3	Fontelis 19.6 fl oz + Damoil 2 qt/100 gal Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	0	a	<1	a	<1	ab	1	a
4	Penncozeb 75DF 4 lb Fontelis 1.67SC 19.6 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC P-2C 3C →	0	a	0	a	<1	ab	0	a
5	Fontelis 1.67SC 13.9 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	<1	a	3	b	13	f	0	a
6	Omega 4SC 13.8 fl oz Inspire Super EW 12 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC & Bl P,PF-2C 3C →	0	a	0	a	2	a-d	0	a
7	Omega 4SC 13.8 fl oz Inspire Super EW 12 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC&PF #2,3,5,6 3C →	0	a	0	a	<1	a-c	0	a
8	Omega 4SC 13.8 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	0	a	<1	a	3	b-e	1	a
9	Inspire Super EW 12 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	0	a	0	a	<1	ab	0	a
10	Omega 4SC 13.8 fl oz Inspire Super EW 12 fl oz + Penncozeb 3 lb Inspire Super 2.82 EW 12 fl oz	TC-PF 1C-2C 3C →	0	a	0	a	<1	ab	0	a
11	Inspire Super 2.82 EW 12 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	0	a	0	a	0	a	1	a
12	Flint 50WG 2 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	0	a	<1	a	4	c-e	0	a
13	Luna Sensation 4.0 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	0	a	<1	a	5	e	0	a
14	Merivon 4 fl oz + Silwet L-77 114 ml/100 gal	TC →	0	a	<1	a	4	de	0	a
15	Merivon 5.5 fl oz + Silwet L-77 114 ml/100 gal	TC →	<1	a	<1	a	<1	ab	0	a
16	Topguard 125SC 10 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	0	a	<1	a	0	a	0	a
17	Indar 2F 8 fl oz + LI-700, 2 pt/100 gal Indar 8 fl oz + Captan 30 oz + LI-700, 2 pts/100 gal	TC-1C 2C →	0	a	0	a	<1	a-c	0	a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four reps; 10 shoots/tree rated: 2 Jun (Idared), 28 Jun (Golden Delicious) or 11 Jul (York). Fruit data represent postharvest counts of 25 fruit per replicate tree sampled: 22 Sep (Golden Delicious), 26 Sep (Idared), or 4 Oct (York).
Fungicides applied to both sides of the tree on each indicated application date at 100 gal/A as follows: 7 Apr (TC- tight cluster); 14 Apr (P-pink), 25 Apr (Bl-York, full bloom; Golden and Idared, petal fall); 6 May (PF-York, petal fall); 1st-6th covers (1C-6C): 20 May, 3 Jun, 17 Jun, 7 Jul, 28 Jul, 17 Aug.

Table 12. Sooty blotch and flyspeck control on Idared, Golden Delicious and York apples.

			% fruit infected											
			Sooty blotch						Flyspeck					
	Treatment and rate/A	Timing	Idared		G.Del		York		Idared		G.Del		York	
0	No fungicide	---	95	f	84	c	69	d	92	g	55	e	56	f
1	Rally 40WSP 5 oz + Penncozeb 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C →	4	b-d	0	a	1	ab	11	cd	3	ab	5	a-d
2	Fontelis 1.67SC 19.6 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	6	a-c	0	a	0	a	23	d-f	12	d	22	e
3	Fontelis 19.6 fl oz + Damoil 2 qt/100 gal Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	8	c-e	0	a	2	b	20	d-f	10	cd	10	c-e
4	Penncozeb 75DF 4 lb Fontelis 1.67SC 19.6 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC P-2C 3C →	9	c-e	2	b	0	a	34	f	4	a-d	15	de
5	Fontelis 1.67SC 13.9 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	5	a-d	0	a	5	c	17	de	0	a	12	de
6	Omega 4SC 13.8 fl oz Inspire Super EW 12 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC & Bl P,PF-2C 3C →	1	ab	1	ab	0	a	1	ab	0	a	3	a-c
7	Omega 4SC 13.8 fl oz Inspire Super EW 12 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC&PF #2,3,5,6 3C →	0	a	0	a	0	a	3	ab	1	ab	0	a
8	Omega 4SC 13.8 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	4	b-d	2	ab	0	a	20	de	8	b-d	7	b-d
9	Inspire Super EW 12 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	1	ab	0	a	0	a	1	ab	1	ab	1	ab
10	Omega 4SC 13.8 fl oz Inspire Super EW 12 fl oz + Penncozeb 3 lb Inspire Super 2.82 EW 12 fl oz	TC-PF 1C-2C 3C →	0	a	0	a	0	a	0	a	0	a	0	a
11	Inspire Super 2.82 EW 12 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	0	a	0	a	0	a	1	ab	2	ab	3	a-c
12	Flint 50WG 2 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	13	e	0	a	0	a	27	ef	4	a-c	14	de
13	Luna Sensation 4.0 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	9	de	1	ab	0	a	17	de	6	b-d	10	b-d
14	Merivon 4 fl oz + Silwet L-77 114 ml/100 gal	TC →	2	ab	1	ab	0	a	0	a	1	ab	1	a-c
15	Merivon 5.5 fl oz + Silwet L-77 114 ml/100 gal	TC →	0	a	0	a	0	a	0	a	1	ab	1	ab
16	Topguard 125SC 10 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	6	b-e	0	a	0	a	17	de	0	a	0	a
17	Indar 2F 8 fl oz + LI-700, 2 pt/100 gal Indar 8 fl oz + Captan 30 oz + LI-700, 2 pts/100	TC-1C 2C →	7	c-e	0	a	0	a	5	bc	2	ab	3	a-c

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four reps; Data represent postharvest counts of 25 fruit per replicate tree sampled: 22 Sep (Golden Delicious), 26 Sep (Idared), or 4 Oct (York).

Fungicides applied to both sides of the tree on each indicated application date at 100 gal/A as follows:
7 Apr (TC- tight cluster); 14 Apr (P-pink), 25 Apr (Bl-York, full bloom; Golden and Idared, petal fall);
6 May (PF-York, petal fall); 1st-6th covers (1C-6C): 20 May, 3 Jun, 17 Jun, 7 Jul, 28 Jul, 17 Aug.

Table 13. Postharvest storage rots on Golden Delicious apples.

			Post-incubation rot incidence (%)*									
			Any		Bitter		White		Phom-		Alter	
	Treatment and rate/A	Timing	rot		rot		rot		opsis		naria	
0	No fungicide	---	73	d	55	e	16	c	8	b	6	a
1	Rally 40WSP 5 oz + Penncozeb 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C →	37	a-c	24	a-d	12	c	0	a	9	a
2	Fontelis 1.67SC 19.6 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	17	a	13	a	0	a	0	a	4	a
3	Fontelis 19.6 fl oz + Damoil 2 qt/100 gal Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	45	b-d	41	c-e	11	bc	0	a	12	a
4	Penncozeb 75DF 4 lb Fontelis 1.67SC 19.6 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC P-2C 3C →	33	a-c	27	a-e	5	a-c	0	a	5	a
5	Fontelis 1.67SC 13.9 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	48	cd	36	b-e	11	c	1	a	7	a
6	Omega 4SC 13.8 fl oz Inspire Super EW 12 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC & Bl P,PF-2C 3C →	31	a-c	18	a-d	13	bc	0	a	2	a
7	Omega 4SC 13.8 fl oz Inspire Super EW 12 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC&PF #2,3,5,6 3C →	30	a-c	22	a-d	2	ab	0	a	8	a
8	Omega 4SC 13.8 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	47	cd	34	a-e	14	c	0	a	12	a
9	Inspire Super EW 12 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	22	a-c	17	a-c	2	ab	0	a	6	a
10	Omega 4SC 13.8 fl oz Inspire Super EW 12 fl oz + Penncozeb 3 lb Inspire Super 2.82 EW 12 fl oz	TC-PF 1C-2C 3C →	48	cd	37	b-e	9	bc	0	a	6	a
11	Inspire Super 2.82 EW 12 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	30	a-c	20	a-c	5	a-c	1	a	6	a
12	Flint 50WG 2 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	52	cd	47	de	8	bc	0	a	8	a
13	Luna Sensation 4.0 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	28	a-c	24	a-d	5	a-c	0	a	3	a
14	Merivon 4 fl oz + Silwet L-77 114 ml/100 gal	TC →	27	a-c	21	a-d	1	a	1	a	5	a
15	Merivon 5.5 fl oz + Silwet L-77 114 ml/100 gal	TC →	15	ab	12	ab	1	a	0	a	1	a
16	Topguard 125SC 10 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	46	cd	38	b-e	8	bc	0	a	3	a
17	Indar 2F 8 fl oz + LI-700, 2 pt/100 gal Indar 8 fl oz + Captan 30 oz + LI-700, 2 pts/100	TC-1C 2C →	31	a-c	23	a-d	6	a-c	1	a	5	a

* Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four reps; Data represent postharvest counts of 25 fruit per replicate tree sampled: 22 Sep and rated after 27 days storage at 39°F then 26 days incubation at ambient temperatures 61-78°F.

Fungicide application dates: 7 Apr (TC- tight cluster); 14 Apr (P-pink), 25 Apr (Bl-York, full bloom; Golden petal fall); 6 May (PF-York, petal fall); 1st-6th covers (1C-6C): 20 May, 3 Jun, 17 Jun, 7 Jul, 28 Jul, 17 Aug.

Table 14. Postharvest storage rots on York and Idared apples.

			Post-incubation rot incidence (%)									
			York									
					White		Alter-		Bitter rot			
	Treatment and rate/A	Timing	Any rot		rot		naria		York		Idared	
0	No fungicide	---	78	f	26	b	14	b	68	e	100	g
1	Rally 40WSP 5 oz + Penncozeb 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C →	21	a-d	2	a	2	ab	18	a-c	27	c-f
2	Fontelis 1.67SC 19.6 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	18	a-c	0	a	5	ab	14	ab	26	c-e
3	Fontelis 19.6 fl oz + Damoil 2 qt/100 gal Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	63	ef	3	a	1	a	60	de	27	c-f
4	Penncozeb 75DF 4 lb Fontelis 1.67SC 19.6 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC P-2C 3C →	26	a-d	7	a	4	ab	17	a-c	20	a-d
5	Fontelis 1.67SC 13.9 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	44	de	7	ab	7	ab	36	cd	30	d-f
6	Omega 4SC 13.8 fl oz Inspire Super EW 12 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC & Bl P,PF-2C 3C →	28	cd	4	a	4	ab	27	bc	23	b-c
7	Omega 4SC 13.8 fl oz Inspire Super EW 12 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC&PF #2,3,5,6 3C →	32	c-e	4	a	3	ab	31	bc	19	a-d
8	Omega 4SC 13.8 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	32	c-e	8	ab	4	ab	27	bc	14	a-c
9	Inspire Super EW 12 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	14	a-c	4	a	0	a	12	a-c	23	b-d
10	Omega 4SC 13.8 fl oz Inspire Super EW 12 fl oz + Penncozeb 3 lb Inspire Super 2.82 EW 12 fl oz	TC-PF 1C-2C 3C →	32	c-e	7	ab	9	ab	24	bc	42	f
11	Inspire Super 2.82 EW 12 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	27	b-d	8	ab	5	ab	19	a-c	39	ef
12	Flint 50WG 2 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	31	c-e	8	ab	5	ab	22	a-c	26	c-e
13	Luna Sensation 4.0 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	24	a-d	4	a	3	ab	18	a-c	10	a
14	Merivon 4 fl oz + Silwet L-77 114 ml/100 gal	TC →	5	ab	0	a	0	a	5	a	22	a-d
15	Merivon 5.5 fl oz + Silwet L-77 114 ml/100 gal	TC →	21	a-d	1	a	4	ab	16	a-c	10	ab
16	Topguard 125SC 10 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	25	a-d	3	a	5	ab	20	a-c	10	ab
17	Indar 2F 8 fl oz + LI-700, 2 pt/100 gal Indar 8 fl oz + Captan 30 oz + LI-700, 2 pts/100	TC-1C 2C →	5	a	0	a	0	a	5	a	11	ab

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four reps; Data represent postharvest counts of 25 fruit per replicate tree. York sampled 4 Oct and rated after 24 days; Idared sampled 26 Sep and rated after 17 days incubation at ambient temperatures 61-78°F.

Table 15. Fruit finish on Golden Delicious, Idared and York apples.

			Golden Del. russet*				Opalescence			
			russet		% USDA		rating (0-5)*			
	Treatment and rate/A	Timing	rating 0-5		Fcy & X-Fcy		Idared		York	
0	No fungicide	---	2.7	de	51	e	2.3	i	1.7	a
1	Rally 40WSP 5 oz + Penncozeb 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C →	2.6	c-e	68	de	1.3	d-h	1.4	a
2	Fontelis 1.67SC 19.6 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	2.0	ab	87	a-d	1.5	h	1.5	a
3	Fontelis 19.6 fl oz + Damoil 2 qt/100 gal Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	2.0	ab	88	a-d	1.2	b-e	2.1	a
4	Penncozeb 75DF 4 lb Fontelis 1.67SC 19.6 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC P-2C 3C →	2.0	ab	88	a-d	1.2	c-g	1.6	a
5	Fontelis 1.67SC 13.9 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	1.9	a	85	a-d	1.4	f-h	1.6	a
6	Omega 4SC 13.8 fl oz Inspire Super EW 12 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC & Bl P,PF-2C 3C →	2.5	b-e	87	a-d	1.4	e-h	1.5	a
7	Omega 4SC 13.8 fl oz Inspire Super EW 12 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC&PF #2,3,5,6 3C →	2.2	a-e	80	a-d	1.3	d-h	1.6	a
8	Omega 4SC 13.8 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	2.2	a-e	94	a	1.2	c-f	1.6	a
9	Inspire Super EW 12 fl oz + Penncozeb 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	2.4	a-e	69	c-e	0.9	ab	2.0	a
10	Omega 4SC 13.8 fl oz Inspire Super EW 12 fl oz + Penncozeb 3 lb Inspire Super 2.82 EW 12 fl oz	TC-PF 1C-2C 3C →	2.1	a-d	89	ab	1.3	e-h	1.9	a
11	Inspire Super 2.82 EW 12 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	2.2	a-e	75	b-e	1.3	e-h	1.8	a
12	Flint 50WG 2 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	2.1	a-c	75	b-e	0.9	a-c	1.7	a
13	Luna Sensation 4.0 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	2.2	a	88	a-c	1.0	a-d	1.5	a
14	Merivon 4 fl oz + Silwet L-77 114 ml/100 gal	TC →	1.8	a	85	a-d	1.2	d-g	1.7	a
15	Merivon 5.5 fl oz + Silwet L-77 114 ml/100 gal	TC →	2.2	a-e	82	a-d	0.9	a	1.8	a
16	Topguard 125SC 10 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-2C 3C →	2.5	b-e	76	b-e	1.5	gh	2.0	a
17	Indar 2F 8 fl oz + LI-700, 2 pt/100 gal Indar 8 fl oz + Captan 30 oz + LI-700, 2 pts/100	TC-1C 2C →	2.7	e	71	b-e	0.8	a	1.7	a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four reps; Fruit data represent postharvest counts of 25 fruit per replicate tree sampled: 22 Sep (Golden Delicious), 26 Sep (Idared), or 4 Oct (York).

* Fruit finish rated on a scale of 0-5 (0=perfect finish; 5=severe russet). USDA Extra fancy and fancy grades after downgrading by russet presumed not to be caused by mildew.

Fungicides applied to both sides of the tree on each indicated application date at 100 gal/A as follows: 7 Apr (TC- tight cluster); 14 Apr (P-pink), 25 Apr (Bl-York, full bloom; Golden and Idared, petal fall); 6 May (PF-York, petal fall); 1st-6th covers (1C-6C): 20 May, 3 Jun, 17 Jun, 7 Jul, 28 Jul, 17 Aug.

EARLY SEASON DISEASE MANAGEMENT WITH COMBINED FUNGICIDES ON RED DELICIOUS, GOLDEN DELICIOUS, AND ROME APPLES

K. S. Yoder, A. E. Cochran II, W. S. Royston, Jr., S. W. Kilmer and G. Engleman
Virginia Tech Agr. Res. & Ext. Center
595 Laurel Grove Road, Winchester, VA 22602

Nine treatments, aimed primarily at early season and early summer diseases, were compared for season-long fungal disease control and fruit finish effects on three apple cultivars. Treatments were evaluated on 22-yr-old, three-cultivar tree sets in a four-replicate randomized block design. The Rome trees used in the test had not been treated in 2010 to allow powdery mildew inoculum to stabilize in the 2011 test trees. Dilute treatments were applied to the point of runoff with a single nozzle handgun at 450 psi as follows: 7 Apr (Rome ½" G-TC, ½" green-tight cluster; G Del. and R. Del. TC); 14 Apr (Rome-open cluster; G. Del. open cluster-pink); 25 Apr (Rome bloom; Golden and Red Del. petal fall); 3 May (Rome, petal fall; included Rally in #9). First-6th covers (1C-6C): 16 May (Rome, included Rally in #9), 31 May, 15 Jun, 1 Jul, 15 Jul, 11 Aug. Maintenance sprays, applied separately to the entire test block with a commercial airblast sprayer, included: Supracide, Altacor, Assail, Imidan, Provado, Delegate, and Calypso. Inoculum over each Golden Delicious test tree included: cedar rust galls placed 6 Apr and wild blackberry canes with the sooty blotch and flyspeck fungi and bitter rot mummies placed 5 May. Other diseases developed from inoculum naturally present in the test area, including cedar-apple rust inoculum from red cedars in the vicinity. Foliar data represent averages of counts of ten terminal shoots from each of four single-tree reps 7 Jun (Rome), 5 Aug (Golden Del.), or 16 Aug (Red Delicious). Postharvest fruit counts are means of 25-fruit samples picked from each of four single-tree reps 22 Sep (Red Del. and Golden Delicious), or 27 Sep (Rome), placed in cold storage at 4°C. Following initial fruit evaluation, fruit were incubated at ambient warm temperatures 62-76°F and rated after 18 days (Rome), 21 days (Golden Del.), and 28 days cold storage (Red Delicious) before final storage rot assessment. Percentage data were converted by the square root arcsin transformation for statistical analysis.

Early season weather and inoculum conditions were favorable for scab, cedar-apple rust and powdery mildew. Early scab pressure was moderate with the first infection period occurring 1 Apr, one week before the first treatment application 7 Apr, and lesions were observed Apr 28. But seven secondary infection periods and nearly 4 inches of rain in one week in mid-May resulted in heavier pressure on fruit. Under these conditions, Merivon and Flint-related treatments provided the best scab control on foliage and fruit (Table 16). Experimental compound IKF-5411 gave significant scab suppression but with little rate response. IKF-309 + Penncozeb gave scab control comparable to Rally + Penncozeb. Treatments involving the SI fungicide Rally gave the best control of cedar-apple rust. A half rate of Rally, included with Flint, significantly improved the weaknesses of that treatment against rust (Table 17). Experimental compounds IKF-5411, IKF-309 + Penncozeb and Merivon gave significant rust control, but were less effective than Rally. All treatments gave adequate control of quince rust and cedar-apple rust on fruit. It should be noted that scab and mildew control may be affected by SI fungicide resistance in this test block. Also, due to a misunderstanding in the rate/A adjustment, Merivon was applied dilute at 4X rates in this test block. Mildew pressure was high in this test block with conidia available from late 23 March and 28 days in April and May were favorable for mildew infection. Under these conditions Flint gave the best control on foliage, but its control on fruit was improved by mixing a half rate of Rally with it. All treatments gave significant suppression of percent leaf area and percent fruit affected by mildew, and most treatments gave significant control of percent leaves infected. Under light disease pressure and slow mid-summer wetting hour accumulation, all treatments except IKF-5411, gave adequate commercial control of sooty blotch and flyspeck (Table 18). All treatments gave significant control of one or more rots (Table 19), but Merivon was superior overall. Although there were significant differences among treatments in fruit finish, none were significantly worse than non-treated fruit (Table 18).

Table 16. Scab control on Rome Beauty, Golden Delicious and Red Delicious apples.

			Scab, % leaves inf.						Scab, lesions/leaf						Scab, % fruit inf.					
	Treatment and formulated rate/100 gal	Timing	Rome		G Del		R Del		Rome		G. Del.		R. Del.		Rome		G. Del.		R. Del.	
0	Non-treated control	---	10	d	17	e	57	e	0.3	b	1.0	b	7.5	c	59	e	45	f	88	g
1	Rally 40WSP 1.25 oz + Penncozeb 75DF 12 oz Captan 80WDG 7.5 oz + Ziram 76DF 12 oz	TC-2C 3C →	5	c	12	e	30	d	0.1	a	0.6	ab	1.1	ab	24	d	11	de	27	ef
2	Flint 50WG 0.5 oz Captan 80WDG 7.5 oz + Ziram 76DF 12 oz	TC-2C 3C →	4	bc	6	cd	17	c	0.1	ab	0.2	ab	1.2	ab	8	bc	4	b-d	10	cd
3	IKF-5411 400SC 51.8 ml	TC→	7	cd	10	c-e	28	d	0.2	ab	0.3	ab	1.2	ab	20	d	16	e	40	f
4	IKF-5411 400SC 72.1 ml	TC→	7	cd	11	de	27	d	0.1	ab	0.3	ab	0.9	ab	27	d	13	c-e	34	f
5	IKF-5411 400SC 92.4 ml	TC→	11	d	9	c-e	33	d	0.2	ab	0.3	ab	2.3	b	24	d	15	e	28	ef
6	IKF-309 300SC 1 fl oz + Penncozeb 75DF 12 oz Captan 80WDG 7.5 oz + Ziram 76DF 12 oz	TC-2C 3C →	6	cd	12	de	27	d	0.2	ab	0.6	ab	0.8	ab	13	cd	5	a-c	16	de
7	Merivon 4 fl oz + Silwet L-77 3.8 fl oz Merivon 1 fl oz + Silwet L-77 3.8 fl oz	TC-PF 1C→	<1	a	1	a	1	a	0.01	a	<0.01	a	<0.01	a	3	ab	5	b-d	0	a
8	Merivon 5.5 fl oz + Silwet L-77 3.8 fl oz Merivon 1.38 fl oz + Silwet L-77 3.8 fl oz	TC-PF 1C→	<1	a	3	ab	1	a	<0.01	a	<0.01	a	<0.01	a	0	a	1	ab	3	ab
9	Flint 50WG 0.5 oz (+ Rally 0.6 oz post-inf) Captan 80WDG 7.5 oz + Ziram 76DF 12 oz	TC-2C 3C →	1	ab	4	bc	6	b	<0.01	a	<0.01	ab	0.5	a	7	bc	0	a	5	bc

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Counts based on 10 shoots per rep 7 Jun (Rome), 5 Aug (Golden), or 16 Aug (Red Delicious). Rome trees in 2011 test were not in test in 2010 to stabilize mildew inoculum pressure for 2011.

Treatments were applied dilute to run-off: 7 Apr (Rome ½" G-TC, ½" green-tight cluster; G Del. and R. Del., TC); 14 Apr (Rome- open cluster; G. Del. open cluster-pink); 25 Apr (Rome, bloom; Golden and Red Del., petal fall); 3 May (Rome, petal fall; included Rally in #9). First-sixth covers (1C-6C): 16 May (Rome, included Rally in #9), 31 May, 15 Jun, 1 Jul, 15 Jul, 11 Aug.

Postharvest fruit counts are means of 25-fruit samples picked from each of four single-tree reps 22 Sep (Red Del. and Golden Delicious), or 27 Sep (Rome), placed in cold storage at 4°C and then rated after 37 days (Rome), 33 days (Golden Del., 27 days cold storage (Red Del.).

Table 17. Rust and mildew control on Rome Beauty and Golden Delicious apples. Block #11, Virginia Tech AREC.

			Cedar-apple rust					Quince	Powdery mildew infection				
			% leaves		Lesions/leaf		% fruit	rust, %	% leaves		% leaf area		% fruit
	Treatment and formulated rate/100 gal	Timing	Rome	G.Del	Rome	G. Del.	Rome	R. Del.	Rome	G.Del	Rome	G. Del	Rome
0	Non-treated control	---	55 d	47 e	2.60 d	2.47 d	8 b	5 b	62 e	61 e	41 e	23 e	53 f
1	Rally 40WSP 1.25 oz + Penncozeb 12 oz Captan 80WDG 7.5 oz + Ziram 76DF 12 oz	TC-2C 3C →	<1 a	<1 a	<.01 a	<.01 a	0 a	0 a	51 de	42 d	16 cd	9 d	9 cd
2	Flint 50WG 0.5 oz Captan 80WDG 7.5 oz + Ziram 76DF 12 oz	TC-2C 3C →	13 b	17 cd	0.67 ab	0.52 a-c	1 a	0 a	35 c	27 c	5 b	4 bc	3 ab
3	IKF-5411 400SC 51.8 ml	TC→	34 c	24 d	2.34 cd	1.24 c	1 a	1 ab	46 d	35 cd	11 c	5 b-d	22 e
4	IKF-5411 400SC 72.1 ml	TC→	32 c	25 d	2.14 b-d	1.10 bc	1 a	0 a	43 cd	37 cd	12 cd	8 cd	17 de
5	IKF-5411 400SC 92.4 ml	TC→	29 c	18 cd	1.30 a-d	0.67 a-c	0 a	1 ab	50 d	44 d	18 d	11 d	14 de
6	IKF-309 300SC 1 fl oz + Penncozeb 12 oz Captan 80WDG 7.5 oz + Ziram 76DF 12 oz	TC-2C 3C →	34 c	37 e	1.82 b-d	1.21 c	1 a	0 a	53 de	42 d	17 cd	7 b-d	20 de
7	Merivon 4 fl oz + Silwet L-77 3.8 fl oz Merivon 1 fl oz + Silwet L-77 3.8 fl oz	TC-PF 1C→	29 c	12 bc	2.40 cd	0.33 ab	0 a	0 a	10 a	5 a	2 a	1 a	2 a-c
8	Merivon 5.5 fl oz + Silwet L-77 3.8 fl oz Merivon 1.38 fl oz + Silwet L-77 3.8 fl oz	TC-PF 1C→	17 b	8 b	0.96 a-c	0.18 a	0 a	0 a	8 a	3 a	2 a	1 a	0 a
9	Flint 50WG 0.5 oz (+ Rally 0.6 oz post-inf) Captan 80WDG 7.5 oz + Ziram 76DF 12 oz	TC-2C 3C →	2 a	<1 a	0.02 a	0.01 a	0 a	0 a	19 b	16 b	3 ab	3 ab	9 b-d

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Counts based on 10 shoots per rep 7 Jun (Rome), 5 Aug (Golden), or 16 Aug (Red Delicious). Rome trees in 2011 test were not in test in 2010 to stabilize mildew inoculum pressure for 2011.

Treatments were applied dilute to run-off: 7 Apr (Rome ½" G-TC, ½" green-tight cluster; G Del. and R. Del. TC); 14 Apr (Rome- open cluster; G. Del. open cluster-pink); 25 Apr (Rome bloom; Golden and Red Del. petal fall); 3 May (Rome, petal fall; included Rally in #9). First-sixth covers (1C-6C): 16 May (Rome, included Rally in #9), 31 May, 15 Jun, 1 Jul, 15 Jul, 11 Aug.

Postharvest fruit counts are means of 25-fruit samples picked from each of four single-tree reps 22 Sep (Red Del. and Golden Delicious), or 27 Sep (Rome), placed in cold storage at 4°C and then rated after 37 days (Rome), 33 days (Golden Del., 27 days cold storage (Red Del.).

Table 18. Sooty blotch, flyspeck and fruit finish on Rome Beauty, Golden Delicious and Red Delicious apples.

			% fruit infected												Opalescence				Golden Del. finish*			
			Sooty blotch						Flyspeck						rating (0-5)*				% USDA		russet	
	Treatment and formulated rate/100 gal	Timing	R. Del.		G. Del.		Rome		R. Del.		G. Del.		Rome		R. Del.		Rome		X-fancy		rating (0-5)	
0	Non-treated control	---	99	d	95	c	100	e	80	d	62	d	78	g	0.9	b	1.5	a	27	a-c	2.7	bc
1	Rally 40WSP 1.25 oz + Penncozeb 12 oz Captan 80WDG 7.5 oz + Ziram 76DF 12 oz	TC-2C 3C →	14	b	7	a	1	a	8	a-c	8	ab	4	ab	0.7	b	1.5	a	50	ab	2.3	ab
2	Flint 50WG 0.5 oz Captan 80WDG 7.5 oz + Ziram 76DF 12 oz	TC-2C 3C →	6	ab	8	a	4	a	3	ab	5	ab	10	b-d	0.8	b	1.3	a	54	a	2.1	a
3	IKF-5411 400SC 51.8 ml	TC→	54	c	27	b	36	d	22	c	5	ab	40	f	0.7	ab	1.8	a	32	a-c	2.6	a-c
4	IKF-5411 400SC 72.1 ml	TC→	37	c	28	b	31	cd	14	bc	11	b	22	d-f	0.7	b	1.6	a	40	a-c	2.4	a-c
5	IKF-5411 400SC 92.4 ml	TC→	41	c	23	b	30	cd	9	ab	26	c	26	ef	0.9	b	1.8	a	19	c	3.0	c
6	IKF-309 300SC 1 fl oz + Penncozeb 12 oz Captan 80WDG 7.5 oz + Ziram 76DF 12 oz	TC-2C 3C →	7	ab	3	a	16	bc	11	ab	4	a	12	b-e	0.4	a	1.7	a	54	a	2.4	a-c
7	Merivon 4 fl oz + Silwet L-77 3.8 fl oz Merivon 1 fl oz + Silwet L-77 3.8 fl oz	TC-PF 1C→	3	ab	1	a	9	ab	2	a	2	a	9	bc	0.8	b	1.2	a	48	a-c	2.4	a-c
8	Merivon 5.5 fl oz + Silwet L-77 3.8 fl oz Merivon 1.38 fl oz + Silwet L-77 3.8 fl oz	TC-PF 1C→	1	a	1	a	3	a	7	ab	5	ab	0	a	0.8	b	1.3	a	23	bc	2.9	bc
9	Flint 50WG 0.5 oz (+ Rally 0.6 oz post-inf) Captan 80WDG 7.5 oz + Ziram 76DF 12 oz	TC-2C 3C →	15	b	5	a	2	a	10	a-c	2	a	17	c-e	0.8	b	1.6	a	40	a-c	2.6	a-c

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four single-tree reps. Harvest counts based on 25 fruit per replication.

Postharvest fruit counts are means of 25-fruit samples picked from each of four single-tree reps 22 Sep (Red Del. and Golden Delicious), or 27 Sep (Rome), placed in cold storage at 4°C and rated after 37 days (Rome), 33 days (Golden Del., 27 days cold storage (Red Del.).

* Fruit finish rated on a scale of 0-5 (0=perfect finish; 5=severe russet). USDA Extra fancy and fancy grades after downgrading by russet.

Treatments were applied dilute to run-off: 7 Apr (Rome ½" G-TC, ½" green-tight cluster; G Del. and R. Del. TC); 14 Apr (Rome- open cluster; G. Del. open cluster-pink); 25 Apr (Rome bloom; Golden and Red Del. petal fall); 3 May (Rome, petal fall; included Rally in #9). First-sixth covers (1C-6C): 16 May (Rome, included Rally in #9), 31 May, 15 Jun, 1 Jul, 15 Jul, 11 Aug.

Table 19. Post-storage rot control on Rome Beauty, Golden Delicious, and Red Delicious apples.

			Post-incubation storage rots, % fruit infected																									
			Any rot						Bitter rot						White (Bot) rot						Alternaria rot						Phomopsis	
	Treatment and formulated rate/100 gal	Timing	Rome		G.Del		R.Del		Rome		G.Del		R.Del		Rome		G.Del		R.Del		Rome		G.Del		R.Del		Red Del.	
0	Non-treated control	---	59	e	58	f	36	e	39	d	30	c	22	d	30	c	22	d	7	b	2	a	8	c	3	b	5	c
1	Rally 1.25 oz + Penncozeb 12 oz Captan 7.5 oz + Ziram 12 oz	TC-2C 3C →	12	bc	14	cd	0	a	0	a	8	b	0	a	11	a-c	7	b	0	a	1	a	1	ab	0	a	0	a
2	Flint 50WG 0.5 oz Captan 7.5 oz + Ziram 12 oz	TC-2C 3C →	18	bc	13	bc	8	cd	6	ab	12	b	6	bc	12	ab	0	a	2	ab	0	a	0	a	0	a	0	a
3	IKF-5411 400SC 51.8 ml	TC→	37	c-e	34	e	8	cd	24	cd	16	bc	1	ab	13	bc	16	cd	4	b	3	a	2	ab	1	ab	2	a-c
4	IKF-5411 400SC 72.1 ml	TC→	27	cd	25	de	4	bc	20	b-d	14	bc	2	a-c	11	ab	11	bc	0	a	3	a	0	a	0	a	1	ab
5	IKF-5411 400SC 92.4 ml	TC→	41	de	24	de	16	d	24	b-d	14	bc	9	c	19	bc	8	bc	6	b	3	a	2	ab	2	ab	0	a
6	IKF-309 1 fl oz + Penncozeb 12 oz Captan 7.5 oz + Ziram 12 oz	TC-2C 3C →	36	c-e	25	de	5	cd	21	b-d	11	b	1	ab	15	bc	12	bc	1	ab	4	a	3	bc	0	a	3	bc
7	Merivon 4 fl oz + Silwet L-77 3.8 fl oz Merivon 1 fl oz + Silwet L-77 3.8 fl oz	TC-PF 1C→	5	ab	0	a	5	c	1	a	0	a	4	a-c	4	ab	0	a	1	ab	0	a	0	a	0	a	0	a
8	Merivon 5.5 fl oz + Silwet L-77 3.8 fl oz Merivon 1.38 fl oz + Silwet L-77 3.8 fl oz	TC-PF 1C→	0	a	4	b	1	ab	0	a	4	ab	0	a	0	a	0	a	0	a	0	a	0	a	0	a	1	ab
9	Flint 0.5 oz (+ Rally 0.6 oz post-inf) Captan 7.5 oz + Ziram 12 oz	TC-2C 3C →	18	bc	20	c-e	6	bc	13	a-c	10	b	2	a-c	8	ab	10	bc	2	ab	1	a	1	ab	2	ab	0	a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Counts based on 25 fruit per tree.

Postharvest fruit counts are means of 25-fruit samples picked from each of four single-tree reps 22 Sep (Red Delicious and Golden Delicious), or 27 Sep (Rome), placed in cold storage at 4°C and rated after 37 days (Rome), 33 days (Golden Del., 21 days cold storage (Red Delicious).

Following cold storage, fruit were incubated at ambient warm temperatures 62-76°F and rated after 18 days (Rome), 21 days (Golden Del.), and 28 days (Red Delicious).

EVALUATION OF EXPERIMENTAL AND REGISTERED COVER SPRAY FUNGICIDE COMBINATIONS FOR DISEASE CONTROL ON FUJI APPLES

K. S. Yoder, A. E. Cochran II, W. S. Royston, Jr., S. W. Kilmer and G. Engleman
Virginia Tech Agr. Res. & Ext. Center
595 Laurel Grove Road, Winchester, VA 22602

Eight treatments involving package-mix fungicides and a standard summer schedule were compared during the mid-season cover spray period on 16-yr-old trees. The test was conducted in a randomized block design with four single-tree replicates separated by border rows and in-row border trees. No fungicides were applied before the treatment series began 16 May. Test 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: 6 May (petal fall); first to sixth cover sprays 16 May, 30 May, 14 Jun, 28 Jun, 26 Jul and 16 Aug. All diseases developed from inoculum naturally present in the test area. Fruit data are based on 25-fruit sample per rep harvested 17 Oct and held at ambient temperatures 68-76ºF; first evaluated 19 Oct, then re-evaluated for storage rots 17 Nov. Insecticides applied to the entire test block with the same equipment during the test period included: Assail, Delegate, Calypso, Altacor, Imidan, and Provado. Percentage data were converted by the square root arcsin transformation for statistical analysis.

Scab and rust infection periods before and after the first application in this test: Primary scab infection periods: 30 Mar-1 Apr, 8-9 Apr; 12-13 Apr; 16 Apr; 19-20 Apr; 22-23 Apr. This would have been a secondary period because these trees were not protected 30 Mar - 1 Apr. Primary or secondary scab infection period: Apr 24-25. Lesions were observed in another area of the farm 28 Apr.
Secondary infection periods: 1-2 May; 3-4 May.
First application: 6 May (petal fall);
Later infection periods: 12-13 May; 13-14 May, 14-15 May, 15-16 May.
Second application: 16 May.
Later infection periods: 16-17 May, 17-18 May, 18-19 May (This made seven infection periods and 3.89 inches of rain in one week); 23 May; 27 May, 28 May, (*12 infection periods in May*). Summary: Six primary infection periods; 14 secondary through May.

Rusts: A definite cedar-apple and quince rust infection period occurred 24-25 Apr. Additional cedar-apple rust infection periods occurred 1- 2 May, 3-4 May, 13-14 May, 14-15 May, and 15-16 May.

The test was set up primarily to evaluate the treatments for summer disease control, starting at petal fall, and scab lesions were already present in the test block when the treatment series began. All of the treatments suppressed the amount of scab, rated by appearance as active or inactive on leaves and active or inhibited on fruit (Table 20). Inspire Super was the most effective treatment against foliar and fruit scab under these strong test conditions. The standard treatment may have been impacted by resistance to both SI and benzimidazole fungicides. Some rust infection had already occurred before the treatment series began and several more occurred between the first and second applications, and all treatments gave significant rust control under these conditions. Pristine suppressed the appearance of mildew russetting on fruit. Sooty blotch and flyspeck developed late in the season and, under moderate disease pressure, all treatments gave commercial control (Table 21). The higher rate of Merivon gave the best suppression of a mixture of fruit rots that developed under post-harvest warm temperature incubation. There was no significant fruit finish effect by any treatment.

Table 20. Early season disease control by fungicides first applied at petal fall for summer disease control. Block #28-S. Fuji.

			% leaves or fruit infected																				Finish ratings *			
			% leaves with scab						fruit with scab				cedar rust				leaf		mildew						opal-	
	Treatment and rate/ acre	Timing	active		inactive		any scab		active		inhibited		lvs		fruit		spot		lvs		fruit		russet		escence	
0	Non-treated control	---	43	d	18	d	60	e	74	c	74	c	17	c	10	b	29	c	4.7	b	34	c	2.0	a	1.9	a
1	Rally 40WSP 5 oz + Penncozeb 75WG 3 lb Topsin M 70W 8 oz + Captan 80WDG 2 lb	PF-2C 3C →	19	c	15	cd	34	d	7	b	34	b	3	ab	1	a	29	c	1.5	ab	19	ab	2.2	a	1.8	a
2	Inspire Super 12 fl oz	PF →	4	a	7	ab	12	a	4	a	18	a	1	a	0	a	11	a	0.9	ab	13	ab	2.4	a	1.8	a
3	Pristine 38WG 14.5 oz	PF →	13	bc	15	cd	28	cd	0	a	31	b	4	ab	0	a	17	b	0.7	ab	8	a	2.1	a	1.6	a
4	Luna Sensation 4 fl oz	PF →	6	a	6	a	12	ab	0	a	27	ab	3	ab	0	a	10	a	0	a	16	a	2.5	a	2.1	a
5	Merivon 4 fl oz + Silwet L-77 113.6 ml/100 gal	PF →	8	ab	12	b-d	20	bc	1	a	26	ab	1	a	0	a	11	ab	0.7	ab	19	b	2.3	a	1.9	a
6	Merivon 5.5 fl oz + Silwet L-77 113.6 ml/100 gal	PF →	5	a	11	a-d	17	ab	0	a	26	ab	4	ab	1	a	15	ab	0.1	a	25	bc	2.4	a	1.9	a
7	Merivon 4 fl oz + Captan 2 lb 80WDG + Silwet L-77 113.6 ml	PF →	6	a	11	b-d	18	ab	1	a	30	b	6	b	1	a	14	ab	0	a	21	bc	2.3	a	2.1	a
8	Merivon 4 fl oz + Penncozeb 75WG 3 lb + Silwet L-77 113.6 ml Merivon 4 fl oz + Captan 2 lb 80WDG + Silwet L-77 113.6 ml	PF-2C 3C →	6	a	10	a-c	16	ab	0	a	35	b	4	ab	1	a	15	ab	0.4	ab	19	b	2.3	a	2.1	a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four single-tree replications. Foliar counts based on 10 shoots per rep 21 Jul. Fruit counts based on 25 fruit per replication, harvested 17 Oct.

No fungicides applied until after scab lesions were present in the test trees. Treatments applied at 100 gpa to both sides of the tree row on each application date airblast: 6 May (petal fall); first to sixth cover sprays 16 May, 30 May, 14 Jun, 28 Jun, 26 Jul and 16 Aug.

* Fruit finish rated on a scale of 0-5 (0 = perfect finish, 5 = severe russet or opalescence.

Table 21. Summer disease effects by cover spray fungicide treatments.

			% fruit or fruit area infected								% fruit with rot after 31 day incubation									
			sooty blotch				flyspeck				any		bitter		white		Alter-		blue	
	Treatment and rate/ A	Timing	% fruit		% area		% fruit		% area		rot		rot		rot		naria		mold	
0	Non-treated control	---	90	c	6	b	71	d	4	d	32	d	16	b	17	c	2	a	1	a
1	Rally 40WSP 5 oz + Penncozeb 75WG 3 lb Topsin M 70W 8 oz + Captan 80WDG 2 lb	PF-2C 3C →	0	a	0	a	0	a	0	a	10	bc	3	a	3	ab	4	a	0	a
2	Inspire Super 12 fl oz	PF →	0	a	0	a	0	a	0	a	13	c	6	ab	5	b	3	a	1	a
3	Pristine 38WG 14.5 oz	PF →	2	ab	<1	a	1	ab	<1	ab	5	ab	4	a	1	ab	1	a	0	a
4	Luna Sensation 4 fl oz	PF →	7	ab	<1	a	1	ab	<1	ab	7	a-c	3	a	4	b	0	a	2	a
5	Merivon 4 fl oz + Silwet L-77 113.6 ml/100 gal	PF →	3	ab	<1	a	2	a-c	<1	a-c	9	bc	7	ab	1	ab	0	a	2	a
6	Merivon 5.5 fl oz + Silwet L-77 113.6 ml/100 gal	PF →	0	a	0	a	1	ab	<1	ab	2	a	0	a	0	a	1	a	1	a
7	Merivon 4 fl oz + Captan 2 lb 80WDG + Silwet L-77 113.6 ml	PF →	1	ab	<1	a	7	bc	<1	bc	9	bc	3	a	4	b	2	a	0	a
8	Merivon 4 fl oz + Penncozeb 75WG 3 lb + Silwet L-77 113.6 ml Merivon 4 fl oz + Captan 2 lb 80WDG + Silwet L-77 113.6 ml	PF-2C 3C →	4	b	<1	a	7	c	<1	c	5	a-c	2	a	2	ab	0	a	1	a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Randomized block design with four single-tree reps.

Treatments applied airblast at 100 gpa to both sides of the tree row on each application date: 6 May (petal fall); 16 May, 30 May, 14 Jun, 28 Jun, 26 Jul and 16 Aug.

