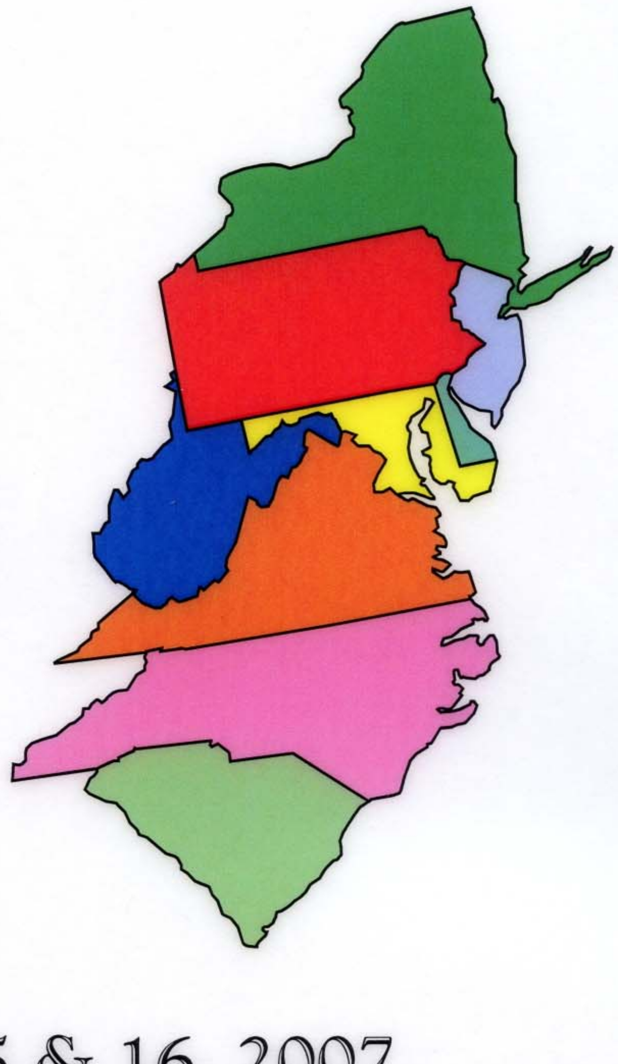
PROCEEDINGS

83rd

CUMBERLAND-SHENANDOAH FRUIT WORKERS CONFERENCE



November 15 & 16, 2007

WINCHESTER, VIRGINIA

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83rd Annual Cumberland-Shenandoah Fruit Workers Conference
November 15th - 16th, 2007
Hampton Inn and Conference Center, Winchester, Virginia

CONFERENCE AGENDA

Thursday November 15th

8:00 – 9:00 a.m.	Registration
9:00 – 9:05 a.m.	Call to order – 83rd Annual Cumberland-Shenandoah Fruit Workers Conference – *Washington Room*
9:05 – 9:30 a.m.	Call of the States
9:30 – 10:00 a.m.	General Session Theme – Organic Fruit Production – *Washington Room*
	PROFIT 2007 An Update. *J.W. Travis. Pennsylvania State University.*
	Market Opportunities for Organic Tree Fruits in the Mid-Atlantic: Some Observations. *Matt Harsh. Pennsylvania State University.*
10:15 – 10:30 a.m.	Break
10:30 – 11:45 a.m.	General Session Continued
	Putting Together a Winning Organic Tree Fruit Proposal. *Mark Brown. USDA-ARS Kearneysville.*
	Impact of Organic Pest Control on Productivity of 15 Apple Cultivars. *D. A. Rosenberger, P. J. Jentsch, and F. W. Meyer. Cornell University.*
Noon – 1:00 p.m.	Lunch – *Washington Room*
1:00 – 5:00 p.m.	Concurrent Sessions Entomology – *Washington Room* Horticulture – *Jefferson Room* Pathology – *Madison Room*
5:30 – 7:30 p.m.	Mixer (Sponsored by: Bayer CropScience, CBC America, Chemtura, Dow AgroSciences, Dupont Crop Protection, Gowan, Suterra, Syngenta, and Uniphos) – *Pre-registration Room*

Friday November 16th

8:00 – 9:00 a.m.	Business Meeting – *Washington Room* **Electronic Information Sharing: listserv and Scholar.** *Doug Pfeiffer. Virginia Polytechnic Institute and State University.*
9:00 a.m. – Noon	Concurrent Sessions (as needed)

CONCURRENT SESSIONS AGENDA

Entomology Session – *Washington Room*

<u>Thursday Afternoon, November 15th, 2007</u>

1:00 – 1:15	**Some Questions about Codling Moth Resistance Management.** *Jim Walgenbach, Vonny Barlow, Leonardo Magales. North Carolina State University.*
1:15 – 1:30	**Codling moth resistance and associated phytochemical variation in fruit of *Malus tschonoskii*.** *Clayton T. Myers. USDA-ARS Kearneysville.*
1:30 – 1:45	**Management of a high codling moth infestation in the vicinity of an apple packinghouse.** *Henry W. Hogmire. West Virginia State University.*
1:45 – 2:00	**Sustainable codling moth mating disruption in diverse agricultural environments.** *Peter McGhee, David Epstein, Larry Gut*
2:00 – 2:15	**Challenges in monitoring of codling moth.** *Greg Krawczyk and Larry A. Hull. Pennsylvania State University.*
2:15 – 2:30	**Rutgers Tree Fruit Entomology: 2007 results.** *Peter W. Shearer and Ann Rucker. Rutgers University.*
2:30 – 2:45	**Efficacy and Possible Use Patterns of Altacor, Belt, and Delegate for Internal Lepidoptera and Leafroller Control on Apples.** *Larry Hull and Greg Krawczyk. Pennsylvania State University.*
2:45 – 3:00	**Ultor 150SC for Control of Apple Pests.** *David Combs. Cornell University.*
3:00 – 3:15	Break
3:15 – 3:30	**Pollinators As Bioindicators in Pennsylvania Reduced Risk IPM Apple Orchards.** *David Biddinger, Jim Frazier, Maryann Frazier, and Rick Donovall. Pennsylvania State University.*
3:30 – 3:45	**The role of extrafloral nectar in manipulating biological control in orchards.** *Mark W. Brown, and Clarissa R. Mathews. USDA-ARS Kearneysville.*
3:45 – 4:00	**Eco-Apple: A project to produce certified reduced-risk fruit for the specialty market - Year 1 Report.** *Harvey Reissig, Art Agnello and Jan Nyrop. Cornell University.*
4:00 – 4:15	**Disruption of dogwood borer mate finding using a behavioral antagonist.** *Tracy C. Leskey, J. Christopher Bergh, Jim Walgenbach, and Aijun Zhang.USDA-ARS Kearneysville.*
4:15 – 4:30	**Optimizing pheromone trapping for dogwood borer.** *C. Bergh, T. Leskey and A. Zhang.Virginia Polytechnic Institute and State University.*
4:30 – 4:45	**Possible regional variation in over-wintering stage of *Oncometopia orbona*, vector of Pierce's disease: Basis for additional research.** *Anna K. Wallingford and Douglas G. Pfeiffer. Virginia Polytechnic Institute and State University.*
4:45 – 5:00	**Control of Japanese beetle in primocane-bearing brambles – 2007.** *Laura M. Maxey and Douglas G. Pfeiffer. Virginia Polytechnic Institute and State University.*

CONCURRENT SESSIONS AGENDA

Pathology Session – *Madison Room*

Thursday Afternoon, November 15th, 2007

1:00 – 1:15	**Fire blight control with antibiotics and integrated treatments in 2007.** *K. S. Yoder. Virginia Polytechnic Institute and State University.*
1:15 – 1:30	**Highlights of apple fungicide testing in 2007.** *K. S. Yoder. Virginia Polytechnic Institute and State University.*
1:30 – 1:45	**Phosphite Fungicides: A New Tool for Apple Disease Control?** *D. A. Rosenberger, F. W. Meyer, and A. L. Rugh. Cornelll University.*
1:45 – 2:00	**Can Preharvest Sprays Control Postharvest Decays of Apples?** *D. A. Rosenberger, F. W. Meyer, and A. L. Rugh. Cornell University.*
2:00 – 2:15	**Evaluation of Products for Bacterial Spot Control.** *Ngugi, H.K., Travis, J.W., Halbrendt, N.O., and Lehman, B.L. Pennsylvania State University.*
2:15 – 2:30	**Peach disease and postharvest apple disease control tests in 2006-07.** *K. S. Yoder. Virginia Polytechnic Institute and State University.*
2:30 – 2:45	**Management of Peach Brown Rot, Scab, and Rusty Spot: Efficacy and Comparison of Experimental Fungicides.** *N. Lalancette, K. McFarland, and A. Burnett. Rutgers University.*
2:45 – 3:00	**Bacterial Spot of Stone Fruit: Efficacy of Copper Hydroxide, Kasugamycin, and Phosphorous Acid.** *N. Lalancette and K. McFarland. Rutgers University.*
3:00 – 3:15	Break
3:15 – 3:30	**Mechanism of DMI fungicide resistance in *Monilinia fructicola* and evidence of predisposition to QoI fungicides.** *Guido Schnabel and Chao-Xi Luo. Clemson University.*
3:30 – 3:45	**Promotion and Inhibition of *Monilinia fructicola* Sporulation by QoI Fungicides.** *A. Burnett, N. Lalancette, and K. McFarland. Rutgers University.*
3:45 – 4:00	**Epidemiology of Cherry Leaf Spot on Tart Cherry in Pennsylvania.** *Ngugi, H.K., Travis, J.W., Halbrendt, N.O., and Lehman, B.L. Pennsylvania State University.*
4:00 – 4:15	**Reduced Program for Control of Apple Diseases.** *James W. Travis , Noemi O. Halbrendt, and Brian Lehman. Pennsylvania State University.*
4:15 – 4:30	**Evaluation of Alternative and Organic Fungicides for Management of Peach & Nectarine Diseases.** *Noemi O. Halbrendt , James W. Travis, Brian Lehman and Henry Ngugi. Pennsylvania State University.*
4:30 – 4:45	**Performance of four spray programs for grape disease control.** *Anne DeMarsay. University of Maryland.*
4:45 – 5:00	**Harvest Rot Mangement on Grapes.** *Brian Lehman, Noemi O. Halbrendt, and James W. Travis. Pennsylvania State University.*

CONCURRENT SESSIONS AGENDA

Horticulture Session – *Jefferson Room*

Thursday Afternoon, November 15th, 2007

1:00 – 1:15	**Effects of AVG, 1-MCP and NAA on preharvest fruit drop and expression of genes related to ethylene biosynthesis, perception and cell wall degradation in 'Delicious' apples.** *Jianguo Li, Rongcai Yuan. Virginia Polytechnic Institute and State University.*
1:15 – 1:30	**Efficacy of a sprayable formulation of 1-MCP on apple quality after long-term storage.** *S. McArtney, J. Schupp, M. Parker, J.D. Obermiller, Edney and T. Edgington. North Carolina State University.*
1:30 – 1:45	**Response of young apple trees to grass and irrigation.** *T. Tworkoski and D.M. Glenn. USDA*
1:45 – 2:00	**Calcium sprays reduce bitter pit in 'Honeycrisp'.** *Steve Miller and Mark Brown. USDA*
2:00 – 2:15	**Performance of an airblast sprayer configured with conventional or air-induction nozzles.** *Steve McArtney and JD Obermiller. North Carolina State University.*
2:15 – 2:30	**Ethrel or NAA treatments for increasing return bloom of biennial apple cultivars in the Southeast.** *S. McArtney, R. Unrath, and J.D.Obermiller. North Carolina State University.*
2:30 – 2:45	**'Sunrise' – A New Pear Cultivar from the USDA Breeding Program.** *R. L. Bell and T. van der Zwet. USDA-ARS Kearneysville.*
2:45 – 3:00	Discussion
3:00 – 3:15	Break
3:15 – 3:30	**Influence of essential oil application and defoliation on blossom thinning of peach and apple trees.** *Steve Miller and Tom Tworkoski. USDA-ARS Kearneysville.*
3:30 – 3:45	**Chemical and Mechanical Thinning of Peaches.** *Maggie Reid*, Tara Baugher, Jim Schupp, Steve Miller, Matt Harsh, Katy Lesser, Katie Reichard. Pennsylvania State University.*
3:45 – 5:00	General Discussion

CONCURRENT SESSIONS AGENDA

Entomology Session – *Washington Room*

Friday Morning, November 16th, 2007

9:00 – 9:15	**Small-plot and whole-farm assays of obliquebanded leafroller management strategies.** *Art Agnello, Harvey Reissig and Jan Nyrop. Cornell University.*
9:15 – 10:30	**PAWS.COM (AWMD) - Year 2 (2007) in Review: Results, Additions, and Changes.** *Eric Bohnenblust, Larry A. Hull, Greg Krawczyk, David Biddinger. Pennsylvania State University.*
10:30 – 10:45	**A geospatial approach to landscape level population dynamics of *Euschistus spp.* stink bugs.** *R. Mizell, T. Cottrell, J. Green and C. Riddle*
10:45 – 11:00	**Eastern tree fruit Risk Avoidance and Mitigation Program (RAMP): Year I results from Virginia.** *Siddharth Tiwari and Chris Bergh. Virginia Polytechnic Institute and State University.*
11:00 – 11:15	**Feasibility of the whole-Farm Approach to pest Management in Eastern Apple Production; Where we are after the first year.** *Vonny M. Barlow and James F. Walgenbach. North Carolina State University.*
11:15 – 11:30	**Spatial distribution and treatment of blueberry maggot, year 2.** *Dean Polk, Cesar Rodriguez-Saona, Peter Oudemans. Rutgers University.*
11:30 – 12:00	General Discussion

83rd Cumberland-Shenandoah Fruit Workers Conference
Program Highlights and Business Meeting Minutes November 16, 2007

New Jersey (Rutgers University) and South Carolina (Clemson University) were the co-hosts of the 83rd Cumberland-Shenandoah Fruit Workers Conference at the Hampton Inn and Conference Center in Winchester, VA on November 15th and 16th 2007. The registration fee was $60 in advance and $75 at the conference. The general chair was Dan Ward with Gail Lokaj serving as secretary and Steve Miller as treasurer.

The meeting began at 9:00 AM on Thursday November 15th with the traditional "Call of the States" wherein brief oral reports of crop, weather and pest conditions were given by representatives from the participating states. A general plenary session followed with a theme of "Organic Fruit Production". Presentations in the general session were given by Jim Travis, Mark Brown, and Dave Rosenberger. In the afternoon concurrent sessions for Entomology, Plant Pathology, and Horticulture were held. A social mixer was held on Thursday evening sponsored by: Bayer CropScience, CBC America, Chemtura, Dow AgroSciences, Dupont Crop Protection, Gowan, Suterra, Syngenta, and Uniphos. Friday morning's business meeting was followed by the remaining session in Entomology.

The business meeting was called to order at 8:00 AM by general chair Dan Ward.

The Treasurer's report was presented by Steve Miller (see financial report). The question of whether there was a need to increase registration cost was discussed. General consensus was that an increase was not needed. Doug Pfeiffer made a motion to accept the treasurer's report. Alan Biggs seconded the motion, which was unanimously accepted.

Section reports for Entomology, Plant Pathology and Horticulture were presented by Dean Polk, Norm Lalancette, and Dan Ward respectively. There were 21 Entomology presentations, 12 Plant Pathology presentations, and 9 Horticulture presentations.

The host for the 2008 conference will be New York. Art Agnello will serve as general chair. To avoid conflicting with the planned Entomology Society of America meeting and NC-140 meeting this meeting has been moved to the first week in December. The date for the 2008 Cumberland-Shenandoah Fruit Workers Conference was set as December 4th and 5th.

There was a discussion of whether industry representatives from chemical companies should be invited to present at future conferences. It was suggested that their slides should be previewed to insure that there was no advertising. Norm Lalancette made a motion that in preparation for next year's conference, the Chair contact one representative of each company that has attended in the past, to determine their interest in participating. Doug Pfeiffer seconded the motion. Motion was passed unanimously.

Peter Shearer thanked the industry representatives for their contributions. The group was asked if we should include registration gratis for making a donation. Steve Miller replied that in the past the feeling was that a contribution was made by the company by their own free will and that registration for the conference was a separate item. Industry representatives explained that it is standard procedure to consider donations and registration fees as two different issues.

Doug Pfeiffer made a presentation concerning a possible future for electronic communications for the group titled: *Electronic Information Sharing: CSFWC Listserv and Scholar*. He has created a moderated listserv for the group (csfwc@listserv.vt.edu). He has also initiated a website using the *Scholar* system. Clayton Meyers made a motion that Doug Pfeiffer set up the site to include everyone. Anne DeMarsay added that it be set up experimentally to make sure that there is not too much administrative work and run it on a trial basis. Alan Biggs seconded the motion, which passed unanimously. Doug informed everyone that once added to the site, each member would receive an e-mail with a password which will give access to the site. Initially this privilege will be open to all members, not just those attending this year's meeting. The *Scholar* e-mail address for CSFWC: CSFWC@scholar.vt.edu

Anne DeMarsay made a motion of appreciation to the industry representatives for their donations sponsoring the excellent mixer which provided the opportunity to meet with people that we may only see once a year.

It was recommended that the next meeting Chair reserve some time for general discussion. Limiting the general session to one speaker and utilizing the remaining time in whatever way the group saw fit was discussed and approved unanimously by vote. It was agreed to put it in the minutes that this vote be adhered to at the next meeting.

The business meeting adjourned at 9:30 a.m.

Respectfully submitted by,

Gail Lokaj, Secretary, Rutgers University
Steve Miller, Treasurer, USDA Kearneysville, WV
Dan Ward, General Chair, Rutgers University

Financial Report

2006/2007 Cumberland-Shenandoah Fruit Workers Conference

Balance Preceding the 2006 Meeting (11/15/06) -	**$687.29**

Income (2006) –

Receipts from registration (78)	**$5,115.00**
Support for Mixer	**$1,200.00**
Total Assets (Nov. 18, '06)	**$7,002.29**

Expenses (Nov. '06 to Oct. '07)–

Hampton Inn – room rental	
Luncheon, breaks, mixer	**$3436.68**
Proceedings, 2006 (copy, bind, etc.)	**875.12**
Laminate covers	**89.70**
Postage and handling	**259.29**
Meeting requirements(name badges, etc.)	**60.99**
Total Expenses (2006-'07)	**$4,721.78**

Additional Income (2006/2007)

Interest on Account(Nov.'06-Oct.'07)	**26.71**
Sale of Proceedings	**30.00**
Balance as of 11/14/07	**$2,337.22**
Paid Registrations, '07 (78)	**$5,055.00**
Donations to CSFWC Mixer	**3,000.00**
Balance as of 11/16/07	**$10,392.22**

CSFWC Registrations –	**Meeting Hosts**
2007 - 78	
2006 - 78	
2005 - 60	**2007 - NewJersey/SC**
2004 - 70	**2008 – New York**
2003 - 50	**2009 - Virginia**
2002 - 71	**2010 – Maryland/WV**
2001 - 86	**2011 - North Carolina**
2000 - 67	**2012 - USDA**
1999 - 73	**2013 - Pennsylvania**
1998 - 58	**2014 – New Jersey/SC**
1997 - 69	**2015 - New York**

Total Meeting Costs	**Cost per attendee**
1997 - 2,563.73	**37.15**
1998 - 2,491.95	**42.96**
1999 - 2,805.55	**38.43**
2000 - 3,596.31	**53.67**
2001 - 3,935.10	**45.76**
2002 - 3,055.21	**43.03**
2003 - 2,841.22	**56.82**
2004 - 3,747.77	**53.54**
2005 - 3,131.76	**52.20**
2006 - 4,721.78	**60.54**

CALL OF THE STATES

New Jersey Crop Conditions – 2007

David Schmitt, Dean Polk
Rutgers Cooperative Extension

In southern counties, peach full bloom was on April 21 and apple full bloom was on April 30.

Cropping was good on both peach and apple despite a frost on April 11 when temperatures dropped to the mid 20's. Cropping was reduced on peaches in the coldest areas but otherwise we had a normal crop. In general, disease problems were not prevalent this year despite a wet spring. Susceptible peach varieties experienced severe bacterial spot, however we escaped any major epidemics. Peach scab was troublesome in only a few orchards. Sooty blotch and flyspeck symptoms were nonexistent on all but the latest apple cultivars due to a very dry August and September. Corking was also noted in many apple varieties and high percentages were noted in orchards without irrigation. It was very difficult to distinguish between corking and suspected stinkbug injury. Thrips were troublesome on Nectarines at petal fall especially where no effective materials were used. Severe injury was noted in these cases. Plum curculio was also troublesome in both peach and apple. Over reliance on pyrethroid insecticides has made both plum curculio and San Jose scale difficult to control.

Orchards in North Jersey had many of the same issues as were found in the southern part of the state. In addition, fireblight was a problem in many apple orchards. A late season hailstorm severely damaged several orchards in Hunterdon County.

Wholesale prices for tree fruit improved over 2006, and most growers maintained both volume and price.

Blueberry acreage increased slightly since 2006, with at least 3 tree fruit growers planting over 600 acres of blueberries. Wholesale prices increased over 2006. Pest pressure was light, but spring frosts hurt the early variety ‘Duke’ on some farms.

CUMBERLAND-SHENANDOAH FRUIT WORKERS CONFERENCE

Call of the States Report – New York, 2007

Art Agnello, Entomology
NYS Agricultural Experiment Station, Geneva

After a mid-April drenching, and even a foot of snow in some higher elevations, things dried out, with Geneva receiving only 57% of normal rainfall for the period May–August. September started out equally dry, but eventually got some normal rainfall amounts. Despite good quality in both the pome and stone fruit crops, the lack of rain resulted in some fruit size issues by harvest time. In terms of degree day accumulation, however, we ended up right about normal. Most spring insect activity was very low-key and predictable, with no real events of note except a very pleasant progression through pink bud, bloom and petal fall. Once Memorial Day passed, however, it was another story entirely; we were routinely in the high 80s, heat units were even with or ahead of average, and the rainfall totals dropped to deficit levels.

As in 2006, the weather had the positive effect of obstructing many of the early season pests such as **European red mite, spotted tentiform leafminer,** and **pear psylla**. The same was initially true also for **rosy apple aphid**, which was essentially absent from most orchards we were scouting, until sometime after petal fall, when many sites suddenly showed up with troublesome infestations, often in combination with **green aphids**, that needed attention if only to prevent the buildup of honeydew, sooty mold and foliar deformities. Similar to the last two years, there was enough post-bloom heat to give **plum curculio** a boost through its oviposition period, so that most locations were able to get by with just the petal fall and 1st cover applications to obtain sufficient protection.

The traditional summer moth pests seemed to maintain their pattern of heavy flights this year, among them **obliquebanded leafroller** and the **internal worm (oriental fruit moth, codling moth, etc.)** complex, with high moth catches and some fruit damage showing up in the traditional high-pressure spots. Some new chemistry appeared to tame many of the early season OBLR problems, and many growers did a good job of staying on top of the internal worms, although by harvest, codling moth reasserted its need to be considered a predictable key NY pest rather than a troublesome footnote in a few local spots. As before, more growers have been using OP-alternative CM and OFM control measures (including mating disruption, neo-nics like Assail and Calypso, and CM virus) around the state.

Apple maggot suffered from the summer heat this year, as the dry soil conditions hampered its ability to emerge in normal numbers from the overwintering pupal sites in the ground. **European red mite** populations were unexpectedly slow to build, possibly because of the effective preventive and rescue acaricides available, although eventually a number of orchards did develop some late season mite populations, including peach and other stone fruit plantings, which came up with the **twospotted spider mites** that we tend to expect during hot and dry years. **Woolly apple aphid** was evident in a number of places once again, showing up early but not necessarily taking off the way they are capable of doing.

Other sporadic summer pests were also to be found, depending on the specific locality: **pear psylla** and **potato leafhopper**, **stink bugs,** and **San Jose scale** all generated their share of attention in one area of the state or another. For the second year running, **tent caterpillars** and **Japanese beetle** were also notable for their abundance during midsummer.

Call of the States – Virginia

Horticulture: The Easter freeze caused serious damage to peaches, cherries and red 'Delicious' apples in central and southern Virginia, although 'Golden Delicious', 'Fuji' and 'Gala' apples were fine due to fruit produced by a late bloom that was caused by the freeze. In northern Virginia, cloud cover and moving air ameliorated the effects of the freeze and although some loss of king bloom on apples occurred, yields of peaches and apples were normal (about 6 million bushels of apples in 2007, compared with 5.7 million bushels in 2006). Warm weather during fruit thinning in mid and late May translated to good thinning. Apples ripened normally although the weather was dry and warm in August, September, and October.

Plant Pathology: About half of the days in April and May were favorable for mildew infection, which translated into a year in which powdery mildew was more problematic than scab. Growers who used fewer SI applications because of concerns about resistance in apple scab, but rather opted for scab/rust protectants such as EBDCs, should expect increased prevalence of mildew and be aware of its chronic effects on yield.

Infrequent, relatively brief wettings prolonged the cedar-apple rust gall inoculum into June in the Winchester area. Although this is a rather unusual occurrence, the same was situation has now occurred for two consecutive years.

Actual *MARYBLYT* infection periods occurred at the Winchester AREC on April 24, 25, 27 and on May 1-2 and scattered fire blight was not uncommon in commercial orchards.

The first report of Alternaria leaf blotch on Red Delicious foliage in southern Frederick County occurred in the fall of 2006. In the fall of 2007, it was reported north of Winchester, although we have not yet identified it in Red Delicious plantings at our research station. Summer diseases: This was not an unusual year for summer diseases, although however a localized hail event on August 25 likely increased the rot inoculum pressure in some orchards.

Questions regarding calcium uptake an bitter pit/ cork spot problems have been raised. This may have been due to low rainfall at critical times and there may be some confusion about distinguishing hail injury from cork spot symptoms.

Peach mildew and rusty spot were quite common on susceptible varieties, as should be expected in seasons favorable for apple powdery mildew.