Fruit counts based on 25 fruit per replication, harvested 17 Oct and held at ambient temperatures 68-76ºF; first evaluated 19 Oct, then re-evaluated for storage rots 17 Nov.

EARLY SEASON DISEASE CONTROL BY PROTECTANT FUNGICIDES ON NITTANY APPLES

K. S. Yoder, A. E. Cochran II, W. S. Royston, Jr., S. W. Kilmer and G. Engleman
Virginia Tech Agr. Res. & Ext. Center
595 Laurel Grove Road, Winchester, VA 22602

Nine treatments involving selected combinations of registered fungicides were compared at Virginia Tech AREC where scab resistance to SI fungicides is well documented and where a shift toward resistance to dodine had been noted in 2004. The test was conducted on 30-yr-old trees with a 28-ft row spacing in a randomized block design with four single-tree replicates separated by border rows. Tree-row-volume was determined to require a 400 gal/A dilute base for adequate spray coverage. Test 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: 25 Mar (GT); Apr 6, (1/2G-TC); Apr 14 (pink, Pk); Apr 20 (bloom, Bl), May 2 (petal fall, PF); 1st- 8th covers (1C-8C): 11 May, 16 Jun, 30 Jun, 13 Jul, 27 Jul, 10 Aug, 24 Aug and 9 Sep. All diseases developed from inoculum naturally present in the test area. Foliar fungal data based on counts of 10 shoots per tree from each of four single-tree replications 9 Jun. Postharvest fruit data are based on 25-fruit sample per rep harvested 26 Sep and held in cold storage until rating 17 Oct, then evaluated for rot development after 28 days at ambient temperatures 65-73ºF. Maintenance materials applied to the entire test block with the same equipment included Supracide, Altacor, Assail, Calypso, Delegate, Imidan, and Provado. Percentage data were converted by the square root arcsin transformation for statistical analysis.

Early scab pressure was moderate with the first infection period occurring 1 Apr, and lesions were observed 28 Apr. But seven secondary infection periods and nearly 4 inches of rain in one week in mid-May resulted in heavier pressure on fruit. Under these conditions, all treatments gave adequate control of scab on leaves and fruit. Although Nittany is not particularly susceptible to powdery mildew, inoculum pressure and favorable weather conditions with 28 days in April and May provided a relatively strong mildew test. Treatments that had Sovran at late bloom and first cover (Trts. 6&7) gave better mildew control on foliage than the parallel treatments which had at Rally in those applications (Trts. 2 & 3). Under light disease pressure, all treatments gave adequate control of cedar-apple rust which infected in late April and May. Rot pressure was somewhat variable, but nearly all treatments, covered by Captan + Ziram in late season, gave significant control of post-storage bitter rot and white rot. Apart from what was judged to be mildew russetting, there was no significant treatment effect on (p=0.05) in fruit finish by any treatment compared to non-treated fruit.

Table 22. Early season disease control by protectant fungicides on Nittany apple.

			% fruit, leaves, leaf area infected or lesions/leaf													
			Scab						c. rust		mildew infection, %					
	Treatment and rate per acre	Timing	% lvs		les/leaf		fruit		% lvs		% lvs		lf area		fruit	
0	No fungicide		22	b	1.30	b	41	b	3.8	b	33	e	6	c	37	d
1	Rally 40W 6 oz + Penncozeb 75DF 3 lb Captan 80WDG 5 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	GT-1C 2C 3C →	4	a	0.04	a	4	a	0	a	13	a-d	2	ab	22	cd
2	Syllit 3.4F 1.5 pt Rally 40W 6 oz + Penncozeb 75DF 3 lb Captan 80WDG 5 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	GT-TC Pk-1C 2C 3C →	4	a	0.07	a	1	a	0.1	a	15	cd	3	ab	6	ab
3	Syllit 3.4F 1.5 pt + Penncozeb 75DF 3 lb Rally 40W 6 oz + Penncozeb 75DF 3 lb Captan 80WDG 5 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	GT-TC Pk-1C 2C 3C →	3	a	0.10	a	2	a	0.3	ab	19	d	3	b	5	a
4	Syllit 3.4F 1.5 pt + Captan 80WDG 2.5 lb Rally 40W 6 oz + Penncozeb 75DF 3 lb Captan 80WDG 5 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	GT-TC Pk-1C 2C 3C →	2	a	0.03	a	2	a	0	a	16	cd	2	ab	7	ab
5	Penncozeb 3 lb + Captan 80WDG 2.5 lb Rally 40W 6 oz + Penncozeb 75DF 3 lb Sovran 50DF 4 oz + Penncozeb 75DF 3 lb Captan 80WDG 5 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	GT-TC Pk & PF Bl & 1C 2C 3C →	2	a	0.03	a	1	a	0.7	ab	15	b-d	3	ab	4	a
6	Syllit 3.4F 1.5 pt Rally 40W 6 oz + Penncozeb 75DF 3 lb Sovran 50DF 4 oz + Penncozeb 75DF 3 lb Captan 80WDG 5 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	GT-TC Pk & PF Bl & 1C 2C 3C →	2	a	0.05	a	0	a	0.8	ab	7	a	1	a	14	a-c
7	Syllit 3.4F 1.5 pt + Penncozeb 75DF 3 lb Rally 40W 6 oz + Penncozeb 75DF 3 lb Sovran 50DF 4 oz + Penncozeb 75DF 3 lb Captan 80WDG 5 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	GT-TC Pk & PF Bl & 1C 2C 3C →	2	a	0.02	a	2	a	0.3	ab	8	ab	2	a	4	a
8	Syllit 3.4F 1.5 pt + Captan 80WDG 2.5 lb Rally 40W 6 oz + Penncozeb 75DF 3 lb Sovran 50DF 4 oz+ Penncozeb 75DF 3 lb Captan 80WDG 5 lb Captan 80WDG 30 oz+ Ziram 76DF 3 lb	GT-TC Pk & PF Bl & 1C 2C 3C →	2	a	0.03	a	1	a	0.6	ab	10	a-c	2	a	18	b-d
9	Kocide 2000 53.8DF 3.5 lb + Penncozeb 3 lb Rally 40W 6 oz + Penncozeb 75DF 3 lb Captan 80WDG 5 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	GT-TC Pk-1C 2C 3C →	3	a	0.06	a	4	a	0	a	14	b-d	2	ab	19	b-d

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four single-tree replications.

Foliar fungal data based on counts of 10 shoots per tree from each of four single-tree replications 9 Jun. Postharvest fruit data are based on 25-fruit sample per rep harvested 26 Sep and held in cold storage until rating 17 Oct, then evaluated for rot development after 28 days at ambient temperatures 65-73ºF.

Fungicide treatments were applied to both sides of the tree on each indicated application date with a Swanson Model DA-400 airblast sprayer at 100 gal/A as follows: 25 Mar (GT); Apr 6, (1/2G-TC); Apr 14 (pink, Pk); Apr 20 (bloom, Bl), May 2 (petal fall, PF); 1st -8th covers (1C-8C): 11 May, 16 Jun, 30 Jun, 13 Jul, 27 Jul, 10 Aug, 24 Aug and 9 Sep.

Table 23. Summer disease control by protectant fungicides on Nittany apples.

			% fruit infected				% fruit infected after incubation*							
			Sooty		Fly-		Any		Bitter		White		Alter-	
	Treatment and rate per acre	Timing	blotch		speck		rot		Rot		rot		naria	
0	No fungicide		32	b	45	c	60	d	40	c	19	c	5	a
1	Rally 40W 6 oz + Penncozeb 75DF 3 lb Captan 80WDG 5 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	GT-1C 2C 3C →	0	a	0	a	4	a-c	0	a	2	a	2	a
2	Syllit 3.4F 1.5 pt Rally 40W 6 oz + Penncozeb 75DF 3 lb Captan 80WDG 5 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	GT-TC Pk-1C 2C 3C →	0	a	2	a	3	ab	1	a	0	a	2	a
3	Syllit 3.4F 1.5 pt + Penncozeb 75DF 3 lb Rally 40W 6 oz + Penncozeb 75DF 3 lb Captan 80WDG 5 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	GT-TC Pk-1C 2C 3C →	2	a	3	ab	15	bc	10	b	2	a	5	a
4	Syllit 3.4F 1.5 pt + Captan 80WDG 2.5 lb Rally 40W 6 oz + Penncozeb 75DF 3 lb Captan 80WDG 5 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	GT-TC Pk-1C 2C 3C →	0	a	2	a	2	a	1	a	1	a	0	a
5	Penncozeb 3 lb + Captan 80WDG 2.5 lb Rally 40W 6 oz + Penncozeb 75DF 3 lb Sovran 50DF 4 oz + Penncozeb 75DF 3 lb Captan 80WDG 5 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	GT-TC Pk & PF Bl & 1C 2C 3C →	1	a	2	ab	12	a-c	4	ab	6	ab	2	a
6	Syllit 3.4F 1.5 pt Rally 40W 6 oz + Penncozeb 75DF 3 lb Sovran 50DF 4 oz + Penncozeb 75DF 3 lb Captan 80WDG 5 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	GT-TC Pk & PF Bl & 1C 2C 3C →	1	a	4	ab	9	a-c	5	ab	3	a	1	a
7	Syllit 3.4F 1.5 pt + Penncozeb 75DF 3 lb Rally 40W 6 oz + Penncozeb 75DF 3 lb Sovran 50DF 4 oz + Penncozeb 75DF 3 lb Captan 80WDG 5 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	GT-TC Pk & PF Bl & 1C 2C 3C →	1	a	9	b	6	a-c	3	ab	1	a	3	a
8	Syllit 3.4F 1.5 pt + Captan 80WDG 2.5 lb Rally 40W 6 oz + Penncozeb 75DF 3 lb Sovran 50DF 4 oz+ Penncozeb 75DF 3 lb Captan 80WDG 5 lb Captan 80WDG 30 oz+ Ziram 76DF 3 lb	GT-TC Pk & PF Bl & 1C 2C 3C →	0	a	1	b	14	c	0	a	10	bc	1	a
9	Kocide 2000 53.8DF 3.5 lb + Penncozeb 3 lb Rally 40W 6 oz + Penncozeb 75DF 3 lb Captan 80WDG 5 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	GT-TC Pk-1C 2C 3C →	1	a	5	ab	7	a-c	3	ab	3	a	1	a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four single-tree replications.
Data represent postharvest counts of 25 fruit per replicate tree sampled 26 Sep and rated after 21 days storage at 39°F then 28 days incubation at ambient warm temperatures 65-73°F.
Fungicide treatments were applied to both sides of the tree on each indicated application date with a Swanson Model DA-400 airblast sprayer at 100 gal/A as follows: 25 Mar (GT); Apr 6, (1/2G-TC); Apr 14 (pink, Pk); Apr 20 (bloom, Bl), May 2 (petal fall, PF); 1st 8th covers (1C-8C): 11 May, 16 Jun, 30 Jun, 13 Jul, 27 Jul, 10 Aug, 24 Aug and 9 Sep.

MANAGEMENT OF APPLE SCAB WITH EXISTING AND NEW FUNGICIDES IN PA

Noemi O. Halbrendt and Henry K. Ngugi
Penn State University, Department of Plant Pathology
Fruit Research & Extension Center, Biglerville, PA 17307

Apple scab, caused by the fungus *Venturia inaequalis* is a destructive disease of apple affecting commercial production in Pennsylvania. If not managed, apple scab results in severe yield losses and a reduction in market value of harvested fruits. Therefore, apple growers must apply fungicides on a regular basis to prevent infection that can result in a reduction in fruit quality or crop loss. To provide growers with information needed to make fungicide choices for their orchards, efficacy of new and existing fungicides applied alone or in combination with other fungicides for scab control was evaluated at the Penn State Fruit Research & Extension Center orchard, Biglerville, PA. The test was conducted in a randomized complete block design with four replications per treatment on Rome Beauty apple trees. Treatments were applied dilute to both sides of the trees with a boom sprayer at 400 psi, which delivered 100 gal/A. Treatment applications were made on 7-14 day intervals from 11 Apr (half-in. green) to 7 Jun (2nd cover). A standard maintenance program for insects was applied separately to all the treatments. Weather data was recorded with electronic monitoring systems (Campbell Scientific) and scab infection periods calculated using a modified Mills apple scab infection model. Rainfall for Apr, May, Jun, Jul, and Aug was 11.4 in., 4.3 in., 1.4 in., 3.9 in., and 4.2 in., respectively. Overall, apple scab pressure was severe at the test site during the primary period 16 Mar to 15 Jun with 55 scab infection events. Incidence of scab on shoot and fruit was determined on 18 May and 15 Jun by examining all leaves of 25 arbitrarily selected shoots and fruit. Severity was rated on a 0 to 7 scale based on % area covered with symptoms and number of scab lesions: 0=0; 1=1-3% (1-3 lesions); 2=3-6% (3-7 lesions); 3=6-12% (6-15 lesions); 4=12-25% (15-25 lesions); 5=25-50% (25-50 lesions); 6=50-75% (50-80 lesions); 7=more than 75% (80 plus lesions). Data obtained was analyzed by analysis of variance and significance between means was determined by the Fisher's Protected LSD test ($P \leq 0.05$).

Incidence of scab on nontreated Rome Beauty shoot leaves and fruit on 28 May was 49 and 35%, and increased to 97 and 99%, respectively by 15 Jun. Scab severity on nontreated shoot leaves and fruit on 15 Jun was 42 and 10%, respectively. Incidence of scab on treated shoot leaves on 18 May ranged from 0 to 6% and increased to 1 to 37% on 15 Jun. All treatments provided a reduction in disease incidence and severity, but efficacy among treatments varied. Merivon, Fontelis/Manzate, Luna Sensation/Penncozeb, and Inspire Super/Penncozeb equally provided the highest reduction in scab incidence on shoot leaves relative to the nontreated check. Topguard/Captan program was more effective in controlling scab on leaves compared to Topguard/Koverall program. Topguard/Koverall programs were not as effective in controlling scab on leaves compared to the other treatments, but significantly reduced scab on fruit, as did the programs with Merivon, Fontelis, Luna Sensation, and Inspire Super (Table 1). No phytotoxicity was observed.

Acknowledgments: We would like to thank Bashar Jarjour, Terry Salade and FREC Tech Service for technical assistance in this project.

Table 1. Efficacy of various fungicide programs for apple scab on Rome Beauty apples.

		% Incidence[y]				% Severity[y]	
		Shoot	Shoot	Fruit	Fruit	Shoot	Fruit
Treatment and rate/A	Timing[z]	18 May	15 Jun	18 May	15 Jun	15 Jun	15 Jun
Untreated check		49.0 a	97.0 a	35.0 a	99.0 a	42.4 a	10.2 a
Merivon 4 fl oz + Sylgard 0.03%	½" GT-2C	4.0 bc	1.0 ef	0.0 b	0.0 c	0.1 cd	0.0 c
Merivon 5.5 fl oz + Sylgard 0.03%	½" GT-2C	1.0 d	1.0 ef	0.0 b	2.0 b	0.0 e	0.1 bc
Manzate Pro-Sick 5 lb + Vangard WG 4 oz Fontelis (1.67SC) 20 fl oz + JMS Stylet Oil 1% Manzate Pro-Stick 5 lb	½" GT,TC TC,B,PF,1C 2C	1.0 d	8.0 cd	0.0 b	2.0 b	0.2 bc	0.1 bc
Manzate Pro-Sick 5 lb + Vangard WG 4 oz Fontelis (1.67SC) 20 fl oz + JMS Stylet Oil 1% + Manzate Pro-Stick 3 lb Manzate Pro-Stick 3 lb	½" GT,TC TC,B,PF,1C 2C	0.0 d	4.0 de	0.0 b	1.0 b	0.1 cd	0.0 c
Penncozeb 75DF 5 lb + Captan 80WDG 2 lb Luna Sensation 4 fl oz + Penncozeb 75DF 3 lb Inspire Super 2.82EW 12 fl oz + Penncozeb 75DF 3 lb	½" GT TC,P,PF,1C B,2C	0.0 d	5.0 de	0.0 b	3.0 b	0.1 cd	0.1 bc
Penncozeb 75DF 5 lb + Captan 80WDG 2 lb Luna Sensation 4 fl oz Inspire Super 2.82EW 12 fl oz + Penncozeb 75DF 3 lb	½" GT TC,P,PF,1C B,2C	0.0 d	7.0 de	0.0 b	1.0 b	0.1 bc	0.9 bc
Penncozeb 75DF 6 lb + Captan 80WDG 2.5 lb Captan 50W 5 lb Inspire Super 2.82EW 12 fl oz + Penncozeb 75DF 3 lb	½" GT TC-P B-2C	0.0 d	1.0 ef	0.0 b	0.0 c	0.0 e	0.0 c
Topguard 13 fl oz + Captan 80WDG 4 lb	½" GT-2C	2.0 bc	9.0 c	0.0 b	0.0 c	0.2 bc	0.0 c
Flint 2.5 oz + Koverall 3 lb Topguard 13 fl oz + Koverall 3 lb	½" GT,B-PF TC,1C,2C	6.0 b	37.0 b	0.0 b	1.0 b	1.0 b	0.0 c

[z] Application timings were: 1=11 Apr (half-inch green = 1/2" GT); 2=18 Apr, (tight cluster/pink -TC-P); 3=29 Apr (pink/bloom-P-B); 4=11 May (petal fall-PF); 5=21 May (1st cover-1C); 6=7 Jun (2nd cover-2C).

[y] All values are scab incidence and the means of at least 25 terminal shoots, leaves, and fruit across four replicate trees arranged in randomized complete blocks. Values within columns followed by the same letter(s) are not significantly different ($P \leq 0.05$) according to Fisher's Protected LSD test.

PERFORMANCE OF FONTELIS (LEM-17) FOR EARLY SEASON APPLE DISEASES IN LARGE BLOCK AND SMALL PLOT TRIALS

Alan R. Biggs
West Virginia University, KTFREC
Kearneysville, West Virginia 25430

Three experiments were conducted in 2011 to evaluate the effectiveness of Fontelis (DuPont's LEM-17) for early season apple diseases. The 2011 growing season was atypical with twice normal monthly rainfall in Apr, May and Sep. Total precipitation (inches) in Apr, May, Jun, Jul, Aug, and Sep was 8.5, 6.3, 2.6, 3.5, 4.0 and 6.7, respectively. Seventeen early season infection periods (prior to 1 Jun) were followed by 16 additional infection periods from the period 1 Jun through 8 Sep. Sixteen infection periods occurred during the test period (HG through 1C). Generally warm temperatures and abundant rainfall in May were very favorable for early season disease development (Fig. 1).

Treatments in experiments one and two included: for treatments one and two only, Vangard + EBDC on Apr 4 and Rally + EBDC on Apr 11, followed by (treatment one) Fontelis 20 oz/A (for 4 consecutive applications, 18, 25 April, and 3, 16 May), or (treatment 2) Fontelis 15 oz/A + EBDC 3 lb/A (for 4 consecutive applications, 18, 25 April, and 3, 16 May), or (treatment 3) a standard program with no insecticides, or (treatment 4) a nonsprayed treatment. The standard program (treatment 3) consisted of Apr 4 - Syllit + EBDC, 1.5 lb + 3.0 lb; Apr 11 - Flint + EBDC, 2.5 oz + 3.0 lb; Apr 18 - Inspire Super, 12 oz; Apr 25 - Flint + EBDC, 2.5 oz + 3.0 lb; May 3 - Inspire Super, 12 oz; May 16 - Flint + EBDC, 2.5 oz + 3.0 lb; May 31 - Captan + Ziram, 2 lb + 3 lb.

The first test was conducted in 4 36-tree 'Golden Delicious' miniblocks, each 1/3 acre, of 33-yr-old trees on MM 111 rootstock and were planted at a spacing of 20 x 20 ft. Each miniblock received one of the four treatments. Arthropod management was a standard program that used Helena products. The second test was conducted in a 2.6-acre block of 31-yr-old trees with alternating rows of 'Rome' and 'Golden Delicious' trees spaced 15 x 22 ft. This block was subdivided into 4 treatment areas of 2/3 acre. Arthropod management was a standard program that used CPS products. In both experiments, treatments were applied as complete sprays to both sides of the trees with a Swanson DA500A airblast sprayer, which traveled at 2.6 mph and delivered a spray volume of 100 GPA. Data were collected from 10 trees per block in experiment one and 10 trees per block per cultivar in experiment two. Results showed that Fontelis was equal to or better than the standard for controlling scab, rust and frog eye leaf spot (Table 1).

In a third experiment, different schedules of Inspire Super, Topguard, Fontelis, and a Rally + Dithane standard were evaluated for early-season disease control in an 11-yr-old research orchard spaced 4.3 m x 7.3 m on M.111 rootstock. The test was conducted in a randomized block design with four single-tree replications per treatment. Treatments were applied from both sides of the row with a Swanson model DA-500 airblast sprayer (935 L/ha, 100 gal/A) as follows: 6 Apr (half-inch green, HG), 14 Apr (tight cluster, TC), 20 Apr (pink, P), 2 May (bloom, B), 10 May (petal fall, PF), 25 May (first cover, 1C), 1 Jun (second cover, 2C), 15 Jun (third cover, 3C), 30 Jun (fourth cover, 4C), 15 Jul (fifth cover, 5C), 28 Jul, (sixth cover, 6C), and 17 Aug (seventh cover, 7C) (Table 2). Maintenance insecticide sprays were applied separately with the same equipment. Control of summer diseases was accomplished with Captan 80WDG + Topsin-M 70WP applied at approximately 14-day intervals at 3rd through 7th cover. Incidence on leaves was determined on 10 Jun from 5 terminal shoots per tree from single-tree plots in each of the four replications. Incidence of diseases on fruit was determined on 16 Jun and 12 Sep from 100 and 25 fruit, respectively, from each treatment and block (400 and 100 total fruit per treatment in Jun and Sep, respectively). Percent data were transformed (arcsin transformation) and subjected to analysis of variance and means separation with the Waller-Duncan k-ratio t-test.

Non-sprayed foliage in Jun showed 32% of leaves with scab and 28% of leaves with cedar apple rust. For leaf scab, all treatments were significantly better than the nonsprayed control and not significantly different from each other (Table 1). The Fontelis treatments were less effective for cedar apple rust than the Rally, Inspire Super, or Topguard treatments; although both of the Fontelis treatments were significantly better than the control. All treatments were similar and significantly better than the nonsprayed control for frog eye leaf spot incidence. Fruit from nonsprayed trees showed 96% and 92% of the fruit with scab in Jun and Sep, respectively. All treatments were significantly better than the nonsprayed control and the Rally standard in Jun, but not Sep. Incidence of total rots at harvest was lowest in the Fontelis treatments, although not significantly different from the Rally and Topguard treatments. No phytotoxicity was observed in any of the treatments.

Figure 1. For April and May, 2011 (days, on the x-axis), precipitation (blue bars, in inches, left y-axis), and mean daily temperature (red line, in degrees F, right y-axis).

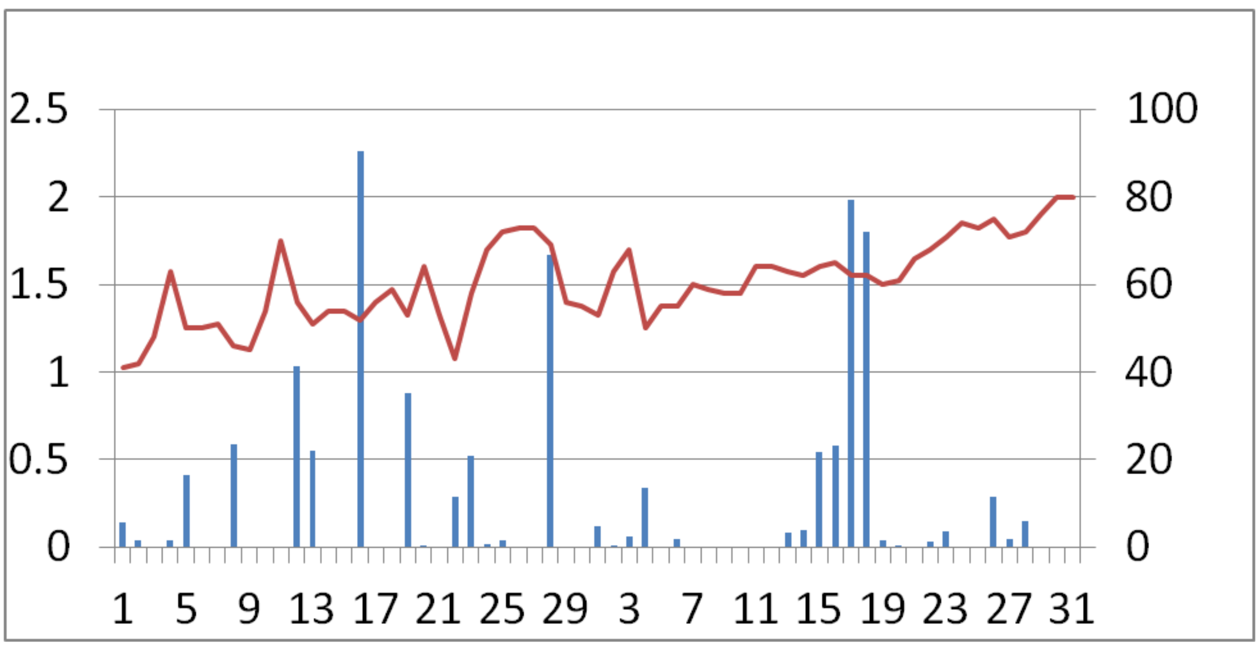


Table 1. Leaf scab, leaf rust, and frog eye leaf spot assessed on 9 June 2011, and fruit scab assessed at harvest, on Golden Delicious and Rome apples.

Leaf Scab – 9 June Treatment	Experiment 1	Experiment 2	
	Gold. Del.	**Gold. Del.**	**Rome**
Fontelis 15 + EBDC	1.2 b	0.4 b	2.0 b
Fontelis 20	0.4 b	3.5 b	1.7 b
Standard	0.8 b	0.5 b	1.4 b
Non-sprayed	15.3 a	17.1 a	39.5 a
Leaf Rust – 9 June Treatment	**Experiment 1**	**Experiment 2**	
	Gold. Del.	**Gold. Del.**	**Rome**
Fontelis 15 + EBDC	2.0 c	20.4 b	33.6 b
Fontelis 20	1.6 c	14.2 bc	34.2 b
Standard	11.3 b	12.1 c	37.4 b
Non-sprayed	49.0 a	58.8 a	79.3 a
FELS – 9 June Treatment	**Experiment 1**	**Experiment 2**	
	Gold. Del.	**Gold. Del.**	**Rome**
Fontelis 15 + EBDC	13.9 a	8.5 a	6.5 b
Fontelis 20	12.9 ab	12.0 a	4.6 b
Standard	7.5 b	7.2 a	3.0 b
Non-sprayed	10.8 ab	10.6 a	12.4 a
Fruit Scab – Harvest Treatment	**Experiment 1**	**Experiment 2**	
	Gold. Del.	**Gold Del.**	**Rome**
Fontelis 15 + EBDC	0.0 b	0.0 b	0.3 b
Fontelis 20	0.0 b	0.0 b	0.0 b
Standard	0.0 b	0.3 b	0.0 b
Non-sprayed	16.2 a	7.8 a	50.8 a

Table 2. Scab, rust, frog eye leaf spot assessed on foliage on 10 June, scab assessed on fruit on 16 June, and fruit diseases assessed at harvest, 12 Sept. 2011.

No.	Treatment: Fungicide	Rate/A	Timing[z]	Leaves – 10 June[y]: Scab (%)	Leaves – 10 June[y]: Cedar-apple rust (%)	Leaves – 10 June[y]: FELS (%)	Fruit diseases[x]: Fruit Scab 16-Jun	Fruit diseases[x]: Fruit Scab 12-Sep	Fruit diseases[x]: Fly speck 12-Sep	Fruit diseases[x]: All Rots (%) 12-Sep
1	Manzate 75DF + Vangard 75WG	3 lb + 4 oz	HG,TC	6.0 b	19.2 b	1.0 b	5.5 c	9.0 b	1.0 a	5.0 c
	Fontelis	20 fl oz	P,B,PF							
	Captan 80WDG + Ziram 76DF	2 lb + 3 lb	2C,3C							
	Captan 80WDG + Topsin-M 70WP	2 lb + 8 oz	1C,4C-7C							
2	Manzate 75DF + Vangard 75WG	3 lb + 4 oz	HG,TC	8.8 b	12.2 b	0.6 b	5.5 c	5.0 b	6.0 a	0.0 c
	Fontelis + Manzate 75	14 fl oz + 3 lb	P,B,PF							
	Captan 80WDG + Ziram 76DF	2 lb + 3 lb	2C,3C							
	Captan 80WDG + Topsin-M 70WP	2 lb + 8 oz	1C,4C-7C							
3	Flint 50W + Koverall 75[v]	2.5 oz + 3 lb	HG,P	5.5 b	0.6 c	5.1 b	4.2 c	8.0 b	10.0 a	7.0 bc
	Topguard + Koverall 75	13 oz + 3 lb	TC,B,PF,1C							
	Captan 80WDG + Ziram 76DF	2 lb + 3 lb	2C,3C							
	Captan 80WDG + Topsin-M 70WP	2 lb + 8 oz	4C-7C							
4	Manzate 75DF	3 lb	HG	1.7 b	0.0 c	3.3 b	8.2 c	1.0 b	1.0 a	19.0 ab
	Inspire Super	8.5 fl oz	TC,PF,1C							
	Flint 50W + Manzate 75	2.5 oz + 3 lb	P							
	Fontelis	20 fl oz	B							
	Captan 80WDG + Ziram 76DF	2 lb + 3 lb	2C,3C							
	Captan 80WDG + Topsin-M 70WP	2 lb + 8 oz	4C-7C							
5	Manzate 75DF	3 lb	HG	7.4 b	0.0 c	4.5 b	16.0 b	10.0 b	6.0 a	9.0 bc
	Rally 40W + Manzate 75	5 oz + 3 lb	TC,P,B,PF1C							
	Captan 80WDG + Ziram 76DF	2 lb + 3 lb	2C,3C							
	Captan 80WDG + Topsin-M 70WP	2 lb + 8 oz	4C-7C							
6	Untreated	---	---	31.7 a	27.5 a	16.5 a	96.5 a	92.0 a	12.0 a	26.0 a

[z] Application timings: HG = 6 April, TC = 14 April, P = 20 April, B = 2 May, PF = 10 May, 1C = 25 May, 2C = 1 Jun, 3C = 15 Jun., 4C = 30 Jun., 5C = 15 Jul., 6C = 28 Jul., 7C = 17 Aug., 2011.

[y] Data are mean percent incidence from 10 terminal shoots per tree from each of four single-tree replicates arranged in randomized blocks. Different letters within columns denote significant differences among arcsine-transformed percentage values. Percentages reported in columns. FELS = frog eye leaf spot, caused by *Botryosphaeria obtusa*.

[x] Data are mean percent incidence from 100 (Jun) or 25 (Sep) fruit per tree from each of four single-tree replicates arranged in randomized blocks. Different letters within columns denote significant differences among arcsine-transformed percentage values. Percentages reported in columns.

[w] Means marked with the same letter are not significantly different within columns among arcsine-transformed percentage values according to the Waller Duncan *K*-ratio *t*-test (K=100; α=0.05);. Actual percentages reported in columns.

[v] Due to availability issues, HG and TC applications in treatment 3 included Manzate 75DF instead of Koverall 75.

INFLUENCE OF CANOPY LOCATION AND MICROCLIMATE ON SI FUNGICIDE RESISTANCE IN *Venturia inaequalis* POPULATIONS

Sasha C. Marine[1], Erik L. Stromberg[2], and Keith S. Yoder[1]
[1]Virginia Tech AHS AREC, Winchester, VA 22602
[2]Virginia Tech PPWS Department, Blacksburg, VA 24061

Venturia inaequalis is the casual organism of apple scab, an economically devastating disease of apples that occurs wherever apples are grown (1). Management has predominantly relied on chemical applications, and fruit tree training and orchard layout have paralleled this trend. However, studies have found that in more conventional plantings (less than 150 trees/A), leaf moisture (2) and the concentration of airborne *V. inaequalis* ascospores are not uniformly distributed within an orchard, within a block of the same cultivar, or within an individual tree. A preliminary investigation on the influence of canopy location and microclimate on SI fungicide resistance in Virginia's scab population yielded mixed results. The objectives of this study were to (i) determine the spray deposition within the tree canopy, (ii) characterize SI fungicide resistance in *V. inaequalis* isolates collected from different locations within the tree canopy, and (iii) monitor the microclimate within the trees.

For the first objective, four mature Stayman trees were selected from a more conventionally-planted test block. Twenty-five leaves were collected from seven locations within each tree (lower west, middle west, upper west, lower east, middle east, upper east, or middle by the trunk). Mancozeb (Manzate Prostick) was applied airblast to both sides of the tree at a rate of 3 lb/A, after which twenty-five leaves were collected from the same seven locations. Air-dried leaves were mailed to A&L Eastern Laboratories for processing, and data were averaged from the four single tree replications. Manganese levels were not significantly different amongst the seven locations prior to mancozeb application, indicating uniform background levels. Following mancozeb application, the seven locations were significantly different from one another, with the middle by the trunk having the lowest manganese level (137.25 ppm) and the lower east having the highest (271.25 ppm).

For the second objective, eight mature Stayman trees were selected. Myclobutanil (Rally 40W) was applied airblast at a rate of 5 oz/100 gal. Shoot growth on treated and non-treated trees within each replication was monitored using neon-colored rubber bands to ensure the most recently infected leaves were collected at each sampling interval. Ten leaves containing at least one scab lesion were collected from five sampling zones (lower interior, lower exterior, middle interior, middle exterior or upper) of individual trees on 12 May, 13 June and 8 July 2011. Monoconidial isolates were cultured on PDA, and fungicide resistance was determined by the percent difference in colony growth on 0 and 1.0 ppm technical grade myclobutanil at 28 days. Data were analyzed using PROC GLM (α=0.05) in SAS® (Windows®, release 9.2, SAS Institute Inc., Cary, NC). Generally, the mean colony growth of *V. inaequalis* isolates was not significantly different amongst replication, tree treatment, canopy height or canopy zone (Table 1). The majority of isolates (85/105) were classified as SI-sensitive (percent difference >50) and were collected from both treated and non-treated trees. Only two isolates (percent difference <25) were SI-resistant.

Table 1. ANOVA for differences between factors when accounting for collection dates.

	Type III SS, P-value			
Factor	**May (N=35)**	**June (N=36)**	**July (N=34)**	**All (N=105)**
Replication	<0.001	0.069	0.002	0.251
Tree treatment	0.004	0.424	<0.001	0.043
Canopy Height	0.238	0.047	0.4	0.234
Canopy Zone	0.239	0.098	0.149	0.286
Collection Date	-	-	-	<0.001
Assay Treatment	<0.001	<0.001	<0.001	<0.001
Assay Time	<0.001	<0.001	<0.001	<0.001

For the third objective, the eight Stayman trees from the previous objective were outfitted with weather sensors. Seven EL-USB-1 data loggers (temp and RH) were positioned at three canopy heights (lower, middle and upper) and facing in three directions (East, West or by the trunk) within each tree. Four WatchDog A-series data loggers (temp and LW) were positioned in the middle (1.5-3m from the ground) by the trunk of two treated and two non-treated trees. Weather data was recorded from 4 April until 26 August 2011, and infection periods or secondary wettings prior to a sampling interval were analyzed as a group using PROC MIX (α=0.05) in SAS®.

Eight infection periods occurred between 4 April and 12 May, nine between 13 May and 13 June, and seven between 14 June and 8 July. Generally, temperature and relative humidity were significant (P<0.001) amongst canopy height and direction (Table 2). Which canopy location had the highest temperature or most relative humidity, however, varied throughout the field season.

Table 2. ANOVA for the differences between factors when accounting for infection period before a collection.

EL-USB (56)				P-value		
	4April-12May (N=8)		**13May-13June (N=9)**		**14June-8July (N=7)**	
Factor	Temp	RH	Temp	RH	Temp	RH
Canopy Height	<0.001	<0.001	0.009	<0.001	0.011	<0.001
Direction	<0.001	0.07	<0.001	<0.001	0.059	0.111
Height x Direction	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Infection Period	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

The results from this study show that, although spray deposition and microclimate is influenced by canopy location, SI fungicide resistance does not appear to be present.

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MANAGEMENT OF BACTERIAL SPOT ON PEACH WITH NOVEL BACTERICIDES

Norman Lalancette and Kathleen McFarland
Rutgers University, Agricultural and Extension Center
Bridgeton, NJ 08302

Xanthomonas arboricola pv. *pruni*, the pathogen that causes bacterial spot on stone fruit, multiplies rapidly in warm, humid conditions, and spreads from tree to tree through wind and rain. Infection of fruit results in the formation of small water-soaked, brownish lesions that become black and pitted with age; many lesions can coalesce and cause significant fruit cracking. Under favorable conditions of environment and inoculum availability, severe epidemics can result in significant crop loss and defoliation.

In this field study, six new bactericides containing copper and other metallic ions were examined for their efficacy at controlling fruit infection on peach. Since copper can be phytotoxic to peach leaves, foliar defoliation assessments were also conducted. The current standards for bacterial spot control, the antibiotic oxytetracycline (Mycoshield) and copper hydroxide (Kocide 3000), were included for comparison.

Materials and Methods

Orchard Site. The experiment was conducted during the spring and summer of the 2011 growing season. The block consisted of 6-8 year old 'O'Henry' peach trees grafted on Lovell and Halford rootstocks. O'Henry is highly susceptible to bacterial spot.

Treatments. Bactericide treatments were replicated four times in a randomized complete block design using single tree plots. Treatment trees were surrounded on all sides by non-sprayed buffer trees. A Rears Pak-Blast-Plot airblast sprayer calibrated to deliver 100 gal/A at 100 psi traveling at 2.1 mph was used for bactericide applications. All trees in the block received Ziram at 4 lb/A on 17 Mar for leaf curl control. Insecticides and miticides were applied as needed to the entire block using a commercial airblast sprayer. Treatment application dates and phenological timing are shown in Table 1.

Bactericides were applied 12 times throughout the growing season, from shuck split, SS, through 11th cover, 11C (Table 1). Time periods between sprays varied from 6 days to 11 days, with most intervals having 7-8 days duration. Due to late arrival of some test bactericides, the shuck-split spray (for all treatments) was applied late at 71% of calyxes split. The optimum timing of this spray is typically at 5% of calyxes split, which occurred about 7 days earlier in 2011.

Water used for spraying was quite acidic, with a pH of 4.3. Spray solutions for the first five sprays (SS – 4C) were un-buffered. Measured pH's of these spray solutions, immediately after mixing, were: Mycoshield, 3.5; Kocide, 5.7; Nordox low rate, 4.9; Nordox high rate, 5.0; Agion-A, 5.9; Agion-B, 5.9; Agion-C, 6.0, Agion-D, 5.9; and Cueva (na). Sprays mixtures applied from 5C onward were treated with the alkaline buffer potassium carbonate. After correction, pH's ranged from 6.4 to 7.1.

Fruit Assessment. Bacterial spot development on fruit was assessed on 27 June and 27 July. In both assessments, 25 fruit were arbitrarily selected from each tree and the total number of lesions were counted on each fruit. Using these data, disease incidence was expressed as percent infected fruit and lesion density, a measure of disease severity, as average number of lesions per fruit. In addition, the percent of fruit surface area occupied by lesions (including healthy tissue between spots) was visually estimated during the second assessment.

Foliar Assessment. Three separate disease/phytotoxicity assessments were conducted on foliage. Both bacterial spot infection and copper injury can cause leaf abscission. The first foliar assessment was performed on 9 June and measured defoliation on shoots treated with non-buffered sprays. Five vegetative shoots were cut from the trees and all leaves present and missing were counted.

The second and third foliar assessments were performed on 11 July and 10 August, respectively. These assessments were conducted on ten tagged vegetative shoots arbitrarily selected on each tree. The total number of present and missing leaves was counted on each shoot to provide a measure of defoliation. The same 10 [tagged] shoots were examined at each assessment.

The youngest leaf on each tagged shoot was marked at fifth cover (5C) to indicate the time at which pH buffering began for all treatments. Then, during the third assessment on 10 August, a separate defoliation estimate was performed on this upper portion of the shoots to determine if buffering was reducing phytotoxicity.

Weather Data. Air temperatures and rainfall data were recorded by a Campbell Scientific 21X data logger located at the research station. Observations were taken every minute and summarized every hour. Monthly temperature averages and rainfall accumulations were compared to 30-year means or sums, respectively, for Bridgeton.

Statistical Analysis. Analyses of variance (ANOVA) and treatment mean comparisons were performed using the General Linear Models (GLM) procedure of SAS v9.2. Arcsin and log transformations were performed as needed for proportions and lesion count data, respectively, to correct for departures from the ANOVA assumptions.

Results and Discussion

Environment. Overall, the growing season (Apr to early Sep) was very wet with above average temperatures (Table 1). Rainfall in April, June, July, and August were 1.31, 0.16, 1.53, and 18.44 inches above the 30-year average, respectively. Heavy down pours on 14 Aug and Hurricane Irene on 27-28 Aug, which both occurred after this study ended, resulted in that month's excessive rainfall accumulation. May was the only month to receive less rainfall than the 30 year average (2.18 in below average).On a state-wide level, the summer (June-August) and August itself were the wettest on record (since 1895).

Every month except August had temperatures well above average. April, May, June, and July had temperatures 3.9º, 2.8º, 2.1º, and 2.4ºF above average, respectively. The temperature for August, 2.0ºF below average, was most likely due to the rainfall and cloud coverage that month. Average monthly temperatures this growing season were: Apr, 55.8ºF, May 64.8ºF, Jun 73.1ºF, Jul 78.4ºF, and Aug 73.0ºF.

Disease Pressure. Bacterial spot pressure was moderate to high this season. Frequent rainfalls and optimum temperatures for infection (75-84 ºF) were observed from approximately mid-June onward. The non-treated control had 39% fruit infection and an average of 3.2 lesions per fruit on 27 June (Table 2). By late July fruit infection increased to 92% with an average of 21.1 lesions per fruit. on-treated fruit had an average of 9.1% surface area with lesions. In years that were very conducive for bacterial spot, non-treated O'Henry trees had 100% infection with *several hundred* lesions per fruit late in the season.

Fruit Infection. At the first assessment on 27June, four treatments had significantly lower fruit disease incidence and severity (lesion density) than the non-treated control: Kocide 3000, Nordox 1.3 oz, Nordox 2.7 oz, and Cueva (Table 2). These four bactericides, which were not significantly different from each other, provided 38, 49, 59, and 51% disease control, respectively. The four Agion materials and the antibiotic standard, Mycoshield, did not significantly reduced disease incidence or severity at this time. However, five of the seven bactericide applications prior to this assessment were made using non-buffered water.

By the second assessment on 27July, all treatments showed significant reductions in fruit disease incidence and severity (Table 2).Disease control ranged from 23% for Mycoshield and Agion-A to 59% for Nordox 2.7 oz. Four treatments - Nordox 1.3 oz, Nordox 2.7 oz, Cueva, and Agion-B - had significant less infected fruit than both the Mycoshield and Kocide 3000 standards. Of these four treatments, Nordox 2.7 oz and Cueva provided significantly lower disease severity than both standards, yielding 81% and 87% reductions in lesion density, respectively. Agion-B provided the next best reduction in lesion density, reducing the number of lesions per fruit by 74%.

The first fruit disease assessment primarily measured the effects of non-buffered treatment applications, while the second assessment included the effects of both non-buffered and buffered sprays. Thus, the difference in disease levels between these two assessments provides a measure of disease control using only buffered applications. Given this premise, the increase in disease incidence between the two assessments for the four most effective bactericides, Nordox 1.3 oz, Nordox 2.7 oz, Cueva, and Agion-B, was 34, 32, 24, and 19%, respectively. In comparison, disease incidence levels for the standards Mycoshield and Kocide 3000 each increased by 46% during the same period.

Defoliation. Leaf loss on peach and nectarine cultivars is due to both bacterial spot infection and copper phytotoxicity. As the number of bacterial spot lesions and/or spots from copper injury increase on foliage, the likelihood of leaf abscission increases.

None of the bactericide treatments significantly reduced defoliation relative to the control (Table 3). Of course, for the copper-based materials, any reduction in defoliation from foliar disease control may have been offset by leaf loss due to phytotoxicity. Most defoliation estimates for Mycoshield, the only non-phytotoxic bactericide examined, were numerically lower than the non-treated control, indicating some level of disease control. However, only one of these estimates (11 July) was significantly lower.

Based on the amount of defoliation observed from early June through early August, the copper-based treatments could be divided into two groups (Table 3). The first group had some defoliation estimates equivalent to and some greater than their respective non-treated control. These "intermediate" materials were Kocide, Nordox, and Cueva. The second group, which consists of all four Agion materials, had consistently higher levels of defoliation than the non-treated control. Since defoliation on the non-treated control was only due to bacterial spot infection, significantly higher defoliation for treatments in these two groups was presumably due to phytotoxicity.

The assessment on 9 June evaluated the effects of five *non-buffered* bactericide applications on defoliation, while the assessment conducted on the upper portion of the shoots on 10Aug evaluated the effects of seven *buffered* applications (Table 3). Although statistical comparison was not performed due to different environmental conditions, increasing water pH with a buffering agent (thereby reducing concentration of soluble copper ions) appears to reduce defoliation (as expected).

Optimization. The most desirable bactericides provide maximum disease control with minimal amounts of defoliation. To evaluate this potential and compare bactericides, disease control – defoliation graphs were constructed based on disease incidence (Fig. 1) and disease severity data (Fig. 2).

Nordox 2.7 oz, Cueva, and Agion-B provided the highest disease control (Fig. 1) and reductions in lesion density (Fig. 2), while having an intermediate level of defoliation. Reducing the Nordox rate to 1.3 oz lessened defoliation, but also decreased disease control ability.

Kocide 3000 treated trees had the lowest amount of defoliation of all treatment trees. Although the disease control level was low, Kocide nevertheless provided a 75% reduction in lesion density. This ability of Kocide to significantly reduce the number of lesions on fruit, but not all lesions (resulting in high incidence) is a property that has been observed in past studies.

Finally, the remaining Agion materials (Agion-A, Agion-C, and Agion-D) displayed both low disease control ability and high defoliation.

Conclusion

- Late application of the first (shuck-split) spray, due to late arrival of some test materials, may have reduced the overall level of disease control. Rainfall during the 7-10 day period prior to the first application may have provided conditions favorable for infection.

- The standard **Mycoshield** significantly reduced disease incidence and severity by the second assessment, but disease levels were still quite high. The very short residual activity of this antibiotic, combined with the frequent rainfalls during the study, were most likely the major cause for poor disease management.

- Although defoliation for all copper-based treatment programs was considerably higher than observed on non-treated shoots, use of spray water at the proper pH should aid in diminishing phytotoxicity issues.

- Under the conditions of the study, **Nordox** at the high rate, **Cueva**, and **Agion-B** provided the best overall fruit disease control / phytotoxicity profiles of all test materials. Furthermore, more copper should remain fixed at pH's closer to neutral, thereby improving residual activity and perhaps disease control as well.

- As a highly susceptible cultivar, O'Henry is a good candidate for evaluating bactericide efficacy. However, because of this susceptibility, O'Henry is generally not planted in the eastern United States. Thus, better disease control would be expected on less susceptible commercial cultivars.

Table 1. Daily average air temperature (°F) and rainfall accumulation (inches) during 2011 at the Rutgers Agricultural Research and Extension Center, Bridgeton NJ. Dates of bactericide applications indicated by **bold** phenological stages. Fruit & foliar assessment dates are in *italic*.

Date	Temp	Rain	Activity	Date	Temp	Rain	Activity	Date	Temp	Rain	Activity
1-Apr	39.9	0.18		1-May	56.0	0		1-Jun	80.1	0	
2-Apr	43.9	0		2-May	60.7	0		2-Jun	76.3	0	
3-Apr	47.6	0		3-May	67.6	0	**Shuck Split**	3-Jun	66.5	0	
4-Apr	59.3	0.02		4-May	55.3	0.69		4-Jun	64.4	0	
5-Apr	56.2	0.28		5-May	54.5	0		5-Jun	67.4	0	
6-Apr	46.6	0		6-May	57.1	0		6-Jun	69.4	0	**4th Cover**
7-Apr	48.1	0		7-May	58.5	0.06		7-Jun	74.7	0	
8-Apr	41.5	0.65		8-May	58.9	0		8-Jun	79.4	0	
9-Apr	47.5	0		9-May	59.6	0		9-Jun	83.9	0	*Foliar #1*
10-Apr	51.9	0		10-May	59.9	0		10-Jun	76.5	0.22	
11-Apr	64.0	0		11-May	57.6	0	**1st Cover**	11-Jun	73.6	0	
12-Apr	61.8	0.35		12-May	60.0	0		12-Jun	72.1	0	
13-Apr	49.6	0.17		13-May	58.2	0		13-Jun	69.7	0	
14-Apr	55.7	0		14-May	58.7	0.37		14-Jun	64.7	0.22	**5th Cover**
15-Apr	50.4	0		15-May	66.3	0.13		15-Jun	67.9	0	
16-Apr	50.1	1.46		16-May	66.3	0		16-Jun	70.9	0.07	
17-Apr	55.5	0.62		17-May	63.3	0.22		17-Jun	72.6	0.05	
18-Apr	58.3	0		18-May	64.0	0.11		18-Jun	74.0	0.01	
19-Apr	60.0	0.02		19-May	63.0	0.09	**2nd Cover**	19-Jun	74.6	0	
20-Apr	62.3	0		20-May	60.1	0.2		20-Jun	69.6	0	
21-Apr	57.2	0		21-May	65.4	0.01		21-Jun	71.7	0.16	**6th Cover**
22-Apr	44.7	0.01		22-May	62.4	0		22-Jun	77.1	0.72	
23-Apr	54.7	0.23		23-May	67.0	0		23-Jun	79.1	0	
24-Apr	69.4	0.24		24-May	75.5	0		24-Jun	77.9	0	
25-Apr	72.0	0.12		25-May	73.5	0		25-Jun	74.1	0	
26-Apr	72.1	0		26-May	75.7	0	**3rd Cover**	26-Jun	72.3	0	
27-Apr	69.9	0.18		27-May	75.6	0		27-Jun	72.6	0.01	*Fruit #1*
28-Apr	70.2	0.36		28-May	73.5	0.01		28-Jun	72.7	2.07	**7th Cover**
29-Apr	61.4	0		29-May	75.4	0		29-Jun	76.4	0	
30-Apr	54.4	0		30-May	79.7	0		30-Jun	71.0	0	
				31-May	79.3	0					

Table 1 – continued –

Date	Temp	Rain	Spray	Date	Temp	Rain	Spray	Date	Temp	Rain	Spray
1-Jul	71.4	0		1-Aug	79.9	0.02		1-Sep	70.0	0	
2-Jul	74.2	0		2-Aug	77.6	0		2-Sep	67.5	0	
3-Jul	77.6	0.04		3-Aug	75.3	0.04		3-Sep	71.1	0	
4-Jul	78.2	0		4-Aug	72.1	0.25		4-Sep	73.9	0	
5-Jul	79.0	0		5-Aug	71.8	0		5-Sep	75.3	0	
6-Jul	77.9	0	**8th Cover**	6-Aug	75.2	0					
7-Jul	78.8	0.65		7-Aug	80.6	0					
8-Jul	74.8	1.57		8-Aug	81.1	0					
9-Jul	76.2	0		9-Aug	75.3	2.51					
10-Jul	76.4	0		10-Aug	76.1	0	*Foliar #3*				
11-Jul	80.7	0	*Foliar #2*	11-Aug	72.1	0					
12-Jul	81.6	0	**9th Cover**	12-Aug	70.2	0					
13-Jul	79.3	0		13-Aug	70.3	0.37					
14-Jul	72.4	0		14-Aug	70.5	9.47					
15-Jul	72.5	0		15-Aug	71.5	0.55					
16-Jul	74.3	0		16-Aug	70.6	0.02					
17-Jul	76.2	0		17-Aug	73.5	0					
18-Jul	79.7	0		18-Aug	74.8	0.12					
19-Jul	80.7	1.44	**10th Cover**	19-Aug	72.2	0.5					
20-Jul	76.9	0		20-Aug	72.2	0.01					
21-Jul	82.8	0		21-Aug	74.7	0.05					
22-Jul	88.1	0		22-Aug	72.0	0					
23-Jul	87.6	0		23-Aug	67.0	0					
24-Jul	82.7	1.82		24-Aug	69.8	0					
25-Jul	76.3	0.01		25-Aug	73.6	0.94					
26-Jul	79.4	0		26-Aug	74.8	0					
27-Jul	77.5	0	*Fruit #2*	27-Aug	73.5	4.85					
28-Jul	76.8	0		28-Aug	72.5	2.92					
29-Jul	81.0	0.3	**11th Cover**	29-Aug	66.0	0					
30-Jul	81.1	0		30-Aug	67.0	0					
31-Jul	79.2	0		31-Aug	68.9	0					

Table 2. Bacterial Spot Fruit Incidence and Severity

			27 June*		27 July*		
Treatment	**Timing**	**Rate/A**	**% Infected Fruit**	**# Lesions / Fruit****	**%Infected Fruit**	**# Lesions / Fruit****	**% Area Infected****
Non-treated Control	-----	-----	39.0 a	3.2 a	92.0 a	21.1 a	9.1 a
Mycoshield 17WP	SS 1C-11C	1.5 lb	25.0 abc	2.8 abc	71.0 b	13.9 bc	5.9 bc
Kocide 3000 30DF	SS 1C-11C	5.0 oz 3.3 oz	24.0 bc	1.6 bc	70.0 b	5.2cd	2.1de
Nordox 75WG	SS 1C-11C	2.0 oz 1.3 oz	20.0 bc	1.5 bc	54.0 cd	7.4 de	2.8 cde
Nordox 75WG	SS 1C-11C	4.0 oz 2.7 oz	16.0 c	1.0 c	38.0 e	4.0 e	1.7 e
Cueva 0.16F	SS 1C-11C	75 fl oz 50 fl oz	19.0 bc	1.8 bc	43.0 de	2.7 e	1.1 e
Agion-A	SS,1C,2C 3C–11C	5.88 gal 2.94 gal	29.0 abc	5.3 abc	71.0 b	15.8 b	7.2 ab
Agion-B	SS,1C,2C 3C–11C	5.88 gal 2.94 gal	28.0 abc	2.0 abc	47.0 de	5.5 de	2.7 de
Agion-C	SS,1C,2C 3C–11C	5.88 gal 2.94 gal	33.0 ab	4.7 ab	75.0 b	17.2 bc	7.7 ab
Agion-D	SS,1C,2C 3C–11C	5.88 gal 2.94 gal	31.0 ab	2.5 abc	63.0 bc	11.1 bcd	4.6 bcd

*Means in the same column with the same letter do not differ significantly according to the Waller-Duncan *K*-ratio t-test (α=0.05, *K*=100).

** Analyses conducted on transformed means; data displayed are non-transformed means.

Table 3. Defoliation of Vegetative Shoots

			% Leaves Abscised*			
			Whole Shoot			Upper Shoot
Treatment	**Timing**	**Rate/A**	**9 June****	**11 July**	**10 August**	**10 August****
Non-treated Control	-----	-----	17.0 de	37.1 c	45.0 de	6.6 f
Mycoshield 17WP	SS, 1C-11C	1.5 lb	12.6 e	26.0 d	37.3 e	9.3 ef
Kocide 3000 30DF	SS 1C-11C	5.0 oz 3.3 oz	25.8 cd	34.5 cd	43.8 de	7.8 f
Nordox 75WG	SS 1C-11C	2.0 oz 1.3 oz	32.2 c	33.1 cd	50.0 cd	12.2 def
Nordox 75WG	SS 1C-11C	4.0 oz 2.7 oz	47.6 b	49.4 b	60.1 abc	23.0 bcd
Cueva 0.16F	SS 1C-11C	75 fl oz 50 fl oz	28.5 c	37.0 c	52.7 bcd	21.2 cde
Agion-A	SS,1C,2C 3C–11C	5.88 gal 2.94 gal	68.2 a	63.5 a	67.4 a	34.1 ab
Agion-B	SS,1C,2C 3C–11C	5.88 gal 2.94 gal	60.0 a	56.4 ab	64.4 a	27.3 abc
Agion-C	SS,1C,2C 3C–11C	5.88 gal 2.94 gal	63.8 a	49.2 b	62.9 ab	31.2 a
Agion-D	SS,1C,2C 3C–11C	5.88 gal 2.94 gal	59.3 a	56.4 ab	64.2 a	25.3 abc

*Means in the same column with the same letter do not differ significantly according to the Waller-Duncan *K*-ratio t-test (α=0.05, *K*=100).

** Assessment on 9 June based on foliage treated with five non-buffered applications (SS-4C); upper shoot assessment on 10 August based on foliage treated with seven buffered applications (5C-11C).

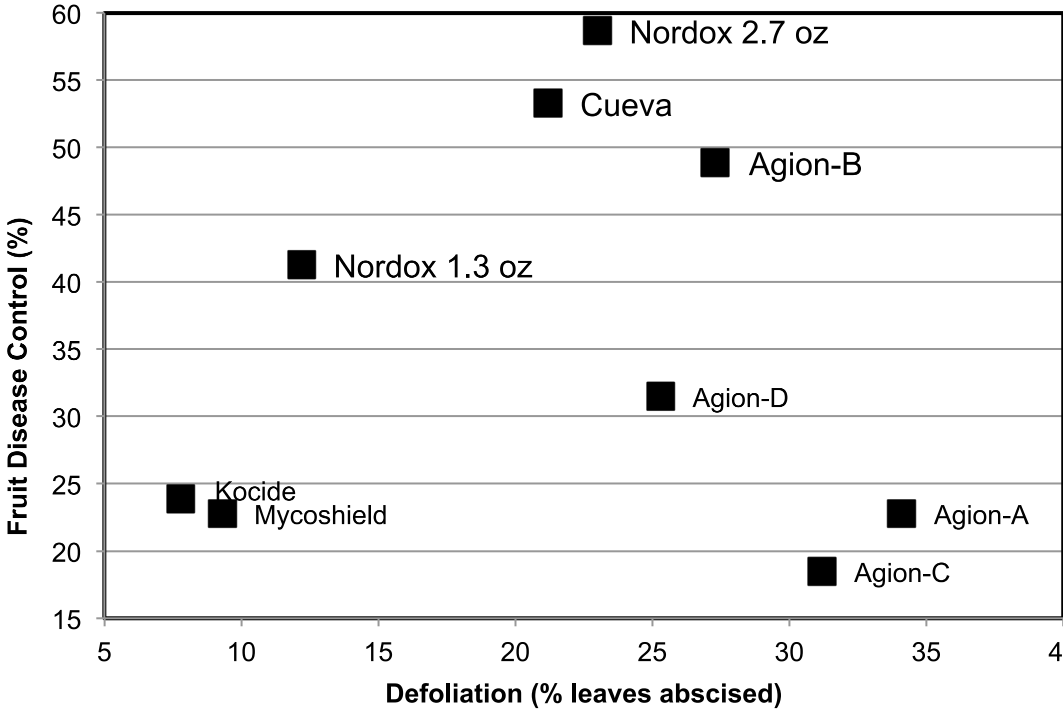


Figure 1. Comparison of fruit disease control and defoliation for nine bactericide treatments. Disease control estimates were based on observations from the 27 July assessment (Table 2). Defoliation data were from the upper shoot assessment on 10 Aug, which was based on leaves receiving only pH buffered sprays (Table 3).

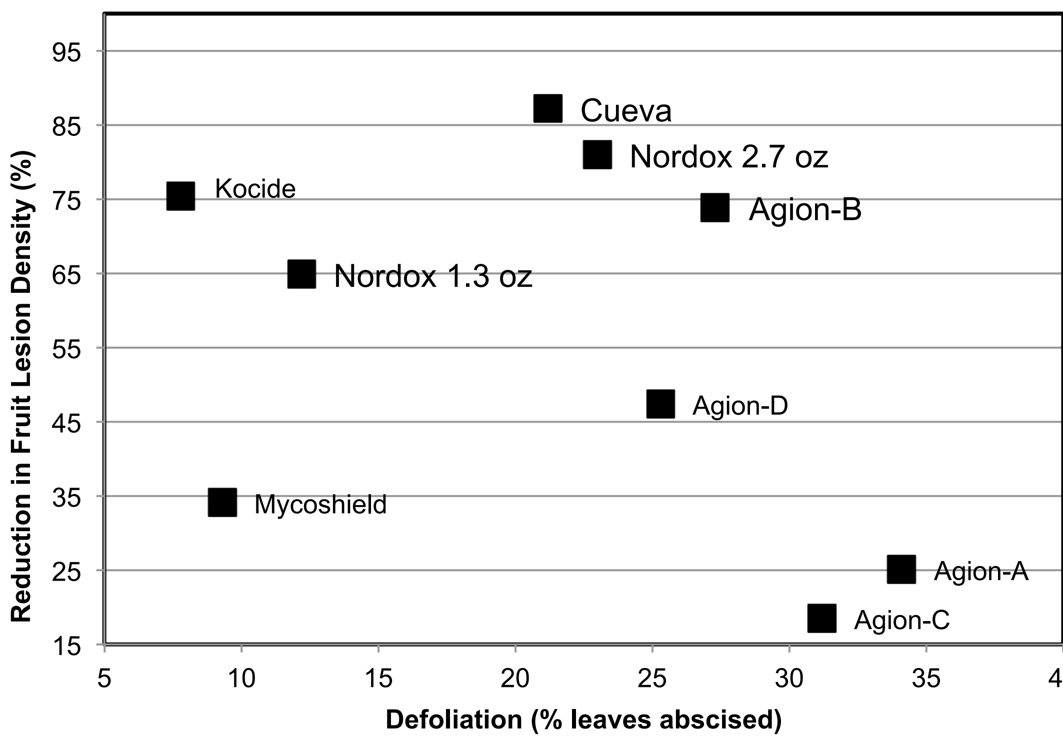


Figure 2. Comparison of reduction in fruit lesion density and defoliation for nine bactericide treatments. Lesion data were from the final 27 July assessment (Table 2). Defoliation data were from the upper shoot assessment on 10 Aug, which was based on leaves receiving only pH buffered sprays (Table 3).

MANAGEMENT OF PEACH BROWN ROT BLOSSOM BLIGHT AND FRUIT ROT

Norman Lalancette and Kathleen McFarland
Rutgers University, Agricultural Research and Extension Center
Bridgeton, NJ 08302

The fungicides Merivon (pyraclostrobin + fluxapyroxad), Inspire XT (difenoconazole + propiconazole), Inspire Super (difenonconazole + cyprodinil), Quadris Top (difenoconazole + azoxystrobin), Luna Sensation(trifloxystrobin + fluopyram), and Fontelis (penthiopyrad) were tested and compared to each other and to the standard, Indar, for efficacy against blossom blight and brown rot. Results were also recorded for rusty spot, scab, and Rhizopus rot.

Materials and Methods

Orchard Site. The experiment was conducted during the spring and summer of the 2011 growing season. The test block consisted of a 16-year-old 'Autumnglo' peach orchard planted at 25 ft x 25 ft spacing.

Treatments. Fungicide treatments were replicated four times in a randomized complete block design with single tree plots. Treatment trees were surrounded on all sides by non-sprayed buffer trees. A Rears Pak-Blast-Plot airblast sprayer calibrated to deliver 100 gal/A at 100 psi traveling at 2.1 mph was used for applications. All trees in the block received Ziram at 4lb/A on 17 Mar for leaf curl control. Insecticides and miticides were applied as needed to the entire block using a commercial airblast sprayer. Treatment application dates and phenological timing are shown in Table 1.

Assessment. Blossom blight (*Monilinia fructicola*) was evaluated on 11-12 July examining 20 shoots per tree. Rusty spot (*Podosphaera leucotricha*) was evaluated on 16 Jun by examining 40 fruit per tree. Scab (*Fusicladium carpophilum*) was evaluated at harvest on 5 Sept examining 25 fruit per tree. Brown rot (*M. fructicola*)was evaluated at harvest on 5 Sep by examining all fruit on four or more branches per replicate tree (75-87 fruit per tree). For postharvest evaluations, 25 asymptomatic uninjured fruit were harvested from each tree and placed on benches in the greenhouse (ave. air temp. = 75.8ºF). Brown rot and other rots were evaluated at 3 and 6 days postharvest (DPH).

Weather Data. Air temperatures and rainfall data were recorded by a Campbell Scientific 21X data logger located at the research station. Observations were taken every minute and summarized every hour. Monthly temperature averages and rainfall accumulations were compared to the 30-year means or sums, respectively, for Bridgeton, NJ.

Statistical Analysis. Analyses of variance (ANOVA) and treatment mean comparisons were performed using the General Linear Models (GLM) procedure of SAS v9.2. Arcsin and log transformations were performed as needed for proportions and lesion count data, respectively, to correct for departures from the ANOVA assumptions.

Results and Discussion

Environment. Overall, the growing season (Apr to early Sep) was very wet with above average temperatures (Table 1). Rainfall in April, June, July, and August were 1.31, 0.16, 1.53, and 18.44 inches above the 30-year average, respectively. Heavy down pours on 14 Aug, which caused flash flooding and loss of many bridges in south Jersey, and Hurricane Irene on 27-28 Aug, resulted in that month's excessive rainfall accumulation. May was the only month to receive less rainfall than the 30 year average (2.18 in below average).On a state-wide level, the summer (June-August) and August itself were the wettest on record (since 1895).

Every month except August had temperatures well above average. April, May, June, and July had temperatures 3.9º, 2.8º, 2.1º, and 2.4ºF above average, respectively. The temperature for August,2.0ºF below average, was most likely due to the rainfall and cloud coverage that month. Average monthly temperatures this growing season were: Apr, 55.8ºF, May 64.8ºF, Jun 73.1ºF, Jul 78.4ºF, and Aug 73.0ºF.

Blossom Blight. Although light rainfalls occurred regularly through the bloom period (P, B, PF), most daily temperatures at this time were in the 50s and 60s, well below the optimum of 77ºF necessary for infection of flowers (Table 1). Thus, blossom blight canker incidence was below normal at only 6.3%on non-treated trees (Table 2). Typically, 10-25% of shoots develop cankers on the control treatment (e.g. 20% occurred in 2010).

Given the low disease pressure, all fungicide treatments provided 100% control and had significantly lower incidence than the non-treated control. No differences were observed between fungicide treatments.

Rusty Spot. Disease pressure was low in 2011 and atypical for the highly susceptible 'Autumnglo' cultivar (Table 3). Only 35.6% fruit infection was observed on control fruit, with lesion density of only 0.41 lesions per fruit. In contrast, the non-sprayed control trees in 2010 had 82.4% fruit infection with an average of 3.38 lesions per fruit.

The standard rusty spot program consists of four sprays: PF, SS, 1C, and 2C. The first of these spays (PF) consisted of the test fungicide that was applied for blossom blight control. All treatments then received the same standard rusty spot fungicide, Rally (myclobutanil), for the remaining three (SS, 1C, and 2C) sprays; note neither Bravo nor Captan, applied for scab management, provide any rusty spot control.

Although this study was not designed for evaluating rusty spot management, differences at the PF timing do allow comparison of the treatment programs (Table 3). First, all treated fruit had significantly less disease than non-treated fruit. Disease control was very good to excellent, ranging from 81% for Indar to 96% for Merivon at the high rate. Second, both Merivon treatments and Inspire XT had significantly fewer infected fruit than the Indar treatment. Finally, note that a "complete" standard program for rusty spot, which consists of Rally at all four timings, was not included in the study.

Scab. Although wet weather conditions in 2011 should have favored scab development, non-sprayed trees had only 22% infected fruit (Table 4). Since infection in 2010 was also low (22.5%), the 2011 outcome was most likely due to inadequate inoculum from lower densities of overwintering twig lesions. In comparison, non-sprayed trees in this block in 2009, a scab-favorable year, had 100% fruit infection with over 99% of fruit having 10 or more lesions.

Since the study was not designed for evaluating scab management, all treatments received the same fungicides for scab control, namely Bravo at SS followed by Captan cover sprays. Hence, no significant differences were observed between treatments and all had significantly fewer infected fruit than the non-treated control. Disease control ranged from 91-100%.

Brown Rot. Surprisingly, weather conditions were only moderately favorable for brown rot development (Table 1). Significant rainfall (> 0.10 in) only occurred twice during the preharvest spray period: once on 25 Aug and again during Hurricane Irene (27-28 Aug). No rain occurred between the 7-dph spray and harvest. During this period, temperatures were cool, with most daily averages in the 60s and lower 70s. Significant amounts of rain did occur in the week prior to the first preharvest spray at 16-dph, but few fruit would have been susceptible at this time.

In a highly disease-favorable season, nearly 100% of fruit can become infected. In 2011, non-treated control trees had 55.8% brown rotted fruit at harvest (Table 5). Under these conditions, all treatments significantly reduced brown rot incidence. Furthermore, no statistical differences were observed between treatments. Disease control at harvest ranged from 82% for Luna Sensation to 91-93% for the Merivon treatments.

Postharvest brown rot pressure was moderate to high. Non sprayed fruit reached40.8% infection at 3-DPH and 73.2% infection at 6-DPH (Table 5). All treatments significantly reduced brown rot at both postharvest assessments. Disease control ranged from68-95% at 3-DPH and 51-84% at 6-DPH. At the final assessment, Indar and the two Merivon treatments provided significantly better control than Inspire Super, Quadris Top, and Luna Sensation.

Rhizopus Rot. Rot incidence on non-treated trees in the field at harvest was very low (1.8%), but was observed to increase to about 17% incidence at 6-DPH. Indar, Merivon, Inspire Super, and Fontelis were the only treatments which had significantly less Rhizopus rot than the non-treated control in all three assessments.

Other Rots. Other fruit rots caused by *Colletotrichum* species (anthracnose), *Phomopsis* species, and Botryosphaeria species were below 1% and 5% incidence at harvest and postharvest, respectively.

Conclusion

- All fungicide treatments provided excellent control of blossom blight, although disease pressure was below average.

- **Indar**, at the 9 fl oz rate (allowed via a 24C SLN registration for New Jersey), provided excellent control of brown rot. None of the test fungicides was better than this standard.

- **Merivon** at either the low or high rate provided excellent control of brown rot, matching Indar's efficacy. The higher 6.5 fl oz rate had numerically less disease than the 5.0 fl oz rate in the postharvest assessments, but the difference was not significant.

- Although **InspireSuper, Quadris Top, and Luna Sensation** provided excellent control of brown rot at harvest, postharvest control was diminished relative to the other fungicides.

- **Inspire XT** and **Fontelis** also provided excellent brown rot control at harvest. At 6-DPH, these fungicides provided an intermediate level of control. That is, they were not significantly different from the most effective Indar / Merivon grouping or the less effective Inspire Super / Quadris Top / Luna Sensation grouping.

Table 1. Weather and spray timings for 2011 growing season at the Rutgers Agricultural Research & Extension Center, Bridgeton, NJ. Sprays are indicated by bolded phenological stage. Units for daily average air temperature and rainfall accumulation are ºF and inches.

Date	Temp	Rain	Spray	Date	Temp	Rain	Spray	Date	Temp	Rain	Spray
1-Apr	39.9	0.18		1-May	56.0	0		1-Jun	80.1	0	
2-Apr	43.9	0		2-May	60.7	0	**Shuck Split**	2-Jun	76.3	0	
3-Apr	47.6	0		3-May	67.6	0		3-Jun	66.5	0	
4-Apr	59.3	0.02		4-May	55.3	0.69		4-Jun	64.4	0	
5-Apr	56.2	0.28		5-May	54.5	0		5-Jun	67.4	0	
6-Apr	46.6	0		6-May	57.1	0		6-Jun	69.4	0	
7-Apr	48.1	0		7-May	58.5	0.06		7-Jun	74.7	0	**3rd Cover**
8-Apr	41.5	0.65		8-May	58.9	0		8-Jun	79.4	0	
9-Apr	47.5	0		9-May	59.6	0		9-Jun	83.9	0	
10-Apr	51.9	0		10-May	59.9	0		10-Jun	76.5	0.22	
11-Apr	64.0	0	**Pink**	11-May	57.6	0		11-Jun	73.6	0	
12-Apr	61.8	0.35		12-May	60.0	0	**1st Cover**	12-Jun	72.1	0	
13-Apr	49.6	0.17		13-May	58.2	0		13-Jun	69.7	0	
14-Apr	55.7	0		14-May	58.7	0.37		14-Jun	64.7	0.22	
15-Apr	50.4	0		15-May	66.3	0.13		15-Jun	67.9	0	
16-Apr	50.1	1.46		16-May	66.3	0		16-Jun	70.9	0.07	
17-Apr	55.5	0.62		17-May	63.3	0.22		17-Jun	72.6	0.05	
18-Apr	58.3	0	**Bloom**	18-May	64.0	0.11		18-Jun	74.0	0.01	
19-Apr	60.0	0.02		19-May	63.0	0.09		19-Jun	74.6	0	
20-Apr	62.3	0		20-May	60.1	0.2		20-Jun	69.6	0	
21-Apr	57.2	0		21-May	65.4	0.01		21-Jun	71.7	0.16	
22-Apr	44.7	0.01		22-May	62.4	0		22-Jun	77.1	0.72	**4th Cover**
23-Apr	54.7	0.23		23-May	67.0	0	**2nd Cover**	23-Jun	79.1	0	
24-Apr	69.4	0.24		24-May	75.5	0		24-Jun	77.9	0	
25-Apr	72.0	0.12	**Petal Fall**	25-May	73.5	0		25-Jun	74.1	0	
26-Apr	72.1	0		26-May	75.7	0		26-Jun	72.3	0	
27-Apr	69.9	0.18		27-May	75.6	0		27-Jun	72.6	0.01	
28-Apr	70.2	0.36		28-May	73.5	0.01		28-Jun	72.7	2.07	
29-Apr	61.4	0		29-May	75.4	0		29-Jun	76.4	0	
30-Apr	54.4	0		30-May	79.7	0		30-Jun	71.0	0	
				31-May	79.3	0					

Table 1 – continued –

Date	Temp	Rain	Spray	Date	Temp	Rain	Spray	Date	Temp	Rain	Spray
1-Jul	71.4	0		1-Aug	79.9	0.02		1-Sep	70.0	0	
2-Jul	74.2	0		2-Aug	77.6	0		2-Sep	67.5	0	
3-Jul	77.6	0.04		3-Aug	75.3	0.04		3-Sep	71.1	0	
4-Jul	78.2	0		4-Aug	72.1	0.25		4-Sep	73.9	0	
5-Jul	79.0	0	**5th Cover**	5-Aug	71.8	0	**7th Cover**	5-Sep	75.3	0	**Harvest**
6-Jul	77.9	0		6-Aug	75.2	0					
7-Jul	78.8	0.65		7-Aug	80.6	0					
8-Jul	74.8	1.57		8-Aug	81.1	0					
9-Jul	76.2	0		9-Aug	75.3	2.51					
10-Jul	76.4	0		10-Aug	76.1	0					
11-Jul	80.7	0		11-Aug	72.1	0					
12-Jul	81.6	0		12-Aug	70.2	0					
13-Jul	79.3	0		13-Aug	70.3	0.37					
14-Jul	72.4	0		14-Aug	70.5	9.47					
15-Jul	72.5	0		15-Aug	71.5	0.55					
16-Jul	74.3	0		16-Aug	70.6	0.02					
17-Jul	76.2	0		17-Aug	73.5	0					
18-Jul	79.7	0		18-Aug	74.8	0.12					
19-Jul	80.7	1.44		19-Aug	72.2	0.5					
20-Jul	76.9	0	**6th Cover**	20-Aug	72.2	0.01	**16-dph**				
21-Jul	82.8	0		21-Aug	74.7	0.05					
22-Jul	88.1	0		22-Aug	72.0	0					
23-Jul	87.6	0		23-Aug	67.0	0					
24-Jul	82.7	1.82		24-Aug	69.8	0					
25-Jul	76.3	0.01		25-Aug	73.6	0.94					
26-Jul	79.4	0		26-Aug	74.8	0	**10-dph**				
27-Jul	77.5	0		27-Aug	73.5	4.85	**Hurricane Irene**				
28-Jul	76.8	0		28-Aug	72.5	2.92					
29-Jul	81.0	0.3		29-Aug	66.0	0	**7-dph**				
30-Jul	81.1	0		30-Aug	67.0	0					
31-Jul	79.2	0		31-Aug	68.9	0		**dph** = days preharvet			

Table 2. Blossom Blight Incidence and Severity[1]

Treatment	Rate / A	Timing	% Shoots w. canker[2]	#Cankers per shoot[2]
Non-treated Control	--------	--------	6.3 a	0.06 a
Indar 2F	**9.0 fl oz**	**P, B, PF**		
Bravo Ultrex 82.5WDG + Rally 40WSP	3.3 lb + 5 oz	SS		
Captan 80WDG + Rally 40WSP	3.75 lb + 5 oz	1C, 2C		
Captan 80WDG	3.75 lb	3C-7C		
Indar 2F	9.0 fl oz	16, 10, 7 dph	0.0 b	0.00 b
Merivon 500SC	**5.0 fl oz**	**P, B, PF**		
Bravo Ultrex 82.5WDG + Rally 40WSP	3.3 lb + 5 oz	SS		
Captan 80WDG + Rally 40WSP	3.75 lb + 5 oz	1C, 2C		
Captan 80WDG	3.75 lb	3C-7C		
Merivon 500SC	5.0 fl oz	16, 10, 7 dph	0.0 b	0.00 b
Merivon 500SC	**6.5 fl oz**	**P, B, PF**		
Bravo Ultrex 82.5WDG + Rally 40WSP	3.3 lb + 5 oz	SS		
Captan 80WDG + Rally 40WSP	3.75 lb + 5 oz	1C, 2C		
Captan 80WDG	3.75 lb	3C-7C		
Merivon 500SC	6.5 fl oz	16, 10, 7 dph	0.0 b	0.00 b
Inspire XT 4.17EC	**7.0 fl oz**	**P, B, PF**		
Bravo Ultrex 82.5WDG + Rally 40WSP	3.3 lb + 5 oz	SS		
Captan 80WDG + Rally 40WSP	3.75 lb + 5 oz	1C, 2C		
Captan 80WDG	3.75 lb	3C-7C		
Inspire XT 4.17EC	7.0 fl oz	16, 10, 7 dph	0.0 b	0.00 b
Inspire Super 2.8EW	**20.0 fl oz**	**P, B, PF**		
Bravo Ultrex 82.5WDG + Rally 40WSP	3.3 lb + 5 oz	SS		
Captan 80WDG + Rally 40WSP	3.75 lb + 5 oz	1C, 2C		
Captan 80WDG	3.75 lb	3C-7C		
Inspire Super 2.8EW	20.0 fl oz	16, 10, 7 dph	0.0 b	0.00 b
Quadris Top 2.71SC	**14.0 fl oz**	**P, B, PF**		
Bravo Ultrex 82.5WDG + Rally 40WSP	3.3 lb + 5 oz	SS		
Captan 80WDG + Rally 40WSP	3.75 lb + 5 oz	1C, 2C		
Captan 80WDG	3.75 lb	3C-7C		
Quadris Top 2.71SC	14.0 fl oz	16, 10, 7 dph	0.0 b	0.00 b
Luna Sensation 500SC	**5.0 fl oz**	**P, B, PF**		
Bravo Ultrex 82.5WDG + Rally 40WSP	3.3 lb + 5 oz	SS		
Captan 80WDG + Rally 40WSP	3.75 lb + 5 oz	1C, 2C		
Captan 80WDG	3.75 lb	3C-7C		
Luna Sensation 500SC	5.0 fl oz	16, 10, 7 dph	0.0 b	0.00 b
Fontelis 1.67SC	**20.0 fl oz**	**P, B, PF**		
Bravo Ultrex 82.5WDG + Rally 40WSP	3.3 lb + 5 oz	SS		
Captan 80WDG + Rally 40WSP	3.75 lb + 5 oz	1C, 2C		
Captan 80WDG	3.75 lb	3C-7C		
Fontelis 1.67SC	20.0 fl oz	16, 10, 7 dph	0.0 b	0.00 b

[1] Blossom blight treatments, rates, and application timings in **boldface**.

[2] Means in the same column with the same letter do not differ significantly according to the Waller-Duncan *K*-ratio t-test (α=0.05, *K*=100).

Table 3. Rusty Spot Incidence and Severity[1]

Treatment	Rate / A	Timing	% Infected Fruit [2]	# Lesions/fruit[2]
Non-treated Control	--------	--------	35.6 a	0.41 a
Indar 2F Bravo Ultrex 82.5WDG + **Rally 40WSP** Captan 80WDG + **Rally 40WSP** Captan 80WDG Indar 2F	**9.0 fl oz** 3.3 lb + **5 oz** 3.75 lb + **5 oz** 3.75 lb 9.0 fl oz	P, B**, PF** **SS** **1C, 2C** 3C-7C 16, 10, 7 dph	6.7 b	0.09 b
Merivon 500SC Bravo Ultrex 82.5WDG + **Rally 40WSP** Captan 80WDG + **Rally 40WSP** Captan 80WDG Merivon 500SC	**5.0 fl oz** 3.3 lb + **5 oz** 3.75 lb + **5 oz** 3.75 lb 5.0 fl oz	P, B, **PF** **SS** **1C, 2C** 3C-7C 16, 10, 7 dph	1.9 c	0.02 c
Merivon 500SC Bravo Ultrex 82.5WDG + **Rally 40WSP** Captan 80WDG + **Rally 40WSP** Captan 80WDG Merivon 500SC	**6.5 fl oz** 3.3 lb + **5 oz** 3.75 lb + **5 oz** 3.75 lb 6.5 fl oz	P, B, **PF** **SS** **1C, 2C** 3C-7C 16, 10, 7 dph	1.3 c	0.02 c
Inspire XT 4.17EC Bravo Ultrex 82.5WDG + **Rally 40WSP** Captan 80WDG + **Rally 40WSP** Captan 80WDG Inspire XT 4.17EC	**7.0 fl oz** 3.3 lb + **5 oz** 3.75 lb + **5 oz** 3.75 lb 7.0 fl oz	P, B, **PF** **SS** **1C, 2C** 3C-7C 16, 10, 7 dph	2.5 c	0.03 c
Inspire Super 2.8EW Bravo Ultrex 82.5WDG + **Rally 40WSP** Captan 80WDG + **Rally 40WSP** Captan 80WDG Inspire Super 2.8EW	**20.0 fl oz** 3.3 lb + **5 oz** 3.75 lb + **5 oz** 3.75 lb 20.0 fl oz	P, B, **PF** **SS** **1C, 2C** 3C-7C 16, 10, 7 dph	3.1 bc	0.03 c
Quadris Top 2.71SC Bravo Ultrex 82.5WDG + **Rally 40WSP** Captan 80WDG + **Rally 40WSP** Captan 80WDG Quadris Top 2.71SC	**14.0 fl oz** 3.3 lb + **5 oz** 3.75 lb + **5 oz** 3.75 lb 14.0 fl oz	P, B, **PF** **SS** **1C, 2C** 3C-7C 16, 10, 7 dph	4.4 bc	0.04 bc
Luna Sensation 500SC Bravo Ultrex 82.5WDG + **Rally 40WSP** Captan 80WDG + **Rally 40WSP** Captan 80WDG Luna Sensation 500SC	**5.0 fl oz** 3.3 lb + **5 oz** 3.75 lb + **5 oz** 3.75 lb 5.0 fl oz	P, B, **PF** **SS** **1C, 2C** 3C-7C 16, 10, 7 dph	3.8 bc	0.04 bc
Fontelis 1.67SC Bravo Ultrex 82.5WDG + **Rally 40WSP** Captan 80WDG + **Rally 40WSP** Captan 80WDG Fontelis 1.67SC	**20.0 fl oz** 3.3 lb + **5 oz** 3.75 lb + **5 oz** 3.75 lb 20.0 fl oz	P, B, **PF** **SS** **1C, 2C** 3C-7C 16, 10, 7 dph	3.1 bc	0.04 bc

[1] Rusty spot treatments, rates, and application timings in **boldface**.

[2] Means in the same column with the same letter do not differ significantly according to the Waller-Duncan *K*-ratio t-test ($\alpha=0.05$, $K=100$).