Entomology: Cool weather in April, including three nights with lows between 26 and 29ºF during the Easter weekend translated into the latest OFM biofix since 2000. An abrupt warm-up on April 20 resulted in a strong and sustained flight of OFM starting that evening. Continued warm weather resulted in CM and TABM biofix dates that conformed to previous seasons. Aphid populations were not problematic and leafminers and leafhoppers were not abundant in the post-bloom period. Potato leafhopper did damage in local commercial orchards. Mites were not of particular concern. Growers, scouts and researchers are still having issues with differentiating between cork-spot and stink bug in some locations. Many growers report diminishing susceptibility of internal worms to azinphosmethyl and problems with infested fruit at harvest. In response, local processor seems to have somewhat relaxed standards with respect to fruit showing internal worm damage, relative to previous years. In Februray, a grower from near Roanoke reported damage during the 2006 harvest that was, in all likelihood, from European apple sawfly. This unconfirmed report would represent the farthest south that this damage has been reported, and is in agreement with on-going reports of the southward range expansion of this pest.

West Virginia State Report

Horticulture (Steve Miller)

Weather, as often, was the overriding factor in growing fruit crops in WV in 2007. A week of mild weather in March pushed bud development and resulted in an early bloom for peaches and advanced development for apple and other fruit crops. This was followed by an extended period of very cold temperatures and the infamous “Easter freeze”. In Berkeley and Jefferson Counties, the tree and small fruit crops escaped most of the damage from the freeze with low temperatures in the mid-20’s, but further west in Hampshire County low temperatures were near 20°, resulting in a 20% peach crop and 70% apple crop. A prominent blueberry grower near Morgantown suffered a 100% loss of crop. Sweet cherry was impacted the most throughout the fruit growing region, with 70-100% crop loss in Hampshire County, and a smaller crop than initially anticipated in Berkeley and Jefferson Counties. Warm dry conditions generally prevailed through the summer, which helped to reduce weed growth and was somewhat a benefit to peaches. By early October most of the fruit growing region in the state was showing a rain deficit of 8 to 10 inches. Fruit size was better than expected where thinning was adequate, but the window for good apple thinning was narrow and complicated by the unusually cold temps in early May. With the dry conditions, fruit finish was excellent on apples, peaches and sweet cherry, and for the second consecutive year Goldens had very smooth skin, at least by eastern standards. For several weeks during apple harvest temperatures remained in the mid to upper 80s resulting in poor color on many red cultivars, advanced fruit softening, excessive fruit drop, and more sunburn than most observers can recall in recent memory. ReTain worked well on a few apple varieties like Empire, Mutsu, and Fuji, but poorly on others like York and even some Goldens. Labor continued to be a concern for many growers and the lack of a good immigration policy and potential sanctions/fines for using illegals had many growers uneasy. Overall the WV peach crop was slightly below normal and the apple crop was down slightly from previous years partly as a result of crop loss in regions outside the immediate panhandle and partly due to fewer orchards in production. West Virginia growers continue to diversify their operations to attract customers and maintain a viable fruit growing business.

Plant Pathology (Alan Biggs)

This was another relatively mild and dry year in West Virginia, our third consecutive year with below-normal precipitation. Most counties in the state qualified for drought emergency assistance. During the period March 31 to June 1, there were 7 infection periods conducive to apple scab. Scab lesions were first observed on 14 May in nonsprayed blocks from the April 26-27 infection period. With about 10% leaf scab incidence in non-sprayed blocks, 2007 turned out to be one of the lightest scab years in recent history.

Fire blight levels were surprisingly high in some locations. First open bloom occurred on 22 April. Although no wetting was recorded on that date, high winds occurred and blossom infections were noted on the cultivar Empire. Fire blight infection periods occurred on 1-2 May, and then there were several possible days for infection on later blooming varieties during the extended bloom period on 9-12 May. Little secondary spread was observed in locations with proper timing of streptomycin applications. Where no streptomycin was used, blossom and shoot infections were observed on the cultivar Jonathan on May 24 and a few days later on other cultivars.

Wetting hours accumulated despite the dry periods, due to several periods of extended wetting. We reached 250 accumulated wetting hours during the week of July 16, two weeks later than last year. Sooty blotch was first observed the week of August 6 at about 342 wetting hours, and fly speck was first observed about a week later at 358 hours of accumulated wetting.

Hail on August 25th caused extensive bruising and laceration injuries to fruit in some locations. Many orchards also exhibited a higher-than-normal incidence of fruits with calcium-related disorders, including corking and bitter pit. The combination of these physical and physiological injuries to fruit, as well as increased rot inoculum on fire blight-killed shoots, along with extended warm harvest weather conditions were very favorable for rot development, and resulted in increased rot incidence at harvest in some locations.

Entomology (Henry Hogmire)

Compared with last year, biofix dates for our Lepidopteran pests were 21 days later for oriental fruit moth, and 9 and 8 days later for codling moth and tufted apple bud moth, respectively. However, by June 1, and for the rest of the season, insect development based on degree days was within 1-3 days of last year. There were no extraordinary pest problems in 2007. Fruit injury from internal worms (with CM increasing) and stink bugs continue to be issues for many growers. However, personnel from the Knouse Foods Musselman plant indicated that the number of loads rejected for internal worms was less than last year.

GENERAL SESSION

PA Regional Organic Fruit Industry Transition (PROFIT) Update

Travis, J. W., Schupp. J., Krawczyk, G., and Halbrendt, N, O
Penn State Fruit Research & Extension Center
Department of Plant Pathology
Biglerville, Pennsylvania 17307

Apple production practices utilized over the last 40 years are being replaced by new organic and sustainable approaches to growing fruit. Cultural and pest management methods that are profitable, environmentally sound and focused on meeting consumers' expectations for food safety and quality are being developed.

In 2004, an organic apple demonstration orchard was established at PSU Fruit Research Center to provide researchers and growers with the opportunity to observe best organic practices for local organic apple production (Fig. 1). The first certified organic fruit was produced and sold in 2006. The organic apple project was named Pennsylvania Regional Organic Fruit Industry Transition (PROFIT). "GoldRush" and "Enterprise" apples were planted in a 2 acre research and demonstration orchard. These two apple cultivars “Enterprise” and “GoldRush”, were selected for the demonstration block for their resistance to diseases and for their potential as processing or fresh market varieties.

A spray program consisting of NOP / OMRI / PCO (National Organic Program / Organic Material Review Institute / Pennsylvania Certified Organic) approved organic pesticides and herbicides were utilized. In 2007 growing season, Copper, Sulfur, Lime Sulfur and JMS Stylet oil were applied early in the season to protect the trees from diseases. There was no major occurrence of diseases except powdery mildew and cedar apple rust. Neem (Azadirect), B. t. (Dipel), CYD-X, Pyganic and Kaolin clay (Surround) were applied to control insects. Rosy and green aphids and Japanese beetle were prevalent during the early and middle crop seasons, respectively. Organic insect management observations made as a result of this project include;

1. The secondary insect pests need to be monitored but in most cases no pesticide treatment was necessary;
2. New pests, not observed so far in the orchard, might pose the biggest challenge, although new tools are also available;
3. Controlling insect pest in organic orchard require a change in mind set about various treatment thresholds;
4. Monitoring is the most important, single element necessary to successfully manage possible insect pests.

Weed management alternatives were evaluated and demonstrated in the orchard including; hand hoeing, weed mowing and “mechanical hoeing”, i.e., Weed Badger™ and propane weed burner. The use of organic herbicides containing vinegar/acetic acid was evaluated but not effective.

Disease management studies have focused on the efficacy of sulfur and lime sulfur applied alone, in combination or in rotation with other organic or alternative fungicides to evaluate for effectiveness on apples (Table 1, Fig. 2). Six of the treatment programs (Trts. 3-5, 7-9) reduced the incidence of scab on shoots and fruit compared to the untreated trees (Fig. 2, 3). Citrex (not yet labeled for organic - Trt. 2) and EF 400 (Trt. 6) did not control scab. Scab on shoots and fruit were significantly reduced when Citrex was tank mixed with Micro Sulf at a low rate (Trt. 3), or when EF 400 was rotated with Micro Sulf at a recommended rate (Trt. 7). Sulfur applied alone, Sulfur combined with Citrex, and Lime Sulfur plus Vigor Cal programs provided comparable control on scab incidence on shoots and scab incidence and severity on fruits. Slight phytotoxicity due to Sulfur applied to young trees at high temperatures was observed but was reduced when Sulfur was tank mixed or rotated with Citrex or Vigor Cal. All treatment programs with sulfur and lime sulfur reduced the incidence of scab on shoots and fruit as well as powdery mildew and cedar apple rust compared to the untreated trees. This project demonstrated that high quality organic apples can be grown in the eastern United States with existing and alternative fungicides currently approved for certified organic fruit.

Studies conducted at the PSU Fruit Research and Extension Center on organically-acceptable fruit thinners in crop season 2006 included the following treatments:

1. Hand thinned control;
2. JMS Stylet oil plus Lime Sulfur (LS) followed by hand thinning;
3. Crocker's Fish oil plus Lime Sulfur, followed by hand thinning.

Oils were applied at 2% and Lime Sulfur at 2.5% by spray truck at 100 GPA. These treatments were applied twice, at petal fall and PF+ 5 days to 7 tree plots. Treatments were applied to plots in both the Surround- and non-Surround-treated plots, with 4 replications in both. Fruit set and yield data was collected from the center 3 trees of each plot, while the time required for hand thinning was collected from all 7 trees in the treatment plot. The weather was cool at the time of treatment, which makes chemical thinning more difficult. Nevertheless, Stylet oil and LS thinned trees reduced the time required to hand thin trees. The effects of Fish oil/ LS were milder in 2006 than in previous studies; however both thinners increased production of large fruit by 8%. There were no treatment trends for pack-out or fruit finish. The primary causes of grade-out were, in order of importance:

1. Sunburn
2. Cracking
3. Cedar Apple Rust

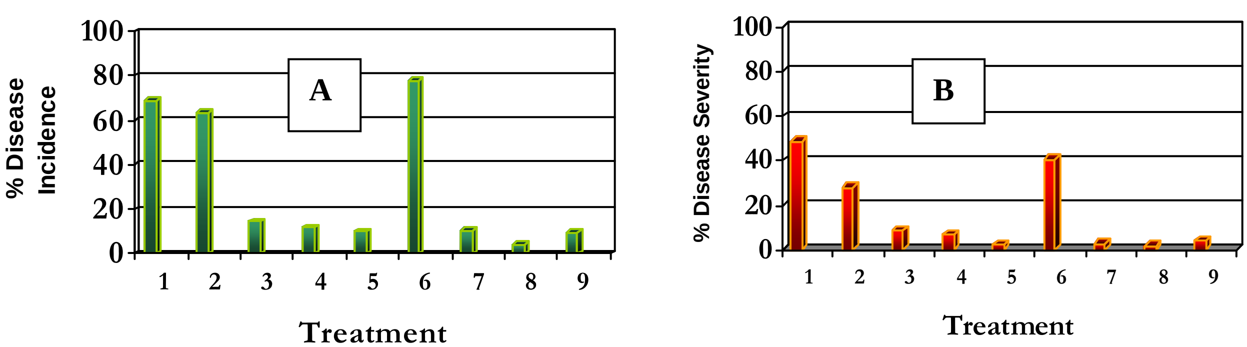
The presence of Surround on half the thinning treatment plots made no difference in the tree response to the treatments.

Fig. 1 Penn State Fruit Research & Extension Center Organic Apple Demonstration Orchard.

Table 1. 2006 Organic Fungicide Program.

Treatment & Rate/A	Timing
1. Nontreated CK	
2. Citrex 8 oz	P-H
3. Citrex 8 oz +	
Micro Sulf 15 lb	P-H
4. Micro Sulf 15 lb	
5. Micro Sulf 15 lb	P-B
Lime Sulfur 2% +	
JMS Oil 2%	PF
MicroSulf 15 lb	1C-H
6. EF-400 OM 32 oz	P-H
7. EF-400 OM 32 oz	
Rot. w/ Micro Sulf 15 lb	P-H
8. Lime Sulfur 1.5% +	P-B
Lime Sulfur 2.0 % +	
JMS Oil 2%	PF
Lime Sulfur 1.0% 14 da	1C-H
9. Micro Sulf 15 lb +	
Vigor Cal 1 gal	P-H

Fig. 2. Scab incidence on leaves (A) and severity (B) on fruits on ‘Golden Delicious’ apple.



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IMPACT OF ORGANIC PEST CONTROL ON PRODUCTIVITY OF 15 APPLE CULTIVARS

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Background: Over the past decade, availability of new products such as kaolin clay particle film (Surround) and spinosad (Entrust), along with the use of lime-sulfur plus fish oil to adjust crop load, have increased the feasibility of organic apple production under NY conditions. However, the best available technologies have rarely (if ever) been combined in full-season, multi-disciplinary evaluations across multiple cultivars.

Our objective in this trial was to evaluate a full-season organic spray program for effectiveness in adjusting crop load (fruit thinning) and in controlling diseases, insects, and mites on 15 apple cultivars.

Methods: Organic insect and disease control strategies were assessed in a 7-yr-old planting at the Hudson Valley Lab that was established as part of the NE-183 multistate project on evaluation of new apple cultivars (see http://www.ne183.org/default.html). The planting contained five single-tree replicates for each of 28 different cultivars arranged in a randomized block design, but only 15 cultivars were used for data collection in this trial. The planting consisted of three long rows with 14 ft between rows and 8.3 ft between trees within rows. The southern row paralleled an overgrown orchard that was abandoned nearly 30 years ago whereas the northern row paralleled other research plots that were minimally sprayed during 2006. Woodlots framed both the eastern and western ends of the test block. Insect and disease monitoring over the past five years has shown that this block is exposed to moderately high but uniform pressure from immigrating plum curculio, apple maggot, and cedar rust spores.

This planting was established in 1999 to evaluate differences among cultivars and therefore did not lend itself to a fully replicated evaluation of the three treatments (unsprayed, standard, organic) that were of interest in this trial. Instead, treatments were applied to complete replicates that had been defined when the orchard was planted. For each parameter evaluated, the Super ANOVA statistical program was used to analyze for differences among cultivars across all five of the replications. Effects of spray treatments were assessed by looking for statistical differences among the replications (or blocks), using the assumption that most of the variability among replications was attributable to different pest control treatments that we imposed on those replicates. Fisher's Protected LSD ($P \leq 0.05$) was used to detect significant differences among both cultivar means and among means from the five replications that were subjected to different pest control programs.

Organic pest control products were applied in three of the five original cultivar replications. Each of these three replicates occupied a single row starting from the western edge of the planting. The northern row was sprayed only from the north side to avoid cross contaminating of the adjoining research plot with "blow-through" from the airblast sprayer. As a result, one replication of the organic treatment was consistently sprayed from one side only. The replication in the middle row was sprayed from both sides and received blow-through deposits from both sides when the adjacent rows were sprayed. The southern row was also sprayed from both sides, but, being the outer row, it received blow-through deposits from only one side.

The fourth replication of 15 varieties was distributed evenly among all three rows, and all trees were sprayed from both sides using standard commercial pesticides. The fifth replication occupied the eastern ends of all three rows and was left as a completely untreated control. Buffer trees (cultivars not used for data collection) occurred at the ends of each row and separated the sections within rows that received different treatments. All trees were trained using the vertical axe system and were supported with conduit stakes attached to a high wire. Trickle irrigation was installed in this block but was not used during the 2006 growing season because timely rains provided adequate soil moisture throughout the season.

Table 1. Products used for disease and insect control in the 2006 field trial at the Hudson Valley Laboratory, Highland, NY.

Program and application dates	Products applied	Rate/A*
Standard fungicide sprays		
3 Apr	COCS	4.0 lb
12 Apr	Dithane	2.3 lb
20, 28 Apr, 8, 15, 24 May, 1, 8 June	Dithane + Rubigan	2.0 lb + 7.67 fl oz
20, 29 June, 11, 20 July, 4, 21 Aug	Topsin M + Captan-80	7.67 oz + 23 oz
Standard insecticide sprays		
15 May	Sevin XLR	2.3 pt
24 May	Imidan	3.83 lb
1, 8, 20, 29 June	Asana	8.4 fl oz
11, 20 July, 4, 21 Aug	Imidan	2.3 lb
Standard fruit thinning spray		
24 May	Fruitone-N	4.6 oz
Organic fungicide sprays		
3 Apr	COCS**	4.0 lb
6 Apr	COCS	2.3 lb
12, 20, 25, 28 Apr, 8, 17, 24 May, 1, 8, 20, 29 June	Microthiol Disperss	11.3 lb
11, 20 July, 4, 21 Aug	Microthiol Disperss	2.3 lb
11, 15 May	Liquid lime-sulfur (LLS)	2.5 gal
Organic insecticide sprays		
6 Apr	Damoil	6.9 gal
20, 25, 28 Apr, 8, 17, 24 May 1, 8 June, 11, 20 July, 4, Aug	Surround WP	38.3 lb
11, 15 May	JMS Stylet Oil	2.0 gal
20 June	DiPel DF	1.53 lb
29 June, 21 Aug	Spintor (instead of Entrust)**	7.67 fl oz
Organic fruit thinning sprays:		
Liquid-lime sulfur plus JMS Stylet Oil applied 11 & 15 May (noted above).		

*Rate/A was calculated based on a tree-row volume of 230 gal/A for dilute sprays.
**COCS and Spintor were used as substitutes in our trial for Champion WP Copper Hydroxide and Entrust, respectively, due to problems accessing the organically approved products.

All of the test materials were applied with a 3-pt hitch Bean airblast sprayer calibrated to deliver 100 gal of spray solution per acre at a travel speed of 2.5 miles per hour. Treatments were generally applied early in the morning under calm conditions.

Standard orchard maintenance practices (fertilizers, herbicides, pruning) were applied across the entire block both to minimize variables that might affect results and to reduce costs for this one-year project. In several cases, we also included in the organic pest control program products that were not approved for organic farmers but which we believed would perform similarly to equivalent products that have OMRI labels. Specifically, COCS and Spintor (neither of which are acceptable in organic programs) were used as substitutes for Champion WP Copper Hydroxide and Entrust due to problems accessing the organically approved products.

Spray application dates and products applied for disease and insect control and for fruit thinning are detailed in Table 1. The organic pest control program was devised using the following generalized rules:

- Apply materials at recommended rates with adjustments as appropriate for tree row volume (TRV). We used TRV-adjusted rates of 200 to 230 gal/A depending on stage of growth.
- For apple scab and fire blight, begin with one or two applications of a copper fungicide.
- For primary scab and rust diseases, apply sulfur (5 lb/100 gal dilute spray) at least weekly beginning after the second copper spray and continuing to mid-June. Shorten spray intervals to less than 7 days if spray deposits are weathered by rainfall totaling one inch or more within the week after application. Liquid lime-sulfur (LLS) should be applied as an anti-sporulant if primary scab lesions appear on leaves due to coverage failures with wettable sulfur.
- For crop load adjustment, apply two sprays of 2% emulsifiable oil with 2.0 to 2.5% liquid lime-sulfur, with the first spray at petal fall and the second 4-5 days later. This strategy is based on previous research done by Dr. Jim Schupp in the Hudson Valley.
- Use kaolin clay (Surround) to control most insects by applying on a 7-10 day interval. Begin at tight cluster so as to develop a significant deposit on trees before European apple sawfly (EAS), tarnished plant bug (TPB), and plum curculio (PC) are expected to become active on fruit. Coverage should be renewed at less than 7-day intervals if heavy rains remove residues.
- Spinosad (Entrust) should be applied once during early summer to help with control of internal lepidopteran pests and once in August to help control apple maggot (AM).

Using the above criteria, trees in the standard block received a total of 15 different applications during the growing season whereas trees in the organic block were sprayed 19 times. Spray dates and weather events are detailed in Table 2. Details of data collections are noted in footnotes to the data tables.

Fire blight has never been detected in or near this research orchard. We therefore assumed that fire blight inoculum is not present in the block and we made no attempt to control fire blight infections during bloom.

Results:

The sulfur-based organic spray program provided excellent control of apple scab but failed to control rust infections on leaves (Table 3A). Control of scab and quince rust with sulfur was unacceptable in the outer row that was sprayed from only one side. The center row that received blow through from both sides had the least disease, but disease incidence in this row and in the outer row sprayed from both sides usually were not significantly different. Although cedar apple rust and hawthorn rust lesions were prevalent on leaves, cedar apple rust infections were relatively uncommon on fruit (data not shown). Only Ambrosia, NJ 90, and Mutsu with 3.2, 1.7, and 2.6%, respectively, had more than 1% of fruit affected.

Of the cultivars evaluated, the first five listed in Table 3B are virtually or completely scab-resistant, but none of the cultivars are resistant to rust diseases. Where one or more scab lesions were reported on cultivars known to carry the Vf gene for scab resistance (i.e., NY 79507-49, CQR10T17, Sundance, and Crimson Crisp), we did not verify whether the scab lesions reported resulted from misidentifications in the field or from scab that escaped control by the Vf gene.

A high percentage of fruit from both standard and organic treatments were out-of-grade due to sooty blotch and flyspeck (SBFS, Table 4A). Some of the disease recorded may have developed after harvest because all fruit from this block was harvested on the dates indicated and then held in cold storage at 36-38 °F until they could be rated in late October. Losses to SBFS would have been much lower if another fungicide treatment had been applied in early September. The first five cultivars listed in Table 4B were all harvested during August or the first week of September, and for these cultivars the mean percent fruit out-of-grade due to SBFS was only 8.8% for those receiving standard treatment and 10.9% for the two rows that received organic sprays from both sides (data not shown in tables). Disease incidence increased with cultivars that were harvested later in the season due to the large accumulation of wetting hours that occurred after the last spray was applied on 21 August (Table 2).

[Text continues after Table 4B.]

Table 2. Spray dates and intervening weather conditions for the 2006 growing season at the Hudson Valley Lab, Highland, NY.

Spray dates: conventional	Spray dates: organic	McIntosh growth stage	Wetting periods: date	start time	duration (hr)	avg. temp (°F)	rainfall (in.)
3 Apr	*3 Apr*	GT	3 Apr	1800	21.25	40.3	0.92
	6 Apr	QIG	7 Apr	1215	21.5	46.4	0.24
12 Apr	*12 Apr*		14 Apr	1315	20.75	53.5	0.35
20 Apr	*20 Apr*	TC	22 Apr	0530	59.5	43	2.35
	25 Apr		25 Apr	1730	4.5		0.08
28 Apr	*28 Apr*	Full Bloom	3 May	1830	13.0	50.9	0.03
8 May	*8 May*		10 May	2315	9.75	54.2	Trace
	11 May	early PF	12 May	0000	36.5	56.6	1.00
15 May	*15 May*	PF-all trees	15 May	1130	4.25	51.9	0.30
			16 May	0145	30.5	50.1	0.41
	17 May		18 May	1615	42.0	50.8	0.54
			21 May	1230	8.5	52.2	0.12
24 May	*24 May*	1st Cover	26 May	1245	21.75	64.7	0.42
			30 May	1915	16.5	63.4	0.36
1 Jun	*1 Jun*	2nd Cover	1 Jun	1445	20.75	66.2	0.23
			2 Jun	2115	38.25	56.6	0.63
			7 Jun	0115	35.5	57.2	1.07
		Accumulations between sprays:			Hr wetting	Rainfall (in.)	
8 June	*8 June*		8 Jun- 19 Jun		79	0.50	
20 Jun	*20 Jun*		20 Jun - 28 Jun		72	3.90	
29 Jun	*29 Jun*		29 Jun -11 Jul		32	0.91	
11 Jul	*11 Jul*		11 Jul - 19 Jul		58	1.61	
20 Jul	*20 Jul*		20 Jul – 3 Aug		84	1.90	
4 Aug	*4 Aug*		4 Aug-21 Aug		79	1.30	
21 Aug	*21 Aug*	harvest dates					
		28 Aug	21 Aug –28 Aug		73	1.76	
		7 Sep	21 Aug – 7 Sep		172	3.57	
		18 Sep	21 Aug – 18 Sep		295	5.94	
		2 Oct	21 Aug – 2 Oct		424	7.42	

Table 3A. Effects of fungicide programs on foliar incidence of apple scab and cedar rust diseases and on the incidence of quince rust on fruit at harvest.

	apple scab infection (%)			Rust infection (%)		
				leaves		Quince
	cluster lvs[b] 26 May	terminal lvs[c] 10 July	fruit at harvest[d]	clusters[a] 26 May	terminals[c] 10 July	rust on fruit (hvst)[d]
Control	7.3 b[a]	36 d	39 b	70 d	30 cd	12 d
Standard	0.2 a	1 a	1. a	<1 a	3 a	1 a
Organic-center row sprayed both sides	1.0 a	4 ab	1 a	53 bc	18 b	2 ab
Organic-outside row sprayed both sides	0.7 a	8 b	2 a	48 b	23 bc	5 bc
Organic-outside row sprayed one side	0.1 a	20 c	6 a	65 cd	35 d	7 cd

[a] Means are from 15 different cultivars evaluated in each of the five blocks. Letter separations indicated significant differences among blocks (rep effects) as determined via ANOVA for the 15 cultivars replicated in the five blocks that were included in the statistical analyses.

[b] Cluster leaf data is from all leaves on 10 clusters per tree collected on 26 May.

[c] Five terminals per tree were collected on 10 July '06 from every cultivar in the study group and all leaves were evaluated for diseases.

[d] Fruit data from 50 fruit (or all available fruit if less than 50) per tree harvested at commercial maturity. Mean number of fruit rated per tree for the entire experiment was 43.

Table 3B. Differences among apple cultivars in the foliar incidence of apple scab and cedar rust diseases and in the incidence of quince rust on fruit at harvest. Cultivars are arranged based on apple scab incidence on fruit.

	apple scab infection (%)[a]			Rust infection (%)[a]		
				leaves		Quince
Cultivar	cluster lvs 30 May	terminal lvs 10 July	fruit at harvest	clusters 30 May	terminals 10 July	rust on fruit (hvst)
NY 79507-49	0.0 a[b]	<1 a	0 a	23 a	1 a	0.0 a
CQR10T17	0.0 a	<1 a	0 a	52 cdef	24 c	4.5 abcdef
Sundance	0.4 ab	1 ab	0 a	38 abcde	2 ab	7.8 bcdef
Crimson Crisp	0.0 a	1 ab	0 a	50 bcdef	27 cd	6.3 cdef
NJ 109	0.0 a	4 abc	0 a	30 abcd	25 c	10.8 f
Zestar	3.9 cd	8 abcd	1 ab	44 abcde	4 ab	0.0 a
BC 8S-26-50	1.6 abcd	1 ab	4 abc	44 bcde	30 cd	10.9 def
NJ 90	2.8 bcd	13 cde	7 abcd	30 ab	2 ab	2.0 abcd
Fuji[c]	1.5 abcd	8 bcd	10 abcd	56 def	27 cd	8.7 ef
Mutsu	4.1 cd	13 def	10 abcde	70 f	46 e	14.2 f
Chinook	1.4 abc	12 def	15 abcd	57 ef	43 de	3.5 abcd
Delblush	0.9 abcd	19 defg	17 bcde	39 abcde	5 ab	2.8 abc
Ambrosia	1.8 abcd[y]	19 efg	20 cde	58 ef	32 cd	4.4 abcde
Hampshire	3.7 d	27 fg	26 de	58 ef	9 b	1.2 ab
Roger's Mac	4.4 bcd	27 g	26 e	30 abc	1 a	0.8 a

[a] For details of sampling methods, see footnotes on Table 3A.

[b] Numbers within columns followed by the same small letter do not differ significantly (Fisher's Protected LSD, $P \leq 0.05$). The angular transformation was used for the analysis of data expressed as percentages, but the arithmetic means are shown.

[c] September Wonder strain of Fuji.

Table 4A. Effects of fungicide program on fruit grade and disease incidence at harvest.

	% fruit affected				
	out-of-grade due to:[b]		black	lenticel	bitter
	SBFS	russet	rot	spots[c]	rot
Control	100 c[a]	20 a	28 b	8 ab	1 a
Standard	41 a	20 a	12 a	6 a	<1 a
Organic-center row sprayed both sides	31 a	32 c	32 b	20 bc	4 b
Organic-outside row sprayed both sides	40 a	29 bc	30 b	22 c	6 b
Organic-outside row sprayed one side	72 b	22 ab	24 ab	16 abc	4 b

See footnotes below table 4B.

Table 4B. Differences among apple cultivars in fruit grade and disease incidence at harvest. Cultivars are arranged based on harvest date to illustrate that late-harvested cultivars were generally more affected by sooty blotch and flyspeck (SBFS).

		% fruit affected				
	Harvest	out-of-grade due to:[b]		black	lenticel	bitter
Cultivar	date	SBFS	russet	rot	spots[c]	rot
Ambrosia	28 Aug	44.0 bc[a]	0 a	17.7 abc	55.2 d	3.2 bcd
NJ 109	28 Aug	49.7 bc	1 ab	15.5 abc	11.5 bc	3.0 abcd
Zestar	28 Aug	0.5 a	30 ef	31.2 bcd	4.3 ab	1.6 abcd
Roger's Mac	31 Aug	28.4 b	5 abc	17.8 abc	10.3 bc	0.0 a
NY 79507-49	7 Sep	42.0 bc	18 cde	13.2 ab	0.0 a	1.6 abcd
Fuji[d]	7 Sep	51.3 bc	19 de	36.9 cd	0.0 a	5.2 cd
NJ 90	12 Sep	42.4 bc	8 bcd	19.2 abc	0.0 a	0.0 a
BC 8S-26-50	18 Sep	61.0 cde	70 g	46.7 d	0.8 ab	6.0 d
Crimson Crisp	18 Sep	48.4 bc	22 de	38.4 cd	0.0 a	1.0 abc
CQR10T17	18 Sep	61.8 cde	7 bcd	74.3 e	20.0 a	0.8 e
Hampshire	18 Sep	54.0 cd	18 cde	19.2 abc	0.0 a	0.8 abcd
Chinook	2 Oct	81.2 def	49 f	5.5 a	0.0 a	0.4 ab
Sundance	2 Oct	83.5 ef	88 h	24.5 abcd	21.8 c	0.5 abc
Delblush	9 Oct	92.4 f	38 f	11.6 abc	60.5 d	0.0 a
Mutsu	9 Oct	92.5 f	14 cde	7.3 ab	52.7 d	1.9 abcd

[a] Means separations are based on Fisher's Protected LSD ($P \leq 0.05$) from ANOVA for 15 cultivars in five blocks. The angular transformation was applied to incidence data, but the arithmetic means are shown. Means in the upper table represent "block" effects where most of the differences were attributable to spray programs. Means in the lower table represent cultivar effects as measured across all five blocks.

[b] Fruit with sooty blotch and/or flyspeck (SBFS) or surface russetting that would exclude it from USDA Extra Fancy grade.

[c] Lenticel spots were presumably attributable to small infections by *Botryosphaeria* species.

[d] September Wonder strain of Fuji.

The percentage of fruit out-of-grade due to surface russetting was higher in two of the three blocks receiving organic spray treatments and was inversely related to the expected level of spray coverage among those three blocks (Table 4A). Thus, it seems probable that some of the russetting in the organic block was attributable to pesticides applied in that block. The LLS applied for fruit thinning is the most likely culprit.

The organic treatments failed to control black rot and appeared to exacerbate problems with bitter rot and lenticel spots caused by *Botryosphaeria* species (Table 4A). Ambrosia, Delblush, and Mutsu were especially susceptible to lenticel spotting (Table 4B). Ambrosia was harvested 28 August, almost a month before normal maturity, because fruit in the organic plots were beginning to drop due to the severity of lenticel spotting even though fruit were still too immature to be edible. We suspect that lenticel spotting resulted when *B. obtusa* or *B. dothidea* invaded lenticels that had been damaged by sulfur sprays applied during summer. Cultivars that showed high levels of lenticel spotting may be especially sensitive to sulfur injury.

The organic plots had smaller fruit size than the standard and unsprayed plots when king fruits and side fruits were measured on 26 May (Table 5A). This size differential presumably was attributable in large part to the LLS thinning sprays that were applied in mid-May. The larger size of many of the side fruit from the standard spray program apparently made them more attractive to early plum curculio damage. Cultivars with larger fruit on 26 May also tended to have more PC damage (Table 5B). Differences in plum curculio between the organic and the standard programs disappeared by harvest. The high incidence of plum curculio damage at harvest was attributable to extremely heavy pressure (94% in unsprayed control plots), a delayed peak in PC activity in the 2006 season, and perhaps failure to reapply insecticides immediately after the rains on 2 June (Table 2).

The organic program was equivalent to the standard program for controlling EAS and TPB on king fruit and provided better control than the standard program on side fruit (Table 6). Control of PC, EAS, and TPB in the standard program might have been better if an insecticide had been applied at pink. The proportion of fruit showing no insect damage (clean fruit) was still quite high in the organic blocks on 26 May, but it dropped considerably due to later damage from PC (right column, Tables 5A & 5B).

Evaluations of fruit at harvest showed that the organic program was more effective than the standard program for protecting fruit from EAS and TPB, less effective than the standard program against external lep damage (XLEP), and comparable (statistically, though not numerically) for controlling San Jose scale (SJS), internal leps (ILEP) and apple maggot (AM) (Table 7).

Total harvested crop weight per tree was lowest in unsprayed plots, intermediate in organic plots, and highest in standard plots (Table 8). Disease and insect damage to fruits and fruit stems undoubtedly caused fruit to drop from the trees throughout the season in the unsprayed control plots. The reason for greater preharvest drop (i.e., fully-sized fruit on the ground at harvest) in the organic plots compared to the standard plot is not known, but Palmiter and Smock (1954) noted that fruit on trees sprayed with sulfur during summer matured as much as 13 days earlier than fruit from trees sprayed with ferbam during summer.

The LLS+oil thinning sprays were very effective and reduced crop load to a lower number of fruit per tree than did the standard thinning treatment (Table 8). Thus, the increased level of preharvest drop in the organic block is not attributable to "push-offs" that might have occurred if the trees were over-cropped. The calculated crop load based on trunk cross-sectional area was slightly below optimum for most cultivars in both the standard and organic treatments. The low crop load in the control plots was due to fruit abscission caused by pest damage and cannot be used as a gauge for natural fruit set in the absence of thinning treatments. Trees in the organic row that were sprayed from only one side carried a more optimum crop load than trees in the other organic replications where sprays were applied from both sides. This difference suggests that the LLS+oil treatments we applied caused over-thinning and that we might have maintained better productivity if we had used only one application of LLS+oil or if we had opted for lower rates of LLS.

The organic plots had fewer fruit per tree than the standard, but the fruit size also tended to be smaller. The organic row that was sprayed from only one side had more fruit than the other two organic rows, but it also had the smallest fruit size (Table 8). This suggests that over-thinning was not the primary cause of the decreased crop load evident in the organic plots.

In multi-variety plots, it is impossible to pick a single date or application rate for chemical thinning that will optimize production for all of the cultivars due to differences in timing of bloom and petal fall and differences in fruit growth rate after petal fall. Thus, some cultivars (e.g. Crimson Crisp) were severely over-thinned in our plots and others should have had some supplemental hand thinning in June (e.g., Chinook). However, we opted not to do any hand thinning in these plots.

Blossom counts made when trees were in bloom in 2007 showed that trees receiving the standard fungicide program in 2006 had the largest number of flower clusters, although return bloom for the two organic rows that had lighter crop loads in 2006 were not significantly lower than the return bloom in the standard fungicide group (Table 9A). However, the organic replicate that was sprayed from only one side in 2006 and therefore had a 2006 crop load similar to that of the standard had significantly less crop load than the standard in 2007. Thus, trees receiving the organic program and carrying a full crop in 2006 were unable to produce an acceptable return bloom in 2007. As might be expected, the cultivars with the lightest crop loads in 2006 generally produced the highest return bloom in 2007 (Table 9B).

Costs for the various pesticides used in this trial were estimated by asking four consultants and several company sales representatives to provide price quotes typical of what medium-sized apple growers might have paid for these products in 2006. Prices listed in Table 10 represent adjusted averages from all available data sources. The cost of pesticides alone was $350/A for the standard plots compared to $793/A for the organic program. However, the organic blocks were sprayed 19 times compared to only 15 times for the standard block. If application costs (equipment plus labor) are calculated at $20 per acre per application, then total pest control costs were 80% higher for the organic program than for the standard program.

Table 5A. Effects of spray programs on fruitlet size as measured on 26 May for king fruit and side fruit and on incidence of plum curculio damage on 26 May and at harvest.

	Fruitlet diameters (mm)[b]		% plum curculio[b]		
			fruitlets		Har-
REPS	king	sides	king	sides	vest
Control	15.9 b[a]	11.2 c	17 b	10 c	94 b
Standard	15.8 b	11.0 c	6 a	4 b	26 a
Organic-center row sprayed both sides	14.5 a	8.4 a	5 a	1 a	25 a
Organic-outside row sprayed both sides	14.1 a	9.0 b	6 a	2 ab	31 a
Organic-outside row sprayed one side	14.4 a	9.0 b	2 a	2 a	45 a

See footnotes below table 5B.

Table 5B. Differences among apple cultivars in fruitlet size as measured on 26 May for king fruit and side fruit and in incidence of plum curculio damage on 26 May and at harvest. Cultivars are ordered based on the mean size of king fruits.

	Fruitlet diameters (mm)[b]		% plum curculio[b]		
			fruitlets		Har-
Cultivar	king	sides	king	sides	vest
Ambrosia	12.3 a[a]	8.1 ab	0 a	2 ab	41 ab
Delblush	12.8 ab	9.6 cde	3 a	3 ab	35 ab
BC 8S-26-50	13.3 b	8.3 b	0 a	0 a	40 ab
NJ 90	13.4 b	9.2 c	6 ab	2 ab	80 ab
Chinook	13.5 b	7.5 a	4 ab	0 a	47 b
Fuji	14.4 c	10.1 ef	7 ab	5 bc	5 b
Crimson Crisp	14.7 cd	9.5 cd	4 ab	5 bc	33 ab
Hampshire	14.9 cde	10.7 fg	3 a	2 ab	45 ab
NY 79507-49	15.3 def	8.7 b	3 a	2 ab	38 ab
Mutsu	15.3 def	9.7 cde	7 ab	6 bc	38 ab
Sundance	15.5 efg	12.5 h	19 cd	13 d	51 b
CQR10T17	15.9 fg	10.8 g	10 abc	3 ab	46 ab
Roger's Mac	16.3 g	10.7 fg	7 ab	6 bc	42 ab
NJ 109	16.3 g	9.4 c	13 bc	4 abc	39 ab
Zestar	20.3 h	12.5 h	23 d	7 c	28 a

[a] Means separations are based on Fisher's Protected LSD ($P \leq 0.05$) from ANOVA for 15 cultivars in five blocks. The angular transformation was applied to incidence data, but the arithmetic means are shown. Means in the upper table represent "block" effects where most of the differences were attributable to spray programs. Means in the lower table represent cultivar effects as measured across all five blocks.

[b] Fruitlet evaluations were based on all fruitlets from 10 clusters per tree collected 26 May before effects of fruit thinners had caused thinned fruitlets to abscise

Table 6. Effects of spray programs on incidence of undamaged fruitlets and incidence of European apple sawfly (EAS) and tarnished plant bug (TPB) on king fruitlets and on side fruitlets from 10 clusters per tree that were collected on 26 May.

	% damage				% clean fruit 26 May (no insect damage)	
	EAS		TPB			
REPS	king	sides	king	sides	king	sides
Control	21.5 c[a]	14.0 c	17 b	7 c	46 a	68 a
Standard	7.2 b	5.8 b	4 a	4 b	83 b	86 b
Organic-center row sprayed both sides	1.5 a	0.7 a	0 a	<1 a	94 c	98 c
Organic-outside row sprayed both sides	2.0 ab	0.9 a	0 a	1 a	92 c	97 c
Organic-outside row sprayed one side	4.0 ab	2.7 a	1 a	<1 a	94 c	95 c

See footnotes below table 3A.

Table 7. Effects of spray programs on the incidence of insect damage on apple fruit at harvest: EAS = European apple sawfly, TPB = tarnished plant bug, SJS = San Jose scale, XLEP = external feeding damage by lepidoptera, ILEP = internal feeding damage by lepidoptera, AMT = apple maggot tunnels in fruit flesh, CLEAN = fruit with no insect damage.							
	% damage to fruit at **HARVEST** [a]						% clean (no insect damage)[a]
Rep	EAS	TPB	SJS	XLEP	ILEP	AMT	
Control	5 b[a]	8 b	2 a	5 b	26 c	3.2 a	1 a
Standard	7 b	12 c	3 ab	2 a	4 a	0.8 a	52 bc
Organic-center row sprayed both sides	1 a	2 a	7 abc	2 a	6 ab	2.1 a	59 c
Organic-outside row sprayed both sides	1 a	2 ab	10 bc	5 b	6 ab	2.4 a	53 bc
Organic-outside row sprayed one side	1 a	2 ab	10 c	5 b	9 b	1.1 a	47 b

See footnotes below table 3A.

Table 8. Effect of spray program on incidence of preharvest drop, fruit size, and productivity.

	% pre-harvest drop [b]	No. fruit/ tree at harvest [b]	Mean fruit wt (g/fruit) [b]	Total harvest-able crop/tree (lb/tree) [b]
Control	29 b[a]	89 a	128 a	23 a
Standard	11 a	203 c	216 c	93 c
Organic-center row sprayed both sides	27 b	114 ab	197 bc	41 ab
Organic-outside row sprayed both sides	31 b	96 a	195 bc	35 a
Organic-outside row sprayed one side	21 b	155 bc	171 b	56 b

[a] Means separations are based on Fisher's Protected LSD ($P \leq 0.05$) from ANOVA for 15 cultivars in five blocks.

[b] Preharvest drop was determined by counting all fully-sized fruit on the ground at harvest and expressing results as the ratio of drops to total crop (drops plus harvestable fruit). Mean fruit weight was determined by weighing 50 fruit per tree (or all available fruit if less than 50) that were harvested at commercial maturity.

[c] No significant differences.

The higher cost per acre for pest control and the lower productivity of trees in the organic block combined to create large differences in per-bushel costs for pest control (Table 11). The cost of pest control per bushel of harvestable fruit was 76 cents for the standard program compared to $2.98 for the organic program. This difference is based only on the total number of harvestable fruit and does not account for potential differences in the proportion of marketable fruit. Unfortunately, we did not track the total number of marketable fruit in this trial. The data showing percent clean fruit (no insect damage) in Table 7 underestimates the proportion of marketable fruit because many fruit with tarnished plant bug damage and some fruit with PC and external lep damage would still be marketable under USDA grading standards. On the other hand, fruit with black rot, bitter rot, or lenticel spots would not be marketable. Incidence of these diseases was 12 to 20% greater in the organic block than in the standard block (Table 4A), and that factor alone might have created even greater disparities in the economic comparison between organic and standard pest control if we had recorded the final proportion of marketable fruit from each plot.

Discussion:

As with any field trial, one can see in retrospect things that might have been done to improve the outcomes with either the organic, the standard, or both pest control programs. A test orchard with less exposure to cedar rust inoculum and immigrating insects would have allowed more effective pest control than occurred in our trial. Because of the high pest pressure in this orchard, proportions of damaged fruit were unacceptably large for many pests in both the standard and organic blocks. However, our test orchard was not significantly different from many older orchards that new land owners in the Hudson Valley would like to convert to organic production. The difficulty we had in controlling pests in both the standard and the organic blocks illustrates the hurdles that small landowners are likely to face when attempting to grow apples on small acreages that are surrounded by habitat supporting insect and disease pests.

Scab-resistant apple cultivars are preferable for organic production because they negate the need for many of the sulfur sprays that must otherwise be applied to control apple scab. However, even with scab-resistant cultivars, fungicides are still needed during summer to control SBFS, bitter rot, and diseases caused by *Botryosphaeria* species. Using LLS plus oil for fruit thinning is preferable to hand-thinning organic blocks, but finding a thinner with fewer adverse effects on fruit size might help to improve the economics of organic apple production.

Table 9A. Trunk diameters and effects of spray programs on total crop load in 2006 (harvested fruit plus premature drops) and on return bloom in 2007.

	Mean trunk diameter (in.)[b]	Mean fruit per cm^2 of TCSA[c]	Number of flower clusters/tree spring of 2007
Control	3.13 n.s.	3.0 a[a]	55 a
Standard	3.19	4.8 b	160 c
Organic-center row sprayed both sides	2.97	3.9 ab	118 abc
Organic-outside row sprayed both sides	3.18	2.9 a	139 bc
Organic-outside row sprayed one side	3.07	5.0 b	94 ab

[a] Means separations are based on Fisher's Protected LSD ($P \leq 0.05$) from ANOVA for 15 cultivars in five blocks. Means in the upper table represent "block" effects where most of the differences were attributable to spray programs.

[b] Trunk circumference was measured one foot above ground level and was later converted to diameters.

[c] TCSA = trunk cross sectional area. For most cultivars, optimum crop load ranges from 4 to 8 fruit per cm^2 TCSA. Crop loads below 4 fruit/ cm^2 TCSA usually represents over thinning while crop loads above 8 fruit/ cm^2 TCSA indicate over cropping.

[c] No significant differences.

Table 9B. Trunk diameters by cultivars and effects of cultivar on total crop load in 2006 (harvested fruit plus premature drops) and return bloom in 2007, with cultivar order based on mean crop load in 2006.

Cultivar	Mean trunk diameter (in.)[b]	Mean crop load (fruit per cm^2 of TCSA[c]) all reps combined	Standard (1 rep)	Organic (3 reps)	Control (1 rep)	Mean no. flower clusters/tree in 2007 (all reps combined)
Crimson Crisp	3.06 def	1.4 a	2.4	1.3	0.5	236 e
CQR10T17	3.59 gh	1.6 ab	1.4	1.1	3.6	237 e
NJ 109	3.86 h	1.6 ab	3.7	1.3	0.6	205 de
Sundance	3.62 h	2.4 ab	4.5	1.5	0.6	113 abcd
Roger's McIntosh	2.88 bcdef	2.9 abc	5.3	3.0	0.2	171 cde
Zestar	2.64 abc	3.1 abc	3.5	3.0	0.0	138 bcde
Mutsu	3.11 ef	3.1 abc	3.3	3.6	1.2	72 abc
Delblush	3.85 h	3.3 abc	5.5	3.2	1.7	72 abc
NJ 90	2.84 abcde	3.5 abc	3.3	4.2	1.6	142 bcde
September Wonder	3.25 fg	3.8 bc	4.1	3.9	3.0	56 ab
BC 8S-26-50	2.58 ab	3.8 bc	7.0	2.5	4.6	87 abc
NY 79507-49	3.03 cdef	5.2 c	3.5	5.2	6.8	73 abc
Hampshire	2.66 abcd	5.2 c	7.8	5.5	1.5	9 a
Ambrosia	2.77 abcde[a]	5.2 c	5.2	5.1	5.3	63 abc
Chinook	2.39 a	12.5 d	11.6	13.4	10.6	24 a

[a] Means separations are based on Fisher's Protected LSD ($P \leq 0.05$) from ANOVA for 15 cultivars in five blocks. Means in the upper table represent "block" effects where most of the differences were attributable to spray programs.

[b] Trunk circumference was measured one foot above ground level and was later converted to diameters.

[c] No significant differences.

Table 10. Price estimates for products used in this trial and total costs of seasonal spray programs.

Product	Price per unit		total cost /A/yr
Standard program			
COCS	2.00	lb	7.98
Dithane	1.91	lb	31.17
Rubigan	64.58	qt	108.34
Topsin M	13.69	lb	39.38
Captan-80	3.74	lb	32.22
Sevin XLR	25.80	gal	7.42
Imidan	7.17	lb	93.38
Asana	78.62	gal	20.64
Fruitone-N	33.57	lb	9.65
Total cost/A/yr for pesticides			350.17
Application costs ($20/appl X 15 applications)			300.00
TOTAL insect/disease control expenses/A			**$650.17**
Organic program			
Champion WP copper hydroxide	3.00	lb	18.90
Microthiol Disperss	0.68	lb	91.23
Liquid lime-sulfur	8.00	gal	40.00
Damoil	4.71	gal	32.51
Surround WP	400.00	lb	400.24
JMS Stylet Oil	17.00	gal	68.00
DiPel DF	9.45	lb	14.46
Entrust	0.95	lb	127.83
Total cost/A/yr for pesticides			793.16
Application costs ($20/appl X 19 applications)			380.00
TOTAL insect/disease control expenses/A			**$1,173.16**

Table 11. Estimated pest control costs per bushel for the two systems evaluated in 2006.

	lb/tree [a]	Bu/A [b]	Pest control costs (dollars per bushel) [c]
Control	23	209	
Standard	93	861	$0.76
Organic-center row sprayed both sides	41	384	3.05
Organic-outside row sprayed both sides	35	323	3.63
Organic-outside row sprayed one side	56	519	2.26
Mean for three organic rows		409	$2.98

[a] lb/tree represents the mean weight of harvested fruit from 15 cultivars in each of the five blocks including apples with disease and pest-related defects but excluding apples that dropped prior to harvest.

[b] Bushels/A were calculated assuming 390 trees/A and 42 lb/bushel.

[c] Pest control costs were derived by dividing total cost/A including application costs for the standard and organic programs (Table 9) by the number of bushels per acre.

Results from this trial allow the following conclusions:

1. Surround, Entrust, DiPel, and stylet oil can be used to effectively manage most apple insect and mite pests within organic apple production systems.
2. Sulfur can provide effective control of apple scab and powdery mildew. The latter was not evaluated in this trial because Surround residues made it impossible to rate leaves for mildew. However, effectiveness of sulfur as a mildewcide is well established.
3. Sulfur was not effective for controlling cedar rust lesions on leaves, but it suppressed quince rust infections on fruit.
4. Sulfur applied at 1 lb/100 gal of dilute spray during summer did not provide adequate control of bitter rot, black rot, and *Botryosphaeria*-related lenticel spotting on fruit. Higher rates might be more effective, but even the low rate that we used resulted in severe lenticel spotting on some cultivars. Copper fungicides applied at low rates during summer might provide more effective control of summer fruit rots and should be evaluated as a replacement for sulfur during July and August.
5. Ambrosia, Sundance, Delblush, and Mutsu all developed severe lenticel spotting in our organic plots and may be unsuitable cultivars for organic production where sulfur fungicides will be used during summer. Further testing is required to determine if the lenticel spotting is indicative of unusual sensitivity of the fruit to sulfur injury or whether these cultivars are just more susceptible to invasion of lenticels by *Botryosphaeria.*
6. Using sulfur and LLS in apple production systems results in smaller fruit and reduced production. Our results confirm similar reports from the 1950's (e.g., Palmiter & Smock, 1954).
7. Organic pest control on apples will be more expensive than standard IPM approaches to pest control. Our data suggests that organic growers will need to price their fruit considerably higher than standard fruit to cover the higher pest control costs and lower production that is currently inherent in organic apple production systems. Before embarking on expensive organic production systems, growers

should verify that consumers will be willing to pay a higher price for organic fruit as compared to fruit produced with standard pesticides. Otherwise, organic growers may absorb the costs of a three-year transition to organic production systems only to find that they cannot sell their fruit at a profit.