Table 4. Scab Incidence and Severity[1]

Treatment	Rate / A	Timing	% Infected Fruit
Non-treated control	-----	-----	22.0 a
Indar 2F **Bravo Ultrex 82.5WDG** + Rally 40WSP **Captan 80WDG** + Rally 40WSP **Captan 80WDG** Indar 2F	9.0 fl oz **3.3 lb** + 5 oz **3.75 lb** + 5 oz **3.75 lb** 9.0 fl oz	P, B, PF **SS** **1C, 2C** **3C-7C** 16, 10, 7 dph	1.3 b
Merivon 500SC **Bravo Ultrex 82.5WDG** + Rally 40WSP **Captan 80WDG** + Rally 40WSP **Captan 80WDG** Merivon 500SC	5.0 fl oz **3.3 lb** + 5 oz **3.75 lb** + 5 oz **3.75 lb** 5.0 fl oz	P, B, PF **SS** **1C, 2C** **3C-7C** 16, 10, 7 dph	1.0 b
Merivon 500SC **Bravo Ultrex 82.5WDG** + Rally 40WSP **Captan 80WDG** + Rally 40WSP **Captan 80WDG** Merivon 500SC	6.5 fl oz **3.3 lb** + 5 oz **3.75 lb** + 5 oz **3.75 lb** 6.5 fl oz	P, B, PF **SS** **1C, 2C** **3C-7C** 16, 10, 7 dph	1.0 b
Inspire XT 4.17EC **Bravo Ultrex 82.5WDG** + Rally 40WSP **Captan 80WDG** + Rally 40WSP **Captan 80WDG** Inspire XT 4.17EC	7.0 fl oz **3.3 lb** + 5 oz **3.75 lb** + 5 oz **3.75 lb** 7.0 fl oz	P, B, PF **SS** **1C, 2C** **3C-7C** 16, 10, 7 dph	2.0 b
Inspire Super 2.8EW **Bravo Ultrex 82.5WDG** + Rally 40WSP **Captan 80WDG** + Rally 40WSP **Captan 80WDG** Inspire Super 2.8EW	20.0 fl oz **3.3 lb** + 5 oz **3.75 lb** + 5 oz **3.75 lb** 20.0 fl oz	P, B, PF **SS** **1C, 2C** **3C-7C** 16, 10, 7 dph	0.0 b
Quadris Top 2.71SC **Bravo Ultrex 82.5WDG** + Rally 40WSP **Captan 80WDG** + Rally 40WSP **Captan 80WDG** Quadris Top 2.71SC	14.0 fl oz **3.3 lb** + 5 oz **3.75 lb** + 5 oz **3.75 lb** 14.0 fl oz	P, B, PF **SS** **1C, 2C** **3C-7C** 16, 10, 7 dph	0.0 b
Luna Sensation 500SC **Bravo Ultrex 82.5WDG** + Rally 40WSP **Captan 80WDG** + Rally 40WSP **Captan 80WDG** Luna Sensation 500SC	5.0 fl oz **3.3 lb** + 5 oz **3.75 lb** + 5 oz **3.75 lb** 5.0 fl oz	P, B, PF **SS** **1C, 2C** **3C-7C** 16, 10, 7 dph	0.0 b
Fontelis 1.67SC **Bravo Ultrex 82.5WDG** + Rally 40WSP **Captan 80WDG** + Rally 40WSP **Captan 80WDG** Fontelis 1.67SC	20.0 fl oz **3.3 lb** + 5 oz **3.75 lb** + 5 oz **3.75 lb** 20.0 fl oz	P, B, PF **SS** **1C, 2C** **3C-7C** 16, 10, 7 dph	2.0 b

[1] Scab treatments, rates, and application timings in **boldface**.

[2] Means in the same column with the same letter do not differ significantly according to the Waller-Duncan *K*-ratio t-test (α=0.05, *K*=100).

Table 5. Brown Rot Harvest and Postharvest Incidence[1]

			% Fruit Infected [2]		
Treatment	**Rate / A**	**Timing**	**Harvest**	**3-DPH**	**6-DPH**
Non-treated control	-----	-----	55.8 a	40.8 a	73.2 a
Indar 2F Bravo Ultrex 82.5WDG + Rally 40WSP Captan 80WDG + Rally 40WSP Captan 80WDG **Indar 2F**	9.0 fl oz 3.3 lb + 5 oz 3.75 lb + 5 oz 3.75 lb **9.0 fl oz**	P, B, PF SS 1C, 2C 3C-7C **16, 10, 7 dph**	7.5 b	6.7 bc	12.0 c
Merivon 500SC Bravo Ultrex 82.5WDG + Rally 40WSP Captan 80WDG + Rally 40WSP Captan 80WDG **Merivon 500SC**	5.0 fl oz 3.3 lb + 5 oz 3.75 lb + 5 oz 3.75 lb **5.0 fl oz**	P, B, PF SS 1C, 2C 3C-7C **16, 10, 7 dph**	4.1 b	5.0 bc	14.0 c
Merivon 500SC Bravo Ultrex 82.5WDG + Rally 40WSP Captan 80WDG + Rally 40WSP Captan 80WDG **Merivon 500SC**	6.5 fl oz 3.3 lb + 5 oz 3.75 lb + 5 oz 3.75 lb **6.5 fl oz**	P, B, PF SS 1C, 2C 3C-7C **16, 10, 7 dph**	5.2 b	2.0 c	12.0 c
Inspire XT 4.17EC Bravo Ultrex 82.5WDG + Rally 40WSP Captan 80WDG + Rally 40WSP Captan 80WDG **Inspire XT 4.17EC**	7.0 fl oz 3.3 lb + 5 oz 3.75 lb + 5 oz 3.75 lb **7.0 fl oz**	P, B, PF SS 1C, 2C 3C-7C **16, 10, 7 dph**	7.8 b	5.0 bc	27.0 bc
Inspire Super 2.8EW Bravo Ultrex 82.5WDG + Rally 40WSP Captan 80WDG + Rally 40WSP Captan 80WDG **Inspire Super 2.8EW**	20.0 fl oz 3.3 lb + 5 oz 3.75 lb + 5 oz 3.75 lb **20.0 fl oz**	P, B, PF SS 1C, 2C 3C-7C **16, 10, 7 dph**	7.3 b	11.0 bc	36.0 b
Quadris Top 2.71SC Bravo Ultrex 82.5WDG + Rally 40WSP Captan 80WDG + Rally 40WSP Captan 80WDG **Quadris Top 2.71SC**	14.0 fl oz 3.3 lb + 5 oz 3.75 lb + 5 oz 3.75 lb **14.0 fl oz**	P, B, PF SS 1C, 2C 3C-7C **16, 10, 7 dph**	8.7 b	13.0 b	34.0 b
Luna Sensation 500SC Bravo Ultrex 82.5WDG + Rally 40WSP Captan 80WDG + Rally 40WSP Captan 80WDG **Luna Sensation 500SC**	5.0 fl oz 3.3 lb + 5 oz 3.75 lb + 5 oz 3.75 lb **5.0 fl oz**	P, B, PF SS 1C, 2C 3C-7C **16, 10, 7 dph**	9.9 b	9.0 bc	32.0 b
Fontelis 1.67SC Bravo Ultrex 82.5WDG + Rally 40WSP Captan 80WDG + Rally 40WSP Captan 80WDG **Fontelis 1.67SC**	20.0 fl oz 3.3 lb + 5 oz 3.75 lb + 5 oz 3.75 lb **20.0 fl oz**	P, B, PF SS 1C, 2C 3C-7C **16, 10, 7 dph**	7.1 b	5.0 bc	23.0 bc

[1] Brown rot treatments, rates, and application timings in **boldface**.

[2] Means in the same column with the same letter do not differ significantly according to the Waller-Duncan *K*-ratio t-test (α=0.05, *K*=100).

Table 6. Rhizopus Rot Harvest and Postharvest Incidence[1]

			% Fruit Infected [2]		
Treatment	**Rate / A**	**Timing**	**Harvest**	**3-DPH**	**6-DPH**
Non-treated control	-----	-----	1.8 a	4.6 a	16.8 a
Indar 2F Bravo Ultrex 82.5WDG + Rally 40WSP Captan 80WDG + Rally 40WSP Captan 80WDG **Indar 2F**	9.0 fl oz 3.3 lb + 5 oz 3.75 lb + 5 oz 3.75 lb **9.0 fl oz**	P, B, PF SS 1C, 2C 3C-7C **16, 10, 7 dph**	0.0 b	0.0 b	5.3 b
Merivon 500SC Bravo Ultrex 82.5WDG + Rally 40WSP Captan 80WDG + Rally 40WSP Captan 80WDG **Merivon 500SC**	5.0 fl oz 3.3 lb + 5 oz 3.75 lb + 5 oz 3.75 lb **5.0 fl oz**	P, B, PF SS 1C, 2C 3C-7C **16, 10, 7 dph**	0.0 b	1.0 b	3.0 b
Merivon 500SC Bravo Ultrex 82.5WDG + Rally 40WSP Captan 80WDG + Rally 40WSP Captan 80WDG **Merivon 500SC**	6.5 fl oz 3.3 lb + 5 oz 3.75 lb + 5 oz 3.75 lb **6.5 fl oz**	P, B, PF SS 1C, 2C 3C-7C **16, 10, 7 dph**	0.0 b	0.0 b	1.0 b
Inspire XT 4.17EC Bravo Ultrex 82.5WDG + Rally 40WSP Captan 80WDG + Rally 40WSP Captan 80WDG **Inspire XT 4.17EC**	7.0 fl oz 3.3 lb + 5 oz 3.75 lb + 5 oz 3.75 lb **7.0 fl oz**	P, B, PF SS 1C, 2C 3C-7C **16, 10, 7 dph**	0.0 b	2.0 ab	5.0 b
Inspire Super 2.8EW Bravo Ultrex 82.5WDG + Rally 40WSP Captan 80WDG + Rally 40WSP Captan 80WDG **Inspire Super 2.8EW**	20.0 fl oz 3.3 lb + 5 oz 3.75 lb + 5 oz 3.75 lb **20.0 fl oz**	P, B, PF SS 1C, 2C 3C-7C **16, 10, 7 dph**	0.0 b	1.0 b	5.0 b
Quadris Top 2.71SC Bravo Ultrex 82.5WDG + Rally 40WSP Captan 80WDG + Rally 40WSP Captan 80WDG **Quadris Top 2.71SC**	14.0 fl oz 3.3 lb + 5 oz 3.75 lb + 5 oz 3.75 lb **14.0 fl oz**	P, B, PF SS 1C, 2C 3C-7C **16, 10, 7 dph**	0.0 b	2.0 ab	10.0 ab
Luna Sensation 500SC Bravo Ultrex 82.5WDG + Rally 40WSP Captan 80WDG + Rally 40WSP Captan 80WDG **Luna Sensation 500SC**	5.0 fl oz 3.3 lb + 5 oz 3.75 lb + 5 oz 3.75 lb **5.0 fl oz**	P, B, PF SS 1C, 2C 3C-7C **16, 10, 7 dph**	0.0 b	1.0 b	6.0 ab
Fontelis 1.67SC Bravo Ultrex 82.5WDG + Rally 40WSP Captan 80WDG + Rally 40WSP Captan 80WDG **Fontelis 1.67SC**	20.0 fl oz 3.3 lb + 5 oz 3.75 lb + 5 oz 3.75 lb **20.0 fl oz**	P, B, PF SS 1C, 2C 3C-7C **16, 10, 7 dph**	0.7 b	1.0 b	5.0 b

[1] Rhizopus rot treatments, rates, and application timings in **boldface**.

[2] Means in the same column with the same letter do not differ significantly according to the Waller-Duncan *K*-ratio t-test (α=0.05, *K*=100).

MANAGEMENT OF PEACH SCAB WITH FUNGICIDE MIXTURES

Norman Lalancette and Kathleen McFarland
Rutgers University, Agricultural Research and Extension Center
Bridgeton, NJ 08302

Fungicide pre-mixtures Inspire Super (difenoconazole + cyprodinil), Inspire XT (difenoconazole + propiconazole), Quadris Top (difenoconazole + azoxystrobin), Merivon (pyraclostrobin + fluoxapyroxad), and Luna Sensation (trifloxystrobin + fluopyram) were tested in alternation with Captan for efficacy against peach scab. These test programs were compared to each other and to the standard Bravo / Captan program as well as a Bravo / Captan / Kumulus program.

In addition to the peach scab evaluation, a two-spray peach rusty spot program was compared to the standard four-spray program. Rally (myclobutanil) was used in both of these treatments.

Materials and Methods

Orchard Site. The experiment was conducted during the spring and summer of the 2011 growing season. The test block consisted of a 16-year-old 'Suncrest' peach orchard planted at 25 ft x 25 ft spacing.

Treatments. Fungicide treatments were replicated four times in a randomized complete block design with single tree plots. Treatment trees were surrounded on all sides by non-sprayed buffer trees. A Rears Pak-Blast-Plot airblast sprayer calibrated to deliver 100 gal/A at 100 psi traveling at 2.1 mph was used for applications. All trees in the block received Ziram 76DF at 4 lb/A on 17 Mar for leaf curl control. Insecticides and miticides were applied as needed to the entire block using a commercial airblast sprayer. Treatment application dates and phenological timing are shown in Table 1.

Assessment. Blossom blight canker development (*Monilinia fructicola*) was evaluated on 14 and 18 Jul by examining 20 shoots per tree. Rusty spot (*Podosphaera leucotricha*) was evaluated on 20-21 Jun by examining 40 fruit per tree. Scab (*Fusicladium carpophilum*) was evaluated on 9 Aug by examining 25 fruit per tree.

Weather Data. Air temperatures and rainfall data were recorded by a Campbell Scientific 21X data logger located at the research station. Observations were taken every minute and summarized every hour. Monthly temperature averages and rainfall accumulations were compared to 30-year means or sums, respectively, for Bridgeton.

Statistical Analysis. Analyses of variance (ANOVA) and treatment mean comparisons were performed using the General Linear Models (GLM) procedure of SAS v9.2. Arcsin and log transformations were performed as needed for proportions and lesion count data, respectively, to correct for departures from the ANOVA assumptions.

Results and Discussion

Environment. Overall weather conditions during the scab evaluation period (Apr to early Aug) were very wet with above average temperatures (Table 1). Rainfall in April, June, and July were 1.31, 0.16, and 1.53 inches above the 30-year average, respectively. May was the only month to receive less rainfall than the 30 year average (2.18 in below average). Much of the heavy rain in August, including precipitation from Hurricane Irene on 27-28 Aug, occurred after the scab development period, and therefore had no impact on this target disease. On a state-wide level, the summer (June-August) and August itself were the wettest on record (since 1895).

Every month except August had temperatures well above average. April, May, June, and July had temperatures 3.9º, 2.8º, 2.1º, and 2.4ºF above average, respectively. The temperature for August, 2.0ºF below average, was most likely due to the rainfall and cloud coverage that month. Average monthly temperatures this growing season were: Apr, 55.8ºF, May 64.8ºF, Jun 73.1ºF, Jul 78.4ºF, and Aug 73.0ºF.

Blossom Blight. Adequate rainfalls but sub-optimum temperatures reduced bloom infection and subsequent canker formation. Non-treated trees had only 10% canker incidence as a result of the low disease pressure. In comparison, above normal temperatures in 2010 resulted in 30% canker incidence in this same block.

Blossom blight programs for all treatments consisted of two Vangard applications, one at pink and a second at full bloom, followed by a ‘test’ fungicide at the petal fall timing (Table 2). Six of the eight programs resulted in significant reductions in blossom blight canker formation, with disease control ranging from 62 to 100%. No differences were observed among these six programs.

One Vangard / Rally program and the Vangard / Quadris Top 14 fl oz program provided an intermediate level of control. That is, their disease levels were not different from both the control treatment and the more effective programs. However, it should be noted that the second duplicate Vangard / Rally program did significantly reduce canker incidence, as did the Vangard / Quadris Top 10 fl oz program.

Rusty Spot. Since ‘Suncrest’ is not highly susceptible to rusty spot, the 20% fruit infection observed on non-treated trees can be considered a moderate level for this cultivar (Table 3). Favorable weather conditions in 2010 resulted in 35% fruit infection, which was considered a high amount for Suncrest.

The standard program for rusty spot control consists of four applications of Rally at petal fall, shuck split, first cover, and second cover (Table 3). However, since the programs were primarily designed for scab management, the test fungicides (beginning at petal fall) were alternated with Captan, which lacks rusty spot efficacy. Thus, a second Rally standard with applications only at petal fall and first cover was added for comparison. Note Bravo also has no effect on rusty spot development.

All treatments significantly reduced rusty spot infection of fruit. Disease control ranged from 41% to 88%. Four of the six test programs (Luna Sensation, Merivon, Inspire Super, and Quadris Top 10 fl oz), which consisted of two sprays of these materials at petal fall and first cover, had significantly higher disease incidence levels than the four-spray Rally program, but equivalent levels to the two-spray Rally program (a more appropriate comparison). The two-spray Inspire XT program, however, provided control equivalent to the four-spray Rally program.

Finally, the four-spray Rally program was significantly more effective than the two-spray Rally program. Thus, at least for Rally at 5 oz/A, all four spray timings are necessary for adequate control. Presumably, the difference between these treatments would be even greater at higher levels of disease pressure.

Scab. Although the number of overwintering scab lesions in the block was at best moderate, frequent rainfalls and adequate temperatures from shuck-split onward created highly favorable conditions for scab development. Nearly 100% of fruit on non-treated trees became infected with an average of 160 lesions per fruit (Table 4).

All treatments significantly reduced disease incidence (Table 4). Disease control ranged from 58% for the standard Bravo/Captan program to 97% for the Quadris Top 14 fl oz/Captan program. Lesion density (# lesions/fruit) was markedly decreased by all programs; reductions ranged from 95 to 100% of the non-treated control.

The Luna Sensation/Captan and Merivon/Captan programs provided disease control equivalent to the standard Bravo/Captan program in terms of disease incidence, although the Luna program provided a significantly greater reduction in lesion density (Table 4). In each of these products, the QoI component is likely the more effective active ingredient; SDHI fungicides, such as boscalid, have not provided scab control in past field trials. Substitution of the sulfur product Kumulus for Captan in the 3C-6C timings did not influence efficacy, as this treatment was also equivalent to the standard.

Application of four scab programs, namely Inspire XT/Captan, Inspire Super/Captan, and both Quadris Top/Captan treatments, yielded disease incidence and severity levels that were significantly lower than the Bravo/Captan standard. This outcome may well be due to a high efficacy of difenoconazole, their common active ingredient. The two Inspire products and high rate of Quadris Top provided 1.82 oz/A of difenoconazole, while the low rate of Quadris Top resulted in a 1.3 oz/A rate of this triazole.

Quadris Top at 14 fl oz produced one of the highest levels of control ever achieved under such high scab disease pressure. The success of this product is probably due to the fact that both active ingredients, difenoconazole and azoxystrobin, are active against the pathogen.

Under more typical disease pressure conditions encountered in commercial orchards, all fungicide programs examined in this study would be expected to provide adequate control.

Table 1. Weather and spray timings for 2011 growing season at the Rutgers Agricultural Research & Extension Center, Bridgeton, NJ. Sprays are indicated by bolded phenological stage. Units for daily average air temperature and rainfall accumulation are ºF and inches.

Date	Temp	Rain	Spray	Date	Temp	Rain	Spray	Date	Temp	Rain	Spray
1-Apr	39.9	0.18		1-May	56.0	0		1-Jun	80.1	0	
2-Apr	43.9	0		2-May	60.7	0	**Shuck Split**	2-Jun	76.3	0	
3-Apr	47.6	0		3-May	67.6	0		3-Jun	66.5	0	
4-Apr	59.3	0.02		4-May	55.3	0.69		4-Jun	64.4	0	
5-Apr	56.2	0.28		5-May	54.5	0		5-Jun	67.4	0	
6-Apr	46.6	0		6-May	57.1	0		6-Jun	69.4	0	
7-Apr	48.1	0		7-May	58.5	0.06		7-Jun	74.7	0	**3rd Cover**
8-Apr	41.5	0.65		8-May	58.9	0		8-Jun	79.4	0	
9-Apr	47.5	0	**Pink**	9-May	59.6	0		9-Jun	83.9	0	
10-Apr	51.9	0		10-May	59.9	0		10-Jun	76.5	0.22	
11-Apr	64.0	0		11-May	57.6	0		11-Jun	73.6	0	
12-Apr	61.8	0.35		12-May	60.0	0	**1st Cover**	12-Jun	72.1	0	
13-Apr	49.6	0.17		13-May	58.2	0		13-Jun	69.7	0	
14-Apr	55.7	0		14-May	58.7	0.37		14-Jun	64.7	0.22	
15-Apr	50.4	0		15-May	66.3	0.13		15-Jun	67.9	0	
16-Apr	50.1	1.46		16-May	66.3	0		16-Jun	70.9	0.07	
17-Apr	55.5	0.62		17-May	63.3	0.22		17-Jun	72.6	0.05	
18-Apr	58.3	0	**Bloom**	18-May	64.0	0.11		18-Jun	74.0	0.01	
19-Apr	60.0	0.02		19-May	63.0	0.09		19-Jun	74.6	0	
20-Apr	62.3	0		20-May	60.1	0.2		20-Jun	69.6	0	
21-Apr	57.2	0		21-May	65.4	0.01		21-Jun	71.7	0.16	
22-Apr	44.7	0.01		22-May	62.4	0		22-Jun	77.1	0.72	**4th Cover**
23-Apr	54.7	0.23		23-May	67.0	0	**2nd Cover**	23-Jun	79.1	0	
24-Apr	69.4	0.24		24-May	75.5	0		24-Jun	77.9	0	
25-Apr	72.0	0.12	**Petal Fall**	25-May	73.5	0		25-Jun	74.1	0	
26-Apr	72.1	0		26-May	75.7	0		26-Jun	72.3	0	
27-Apr	69.9	0.18		27-May	75.6	0		27-Jun	72.6	0.01	
28-Apr	70.2	0.36		28-May	73.5	0.01		28-Jun	72.7	2.07	
29-Apr	61.4	0		29-May	75.4	0		29-Jun	76.4	0	
30-Apr	54.4	0		30-May	79.7	0		30-Jun	71.0	0	
				31-May	79.3	0					

Table 1 – continued –

Date	Temp	Rain	Spray	Date	Temp	Rain	Spray	Date	Temp	Rain	Spray
1-Jul	71.4	0		1-Aug	79.9	0.02					
2-Jul	74.2	0		2-Aug	77.6	0					
3-Jul	77.6	0.04		3-Aug	75.3	0.04					
4-Jul	78.2	0		4-Aug	72.1	0.25					
5-Jul	79.0	0	**5th Cover**	5-Aug	71.8	0					
6-Jul	77.9	0		6-Aug	75.2	0					
7-Jul	78.8	0.65		7-Aug	80.6	0					
8-Jul	74.8	1.57		8-Aug	81.1	0					
9-Jul	76.2	0		9-Aug	75.3	2.51					
10-Jul	76.4	0									
11-Jul	80.7	0									
12-Jul	81.6	0									
13-Jul	79.3	0									
14-Jul	72.4	0									
15-Jul	72.5	0									
16-Jul	74.3	0									
17-Jul	76.2	0									
18-Jul	79.7	0									
19-Jul	80.7	1.44									
20-Jul	76.9	0	**6th Cover**								
21-Jul	82.8	0									
22-Jul	88.1	0									
23-Jul	87.6	0									
24-Jul	82.7	1.82									
25-Jul	76.3	0.01									
26-Jul	79.4	0									
27-Jul	77.5	0									
28-Jul	76.8	0									
29-Jul	81.0	0.3									
30-Jul	81.1	0									
31-Jul	79.2	0									

Table 2. Blossom Blight Canker Incidence and Severity[1]

Treatment	Rate / A	Timing	% Shoots w. Canker[2]	# Cankers per shoot[2]
Nontreated Control	-----	-----	10.0 a	0.11 a
Vangard 75WG **Rally 40WSP** Bravo Ultrex 82.5WDG + Rally 40WSP Captan 80WDG + Rally 40WSP Captan 80WDG	**5.0 oz** **5.0 oz** 3.3 lb + 5 oz 3.75 lb + 5.0 oz 3.75 lb	**P, B** **PF** SS 1C, 2C 3C-6C	3.8 ab	0.04 b
Vangard 75WG **Rally 40WSP** Bravo Ultrex 82.5WDG Captan 80WDG + Rally 40WSP Captan 80WDG Kumulus 80DF	**5.0 oz** **5.0 oz** 3.3 lb 3.75 lb + 5.0 oz 3.75 lb 12 lb	**P, B** **PF** SS 1C 2C 3C-6C	1.3 b	0.01 b
Vangard 75WG **Luna Sensation 500SC** Captan 80WDG	**5.0 oz** **5.0 fl oz** 3.75 lb	**P, B** **PF** 1C 3C 5C SS 2C 4C 6C	2.5 b	0.03 b
Vangard 75WG **Merivon 500SC** Captan 80WDG	**5.0 oz** **6.5 fl oz** 3.75 lb	**P, B** **PF** 1C 3C 5C SS 2C 4C 6C	1.3 b	0.01 b
Vangard 75WG **Inspire XT 4.17EC** Captan 80WDG	**5.0 oz** **7.0 fl oz** 3.75 lb	**P, B** **PF** 1C 3C 5C SS 2C 4C 6C	1.3 b	0.01 b
Vangard 75WG **Inspire Super 2.82EW** Captan 80WDG	**5.0 oz** **20.0 fl oz** 3.75 lb	**P, B** **PF** 1C 3C 5C SS 2C 4C 6C	3.3 b	0.03 b
Vangard 75WG **Quadris Top 2.71SC** Captan 80WDG	**5.0 oz** **10.0 fl oz** 3.75 lb	**P, B** **PF** 1C 3C 5C SS 2C 4C 6C	0.0 b	0.00 b
Vangard 75WG **Quadris Top 2.71SC** Captan 80WDG	**5.0 oz** **14.0 fl oz** 3.75 lb	**P, B** **PF** 1C 3C 5C SS 2C 4C 6C	3.8 ab	0.04 b

[1] Blossom blight treatments, rates, and application timings in **boldface**.

[2] Means in the same column with the same letter do not differ significantly according to the Waller-Duncan *K*-ratio t-test (α=0.05, *K*=100).

Table 3. Rusty Spot Incidence and Severity[1]

Treatment	Rate / A	Timing	% Infected fruit[2]	# Lesions/fruit[2]
Nontreated Control	-----	-----	20.0 a	0.23 a
Vangard 75WG **Rally 40WSP** Bravo Ultrex 82.5WDG + **Rally 40WSP** Captan 80WDG + **Rally 40WSP** Captan 80WDG	5.0 oz **5.0 oz** 3.3 lb + **5 oz** 3.75 lb + **5.0 oz** 3.75 lb	P, B **PF** **SS** **1C, 2C** 3C-6C	2.5 d	0.03 d
Vangard 75WG **Rally 40WSP** Bravo Ultrex 82.5WDG Captan 80WDG + **Rally 40WSP** Captan 80WDG Kumulus 80DF	5.0 oz **5.0 oz** 3.3 lb 3.75 lb + **5.0 oz** 3.75 lb 12 lb	P, B **PF** **SS** **1C** **2C** 3C-6C	6.9 bc	0.08 c
Vangard 75WG **Luna Sensation 500SC** Captan 80WDG	5.0 oz **5.0 fl oz** 3.75 lb	P, B **PF** **1C** 3C 5C **SS** **2C** 4C 6C	6.9 bc	0.08 bc
Vangard 75WG **Merivon 500SC** Captan 80WDG	5.0 oz **6.5 fl oz** 3.75 lb	P, B **PF** **1C** 3C 5C **SS** **2C** 4C 6C	6.9 bc	0.07 cd
Vangard 75WG **Inspire XT 4.17EC** Captan 80WDG	5.0 oz **7.0 fl oz** 3.75 lb	P, B **PF** **1C** 3C 5C **SS** **2C** 4C 6C	2.5 d	0.03 d
Vangard 75WG **Inspire Super 2.82EW** Captan 80WDG	5.0 oz **20.0 fl oz** 3.75 lb	P, B **PF** **1C** 3C 5C **SS** **2C** 4C 6C	6.7 bc	0.07 cd
Vangard 75WG **Quadris Top 2.71SC** Captan 80WDG	5.0 oz **10.0 fl oz** 3.75 lb	P, B **PF** **1C** 3C 5C **SS** **2C** 4C 6C	11.9 b	0.13 b
Vangard 75WG **Quadris Top 2.71SC** Captan 80WDG	5.0 oz **14.0 fl oz** 3.75 lb	P, B **PF** **1C** 3C 5C **SS** **2C** 4C 6C	3.8 cd	0.04 cd

[1] Rusty spot treatments, rates, and application timings in **boldface**.

[2] Means in the same column with the same letter do not differ significantly according to the Waller-Duncan *K*-ratio t-test (α=0.05, *K*=100).

Table 4. Scab Incidence and Severity [1]

Treatment	Rate / A	Timing	% Infected Fruit[2]	# Lesions / fruit[2]
Nontreated Control	-----	-----	98.0 a	159.65 a
Vangard 75WG Rally 40WSP **Bravo Ultrex 82.5WDG** + Rally 40WSP **Captan 80WDG** + Rally 40WSP **Captan 80WDG**	5.0 oz 5.0 oz **3.3 lb** + 5 oz **3.75 lb** + 5.0 oz **3.75 lb**	P, B PF **SS** **1C, 2C** **3C-6C**	41.0 b	6.44 bc
Vangard 75WG Rally 40WSP **Bravo Ultrex 82.5WDG** **Captan 80WDG** + Rally 40WSP **Captan 80WDG** **Kumulus 80DF**	5.0 oz 5.0 oz **3.3 lb** **3.75 lb** + 5.0 oz **3.75 lb** **12 lb**	P, B PF **SS** **1C** **2C** **3C-6C**	34.0 bc	8.00 b
Vangard 75WG **Luna Sensation 500SC** **Captan 80WDG**	5.0 oz **5.0 fl oz** **3.75 lb**	P, B PF **1C 3C 5C** **SS 2C 4C 6C**	25.0 bcd	1.12 d
Vangard 75WG **Merivon 500SC** **Captan 80WDG**	5.0 oz **6.5 fl oz** **3.75 lb**	P, B PF **1C 3C 5C** **SS 2C 4C 6C**	30.0 bcd	1.50 cd
Vangard 75WG **Inspire XT 4.17EC** **Captan 80WDG**	5.0 oz **7.0 fl oz** **3.75 lb**	P, B PF **1C 3C 5C** **SS 2C 4C 6C**	19.0 cd	0.46 de
Vangard 75WG **Inspire Super 2.82EW** **Captan 80WDG**	5.0 oz **20.0 fl oz** **3.75 lb**	P, B PF **1C 3C 5C** **SS 2C 4C 6C**	20.0 d	0.33 de
Vangard 75WG **Quadris Top 2.71SC** **Captan 80WDG**	5.0 oz **10.0 fl oz** **3.75 lb**	P, B PF **1C 3C 5C** **SS 2C 4C 6C**	16.0 d	0.92 de
Vangard 75WG **Quadris Top 2.71SC** **Captan 80WDG**	5.0 oz **14.0 fl oz** **3.75 lb**	P, B PF **1C 3C 5C** **SS 2C 4C 6C**	3.0 e	0.04 e

[1] Scab treatments, rates, and application timings in **boldface**.

[2] Means in the same column with the same letter do not differ significantly according to the Waller-Duncan *K*-ratio t-test ($\alpha=0.05$, $K=100$).

FUNGICIDE TRIALS FOR BROWN ROT ON PEACH AND NECTARINE IN PA

Noemi O. Halbrendt and Henry K. Ngugi
Penn State University, Department of Plant Pathology
Fruit Research & Extension Center, Biglerville, PA 17307

Brown rot, caused by *Monilinia fructicola*, is an important preharvest and postharvest disease of stone fruit in Pennsylvania. Brown rot management is highly dependent on the use of fungicides that are effective and available in the market. We evaluated various fungicide programs for control of brown rot and Rhizopus rot and were conducted at the Penn State Fruit Research & Extension Center (FREC) on Easternglo nectarine and Sweet Dream and Beekman peach trees. The experimental design was a four replicate split-plot arrangement with treatment and cultivar assigned to main-plots and sub-plots, respectively. Sub-plot treatments consisted of single tree. of each cultivar. Treatments were applied with a boom sprayer (100 gal/A spray volume at 400 psi) on each side of the tree. Two bloom applications at 20-50% bloom (B1) and at 50-80% (B2) bloom were made on 19 and 25 Apr. Preharvest (PH) and harvest applications (H) sprays were made on 11 and 21 Jul for Easternglo; 5 Aug (PH for Sweet Dream), 19 Aug (H for Sweet Dream and, PH for Beekman), and 22 Aug (H for Beekman. Maintenance sprays for other diseases and insects were applied to all treatments from petal fall through the cover sprays with an airblast sprayer (100 gal/A spray volume at 400 psi). There was no blossom blight observed after bloom. At maturity, 50 fruits were harvested from each plot for assessments. Fruits were harvested on 22 Jul (Easternglo), 19 Aug (Sweet Dream) and 22 Aug (Beekman) and placed on fiber produce trays and incubated in a temperature-controlled room at 72^{o} F. Brown rot and Rhizopus rot were assessed at 0, 3, and 7 days after harvest incubation (DAI). Data obtained was analyzed by analysis of variance and significance between means tested with Fisher's Protected LSD test at $\alpha = 0.05$.

Dry weather conditions in mid to late summer resulted to low risk of brown rot infection in the test site. Incidence of brown rot and Rhizopus rot on nontreated Easternglo trees at 0-7 days after harvest (DAI) ranged from 4-18% and 5-25%, respectively (Table 1). Most of the treatments were not significantly different in brown rot control, and none of the treatments provided Rhizopus rot control. On Sweet Dream and Beekman, incidence of brown rot on nontreated trees at 0-7 DAI ranged from 5-62% and 21-63%, respectively (Table 2, 3). Incidence of brown rot on treated Sweet Dream and Beekman trees ranged from 0-45 and 0-22%, respectively. Some control differences were observed in brown rot at 7 DAI. All treatments at 7 DAI, except Inspire Super program, provided significant suppression of brown rot when compared to nontreated Sweet Dream. By comparison, Inspire Super program provided similar levels of brown rot control on Sweet Dream with Inspire XT, Orbit and Quintec programs. On Beekman, all treatments significantly reduced levels of brown rot compared to nontreated trees. None of the treatments controlled Rhizopus rot. However, some of the treatments resulted in more Rhizopus rot than the untreated fruit. Beekman had the lowest incidence of Rhizopus rot between the cultivars. No phytotoxicity was observed.

Acknowledgments: We would like to thank Bashar Jarjour, Terry Salade and FREC Tech Service for technical assistance in this project.

Table 1. Evaluation of fungicide programs to manage brown rot and Rhizopus rot Easternglo nectarine.

		% Infected fruit					
		Brown rot incidence			Rhizopus rot incidence		
Treatment & Rate/A	Timing[z]	0 DAI	3 DAI	7 DAI	0 DAI	3 DAI	7 DAI
Untreated check		4.0 a[y]	8.0 a	17.5 a	5.0 a	15.5 a	25.0 abc
Pristine 38WG 14.5 oz + LI 700 1 pt	B1, B2, PH, H	0.0 b	0.5 b	1.5 c	0.0 b	3.0 b	8.5 bc
Inspire XT 4.17EC 7 fl oz + LI 700 1 pt	B1, B2, PH, H	0.0 b	0.0 b	10.5 ab	0.0 b	13.5 ab	34.0 a
Inspire Super 2.82EW 20 fl oz + LI 700 1 pt	B1, B2, PH, H	0.5 b	1.5 b	7.5 bc	0.0 b	9.5 ab	24.5 abc
Indar 2F 10 fl oz + LI 700 1 pt	B1, B2, PH, H	0.0 b	0.0 b	8.5 bc	1.0 b	7.5 ab	18.0 abc
Merivon 5 fl oz + Latron B-1956 7.7 fl oz	B1, B2, PH, H	0.0 b	0.0 b	4.0 bc	0.0 b	2.0 b	7.0 c
Merivon 6.5 fl oz + Latron B-1956 7.7 fl oz	B1, B2, PH, H	0.5 b	1.0 b	4.5 bc	0.0 b	8.0 ab	14.5 abc
Pristine 12 oz + Latron B-1956 7.7 fl oz	B1, B2, PH, H	1.0 b	1.5 b	6.0 bc	0.0 b	11.5 ab	29.0 ab
Orbit 4 fl oz + Latron B-1956 7.7 fl oz	B1, B2, PH, H	0.0 b	0.0 b	2.0 c	0.0 b	4.5 ab	5.5 c
Quintec 7 fl oz + LI 700 1 pt	B1, B2, PH, H	0.0 b	0.0 b	8.0 bc	0.0 b	7.0 ab	21.5 abc

[z] B1=20-50% Bloom, B2=50-80% Bloom, PH=14 days Preharvest, H=1 day before harvest.

[y] Values within columns followed by the same letter(s) are not significantly different ($\alpha = 0.05$) according to Fisher's Protected LSD test.

Table 2. Evaluation of fungicide programs to manage brown rot and Rhizopus rot on Beekman peach.

		% Infected fruit					
		Brown rot incidence			Rhizopus rot incidence		
Treatment & Rate/A	Timing[z]	0 DAI	3 DAI	7 DAI	0 DAI	3 DAI	7 DAI
Untreated check		21.0 a[y]	44.0 a	63.0 a	2.0 a	6.5 ab	7.5 ab
Pristine 38WG 14.5 oz + LI 700 1 pt	B1, B2, PH, H	1.5 b	6.0 b	17.0 bcd	0.0 b	2.5 abc	12.0 a
Inspire XT 4.17EC 7 fl oz + LI 700 1 pt	B1, B2, PH, H	1.0 b	6.5 b	15.5 bcd	0.5 ab	7.0 a	12.5 a
Inspire Super 2.82EW 20 fl oz + LI 700 1 pt	B1, B2, PH, H	0.5 b	9.5 b	22.5 b	0.5 ab	4.5 abc	9.0 ab
Indar 2F 10 fl oz + LI 700 1 pt	B1, B2, PH, H	1.0 b	1.5 b	7.5 cd	0.5 ab	1.5 c	4.0 ab
Merivon 5 fl oz + Latron B-1956 7.7 fl oz	B1, B2, PH, H	0.0 b	2.0 b	6.5 d	0.0 b	2.0 bc	5.0 ab
Merivon 6.5 fl oz + Latron B-1956 7.7 fl oz	B1, B2, PH, H	0.0 b	0.5 b	4.0 d	0.0 b	0.0 c	1.5 b
Pristine 12 oz + Latron B-1956 7.7 fl oz	B1, B2, PH, H	0.5 b	2.0 b	5.0 d	0.5 ab	1.5 c	5.0 ab
Orbit 4 fl oz + Latron B-1956 7.7 fl oz	B1, B2, PH, H	2.0 b	7.5 b	22.0 bc	0.0 b	2.0 bc	11.0 a
Quintec 7 fl oz + LI 700 1 pt	B1, B2, PH, H	0.5 b	3.5 b	13.5 bcd	0.0 b	2.0 bc	7.0 ab

[z] B1=20-50% Bloom, B2=50-80% Bloom, PH=14 days Preharvest, H=1 day before harvest.

[y] Values within columns followed by the same letter(s) are not significantly different ($\alpha = 0.05$) according to Fisher's Protected LSD test.

Table 3. Evaluation of fungicide programs to manage brown rot and Rhizopus rot on Sweet Dream peach.

		% Infected fruit					
		Brown rot incidence			Rhizopus rot incidence		
Treatment & Rate/A	Timing[z]	0 DAI	3 DAI	7 DAI	0 DAI	3 DAI	7 DAI
Untreated check		5.0 a[y]	31.5 a	62.0 a	1.0 a	7.5 ab	13.5 ab
Pristine 38WG 14.5 oz + LI 700 1 pt	B1, B2, PH, H	0.5 b	8.0 bc	23.5 c	0.0 a	6.5 ab	16.0 ab
Inspire XT 4.17EC 7 fl oz + LI 700 1 pt	B1, B2, PH, H	1.0 b	17.5 abc	35.5 bc	0.0 a	6.5 ab	15.0 ab
Inspire Super 2.82EW 20 fl oz + LI 700 1 pt	B1, B2, PH, H	0.0 b	22.0 ab	45.0 ab	0.0 a	15.0 a	29.5 a
Indar 2F 10 fl oz + LI 700 1 pt	B1, B2, PH, H	0.5 b	8.5 bc	17.5 c	1.0 a	3.5 b	11.5 ab
Merivon 5 fl oz + Latron B-1956 7.7 fl oz	B1, B2, PH, H	0.0 b	7.5 c	15.5 c	0.0 a	2.5 b	10.0 b
Merivon 6.5 fl oz + Latron B-1956 7.7 fl oz	B1, B2, PH, H	0.0 b	8.0 bc	22.5 c	0.0 a	4.0 b	21.0 ab
Pristine 12 oz + Latron B-1956 7.7 fl oz	B1, B2, PH, H	0.5 b	13.5 bc	21.0 c	0.0 a	5.0 b	12.5 ab
Orbit 4 fl oz + Latron B-1956 7.7 fl oz	B1, B2, PH, H	0.0 b	13.0 bc	28.5 bc	0.0 a	7.0 ab	21.0 ab
Quintec 7 fl oz + LI 700 1 pt	B1, B2, PH, H	0.0 b	8.0 bc	31.5 bc	0.0 a	3.5 b	26.5 ab

[z] B1=20-50% Bloom, B2=50-80% Bloom, PH=14 days Preharvest, H=1 day before harvest.

[y] Values within columns followed by the same letter(s) are not significantly different ($\alpha = 0.05$) according to Fisher's Protected LSD test.

FUNGICIDE PERFORMANCE TRIAL FOR DOWNY MILDEW OF GRAPE

Mizuho Nita and Kay Miller
Virginia Polytechnic Institute and State University
AHS Agricultural Research and Extension Center
595 Laurel Grove Rd, Winchester, VA 22602

This trial was conducted with 'Chardonnay' grapes planted in 2009, trained to a vertical positioning (VSP) system with bilateral cordons, with a spacing of 5-ft between vines and 10-ft between rows. Plots consisted of three consecutive vines, and were arranged in completely randomized design with four replications. Treatments were applied with a 4 gal backpack air sprayer, regulated to 21 psi by a CF Valve system (GATE LLC) through a single boom with a flat fan nozzle (TeeJet 8003VS). Treatments were started 4 d before bloom and repeated two times, rotated once with Ridomil Gold/MZ (2 lb/A), then repeated two more times. The interval between applications was approximately 14 days (varied based on the growth of grape). All treatments were tank mixed with Microthiol Disperss (3 lb/A) in order to suppress powdery mildew infection. Also, an adjuvant Sylgard (0.3%) was added to all treatments. Prior to the experimental treatment, all vines were treated with Penncozeb (3 lb/A) and Microthiol Disperss (3 lb/A) to control various diseases. Also, at bloom, all vines were treated with Vangard (8 oz/A) to control blossom blight by Botrytis. Diseases were visually assessed four times during the season, and results from 26 July are shown. Of three vines used for each plot, outer cordons that were adjacent to the next treatment were not assessed in order to avoid recording potential fungicide drift effects. Fifteen leaves and five clusters from the inner cordon of vines that were adjacent to the next treatment, and 30 leaves and 10 clusters from the central vine were assessed (a total of 240 leaves per treatment). These leaves and clusters were randomly selected, and the estimated percentage of infected area (disease severity) was recorded. The linear mixed model was used to conduct the analysis of variance (JMP 7.0.1, SAS institute, Cary NC). Treatment was considered as a fixed effect, and replication was considered as a random effect. Data were transformed using angular transformation ($\arcsin\sqrt{proportion}$) prior to the analysis.

Bud break at Winchester was 19 April, and 50% bloom was 30 May. There were consistent rain events between bud break to bloom. The total amount of precipitation at Winchester was about 3.5 inches between bud break to bloom. However, after mid-May, we did not receive significant rain until 8 July. Although there were several infection events for downy mildew earlier in the season, overall dryness, lack of humid nights (to promote downy mildew spore production) prior to rains, and lack of downy mildew inoculum (we observed very little downy mildew in 2010) were potential reasons for relatively low disease intensity in 2011. Mean downy mildew leaf disease incidence varied from 1.7% to 13% and severity varied from 0.02% to 0.28%. Treatment differences were highly significant (P< 0.01 for both incidence and severity). Although numerically lower in leaf disease incidence, some of treatments (Revus, Zampro 14 fl oz, and the Penncozeb "standard") were not significantly different from the DM check. This was probably due to high variability in disease incidence among repetitions. Disease on clusters mainly developed in the form of blossom blight. Cluster disease incidence and severity varied from 15-46% and 0.2-1.5%, respectively. Treatment differences were highly significant (P< 0.03 and P< 0.01 for incidence and severity, respectively). As with leaf disease intensity, despite of the numerical differences, some of treatments (Zampro 11 fl oz and "standard") were not significantly different from DM check.