8. The organic pest control treatments evaluated in this trial have some disadvantages that are not apparent from the data presented. Both sulfur and LLS are noxious to pesticide applicators and field workers due to their odor and their potential for causing eye irritation. The odor and irritating residue can persist for many weeks after application if the residues are not weathered by rainfall. The chalky residue left by the kaolin clay treatments persists on fruit at harvest and must be removed before fruit can be marketed. In this trial, we removed the visible residues by hand-wiping fruit prior to rating them. It should be possible to remove the residues on a packing line by soaking fruit in commercial detergents, washing them with high-pressure streams of water, and/or running them over brush beds on the packing line. All of those options may add costs that were not included in our cost comparisons.

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ENTOMOLOGY

Japanese Beetle Control and Varietal Comparisons in Primocane-bearing Caneberries

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Introduction

Today there is an increasing demand for the production of raspberries and blackberries due to their nutritional and economical values (Pritts 1989). The fruits themselves contain soluble fiber, vitamins, and minerals and, like other fruits, contain their greatest nutritional value when they are fresh. However, harvesting an aesthetically pleasing fresh fruit is difficult due to the potential of the delicate raspberries and blackberries being damaged by insect pests, molds and other diseases and natural decay.

Raspberries and blackberries are classified as either floricane (summer) or primocane (fall) bearing (Demchak et al. 2005). For this experiment only primocane varieties were considered. The classification of primocane bearing refers to the fact that on these plants the primocanes are capable of flowering and fruiting in the same year as shoot growth. In most of these varieties the fruit appears in August with a few varieties bearing fruit in late July. The fruit then remains on the bushes until late September or until a hard frost or freeze. Weekly yields are somewhat lower on primocane-bearing varieties compared with floricane varieties however, the loss is made up by the primocane varieties' lengthened fruiting season (Koester et al. 2003).

One serious pest of the raspberries and blackberries is the Japanese beetle (*Popillia japonica* Newman). With the adults consuming foliage, fruits, or flowers of more than 300 species of plants, these beetles are among the most polyphagous of plant-feeding insects (Potter et al. 2002). In raspberries and blackberries, adult Japanese beetles feed on both the foliage and the fruit (Spangler and Agnello 1989, Demchak et al. 2006). The leaf damage is characterized as skeletoning. The damaged berries contain holes from the beetle's chewing. The ripened berries exposed to sunlight are favored (Funt et al. 2006). Therefore, since the primocane bearing varieties bear fruit late in July through mid-September when the sun is prevalent, the Japanese beetles can cause severe damage. This damage not only makes the fruit unmarketable, it also makes the plants susceptible to diseases. Due to the Japanese beetle's destructive behavior, it is easy to see why many biological, chemical, and other methods have been applied to rid plants of these pests.

There are several chemicals that are recommended for Japanese beetle control on caneberries. However, most of these recommended controls such as Sevin and Sevin XLR Plus have long preharvest intervals. These preharvest intervals present problems when applied on frail fruit such as raspberries and blackberries since the berries decay rapidly (Demchak et al). Therefore, it would be ideal for this system to have a pesticide applied that has a shorter preharvest interval while providing effective control of Japanese beetles.

In an attempt to understand which pesticides decrease the number of Japanese beetles, certain pesticides were applied to the brambles and the numbers of Japanese beetles present after application were counted. We wished to determine effects of treatments on seasonal yields, as well as varietal differences. We are hopeful that the short preharvest interval treatments applied will reduce the number of the Japanese beetles. The decrease in beetle number could in turn increase the profit and sales from fresh berries and provide a new method for controlling Japanese beetles.

Materials and Methods

On 19 June, 27 June, 4 July, 9 July, 18 July, 26 July, 11 August and 24 August 2007, a honey/milk solution (1 gal milk, 12 fl oz honey and 9 gal water), azadirechtin (Aza-Direct 1.2%) (2 pt/acre), deltamethrin (Battalion 0.2EC) (12 fl oz/ acre), lime and aluminium potassium sulfate (Lime-Alum) (1 lb hydrated lime, 5 oz alum and 10 gal water), metaflumizone (Alverde) and a control were applied to a 2-meter section of rows, with 8 replications. The raspberry varieties used included Fall Gold, Heritage, Dinkum, Autumn Bliss, Prelude, Caroline, Himbo Top and Anne. Also, on the same dates listed above, thyme oil (Proud 3) (1 qt/25gal/acre), potassium bicarbonate (Agricure 85) (5 lbs/ acre), bifenthrin (Capture 2EC) (6.4 fl oz/acre), capsaicin (Hot Pepper Wax 0.00018%) (600 fl oz/ acre), and deltamethrin (Battalion 0.2EC) (12 fl oz/ acre) were applied to 2-meter sections of the rows in the blackberries. The treatments were applied to a 2-meter section of rows, with 4 replications, and comparison with an untreated control. There were only two varieties of blackberries, Prim Jim and Prim Jan, used. All treatments were applied to the plants using a randomized complete block design, blocking on variety. All treatments were applied using a CO_2-powered backpack sprayer. Starting on 26 June the plants were carefully observed twice a week in an attempt to count all the beetles present in the marked off plots. The plots were observed twice a week until 18 July. Also to see if either the treatments or the variety affected the yield, berries were picked within the sprayed or control 2-meter section of the row for each variety. All berries collected were divided into marketable and unmarketable yields. A berry was considered marketable if it did not contain damage whereas unmarketable berries contained damage. Yield data was collected twice a week from 14 August to 29 September. Both the Japanese beetle count data and the yield data were then analyzed using analysis of variance followed by Fisher's HSD.

Results and Discussion

Raspberry Japanese beetle numbers:

Table 1 shows the average number of Japanese beetles present on the plots sprayed with the different treatments. The days included were the only days in which there were significant numbers of beetles and therefore could be further analyzed. On 26 June when comparing the number of beetles present on the control plots with the other treated plots, there were significantly more beetles present on plots treated with the Aza-Direct and honey/milk treatments. On 29 June there was also an increase in numbers from the control for the honey/milk treatment. The data from 2 July does not correspond with the rest of the data since the numbers of beetle on the plots did not differ from the control. On 5 July there were significantly fewer beetles on plots treated with Battalion and Lime-Alum. On 9, 12 and 17 July the Lime-Alum and Battalion treatments continued to control the numbers of beetles present. This trend continues even when the numbers of beetles for the year were compared. On 12 July the plots treated with Aza-Direct had fewer Japanese beetles than the control, however honey/milk and Alverde provided no control. All plots that were treated with a chemical spray on the 17 July had significantly fewer numbers of beetles than the control plots. On 20 July only Battalion and the lime-alum treatments had lower numbers. When looking at the total numbers of beetles present from the year the plots treated with Battalion and lime-alum were the only plots that displayed control. The lime-alum treatment had the lowest number of beetles present. However, the treatment left a white residue that kept everything off of the plants including the sun. However, since there was such a high degree of control perhaps future research could include a lower concentration or even applying this treatment only once every two weeks instead of once a week as was done this year. Another disadvantage to this treatment was that it clogged the spray tips while being applied.

Table 2 shows the varietal effects on the number of Japanese beetles present. Again only the dates with a significant difference in the numbers present were compared. Throughout the dates listed, there were always significantly fewer numbers of beetles present on the Dinkum, Heritage and Himbo Top and always higher numbers present on Prelude. When we look at the totals for the year we see that there were significantly fewer beetles on the Caroline, Dinkum, Heritage and Himbo top varieties. Anne, Autumn Bliss and Fall Gold varieties had intermediate numbers of beetles present. Prelude consistently had the highest populations of Japanese beetle.

Blackberry Japanese beetle numbers:

Table 3 shows treatment effects on beetles present in the blackberries. Again, the only days included were the days in which there were significant numbers of beetles. For the blackberries there were significant differences in numbers of beetles present only on the 29 June, 5 July and 12 July. On 29 June there were significantly fewer beetles on the plots treated with Agricure, Battalion and Capture than the control. On 5 July there were lower numbers present only on the Battalion treated plots. Battalion and Capture provided control on 12 July. Battlion and Capture provided the greatest control over the whole season and Agricure, Hot Pepper wax and Proud were not significantly different from the control.

When looking at the differences between the blackberry cultivars in numbers of Japanese beetles (Table 4), the only days in which there were significant differences in beetle numbers were 12, 17 and 20 July. For these three dates as well as for the year, there were significantly fewer Japanese beetles present on the PrimJan variety. This was consistent with last year.

Raspberry Yield:

The treatments applied did not affect the percent of the fruit that was marketable in the raspberries or blackberries. However, there were differences among the varieties. Table 5 indicates the percent of fruit that was marketable for each variety of raspberries with the percentages listed from highest to lowest. Therefore, Autumn Bliss had the most marketable fruit and that Heritage had the least. Also, even though Prelude had more Japanese beetles present on the plant, almost 83% of the fruit was marketable.

Blackberry Yield:

Among the blackberry varieties, PrimJim had the most marketable fruit (Table 6). This fact was surprising considering there were also more Japanese beetles on this variety. When comparing PrimJim's percent marketable yield with Heritage's percent marketable yield, PrimJim's percent is lower. This shows that the raspberry variety that has the least marketable fruit is still better than these two blackberry varieties when it comes to marketable yield.

In the future the Battalion, Capture and the lime-alum treatments will continue to be used in hopes that they will maintain control of the number of Japanese beetles. However, a better method of applying the lime-alum treatment should be considered. Also, since it seems that the blackberries are naturally lighter bearing than the raspberries and lower numbers of beetles are present on them than the raspberries, emphasis should be given to applying the treatments to the raspberries.

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Table 1. Effects of five chemical treatments and an untreated control on numbers of Japanese beetles per 2 m of row in a raspberry planting at Kentland Farm (Montgomery County Virginia).

Trt	26 Jun	29 Jun	2 Jul	5 Jul	9 Jul	12 Jul	17 Jul	20 Jul	**Year Total**
Alverde	0.0b	1.0b	6.6a	16.3a	10.5ab	10.5ab	9.1b	11.6 a	**67.3a**
Battalion	0.1b	0.1b	6.4a	1.6b	4.3bc	2.5c	7.0b	2.5b	**25.0 b**
Lime-Alum	0.0b	0.1b	0.3b	0.4b	1.6c	0.4c	6.5b	1.3b	**11.8 b**
Aza-Direct	0.6a	2.1b	8.8a	16.9a	9.5ab	8.1b	9.6b	5.9ab	**62.8 a**
Honey-Milk	0.9a	5.4a	11.9a	21.6a	16.3a	13.8ab	12.9b	7.1a	**92.8 a**
Control	0.0b	1.8b	5.0ab	12.8a	14.3a	17.0a	23.8a	9.3 a	**86.9 a**

Means in a column followed by the same letter are not significantly different, α=0.05 (Fisher's protected LSD test,
following $((x+0.5)^{-0.5})$ transformation).

Table 2. Differences among eight primocane-bearing raspberry cultivars in numbers of Japanese beetles per 2 m of row at Kentland Farm (Montgomery County Virginia).

Variety	5 Jul	9 Jul	17 Jul	20 Jul	Year Total
Anne	12.0ab	5.8b	10.3ab	4.2b	50.5bc
Autumn Bliss	5.7b	11.8a	13.5a	8.5b	56.3bc
Caroline	9.8ab	7.2b	4.2b	1.5b	40.2c
Dinkum	5.0b	6.7b	7.8b	2.7b	37.2c
Fall Gold	22.8a	13.2a	15.7a	4.0b	80.2b
Heritage	6.8b	4.3b	10.2b	2.3b	38.2c
Himbo Top	3.3b	4.8b	8.8b	5.5b	34.5c
Prelude	27.2a	21.3a	21.3a	21.5a	124.8a

Means in a column followed by the same letter are not significantly different, α=0.05 (Fisher's protected LSD test,
following $((x+0.5)^{-0.5})$ transformation).

Table 3. Effects of five chemical treatments and an untreated control on numbers of Japanese beetles per 2 m of row in a blackberry planting at Kentland Farm (Montgomery County Virginia).

Treatment	29 June	5 July	12 July	Year Total
Agricure	0.0c	7.3ab	7.0ab	44.8ab
Battalion	0.0c	2.3c	2.5b	15.3c
Capture	0.3bc	3.8bc	2.0b	28.0bc
Hot Pepper Wax	2.5ab	8.3ab	12.3a	54.5ab
Proud	3.8a	12.0a	8.5ab	46.8ab
Control	3.0ab	8.3ab	17.3a	59.0a

Means in a column followed by the same letter are not significantly different, α=0.05 (Fisher's protected LSD test,
following $((x+0.5)^{-0.5})$ transformation).

Table 4. Differences among two primocane-bearing blackberry cultivars in numbers of Japanese beetles per 2 m of row at Kentland Farm (Montgomery County)

Variety	12 Jul	17 Jul	20 Jul	Year Total
PrimJim	3.4a	3.5a	2.0a	56.4a
PrimJan	1.8b	1.8b	1.2b	26.3b

Means in a column followed by the same letter are not significantly different, α=0.05 (Fisher's protected LSD test, following $((x+0.5)^{-0.5})$ transformation).

Table 5. Differences among eight primocane-bearing raspberry cultivars in percent of the yield that was marketable from the year's total yield at Kentland Farm (Montgomery County).

Variety	% Marketable Fruit
Autumn Bliss	87.2a
Fall Gold	83.6ab
Himbo Top	83.5ab
Prelude	82.9ab
Dinkum	81.8b
Anne	81.0bc
Caroline	76.81cd
Heritage	75.5d

Table 6. Differences among two primocane-bearing blackberry cultivars in percent of the yield that was marketable from the year’s total yield at Kentland Farm (Montgomery County).

Variety	% Marketable Fruit
PrimJim	71.5 a
PrimJan	45.1 b

Possible regional variation in over-wintering stage of *Oncometopia orbona*, vector of the causal agent of Pierce's disease: Forming a case for more research.

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Pierce's disease (PD) is a vascular disease of grapevines. Vine decline follows when this bacterium, *Xylella fastidiosa* (*Xf*), introduced by insect vectors, proliferates to numbers great enough to block flow of nutrients from roots to shoots in the xylem vessels. Most of Virginia's grape growing regions were thought to be low risk to chronic infection because of our colder climate but upward trends in winter temperatures has created more concern for this type of infection (Sutton 2005).

Our first objective was to identify areas of Virginia where efficient vectors are present. *Oncometopia orbona* and *Graphocephala versuta*, efficient vectors of *Xf* (Myers 2005), were trapped on yellow sticky cards at all sites monitored from March through October 2006, 2007 in the following Virginia counties: Accomack, Albemarle, Augusta, Fauquier, Franklin, James City, Nelson, Northampton and Patrick.

A second objective of our study was to identify areas where the causal agent is present in grapevines. Petiole samples taken in October of 2006 and 2007 were tested using DAS-ELISA (Agdia, Elkhart, IN). At least one vine tested positive at each site in the following Virginia counties: Accomack, Hanover, James City, King George, Lancaster, New Kent, Northampton, Powhatan (located within the modeled boundary of strains of Xf causing PD), Albemarle, Amherst, Bedford, Fauquier, Halifax, Nelson, Patrick and Rockbridge (located outside the modeled boundary of strains of *Xf* causing PD; Hoddle 2004). We extended the know range of Pierce's disease to include most Virginia vineyards (Wallingford et al. 2007).

Although both vector and causal agent are present in all growing regions of Virginia, symptoms can be seen in varying severity. Vineyards in Northampton Co. (Eastern Shore) already have management programs in place. Though our survey project we have identified vineyards in Albemarle Co. that will may require PD management. Any location that does not experience cold weather events of 15F or below for several consecutive years is considered at risk and in need of recommendations on PD management.

Imidacloprid has been shown to slow the spread of infection by reducing vector pressure (Krewer 2002). A major challenge in recommending insecticide applications for PD vectors is determining proper timing. Research in North Carolina has shown that sharpshooters tested for *Xf* were more likely to be infective in April or May, shortly before peak capture, while numbers of infected individuals dip down around the time of peak capture in late May, early June (Myers 2007). An early infection is a dangerous infection as bacteria are introduced closer to the cordon and have more time to proliferate throughout the growing season.

Even though we trap it in much lower numbers than *G. versuta*, we tend to focus on *O. orbona* because it feeds in the vineyard earlier in the season. Also *O. orbona* prefers to feed on stems, while *G. versuta* prefers to feed on leaves (Myers 2007). Because they over-winter as adults, vectors that were infective the year before are infective right away in the spring. As the next generation takes over, you see a drop in proportion of infective individuals as these new leafhoppers have to acquire the bacteria from an infected host before they are themselves infective.

Total number of *O. orbona* trapped in six traps associated with mean growing degree days accumulated between start and end of each trapping period is shown in Figures 1-3. Growing degree days after April 1st = ((Tmax + Tmin)/2 – 50F; Popenoe et al. 1990); this is standard procedure for predicting vine phenology.

An expected pattern of capture is shown in figures 1 and 2. First capture of *O. orbona* occurs at 100-200 growing degree days, roughly bud break depending on the variety of grape. Peak capture occurs later in the season at 600-1000 growing degree days. This occurs in May or June depending on the region, when Myers found populations to be least infective. Possibly the next generation of leafhoppers which must feed on infected plants to acquire bacteria and become infective themselves.

Figure 3 shows data from two different sites in Fauquier Co. First capture of *O. orbona* is not seen until well after bud break and peak capture is seen at 600-1000 growing degree days. Although it is possible that *O. orbona* are feeding on other host-plant species at this time, questions are raised as to what proportion of leafhoppers do over-winter as adults. This is especially relevant in vineyard A in Figure 3 as edge traps were very close to wooded borders and there was such a large number of *O. orbona* trapped at peak capture. There's an argument that PD won't spread to certain parts of the world because their insect vectors overwinter as eggs (Purcell personal communication).

Our study has revealed a need for PD management recommendations as efficient vectors and the causal agent are present in all grape-growing regions. Future research should investigate proper timing of spray recommendations, identifying the time that populations pose the highest risk. Differences in over-wintering patterns may be part of understanding infectivity of populations.

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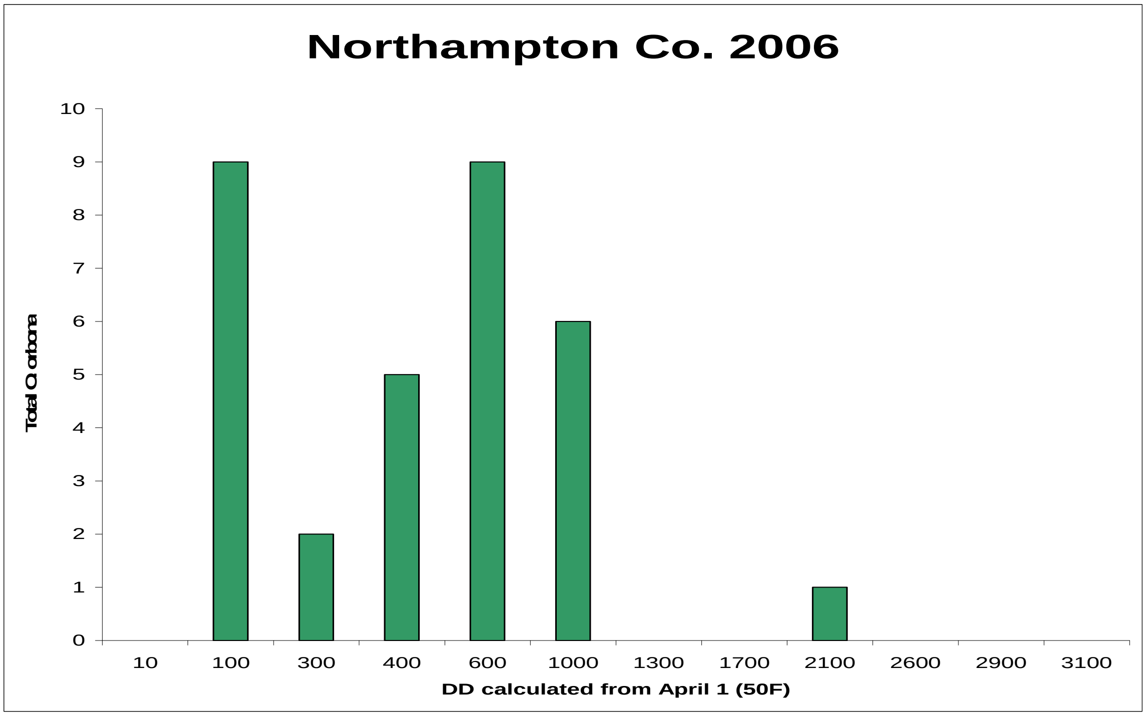

Figure 1: Total number of *O. orbona* trapped in six traps associated with mean growing degree days accumulated between start and end of each trapping period at Vineyard A in Northampton, high risk to PD infection according to climate records.

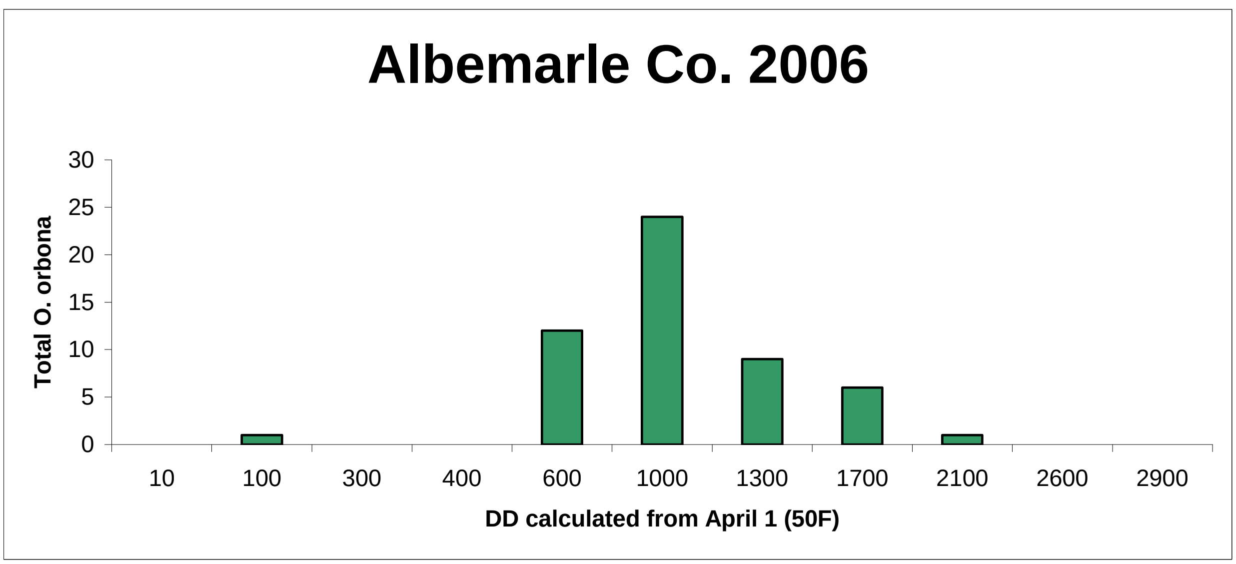

Figure 2: Total number of *O. orbona* trapped in six traps associated with mean growing degree days accumulated between start and end of each trapping period at Vineyard A in Albemarle Co., moderate risk to PD infection according to climate records.

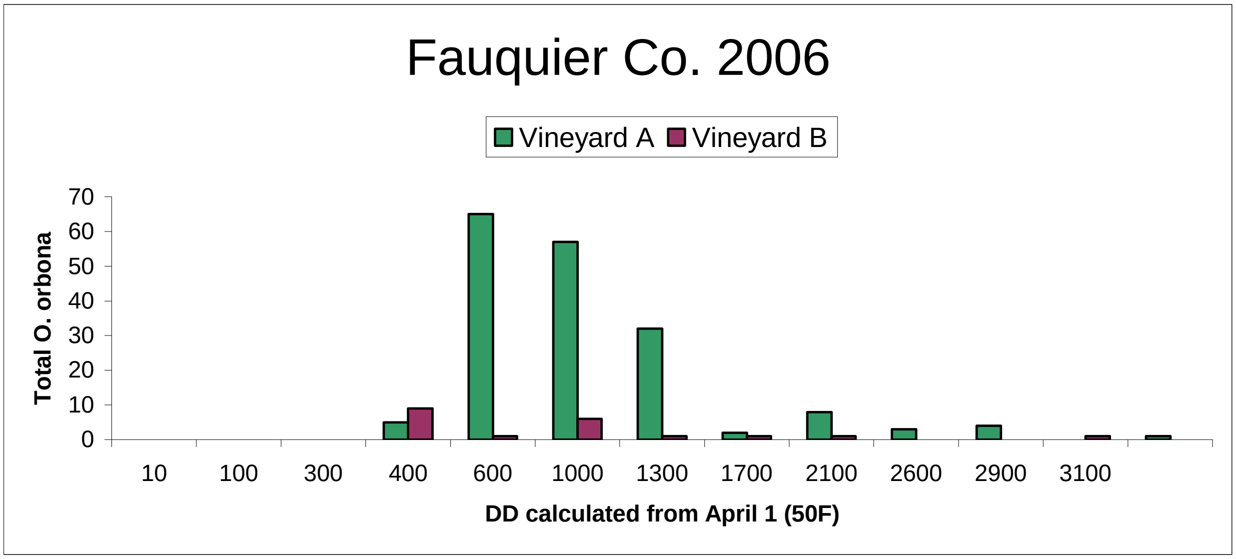

Figure 3: Total number of *O. orbona* trapped in six traps associated with mean growing degree days accumulated between start and end of each trapping period at Vineyard A and B in Fauquier Co., low risk to PD infection according to climate records.