Table 1.

	Days after first	Leaf					
Treatment[z]	application[y]	Disease incidence[x]		% control[w]	Disease severity[v]		% control[w]
Penncozeb 75DF 3lb (Standard)	33, 42, 54, 69, 82	7.5	AB	41.9	0.23	AB	17.6
Revus Top 7 oz	33, 42, 54, 69, 82	1.7	B	87.1	0.02	C	94.1
Revus 7oz	33, 42, 54, 69, 82	4.6	AB	64.5	0.05	BC	83.8
Zampro 11 oz	33, 42, 54, 69, 82	2.5	B	80.6	0.04	C	85.3
Zampro 14 oz	33, 42, 54, 69, 82	5.4	AB	58.1	0.07	BC	75.0
DM check (Microthiol 3 lb only)	33, 42, 54, 69, 82	12.9	A		0.28	A	
	Days after first	Cluster					
Treatment[z]	application[y]	Disease incidence[x]		% control[w]	Disease severity[v]		% control[w]
Penncozeb 75DF 3lb (Standard)	33, 42, 54, 69, 82	43.8	AB	5.4	1.25	A	13.8
Revus Top 7 oz	33, 42, 54, 69, 82	15.0	C	67.6	0.20	B	86.2
Revus 7oz	33, 42, 54, 69, 82	21.3	BC	54.1	0.71	B	50.9
Zampro 11 oz	33, 42, 54, 69, 82	26.3	ABC	43.2	0.79	AB	45.7
Zampro 14 oz	33, 42, 54, 69, 82	21.3	C	54.1	0.58	B	60.3
DM check (Microthiol 3 lb only)	33, 42, 54, 69, 82	46.3	A		1.45	A	

[z]All rates were calculated based on per acre bases using 100 gal of water, DM Check received sulfur (Microthiol Disperss 3 lb/A) during the experiment to prevent powdery mildew.

[y] The first application was made in 25 April. Unless noted otherwise, sprays prior to the day 33 (days 1, 10, 17, 23) included mancozeb (Penncozeb) applied at 3 lb per acre. The treatment applied for day 54 was Ridomil Gold MZ

[x]Disease incidence = percentage of diseased leaves: Numbers presented are the least square mean of percentage. The same letter indicates there was no significant difference between treatments (Tukey-Kramer adjustment method, the overall error rate = 0.05)

[v]Disease severity = percentage of area of leaves or bunches that is diseased: Numbers presented are the least square mean of percentage. The same letter indicates there was no significant difference between treatments (Tukey-Kramer adjustment method, the overall error rate = 0.05)

[w]%Control = the percentage of disease controlled, compared with DM check

PROGRESS IN BUNCH ROT CONTROL OF GRAPES IN PENNSYLVANIA THROUGH THE INTEGRATION OF NON-CHEMICAL STRATEGIES

Bryan Hed[1], Henry Ngugi[2], and Noemi Halbrendt[2]
Dept. Plant Pathology, Penn State University, (1) North East, Pennsylvania 16428; (2) Biglerville, Pennsylvania 17307

The compactness of a grape cluster plays a large role in the susceptibility of that cluster to harvest bunch rots; susceptibility increases with increasing cluster compactness (1-4). Research at the Lake Erie Regional Grape Research and Extension Center at North East Pennsylvania, has shown that early cluster zone leaf removal (applied at 'trace' bloom, when first flowers are opening) and gibberellic acid (applied at full bloom) have the effect of reducing fruit set over untreated vines. The reduction in fruit set reduces the compactness of clusters and their susceptibility to bunch rots, and improves the penetration of pesticides into the cluster (1-4).

In 2010, trials were established to evaluate early cluster zone leaf removal and gibberellic acid in six commercial vineyards (four in Southern Pennsylvania (vineyards 4, 5, 7, and 8) and two in Northwestern Pennsylvania (vineyards 1 and 2)) and two Penn State experimental vineyard sites (the Lake Erie Regional Grape Research and Extension Center (Erie county, vineyard 3) and the Fruit Research and Extension Center (Adams county, vineyard 6)). Seven sites contained acreage of *Vitis vinifera* 'Chardonnay', two of 'Pinot Noir', two of 'Pinot Gris', two of 'Riesling', and one of *Vitis* interspecific hybrid 'Vignoles'; all commercially important varieties considered very susceptible to harvest bunch rots due to an overly compact cluster. Over two seasons, treatments were applied to the same vines in 3 to 4-vine plots in a randomized complete block design with 4 replications. Fruit clusters were monitored for effects on bunch rot (at or near harvest), cluster architecture, and juice quality. Effects on return bloom ('year after' effects of the treatments) were also recorded in the spring of 2011 and will be reevaluated in the spring of 2012.

As in 2010, trials compared a 'Grower Standard' or GS (without cluster zone leaf removal = GS1; with post bloom leaf removal = GS2) to GS + leaf removal at trace bloom (trace LR) and GS + gibberellic acid (GA3 at 25 ppm). Rainfall was recorded at several vineyards with portable rain buckets supplied with data-loggers or Campbell weather stations, to provide data on disease pressure during the ripening period. In Southern Pennsylvania, the ripening period was plagued by very wet conditions in 2011 that were associated with two major storm systems; hurricane Irene (end of August) and tropical storm Lee (early September). These weather systems made late season bunch rot control extremely challenging, especially for growers around Lancaster and Harrisburg, and to a lesser extent, Adams County. Northwestern Pennsylvania (Erie County) was relatively unaffected by these two storm systems. Nevertheless, rainfall during the ripening period was above average in all vineyards in this project in 2011.

Results

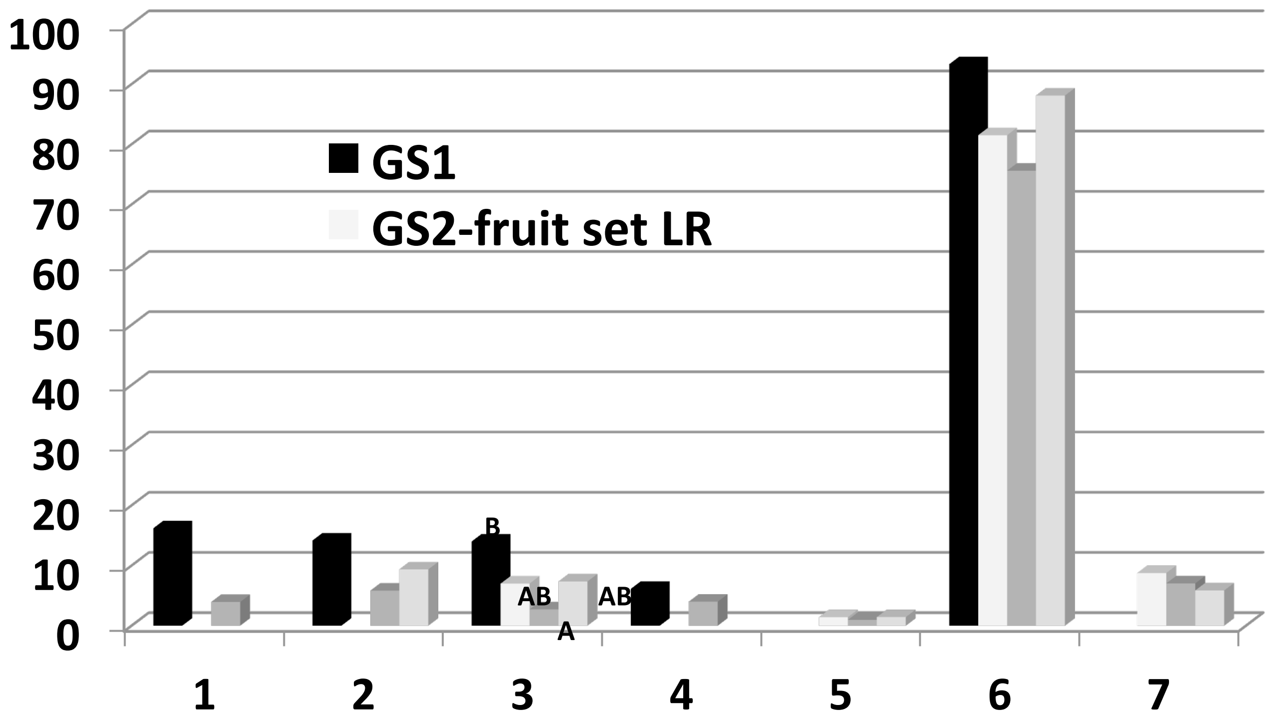
<u>Harvest bunch rots:</u> The severity of bunch rot development in southeastern vineyards was similar in both years, despite heavier rainfall in 2011. This is in part because these vineyards (vineyards 4, 5, and 8) were rated for bunch rot on August 29 and 30 and therefore do not reflect the effects of 'Lee'. On the other hand, vineyards in Adams county were rated shortly after tropical storm Lee (September 11) and bunch rot levels were more severe than in 2010.

Cluster loosening treatments designed to reduce fruit set and cluster compactness (trace bloom leaf removal (trace LR) and gibberellin (GA)) were generally successful at reducing harvest bunch rot development (Figures 1, 2, and 3), although the magnitude of the reductions depended on location, weather (especially rainfall), intensity of vineyard management, and timing of harvest. In 2011, the trace LR was most successful on Chardonnay, with an average reduction in rots of 46 % across 7 vineyards (when compared with the grower standard alone), whereas the average reduction in rots over all vineyards and all varieties (14 vineyard blocks) was 43 % (compared with 40 % in 2010). The GA treatment was less successful at reducing rots in 2011 when compared to trace LR, and was most successful on Pinot Gris/Noir, with an average reduction in rots of 36 % across 3 vineyards. The average rot reduction from GA over all vineyards and all varieties (11 vineyard blocks) was 30 % (compared with 57 % across 8 vineyard blocks in 2010). In 2011, injury to clusters from insect feeding, powdery mildew, and Phomopsis fruit rot was less prevalent than in 2010. However, 2011 dealt out its own unique challenges to bunch rot control, the greatest of these being the excessive rainfall during the latter half of the ripening period in the eastern half of the state, especially where harvest was delayed until mid September. This factor greatly increased susceptibility to bunch rots as clusters remained wet for long periods of time, having its greatest negative impact where opening of the cluster zone was omitted (no leaf removal; for example, GS1 and GS1 + GA). In retrospect, *Botrytis* specific fungicide applications during late August and early September were extremely important in eastern PA in 2011. The data from the past two years of this project clearly illustrate that leaf removal at trace bloom and gibberellin at bloom reduce the susceptibility of tight bunches to late season rots. However, these treatments should be viewed as part of an integrated bunch rot control program with regular *Botrytis* specific fungicide applications for maximum protection against harvest rots, especially under the extreme weather conditions in eastern Pennsylvania in 2011.

<u>‘Year after’ effects of treatments:</u> Effects on return bloom were recorded in the spring of 2011 by counting the number of flower clusters per shoot from a sample of primary canes in each plot of vineyards 2, 4, and 5. There were no negative ‘year after’ effects of trace bloom leaf removal (trace LR) on return bloom in either Chardonnay (vineyards 2, 4, and 5), Pinot Gris (vineyards 2 and 4), or Riesling (vineyard 3). Return bloom of Chardonnay and Pinot Gris did not appear to be affected by a bloom application of gibberellic acid (GA). This harmonizes with earlier experiments with Chardonnay from trials at the Penn State experimental vineyard in Erie County (vineyard 3) from 2007-2009. In addition, earlier testing with the white French hybrid Vignoles at the Penn State vineyard provided clear evidence of the benefits of GA sprays to Vignoles (reduced fruit set, cluster compactness, and rot) with little or no evidence of negative ‘year after’ effects after 4 years of application to the same vines. In contrast, GA application to Riesling reduced return bloom by 19 and 45 % (in 2011) when applied at 5 and 25 ppm (in 2010), respectively. This provides more evidence that the negative ‘year after’ effects of GA are variety specific and must be tested on each variety before judgment can be passed on the usefulness of this inexpensive tool. The effects of these two treatments on return bloom will be reevaluated in the spring of 2012 after 2 consecutive years of treatment to the same vines and should provide clearer evidence of the benefits and dangers of trace LR and GA to these varieties.

The following two figures show the level of rot severity (vertical axis; 0-100) in each vineyard location (horizontal axis; 1-7) for Chardonnay and Pinot Noir/Gris.

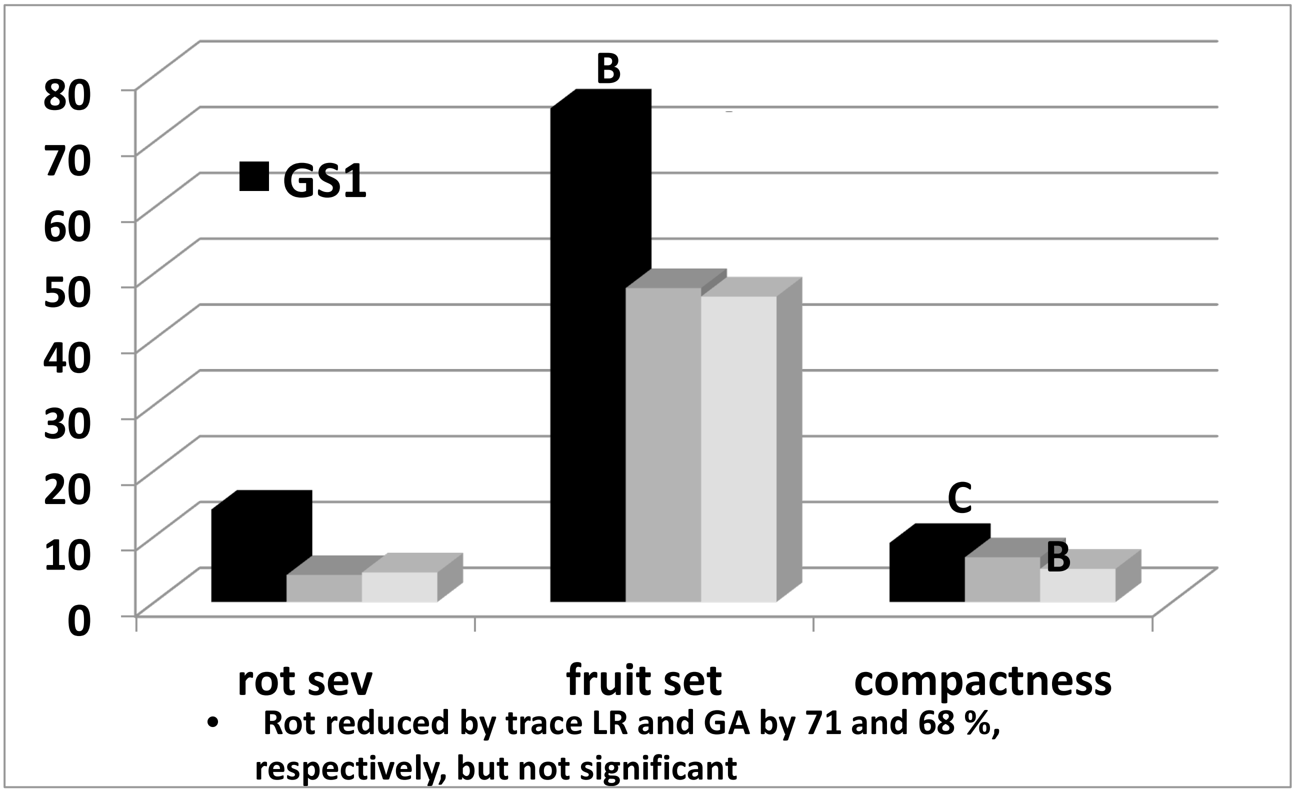
Figure 1; Chardonnay, Rot Severity



• **ANOVA, Fisher's Protected LSD (*P* ≤ 0.05).**

• **Significant reductions occurred in vineyards 3 and 4.**

Figure 3: Vineyard 8 - Vignoles rot severity, fruit set, and compactness



Effects on cluster architecture: Thus far, we have completed work to determine these parameters from samples of Chardonnay clusters collected in Erie county vineyards (vineyards 1, 2, and 3), and Vignoles at vineyard 8 (Figure 3) during the 2011 season. Our results agree with what we determined in 2010: trace LR and GA reduce fruit set and cluster compactness. For example, trace LR reduced fruit set by 12, 12, 41, and 36 %, and cluster compactness by 9, 17, 30, and 24 % in vineyards 1, 2, 3, and 8 respectively. GA reduced fruit set by 42, 26, and 38 %, and cluster compactness by 33, 24, and 44 % in vineyards 2, 3, and 8 respectively.

Costs to consider: The gibberellic acid treatment (25 ppm) is estimated at about $10-15/acre, less than the price of a single *Botrytis* fungicide application at $40-60/acre. Unfortunately, this treatment is not currently listed on the label for seeded wine varieties and remains experimental. Trace bloom leaf removal is very labor intensive and may cost up to $250 per acre if applied by hand, depending on the trellis system, skill of the workers, vigor and growth stage of the vines. However, the cost of hand leaf removal decreases with earlier timing; experiments at the Penn State vineyard in Erie county showed that trace bloom leaf removal was 15% less costly to apply than leaf removal at, or just after, fruit set (the currently recommended timing). Early leaf removal and GA (at bloom) typically reduce cluster weights, and unless cluster numbers per vine are increased, per acre tonnage and revenues may be reduced. However, in previous experiments, whole vine yield data from large 24 vine plots of Vignoles showed no reduction in per acre yields over 2 years of GA application to the same vines, when compared to an unsprayed check.

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FUNGICIDE PERFORMANCE TRIAL FOR POWDERY MILDEW OF GRAPE

Mizuho Nita and Kay Miller
Virginia Polytechnic Institute and State University
AHS Agricultural Research and Extension Center
595 Laurel Grove Rd, Winchester, VA 22602

This trial was conducted with 'Chardonnay' grapes planted in 2009, trained to a vertical positioning (VSP) system with bilateral cordons, with a spacing of 5-ft between vines and 10-ft between rows. Plots consisted of three consecutive vines, and were arranged in completely randomized design with four replications. Treatments were applied with a 4 gal backpack air sprayer, regulated to 21 psi by a CF Valve system (GATE LLC) through a single boom with a flat fan nozzle (TeeJet 8003VS). Treatments were started 5 d after bloom and repeated three consecutive times. The interval between applications was approximately 14 days (varied based on the growth of grape). Treatments were tank mixed with Revus (7 floz/A) in order to suppress downy mildew infection. Prior to the experimental treatment, all vines were treated with Penncozeb (3 lb/A) and Microthiol Disperss (3 lb/A) to control various diseases. Also, an adjuvant Sylgard (0.3%) was added to all treatments. At bloom, all vines were treated with Vangard (8 oz/A) to control blossom blight by Botrytis. Diseases were visually assessed four times during the season, and results from 19 July are shown. Of three vines used for each plot, outer cordons that were adjacent to the next treatment were not assessed in order to avoid recording effects from fungicide drift. Fifteen leaves and five clusters from the inner cordon of vines that were adjacent to the next treatment, and 30 leaves and 10 clusters from the central vine were assessed (a total of 240 leaves per treatment). These leaves and clusters were randomly selected, and the estimated percentage of infected area (disease severity) was recorded. The linear mixed model was used to conduct the analysis of variance (JMP 7.0.1, SAS institute, Cary NC). Treatment was considered as a fixed effect, and replication was considered as a random effect. Data were transformed using angular transformation ($\arcsin\sqrt{proportion}$) prior to the analysis.

The bud break at Winchester was 19 April, and 50% bloom was 30 May. There were consistent rain events between bud break to bloom. The total amount of precipitation at Winchester was about 3.5 inches between bud break to bloom. However, after mid-May, we did not receive significant rain until 8 July. This dry condition and abundance of inoculum (we observed powdery mildew outbreak in 2010) probably promoted development of powdery mildew. Mean leaf disease incidence of powdery mildew varied from 4% to 99% and disease severity varied from 0.1% to 26%. Cluster disease incidence and severity varied from 5% to 100% and 0.1% to 59%, respectively. Treatment differences were highly significant ($P < 0.001$) on all disease measurements, and a good separation of treatment means was found. Percent control on leaf infection varied. One treatment resulted in below 4% disease incidence (Luna Experience with >96% disease control) while others were around 30-40% (70-60% disease control). The difference might be due to tebuconazole, which is included in Luna Experience, because it has a curative activity against powdery mildew. Leaf disease severity resulted in below 2% on all treatments except "standard" (sulfur only), indicating that many of colonies observed were very small. Compared to severe infection on untreated vines, all treatments presented good to excellent control on leaves. On the other hand, high disease incidence was observed on clusters with all treatments (~15% control), except with Luna Experience. As with leaf severity, low cluster disease severity (< 5%) indicated that many of observed colonies were small in size.

Table 1.

	Days after first	Leaf					
Treatment^z	application^y	Disease incidence^x		% control^w	Disease severity^v		% control^w
Luna Experience 8 oz	43, 54, 69	3.8	D	96.2	0.1	D	99.8
Quintec 4fl oz	43, 54, 69	40.0	C	59.7	1.3	C	95.0
Torino 3.4 floz rotated with Vivando 10 oz	33, 43, 54, 69	28.8	C	71.0	1.0	C	96.2
Vivando 10 oz	43, 54, 69	36.7	C	63.0	2.1	C	92.1
Vivando 15 oz	43, 54, 69	32.1	C	67.6	1.0	C	96.4
PM check (Revus 7 oz Only)	43, 54, 69	99.2	A	0.0	26.6	A	0.0
Standard (Microthiol 3 lb)	43, 54, 69	78.3	B	21.0	10.5	B	60.7
		Cluster					
Treatment^z	Days after first application^y	Disease incidence^x		% control^w	Disease severity^v		% control^w
Luna Experience 8 oz	43, 54, 69	5.0	B	94.7	0.1	D	99.9
Quintec 4fl oz	43, 54, 69	80.0	A	14.7	2.7	C	95.5
Torino 3.4 floz rotated with Vivando 10 oz	33, 43, 54, 69	82.5	A	12.0	4.8	C	91.9
Vivando 10 oz	43, 54, 69	82.5	A	12.0	4.4	C	92.5
Vivando 15 oz	43, 54, 69	78.8	A	16.0	2.8	C	95.4
PM check (Revus 7 oz Only)	43, 54, 69	93.8	A	0.0	59.2	A	0.0
Standard (Microthiol 3 lb)	43, 54, 69	100.0	A	-6.7	37.1	B	37.3

^{z}All rates were calculated based on per acre bases using 100 gal of water, PM Check received mancozeb (Penncozeb 3 lb/A) during the experiment to prevent downy mildew and black rot.

^{y} The first application was made in 25 April. Unless noted otherwise, sprays prior to the day 43 (days 1, 10, 17, 23, 33) included sulfur applied at 3 lb per acre. The treatment applied for day 54 contained Ridomil Gold MZ for downy mildew control

^{x}Disease incidence = percentage of diseased leaves: Numbers presented are the least square mean of percentage. The same letter indicates there was no significant difference between treatments (Tukey-Kramer adjustment method, the overall error rate = 0.05)

^{v}Disease severity = percentage of area of leaves or bunches that is diseased: Numbers presented are the least square mean of percentage. The same letter indicates there was no significant difference between treatments (Tukey-Kramer adjustment method, the overall error rate = 0.05)

^{w}%Control = the percentage of disease controlled, compared with PM 89

LIMITED EFFECTS OF FOLIAR INSECTICIDAL TREATMENTS ON THE CONTROL OF MEALYBUGS ON GRAPE

Mizuho Nita and Taylor Jones
Alson H. Smith, Jr. Agricultural Research and Extension Center
Virginia Tech, Winchester, VA 22601

Small, white, waxy insects called mealybugs are starting to make their presence known in Virginia vineyards thanks to their ability to vector Grapevine Leafroll Disease (GLD). GLD is caused by a group of viruses that can significantly reduce both crop yield and grape quality, which inevitably will determine the wine quality (Kovacs et al., 2001). In a severely infected vineyard with a susceptible variety, the crop loss can be up to 30, even 50% (Martinson et al., 2008).Mealybugs (Pseudococcidae), soft scale insects (Coccidae), vegetative propagation, and grafting are all methods of dissemination for this disease (Martinson et al., 2008, Rayapati et al., 2008, Charles et al., 2006). Our research focused on the mealybug aspect of this disease as mealybugs are a common insect in Virginia and are hard to control. On the vine, mealybugs can be found along the roots, on the trunk, under any bark, along the cordons, and even in the fruit clusters. For this reason, insecticidal control is necessary. With the current spreading of GLD and the fact that little is known regarding the control of these vectors, we proposed a study to observe the effects of insecticides on the control of mealybug populations in vineyards where mealybugs were already present.

Two field experiments were conducted to investigate the effectiveness of foliar insecticide sprays on controlling mealybug populations: one at the experimental farm at the Winchester AREC during the summers of 2010 and 2011, and the other at a commercial vineyard in Virginia in the summer of 2011. The experimental farm vineyard block has 21-year old 'Cabernet Sauvignon' grapevines infected with grapevine leafroll associated virus-3 and has mealybugs present. Within each row, all but one of the infected vines were removed and re-planted with certified Cabernet Franc cuttings at approximately 5 and 10 feet away from each infected vine. After planting, foliar insecticide treatments were applied in a randomized block design of six replications. There were three treatments: 1) two insecticide applications (Acetamiprid (Assail, 2.5 oz/acre, United Phosphorus, Inc. (UPI), King of Prussia, PA) at delayed dormant and a pyrethroid (Baythroid XL, 3 oz/acre, Bayer CropScience LP, Research Triangle, NC) in season); 2) one insecticide applied once (Acetamiprid (2.5 oz/acre) at delayed dormant); and 3) no insecticide spray (serves as a control). At the commercial vineyard one row of Chardonnay vines was sprayed foliarly with either a control spray or one of two neonicotinoids [Spirotetramat (Scopion, 4 oz/A, Gowan Company, Yuma, AZ) or Dinotefuran, (Movento, 6 oz/A, Bayer Crop Science LP)]. The treatments were set up in a completely randomized design with four replications. Following treatments at both locations, mealybug numbers were assessed by a rater, who spent 5 minutes per vine visually counting the insects.

At both locations, insecticides seemed to provide a limited control of these insects. At the Winchester AREC, in both years mealybugs were mostly present on older vines and showed a significant difference on average, which was expected. However, there was movement/survival of mealybugs on all vines regardless of treatment. In the summer of 2011, the greatest number of mealybugs was present on the twice sprayed vines. This was due to the initial neonicotinoid spray not killing off all mealybugs already present. Then, the following pyrethroid spray killed off all beneficial/predatory insects and allowed the mealybug population to rebound and grow. Here, vine location (e.g. old vine and the two young vines) was always significant after June 30th.

At the commercial vineyard, both time and treatment were significant. At two dates, July 1 and August 5 2011, the average number of mealybugs per vine was significantly different between the control treatment and the other two test treatments, suggesting these insecticides may be a better option. Also, there was a general declining trend in the data, suggesting mealybug population were in fact declining over time; however, the reduction over time was not significant enough to make any conclusions.

Overall, both trials showed some limitations with foliar applications of insecticides with the intentions of cleaning up a vineyard after mealybugs have been established. A spray of a pyrethroid after a neonicotinoid seems to have led to a large population rebound, which would suggest it as a bad practice in regards to mealybug control. Movento and Scorpion both seemed to provide some sufficient control when sprayed foliarly; however, drip applications should also be tested since these chemicals are systemic. From these results and others, it seems the best method of mealybug control is a preventative one rather than an extinguishing one. Sprays with Movento or Scorpion in a vineyard where mealybugs have not yet been reported can be suggested to prevent the insects from invading. Mealybugs are hard to eliminate once they have been establish within-field.

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UPDATE OF FUNGICIDE TESTING ON WINE GRAPES IN PA

Noemi O. Halbrendt and Henry K. Ngugi
Penn State University, Department of Plant Pathology
Fruit Research & Extension Center, Biglerville, PA 17307

Grape growers encounter pressure from seasonal diseases and they are highly dependent on chemical control to manage them in order to reach their yield and quality targets. To address this concern, we evaluated the efficacy of various new and existing fungicides and combination of fungicides for control of preharvest and postharvest bunch rots (ripe rot - caused by *Colletotrichum* sp., Botrytis rot - caused by *Botrytis cinerea*, and sour rots – complex disease caused by various bacteria, fungi and yeasts) of wine grapes in PA. This test was conducted in a mature vineyard at the Penn State Fruit Research & Extension Center vineyard, Biglerville, PA. Vines were spaced at 6 x 9 ft and were Scott Henry-trained and hand-pruned. The experiment was arranged in a randomized complete block design with four replications. A standard insecticide program was separately applied using an air-blast sprayer delivering 100 gal/A at 400 psi. A standard fungicide program provided season-long control of the common grapevine diseases other than Botrytis rot. Treatments were applied using a Bean covered-boom dilute sprayer delivering 50-100 gal/A depending on the stage of canopy development. The incidence (percent clusters infected), and severity (percent area infected) of ripe rot were determined on 8 Aug; Botrytis and sour rots were determined on 16 Sep (Pinot Noir) and 26 Sep (Cabernet Franc) from 25 arbitrarily-selected clusters per plot. Severity was rated using the Barratt-Horsfall scale and was converted to percent area infected using Elanco conversion tables. Data was analyzed using analysis of variance and mean separation was determined by the Fisher's Protected LSD test ($P \leq 0.05$).

Rainfall for Apr, May, Jun, Jul, and Aug was 11.35 in., 4.32 in., 1.42 in., 3.86 in., and 4.21 in., respectively. Overall, disease pressure was moderate for ripe rot and high for Botrytis rot. Sour rot was the most prevalent bunch rot observed, which was due to high accumulation of rainfall in the weeks before harvest. Control plots of Pinot Noir had a higher incidence of ripe rot (77%, Table 1) compared to Cabernet Franc (23%, Table 2). All treatments provided significant ripe rot control compared to the nontreated plots. Cabernet Franc had a higher incidence of Botrytis (68%) and sour (84%) rots compared to Pinot Noir (1.2%) and (77%), respectively. All Cabernet Franc treatments significantly reduced the incidence and severity of ripe rot, Botrytis, and sour rots compared to the untreated check. Incidence of sour rot on treated Pinot Noir vines ranged from 65-87% and none of the fungicide treatments provided sour rot control. The rotation of Luna Experience and IKF 5411 showed the lowest incidence (65%) of sour rot on Pinot Noir. Solo programs of IKF 5411 (29%) and Luna Experience (30%) provided the lowest incidence of sour rot on Cabernet Franc. None of the treatments caused phytotoxicity on the leaves or fruits of the two wine grape cultivars.

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Table 1. Incidence of bunch rots on Pinot Noir in PA.

		Ripe rot[y]		Botrytis rot[y]		Sour rot[y]	
Program & Rate/A	Timing[z]	% Incid	% Sev	% Incid	% Sev	% Incid	% Sev
Untreated check		77.0 a[x]	3.2 a	1.2 a	22.0 a	77.0 bc	20.6 ab
Luna Experience 8 oz	B,PC,V,PH	17.0 b	0.5 b	0.1 c	4.0 e	80.0 bc	15.1 c
IKF 5411 22 fl oz	B,PC,V,PH	6.0 cd	0.1 e	0.0 c	0.0 g	73.0 d	10.2 de
IKF 5411 22 fl oz rot. Luna Experience 8 oz	B,V PC,PH	7.0 cd	0.2 cd	0.2 c	8.0 bc	65.0 f	19.6 abc
Regalia 4 pt rot, Luna Experience 8 oz	PC,PH B,V	9.0 cd	0.2 cd	0.0 c	1.0 fg	76.0 bc	11.9 de
Expt. PA-V 12 fl oz	B,PC,V,PH	6.0 cd	0.2 cd	0.6 bc	11.0 b	79.0 bc	20.5 ab
Rovral/Iprodione 4L AG 2 pt Vangard WG 10 oz Pristine 19 oz	B,PC V PH	4.0 de	0.1 e	0.3 c	11.0 b	85.0 ab	21.1 ab
Rovral/Iprodione 4L AG 2 pt Vangard WG 10 oz Pristine 19 oz	B,PC V PH	11.0 bc	0.3 bc	0.2 c	6.0 cd	84.0 ab	22.2 a
Pristine 19 oz	B,PC,V,PH	4.0 de	0.1 e	0.4 c	11.0 b	87.0 a	17.8 a-d
Merivon H 11 fl oz	B,PC,V,PH	7.0 cd	0.2 cd	0.0 c	0.0 g	78.0 bc	10.0 de
Elevate 1 lb	B,PC,V,PH	1.0 f	0.0 e	0.1 c	3.0 fg	71.0 de	12.4 d

[z] Timings: TB=Trace Bloom (25 May); B=Bloom (3 Jun); PC or BT=Preclosure/Berry Touch (24 Jun); V=Veraison (14 Aug); PH=Preharvest (30 Aug).

[y] All values are ripe rot (8 Aug), Botrytis and sour rot (16, Sep) incidence and severity and the means of at least 25 fruit clusters per vine across four replicate plots.

[x] Values within columns followed by the same letter(s) are not significantly different ($P \leq 0.05$) according to Fisher's Protected LSD Test.

Table 2. Incidence of bunch rots on Cabernet Franc in PA.

		Ripe rot[y]		Botrytis rot[y]		Sour rot[y]	
Program & Rate/A	Timing[z]	% Incid	% Sev	% Incid	% Sev	% Incid	% Sev
Untreated check		23.0 a[x]	0.8 a	68.0 a	33.8 a	84.0 a	12.4 a
Luna Experience 8 oz	B,PC,V,PH	9.0 bc	0.3 b	1.0 cde	1.3 de	30.0 de	0.1 c
IKF 5411 22 fl oz	B,PC,V,PH	6.0 cd	0.3 b	0.0 e	1.7 de	29.0 e	0.1 c
IKF 5411 22 fl oz rot. Luna Experience 8 oz	B,V PC,PH	11.0 b	0.3 b	2.0 cde	1.4 de	40.0 cde	0.1 c
Regalia 4 pt rot, Luna Experience 8 oz	PC,PH B,V	5.0 cde	0.1 cd	13.0 bc	8.1 b	54.0 bc	0.5 bc
Expt. PA-V 12 fl oz	B,PC,V,PH	11.0 b	0.3 b	16.0 b	4.1 cd	59.0 b	2.5 b
Rovral/Iprodione 4L AG 2 pt Vangard WG 10 oz Pristine 19 oz	B,PC V PH	9.0 bc	0.2 bc	10.0 bcd	2.9 cde	52.0 bcd	0.3 c
Rovral/Iprodione 4L AG 2 pt Vangard WG 10 oz Pristine 19 oz	B,PC V PH	9.0 bc	0.2 bc	17.0 b	5.7 bc	51.0 bcd	0.7 bc
Pristine 19 oz	B,PC,V,PH	7.0 c	0.3 b	8.0 bcd	2.3 cde	50.0 bcd	0.3 c
Merivon H 11 fl oz	B,PC,V,PH	4.0 de	0.1 cd	1.0 cde	2.1 cde	42.0 cd	0.1 c
Elevate 1 lb	B,PC,V,PH	5.0 cde	0.2 bc	4.0 cd	2.7 cde	40.0 cde	0.1 c

[z] Timings: TB=Trace Bloom (25 May); B=Bloom (3 Jun); PC or BT=Preclosure/Berry Touch (24 Jun); V=Veraison (14 Aug); PH=Preharvest (30 Aug).

[y] All values are ripe rot (8 Aug), Botrytis and sour rot (26, Sep) incidence and severity and the means of at least 25 fruit clusters per vine across four replicate plots.

[x] Values within columns followed by the same letter(s) are not significantly different ($P \leq 0.05$) according to Fisher's Protected LSD test.

EVALUATION OF BACTERICIDES FOR MANAGEMENT OF THE BLOSSOM AND SHOOT PHASES OF FIRE BLIGHT

Brian L. Lehman, Noemi O. Halbrendt, and Henry K. Ngugi
Penn State University, Fruit Research & Extension Center,
Biglerville, PA 17307

Fire blight is highly destructive bacterial disease of tree fruit in the Northeastern U.S. The standard method for their control is the use of the antibiotics mainly, streptomycin. With heavy reliance on antibiotics there is always the risk of bacterial resistance to the antibiotics. A field experiment was designed to test the effectiveness of alternative antibiotics and other chemicals for fire blight control, while a potted plant experiment was designed to test the effectiveness of the SAR inducer, Actigard.

The field test was carried out in a mature Rome Beauty and Golden Delicious apple orchard at the Penn State Fruit Research and Extension Center in Biglerville, PA. Trees received insecticide and fungicide applications consistent with standard commercial practice for the northeastern U.S. Treatments included three antibiotics, (Agri-Mycin, Kasumin, and two rates of an experimental antibiotic [ARY-0416-06]), a broad-spectrum protectant fungicide (Penncozeb) tank-mixed with a copper product (Kocide 3000), and a program consisting of Agri-Mycin followed by an application of the Kocide 3000 + Penncozeb mixture. Streptomycin (Agri-Mycin) was applied as the standard treatment and an untreated control (Nu-film only) was used for comparison. All treatments including the untreated control were applied with Nu-film at 4 fl oz/A. Treatment applications were applied on 26 Apr (15-20% bloom, pre-inoculation) and 28 and 29 Apr, 24-36h after inoculation for all treatments, except for the Agri-Mycin/Kocide + Penncozeb combination, where Agri-Mycin was applied at 15-20% bloom (pre-inoculation) and Kocide + Penncozeb were applied 24-36h after inoculation. Treatments were applied with a boom sprayer at 400 psi calibrated to deliver 100 gal/A. The experimental design was a factorial arrangement with treatments and cultivars as factors and there were four replicates. An average of 35 clusters were tagged on each tree and inoculated on 27 Apr with a suspension of $1x10^7$ CFUs of *Erwinia amylovora* strain Ea273. Trees were rated for fire blight incidence (percent diseased clusters) on 9 May and 20 May, and disease severity on 20 May using a severity scale of 1 to 7, where 1 = no symptoms; 2 = blossoms wilted only; 3 = 1 leaf wilted; 4 = 2 leaves wilted; 5 = 3 leaves wilted; 5 = 4 leaves; wilted; 6 = 25-50% of the shoot infected; 7 = more than 50% of the shoot infected. Data were analyzed with analysis of variance and means separated with Fisher's protected LSD test ($\alpha = 0.05$).

The temperature ranged from 69-72°F and the sky was mostly cloudy on the day of inoculation providing ideal conditions for fire blight inoculation. Weather in the two weeks post inoculation was suitable for fire blight development and several infection periods were recorded. Disease development was high with 90% of the shoots showing symptoms on the control treatment by the second rating date. Both the Agri-Mycin treatments as well as the higher rate of ARY-0416-06 significantly reduced fire blight incidence compared to the control on the first rating date, while the higher rate of Kasumin also reduced incidence by 20 May (Table 1). All treatments except the low rate of ARY-0416-06, the higher rate of Kasumin, and the Kocide /Penncozeb combination significantly reduced fire blight severity (Table 2). Additional research is warranted to test the effectiveness of experimental antibiotics compared to streptomycin, or whether products like Kocide and Penncozeb could be used effectively in rotation with an antibiotic treatment to reduce antibiotic use to control fire blight.

The potted plant test was carried out on trees grafted on M9 rootstocks grown outdoors under a shade cloth. Actigard 50WG was applied by two different treatment methods to determine their effectiveness relative to a standard antibiotic (streptomycin) application. Experimental treatments consisted of two pre-inoculation soil drenches of Actigard, two pre-inoculation bark drenches with Actigard and Pentra-Bark, a pre-inoculation and post-inoculation foliar application of Agri-Mycin 17, and an untreated inoculated control. Actigard was applied to the pots as a solution at the rate of 0.4g in 475 ml of water per pot for the soil drench, and 0.4g of Actigard and a 1% solution of Pentra-Bark in 475 ml of water per tree for the bark treatment. The Agri-Mycin foliar treatment was applied at a concentration of 100 ppm. Actigard drench and bark treatments were applied at 14 days and 7 days prior to inoculation. The Agri-Mycin 17 treatments were applied at 24 hrs prior to inoculation and 2 hrs post-inoculation. Treatments were set up as a randomized complete block design with five tree replicates and four shoots were inoculated per tree. Shoots were inoculated by wounding shoot tips on 6 Jul with a suspension of $1X10^8$ CFUs of *Erwinia amylovora* strain Ea273. Fire blight was rated three weeks after inoculation as a percent of total shoot length (visually) infected and on a severity scale of 1-7, with 1 being the least severe and 7 being the most severe. Data for percent severity estimates were analyzed with analysis of variance and means separated with Fisher's protected LSD test ($\alpha = 0.05$). Data for severity scores were analyzed with Wilcoxon Rank Sum Test ($P = 0.05$).

Conditions for disease development were favorable and disease severity on control trees was moderately high. The Agri-Mycin and Actigard soil drench treatment both significantly reduced fire blight severity compared to the control, while the bark drench did not. Numerically the soil drench was the most effective at reducing fire blight severity, reducing it by more than three times that of the control (Fig. 1). When using a rating scale of 1-7, the results are very similar to those of the percent severity (Fig. 2). The data suggests drench applications of Actigard have the potential to reduce fire blight development, although they may not reduce the incidence of infections as effectively as streptomycin would. Further research is required to confirm this observation, establish the optimal timing and rate of drench applications and to research whether this would have feasibility in field applications.

	9 May		20 May	
Treatment and rate/acre	inc. (%)	% control	inc. (%)	%control
Nufilm 17 4 fl oz (control)	66.0 a	---	90.5 a	---
Agri-Mycin 8 oz	43.4 bc	34.2	67.8 cd	25.1
Kasumin 2 qt	56.7 ab	14.1	77.6 bc	14.3
Kasumin 1 qt	54.7 ab	17.1	81.9 ab	9.5
ARY-0416-06 8%L 2qt	34.0 c	48.5	62.9 d	30.5
ARY-0416-06 8%L 1qt	53.4 ab	19.1	79.8 ab	11.8
Kocide 3000 8 oz + Penncozeb 75 WG 3 lbs	53.1 ab	19.5	82.4 ab	9.0
Agri-Mycin 17 8oz , then Kocide 3000 8 oz + Penncozeb 75 WG 3 lbs	45.5 bc	31.1	72.1bcd	20.3

Table 1. Mean fire blight incidence on 'Rome Beauty' and 'Golden Delicious' apples combined at the Penn State Fruit Research Extension Center, in Biglerville, PA in 2011. Values are means of four replicate single-tree plots with an average of 35 inoculated clusters per tree. Columns means with the same letter(s) are not significantly different according to Fisher's Protected LSD test (α=0.05).