EVALUATION OF ULTOR 150SC AGAINST SAN JOSE SCALE AND GREEN APPLE APHID, 2007

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Insecticide programs were applied with a Durand-Wayland airblast sprayer at 100 gpa.Treatments were; 1) Ultor 150SC (14.0 oz/A) at PF, Stylet Oil (1.0%) at PF, Belt 480SC (5.0oz/A) 2nd – 6th cover; 2) Ultor 150SC (14.0 oz/A) at PF and 1st cover, Stylet Oil (1.0%) at PF and1st cover, Belt 480SC (5.0 oz/A) 2nd – 6th cover; 3) Calypso 4F (3.0 oz/A) at pink, Ultor 150SC (14.0 oz/A) at PF, Stylet Oil (1.0%) at PF, Belt 480SC (5.0 oz/A) 2nd – 6th cover; 4) Esteem35WP (5.0 oz/A) at pink, Belt 480SC (5.0 oz/A) 2nd – 6th cover; 5) Guthion 50WSP(1.5 lb/A) atPF – 6th cover; 6) Untreated Check. Treatments, including the untreated check, were replicated 3times in 4-tree blocks and arranged in a RCB design. Cultivars within the treatment blocks were 'Empire', 'Cortland', 'Jonagold', and 'Delicious'. San Jose Scale damage was taken by inspecting100 fruit from each replicate for the over-wintering generation on 29 Jun and again for the 1st summer generation on 27 Jul. Harvest evaluations were made on 12 – 14 Sep by inspecting 100fruit from each treatment. Green Apple Aphids were also sampled and rated on 29 Jun by counting 100 terminals/plot and estimating populations levels. Data then was transformed and subjected to an AOV with SuperAnova. Means were separated with Fisher’s Protected LSD Test (P<0.05).

Sparse populations of SJS in the 2006 growing season probably account for the sporadic results found on the 29 Jun sample. With the exception of the Esteem 35WP plot, the remainder of the treatments had quite low infestations, including the untreated check. It would seem apparent that the Esteem 35WP was not effective in controlling SJS at this application timing, as well as these plots probably had more over-wintering black caps. No further insecticide applications specifically for SJS were made to these plots for subsequent generations. The Belt 480 SC applications had no effect on scale and were applied to protect the fruit from other insects. The fruit sample taken on 27 Jul indicates that the three treatments that received Ultor 150SCapplications were still controlling SJS quite effectively with one or two sprays at the start of the growing season. The Guthion 50WSP treatment also controlled SJS well; however the repeated application of this product is unrealistic. Esteem 35WP would normally be applied again against the summer broods, however true comparisons would then be difficult as Ultor 150SC was not reapplied. It is also apparent that the population of this pest within the test orchard was increasing as the untreated check plot rose nearly 15.0% in damage from the over-wintering generation sample. Final harvest evaluations taken in Sep revealed that the Ultor 150SCtreatments managed to control SJS through out the entire season. The Guthion 50WSP program also controlled the pest, however this product will soon no longer be available as well as the frequency of applications needed for control would not be in the best interest for resistance management considerations. The Esteem 35WP program did not hold up as well and the damage found at harvest would not be commercially acceptable. However, the untreated check plot had a 19-fold increase in damage from the sample taken for the over-wintering brood, whereas the Esteem 35WP plot actually decreased in damage from that sample. GAA populations were also impeded by the Ultor 150SC, not only in the amount of infestation but with the severity of colonies as well. The other programs had little or no effect at all on GAA, and number/colony seemed to increase as the infestation of terminals increased. The two – spray program seemed to have an even greater effect on GAA probably due to more foliage being exposed at the time of the second application.

EVALUATION OF ULTOR 150SC AGAINST SAN JOSE SCALE AND GREEN APPLE APHID, 2007

	San Jose Scale Damage			Green Apple Aphid	
Treatment	29 June	27 July	12-14 Sep	% Terminal Infestation	Infestation Rating*
Ultor 150SC (14.0oz/A) @ PF Stylet Oil (1.0%) @ PF Belt 480SC (5.0oz/A) 2-6 cover	0.3 a	1.0 ab	4.0 ab	47.3 bc	1.3 ab
Ultor 150SC (14.0oz/A) @ PF, 1C Stylet Oil (1.0%) @ PF, 1C Belt 480SC (5.0oz/A) 2-6 cover	2.0 ab	3.7 abc	2.3 a	6.0 a	0.3 a
Calypso 4F (3.0oz/A) @ pink Ultor 150SC (14.0oz/A) @ PF Stylet Oil (1.0%) @ PF Belt 480SC (5.0oz/A) 2-6 cover	0.3 a	5.7 abc	4.3 ab	46.7 ab	1.7 a
Esteem 35WP(5.0oz/A) @ pink Belt 480SC (5.0oz/A) 2-6 cover	18.3 b	17.0 bc	14.0 ab	84.0 cd	4.3 bc
Guthion 50WSP(1.5lb/A) @ 1-6C	0.7 a	0.3 a	0.3 a	83.3 bcd	4.0 b
Untreated Check	2.3 ab	17.7 c	38.7 b	100.0 d	4.7 c

Means within a column followed by the same letter are not significantly different (Fisher's Protected LSD Test, $P \leq 0.05$).

*Infestation Rating
1.0-1.9 – 1-25/terminal
2.0-2.9 - 25-50/terminal
3.0-3.9 – 50-75/terminal
4.0-4.9 – 75-100/terminal
5.0 -100+/terminal

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Without Consent of the Author

MANAGEMENT OF A HIGH CODLING MOTH INFESTATION IN THE VICINITY OF AN APPLE PACKINGHOUSE

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Introduction

A commercial fruit grower in Hampshire County, WV has been experiencing increasing fruit losses from codling moth (CM) in apple orchards near an apple packinghouse since 2000. A variety of factors have contributed to this problem. A spray schedule consisting of four postbloom insecticide applications on a monthly interval, which had provided acceptable control for many years, was no longer as effective. Apples interplanted with PYO sweet cherries could not be sprayed near cherry harvest because of pesticide PHI and spray drift issues. The grower experienced difficulties in scheduling spray applications for second generation CM control because of peach harvest. Bulk bins infested with CM have been stored at the apple packinghouse. There is suspected CM resistance to organophosphate insecticides due to the long history of use for control of this pest.

A three year project was initiated in 2006 to investigate the feasibility of managing this high population of CM, along with a low population of oriental fruit moth (OFM), with the integration of pheromone matiing disruption and use of reduced-risk insecticides. Results of the first two years of the study are presented here.

Materials and Methods

This study was conducted in Romney (Hampshire County), WV in 25 acres of apple orchard surrounding an apple packinghouse. Delicious was the predominant cultivar, but also included were Golden Delicious, Stayman, Jonathan, Honeycrisp and Gala. Tree size ranged from 8 to 16 ft in height, and tree spacing ranged from 12 x 18 to 16 x 24 feet. The entire 25 acres was treated with a full season insecticide program (Table 1 and 2), specifically timed for CM control, applied as complete sprays with a Durand-Wayland airblast sprayer which traveled at 3 mph and delivered a spray volume of 80 gal/acre. On April 19, 2006 and April 25, 2007, prior to the beginning of CM flight, Isomate CM/OFM TT dispensers were installed in the innermost 14 of the 25 acres of orchards (apple with some cherry) immediately surrounding the apple packinghouse. Dispensers were installed in the upper third of the tree canopy at a density of 200 per acre (1 or 2 dispensers/tree depending upon tree spacing). Moth populations of CM and OFM were monitored weekly with Scenturion large plastic delta traps baited with either 1X (OFM) or 10X (CM) lures, and installed at either head height (OFM) or in the upper third of the tree canopy (CM). Three traps for each insect were placed in each of two orchard sections under pesticides + mating disruption, and two (2006) or three (2007) adjoining orchard sections without mating disruption (pesticides only). Fruit injury from CM and OFM was determined periodically during the season and at harvest by examining 100 fruit/tree (50 high and 50 low) on each of 10 trees in each orchard section. Up to 25 injured apples were collected from each treatment on each sampling date, and internal larvae were identified to species. All larvae were collected and identified from fruit examined at harvest.

Table 1. Pest management program in 2006.

	Pesticide (11 acres)*	
Date	Material	Rate/acre
May 27	Guthion 50W	2 lb
June 9	Imidan 70WSB	3 lb
July 15	Assail 70W + Oil	2.7 oz + 1 gal
July 29	Assail 70W + Oil	2.7 oz + 1 gal
Aug. 12	Rimon 0.83EC	20 oz
Aug. 26	Rimon 0.83EC	20 oz

*This same program was also used on an adjoining (innermost) 14 acres which was overlaid with mating disruption.

Table 2. Pest management program in 2007.

	Pesticide 1 (7 acres)*		Pesticide 2 (4 acres)		Altacor EUP (3 acres)	
Date	Material	Rate/acre	Material	Rate/acre	Material	Rate/acre
May 30	Carpovirusine	6.75 oz	Guthion 50W	2 lb	Altacor 35WG	3 oz
June 6	Carpovirusine	6.75 oz				
June 13	Carpovirusine	6.75 oz	Guthion 50W	2 lb	Altacor 35WG	3 oz
June 18	Carpovirusine	6.75 oz				
June 25	Carpovirusine	6.75 oz				
July 16	Calypso 4F	6 oz	Calypso 4F	6 oz	Altacor 35WG	3 oz
July 31	Calypso 4F	6 oz	Calypso 4F	6 oz	Calypso 4F	6 oz
Aug. 14	Rimon 0.83EC	20 oz	Rimon 0.83EC	20 oz	Rimon 0.83EC	20 oz
Aug. 28	Intrepid 2F	16 oz	Intrepid 2F	16 oz	Intrepid 2F	16 oz

*This same program was also used on an adjoining (innermost) 14 acres which was overlaid with mating disruption.

Result and Discussion

2006

Pheromone trap captures of CM were similar and high in both pesticides + MD and pesticides only plots. Mating disruption provided virtually complete trap shutdown of OFM, with low captures throughout the season in the pesticides only plot (Fig. 1).

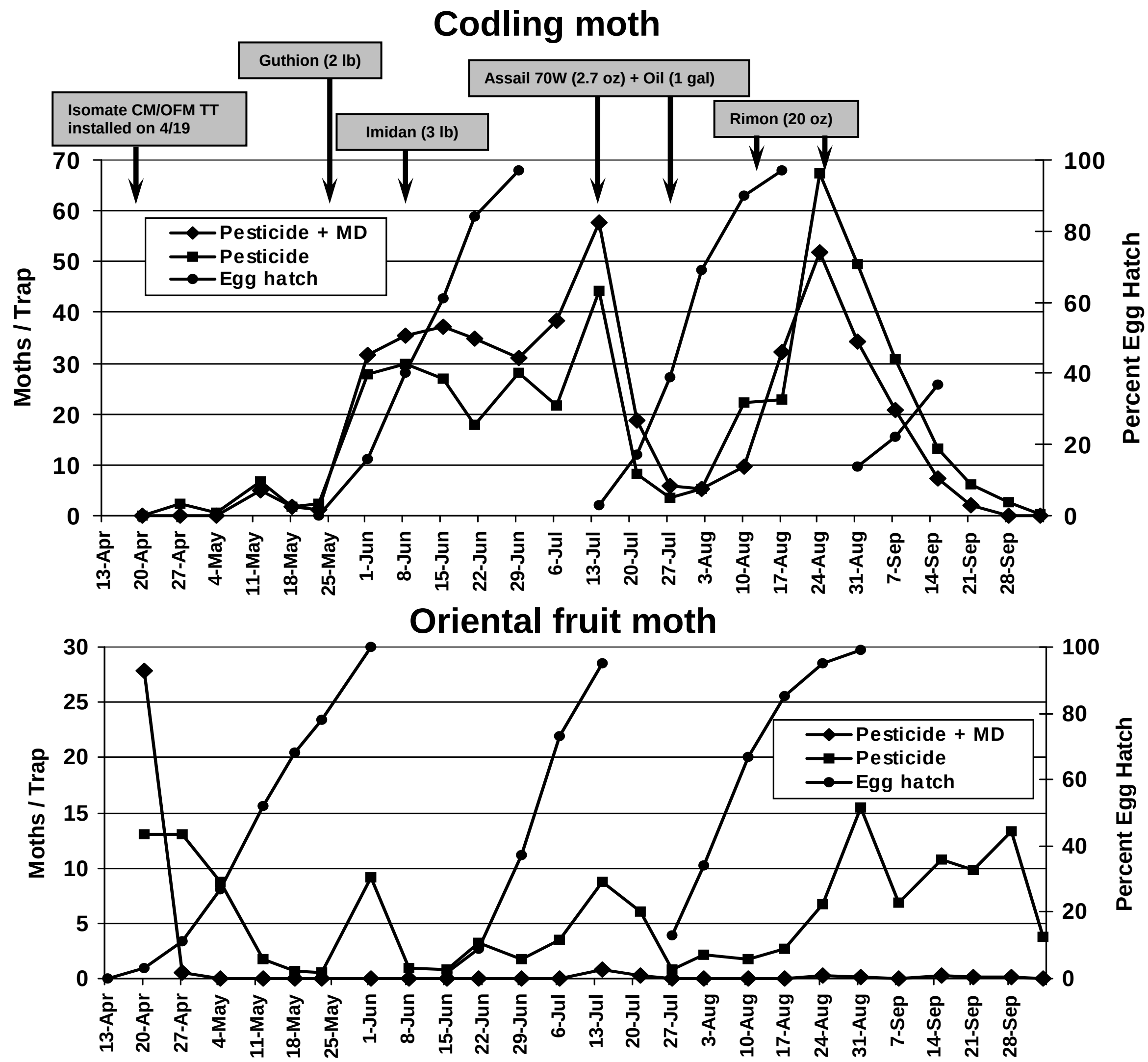

Fig. 1. Pheromone trap capture, estimated egg hatch, and timing of spray applications for control of CM and OFM in 2006.

Injury to fruit in both pesticides + MD and pesticide only plots was almost entirely due to CM, which represented 100 and 99%, respectively of internal worms found in infested fruit. A low and similar level of injury from first generation CM occurred in both plots on June 21 (Table 3). Injury increased substantially in both plots on July 27. Based on the egg hatch curves and size range of worms found in infested fruit, this injury most likely included late first generation and early second generation larvae. It is believed that the spray application schedule and weather conditions contributed to a high rate of survival of late hatching first generation larvae. Imidan was applied on June 9 at about 45% egg hatch, followed by a 36-day interval until application of Assail on July 15. In addition, about 5 inches of rain occurred on June 25-27, which would have completely deleted any remaining residue from the June 9 Imidan application. Although the egg hatch curves are based on CM moth biofix on April 27, the low moth flight for the next 4 weeks probably delayed egg hatch (shifted egg hatch curve to right). In actuality, probably greater than 55% egg hatch was yet to occur following the June 9 Imidan application, resulting in an even higher survival of first generation larvae which contributed to the substantial increase in fruit injury on July 27. In the pesticides + MD plot, fruit injury increased slightly on August 24 and again on September 15 (harvest) as compared with July 27. In the pesticides only plot, there was a slight decrease in injury on August 24, followed by a 85% increase on September 15 (Table 3). Mean fruit injury at harvest was about 5% higher in the pesticides only than in the pesticides + MD plot. Mean fruit injury for the entire season was slightly higher in the pesticides only plot. Considering that fruit injury in past years was highest closest to the packinghouse, the additional benefit provided by the mating disruption was probably even greater than these data would indicate.

Table 3. Mean ± SEM fruit injury from CM and OFM in 2006.

	% CM & OFM fruit injury				
Treatment	June 21	July 27	August 24	September 15	Mean
Pesticides only	0.3 ± 0.16	9.0 ± 1.26	8.7 ± 1.32	16.1 ± 1.88	8.5 ± 3.23
Pesticides + MD	0.1 ± 0.07	8.3 ± 1.30	10.3 ± 1.15	11.2 ± 1.67	7.5 ± 2.53

2007

Pheromone trap captures of CM were highest and similar in Altacor and pesticide 2 plots, with lower and similar levels in pesticide 1 and pesticide 1 + MD plots (Fig. 2). Captures of OFM were highest in the Altacor plot, with lower and similar levels in pesticide 1 and 2 plots, and complete trap shutdown where MD was used. As in 2006, fruit injury was almost entirely due to CM, except for in the Altacor plot on July 3 and September 20, and in the pesticide 1 and 2 plots on September 20, where OFM represented 18-30% of larvae found in injured fruit. Fruit injury on July 3 was lowest in the Altacor plot, highest in the pesticide 2 plot, with intermediate and similar levels in pesticide 1 and pesticide 1 + MD plots (Table 4). This same trend continued through the August 16 and September 20 (harvest) fruit evaluations. Injury increased throughout the season in all plots, especially in the pesticide 2 treatment. Five applications of Carpovirusine (pesticide 1) provided significantly more effective control of first generation CM than two applications of Guthion (pesticide 2). Although there was some benefit from addition of MD, control was not significantly better than that provided by pesticide 1 alone, but probably greater than indicated due to higher pressure immediately surrounding the packinghouse where MD was used.

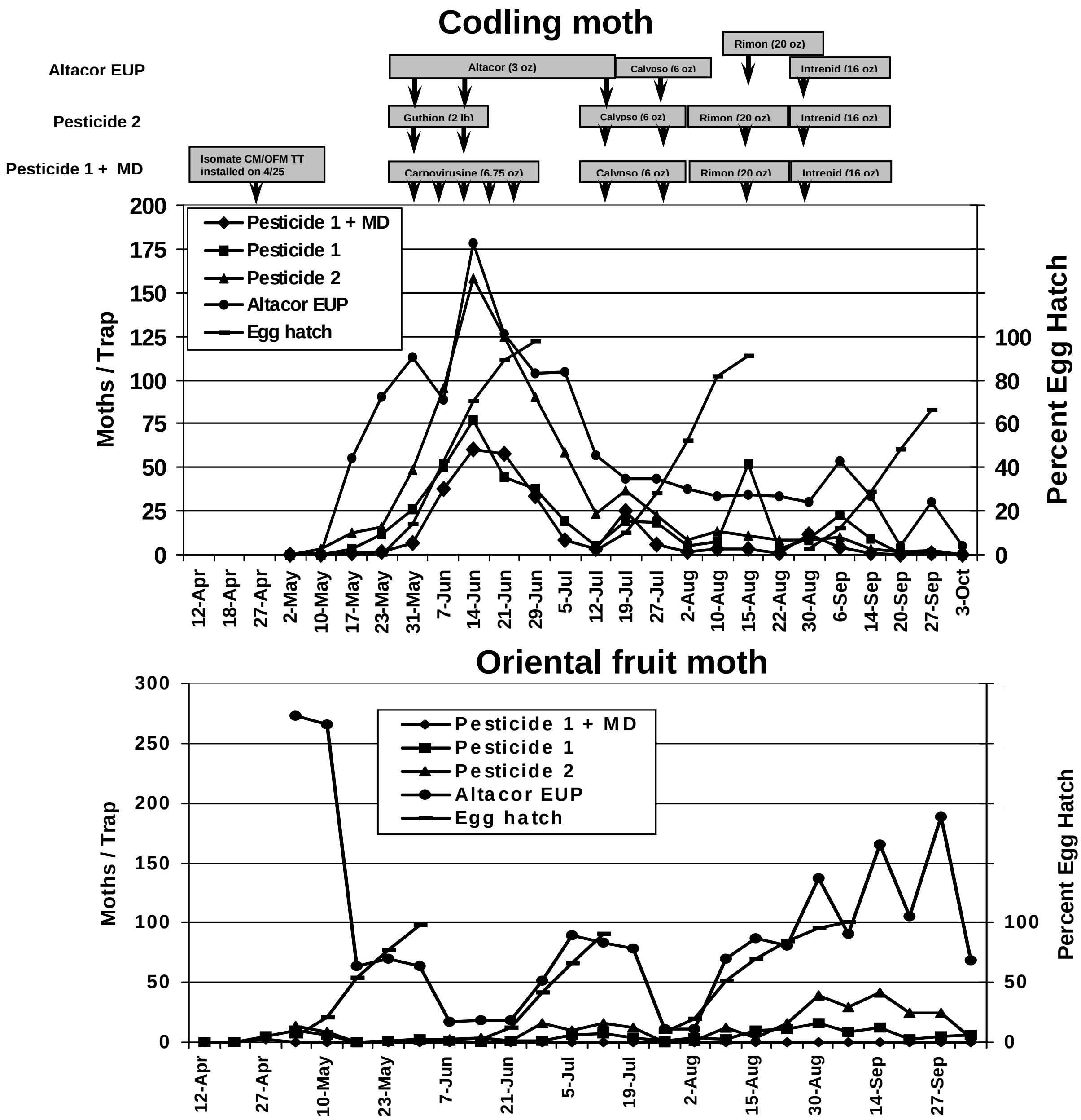

Fig. 2. Pheromone trap capture, estimated egg hatch, and timing of spray applications for control of CM and OFM in 2007.

Table 4. Mean ± SEM fruit injury from CM and OFM in 2007.

	% CM & OFM fruit injury			
Treatment	July 3	August 16	September 20	Mean
Pesticide 1 + MD	4.3 ± 0.60	6.3 ± 0.72	8.4 ± 0.84	6.3 ± 1.18
Pesticide 1 only	3.3 ± 0.77	6.9 ± 1.10	10.5 ± 1.40	6.9 ± 2.08
Pesticide 2 only	10.2 ± 1.51	25.1 ± 3.17	28.3 ± 3.07	21.2 ± 5.58
Altacor EUP	0.7 ± 0.34	2.1 ± 1.29	5.0 ± 1.04	2.6 ± 1.27

WHOLE-FARM ASSAYS OF OBLIQUEBANDED LEAFROLLER MANAGEMENT STRATEGIES
2007

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Obliquebanded leafroller (OBLR) is the most challenging fruit-feeding, or direct pest, of apple in New York State. Its life cycle is out of sync with that of most other orchard pests, as it overwinters as a partially grown larva and begins feeding immediately in the spring as temperatures warm. This necessitates extra pesticide applications specifically targeting summer populations. Additionally, OBLR has developed resistance to many conventional pesticides (e.g., OPs and pyrethroids), so effective management requires the use of selective, speciality materials (such as B.t., IGRs, microbials, etc.). Even so, it is still very difficult to completely eliminate damage from this pest. In high-pressure situations, 1-3% fruit damage at harvest is common. It has the capacity for long flight, plus other behavioral traits that render it unsuitable for pheromone mating disruption.

Furthermore, there has always been an incomplete understanding of the role of such factors as habitat, alternate hosts, adult movement, natural enemies, etc. in the incidence of fruit infestation. For instance, overwintered larvae can often be found in unmanaged or feral sites, but the subsequent summer populations are negligible. This is essentially the opposite of the situation seen in commercial orchards. Larval sampling is not always a reliable indicator of population pressure. In previous studies, we attempted to eradicate the overwintered generation in 5-A plots in order to eliminate summer population damage. Despite obtaining extremely low larval numbers at bloom and during the July sampling period, fruit damage at harvest occurred as before.

Materials & Methods

In 2007, trials were set up in much larger plots on three commercial farms having a history of OBLR infestation in Wayne and Onondaga Counties: Endres (18 A), Apple Acres (29 A), and Furber (33 A); the two largest sites were essentially self-contained, whole-farm units. An unrealistically aggressive early season program was used to eradicate the overwintered generation of larvae; growers applied Intrepid at pink bud, Dipel was used at bloom (at Endres only), and then Proclaim was applied at petal fall. From 1–5 June, to assess how successfully we had been able to completely eliminate the overwintered larvae from these farms, a post-petal fall sampling bout was conducted by inspecting 25 terminals or blossom clusters for live larvae on each of 20 trees at 12 different locations at each farm. These 12 locations or "stations" were located at different orchard strata: orchard "Edge"; 20–30 m in, "Mid-interior"; and 20–30 m in, "Center", on all four ordinal sides of the farm (N, S, E, and W).

To obtain a good temporal and spatial picture of summer larval re-infestation patterns in these plantings, a number of sampling and monitoring procedures were used. Summer generation adult males were monitored using a network of pheromone traps located at each of the stations described above. This resulted in a 12-station crossed transect throughout the planting. Two Trécé Pherocon IIB traps were placed (separated by 20–30 m) at each station between 1–5 June, and checked weekly through August; counts from the two traps at each station were averaged to obtain a mean number of moths per trap at each station.

Weekly samples for larval infestations were taken at each station, starting 25 June; 500 samples were counted per station, for a total of 6000 per farm each week. During the weeks of 25 June, and 2, 9, and 16 July, newly expanding terminals were inspected for active infestations, and during the weeks of 23 and 30 July plus 6 August, developing fruits were inspected (on the tree) for evidence of feeding damage. Because of the difficulty of thoroughly detecting small larvae in foliar terminals, we additionally collected 200 apparently non-infested terminals from Edge-station trees (50 each from the N, S, E, and W borders) during each of the first two weeks of foliar sampling. These were held individually in diet cups in the lab rearing chamber for 1 wk, after which time they were inspected for evidence of larvae that may have been concealed in the terminals while still on the tree. This was done to evaluate our ability to determine the presence (or absence) of small larvae infesting newly expanding terminals, and to indicate our relative efficiency in concluding that a terminal did not contain a larva. Growers were informed of the results of the weekly counts, and some used this information for making management decisions. Fruit damage at harvest was assessed by randomly picking and inspecting 100 fruits (20 per tree from each of 5 trees) in each of the 12 station locations per farm; harvest evaluations took place from 13–17 September.

Data on pheromone trap catch and larval damage to foliage and fruit were log transformed and analyzed using analysis of variance (SuperANOVA, Abacus Concepts, Inc., Berkeley, CA), with means separation by Fisher's Protected lsd test ($\alpha = 0.05$).

Results & Discussion

Inspection of the terminals brought to the lab and held long enough to detect hidden larvae revealed that in most, but not all cases, we were correctly able to determine the infestation status of terminals when the OBLR were very small (Table 1). Most of the time (21 of the 24 samples collected), terminals presumed to be uninfested actually were so; in 2 of the samples, we missed detecting a single larva, and in one sample we missed three. This exercise demonstrated some of the inherent difficulties in making OBLR management decisions based on terminal larval samples, a practice that we have traditionally relied upon and recommended in our IPM management guidelines (Agnello et al. 2007).

The pheromone traps caught fairly high numbers of male moths, particularly at the Endres site (where maximum catches ranged from 10-21 moths/trap per week), and there was a distinct trend toward higher catches on the orchard Edges than in the Mid-interior or Center sites, at statistically significant levels on two of the three farms (Table 2). Some directional trends were noted at each farm, but these did not conform to any specific compass point or adjacent habitat (Table 2). At Apple Acres, significantly fewer moths were caught in the western sector, and all sides were uniformly surrounded by woods. At Endres, significantly fewer were caught in the eastern sector, which was adjacent to other commercial plantings, as were the north and west edges; the south was bordered by woods. At Furber, the fewest moths were caught in the southern sector, which was adjacent to an abandoned block; woods were on the west, and other commercial plantings were to the north and east.

Weekly inspections for larval damage to foliar terminals and developing fruits revealed relatively low infestation rates compared with that generally observed most seasons. In almost all cases, there were no significant differences in foliar or fruit damage in the different orchard strata; the one exception was statistically less fruit damage in the Center sites than in the Mid-interiors or Edges at Furber, where the overall infestation levels were the lowest (Table 3). Final fruit damage at harvest ranged from 0.7-2.1% when averaged across the entire farms. When separated according to orchard strata, damage levels ranged from 0.5-3.5%, with no significant differences among Edge, Mid-interior and Center sites at each farm (Table 3).

These results suggest that large-scale or whole-farm OBLR management might reduce damage from summer generation larvae more effectively than treating individual blocks or small plots. Results of our weekly monitoring sessions suggest that sampling the fruit might better determine the treatment need and initial timing than our traditional practice of timing preventive sprays for 1st egg hatch and then sampling foliar terminals for larvae. If fruit damage actually does tend to occur uniformly anywhere throughout these large blocks, then it should be possible to sample any representative portion of a whole-farm planting as a basis for developing a fruit damage threshold to optimize the economics of making OBLR management decisions on this scale.

Acknowledgments

We are grateful to the following growers for allowing us to conduct this research on their farms: W. Blackler, Apple Acres, Lafayette; R. Endres, Fruition Farm, Sodus; T. Furber, Cherry Lawn Farms, Sodus. We also acknowledge J. Eve Consulting, Naples, for assistance in coordinating with grower program schedules, and for the following technical assistants' efforts in plot setup, maintenance, and sample collection and processing: Marybeth Butler, Dave Chicoine, Dave Combs, Nicole Gottschall, Brody McLaughlin, Samantha Tandle, and James Watt. Contributions of crop protectants and trapping supplies were made by: Cerexagri-Nisso (J. Huether); Dow AgroSciences (B. Olson); Syngenta (J. Zelna); and Trécé (W. Lingren). This work was partly supported by a grant from the USDA RAMP Program.

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Table 1. Larvae recovered from terminal samples held in diet cups after first two foliar inspections during 2007 Large-Plot OBLR trial

	Collection date 26 June		Collection date 3 July	
Orchard/Edge	# terminals	# OBLR larvae	# terminals	# OBLR larvae
Apple Acres				
North	49	0	48	0
East	49	0	47	0
South	49	0	48	0
West	49	1	49	0
	% "False negatives"	0.51%		0.00%
Endres				
North	49	0	49	3
East	49	0	48	0
South	49	1	49	0
West	48	0	48	0
	% "False negatives"	0.51%		1.55%
Furber				
North	48	0	48	0
East	50	0	48	0
South	48	0	48	0
West	48	0	48	0
	% "False negatives"	0.00%		0.00%

Table 2. Pheromone trap catches[1] by orchard site and ordinal direction in 2007 Large-Plot OBLR trial, NY

	Weekly mean # moths caught per trap					
	Apple Acres		**Endres**		**Furber**	
Orchard Site						
Edge	1.56	a	4.51	a	2.69	a
Mid-Interior	0.41	b	2.93	a	0.86	b
Center	0.34	b	2.85	a	0.47	b
Directional Sector						
North	1.08	a	4.06	ab	1.05	ab
South	0.74	ab	4.33	a	0.56	b
East	0.92	a	2.52	b	1.52	a
West	0.33	b	2.82	ab	2.24	a

[1]For each category, values in the same column followed by the same letter are not significantly different (*P* = 0.05, Fisher's Protected lsd test).

Table 3. Larval damage[1] by orchard site in 2007 Large-Plot OBLR trial, NY

	Mean % damage to foliar terminals or fruits					
	Apple Acres		**Endres**		**Furber**	
Foliar Damage						
Edge	0.66	a	0.43	a	0.41	a
Mid-Interior	0.59	a	0.40	a	0.29	a
Center	0.46	a	0.25	a	0.29	a
Fruit Damage In-season						
Edge	0.42	a	0.38	a	0.28	a
Mid-Interior	0.35	a	0.30	a	0.12	ab
Center	0.23	a	0.25	a	0.03	b
Harvest Fruit Damage						
Edge	3.50	a	2.50	a	0.50	a
Mid-Interior	1.25	a	2.50	a	0.75	a
Center	0.75	a	1.25	a	0.75	a
Average	**1.83**		**2.08**		**0.67**	

[1]For each category, values in the same column followed by the same letter are not significantly different (*P* = 0.05, Fisher's Protected lsd test).

Feasibility of the whole-Farm Approach to pest Management in Eastern Apple Production; Where we are after the first year

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Highly diverse orchard plantings interspersed among managed and non-managed habitats preclude the use of an area-wide pest management approach to control the top two lepidopteron pests of eastern US apples ; The codling moth,Codling moth Cydia pomonella (L.) (Lepidoptera: Tortricidae) and the Oriental fruit moth, Grapholita molesta (Busck), Lepidoptera: Tortricidae. In 2007, we began a 3-year study to evaluate the feasibility of the whole-farm approach to pest management in eastern apple orchards using mating disruption in combination with reduced risk or conventional insecticides. The mating disruption products evaluated were Sutera PUFFER® CM/OFM, ISCA Technologies Specialized Pheromone & Lure Application Technology (SPLAT®) and the industry standard Isomate® CM/OFM TT.

Materials & Methods

Studies were conducted in four different orchards to compare Puffer and SPLAT mating disruption systems to the standard Isomate CM/OFM TT dispensers (Fig. 1). Two orchards each were used for comparison of Puffer vs. Isomate (Orchards I and II) and SPLAT vs. Isomate (Orchards III and IV). In 2006, codling moth populations were of moderate to high intensity at all test sites. Unless otherwise specified, the same season-long insecticide programs targeting codling moth were followed at all treatments. Unless otherwise indicated, all treatments were sprayed with the same insecticide program within test sites. Although insecticide programs varied among test sites, they consisted of two-wk interval applications of Guthion, Assail, Intrepid and/or Rimon. Finally, a severe area-wide freeze on 8 April resulted in extensive crop loss throughout the region. Although efforts were made to choose sites with crops being managed, not all treatments were sprayed with insecticides, as indicated below.

Puffer Study Sites. Two apple orchards (I & II) were selected to evaluate Puffer pheromone emitters. Orchard I (Henderson County) was approximately 26 acres of contiguous ‘Rome Beauty’ and ‘Golden Delicious’ trees with tree size ranging from 15 – 20 ft. Orchard I consisted of two treatments; a 17-acre block treated with Puffer dispensers and a 12-acre block treated with Isomate CM/OFM TT. Crop loss in the Isomate section of the orchard was high due to a spring freeze, and this treatment was not sprayed with insecticides, but the Puffer treatment was sprayed. Puffers were erected on 20 April, and Isomate dispensers were applied in early April before the freeze.

Orchard II (Polk County) was approximately 25-acres ‘Golden Delicious’ and ‘Rome Beauty’ trees with tree size ranging from 15 – 20 ft. Orchard II was partitioned into three treatments; a 12-acre block treated with Puffer dispensers, a 5-acre area treated with Isomate CM/OFM TT, and an 8-acre area not treated with pheromones. Insecticides were applied to all treatments at Orchard II. Puffers were erected on 20 April, and Isomate dispensers were applied in early April.

Puffer units consisted of aerosol cans containing custom formulations of 24 g (6.25%) OFM pheromone (three-component blend) and 72 g (18.7%) CM pheromone (codlemone) placed into brown plastic computer controlled “cabinet” emitters that released puffs of pheromone at 15-minute intervals between 5pm and 5 am. Puffers were placed at about 60 m intervals along the perimeter of orchards in the top 1m of the tree canopy, with an additional 4 Puffers placed in the interior of the orchards. Orchard I used a total of 17 Puffers per 17 acres and orchard II used a total of 13 puffers per 12 acres. Isomate CM/OFM TT dispensers were hung at a density of 200 dispensers per acre and placed in the upper third of the canopy. Each Isomate CM/OFM TT dispenser contained 318.8 mg of CM pheromone (three-component blend) and 104.8 mg OFM pheromone (three-component blend).

Puffer aerosol cans were weighed at the beginning and end of the season in both orchards. Average weight of cans before placement in the orchards was 492.8 ± 0.5 g. Puffers were in place for 153 and 158 d in Orchard I and II, at which time mean weight was 154.9 ± 1.6 g and 161.2 ± 4.6 g, respectively. Hence, total output per canister of pheromone + inert ingredients was 338.6 g (2.2 g/d) in Orchard I and 330.9 g (2.1 g/d) in Orchard II. Since each canister contained 18.7% codling moth and 6.25% OFM pheromone, total codling moth and OFM pheromone output per canister was 63.3 and 21.1 g in Orchard I and 61.9 and 20.7 g in Orchard II, respectively. Averaged across both orchards, daily pheromone released was 0.41 g/day of codlemone and 0.14 g/day of OFM pheromone.

SPLAT Studies. Two apple orchards (III and IV) with existing populations of CM and OFM populations were used to evaluate SPLAT, which is an amorphous wax polymer matrix for the sustained release of CM and OFM. Orchard III (Henderson County) was a 32 acre orchard of ‘Golden Delicious’ and ‘Granny Smith’ trees with tree size ranging from 14 – 25 ft. At Orchard IV, there were two SPLAT treatments, each 5 acres in size, a 7-acre area treated with Isomate CM/OFM TT (200 dispensers/acre), and a 5-acre non-pheromone treated area. The Isomate treatment was not sprayed because of extensive crop loss due to a spring freeze, but the two SPLAT and non-pheromone treatments were sprayed with the same seasonal insecticide program.

Orchard IV (Polk County) consisted of a 25 acre block ‘Rome Beauty’ and ‘Delicious trees with tree size ranging from 18-25 ft. Orchard III was partitioned into two 5-acre SPLAT treatments, a 5-acre non-pheromone control, and a 15-acre area treated with Isomate CM/OFM TT (200 dispensers/acre). All treatments were sprayed with a seasonal insecticide program. Splat was applied on 26 April and Isomate in early April.

In each of the blocks in both orchards, tree density per unit area was determined to aid in the proper application rate of the SPLAT product to trees. The two SPLAT treatments consisted of 1) SPLAT CM/OFM (both CM and OFM pheromone was combined in the wax mixture) and 2) SPLAT CM + OFM (separate formulations of each pheromone were applied to trees). The Splat CM/OFM formulation consisted of 3% OFM pheromone (3-component blend) and 10% CM pheromone (codlemone), while SPLAT CM had 10% codlemone and SPLAT OFM had 3%

OFM pheromone. Application of SPLAT was made with a metered applicator provided by ISCA Technologies that allowed dollop size to vary from 0.86 – 4.26 g. In both SPLAT treatments, CM pheromone was applied at 75 g a.i./acre (750 g formulated product/acre) and OFM pheromone was applied at 22.5 g a.i./acre (750 g formulated product/acre). Splat CM/OFM and SPLAT CM were applied at about 465 droplets/acre, and SPLAT OFM at about 95 droplets/acre.

Treatment Evaluation. Treatment efficacy was based on male moths captured in pheromone traps and damage to fruit by larvae. At all study sites, CM and OFM male moths were monitored with Delta traps baited with CM-L2 lures OFM-L111, respectively. Traps were placed in each treatment at a density of one CM trap/2.5 acres (trap placed in the upper canopy), and one OFM trap/10 acres (if plot size was <4 ha, only one OFM trap was used) at eye level. Attractant lures were replaced at 12-wk intervals to ensure lure potency. Traps were monitored weekly to record the number of moths captured and to clean and service traps. End of season damage assessments were made in all treatments by collecting a minimum of 5-10 samples per treatment (depending on plot size), with a sample consisting of 50 fruit (half from each the upper and lower canopy). Fruit were cut to detect larval tunnels and live worms.

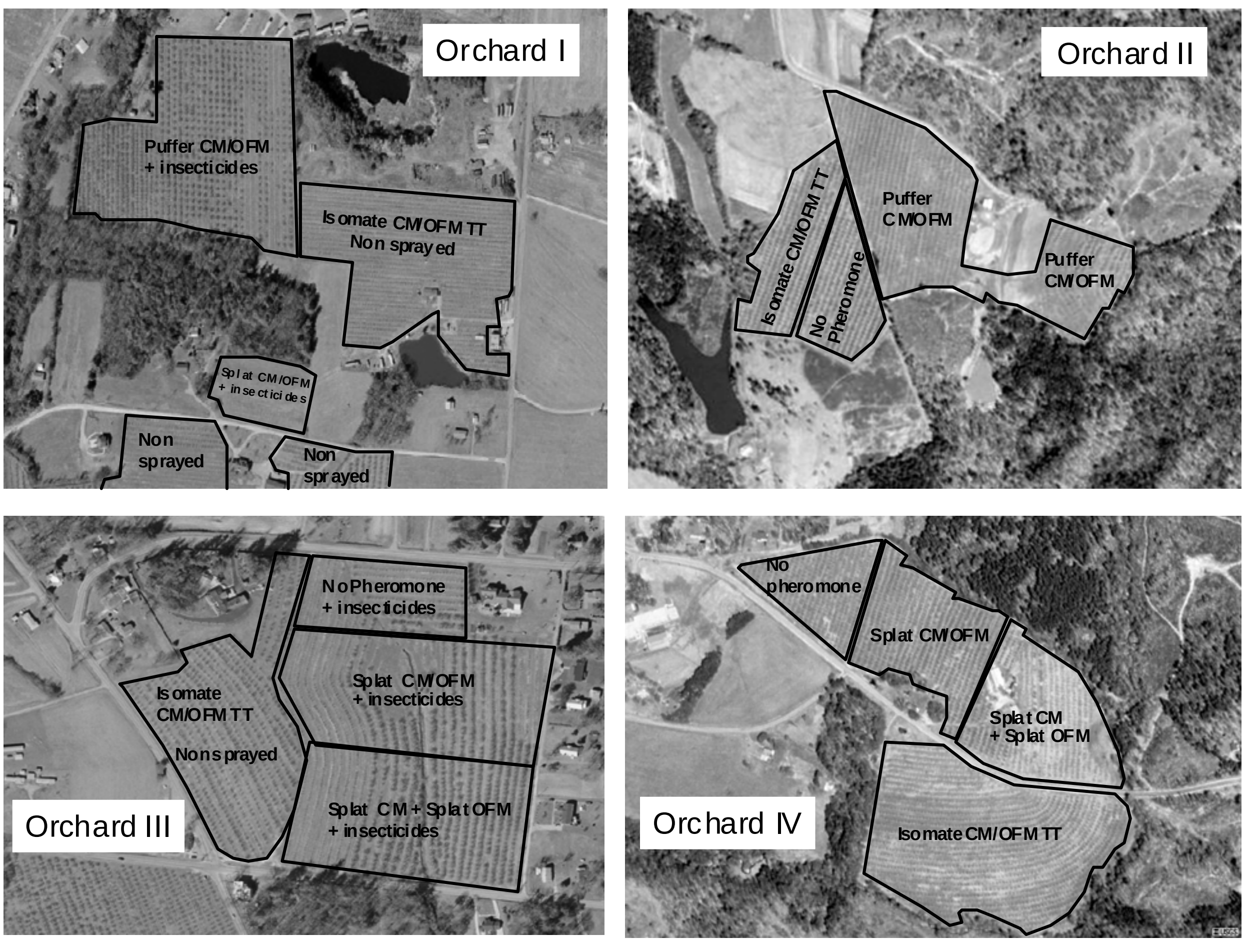


Fig. 1. Aerial view of orchards used for Puffer studies (Orchards I and II) and Splat studies (Orchards III and IV).

Results

Puffer Trials. At Orchard I, codling moth populations were relatively high, with a cumulative season-total trap capture of 50 moths per trap in the Isomate CM/OFM treatment. It should be noted that there were very few apples in the Isomate-treated block due to the severe spring freeze and it was not sprayed with insecticides. Mean cumulative pheromone trap capture in the Isomate and Puffer treatments at the end of first generation flight averaged 35.4 and 13 moths/trap, and the remainder of the season 49.6 and 41.6 moths/trap, respectively (2). In a nearby 2.5-acre block of 'Rome Beauty' trees of smaller size than those in the Puffer block (Fig. 2), mean cumulative trap was 17 moths/trap during first generation and 101 moths/trap during second generation flight.

Codling moth populations were of low to moderate intensity at Ochard II. However, in 2006 codling moth damage in the block treated with Puffers in 2007 was considerably higher than in either the Isomate or control block, so resident codling populations were considerably higher in Puffer than comparison blocks. This probably contributed to higher seasonal codling moth pheromone trap captures in the Puffer block compared to the non-pheromone treated control block; no moths were captured in the Isomate CM/OFM TT treated block.

No oriental fruit moths were captured at either site, and all internal-lepidopteran damage was due to codling moth. Codling moth damage was high in the Puffer treatment at Orchard I (14.0%), but there was undoubtedly extensive immigration from the adjacent non-insecticide treated Isomate block. In the small nearby block treated with Splat CM/OFM, there was only 2.8% damage. Damage was also high in the Puffer treatment (9.6%) at Orchard II compared to either the Isomate (1.4%) or non-pheromone treated (3.8%) blocks (Table 1), but overwintering populations were also higher in this treatment.

Splat Trials. Codling moth populations were high at both Splat study sites, with season total cumulative pheromone trap captures in non-pheromone treated blocks averaging almost 250 and 600 moths/trap at Orchard III and IV, respectively (Fig. 3). OFM populations were low at both sites, with a total of 3 and 8 moths capture in the control plots at Orchard III and IV, respectively. At orchard III in Henderson County where all blocks except the Isomate CM/OFM TT treatment were sprayed with the same insecticide program (the Isomate treatment had very few apples due to the spring freeze), trap captures were highest in the Isomate block through late August, but neither Splat CM + OFM or the combination product Splat CM/OFM were highly effective in suppressing trap capture. At orchard IV in Polk County, where all plots were sprayed with the same insecticide program, Isomate CM/OFM TT was most effective in suppressing pheromone trap capture, capturing 90.1% fewer moths than the control. The individually applied Splat CM + Splat OFM and combination product Splat CM/OFM reduced trap capture by 56.6 and 38.6% respectively.

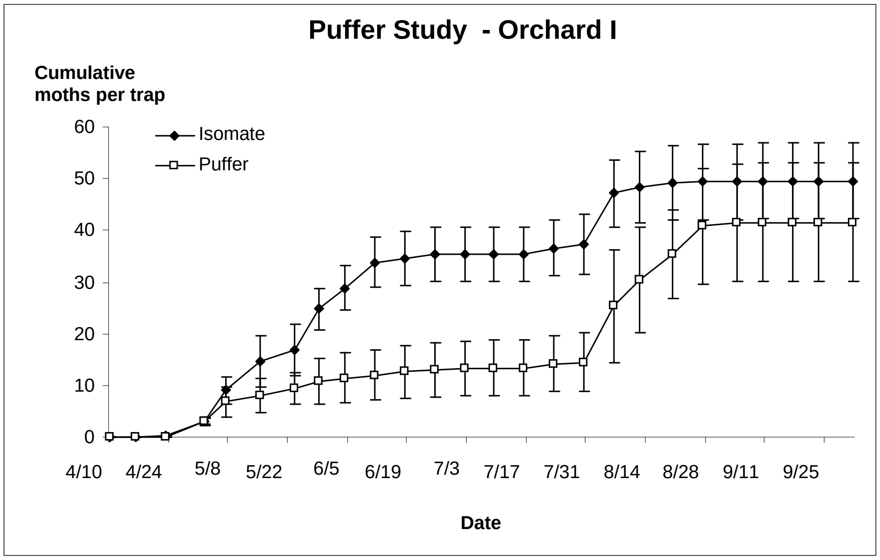
In orchard III, the lowest level of damage was observed in the non-pheromone control (1.2%) and slightly higher levels in the Splat treatments. Damage in treatments at Orchard IV ranged from 0% in the Isomate CM/OFM treatment to 12.0% in the non-pheromone treatment (Table 1). Both Splat treatments did reduce damage below the non-pheromone block, with 1.2 and 4.0% in Spat CM + OFM and Splat CM/OFM, respectively.

Summary

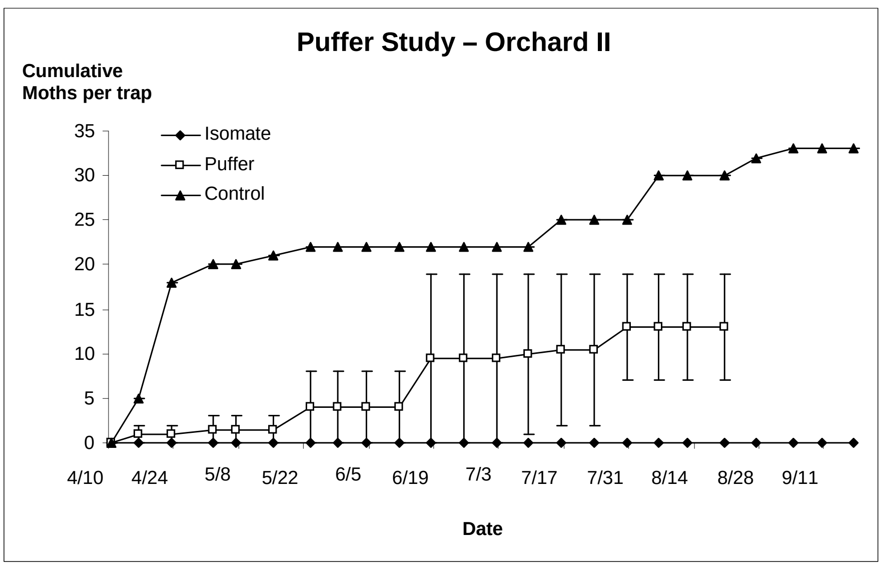
None of the pheromone dispensing products provided consistent trap shutdown among all sites, although Isomate CM-OFM did provide excellent trap shutdown where insecticides were applied (Orchard II and Orchard III). While Splat CM + OFM and Splat CM/OFM did suppress damage at Orchard IV where codling moth populations were very high and insecticides were applied to all plots, suppression of damage was not observed at Orchard III. The April freeze that greatly reduced the apple crop on a regional basis (there was 30% of a normal crop in 2007), likely influence the results of these studies. It is probable that there was significant migration of moths from nearby non-spray orchards that had very few fruit into mating disruption blocks. While nearby non-sprayed orchards were not a factor in the Puffer trial in Orchard II, the overwintering codling moth population was considerably higher in the Puffer vs. the Isomate and non-pheromone treated block. Further evaluations of these products under a normal crop load will be necessary to gauge the efficacy of the pheromone products.

Table 1. Mean percentage of fruit damaged by internal-feeding lepidopteran larvae in blocks of apples managed with different mating disruption products. 2007

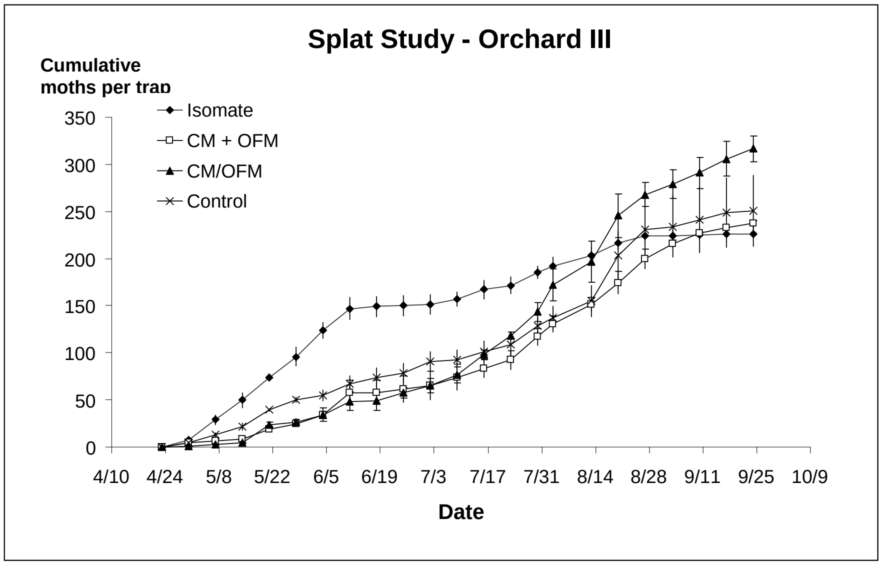
	Mean percent damage (± SEM)				
Orchard	Puffer CM/OFM	SPLAT CM/OFM	SPLAT CM + OFM	ISOMATE CM/OFM TT	Non-Pheromone
I (Henderson Co.)	14.0 (5.2)	2.8 (1.5)		No fruit	
II (Polk Co.)	9.6 (1.8)			1.4 (0.5)	3.8 (1.9)
III (Henderson Co.)		5.2 (2.2)	2.4 (1.2)	No fruit	1.2 (0.8)
IV (Polk Co.)		1.2 (0.8)	4.0 (1.3)	0	12.0 (4.8)
Mean	11.8 (2.2)	3.1 (1.2)	3.2 (0.8)	0.9 (0.4)	7.9 (4.9)



Puffer Study - Orchard I
Cumulative moths per trap
60
50
40
30
20
10
0
Isomate
Puffer
4/10
4/24
5/8
5/22
6/5
6/19
7/3
7/17
7/31
8/14
8/28
9/11
9/25
Date



Puffer Study – Orchard II
Cumulative Moths per trap
35
30
25
20
15
10
5
0
Isomate
Puffer
Control
4/10
4/24
5/8
5/22
6/5
6/19
7/3
7/17
7/31
8/14
8/28
9/11
Date



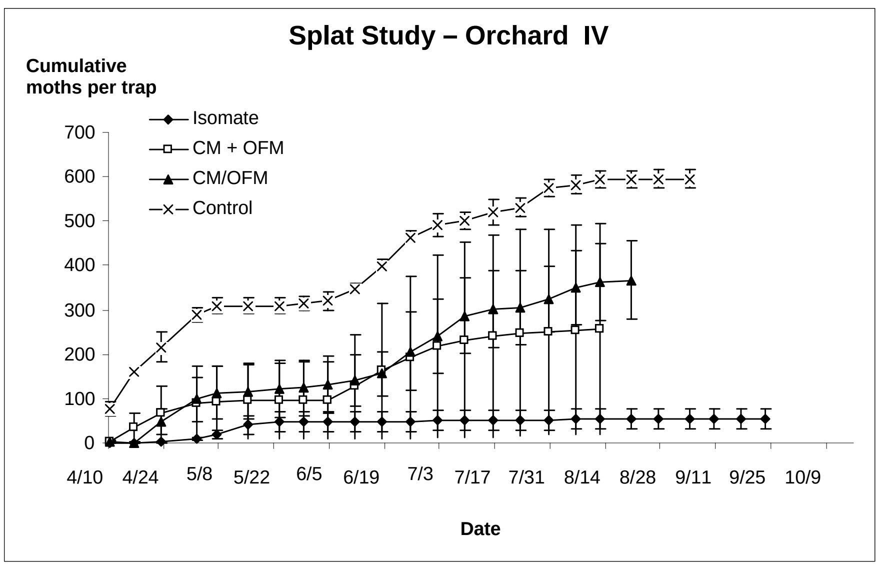


Fig. 2. Mean cumulative codling moth pheromone trap captures in blocks of apples treated Puffer CM/OFM and Isomate pheromone dispensers. 2007.