Treatment and rate/acre	Severity
Nufilm 17 4 fl oz (control)	3.31 ab
Agri-Mycin 8 oz	2.28 e
Kasumin 2 qt	3.44 a
Kasumin 1 qt	3.00 cd
ARY-0416-06 8%L 2qt	2.72 d
ARY-0416-06 8%L 1qt	3.34 ab
Kocide 3000 8 oz + Penncozeb 75 WG 3 lbs	3.09 bc
Agri-Mycin 17 8oz , then Kocide 3000 8 oz + 75 WG 3 lbs	2.77 d

Table 2. Mean fire blight severity on 'Rome Beauty' and 'Golden Delicious' apples combined at the Penn State Fruit Research Extension Center, in Biglerville, PA in 2011. Values are means of four replicate single-tree plots with an average of 35 inoculated clusters per tree. Severity was based on a scale of 0 to 7 where 0= no symptoms; 1= blossom wilted only; 2= 1 leaf wilted; 3= 2 leaves wilted; 4= at least 4 leaves wilted; 5= 35 % of the shoot wilted; 6= 65 % of the shoot wilted; 7= 85 % or more of the shoot wilted. Means in the same column followed by same letter(s) are not significantly different according to Fisher's Protected LSD test (α = 0.05).

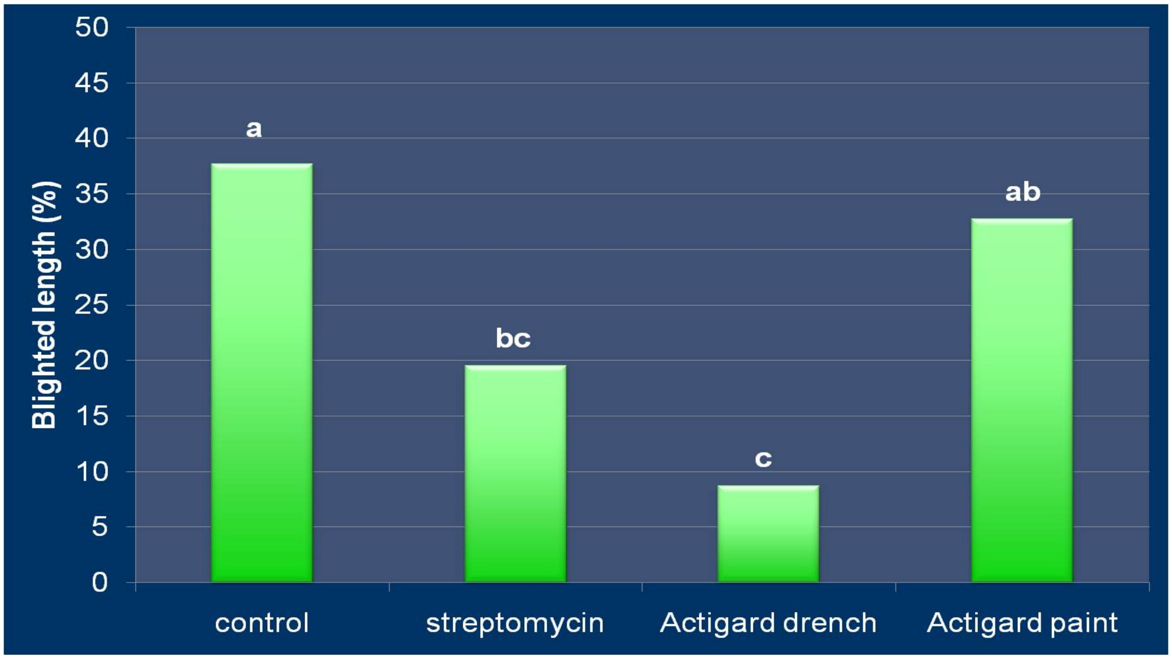

Figure 1. Mean fire blight severity on potted ‘Gala’ apples combined at the Penn State Fruit Research Extension Center, in Biglerville, PA in 2011. Values are means of four inoculated shoots with five replicates. Severity was based on the percent of the shoot that showed fire blight symptoms. Bars with the same letter(s) are not significantly different according to Fisher's Protected LSD test (α = 0.05).

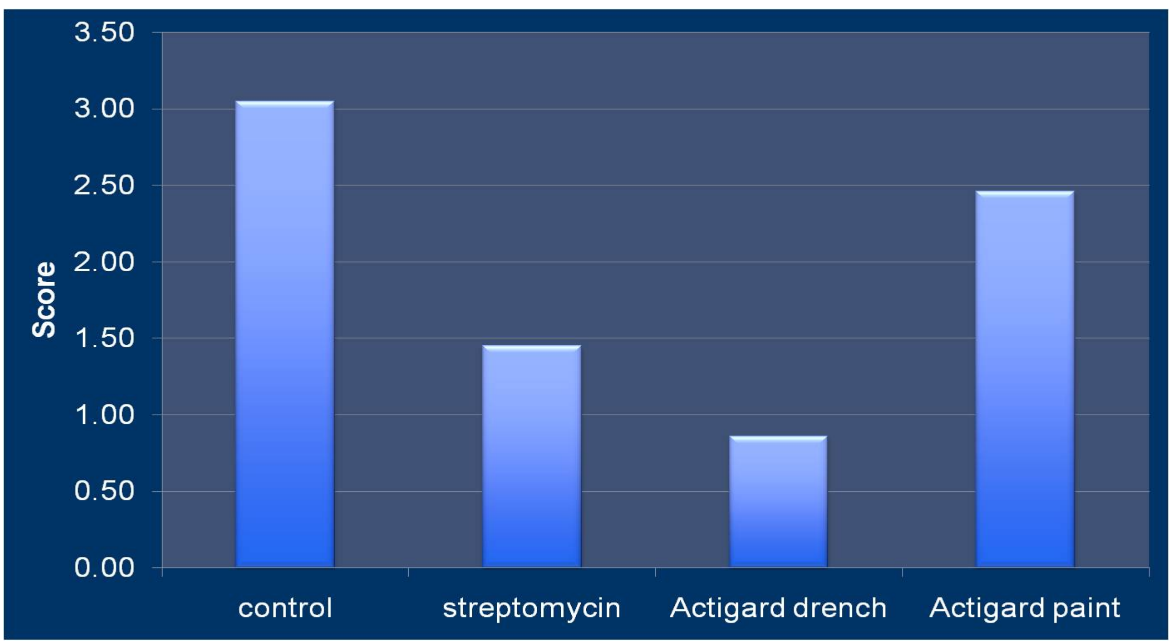

Figure 2. Mean fire blight severity score on potted ‘Gala’ apples combined at the Penn State Fruit Research Extension Center, in Biglerville, PA in 2011. Values are means of four inoculated shoots with five replicates. The rating score was based on a scale of 1-7, where 1 = no symptoms; 2= 1 leaf wilted; 3= 2 leaves wilted; 4= at least 4 leaves wilted; 5= 35 % of the shoot wilted; 6= 65 % of the shoot wilted; 7= 85 % or more of the shoot wilted.

SUPPRESSION OF FIRE BLIGHT BLOSSOM BLIGHT BY EXPERIMENTAL AND REGISTERED COMPOUNDS ON IDARED APPLES

K. S. Yoder, A. E. Cochran II, W. S. Royston, Jr. and S. W. Kilmer
Virginia Tech Agr. Res. & Ext. Center
595 Laurel Grove Road, Winchester, VA 22602

Two kasugamycin formulations and Quintec were compared to streptomycin (Firewall) for blossom blight control and fruit finish effects. The test was established in four randomized blocks on 29-yr-old trees using single-tree replications with border rows between treatment rows. All treatments were applied to both sides of the tree with a Swanson Model DA-400 airblast sprayer at 100 gallons per acre 15 Apr (pink- 25% of bloom open), 20 Apr (full bloom), 22 Apr (full bloom-petal fall of king bloom) and again 25 Apr (most petals off). LI-700 was included with all treatments. Four selected branches per tree, each with 25 to 40 blossom clusters, were inoculated by spraying to wet with a bacterial suspension containing $1X10^6$ Erwinia amylovora cells/ml in the evening of 23 Apr, the day after the third test application. Infection data were based on counts of number of blossom clusters present on the inoculated branch at the time of inoculation. A cluster was rated as infected if it had at least one blossom with fire blight symptoms on 10 May. Maintenance insecticides were applied to the entire block with a commercial airblast sprayer. Fruit finish was rated on 25 fruit per replication after harvest 23 Sep.

Every test year poses its unique challenges with regard to when to treat and when to inoculate based on predicted weather conditions. Our general test strategy was to make several applications before inoculating in the evening in anticipation of a relatively warm day. This year we inoculated after the third application, then made a fourth application without follow-up inoculation. Inoculation and weather conditions favored a strong fire blight test. In addition to the inoculation 23 Apr, eight natural infection periods (based on *MaryBlyt*) occurred 11 Apr (first bloom open), 14 Apr, 20 Apr and 24-28 Apr. The five consecutive infection days 24-28 Apr, were the most consecutive days we have had since 2004. Application weather was challenging, but the schedule was reasonable given the situation, goals for the test, and time of inoculation. The streptomycin standard (Firewall), performed as expected under these conditions, with significant suppression of cluster leaf infection by both rates. There was no significant difference between streptomycin rates. Also, there was no significant difference (p=0.05) among the Firewall or Kasumin treatments or the two kasugamycin formulations; however, numerically all of the higher test rates had slightly less infection. Quintec alone was not effective, and Quintec + Firewall 12 oz gave control comparable to Firewall 12 oz. There was no significant (P=0.05) treatment effect on fruit finish, however, the Kasumin 8L treatments both had significantly more russet than firewall 12 oz/A.

Table 24. Control of fire blight on Idared blossoms.

	All treatments applied airblast at 100 gal/acre	% clusters		%	Finish rating (0-5)**			
	Treatment and rate/A (or /100 gal in tank for LI-700)	Infected*		control	russet		opalescence	
0	No treatment	32.4	b	--	1.3	a	1.4	ab
1	Firewall 17 12 oz + LI-700 1 pt/ 100 gal	12.9	a	60	1.2	a	0.9	a
2	Firewall 17 1.5 lb + LI-700 1 pt/ 100 gal	11.0	a	66	1.7	a	1.4	ab
3	Kasumin 2L 6 qt (100 ppm) + LI-700 1 pt/ 100 gal	13.2	a	59	1.6	a	1.5	ab
4	Kasumin 2L 3 qt (50 ppm) + LI-700 1 pt/ 100 gal	16.2	a	50	1.4	a	1.4	ab
5	Kasumin 8L 3 pt (100 ppm) + LI-700 1 pt/ 100 gal	9.4	a	71	1.6	a	1.7	b
6	Kasumin 8L 1.5 pt (50 ppm) + LI-700 1 pt/ 100 gal	16.4	a	51	1.6	a	1.7	b
7	Quintec 2SC 4 fl oz + LI-700 1 pt/ 100 gal	30.5	b	6	1.3	a	1.0	a
8	Quintec 2SC 4 fl oz + FireWall 12 oz + LI-700 1 pt/ 100 gal	11.4	a	65	1.2	a	1.1	a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four single-tree reps with border rows between treatment rows and in-row border trees.

* Infection data based on counts of number of clusters at inoculation and number of clusters with any infection on inoculated branches 10 May.

** Fruit finish rated on a scale of 0-5 (0=perfect finish; 5=severe russet or opalescence).

EVALUATION OF EXPERIMENTAL FUNGICIDES FOR DISEASE CONTROL ON LORING PEACH AND REDGOLD NECTARINE

K. S. Yoder, A. E. Cochran II, W. S. Royston, Jr., S. W. Kilmer and G. Engleman
Virginia Tech Agr. Res. & Ext. Center
595 Laurel Grove Road, Winchester, VA 22602

Several experimental fungicides were compared to registered programs for broad-spectrum disease control on 19-yr-old trees. The test trees were not treated with fungicides in 2010 to allow the buildup of scab inoculum. Dilute treatments were applied to the point of run-off (approximately 200 gal/A) with a single nozzle handgun at 350 psi in a randomized block design with four replications as follows: 22 Mar (BS, swollen bud-pink showing); 6 Apr (P, pink); 14 Apr (bloom); 20 Apr (PF, petal fall); 2 May (SS, shuck split); 1st through 5th covers (1C-5C): 16 May, 1 Jun, 15 Jun, 1 Jul, 15 Jul; 29 Jul (1st pre-harvest, 1PH); 10 Aug (2nd pre-harvest, 2PH). Commercial insecticides were applied to the entire test block with a commercial airblast sprayer. Leaf curl incidence was rated on 15 shoots per tree 11 May. Scab and rusty spot were assessed on 40 fruit on each tree 11 Aug. Samples of 40 apparently rot-free fruit per replicate tree were harvested from both Loring and Redgold 12 Aug. Fruit were selected for uniform ripeness, grouped into 20-fruit subsamples, and placed on fiber trays. One set was misted with de-ionized water, and the other subsample was inoculated with a suspension containing 20,000 M. fructicola conidia/ml. All fruit were incubated in polyethylene bags at ambient temperatures before rating rot development at the indicated intervals. All fruit were incubated in polyethylene bags at ambient temperatures before rating rot development at the indicated intervals. Mean high-low daily temperatures during incubation were 82.9 and 76.4°F (mean 79.7° F).

Bravo and Ziram, applied at bud swell, gave excellent control of leaf curl, but other treatments, not applied until pink, also gave significant suppression. Scab inoculum was high on the test trees and weather in the early cover spray period was favorable for scab development. Under these strong test conditions with 79% of untreated Loring and 94% of Redgold fruit infected with scab, most treatments gave good to excellent control. Pristine, Luna Sensation, and Merivon gave significantly better control of scab and rusty spot than Sulfur. The relatively dry pre-harvest period reduced brown rot pressure on non-inoculated fruit and all treatments gave almost complete control. Inoculation increased brown rot pressure on both treated and non-treated fruit, with excellent control by Merivon, comparable to the Indar standard. Fontelis was the weakest treatment but gave significant residual control on inoculated fruits.

Table 25. Control of scab, and rusty spot on Loring peach and Redgold nectarine.

			Leaf curl, %				Scab, % fruit inf. or lesions/fruit								Rusty	
	Treatment		shoots infected				Loring				Redgold				spot, %	
	and rate/100 gal dilute	Timing	Loring		Redgold		fruit		lesions		fruit		lesions		Loring	
0	No fungicide	---	61	c	38	c	79	b	9.59	b	94	c	15.3	b	29	d
1	Bravo Weather Stik 6F 1 pt Microfine Sulfur 90W 3 lb Indar 2F 3 fl oz+ B-1956 8 fl oz	BS-SS 1C-5C 1&2 PH	4	a	3	a	8	a	0.41	a	21	b	1.50	a	13	c
2	Ziram 76DF 20 oz Pristine 38WG 6oz Microfine Sulfur 90W 3 lb Pristine 38WG 6oz	BS P-2C 3C-5C 1&2 PH	4	a	4	a	2	a	0.02	a	6	a	0.13	a	5	ab
3	Fontelis SC10 fl oz Microfine Sulfur 90W 3 lb FontelisSC10 fl oz	P-2C 3C-5C 1&2 PH	22	b	24	bc	3	a	0.13	a	13	ab	0.33	a	6	b
4	Luna Sensation 2 fl oz Microfine Sulfur 90W 3 lb Luna Sensation 2 fl oz	P-2C 3C-5C 1&2 PH	11	ab	15	b	1	a	0.02	a	4	a	0.13	a	3	a
5	Merivon 500SC 3.25 oz Microfine Sulfur 90W 3 lb Merivon 500SC 3.25 oz	P-2C 3C-5C 1&2 PH	25	b	22	bc	4	a	0.10	a	4	a	0.13	a	3	ab

Four single tree reps. Column mean separation by Waller-Duncan K-ratio t-test (p=0.05).

Note: Data are aligned with the treatment timing most likely to have affected indicated disease.

Table 26. Treatment effects on postharvest brown rot development on Loring peach, 2011

			% fruit with brown rot after days incubation															
			Non-inoculated fruit								Inoculated fruit							
	Treatment and rate/100 gal dilute	Timing	5 day		6 day		7day		8 day		5 day		6 day		7day		8 day	
0	No fungicide	---	15	b	26	b	38	b	64	b	50	c	68	c	93	d	97	c
1	Bravo Weather Stik 6F 1 pt Microfine Sulfur 90W 3 lb Indar 2F 3 fl oz+ B-1956 8 fl oz	BS-SS 1C-5C 1 & 2 PH	0	a	1	a	1	a	1	a	0	a	1	a	9	ab	8	a
2	Ziram 76DF 20 oz Pristine 38WG 6oz Microfine Sulfur 90W 3 lb Pristine 38WG 6oz	BS P-2C 3C-5C 1 & 2 PH	0	a	0	a	3	a	3	a	4	b	6	ab	9	b	9	a
3	Fontelis SC10 fl oz Microfine Sulfur 90W 3 lb FontelisSC10 fl oz	P-2C 3C-5C 1 & 2 PH	0	a	0	a	1	a	1	a	5	b	14	b	24	c	25	b
4	Luna Sensation 2 fl oz Microfine Sulfur 90W 3 lb Luna Sensation 2 fl oz	P-2C 3C-5C 1 & 2 PH	0	a	0	a	0	a	0	a	0	a	5	a	9	b	13	a
5	Merivon 500SC 3.25 oz Microfine Sulfur 90W 3 lb Merivon 500SC 3.25 oz	P-2C 3C-5C 1 & 2 PH	0	a	0	a	0	a	0	a	0	a	1	a	3	a	6	a

Four single tree reps. Column mean separation by Waller-Duncan K-ratio t-test (p=0.05).

Treatment dates: 22 Mar (BS, swollen bud-pink showing); 6 Apr (P, pink); 14 Apr (bloom); 20 Apr (PF, petal fall); 2 May (SS, shuck split); 1st through 5th covers (1C-5C): 16 May, 1 Jun, 15 Jun, 1 Jul, 15 Jul; 29 Jul (1st pre-harvest, 1PH); 10 Aug (2nd pre-harvest, 2PH). Actual harvest date 12 Aug, 2 days after the last application.

Table 27. Treatment effects on postharvest brown rot development on Redgold Nectarine.

			% fruit with brown rot after days incubation															
			Non-inoculated fruit								Inoculated fruit							
	Treatment and rate/100 gal dilute	Timing	5 day		6 day		7day		8 day		5 day		6 day		7day		8 day	
0	No fungicide	---	16	b	29	b	38	b	53	b	38	c	51	c	66	c	95	c
1	Bravo Weather Stik 6F 1 pt Microfine Sulfur 90W 3 lb Indar 2F 3 fl oz+ B-1956 8 fl oz	BS-SS 1C-5C 1 & 2 PH	0	a	0	a	0	a	0	a	1	a	1	a	3	a	4	a
2	Ziram 76DF 20 oz Pristine 38WG 6oz Microfine Sulfur 90W 3 lb Pristine 38WG 6oz	BS P-2C 3C-5C 1 & 2 PH	0	a	0	a	0	a	0	a	3	ab	5	ab	11	b	14	b
3	Fontelis SC10 fl oz Microfine Sulfur 90W 3 lb FontelisSC10 fl oz	P-2C 3C-5C 1 & 2 PH	0	a	0	a	0	a	0	a	6	b	13	b	13	b	16	b
4	Luna Sensation 2 fl oz Microfine Sulfur 90W 3 lb Luna Sensation 2 fl oz	P-2C 3C-5C 1 & 2 PH	0	a	0	a	0	a	0	a	0	a	1	a	3	a	9	ab
5	Merivon 500SC 3.25 oz Microfine Sulfur 90W 3 lb Merivon 500SC 3.25 oz	P-2C 3C-5C 1 & 2 PH	**0**	a	0	a	0	a	0	a	0	a	1	a	3	a	5	a

Four single tree reps. Column mean separation by Waller-Duncan K-ratio t-test (p=0.05).

Treatment dates: 22 Mar (BS, swollen bud-pink showing); 6 Apr (P, pink); 14 Apr (bloom); 20 Apr (PF, petal fall); 2 May (SS, shuck split); 1st through 5th covers (1C-5C): 16 May, 1 Jun, 15 Jun, 1 Jul, 15 Jul; 29 Jul (1st pre-harvest, 1PH); 10 Aug (2nd pre-harvest, 2PH). Actual harvest date was 12 Aug, 2 days after the last application.

CONTROL OF SCAB AND BROWN ROT BY TETRACONAZOLE AND FEBUCONAZOLE ON REDHAVEN PEACH

K. S. Yoder, A. E. Cochran II, W. S. Royston, Jr., S. W. Kilmer and G. Engleman
Virginia Tech Agr. Res. & Ext. Center
595 Laurel Grove Road, Winchester, VA 22602

Tetraconazole (Mettle125ME) was compared to fenbuconazole (Indar 2F) for broad-spectrum disease control on 19-yr-old trees. The test trees were not treated with fungicides in 2010 which allowed the buildup of scab inoculum. Dilute treatments were applied to the point of run-off (approximately 200 gal/A) with a single nozzle handgun at 350 psi in a randomized block design with four replications. Treatments were applied as follows: 2 May (SS, shuck split); 1st through 5th covers (1C-5C: 16 May, 1 Jun, 15 Jun, 1 Jul, 15 Jul (11day pre-harvest). Commercial insecticides were applied to the entire test block at 2-wk intervals with a commercial airblast sprayer. Samples of 40 apparently rot-free fruit per replicate tree were harvested 26 Jul and rated for scab. Fruit were selected for uniform ripeness, grouped into 20-fruit subsamples, and placed on fiber trays. One set was misted with de-ionized water, and the other subsample was inoculated with a suspension containing 20,000 M. fructicola conidia/ml. All fruit were incubated in polyethylene bags at ambient temperatures before rating rot development at the indicated intervals. Mean high-low daily incubation temperatures were: 81-90°F (mean 85.5° F).

Scab inoculum level was abundant on the test trees, and weather conditions in the early cover spray period were favorable for scab development and weathering of the test treatments. Under these strong test conditions with 51% of non-treated fruit infected, all treatments gave significant suppression of scab. Due to relatively dry summer conditions, only occasional fruit with brown rot were observed on non-treated trees. Post-harvest inoculation by misting fruit with a conidial suspension increased fruit rot incidence. The lower Mettle rate was significantly weaker than Indar after 3 days' incubation, but there was no significant difference among treatments on non-inoculated fruit through 8 days' incubation. All treatments gave significant control of Rhizopus which developed without inoculation.

Table 28. Control of scab and post-harvest fruit rots on Redhaven peach.

			Scab		% fruit with brown rot after indicated days incubation														% fruit	
	Treatment and		% fruit,		Inoculated fruit						Non-inoculated fruit								Rhizopus	
	rate/100 gal	Timing	harvest		3 days		5 days		6 days		3 days		5 days		6 days		8 days		8 days	
0	No fungicide	---	51	b	55	c	100	b	100	b	0	a	13	b	19	b	75	b	9	b
1	Indar 2F 3 fl oz	SS-PH	2	a	0	a	25	a	35	a	0	a	0	a	3	a	8	a	0	a
2	Mettle 125ME 3 fl oz	SS-PH	8	a	18	b	33	a	49	a	0	a	0	a	4	a	10	a	3	a
3	Mettle 125ME 4 fl oz	SS-PH	5	a	11	ab	39	a	54	a	0	a	0	a	1	a	4	a	0	a

Four single tree reps. Column mean separation by Waller-Duncan K-ratio t-test (p=0.05).

Treatments applied dilute to runoff at 350 psi as follows: 2 May (SS, shuck split); 1st through 5th covers (1C-5C); 16 May, 1 Jun, 15 Jun, 1 Jul, 15 Jul (11 days pre-harvest). Harvest date: 26 Jul.

ENTOMOLOGY

FIRST DETECTION AND PHENOLOGY OF SPOTTED WING DROSOPHILA IN PA

D. Biddinger, K. Demchak, A. Surcica, N. Joshi, E. Rajotte and [1]B. Butler
Penn State University
[1]University of Maryland Extension

Another new invasive Asian pest, the Spotted Wing Drosophila (SWD – *Drosophila suzukii*) has moved into the mid-Atlantic region. First found in California in 2008, it spread throughout most of the west coast in only a year and was found in Florida and Michigan in 2010. In 2011 it spread throughout most of the east coast and was first found in Pennsylvania in July of this year. It has since been detected in 13 counties throughout the state using apple cider vinegar traps and caused the loss of over 50% in a late season raspberry crop near Biglerville. Unlike other flies of this type in our area which attack only soft, over-ripe fruit, SWD will also attack fruits before they have ripened. Preferring small fruits such as berries, it will also attack most stone fruits, with a preference for cherries. Similar to the brown marmorated stink bug problem experienced over the last two seasons, this pest has a very wide range of suitable hosts outside of orchards on which large resident populations can develop and serve as a continual source for re-infestation. With a short generation time and up to 13 generations in some Asian regions, this pest has the potential to build to high numbers very quickly. Identification keys have been developed to distinguish this pumice fly from the many other species of similar flies found in our region which also come to the vinegar traps. A search for native biological control agents was discussed including a pteromalid found on the west coast (*Pachycrepoides vindemmiae*), but also known from our region and a species of Proctotrupidae of the genus *Cryptoserphus sp*. found commonly in the traps with SWD.

Vinegar traps without yellow sticky card were very effective in trapping this new pest with almost 1,000 males trapped in a single week in the heavily infested raspberry block. Trapping several different crops on several farms over a 2 square mile area near Biglerville, indicated movement of SWD males from crop to crop throughout the season as crops ripened. First captures of males were in tart cherries two weeks after harvest, but built quickly only after mid-August. SWD persisted in most crops after the fruit had ripened, and continued to feed on dropped fruit until the first frost at the end of October.

Support for this research was provided by a Northeast IPM Center Urgent IPM Grant.

SPOTTED WING DROSOPHILA: A NEW INVASIVE FRUIT PEST MOVES NORTH THROUGH VIRGINIA

D. Pfeiffer, L. M. Maxey, C. A. Laub, E. R. Day, J. C. Bergh, J. Engleman and H. J. Burrack
Department of Entomology, Virginia Tech, Blacksburg, VA 24061
Department of Entomology, North Carolina State University, Raleigh NC 27606

Spotted wing drosophila (SWD), *Drosophila suzukii* (Matsumura), is a fruit pest that has morphological and behavioral traits that set it apart from most other *Drosophila* spp. in terms of being a fruit pest. While most *Drosophila* are very familiar as breeding in overripe or rotting vegetative material, SWD females possesses a large, serrated ovipositor that allow it to deposit eggs in ripening, healthy fruit still on the plant. The common name is derived from a large spot near the apex of the wing in the male (lacking in the female). A modern taxonomic treatment (Markow and O'Grady 2006) makes *D. suzukii* a complex, the *suzukii* subgroup, within the *melanogaster* species group, with the following description of ranges: "*Drosophila mimetica* … is known from Malaysia, *D. lucipennis* … is disjunctly distributed in eastern India and Taiwan, *D. biarmipes* … is known from India and Sri Lanka to southeast Asia, and *D. pulchrella* … is found from India, China, and southeast Asia to Japan."

Spotted wing drosophila has been reported earlier from Hawaii, but was reported from the mainland US in California in 2008 (Walsh et al. 2011). SWD was found in California infesting strawberries and caneberries (Bolda et al. 2009, Lehnert 2010, Walsh et al. 2011). In 2009 it spread up the Pacific Coast to infest fruit in Oregon, Washington, and the Fraser Valley of British Columbia. The spotted wing drosophila is now found in all western counties of Washington State, and in eight eastern counties. In 2009, it was found in Florida (Anon. 2009, Acheampong 2010).

An excellent review of the introduction and biology of SWD in the western states was present by Walsh et al. (2011). Hosts include apples, blackberries, blueberries, cherries, nectarines, peaches, pears, plums, grapes, raspberries, and strawberries (Bolda et al. 2009, Acheampong 2010). Crop losses in blueberries, caneberries and cherries have been reported ranging from 33-100% (Lehnert 2010). Injury was reported to be severe on grape (Anon. 2009), and grapes were thought to be a preferred late season host (Walsh et al. 2010). According to early data from Japan reported by Walsh et al. (2011) SWD takes somewhat longer to develop to the adult state in grape compared with cherry; however its final adult size was somewhat larger in grape. The potential role of SWD as a grape pest was discussed by Pfeiffer et al. (in press)

After its discovery in Florida, and since it spread so quickly up the west coast, a trapping program was established in South Carolina, North Carolina and Virginia. Traps consisted of clear plastic deli cups with small holes near the top edge, filled with a few cm of apple cider vinegar. While traps originally supplemented by yeast, the yeast was later discontinued because the resulting blend was odorous, opaque, and did not result in greater catches of SWD. In 2010, SWD was found in Louisiana, South Carolina and North Carolina; no flies were found in Virginia. It was also found in Michigan in that year (Milkovich 2010, Isaacs 2011).

Trapping was continued in 2011. Virginia sites included Kentland Farm, the research farm of the College of Agriculture and Life Sciences (Montgomery County) at an experimental caneberry planting, the Alson H. Smith Agric. Research and Extension Center at Winchester, the Hampton Roads Agric. Research and Extension Center at Virginia Beach, a commercial caneberry planting in Hanover County, and a county landfill in Sussex County.

The first SWD in Virginia were detected in the apple cider vinegar traps at the Hanover County site, near commercial caneberries, on 27 June 2011. The next detection was made at the Sussex County site on 27 July 2011. On 3 August 2011, SWD were found in traps at the Winchester site, and at the Kentland Farm site on 5 August 2011. The Virginia Beach traps yielded SWD in September. The Virginia collection sites are shown in Fig. 1.

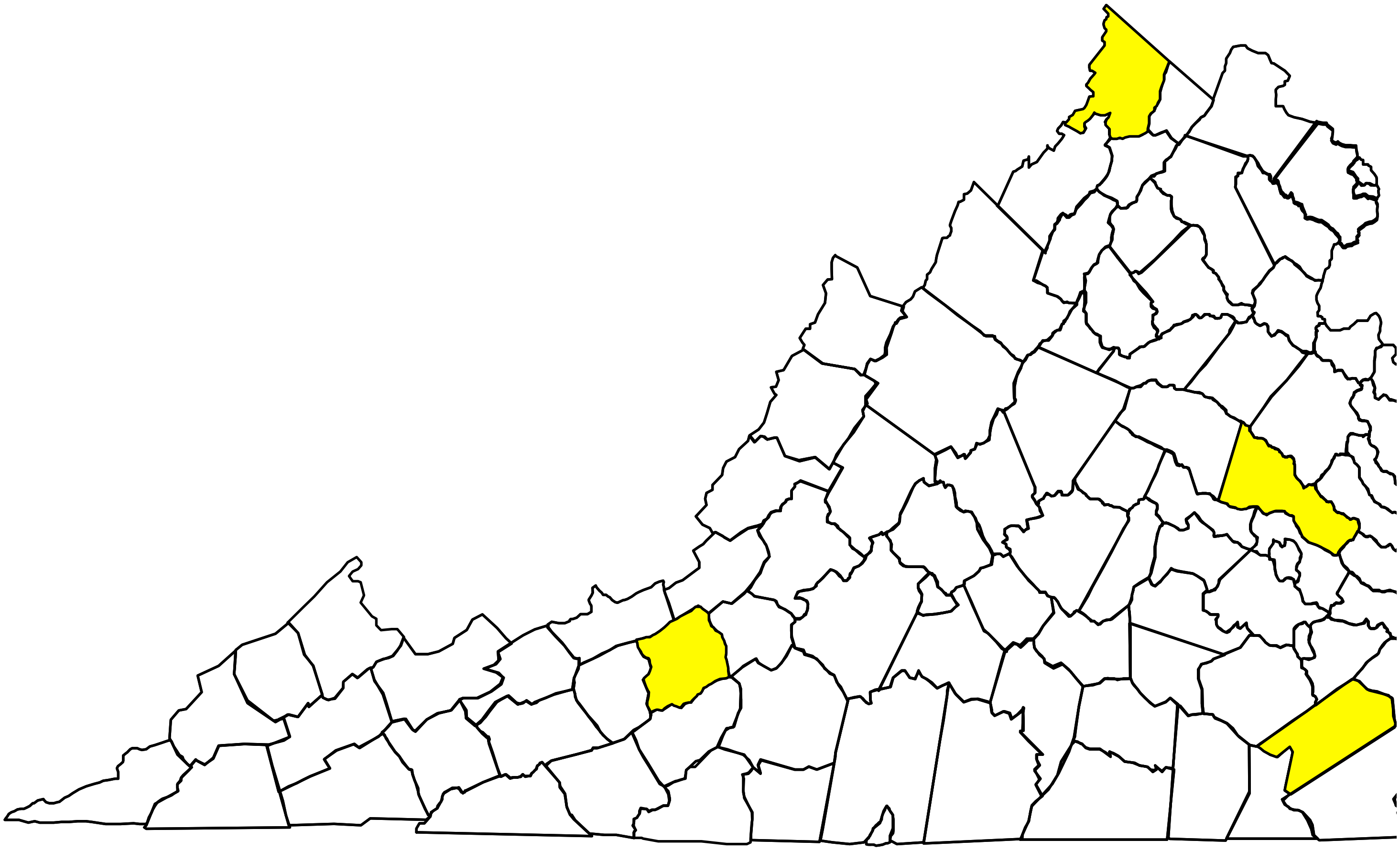

Figure 1. Trapping locations for spotted wing drosophila in Virginia. All sites yielded flies in apple cider vinegar traps.

Subsequently in 2011, SWD continued its spread northward through Pennsylvania and New England (NAPIS 2011).

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ECONOMIC COMPARISON OF ICM AND STANDARD INSECT SPRAY PROGRAMS FOR NEW JERSEY BLUEBERRIES, 2009 AND 2010

J. K. Harper[1], C. Rodriguez-Saona[2], D. Polk[3], F. Zaman[2] and P. Oudemans[2]
[1]Dept. of Agricultural Economics and Rural Sociology, Pennsylvania State Univ., University Park, PA
[2]P.E. Marucci Blueberry and Cranberry Research and Extension Center, Rutgers Univ., Chatsworth, NJ
[3]Rutgers Fruit and Ornamental Research Extension Center, Rutgers Univ., Cream Ridge, NJ

Blueberries are produced in ecologically sensitive areas on porous soils with high water tables. However, blueberry marketing standards have a zero tolerance for many pests, so significant insecticide use is common. While growers have embraced integrated pest management concepts, actual practices often result in overuse of insecticides based on limited information of actual needs. Development, delivery, and adoption of sustainable spatially based whole-farm Integrated Crop Management (ICM) programs for high bush blueberries have the potential to significantly reducing insecticide use, improve pesticide recommendations, reduce management costs, and increase adoption of reduced-risk practices.

Adoption of new management protocols are facilitated when growers better understand the economic consequences of such decisions. In this study, the overall impact of a change from standard pest management programs (STD) to ICM employing reduced-risk tactics was evaluated using a technique called partial budgeting. Partial budgeting is a farm management technique used to examine the profitability of incremental changes in production technologies, the size or scale of operation, or the product mix. A partial budget contains only those income and cost items that change if the proposed change is undertaken. Only the changes in income and expenses are used for a partial budget analysis, not the total values. The final result is an estimate of the increase or decrease in income attributable to the change. Decreased revenues and increased costs are subtracted from increased revenues and decreased costs to identify the net effect of the change. The changes in profitability calculated using partial budgeting will allow blueberry growers to better gauge the impact of adoption of ICM practices on the cash-flow and profitability of their own operations.

The objective of the economic analysis is to compare the cost of standard spray programs (STD) with those using more intensive scouting practices (ICM). To do this, the cost of spray materials, application costs, insect traps, and scouting time were estimated for each program. Spray records were evaluated for four growers who evaluated both ICM and STD insect management programs in 2009 and 2010. The STD data was obtained from 56 fields containing 256 acres. The ICM data was obtained from 141 fields containing 423 acres. The data includes both insecticide and fungicide data and application method.

A comparison of the cost of insect traps and scouting for the ICM and STD management programs can be found in Table 1. Because of marketing standards and export regulations, both the ICM and STD programs have insect traps and scouting costs. The trap and scouting cost for the ICM management program were \$3-\$14/A higher per grower than for the STD program or \$9.77/A higher on average. Although the ICM approach requires more traps and time, this represents a fairly minor increase in cost that could easily be recouped if the number of insecticide sprays can be reduced.

Data on the average number of insecticide sprays for the ICM and STD management programs can be found in Table 2. As expected, the number of insecticide sprays increases for the later season cultivars. However, for three of the four growers in each year the number of sprays were less under

ICM than under the STD program (grower A had more applications in 2009 and grower D had more applications in 2010). Over the course of the two years, the growers who reduced sprays cut out an average of between 0.7 and 6.6 sprays. Grower A had 1.1 more sprays on average for ICM in 2009 and grower D had 0.4 more sprays on average in 2010. Given that typical application cost are $7-$10/A for boom sprayers, $12-$16 for airblast sprayers, and $20-$25 for aerial application, the additional cost of scouting under the ICM protocol can be justified in most cases on the basis of reduced application costs alone.

A comparison of the cost of insecticide materials for the ICM and STD management programs can be found in Table 3. In the case of most growers (except for grower A in 2009) there were significant cost savings from using the ICM protocol compared to the STD program. The grower's cost saving from reduced insecticide use varied from an average of $17 to $122/A during the two years. Grower D had lower average cost of insecticides using ICM (by $54/A), even with a higher average number of applications in 2010. It is apparent that despite higher scouting costs, the ICM program in general results in less applications and lower insecticide costs.

The next step in this study will be to add the final year of data to the analysis. The last year of the grant evaluating ICM practices in high bush blueberries was 2011. The final year of data is expected to further strengthen the basic conclusions that the ICM protocol is superior to the STD practices currently used by most growers. As part of this, a range of application cost information will be included in the comparisons for use in extension publications. In addition, cost data for four growers who evaluated ICM practices without paired STD comparisons will be further evaluated. Data on fungicide costs for the ICM and STD programs was also evaluated for 2009 and 2010, but it was not clear that there was any difference in the number of applications or fungicide cost for the two protocols.

Table 1. Insect trap and scouting costs for integrated crop management (ICM) versus standard scouting practices (STD), by grower.

	---------- STD (cost/A) ----------			---------- ICM (cost/A) ----------		
	Traps	Scouting	Total	Traps	Scouting	Total
Grower A	$5.84	$9.66	$15.50	$6.65	$12.03	$18.68
Grower B	$3.95	$6.95	$10.91	$7.04	$13.12	$20.16
Grower C	$1.32	$2.19	$3.52	$6.99	$10.61	$17.60
Grower D	$1.30	$2.14	$3.44	$5.02	$7.96	$12.98

Table 2. Number of insecticide applications for integrated crop management (ICM) versus standard scouting practices (STD), by grower and cultivar maturity.

		2009		2010	
	Cultivar	ICM	STD	ICM	STD
Cooperator	Maturity	----- Number of insecticide applications -----			
Grower A	early	3.5	2.5	3.4	3.6
	mid-season	4.5	4.0	3.5	5.0
	late	--	--	--	--
	combined	4.1	3.0	3.4	4.1
Grower B	early	3.1	3.8	1.1	4.9
	mid-season	3.0	6.6	1.5	5.0
	late	4.7	--	1.0	--
	combined	3.3	4.5	1.2	4.9
Grower C	early	1.3	--	3.0	--
	mid-season	2.0	8.0	3.0	8.8
	late	2.0	--	3.5	--
	combined	1.4	8.0	3.1	8.8
Grower D	early	4.7	6.6	5.8	6.1
	mid-season	5.7	8.6	8.5	6.7
	late	6.6	9.9	8.5	7.7
	combined	5.3	8.3	7.1	6.7

Table 3. Cost of insecticides for integrated crop management (ICM) versus standard scouting practices (STD), by grower and cultivar maturity.

		2009		2010	
	Cultivar	ICM	STD	ICM	STD
Cooperator	Maturity	---------- Cost of insecticides ----------			
Grower A	early	$58.17	$45.83	$44.60	$44.02
	mid-season	$65.91	$48.02	$37.44	$83.54
	late	--	--	--	--
	combined	$62.58	$46.55	$40.93	$57.00
Grower B	early	$27.63	$56.65	$10.68	$132.90
	mid-season	$32.46	$100.39	$12.94	$134.27
	late	$67.44	--	$8.61	--
	combined	$34.01	$66.98	$11.10	$133.22
Grower C	early	$15.52	--	$32.70	--
	mid-season	$24.84	$129.48	$32.27	$126.09
	late	$24.84	--	$38.80	--
	combined	$16.42	$129.48	$33.24	$126.09
Grower D	early	$74.25	$87.77	$127.23	$168.28
	mid-season	$72.63	$107.56	$155.68	$201.45
	late	$82.05	$157.74	$154.34	$211.26
	combined	$74.16	$110.61	$141.02	$195.62

FEEDING PREFERENCES OF *Halyomorpha halys* FOR APPLE ACCORDING TO CULTIVAR, MATURITY AND CROPLOAD

Nicolas H. Ellis[1], Grzegorz Krawczyk[1]*, James R. Schupp[2], H. Edwin Winzeler[2] and Thomas Kon[2]

[1] Fruit Research and Extension Center, Entomology, The Pennsylvania State University, 290 University Drive, Biglerville, 17307 PA, USA and [2] Fruit Research and Extension Center, Horticulture, The Pennsylvania State University, 290 University Drive, Biglerville, 17307 PA, USA

*Correspondence: Grzegorz Krawczyk, Department of Entomology, Fruit Research and Extension Center, The Pennsylvania State University, PO Box 330, Biglerville, 17307 PA, USA. E-mail: gxk13@psu.edu

Introduction

The objective of these studies was to determine what, if any significance the following factors had on *H. halys* feeding preference on apples:

1. Cropload
2. Maturity
3. Cultivar
    a. Maturing at different times
    b. Mature at the same time

General Methods

All trials were conducted in a greenhouse at the Penn State Fruit Research and Extension Center (PSU-FREC), Biglerville, PA. The greenhouse was maintained at ca. 21.4(±5.7)°C and 62.1(±17.0) RH with a L16:D8 photoperiod. All fruit were picked from trees in research orchards managed under conventional pesticide programs by the PSU-FREC Department of Horticulture. Fruit were washed with cold running water and air-dried prior to exposure to test insects. For all trials, three sample units of each treatment level were exposed to 10 *H. halys* in each of 10 BugDorm (MegaView Science Co., Ltd., Taichung, Taiwan) observation tents. Test insects were from PSU-FREC colonies collected in the field. To investigate any preferences according to life stage, in the cropload study and two of the three time-dependent cultivar trials, a ratio of 7:3 male adult:unsexed 4th instars was incorporated into the BugDorm replicate assignments. After 72 hours the insects were removed and the fruit stored at ca 4°C for 14 days. After 14 days the fruit were measured for diameter and peel color properties with a spectrophotometer. Color spectral data were represented in analyses as CIE L*a*b* color space variables or pigment peel indices (Winzeler and Schupp 2011). After a further 14 days at ca. 21°, the fruit were peeled and examined for subcutaneous injury. In all trials a subsample of experimental fruit was measured for soluble solids and starch content. Statistical analyses consisted of Poisson regression corrected with the Pearson scaling factor for injury counts (SAS PROC GENMOD) incorporating cultivar, size and color as independent variables; and Brown-Mood median tests of fruit physiological variables (SAS PROC NPAR1WAY). Methods specific to particular trials are described with the trial results.