Fig. 3. Mean cumulative codling moth pheromone trap captures in blocks of apples treated with Splat and Isomate pheromone dispensers. 2007.

A GEOSPATIAL APPROACH TO LANDSCAPE-LEVEL POPULATION DYNAMICS OF *EUSCHISTUS* SPP. STINK BUGS

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Stink bugs (Pentatomidae) and leaffooted bugs (Coreidae) are an overarching issue in all types of agriculture in the southeast. Stink bugs, mainly *Euschistus servus* (Say), *E. tristigmus* (Say), *Acrosternum hilare* (Say), and *Nezara viridula* (L.), and the leaffooted bugs, *Leptoglossus* spp. (primarily *L. phyllopus* (L.)) have recently again become important primary pests of most fruit, nut, vegetable and seed crops in the Southeast and other areas of the U.S. Three main factors have contributed to the increased importance of stink bugs in southern region agriculture: FQPA changes in organophosphate insecticide availability and use, the eradication of the boll weevil from cotton production, and the implementation of genetically-modified germplasm in the major large-acreage crops. All three of these changes have decreased the use of broad spectrum insecticides that suppressed stink bug populations on an area-wide basis.

In 2000-2002 using the Florida stink bug trap baited with pheromone, we sampled *Euschistus* spp. weekly in 3 locations of 2.59 km^2 in Georgia and north Florida. Fifty-52 traps 229 m apart were used in a geospatially-referenced grid at each of the 3 locations. Traps were checked weekly and their contents of *E. servus* and *E. tristigmus* were removed and recorded by sex. This report covers the analysis of the Florida study location.

There is no single computational program or method that combines the optimum spatiotemporal statistics and visual tools available, so a combination of programs and methods were used to describe and test spatiotemporal hypotheses. We used the ESRI GIS (ArcView 9.2) tools, the Spatial Analysis of Distance Indices (SADIE) red blue methodology, and repeated measures methodology in SAS (PROC MIXED) to conduct the analyses. GIS methods can be used to construct maps to visualize the spatial distribution of insects over a landscape, as well as to correlate different habitat types with insect abundance. Using SADIE red blue methodology to determine the level of spatiotemporal stability is an important part of evaluating how habitat use and foraging behavior changes over time. SADIE methodology can also be used to evaluate the aggregation behavior of populations and by using the geographic information system (GIS) technology the spatial distribution of insect populations can be monitored in the landscape over time. Repeated measures analysis can be used to compare temporal dynamics of insect populations in different landscapes or habitat types. By removing the spatial component and treating each sample location as a separate replication, the temporal patterns of abundance of two populations can be compared.

Many studies have shown that the distribution of mobile insects is due to within patch movement and patch immigration and emigration rates. Therefore, in a mobile population, at short time intervals, high rates of population redistribution (i.e. low spatiotemporal stability) are usually due to increased patch emigration and immigration rates, as insects forage for better patches. Consequently, evaluating within season spatiotemporal stability of a highly mobile population over short time periods and comparing between years with different environmental conditions allows the comparison of patch leaving rates under different environmental conditions. In this manner, we determined the distribution and abundance temporally and spatially for *Euschistus* spp. at the level of resolution provided by our trapping grid.

Stink bug populations varied dramatically in time and space and were highly aggregated in different locations during a number of weeks in association with changes in available food. Significant aggregations were found during some weeks of the study and it was possible to determine a number of relationships between the biology of the stink bugs over time and space. However, the trap grid spacing of 229 m used in this study was not adequate to fully describe movement over time and space or to determine the potential causal mechanisms. Stink bug movement is driven by food availability and quality and is mediated by landscape structure. These movements appear to be occurring at distances much smaller than was detectable using the trapping grid in this study.

Spatial Treatment of Blueberry Maggot in Highbush Blueberries – Year Two

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Blueberry maggot (*Rhagoletis mendax*) has a "0" tolerance in fresh market blueberries. While easy to control with labeled insecticides, seasonal treatment for this insect represents the single greatest effort needed for insect control in terms of the number of applications, total amount of active ingredient (a.i.), costs of labor and equipment use, and effort made in observing pre-harvest and re-entry spray intervals. In addition, berries possibly destined for Canadian export are required to undergo a strict spray program, either by a calendar method, or as dictated by trapping. The former results in sprays applied to entire farm acreage starting 7-10 days after the first fly is caught anywhere in the state. The trapping method results in an initial spray being applied 5 days after the first fly is caught in a production zone, or group of fields, followed by a second spray 7-10 days later. Additional trap captures demand that additional applications be made within 5 days. Although workable, these management practices have led to overuse of insecticides, time and resources, and do not fit well with resistance management practices, especially since some of the most effective insecticides continue to be the older organophosphates and carbamates, and reduced risk materials such as imidacloprid have limits on total use.

In the wild, high blueberry maggot populations are often found on alternate hosts such as wild huckleberry and blueberry, as well as abandoned non-sprayed fields of highbush blueberries. Because the entire life cycle can be completed on alternate hosts, areas that border cultivated fields pose the highest risk to infestation. On most farms the first flies of the season are often caught on traps placed on field borders near woods.

This is a summary of an initial 3-year project with the following objectives:

1) Identify locations and high-risk areas of BBM activity on a whole farm basis.
2) Demonstrate that these areas can be spatially recognized and individually managed.
3) Refine the trapping and management protocol used for Canadian exports, and ultimately reduce insecticide use where appropriate.

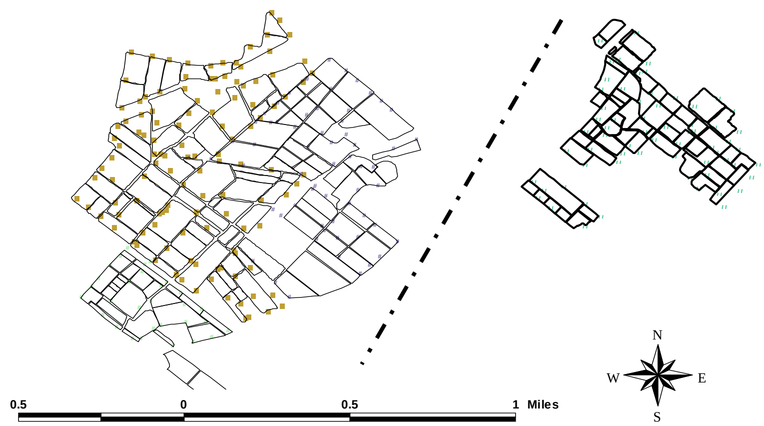
Methods:

Yellow baited sticky board traps (Trecé) were placed on field edges in a rough grid within an entire farm site. Traps were placed in early June, oriented as an upside down tent in the top 6" of the canopy, monitored twice a week and changed every 2 weeks. Berries were boiled and sieved for the presence of maggot larvae for multiple pickings, and in as many fields as possible. The project has involved 5 grower operations with a total of 1820 monitored acres, using 521 traps, with an average of 1 trap for every 2.7 acres. Within the 5 grower group, 1grower (Atlantic Blueberry) is managing 2 farm sites by geo-referenced trapping. Another grower (Mill Rock), has one farm site managed with geo-referenced trapping. Three other growers (Macrie Bros., Variety Farms, and Bridge Ave. Farms) have multiple farm sites, where 1 farm site is managed using geo-referenced traps (spatial treatment or ST farm), and another farm is managed under a calendar based (grower standard or GS farm) practice. All grower standard sites were also monitored for BBM adults, but only for general population presence, and not with a spatial 'grid' method. While data is being gathered from all monitored farm sites for seasonal BBM population distribution, fruit infestation (or lack of), and insecticide use, the use of multiple farm sites allows for a comparison between spatial treatment and grower standard with 3 replicates. The following results summarize data found on the spatial treatment vs. grower standard comparison on the 3 comparison operations, and BBM distribution on all sites.

Comparison Farms

Each farm was about 100 acres or more in size, comprised of 40 or more individual fields, with both ‘Bluecrop’ and ‘Duke.’ One grower standard site has only a few acres of recently planted Duke and not sprayed within the context of this program. Therefore, pesticide use comparisons were run for 3 replicates – total farm, 3 replicates – Bluecrop, and only 2 replicates – Duke. Figure 1 shows the trap distribution for the spatial treatment farms.

Figure 1. Trap locations on 3 spatial treatment farms, 3 other grower standard farms used as comparison sites.



Summary of Results:

In the majority of cases, trap captures were found in traps placed on the borders or border fields of ST farms. On any particular monitoring date, it was common that the vast majority of traps had a “0” capture, and if flies were captured, only 1 or 2 adults were found, typically near areas of dispersal from wild and abandoned hosts, or wooded areas. Figure 2 shows a typical capture date (7/18) where 1 fly was captured on 1 trap bordering the woods, from a total of 65 traps. While some captures were seen on interior fields, these were in the minority. Flies found on interior traps were either in early variety fields no longer being sprayed, or likely represent established interior populations. No infested fruit were found on any of the farms involved in the program during either 2006 or 2007. Insecticide use varied by grower and likely varies by year (2007 pesticide use being analyzed). Over the 3 grower comparison, insecticide use varied by cultivar, with more insecticide used on Bluecrop than on Duke, and greater differences seen between ST farms and GS farms for Bluecrop than for Duke. Since Duke is an earlier variety than Bluecrop, and berries are not present during much of the BBM flight, it is reasonable that less insecticide is used. In 2006 ST farms had a total insecticide use about 50% of that on the GS farms (Figure 3). Other benefits include the fact that fewer insecticide applications translate to improved resistance management for the few insecticides that are available for BBM control. When very low maggot populations are identified, it may also translate to easier labor management with regard to managing re-entry and pre-harvest spray intervals. However, not regarding levels of insecticide use, an accurate picture can be obtained about where alternate host sites are present, where maggot pressure is most likely to occur, and which fields may be at highest risk to maggot damage.

Figure 2. Illustration of typical border capture, Macrie Bros. – 7/18/07 – single adult capture in border field by the woods.

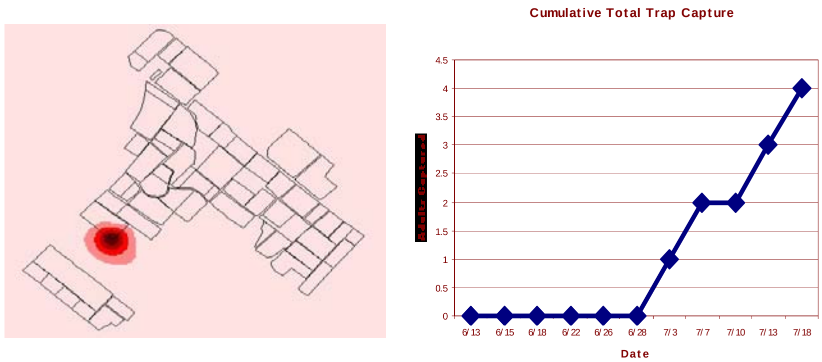
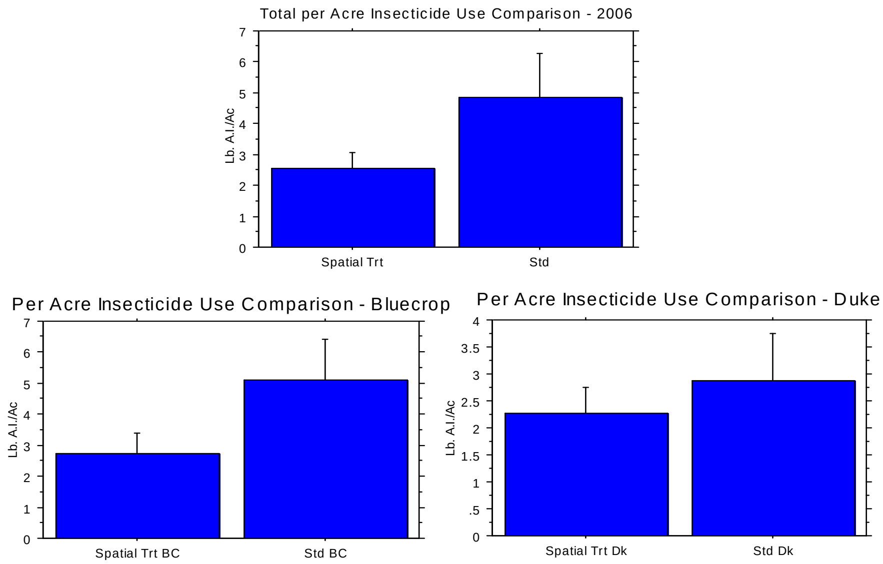


Figure 3. Summary of insecticide a.i. use during 2006 on 3 comparison farms.



HORTICULTURE

RESPONSE OF YOUNG APPLE TREES TO GRASS AND IRRIGATION

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Ground covers and irrigation are important components of orchard floor systems that affect fruit tree vigor and productivity. Experiments were conducted in a greenhouse to determine the relative water use of candidate ground covers (roughstalk bluegrass (RB, *Poa trivialis*), Chewing's fescue (CF, *Festuca rubra* subsp. *commutata* Gaudin), creeping red fescue (RF, *Festuca rubra* L. subsp. *rubra*), tall fescue (TF, *Festuca arundinacea* Schreber, Fawn), and perennial ryegrass (PR, *Lolium perenne* L., Saint)) and the response of apple trees to those ground covers and to drip irrigation applied at two soil depths. Grass ground covers with large and deep root systems (TF and PR) used more water than shallow-rooted grass (RB) and leaf water potential decreased more rapidly in apple trees grown with TF than RB when irrigation was withheld. Although apple tree shoot growth was greater with shallow- than deep-rooted grass, photosynthesis, transpiration, and root biomass distribution were not differentially affected by grass type. When grown with RB or TF, irrigation depth affected apple tree growth. During the first season in the greenhouse, deep irrigation at 37 cm depth increased apple root length density near emitters but shoot growth was less in apple with deep irrigation compared with surface irrigation (0 cm) and split irrigation at 0 and 37 cm. During the second season in the greenhouse, irrigation location did not affect apple shoot growth but deep-rooted TF suppressed it. Deep irrigation did not overcome interference effects of grass on apple trees, regardless of grass root system size or distribution. Split irrigation to surface and 37 cm depths had intermediate effects on apple tree growth and physiology than irrigation only at 0 and 37 cm. The results indicate that grasses with shallow root systems may be grown beneath apple trees and that split irrigation at two depths can provide flexibility that is necessary for water management of ground covers and apple trees.

PLANT PATHOLOGY

APPLE (*Malus* x *domestica* 'Golden Delicious', 'Idared', 'York'),
Scab; *Venturia inaequalis*
Powdery mildew; *Podosphaera leucotricha*
Cedar-apple rust; *Gymnosporangium juniperi-virginianae*
Sooty blotch; disease complex
Flyspeck; *Zygophiala jamaicensis*
Rots (unspecified)
Fruit finish

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Season-long disease control by experimental fungicides on Golden Delicious, Idared, and York Imperial apples, 2007.

Seventeen experimental and combination treatment schedules were compared to registered treatments on 7-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 2006 which allowed mildew inoculum pressure to stabilize on 2007 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: 19 Apr (Golden Delicious OC, open cluster; York tight cluster –open cluster; Idared OC-pink); 1 May (bloom - petal fall); 1st- 7th covers (1C-7C) 17 May, 31 May, 15 Jun, 28 Jun, 13 Jul, 30 Jul, 31 Aug. Maintenance applications applied to the entire test block with the same equipment included Asana, Assail, Lannate LV, Lannate 90SP, Imidan, and Provado. Cedar-apple rust galls, wild blackberry canes with the sooty blotch and flyspeck fungi, and bitter rot mummies were placed over each Idared test tree 26 Apr. Other diseases developed from inoculum naturally present in the test area. Foliar data are from counts of eight shoots per tree from each of four reps: 26 Jul (Golden Delicious), 12 Jul (Idared) or 27 Aug (York). Fruit data represent counts of 25 fruit per tree harvested and stored at 4°C until evaluated Idared (4 Oct, 2 Nov); Golden Delicious (9 Oct, 23 Oct); York (5 Oct, 6 Nov). Percentage data were converted by the square root arcsin transformation for statistical analysis.

Although test schedules were directed toward scab, early season weather and inoculum conditions were more favorable for mildew than for scab, and cedar-apple rust galls persisted well into June. Under this sustained mildew pressure, treatments with an active material through second cover (trts. #1 and 11-17) sprays, gave significant control (Table 1); those with alternating schedules involving Dithane directed toward scab during 1st-2nd covers lacked effective mildew control. Distinguish gave outstanding mildew control on all three cultivars; sulfur, added to Dithane (trt. #9) through second cover, improved control significantly. Cedar-apple rust inoculum persisted into June resulting in a heavy infection period beyond the 2nd cover spray. Most SI-related treatments gave good rust control as expected; Dithane alone was somewhat weaker as indicated by Trt. #8 on York. Under moderate sooty blotch and flyspeck pressure (Table 2), the experimental treatment Distinguish gave control comparable to the captan + ziram standard; Mettle, applied alone, was significantly weaker for control of sooty blotch, flyspeck and Brooks spot (Table 3). All treatments gave significant suppression of fruit rots. Several treatments significantly increased opalescence compared to non-treated trees.

Table 1. Early season disease control by experimental fungicides on Golden Delicious, Idared and York apples, 2007.

			Mildew, % leaves, leaf area or fruit infected							Cedar-apple rust % leaves infected			Scab, % fruit infected	
			Golden Del.		Idared			York						
	Treatment and rate/A	Timing	leaves	area	leaves	area	fruit	leaves	area	G. Del	Idared	York	G Del	Idared
0	No fungicide	---	54 g	18 d	62 h	21 h	15 d	63 h	8 i	30 g	9 e	37 i	6 a	7 b
1	Nova 40W 5 oz + Dithane 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-2C 3C-7C	26 cd	3 ab	32 b-d	5 a-d	1 ab	23 d-g	3 d-h	<1 ab	0 a	2 b-d	0 a	0 a
2	Inspire 250EC 4 fl oz Dithane 75DF 6 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-Bl 1C -2C 3C-7C	40 ef	4 ab	54 gh	9 d-g	4 a-c	30 fg	3 e-h	2 d-f	<1 a	11 gh	0 a	0 a
3	A16001 336SE 7.5 fl oz Dithane 75DF 6 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-Bl 1C -2C 3C-7C	47 fg	6 bc	56 gh	8 d-g	5 a-c	27 e-g	3 e-h	1 b-e	1 a-c	9 f-h	0 a	0 a
4	A16001 336SE 8.5 fl oz Dithane 75DF 6 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-Bl 1C -2C 3C-7C	38 ef	4 ab	52 f-h	8 c-f	4 a-d	30 g	4 h	3 c-f	2 bc	6 e-g	0 a	0 a
5	Flint 50WG 2 oz Dithane 75DF 6 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-Bl 1C-2C 3C-7C	35 de	4 ab	39 c-e	4 a-c	5 b-d	26 d-g	4 f-h	4 ef	3 cd	10 f-h	0 a	0 a
6	Nova 40W 4 oz + Dithane 75DF 3 lb Dithane 75DF 6 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-Bl 1C-2C 3C-7C	38 ef	4 ab	46 e-g	5 a-d	1 ab	23 d-g	4 gh	4 d-f	<1 ab	7 e-g	0 a	0 a
7	Inspire 250EC 3 fl oz + Dithane 75DF 3 lb Dithane 75DF 6 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-Bl 1C-2C 3C-7C	46 fg	5 bc	53 f-h	13 fg	3 a-c	21 c-f	3 c-h	3 d-f	<1 ab	6 d-f	0 a	0 a
8	Dithane 75DF 6 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-2C 3C-7C	47 fg	5 bc	61 h	13 g	2 a-c	31 g	4 f-h	5 ef	1 a-c	15 h	0 a	0 a
9	Dithane 75DF 3 lb + Sulfur 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-2C 3C-7C	35 de	4 ab	46 e-g	6 b-e	5 a-d	19 c-e	3 c-g	3 d-f	<1 ab	5 d-f	1 a	0 a
10	No fungicide first four apps. Captan 80WDG 30 oz + Ziram 76DF 3 lb	--- 3C-7C	44 e-g	10 c	58 h	11 e-g	10 cd	27 d-g	3 e-h	22 g	5 de	36 i	6 a	6 b
11	Mettle 125ME 4 fl oz	TC-7C	24 c	3 ab	33 b-d	3 ab	6 a-d	19 b-d	3 b-f	<1 a-c	<1 ab	<1 a-c	0 a	0 a
12	Mettle 125ME 5 fl oz	TC-7C	20 bc	3 ab	26 b	3 ab	3 a-c	10 a	2 a-d	<1 a-d	0 a	<1 ab	3 a	1 a
13	Mettle 125ME 4 fl oz + Dithane 75DF 3 lb	TC-7C	23 bc	3 ab	42 d-f	4 a-c	0 a	8 a	2 ab	0 a	0 a	<1 ab	0 a	0 a
14	Mettle 4 fl oz + Captan 80WDG 30 oz	TC-7C	19 bc	3 a	34 b-d	4 a-c	3 a-c	12 ab	2 a-c	<1 ab	<1 a	0 a	2 a	0 a
15	Distinguish 480SC 14.2 fl oz	TC-7C	9 a	2 a	17 a	3 a	5 a-d	9 a	2 a	2 b-e	<1 a	3 c-e	0 a	0 a
16	Vangard 75WG 5 fl oz + Dithane 75DF 3 lb Flint 50WG 2 oz Rubigan 1E 9 oz + Dithane 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC Bloom 1C-2C 3C-7C	16 ab	2 a	26 b	3 ab	3 ab	13 a-c	2 a-e	5 f	<1 ab	10 f-h	0 a	0 a
17	Flint 50WG 2 oz + Dithane 75DF 3 lb Rubigan 1E 9 oz + Dithane 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-Bl 1C-2C 3C-7C	15 ab	2 a	28 bc	3 ab	2 ab	13 a-c	2 a-e	3 d-f	<1 ab	9 e-g	0 a	0 a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Foliar counts: eight shoots / tree from each of four reps 26 Jul (Golden Delicious), 12 Jul (Idared) or 27 Aug (York). Fruit: post-harvest counts of 25 fruit /rep; Idared picked 4 Oct, York 5 Oct, and Golden Delicious 9 Oct.

Table 2. Summer disease control by experimental and registered fungicides on Golden Delicious, Idared and York apples, 2007.