Specific Methods and Results

Preference according to cropload. 'Buckeye Gala' trees were thinned mechanically at bloom, resulting in treatment groupings of 1.5, 5.8 or 11.7 fruit/ cm^2 trunk cross-sectional area (TCSA), designated "Low", "Mid", and "High", respectively. *H. halys* did not exhibit a preference for 'Gala' fruit according to crop density (χ^2 = 0.98, d.f. = 2, P = 0.61) or fruit-size (χ^2 = 0.79, d.f. = 1, P = 0.37).

Preference according to maturity. Single-tree-plots of 'Golden Delicious'/Bud.9 and 'Red Yorking'/Bud. 9 trees were randomly assigned into three different levels of apple fruit maturity, created by making the following foliar applications: aminoethoxyvinylglycine (ReTain ® 50 mg · L^{-1}, Valent BioSciences, Inc., Libertyville, IL, USA + Silwet L-77 0.1% vol/vol) 28 days prior to anticipated harvest; Ethephon 2SL, MakhteshimAgan of North America, Inc., Raleigh, NC, 300 mg · L^{-1} + Silwet L-77 0.1% vol/vol 7 days prior to anticipated harvest; along with an untreated control. On the anticipated commercial harvest date for each cultivar, the fruit from the ReTain treatment were picked as "immature"; those from the ethephon treatment picked as "overmature"; and the untreated fruit as "mature". The maturity treatments did not significantly affect *H. halys* feeding on either 'Golden Delicious' (χ^2 = 1.67, d.f. = 2, P = 0.43) or 'York' fruit (χ^2 = 1.1, d.f. = 2, P = 0.58).

Time-dependent cultivar preference. The following seven cultivars were selected for sampling in this study: 'Buckeye Gala'; 'Honeycrisp'; 'Golden Delicious'; 'Cameo'; 'York'; 'Fuji'; and 'Pink Lady'. On each sampling date (19 Aug, 3 Sept, 15 Sept, 6 Oct and 13 Oct), thirty fruit were picked at random from fifteen trees designated for repeated sampling. Significant cultivar effects were observed in all trials. On the first trial date of 19 Aug, the 'Gala' and 'Honeycrisp' apples, which were the most mature, were the least likely to be injured while 'Cameo' was most injured by *H. halys* (χ^2 = 14.5, d.f. = 6, P = 0.026) [Fig. 1]. In the second trial of 3 Sept, 'Honeycrisp' was the least likely to be injured while 'Golden Delicious' and 'Pink Lady' were most likely to be injured (χ^2 = 20, d.f. = 5, P = 0.0013). 'Pink Lady' fruit were injured most on both 15 Sept and 13 Oct (χ^2 = 9.9, d.f. = 4, P = 0.042). In the fourth trial of 6 Oct, 'Golden Delicious' fruit were least likely to be injured while no single cultivar showed a tendency to be "more" injured than the others (χ^2 = 9.7, d.f. = 4, P = 0.046). Fruit size was not a significant factor in occurrence of injury and only in the last trial (13 Oct) did color have a significant effect. Starch ratings of the tested varieties were significantly different across cultivars on all dates (Fig. 2).

Preference according to cultivar. The following seven cultivars were selected for sampling in this study: 'Buckeye Gala'; 'Honeycrisp'; 'Golden Delicious'; 'Cameo'; 'York'; 'Fuji'; and 'Pink Lady'. Thirty fruits were picked non-selectively at the appropriate commercial harvest date for each variety. To ensure standardized maturity among cultivars, immediately following harvest, the fruit were treated with SmartFresh 1-methylcycolpropene (1-MCP) for 24 h. Fruit from 'Pink Lady' trees were not treated with 1-MCP but incorporated into the study without delay along with the treated fruit. 'Pink Lady' was most often injured in the fully mature cultivar trial. 'Gala' and 'Cameo' were next likely to be injured. A significant cultivar effect was observed in this trial (χ^2 = 13.4, d.f. = 6, P = 0.04), and both anthocyanin and CIE L*a*b* color variables were also significant.

Discussion

While the *H. halys* did not show preferences dependent on experimental cropload and maturity treatments, they did feed on immature fruit than on mature fruit significantly more often. In both cultivar studies, 'Pink Lady' was both consistently the lowest in terms of its starch-disappearance ratings, and among the cultivars most often injured. And at the time of the season when the 'Cameo' fruit were highest in starch content (19 Aug), they were the also most injured of the seven cultivars in the time-dependent trials. 'Gala', 'Honeycrisp' and 'Golden Delicious' were not preferred at their optimal times of maturity for harvest (Fig. 1). In the final all-mature cultivar study, 'Pink Lady' was the most preferred on the basis of total injury. In this study, the 'Pink Lady' apples were the second-lowest in starch ratings, following the mature 'York' apples (Table 1). Despite the 'Pink Lady' not being the lowest in starch, our observation that they were the most injured in that trial was consistent with the observations in the time-dependent trials. In both the final time-dependent trial of 13 Oct and the all-mature trial, CIE L*a*b* color variables were found to be significant. Early in the season cultivars such as 'Cameo', 'Fuji', 'Golden Delicious' and 'Honeycrisp' exhibited negative a* (i.e., green color in green-red color space) and positive b* values (i.e., yellow color in blue-yellow color space), corresponding with the greenish-yellow color associated with immature fruit. The L* variable is defined by a continuous range of values between 0 and 100, with 0 being black and 100 being white. In the final all-mature cultivar study in which color was found to be significant, the majority of the fruit exhibited L* values above 50, showing that their color was more "light" than "dark" (Table 1). No difference in feeding preference was detected according to the life stage.

Our results are evidence that different cultivars, at different times of the season, do have properties which elicit preferential feeding responses from adult male and unsexed 4th stadium *H. halys*. These feeding preferences may be directly related to the insects' detection of the sugar content of the fruit. At least one other pentatomid is known to utilize a variety of digestive enzymes for acquiring nutrition from plant sugars such as sucrose and starch (Ramzi and Hosseininaveh 2010) and *L. lineolaris* has been shown to discriminate food sources on the basis of gustatory reception (Hatfield et al. 1982). So it is possible that *H. halys* discriminates similarly, as it was clear that the test insects in our studies fed on both fruit having high sucrose content and fruit having high starch content. Although we did not attempt to investigate the extent to which the color affected the feeding, its significance may be related to fruit chemistry or color perception by the stink bugs. Prokopy and Owens (1983) reviewed several studies indicating yellow to be important for phytophagous insect host-finding. The importance of yellow color for monitoring *H. halys* with visually-attractive traps has been demonstrated by Leskey and Hogmire (2005) and Hogmire and Leskey (2006). Further research focused on the impact of fruit color and chemistry on *H. halys* host-locations has merit, especially in terms of mature female *H. halys* seeking hosts for feeding and oviposition sites. In practical terms, where cultivars of differing maturity periods are interplanted, orchard managers may best use their management resources on fruit 4-6 weeks from harvest, as opposed to using them on fruit the harvest of which is imminent.

Acknowledgements

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Table 1. Median (Interquartile range [IQR]) starch and spectral data for seven cultivars exposed to adult male *H. halys* at maturity, 2011.

Cultivar	n	Starch rating[x]	
Gala	10	7.5	(1) **
Honeycrisp	10	8	(1)
Golden Delicious	10	7	(0.5)
Cameo	10	5.5	(2)
York	10	3	(0)
Fuji	10	6.5	(1)
Pink Lady	10	4	(1)

Table 1 – cont.

Cultivar	n	Chlorophyll index ($nmol/cm^2$)		Carotenoid index ($nmol/cm^2$)		Anthocyanin index ($nmol/cm^2$)	
Gala	30	0.055	(0.023) **	0.53	(0.27) **	5.3	(1.92) **
Honeycrisp	30	0.17	(0.053)	0.37	(0.1)	0.99	(0.70)
Golden Delicious	29	0.12	(0.07)	0.47	(0.18)	0.38	(0.17)
Cameo	30	0.16	(0.073)	0.57	(0.11)	2.36	(1.55)
York	30	0.19	(0.043)	0.41	(0.073)	1.62	(1.14)
Fuji	30	0.21	(0.053)	0.50	(0.17)	3.89	(3.24)
Pink Lady	30	0.16	(0.035)	0.38	(0.12)	3.02	(1.40)

Cultivar	n	CIE L*a*b* a*[y]		CIE L*a*b* b*		CIE L*a*b* L*	
Gala	30	30.46	(3.56) **	18.73	(3.58) **	46.67	(1.92) **
Honeycrisp	30	8.75	(8.96)	36.80	(7.29)	61.35	(5.74)
Golden Delicious	29	3.93	(4.55)	46.65	(6.25)	70.97	(2.48)
Cameo	30	18.2	(7.40)	22.97	(6.44)	53.81	(5.86)
York	30	13.41	(9.96)	27.54	(4.96)	57.69	(5.64)
Fuji	30	22.73	(7.97)	19.42	(6.96)	48.49	(9.46)
Pink Lady	30	24.66	(6.44)	23.54	(2.29)	54.10	(4.62)

** indicates $P < 0.001$

[x]Starch index rating from 1 = no starch disappearance to 8 = total starch disappearance.

[y] a*, b* and L* represent red-green color space; yellow-blue color space; and lightness, respectively.

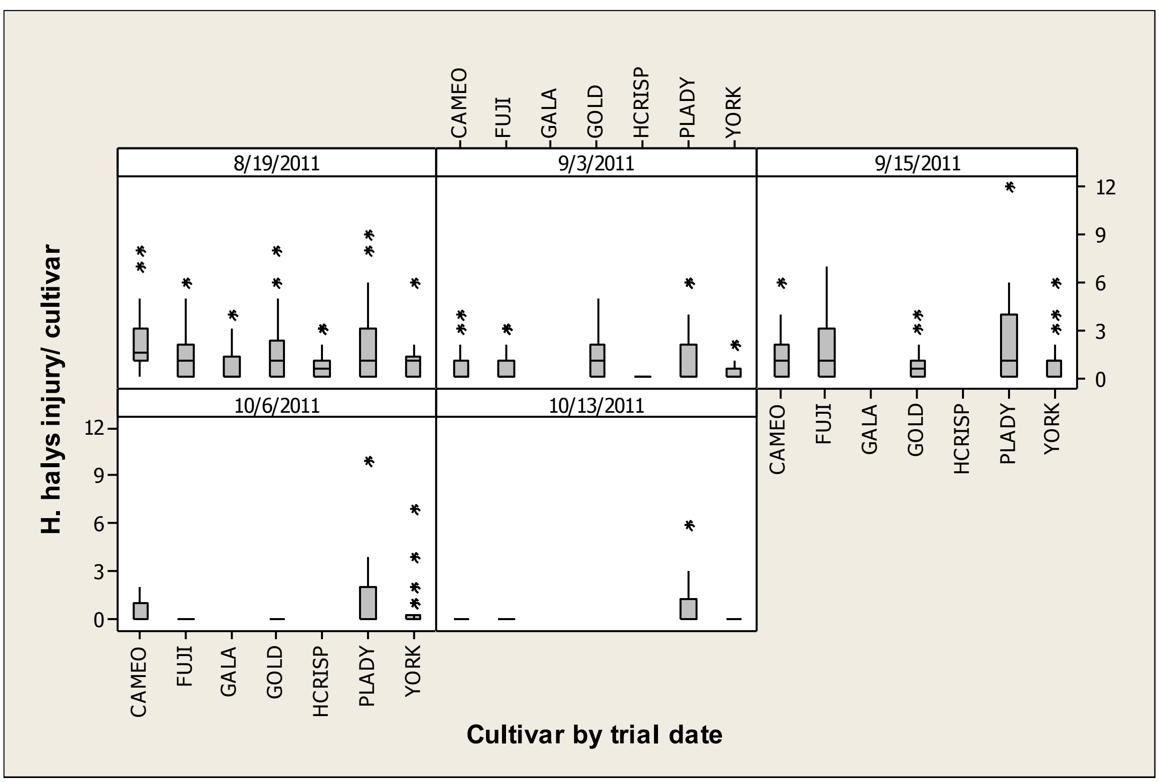


Fig. 1. *H. halys* injury on seven cultivars for five trials, time-dependent cultivar study, 2011.

SURROUND VS. THE STINK BUG:
A DEMONSTRATION PROJECT FOR DIRECT MARKET GROWERS

Bryan R. Butler, Sr.
University of Maryland Extension
Westminster, Maryland 21157

Following the 2010 growing season with its devastating losses in peaches and apples caused by Brown Marmorated Stink Bug (BMSB) many growers in Maryland were ready to use any chemistry required to produce a crop in 2011. The 2011 season proved to be frustrating for growers that experienced BMSB infestations with regard to; pick your own spray schedules, days to harvest, IPM programs being damaged by broad spectrum pesticide application leading to loss of beneficial insects, increased exposure to high toxicity products, cost, increased number of applications, fuel, time, loss of some of these products, public perception, growers are not excited.

Based on lab data from lethality trials Surround mixed with Actara appeared to be somewhat effective in killing BMSB (Leskey et al. 2010) The goal of this project was to determine if "soft" insecticides mixed with a very low rate of Surround applied at what would be considered reasonable intervals by growers could deter BMSB or reduce damage while preserving beneficial insects. Although this demonstration project did not have a control, there was extensive season long monitoring for BMSB on the 500 acre farm and large populations were observed with serious damage in sweet corn, field corn, soybeans, beach plums, raspberries, peaches, and in the borders and fence rows. The interesting observation was that although traps nearby actually did collect large numbers of BMSB adults no egg masses or nymphs were ever detected in the Surround sprayed blocks and adult numbers were very low during weekly three minute observations.

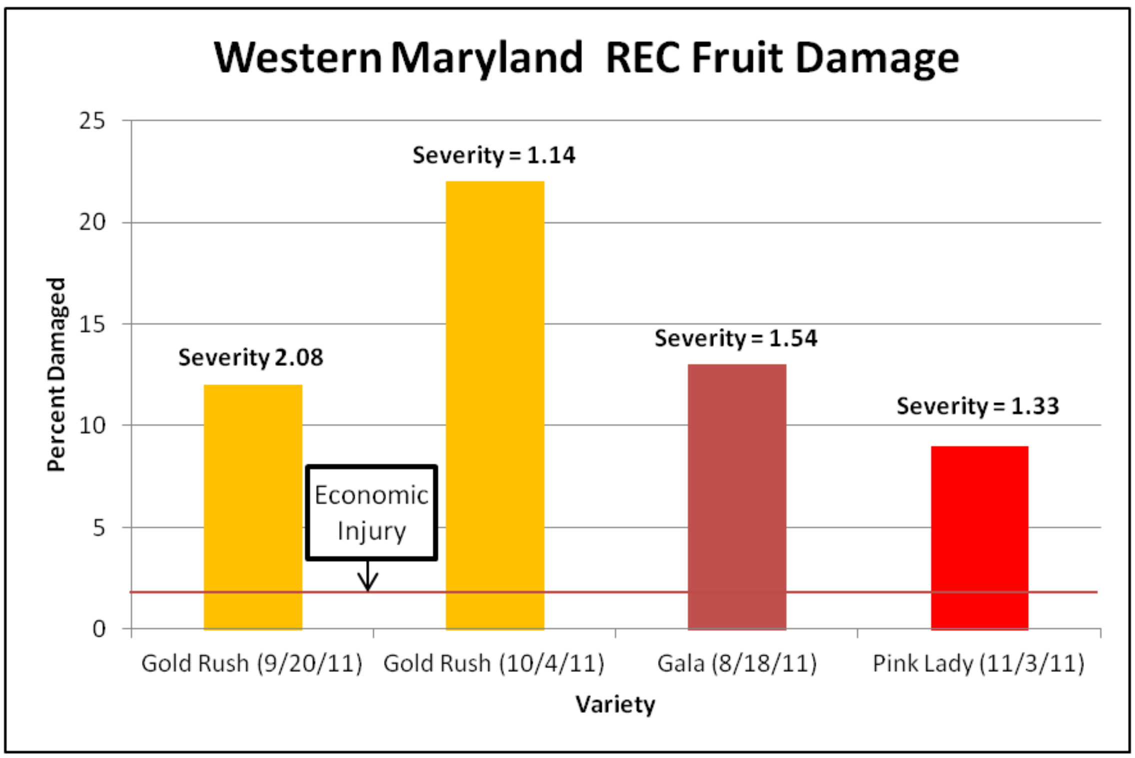
In 2010 damage to apples at WMREC was over 80%. The 2010 spray program was followed both in regards to materials used and intervals between sprays with exceptions only being made to manage fire blight and scab during the 2011 season. This spray program was considerably different from what was done in Central and Western Maryland in commercial orchards

The Surround at a 12.5 pound per 100 gallons may be acting as a repellent or tactile deterrent and could offer greater protection of the fruit, particularly if used as a bridge treatment between, or replacement for insecticide applications, or as part of a push-pull management strategy.

100 fruit were destructively sampled at harvest and although damage was still above what would be considered acceptable economic threshold severity of damage was very low, yielding a high percentage of salable fruit.

Western Maryland Research and Education Center
2011 Apple Spray Schedule

3/17 – Damoil + Champ
4/7 – Manzate Pro-Stick + Rally
4/20 – Agri-Mycin 17 + Rubigan EC + Manzate Pro-Stick
4/25 – Agri-Mycin 17
5/2 – Manzate Pro Stick + Rubigan EC + Agri-Mycin 17
5/12 – Manzate Pro Stick + Vintage SC + Imidan +Surround WP
5/20 – Procure + Manzate Pro Stick + Assail + Surround WP
6/1 – Flint + Actara + Surround WP
6/16 – Captan + Vintage SC + Assail + Surround WP
6/24 – Pristine + Imidan + Surround WP
7/5 – Captan + Surround WP
7/13 – Flint + Assail + Surround WP
7/26 – Captan + Pristine + Actara + Surround WP
8/8 – Flint + Assail + Surround WP
8/16 – Captan + Surround WP (Gala only)
Captan + Danitol + Surround WP (all except Gala)
8/22 – Captan + Venom +Surround WP
8/29 – Venom + Surround WP (Alternate row middles, not on Gala)



FEEDING INJURY AND MANAGEMENT OF BROWN MARMORATED STINK BUG IN VINEYARDS AND RASPBERRY PLANTINGS

S. Basnet, D. G. Pfeiffer, T. P. Kuhar, C. A. Laub and R. S. Mays
Department of Entomology, Virginia Tech, Blacksburg, VA

Introduction

Since brown marmorated stink bug (BMSB) is a recently introduced pest from Asia, very little is known about the behavior of this pest. Lack of natural enemies in its new habitat and capability of hitchhiking on produce and in containers are main causes for the tremendous spread of BMSB. As of January 2012, it has already spread to 36 states of USA. Chemical control is the solution against BMSB until effective biological control approaches are identified. Therefore, we investigated the efficacy of pesticides having different modes of action under field conditions. It causes injury to grape berries as well as tainting the taste of wine when crushed with berries during wine making. Knowledge on the injury imposed by BMSB and the timely application of highly effective chemical pesticides is imperative in Virginia vineyards and raspberry plantings.

Feeding injury in grapes

Grape is one of the preferred hosts for reproduction and development. There is confusion about the type of injury imposed by different stages of BMSB on different fruit developing stages of grape. Injury in grape is conspicuous a few days after BMSB inserting its stylet into the berries for sucking juices. After a few weeks of feeding, small necrotic spots develop in grape berries which increase gradually and finally the complete deformation of the berries occurs. The progression of injury in different fruit stages is still unknown. Our research is continuing and we anticipate further result in next summer.

A cage study was carried out to determine the feeding injury of BMSB in grape. Healthy adult BMSBs were collected from field and starved for one day in the lab. Six BMSBs were placed inside cage and placed around berry cluster at the harvest stage. The berry cluster was also caged without BMSB as a control. The cages were checked every week and lost bugs were replaced. After three weeks, the injury had become conspicuous.

1) Injury in Grape

Figure 1. Control (cage without BMSB)

Fig 2. Injured berries by BMSB (6 bugs in three weeks)

2) Progression of injury in grape berry with time

Fig 3. Stage 1

Fig 4. Stage 2

Fig 5. Stage 3

Management of BMSB

Materials and Methods

Pesticides having different modes of action in insect neurotransmission were used. The organophosphate malathion acts on the acetylcholinesterase enzyme, the pyrethroid etofenprox is a sodium channel modulator and the neonicotinoid dinotefuran binds at a specific site on postsynaptic nicotinic acetylcholine receptor inhibiting insect neurontransmission. Etofenprox and dinotefuran were applied alone and with the synergist piperonyl butoxide as a combined treatment.

The pesticides were applied in 1.2 m sections of treatment plots in a completely randomized design with six treatments and four replications. Cages containing 10 BMSB were placed immediately after spray application over a raspberry stem in each treatment plot. Mortality data were assessed for 1, 2, 3 DAT but mortality was low. Some BMSB escaped from the cages, ranging from 1-5. Percentage mortality data for 6 DAT were analyzed as completely randomized ANOVA. The mortality data were compared among treatments using Tukey-Kramer HSD mean separation procedure at $P \leq 0.05$ level of significance. The percentage mortality data for 6 DAT showed significant difference between pesticides and control.

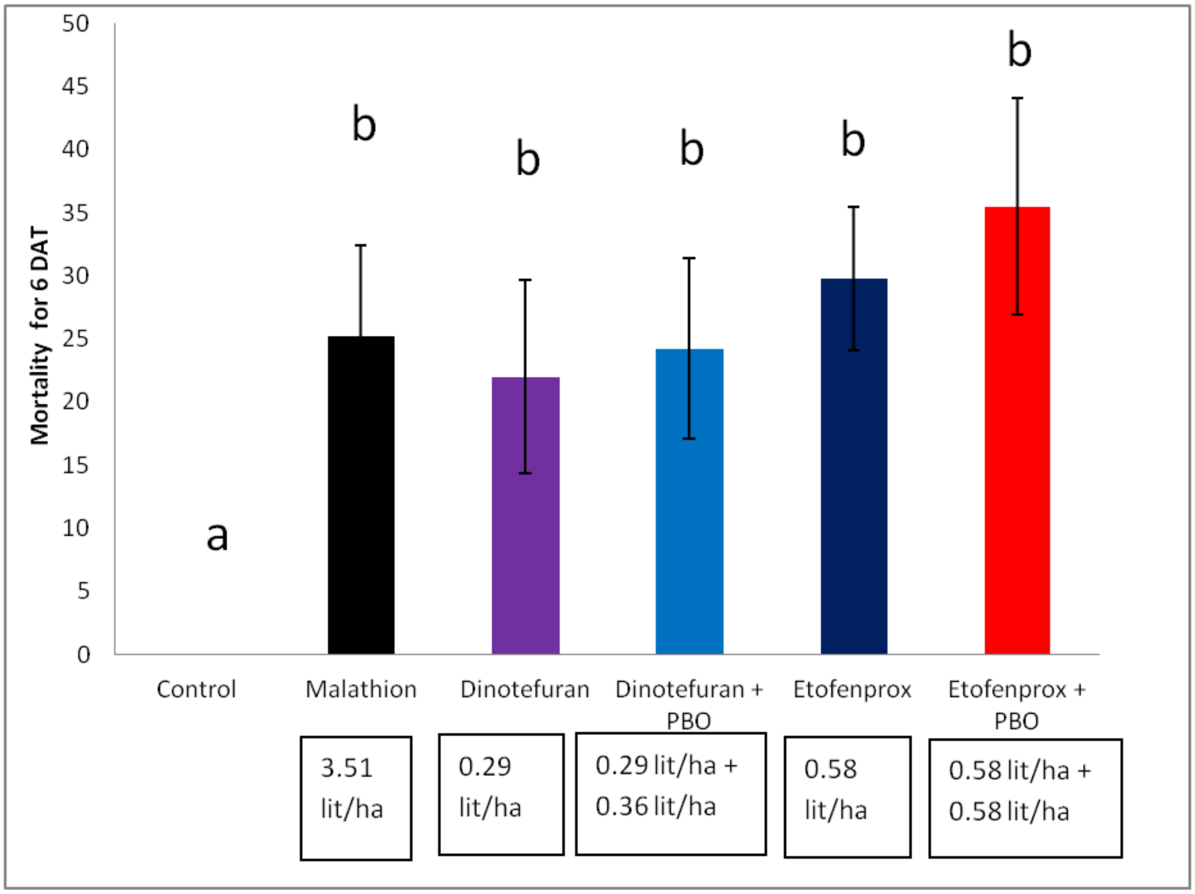


Fig. 1. 6 DAT mortality of brown marmorated stink bug when treated with pesticides at standard rate. Surviving brown marmorated stink bug treated with pesticides were significantly different from the untreated plots ($F = 4.7$, df = 5, $P < 0.039$). Bars with different letters are significantly different.

Result and discussion

There is no significant difference among the pesticides but there was significant difference between pesticides and control. There was no significant difference between pesticide treatment and combined treatment of pesticide and synergist. Since there is no significant difference between dinotefuran and other pesticides, dinotefuran can be used to control BMSB. It is considered to be biologically friendly and natural enemies can be conserved. The mortality percentage is low but is still very efficient in using these pesticides because the data show the mortality data for residual use of pesticides. During the field application, many of the bugs come in direct contact with the pesticides and the mortality is expected to be higher. None of the bugs was dead in control, which suggests that they are very hardy.

A THIRD GENERATION ELECTRONIC INSECT TRAP FOR AUTOMATED MONITORING OF LEPIDOPTERA IN ORCHARDS

Brian L. Lehman[1], Larry A. Hull[1], Johnny Park[2], German Holguin[2], Henry Medeiros[2], Teah Smith[3], Callie C. Baker[3] and Vincent P. Jones[3]
[1]Penn State University Fruit Research & Extension Center,
Biglerville, PA 17307
[2]Purdue University, School of Electrical & Computer Engineering,
West Lafayette, IN 47907
[3]Washington State University Tree Fruit & Extension Center,
Wenatchee, WA 98801

Insect monitoring can provide valuable information about the population density of specific populations of arthropod pests allowing for more effectively timed insecticide applications to reduce both pest populations and material and labor costs. The automation of insect trapping and monitoring has the potential to significantly reduce labor costs by limiting the time laborers spend in the field checking and maintaining insect traps. A completely redesigned bio-impedance based electronic sex pheromone prototype trap was tested in the field in 2011 to monitor adult codling moth (CM), *Cydia pomonella* (L.) and oriental fruit moth (OFM), *Grapholita molesta* (Busck), two major insect pests in tree fruit orchards throughout the U.S. In addition, several redesigned traps using infrared (IR) technology were also tested during the 2011 growing season.

The newly designed automated traps were field-tested alongside large plastic delta traps. Both the bio-impedance sensor based traps and the infrared (IR) sensor based traps were completely redesigned versions of prototypes previously tested in 2009 and 2010. The bio-impedance sensor trap or “Z-Trap” used an electrically charged coil design with a pheromone lure located inside the coil. The traps were designed with modular components so changes to the trap could be made readily if needed. The high-voltage electric grid consisted of a pair of intertwined metallic coils spaced approximately 5 mm apart (pitch). Z-Traps were equipped with a custom 3.2v rechargeable battery to power the coils, a microcontroller and wireless communication technology. When an insect contacted both coils simultaneously, current would flow and stun the moth where it then fell into a collector below the coil. Each time an electrical discharge occurred, the microcontroller recorded the time of the event. The properties of each electric discharge (i.e., the amplitude and duration of the electric current pulse) could then be analyzed to determine whether the event was caused by a target insect, a non-target insect, or various other non-biological factors (i.e., rainfall). The traps were also equipped with wireless technology that allowed GPS and moth capture data to be transmitted from the orchard to a central location where the data was then uploaded to a server and viewed on a website interface.

The IR traps were equipped with two rows of IR sensors placed around a tube that was attached to a funnel, which opened into a collector. Power was supplied by three NiMH D-cell rechargeable batteries. Their spatial arrangement allowed for detecting the direction of moth movement through the funnel to minimize multiple counts if a moth passed the sensor more than once. The IR traps were not equipped with wireless or GPS technology, so the data was downloaded manually from the traps.

Four Z-Traps were deployed at the end of June at the Pennsylvania State University, Fruit Research and Extension Center, in Biglerville, PA to monitor OFM populations and four were deployed at the Sunrise Orchard at the Washington State University, Tree Fruit Research and Extension Center in Wenatchee, WA, to monitor CM populations. Four more Z-traps were deployed in Biglerville in the beginning of August to monitor CM populations. All Z-Traps were paired with a corresponding large plastic delta (LPD) trap, which served as a control, and were placed ≈ 50-75 apart. Each Z-Trap and corresponding LPD was rotated weekly to their original positions. Otherwise, the Z-Traps remained unchanged throughout the test period with the exception of the addition of a coating of Insect-a-Slip (BioQuip Products, Rancho Dominguez, CA) to the inside of the trap funnels on 25 July to determine whether moth capture rates could be improved.

At PSU, Z-Traps typically had OFM capture rates that were comparable, and sometimes higher than the LPD traps. Fig. 1 shows the cumulative OFM capture of the Z-Traps and the LPD traps in 2011. Codling moth capture was slightly lower in the Z-Traps compared to LPD traps, but the capture pattern was similar (Fig. 2). Average weekly OFM moth captures in the Z-Traps ranged from zero earlier in the season to a high of 53. Average weekly capture of the LPD traps ranged from 3.8 to 34. Average weekly CM moth captures ranged from 1.8 to 28.3 in the Z-Traps and 3 to 33.5 in the LPD traps.

A small study was also conducted to test the escape rates of OFM adults through the funnel stem of a modified 1-Liter plastic bottle shaped trap with and without a coating of Insect-a-Slip on the inside and outside funnel surfaces. The coating was applied with a small brush and allowed to dry overnight. Openings at the base of funnel stem measured 13 mm (ID). Ten OFM adult moths were added to each trap and traps were placed in the orchard and checked daily for moth escape. The experiment was repeated six times. The escape rates for the control trap (i.e., no Insect-a-Slip) were 25% greater than the trap with Insect-a-Slip which allowed less than 5% moth escape per day (Fig. 3). Capture rates of OFM also increased in the field with the application of Insect-a-Slip (Fig. 4). Z-Trap captures were consistently lower than LPD capture before the Insect-a-Slip application, and were consistently higher after application, but this data was not analyzed statistically. Data for CM traps were not available because they were deployed with Insect-a-Slip already applied.

Four redesigned IR traps were also deployed in an orchard at the Pennsylvania State Fruit Research and Extension Center in Biglerville, PA in late June 2011. The traps were all equipped with OFM pheromone lures and had LPD traps placed in the same rows as controls. The IR and LPD traps were rotated each week to a new position. Moth capture rates in the IR traps were significantly higher than in 2010, but the cumulative moth capture rate of the IR traps in 2011 was only 60 percent of the capture rate in the LPD traps. Trap funnels for the IR traps were also coated with Insect-a-Slip before being deployed and these funnels were the same funnels used to test escape rates mentioned previously. The IR traps in 2011were again deployed with a Vapona™ strip inside the collecting bucket, which acts as a fumigant to stun the moths so they fall down through the funnel into the collecting bucket. We have anecdotal evidence that the Vapona strip can possibly act as a repellent to certain moth species.

Capture efficiency of the Z-Traps and IR traps were significantly improved in 2011 compared to our 2010 studies. Changes for 2012 will likely focus on continued testing of the traps and a modification of the coil to make it more durable. More testing is also likely for the wireless technology and the trap user interface.

Acknowledgments:

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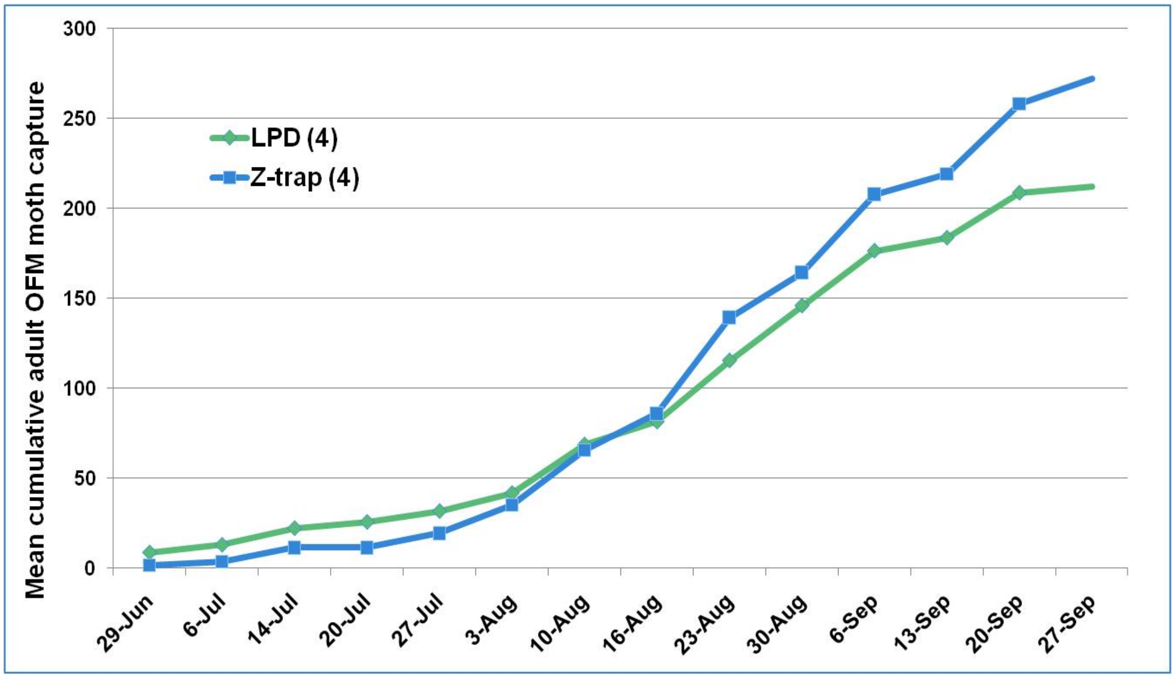

Figure 1. Cumulative moth capture of a Bio-impedance based insect trap (Z-Trap) for oriental fruit moth compared to a standard large plastic delta trap at an orchard at the Penn State Fruit Research and Extension Center in 2011.

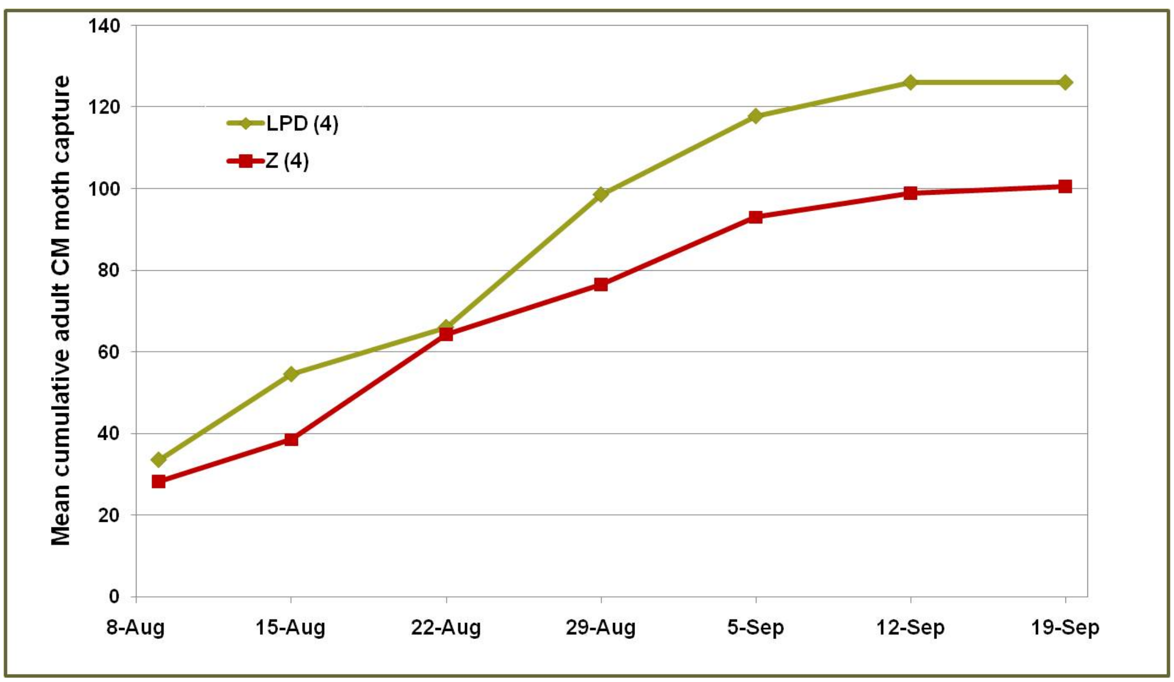

Figure 2. Cumulative moth capture of a Bio-impedance based insect trap (Z-Trap) for codling moth compared to a standard large plastic delta trap at an orchard at the Penn State Fruit Research and Extension Center in 2011.

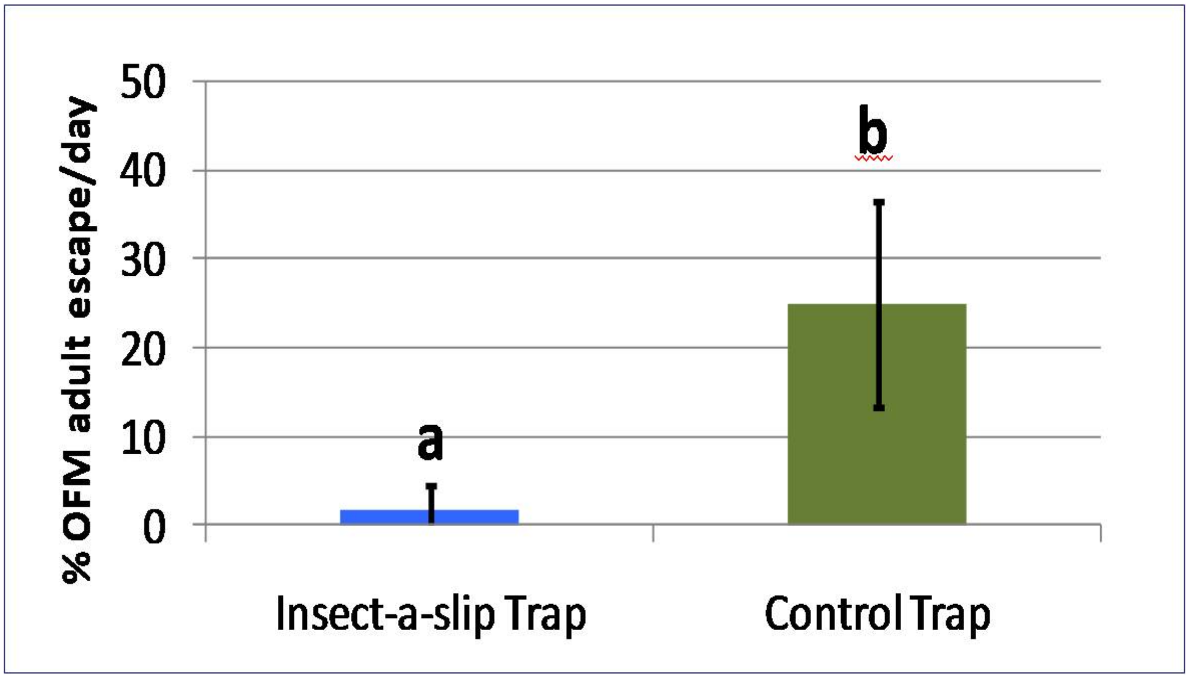

Figure 3. Percent of moths escaping from traps through the funnel opening in modified plastic bottle traps with funnels coated with Insect-a-Slip and non-coated funnels at PSU in 2011. Ten moths were placed in each trap type per day. The test was repeated six times.

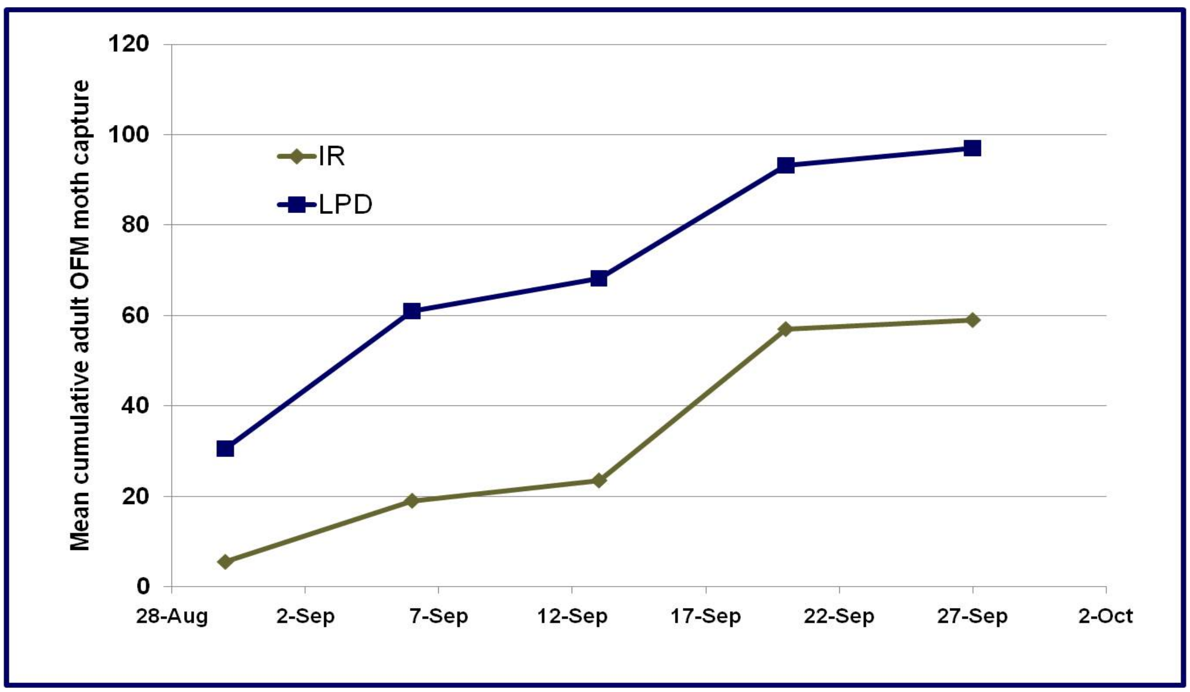

Figure 4. Cumulative oriental fruit moth capture in Infrared (IR) and large plastic delta (LPD) traps at PSU-FREC in 2011.

EVALUATION OF ISOMATE FLEX AND ISOMATE RINGS FOR MATING DISRUPTION OF CODLING MOTH AND ORIENTAL FRUIT MOTH IN NORTH CAROLINA APPLES

James F. Walgenbach and Steve Schoof
Mountain Horticultural Crops Research & Extension Center
NC State University, Mills River, NC 28759

Mating disruption of codling moth and oriental fruit moth (OFM) has been an important component of apple pest management programs in North Carolina for the past five years. Approximately 40% of the apple acreage is under disruption for these pests, and multiple year use has decreased populations to very low levels in many orchards. This has contributed to a considerable reduction in post bloom insecticide applications and enhanced natural control of apple aphids and European red mite.

The most common mating disruption pheromone dispenser used in NC has been Isomate CM/OFM TT, and in almost all situations dispensers have been deployed at 200 per acre. For those growers that have used mating disruption for multiple years and have very low codling moth and OFM populations, the opportunity exists to make mating disruption more economical by either reducing the amount of pheromone or number of dispensers deployed in orchards. This study was conducted to evaluate two different Isomate products – Isomate CM/OFM Rings and Isomate CM/OFM Flex – as options for improving the cost of mating disruption. Isomate Ring is a large dispenser that contains more pheromone per dispenser and is deployed at lower densities compared to Isomate TT. Isomate Flex dispensers are similar to TT, but contain less pheromone and therefore offer the option of reducing the amount of pheromone used without reducing the number of point sources compared to TT.

Materials and Methods

Separate experiments were conducted to compare the performance of Isomate Rings and Isomate TT, and Isomate Flex and Isomate TT. In all instances pheromone dispensers were hung during the first 10 days of April, which was before codling moth emerged and coincided with peak flight of first generation OFM. First generation OFM was not a target of mating disruption, because insecticides applied at petal fall usually provide sufficient control of this generation. At al test sites, an insecticide was applied to all treatments at petal fall (insecticide varied among orchards), Delegate in early to mid June (approximately 600-700 DD after codling moth biofix), mid July for apple maggot (a neonicotinoid). A mid August application of Altacor was applied at the McCraw and Lynch sites, but no August insecticide was applied at the Staton site.

Pheromone dispensers. Chemical components of the three pheromone dispensers examine in these experiments are described below:

Isomate-CM/OFM TT contained 318.0 mg of codling moth pheromone (3-component blend) and 103.3 mg of OFM pheromone (3-component blend) and were hung at a density ranging from 150 to 200 dispensers per acre in the upper third of trees.

Isomate CM/OFM TT Flex contained 128.0 mg of codling moth pheromone (3-component blend) and 42.8 mg of OFM pheromone (3-component blend) and were hung at densities ranging from 150 to 300 dispensers per acre in the upper third of trees.

Isomate CM/OFM Rings contained a total of 1,600 mg of codling moth pheromone (3-component blend) and 535 mg of OFM pheromone (three component blend), and were hung at a density of 40 per acre in the upper third of trees.

Isomate Flex vs. Isomate TT Study. This experiment consisted of five treatments replicated in three different commercial orchards; two Henderson County sites (Staton and McCraw) and one Polk County site (Lynch Rd). Treatments at each site consisted of Isomate CM/OFM TT at 150 and 200 dispensers/acre, Isomate CM/OFM Flex at 150 and 300 dispensers per acre, and a non-pheromone treated control. The total amount of pheromone on a per acre basis in each treatment is shown in Table 1. All study sites consisted of a contiguous block of apples ranging in size from 18 to 25 acres. Plot size at the Lynch, McCraw and Staton sites averaged 3.6, 4.6 and 5.0 acres, respectively. The Lynch and McCraw sites consisted of a mixed block of mature of 'Golden Delicious' and 'Rome Beauty' trees. The Staton orchard had a greater diversity of varieties ('Ginger Gold,' 'Fuji,' 'Golden Delicious' and 'Rome Beauty'), but 'Golden Delicious' were present in all treatments.

Within each treatment, two codling moth and one OFM pheromone trap was used to monitor moth populations within treatments. Large Delta-style traps (i.e., Pherocon VI) with replaceable sticky bottoms were used as traps. Codling moth traps were placed in the upper portion of the canopy and OFM traps were placed at eye level on the outer periphery of trees. Codling moth traps were baited with the Trécé long-life lures (CM-L2) that contained 3.5 mg of (E,E)-8,10-Dodecadien-1-ol, and lures were replaced at 8-wk intervals. OFM traps were baited with a Trécé OFM lure loaded with 100 ug of Z-8-Dodecen-1-yl Acetate that was replaced at 6-wk intervals. In all circumstances, traps were checked at weekly intervals and bottoms were replaced as needed to ensure a clean trapping surface. Fruit were evaluated for codling moth and OFM damage at harvest by harvesting 100 fruit from each of five trees per treatment. All apples were examined on the outside for damage and then cut to detect internal worms.

Isomate Ring vs. Isomate TT Study. The objective of this study was to compare the performance of a reduced rate of Isomate CM/OFM TT (150/acre) to Isomate Ring at 40/acre in orchards that had used mating disruption for multiple years and had low populations of both codling moth and OFM. Hence, the study consisted of only two treatments (Isomate TT at 150/acre and Isomate Ring at 40/acre). These rates resulted in total codling moth pheromone deployment of 47.7 and 64 gm per acre with Isomate TT and Isomate Ring, respectively, and OFM pheromone of 15.5 and 21.4 gm per acre with Isomate TT and Isomate Ring, respectively. Studies were replicated in two Henderson County orchards (Staton and Barnwell) and one in Polk County (Lynch-Home). All test sites consisted of mixed blocks of mature 'Golden Delicious' and 'Rome Beauty' trees. Plots ranged in size from 13 to 20 acres at the various sites. Efficacy was measured as described above for the Isomate Flex vs. Isomate TT study, except that three codling moth pheromone traps were erected in each plot and 50 fruit from each of 10 trees per plot were harvested.

Results

Isomate Flex vs. Isomate TT Study. Season total pheromone trap captures of codling moth were of moderate intensity in the McCraw and Staton orchards, but very low in the Lynch orchard, with approximately equal numbers of first and second generation moth captured (Table 2). Based on pheromone trap captures compared to the control, the density of dispensers appeared to be more important than the total amount pheromone deployed in suppressing codling moth pheromone trap capture. There was little difference between the overall performance of Isomate TT at 200/A and Flex at 300/A, both of which provided a higher level of trap suppression than Isomate TT and Flex at 150/A (Fig. 1). Most apparent was the fact that TT and Flex at 150/A both appeared to "break" 3 weeks earlier than the 200 TT and 300 Flex treatments. Total pheromone on a per acre basis in these treatments was 63.3, 38.4, 47.7, and 19.2 gm/acre in the 200 TT, 300 Flex, 150 TT and 150 Flex, respectively.

Similar to codling moth populations, OFM populations were relatively high in the McCraw and Staton orchards, and very low in the Lynch orchard (Table 3). At the McCraw site, approximately equal numbers of moths were captured during generations I and II as during generations III and IV. However, almost all moths captured at the Staton site were later in the season. In contrast to results with codling moth, the amount of total amount of pheromone deployed appeared to be more important in suppressing trap capture compared to the number of point sources. All treatments provided 100% trap shutdown during the first generation when populations were low, but under high pressure late in the season only the Isomate Flex at 150 failed to provide a high level of trap suppression (Table 3 and Fig. 2). Total amount of pheromone deployed was 20.6, 15.5, 12.8, and 6.4 gm/acre in 200 TT, 150 TT, 300 Flex and 150 Flex, respectively. Perhaps the 6.4 gm/acre rate of pheromone in the 150 Flex treatment was below a "threshold" level for OFM mating disruption.

With the exception of the Staton site, damage by codling moth and oriental fruit moth was very low. At the Staton site, however, there was a fairly high level of damage in all treatments except the block treated with Isomate TT at 200/A (Table 4). The high level of damage at the Staton site was due to the absence of a late-season insecticide application combined with very high OFM populations in August and September. The majority of this damage was due to late-season OFM, with approximately 85% of live worms collected being OFM larvae. The higher level of damage in the 300 Flex (7.6%) compared to 150 Flex (2.7%), despite higher codling moth and OFM trap captures in the 150 vs. 300 treatments, was probably due to the closer proximity of the 300 Flex treatment to the control.

Isomate Ring vs. Isomate TT Study. Codling moth populations were extremely low at all study sites, with season cumulative pheromone trap capture at the Barnwell site being only 3.7 moths per trap (Table 5). A similar number of moths were captured in both treatments when averaged across all sites, with a season total moth capture of only 2.1 and 1.8 moths per trap in Isomate Ring and 150 TT treatments (Fig. 3), respectively. Oriental fruit moth pheromone trap captures were also very low at all sites (Table 6), and averaged across all sites the total trap capture was only 0.7 and 1.7 moths in Isomate Ring and 150 TT (Fig. 4), respectively.

No damage was detected at the Barnwell or Lynch locations, but at the staton site there was an average of 2.0 and 1.4% damage in the Ring and 150 TT treatments (Table 7), respectively. This level of damage at the Staton site was difficult to explain considering the low codling moth and OFM trap captures. It should be noted that the control of the Isomate TT vs. Flex study was approximately 0.25 mi from the Ring and 150 TT treatments, and may have been a source of moths infesting these treatments.

Summary

While it was assumed that all study sites had low populations of codling moth and OFM at the initiation of these studies, this assumption was not true at two of the three sites in the Isomate TT vs. Flex study. In the Lynch orchard where populations were very low, there were no apparent differences among treatment performances. However, where populations were higher, pheromone trap captures suggested that dispenser density was more important than total pheromone deployed for codling moth, while total pheromone deployed was more important than dispenser density for OFM. Isomate Flex at 150 dispensers/A deployed a total of only 6.4 gm of OFM pheromone, and this amount may have been too low for effective disruption. For the Isomate Ring vs. TT study, the pre-study assumption of low codling moth and OFM populations was met, and there were no differences among the two treatments. While the performance of Rings against higher codling moth populations is unknown, such an evaluation could aid in explaining the importance of point sources vs. total pheromone deployed. The 40/A density of Rings represented a total of 21.6 gm of OFM pheromone, which is equivalent Isomate TT at 200/A and should be sufficient under moderate to high OFM pressure.

Shown in Table 8 are the application, product and total costs of the various treatments. Application costs represented a relatively low percentage of the total cost of mating disruption ranging from about 2% with Isomate Ring to 10% for Isomate Flex 300/A. Hence, the primary concern to the grower should be the cost of product and efficacy of the product. While the Isomate Flex 150/A treatment was most economical, the poor performance of this treatment under moderate to high moth pressure probably makes it too risky to use in many situations. It was also interesting that the Isomate Ring treatment only resulted in a \$4/A savings compared to the standard Isomate TT at 200/A. In situations where codling moth populations is known to be very low, use of Isomate TT at 150/A or Flex at 300/A could result in a savings of about >\$20/A compared to full rates.

Table 1. Dispenser rates and total pheromone deployed (gm/acre) in Isomate TT versus Isomate Flex experiment.

Pheromone[1]	Isomate TT 200/A	Isomate TT 150/A	Isomate Flex 300/A	Isomate Flex 150/A
Codling moth	63.6	47.7	38.4	19.2
Oriental fruit moth	31.0	15.5	12.84	6.42

[1]Codling moth pheromone consisted of three-component blend (approximately 84.5% (E, E)-8, 10-Dodecadien-1-ol; 12.9% dodecanol; and 2.6% Tetradecanol), as did OFM pheromone (approximately 92.6% Z-8-Dodecen-1-yl Acetate; 12.9% E-8-Dodecen-1-yl Acetate; and 1.1% Z-8-Dodecen-1-ol).

Table 2. Mean codling moth pheromone trap captures in blocks of apples treated with different pheromone dispensers.

	Cumulative moths/trap			
Treatment	McCraw	Staton	Lynch	Mean
Isomate TT – 200	0	4.0	0	1.3 ± 1.3
Isomate TT – 150	8.5	2.5	0.5	3.8 ± 0.5
Isomate Flex – 300	1.5	2.5	2.5	2.2 ± 0.3
Isomate Flex – 150	1.5	11.5	1.0	4.7 ± 3.4
Control	22.3	8.5	1.3	10.8 ± 6.2
	Generation I			
Isomate TT – 200	0	1.0	0	0.3 ± 0.3
Isomate TT – 150	3.0	1.0	0.5	1.5 ± 0.8
Isomate Flex – 300	1.5	2.5	1.0	1.7 ± 0.4
Isomate Flex – 150	0.5	1.5	1.0	1.0 ± 0.3
Control	10.5	3.7	1.0	5.1 ± 2.8
	General II + III			
Isomate TT – 200	0	3.0	0	1.0 ± 1.0
Isomate TT – 150	5.5	1.5	0	2.3 ± 1.6
Isomate Flex – 300	0	0	1.5	0.5 ± 0.5
Isomate Flex – 150	0.0	10.0	0	3.7 ± 3.2
Control	12.0	4.7	0.5	5.7 ± 3.4

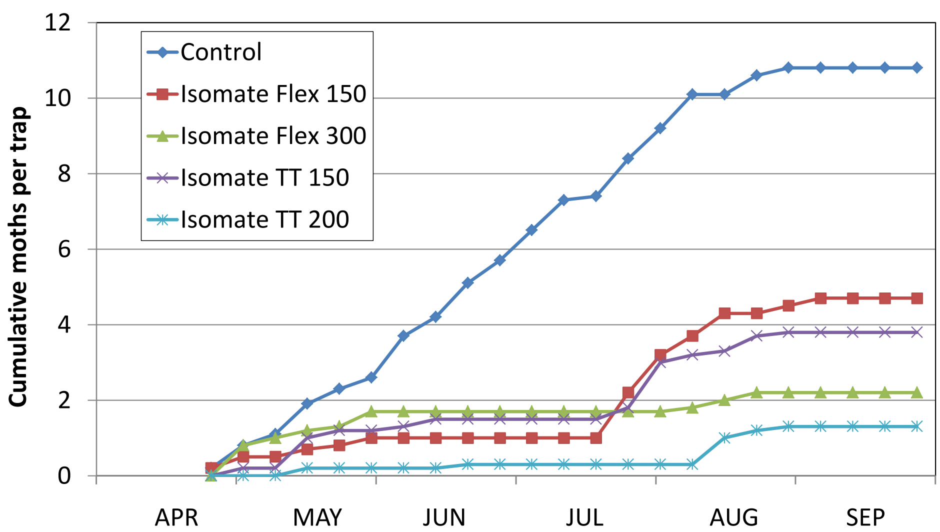

Fig. 1. Mean codling moth captures in pheromone traps (across all sites) of Isomate CM/OFM TT and Flex studies. 2011.

Table 3. Mean codling moth pheromone trap captures in blocks of apples treated with different pheromone dispensers.

	Cumulative moths/trap			
Treatment	McCraw	Staton	Lynch	Mean
Isomate TT – 200	0	1	0	0.3
Isomate TT – 150	0	7	0	2.3
Isomate Flex – 300	0	4	0	1.3
Isomate Flex – 150	1	82	1	28
Control	130	376	22	176
	Generation I + II			
Isomate TT – 200	0	0	0	0
Isomate TT – 150	0	0	0	0
Isomate Flex – 300	0	0	0	0
Isomate Flex – 150	0	0	0	0
Control	67	12	4	27.7
	General III + IV			
Isomate TT – 200	0	1	0	0.3
Isomate TT – 150	0	7	0	2.3
Isomate Flex – 300	0	4	0	1.3
Isomate Flex – 150	0	82	1	27.7
Control	63	364	18	148.3

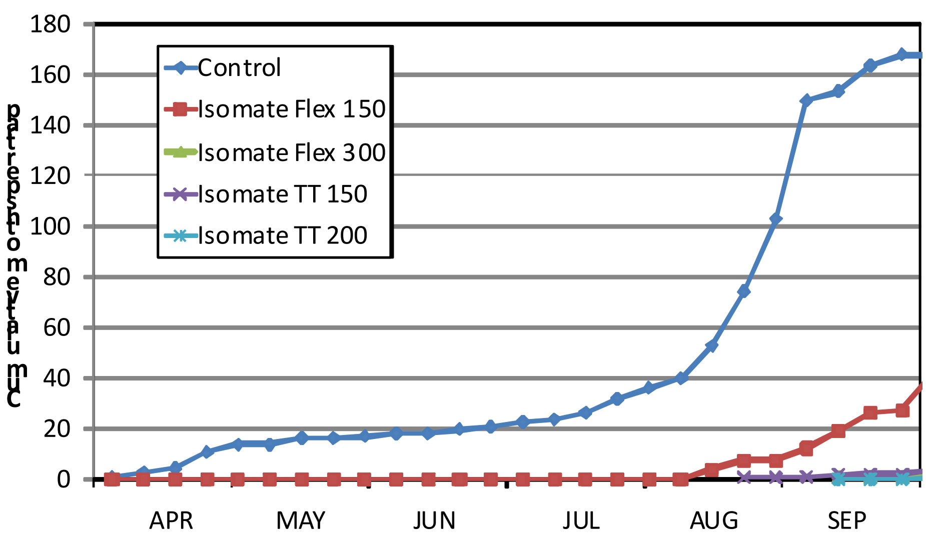

Fig. 2. Mean Oriental fruit moth captures in pheromone traps (across all sites) of Isomate CM/OFM TT and Flex studies. 2011.

Table 4. Mean (± SEM) percentage damage to apples in blocks treated with different pheromone dispensers.

Treatment	McCraw	Staton	Lynch	Mean
Isomate TT – 200	0	0.4 (0.4)	0	0.1 (0.1)
Isomate TT – 150	0.8 (0.4)	2.4 (2.4)	0	1.1 (0.7)
Isomate Flex – 300	0	7.6 (5.2)	0	2.5 (2.5)
Isomate Flex – 150	0	2.7 (1.8)	0	0.4 (0.4)
Control	0.4 (0.4)	5.2 (3.1)	0.4 (0.4)	2.0 (0.7)

Table 5. Mean codling moth pheromone trap captures in blocks of apples treated with different pheromone dispensers.

	Cumulative moths/trap			
Treatment	Barnwell	Staton	Lynch	Mean
Isomate Ring – 40	3.7	2.7	0	2.1 (1.1)
Isomate TT – 150	2.0	2.5	1.0	1.8 (0.4)
	Generation I + II			
Isomate Ring – 40	2.3	2.3	0	1.7 (0.8)
Isomate TT – 150	1.0	1.0	1.0	1.0 (0)
	General III + IV			
Isomate Ring – 40	1.4	0.4	0	0.4 (0.4)
Isomate TT – 150	1.0	0	0	0.8 (0.4)

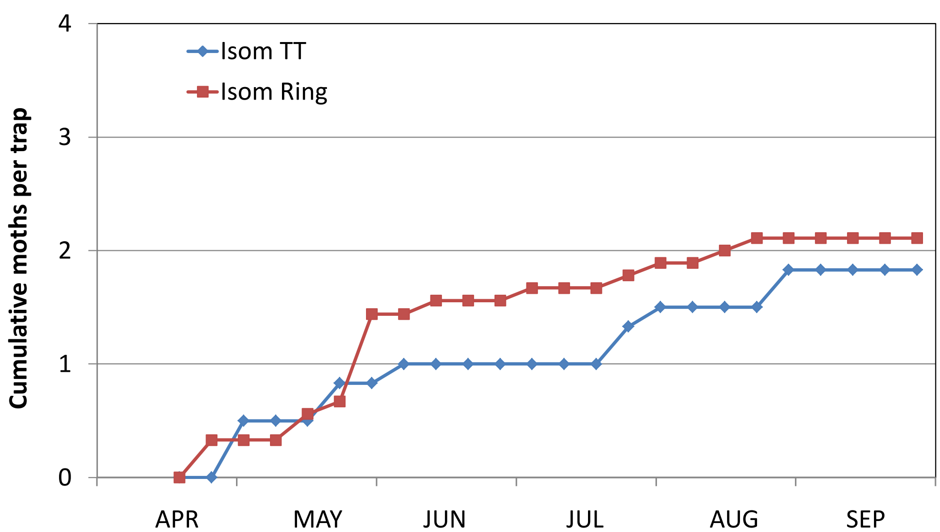

Fig. 3. Mean codling moth captures in pheromone traps (across all sites) of Isomate CM/OFM TT and Flex studies. 2011.

Table 6. Mean oriental fruit moth pheromone trap captures in blocks of apples treated with different pheromone dispensers.

	Cumulative moths/trap			
Treatment	Barnwell	Staton	Lynch	Mean
Isomate Ring – 40	1.0	1	0	0.7 (0.7)
Isomate TT – 150	1.0	4.0	0	1.7 (1.0)
	Generation I			
Isomate Ring – 40	1.0	1	0	0.7 (0.7)
Isomate TT – 150	1.0	0	0	0.3 (0.3)
	General II + III			
Isomate Ring – 40	0	0	0	0
Isomate TT – 150	0	4.0	0	1.4 (1.0)

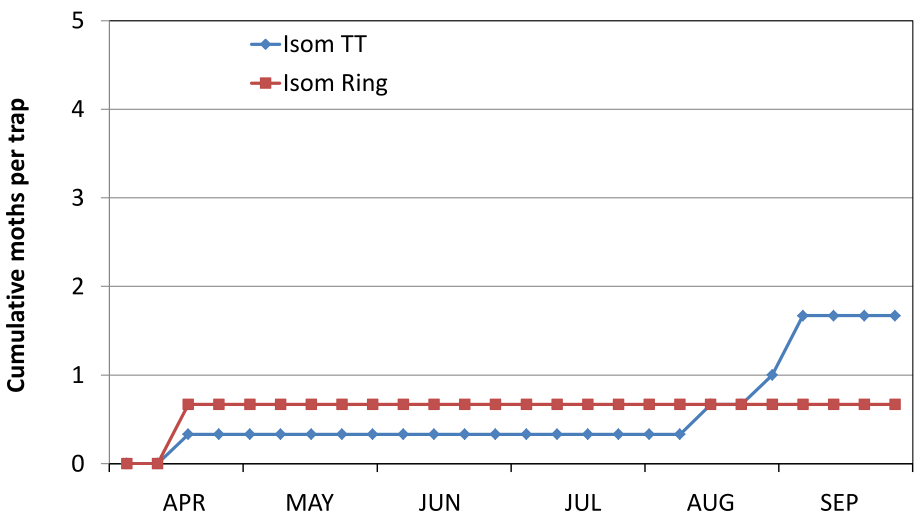

Fig. 4. Mean Oriental fruit moth captures in pheromone traps (across all sites) of Isomate CM/OFM TT and Ring studies. 2011.

Table 7. Mean (± SEM) percentage damage to apples in blocks treated with different pheromone dispensers.

Treatment	Barnwell	Staton	Lynch	Mean
Isomate Ring – 40	0	2.0 (0.9)	0	0.7 (0.7)
Isomate TT – 150	0	1.4 (1.2)	0	0.5 (0.5)

Table 8. Man-hours to apply CM/OFM pheromone dispensers and cost (per acre) for various mating disruption treatments applied to mature trees.

Dispenser	Dispensers per acre	Man hours to apply	Application cost ($8/hr)	Product cost	Total cost
Isomate TT	150	0.67	5.36	90	95.36
Isomate TT	200	0.95	7.60	120	120.00
Isomate Flex	150	0.67	5.36	45	55.36
Isomate Flex	300	1.30	10.40	90	100.40
Isomate Ring	40	0.45	3.60	120	123.60

MATING DISRUPTION PLUS NOVEL BARRIERS FOR DOGWOOD BORER CONTROL

Arthur Agnello and David Kain
Department of Entomology, NYS Agricultural Experiment Station
Geneva, NY 14456

Trunk damage to apple trees caused by pests including insects, such as dogwood borer (DWB), and rodents is a significant problem that receives inadequate attention in most commercial production regions, including the northeastern US. Current management approaches rely on the use of insecticide trunk sprays for borers, and trapping/exclusion methods plus poisoning with rodenticides for voles, mice and rabbits. None of these approaches are entirely effective; because of the time and effort required to employ them, their need for frequent re-treatment, or their hazard potential to farm workers, they are often used improperly, sporadically, or not at all, resulting in continued or expanded incidence of the infestations. We have begun a project to evaluate a combination of non-insecticidal alternatives to control trunk-damaging pests consisting of novel barrier technologies, either used alone or in combination with pheromone mating disruption. Candidate barrier formulations being evaluated include fibrous barriers made of non-woven ethylene vinyl acetate (EVA) generated by a hot melt adhesive unit fitted with a hand-held spray head, and non-fibrous barriers made of common elastomeric compounds used as commercial building coatings, applied either alone or combined with an abrasive material (sand). All barriers will be screened for efficacy against voles in small-plot trials in non-orchard locations with known high vole pressure. To further examine efficacy of DWB control in commercial orchards, all the barrier trials are being replicated in larger scale field tests, both in combination with DWB mating disruption (MD) and without it. Pheromone dispensers containing a newly available DWB sex pheromone blend are deployed in the orchard blocks, and incidence of trunk damage from borers as well as voles is being compared. Barrier field life and durability will be assessed on a regular basis throughout the 2-year study and for a third year after the project has terminated.

During the 2011 season, a few moths were captured in traps beginning 3 June, with sustained catch beginning 10 June. The peak trap catch occurred roughly from mid- to late July. Trap catch was monitored through September 14. Trap shutdown, a measure of mating disruption, was 100% in all treated plots. Compared with trap captures in the same plots in 2010, only low to moderate numbers of moths were captured in all untreated control plots in 2011 (Table 1). Trunk inspections to determine whether disruption was effective in reducing actual crop infestation were conducted 19–23 September. The pheromone MD treatment was comparable to a Lorsban trunk spray standard in 2 of the 3 sites. For the barrier treatments, the EVA formulation in combination with pheromone MD had the lowest infestation readings, although values were statistically significant at only 1 site. Without pheromone MD, the EVA treatment resulted in significantly lower infestation than the untreated Check at 1 site, and lower than the elastomer treatment at 1 site. Early observations of barrier weathering status indicated that the elastomer may not be holding up as well as the EVA, as some cracks and openings were found in the elastomer barriers on some tree trunk sites.

Table 1. Pheromone trap captures of dogwood borer males in plots treated with Isomate DWB dispensers.

Site	Total Avg DWB/trap 2010	Site	Total Avg DWB/trap 2011
Richardson		**Fowler B1E**	
Isomate-DWB	0.0	Isomate-DWB	0.0
Check	835.3	Check	305.7
Dutch		**Fowler V1H**	
Isomate-DWB	0.0	Isomate-DWB	0.0
Check	361.0	Check	169.7
Wafler Hilltop		**Wafler Hilltop**	
Isomate-DWB	0.0	Isomate-DWB	0.0
Check	290.7	Check	77.0

Table 2. Mean percent infested burr knots in trees treated with Isomate DWB dispensers and different barrier formulations.

	% block infested	
Plot	MD	Non-MD
B1E		
Barrier Treatment		
EVA	0.0 a	0.0 a
Elastomer	0.55 a	6.7 b
Check	4.8 a	4.1 ab
V1H		
EVA	3.3 a	2.6 a
Elastomer	5.8 a	5.0 ab
Check	8.4 a	12.5 b
Hilltop		
EVA	0.33 a	4.5 a
Elastomer	6.2 ab	3.2 a
Check	6.2 b	5.7 a

Values followed by the same letter within the same column in the same plot not significantly different (*P* = 0.05, Fisher's lsd test.)

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EVALUATION OF INSECTICIDES AGAINST APPLE MAGGOT

David Combs and W. H. Reissig
Cornell University, New York State Agriculture Experiment Station
630 West North Street, Geneva, NY 14456

A second year of field trials of newer insecticides against the Apple Maggot (AM) was conducted in a Wayne Co., NY commercial orchard with a history of AM pressure. Plots were arranged in a RCB design and replicated three times in a 12-tree block of 'Jonagold' apples. Applications were made every 7 days from 19 Jul to 23 Aug. See Table 1 for a complete list of materials rates and timings. Materials were applied with a conventional air-blast sprayer manufactured by Rears Manufacturing at 100 gpa. Three 'Sticky Red Sphere' AM traps baited with apple volatile lures were placed along the edge of the test orchard to determine the level of pressure from an adjacent abandoned orchard. Traps were checked weekly. See Chart 1 for AM Trap Catch. AM damage was evaluated before harvest on 30 Aug, and at harvest on 23 Sep by destructively sampling 100 apples from each replicate. Apples were inspected for 'stings' (surface punctures with tunnels < 5mm deep) and a 'tunnels' (internal breakdown of the flesh with brown tunnels underneath the skin of the apple greater than 5mm deep). Data was subjected to an AOV with JMP. Means were separated using the Student's t test.

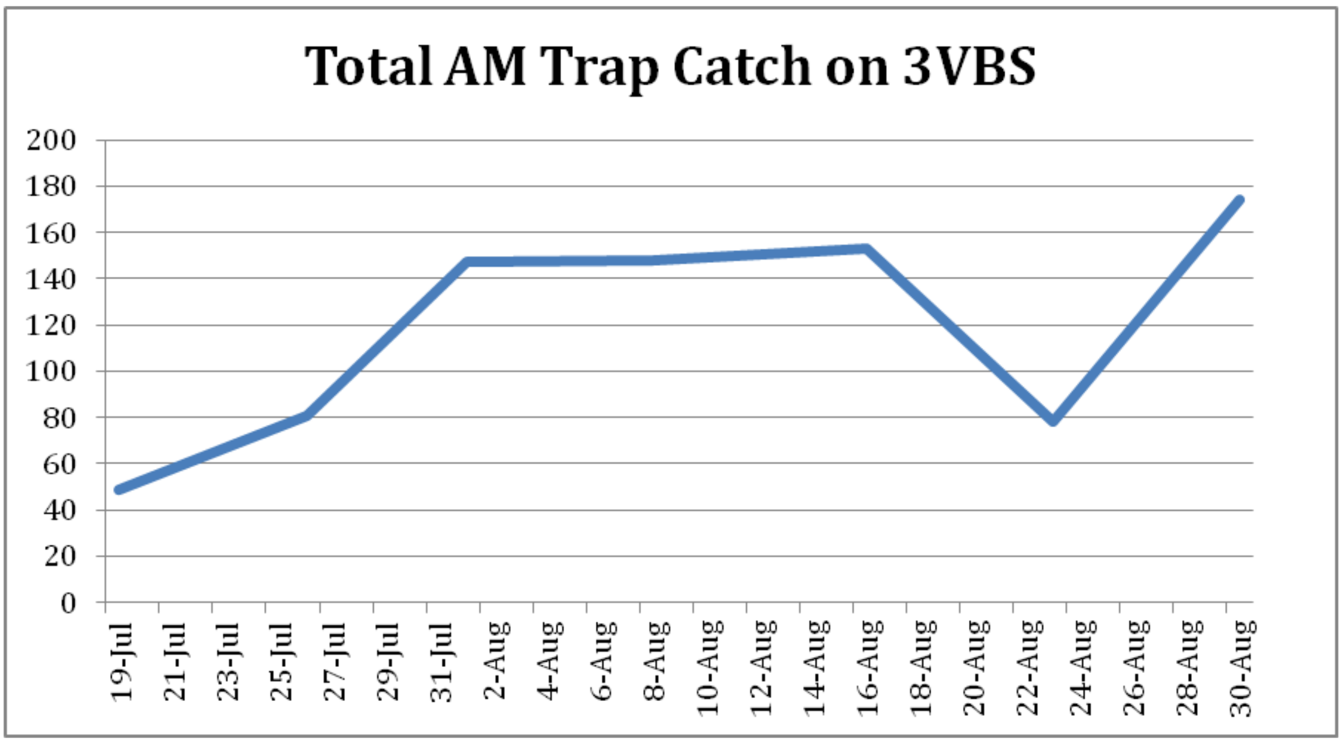
The trap catches shown below in Chart 1 are the total AM catches throughout the season on 3 volatile-baited sticky spheres placed in the check treatments along the outer row of the research plots. These high catches confirm the AM pressure in the test orchard was extremely high throughout the season and consequently, none of the treatments completely eliminated AM damage even though relatively high insecticide rates were applied weekly. In the pre-harvest sample, the percentages of fruit with stings are statistically similar among all treatments including the check plot. All of the insecticide treatments before harvest and at harvest significantly reduced the amount of AM tunneling below that in the check plots, except Altacor, but differences among the treatments were not significantly different. The percentages of fruit with tunneling remained relatively constant in all of the treatments from pre-harvest until harvest except for the Guthion treatment. This suggests that Assail, Calypso, and Altacor may have longer residual effectiveness in preventing internal tunneling damage than Guthion. Calypso was the only material that had a significantly higher percentage of stings at harvest than the check plots, but Assail also had a relatively high number of stings. However, Calypso and Assail were the two most effective materials in preventing internal tunneling. This suggests that these 2 insecticides could have some ovicidal activity or are killing young larvae just beneath the surface of the apple before they can tunnel into the fruit. Assail was the only insecticide that had a higher percentage of clean fruit at harvest than the untreated check plots only because it was slightly more effective in preventing stings than Calypso.

Table 1. Evaluation of Insecticides Against Apple Maggot

Treatment	Rate/A	Timing	Pre-Harvest AM Damage 30 Aug % Sting	% Tunnels	%Clean Fruit	Harvest AM Damage 23 Sep % Sting	% Tunnels	% Clean Fruit
Calypso 4F	8.0 oz	weekly *	17.7 A	7.0 BC	75.3 A	24.3 A	2.7 B	73.0 AB
Assail 30SG	8.0 oz	weekly *	18.0 A	2.0 C	80.0 A	16.0 AB	2.0 B	82.0 A
Delegate 25W	7.0 ox	weekly *	7.3 A	11.0 BC	81.7 A	14.3 AB	12.3 B	73.3 AB
Altacor 35W	4.5 oz	weekly *	7.0 A	24.7 B	68.7 AB	10.3 B	25.3 AB	64.3 AB
Guthion 50WSB	3.0 lbs	weekly *	9.3 A	4.7 BC	86.0 A	16.0 AB	10.0 B	74.0 AB
Untreated Check			6.7 A	47.3 A	46.0 B	4.7 B	51.3 A	44.0 B

* - application dates were 19 Jul, 26 Jul, 1 Aug, 8 Aug, 16 Aug and 23 Aug
Means within a column followed by the same letter are not significantly different. (Students t Test)

Chart 1



PURITY AND EFFICACY OF COMMERCIAL PHEROMONE LURES FOR MONITORING *Paralobesia viteana* IN VINEYARDS

Timothy Jordan[1], Aijun Zhang[2] and Douglas Pfeiffer[1]
[1] Virginia Tech, Department of Entomology, Blacksburg, VA,
[2] Invasive Insect Biocontrol and Behavior Laboratory, USDA-ARS-PSI, Beltsville, MD

Introduction

Pheromone monitoring is employed in Virginia vineyards to observe the phenology of *P. viteana*. For some time it has been known that most *P. viteana* are captured in vineyard traps around bloom, and larvae are found feeding among cluster florets. At this time, chemical controls are applied to eggs and larvae. After bloom, larvae tunnel into the berry leaving only a brief window for control during egg-laying by successive generations. Despite increasing levels of injury in the vineyard through the season, vineyard catch dwindles to few or nonexistent. This late season drought of catch constrains control measures based on pheromone monitoring of insect activity. As such, the ineffectiveness of lure attraction to *P. viteana* was the impetus behind this study.

The objective was to determine whether the purity and efficacy of commercial pheromone lures from different manufacturers affect attraction to *P. viteana* and a non-target species, *E. argutanus*, in the field. Lures that were obtained commercially were loaded with a 9:1 blend of Z9-12:Ac and Z11-14:Ac. The *E* isomer (E9-12:Ac) is considered a contaminant in lures and can contribute to decreased attraction to *P. viteana*. This experiment was conducted in the laboratory and the field using lures from four manufacturers: Alpha Scents Inc., ISCA Technologies, Suterra, Trece Inc. Lure names are coded hereafter. Gray elastomer was used as the base substrate in ISCA septa and red rubber with the other lures.

Methods

Laboratory validation of lures was done using qualitative and quantitative analyses measured using gas chromatography-mass spectrometry. At this time, limited qualitative analyses have been performed, which confirmed that all lures contained a ternary blend including the isomer of the primary component. Additional analyses will be done using chemical standards to determine relative concentrations of lure components.

Field pheromone trapping was done using competitive attraction experiments between lure manufacturers and vineyard environment. The same methods were done in two Concord vineyards from June – August in 2010 & 2011 in an open and wooded vineyard. Four trap stations were deployed in each vineyard. Trap stations consisted of four white delta traps loaded with sticky card inserts arranged on a grid hung at 1.5 – 2 m on a Geneva double curtain trellis. All traps faced the same row-middle and the grid locations within a station were randomized weekly. Counts were made weekly over two lure sets, each lasting four weeks. Target species were counted and removed from the liner.

Open and wooded catch data were analyzed separately. The weekly count data were coded as binomial responses, and logistic regression was used to compare probability of catch among commercial lure manufacturers.

Results and Discussion

An *E* isomer blend component was found in lures from all manufacturers in a preliminary qualitative chemical analysis. The effort is ongoing to determine approximate lure constituents and respective loadings of synthetic pheromones. These quantitative analyses may provide insight into whether the quantities of the *E* isomer or loadings affect the attraction of lures to the moths.

Fewer *P. viteana* were captured in 2010, and limited catch was observed over both years in the wooded vineyard. Lures C and A captured the most moths across both years in the open vineyard. Although it seems monitoring for *P. viteana* is impractical in wooded vineyards, *E. argutanus* attraction does not appear different between environments. In both vineyards, lure A and D captured the fewest and the most *E. argutanus*, respectively.

Catch differences between lures were observed for catch of both moth species. Lures with greater attraction to the target species may be limited by their attraction to non-target insects. Specifically, by catching more *E. argutanus*, lures B, C & D may lead to premature degradation of trap sticky surfaces and increase the risk making a management decision based on misinformation of the target species. Lastly, additional research should address the origin of E9-12:Ac in lures and whether ternary blends containing the *E* isomer have any effect on the attraction of target and non-target species.

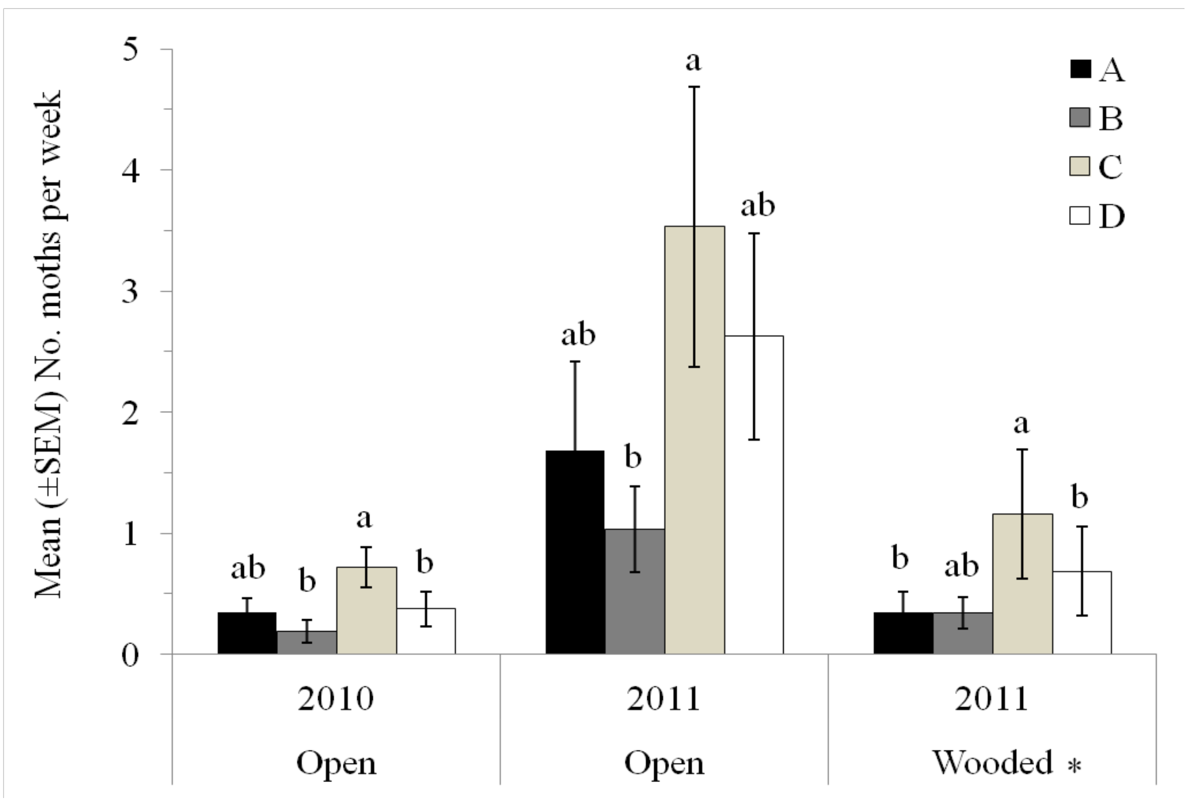


Figure 1. *P. viteana* mean catch (±SE) in an open and wooded vineyard environment. Within groups, bar means with same letter not significantly different (Logistic regression, $P < 0.05$; * $P = 0.067$).

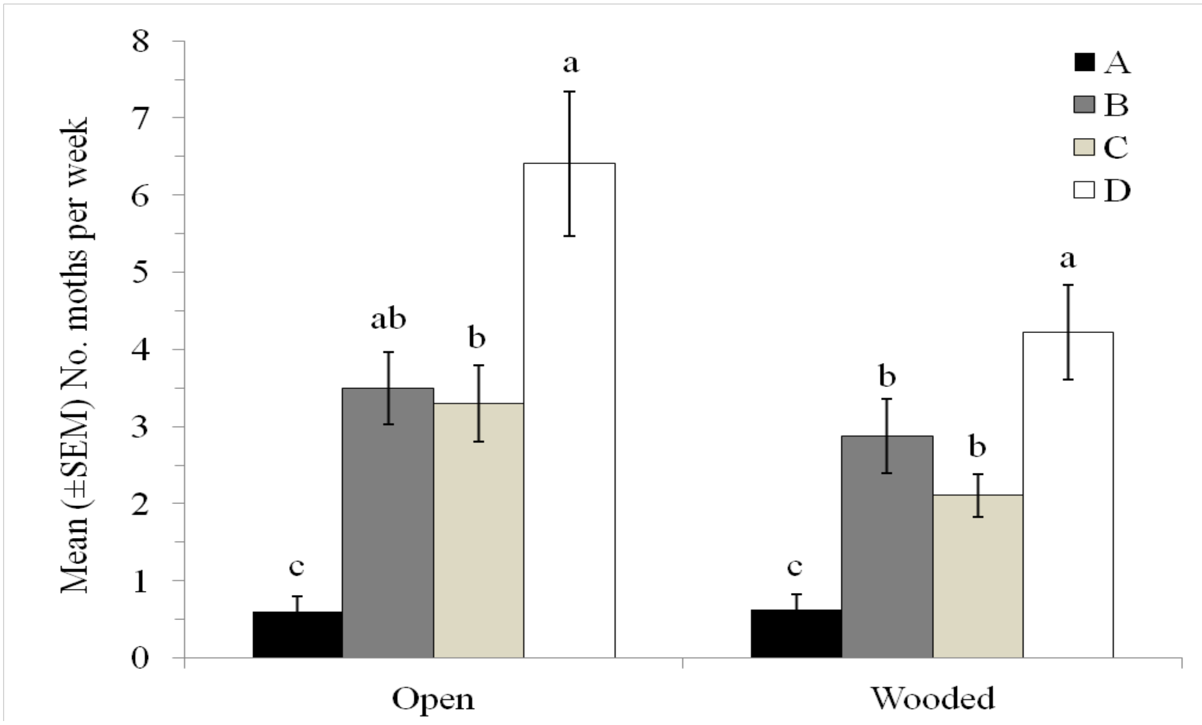


Figure 2. Pooled over both study years, *E. argutanus* mean catch (±SE) in an open and wooded vineyard environment. Within groups, bar means with same letter not significantly different (Logistic regression, $P < 0.05$).