			Sooty blotch, % fruit or fruit area infected						Flyspeck, % fruit or fruit area infected						% fruit inf. with any rot	
			Golden Del.		Idared		York		Golden Del.		Idared		York			
	Treatment and rate/A	Timing	fruit	area	fruit	area	fruit	area	fruit	area	fruit	area	fruit	area	G. Del	Idared
0	No fungicide	---	83 f	7.7 f	81 e	5.5 e	40 d	2.2 d	60 d	3.8 d	64 d	3.5 f	35 d	1.9 d	29 c	12 c
1	Nova 40W 5 oz + Dithane 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-2C 3C-7C	9 b-d	0.5 b-d	7 bc	0.4 bc	3 ab	0.2 ab	9 bc	0.5 bc	12 bc	0.7 de	7 a-c	0.4 a-c	9 b	1 ab
2	Inspire 250EC 4 fl oz Dithane 75DF 6 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-Bl 1C -2C 3C-7C	0 a	0 a	1 ab	0.1 ab	0 a	0 a	0 a	0 a	1 a	0.1 ab	1 a	0.1 a	3 ab	3 ab
3	A16001 336SE 7.5 fl oz Dithane 75DF 6 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-Bl 1C -2C 3C-7C	0 a	0 a	8 c	0.4 c	0 a	0 a	0 a	0 a	5 a-c	0.3 b-e	4 ab	0.2 ab	8 b	0 a
4	A16001 336SE 8.5 fl oz Dithane 75DF 6 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-Bl 1C -2C 3C-7C	9 a-d	0.7 b-d	4 a-c	0.2 a-c	1 a	0.1 a	7 a-c	0.3 ab	3 ab	0.2 a-c	1 a	0.1 a	3 ab	4 ab
5	Flint 50WG 2 oz Dithane 75DF 6 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-Bl 1C-2C 3C-7C	2 a-c	0.1 a-c	1 ab	0.1 ab	1 a	0.1 a	2 ab	0.1 ab	1 a	0.1 ab	3 a-c	0.2 a-c	2 ab	0 a
6	Nova 40W 4 oz + Dithane 75DF 3 lb Dithane 75DF 6 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-Bl 1C-2C 3C-7C	0 a	0 a	2 a-c	0.1 a-c	0 a	0 a	0 a	0 a	3 ab	0.2 a-c	3 a	0.2 a	3 ab	3 ab
7	Inspire 250EC 3 fl oz + Dithane 75DF 3 lb Dithane 75DF 6 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-Bl 1C-2C 3C-7C	10 a-d	0.7 a-c	6 bc	0.3 bc	0 a	0 a	6 ab	0.3 ab	3 ab	0.2 a-c	1 a	0.1 a	3 ab	1 ab
8	Dithane 75DF 6 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-2C 3C-7C	1 ab	0.1 ab	0 a	0 a	0 a	0 a	0 a	0 a	1 a	0.1 ab	4 ab	0.2 ab	3 ab	0 a
9	Dithane 75DF 3 lb + Sulfur 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-2C 3C-7C	4 a-c	0.2 a-c	5 a-c	0.3 a-c	0 a	0 a	3 ab	0.2 ab	3 ab	0.2 ab	2 a	0.1 a	6 ab	1 ab
10	No fungicide first four apps. Captan 80WDG 30 oz + Ziram 76DF 3 lb	--- 3C-7C	3 a-c	0.2 a-c	8 c	0.5 c	0 a	0 a	3 ab	0.2 ab	6 a-c	0.4 b-e	5 a-c	0.3 a-c	2 ab	3 ab
11	Mettle 125ME 4 fl oz	TC-7C	22 d	2.2 de	24 d	1.3 d	6 ab	0.3 ab	9 ab	0.5 ab	16 c	0.8 e	15 c	0.8 c	4 ab	2 ab
12	Mettle 125ME 5 fl oz	TC-7C	49 e	3.4 e	32 d	2.0 d	18 c	0.9 c	23 c	1.2 c	15 bc	0.8 c-e	16 bc	0.8 bc	10 b	7 bc
13	Mettle 125ME 4 fl oz + Dithane 75DF 3 lb	TC-7C	2 a-c	0.1 a-c	4 a-c	0.2 a-c	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	4 ab	5 a-c
14	Mettle 4 fl oz + Captan 80WDG 30 oz	TC-7C	13 cd	0.9 cd	9 bc	0.5 bc	6 b	0.3 b	6 ab	0.3 ab	7 ab	0.4 a-d	4 a-c	0.2 a-c	6 ab	5 bc
15	Distinguish 480SC 14.2 fl oz	TC-7C	1 ab	0.1 ab	5 a-c	0.3 a-c	0 a	0 a	0 a	0 a	3 ab	0.2 a-c	0 a	0 a	7 ab	1 ab
16	Vangard 75WG 5 fl oz + Dithane 75DF 3 lb Flint 50WG 2 oz Rubigan 1E 9 oz + Dithane 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC Bloom 1C-2C 3C-7C	12 a-d	0.8 a-c	5 bc	0.3 bc	0 a	0 a	7 ab	0.4 ab	5 a-c	0.3 a-e	2 a	0.1 a	1 ab	2 ab
17	Flint 50WG 2 oz + Dithane 75DF 3 lb Rubigan 1E 9 oz + Dithane 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-Bl 1C-2C 3C-7C	3 a-c	0.2 a-c	2 a-c	0.1 a-c	0 a	0 a	0 a	0 a	4 a-c	0.2 a-e	4 ab	0.2 ab	0 a	2 ab

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Foliar counts: eight shoots / tree from each of four reps 26 Jul (Golden Delicious), 12 Jul (Idared) or 27 Aug (York). Fruit: post-harvest counts of 25 fruit /rep; Idared picked 4 Oct, York 5 Oct, and Golden Delicious 9 Oct.

Table 3. Fruit finish and Brooks spot control by fungicide treatments on Golden Delicious, Idared and York apples, 2007.

	Treatment and rate/A	Timing	Brooks spot (%), G. Del.	Russet ratings or USDA grade * Ratings (0-5) G. Del.	Idared	York	G. Del. % fancy/x-fcy	Opalescence rating (0-5)* Idared	York
0	No fungicide	---	4 b	2.5 ab	1.6 ab	1.7 a	72 c	1.1 a-c	1.2 a-c
1	Nova 40W 5 oz + Dithane 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-2C 3C-7C	0 a	2.8 b	1.7 ab	1.7 a	58 a	0.9 ab	1.7 c-g
2	Inspire 250EC 4 fl oz Dithane 75DF 6 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-Bl 1C -2C 3C-7C	0 a	2.3 ab	1.5 ab	1.9 a	83 ab	0.7 a	1.7 c-g
3	A16001 336SE 7.5 fl oz Dithane 75DF 6 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-Bl 1C -2C 3C-7C	0 a	2.7 ab	1.7 ab	1.7 a	72 bc	1.1 a-c	1.4 a-d
4	A16001 336SE 8.5 fl oz Dithane 75DF 6 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-Bl 1C -2C 3C-7C	0 a	2.6 ab	1.9 ab	1.8 a	75 bc	1.0 ab	1.4 a-e
5	Flint 50WG 2 oz Dithane 75DF 6 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-Bl 1C-2C 3C-7C	0 a	2.4 ab	1.7 ab	1.9 a	81 ab	1.2 bc	1.6 b-f
6	Nova 40W 4 oz + Dithane 75DF 3 lb Dithane 75DF 6 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-Bl 1C-2C 3C-7C	0 a	2.3 ab	1.6 ab	1.9 a	84 ab	0.9 ab	1.8 d-g
7	Inspire 250EC 3 fl oz + Dithane 75DF 3 lb Dithane 75DF 6 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-Bl 1C-2C 3C-7C	0 a	2.5 ab	1.6 ab	1.8 a	82 ab	0.9 ab	1.8 d-g
8	Dithane 75DF 6 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-2C 3C-7C	0 a	2.1 a	1.4 a	1.6 a	92 a	0.9 ab	1.6 b-f
9	Dithane 75DF 3 lb + Sulfur 8 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-2C 3C-7C	0 a	2.5 ab	1.4 ab	1.6 a	77 bc	1.0 ab	1.6 b-f
10	No fungicide first four apps. Captan 80WDG 30 oz + Ziram 76DF 3 lb	--- 3C-7C	4 b	2.2 ab	1.3 a	1.2 a	87 ab	0.8 ab	1.0 a
11	Mettle 125ME 4 fl oz	TC-7C	1 a	2.3 ab	2.0 ab	1.9 a	78 a-c	1.2 bc	2.1 fg
12	Mettle 125ME 5 fl oz	TC-7C	4 b	2.4 ab	1.4 ab	2.0 a	81 ab	1.0 ab	2.2 g
13	Mettle 125ME 4 fl oz + Dithane 75DF 3 lb	TC-7C	0 a	2.6 ab	1.6 ab	1.0 a	84 ab	1.0 ab	1.1 ab
14	Mettle 4 fl oz + Captan 80WDG 30 oz	TC-7C	0 a	2.3 ab	1.7 ab	1.8 a	82 ab	1.0 a-c	2.0 e-g
15	Distinguish 480SC 14.2 fl oz	TC-7C	0 a	2.3 ab	2.1 b	1.7 a	77 a-c	1.4 c	1.8 d-g
16	Vangard 75WG 5 fl oz + Dithane 75DF 3 lb Flint 50WG 2 oz Rubigan 1E 9 oz + Dithane 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC Bloom 1C-2C 3C-7C	1 a	2.2 ab	1.4 ab	1.6 a	83 ab	1.1 a-c	1.3 a-d
17	Flint 50WG 2 oz + Dithane 75DF 3 lb Rubigan 1E 9 oz + Dithane 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	OC-Bl 1C-2C 3C-7C	0 a	2.4 ab	1.6 ab	1.7 a	78 a-c	1.0 ab	1.6 b-f

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). * Fruit finish rated on a scale of 0-5 (0=perfect finish; 5=severe russet or opalescence). USDA Extra fancy and fancy grades after downgrading by russet. Post-harvest counts; Idared picked 4 Oct, York 5 Oct, and G. Delicious 9 Oct.

APPLE (*Malus* x *domestica* 'Golden Delicious')
Scab; *Venturia inaequalis*
Powdery mildew; *Podosphaera leucotricha*
Cedar-apple rust; *Gymnosporangium juniperi-virginianae*
Sooty blotch; disease complex
Flyspeck; *Zygophiala jamaicensis*
Rot spots (unidentified)
Fruit russet

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Concentrate applications of experimental fungicides on Golden Delicious apple, 2007.

Nine treatments involving several experimental compounds were compared on 35-yr-old trees. The test was conducted in a randomized block design with four single-tree replicates separated by border trees in the row, and by untreated border rows between treatment rows. Tree-row-volume was determined to require a 400 gal/A dilute base for adequate spray coverage. 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: 19 Apr (tight cluster-open cluster, OC); 2 May (petal fall); 1st-6th covers (1C-6C): 17 May, 31 May, 15 Jun, 28 Jun, 12 Jul, and 26 Jul. Insecticides, applied to the entire test block with the same equipment, included Asana, Assail, Imidan WSB, Lannate LV, Lannate SP and Provado. Inoculum, placed over each test tree, included cedar rust galls 11 and 25 Apr; wild blackberry canes with the sooty blotch and flyspeck fungi 11 Apr, and bitter rot mummies 7 Aug. Foliar data represent averages of counts of all leaves on 10 terminal shoots from each of four replicate trees 2-3 Jul. A 25-fruit sample from each replicate tree was harvested 4 Oct and stored at 1C 18 days before rating 22 Oct. Percentage data were converted by the square root arcsin transformation for statistical analysis.

Early season weather and inoculum conditions were more favorable for mildew than for scab, and cedar-apple rust inoculum persisted well into June. Under this mildew pressure, LEM17 + Flint (Trt.#4), applied through 4th cover, provided the most effective control (Table 4); those with alternating schedules involving Dithane directed toward scab and rusts during the early season lacked effective mildew control. Cedar-apple rust inoculum persisted into June resulting in a heavy infection period after the 2nd cover spray. All treatments gave commercially acceptable rust control, but the SI-related treatments (Trts. #6 & 7) were the most effective; Evito and Dithane, alone or alternated with LEM17, were somewhat weaker. Scab incidence was too low in this test for good treatment comparisons. The cumulative wetting hour threshold for presence of the sooty blotch and flyspeck fungi on non-protected fruit was met by 2 Jul. Under moderate summer disease pressure (sooty blotch, flyspeck, and various rot spots, Table 5), Indar (Trt. #7), applied with Dithane through 1st cover and then alone through the rest of the season, gave control of these diseases comparable to Manzate applied throughout the season (Trt. #6). Evito was also highly effective for sooty blotch, flyspeck and rot control. Endorse, applied alone, was significantly weaker for control of sooty blotch, flyspeck and rot spots. All treatments gave significant suppression of fruit rots. Evito significantly increased the fruit russet rating compared to non-treated trees.

Table 4. Early season disease control by experimental fungicides on Golden Delicious, 2007

	Treatment and rate/acre	App. schedule	Mildew % leaves	Mildew % area	Scab, % leaves	Scab, % fruit	Cedar-apple rust % leaves	Cedar-apple rust lesions/lf
0	No fungicide	---	50 f	11 e	3.1 b	1 a	17.5 d	0.39 b
1	LEM17 200SC 15 fl oz Manzate 200 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	Apps 1,3,5 Apps. 2,4,6 5C-6C	41 d-f	5 b-d	1.4 ab	0 a	5.1 bc	0.06 a
2	LEM17 200SC 21.5 fl oz Manzate 200 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	Apps 1,3,5 Apps. 2,4,6 5C-6C	39 c-f	4 a-c	0.8 ab	0 a	3.4 a-c	0.04 a
3	LEM17 200SC 10 fl oz + Manzate 200 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	Apps. 1- 6 5C-6C	25 b	3 ab	0.4 ab	1 a	0.8 a	0.01 a
4	LEM17 200SC 10 fl oz + Flint 50WG 1 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	Apps. 1- 6 5C-6C	13 a	2 a	0 a	0 a	1.8 ab	0.03 a
5	Manzate 200 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	Apps. 1- 6 5C-6C	45 ef	9 de	0.8 ab	0 a	3.2 a-c	0.05 a
6	Nova 40W 5 oz + Manzate 75DF 3 lb Manzate 75DF 3 lb	OC – 2C 3C-6C	33 b-d	4 a-c	0.6 ab	1 a	0.6 a	0.01 a
7	Indar 2E 8 fl oz + Dithane 75DF 3 lb Indar 2E 8 fl oz	OC – 1C 2C – 6C	36 c-e	5 bc	0.6 ab	0 a	0.9 a	0.02 a
8	Evito (TM-47301) 480SC 3.8 fl oz + LI-700 1pt/100 gal	OC – 6C	45 ef	6 cd	0.8 ab	0 a	5.1 c	0.06 a
9	Endorse (Polyoxin-D) 2.5W 28 oz	OC – 6C	30 bc	3 a-c	0.7 ab	0 a	2.9 a-c	0.10 a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Counts of 10 shoots per tree from each of four reps 2-3 Jul or 25-fruit samples picked from each of four single-tree reps 4 Oct and stored at 1C 18 days before rating 22 Oct.

Fungicide applications: Airblast treatments applied to both sides of the tree on each date at 100 gal/A as follows: 19 Apr (tight cluster-open cluster, OC); 2 May (petal fall); 1st-6th covers (1C-6C): 17 May, 31 May, 15 Jun, 28 Jun, 12 Jul, 26 Jul.

Maintenance applications:
30 March (Asana XL 14.5 fl oz); 9 May (Imidan 3 lb + Assail 4 oz/A); 24 May (Imidan 3 lb + Lannate LV 1qt/A); 7 Jun (Imidan 3 lb + Provado 8 fl oz/A); 22 Jun and 12 Jul (Imidan 3 lb + Lannate LV 1qt/A); 27 Jul (Imidan 3 lb + Lannate SP 12 oz/A); 15 Aug (Imidan 3 lb + Provado 8 fl oz/A); 4 Sep (Imidan 3 lb + Lannate SP 12 oz/A).

Table 5. Fruit disease control and fruit finish by experimental fungicides on Golden Delicious, 2007.

	Treatment and rate/acre	App. schedule	Sooty blotch % fruit	Sooty blotch % area	Flyspeck % fruit	Flyspeck % area	Rot spot, % fruit	Russet ratings, (0-5) or grade* rating (0-5)	% x fcy	x fcy/fcy
0	No fungicide	---	81 c	10. c	82 e	6.0 e	48 c	2.5 a	23 a-c	69 ab
1	LEM17 200SC 15 fl oz	Apps 1,3,5								
	Manzate 200 75DF 3 lb	Apps. 2,4,6						2.4 a	30 bc	80 a
	Captan 80WDG 30 oz + Ziram 76DF 3 lb	5C-6C	16 a	1.9 ab	6 a-c	0.3 a-c	1 a			
2	LEM17 200SC 21.5 fl oz	Apps 1,3,5								
	Manzate 200 75DF 3 lb	Apps. 2,4,6						2.5 a	22 a-c	71 ab
	Captan 80WDG 30 oz + Ziram 76DF 3 lb	5C-6C	15 ab	1.6 ab	10 bc	0.6 bc	3 ab			
3	LEM17 200SC 10 fl oz +									
	Manzate 200 75DF 3 lb	Apps. 1- 6						2.4 a	41 c	79 a
	Captan 80WDG 30 oz + Ziram 76DF 3 lb	5C-6C	3 a	0.4 a	3 a-c	0.2 a-c	4 ab			
4	LEM17 200SC 10 fl oz +									
	Flint 50WG 1 oz	Apps. 1- 6						2.6 a	14 a-c	72 ab
	Captan 80WDG 30 oz + Ziram 76DF 3 lb	5C-6C	10 a	0.9 ab	5 a-c	0.3 a-c	2 a			
5	Manzate 200 75DF 3 lb	Apps. 1- 6						2.4 a	27 a-c	81 a
	Captan 80WDG 30 oz + Ziram 76DF 3 lb	5C-6C	19 ab	1.4 ab	10 c	0.5 c	1 a			
6	Nova 40W 5 oz + Manzate 75DF 3 lb	OC – 2C						2.8 ab	15 ab	69 ab
	Manzate 75DF 3 lb	3C-6C	7 a	0.4 a	5 a-c	0.3 a-c	2 a			
7	Indar 2E 8 fl oz + Dithane 75DF 3 lb	OC – 1C						2.6 a	26 a-c	74 a
	Indar 2E 8 fl oz	2C – 6C	8 a	0.5 ab	1 ab	0.1 ab	8 ab			
8	Evito (TM-47301) 480SC 3.8 fl oz +							3.1 b	14 ab	49 b
	LI-700 1pt/100 gal	OC – 6C	12 a	0.7 ab	0 a	0 a	6 ab			
9	Endorse (Polyoxin-D) 2.5W 28 oz	OC – 6C	38 b	2.8 b	34 d	1.9 d	13 b	2.9 ab	8 a	57 ab

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

Fruit counts are means of 25-fruit samples picked from each of four single-tree reps 4 Oct and stored at 1C 18 days before rating 22 Oct.

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

Fungicide applications: Airblast treatments applied to both sides of the tree on each date at 100 gal/A as follows:
19 Apr (tight cluster-open cluster, OC); 2 May (petal fall); 1st-6th covers (1C-6C): 17 May, 31 May, 15 Jun, 28 Jun, 12 Jul, 26 Jul.

Maintenance applications: 30 March (Asana XL 14.5 fl oz); 9 May (Imidan 3 lb + Assail 4 oz/A); 24 May (Imidan 3 lb + Lannate LV 1qt/A); 7 Jun (Imidan 3 lb + Provado 8 fl oz/A); 22 Jun and 12 Jul (Imidan 3 lb + Lannate LV 1qt/A); 27 Jul (Imidan 3 lb + Lannate SP 12 oz/A); 15 Aug (Imidan 3 lb + Provado 8 fl oz/A); 4 Sep (Imidan 3 lb + Lannate SP 12 oz/A)

APPLE (*Malus* x *domestica* 'Stayman Winesap', 'Idared', 'Ginger Gold')
Scab; *Venturia inaequalis*
Powdery mildew; *Podosphaera leucotricha*
Cedar-apple rust; *Gymnosporangium juniperi-virginianae*
Brooks fruit spot; *Mycosphaerella pomi*
Sooty blotch; disease complex
Flyspeck; *Zygophiala jamaicensis*
Rots (unidentified)

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Evaluation of an experimental SI fungicide and mixed schedules on Stayman, Idared, and Ginger Gold apples, 2007.

Ten treatments directed primarily at fungicide resistance management approaches and broad-spectrum control, including the experimental material, Topguard, were tested on 21-yr-old trees in an area where resistance to SI fungicides has been suspected for several years. The test was conducted in a randomized block design with four three-cultivar replicate tree sets separated by untreated border rows. Treatment rows had been used as non-treated border rows in 2006 to stabilize mildew inoculum pressure for 2007. 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: 18 Apr (TC, tight cluster); 2 May (petal fall); First -7th covers (1C-7C): 17 May, 31 May, 15 Jun, 28 Jun, 12 Jul, 26 Jul and 31 Aug (Stayman and Idared only). Maintenance materials applied to the entire test block with the same equipment included Asana, Assail, Lannate LV, Imidan, Provado, and NAA + Sevin XLR. Inoculum, placed over each Idared test tree, included cedar rust galls 11 and 25 Apr, wild blackberry canes with the sooty blotch and flyspeck fungi 11 Apr, and bitter rot mummies 10 Aug. Other diseases developed from inoculum naturally present in the test area. Foliar data represent averages of counts of eight terminal shoots per tree 25 Jul (Idared), 7 Aug (Ginger Gold), or 15 Aug (Stayman). Ginger Gold trees were harvested 15 Aug, and first rated 16 Aug, and rated again following 14 days rot incubation at ambient temperatures 70-86°F (21-30°C), mean 77°F (25°C). Stayman trees were sampled 2 Oct and rated 3 Oct; Idared samples picked 26 Sep, and the 25-fruit samples were rated after storage at 1°C 28 days. Percentage data were converted by the square root arcsin transformation for statistical analysis.

Although over-wintering scab inoculum was high in this test area, infection conditions were not as favorable as several years in the past, improving scab control by the standard Nova + Dithane (Figs. 1 & 2). Test orchard history had shown a decline in control by Nova 4-5 oz/A under consistently heavy disease pressure on foliage, but this year illustrates the importance of weather factors in the perception of "resistance". However, there was a consistent trend toward significantly improved fruit scab control by including the mancozeb protectant, Dithane, in combination with Nova and several rates of Topguard, another SI fungicide, and this was especially true on fruit infection. On Stayman fruit, treatments with Nova 4.5 oz and the 7 fl oz and 13 fl oz rates of Topguard were similar to non-treated trees (Table 6). The strobilurin fungicide, Flint, continued to give excellent control of scab on foliage and fruit. All treatments controlled cedar-apple rust. Under heavy mildew pressure, all treatments gave significant control (Table 7). When applied alone or in combination, Topguard 7 fl oz was approximately equal to Nova 4.5 oz/A for mildew control; Flint 2 oz and Topguard 26 fl oz were significantly more effective than Nova 4.5 oz/A. With all treatments except #9 receiving captan + ziram in the 4 th to 7th covers, any significant control of sooty blotch and flyspeck was related to treatments up to 3rd cover. Nearly all treatments gave significant suppression of sooty blotch, flyspeck, and Brooks spot (Tables 8 & 9), and the presence of Dithane in combination through 3rd cover improved sooty blotch and flyspeck compared to Nova or Topguard alone at the same rate. No treatment had a deleterious fruit finish effect, and several treatments reduced opalescence compared to non-treated trees.

Table 6. Control of scab and cedar-aple rust by experimental fungicides on Stayman, Idared, and Ginger Gold apples, 2007. Virginia Tech AREC, Winchester, VA

			Scab, % leaves or fruit infected						Cedar-apple rust % inf.		
			Stayman		Ginger Gold		Idared		% leaves		G. Gold
	Treatment and formulated rate/acre	Timing	leaves	fruit	leaves	fruit	leaves	fruit	Idared	G. Gold	fruit
0	No fungicide	---	29 e	23 bc	15 c	34 e	2 a	26 d	5 b	10 b	8 b
1	Nova 40W 4.5 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	13 b-d	29 c	9 bc	12 cd	3 a	4 ab	0 a	0 a	0 a
2	Nova 40W 4.5 oz + Dithane RSNT 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	7 bc	2 a	1 a	4 ab	<1 a	0 a	0 a	0 a	0 a
3	Topguard 125SC 3.5 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	17 de	8 ab	8 bc	19 de	2 a	9 bc	0 a	0 a	0 a
4	Topguard 125SC 3.5 fl oz + Dithane 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	10 b-d	3 a	8 bc	4 a-c	2 a	1 a	0 a	<1 a	0 a
5	Topguard 125SC 7.0 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	15 cd	21 bc	8 bc	9 b-d	2 a	16 cd	0 a	0 a	0 a
6	Topguard 125SC 7.0 fl oz + Dithane 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	5 ab	3 a	4 ab	0 a	1 a	4 ab	0 a	<1 a	0 a
7	Topguard 125SC 13.0 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	16 cd	22 bc	5 a-c	6 a-c	2 a	11 bc	0 a	0 a	0 a
8	Topguard 125SC 13.0 fl oz+ Dithane 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	6 bc	3 a	5 ab	5 a-c	2 a	5 ab	0 a	<1 a	0 a
9	Topguard 125SC 26.0 fl oz	TC-7C	5 ab	11 ab	3 ab	4 a-c	<1 a	9 bc	0 a	0 a	0 a
10	Flint 50WG 2 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	1 a	1 a	1 a	0 a	<1 a	1 a	0 a	0 a	0 a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Foliar counts based on eight shoots per rep 25 Jul (Idared); 7 Aug (Ginger Gold); or 15 Aug (Stayman). Fruit scab counted on a 25-fruit sample after harvest.
Fungicide application dates: Fungicide treatments were applied airblast at 100 gpa to both sides of the tree on each application date with a Swanson Model DA-400 airblast sprayer at 100 gal/A as follows: 18 Apr (TC, tight cluster); 2 May (petal fall); First -7th covers (1C-7C): 17 May, 31 May, 15 Jun, 28 Jun, 12 Jul, 26 Jul and 31 Aug (Stayman and Idared only).

Table 7. Control of powdery mildew by experimental fungicides on Stayman, Idared, and Ginger Gold apples, 2007.

			Powdery mildew, % leaves, leaf area or fruit infected						
			Stayman		Idared			Ginger Gold	
	Treatment and formulated rate/acre	Timing	leaves	lf area	leaves	lf area	fruit	leaves	lf area
0	No fungicide	---	71 d	44 b	66 g	33 e	8 a	70 e	41 e
1	Nova 40W 4.5 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	41 a-c	5 a	34 cd	4 a-c	2 a	49 b	6 ab
2	Nova 40W 4.5 oz + Dithane RSNT 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	50 c	6 a	44 ef	6 cd	6 a	56 cd	12 cd
3	Topguard 125SC 3.5 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	52 c	7 a	36 de	5 b-d	5 a	60 cd	12 d
4	Topguard 125SC 3.5 fl oz + Dithane RSNT 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	49 c	6 a	46 f	7 d	0 a	62 d	11 b-d
5	Topguard 125SC 7.0 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	45 bc	6 a	28 bc	3 ab	3 a	54 bc	5 a
6	Topguard 125SC 7.0 fl oz + Dithane RSNT 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	35 ab	4 a	40 d-f	5 b-d	1 a	56 cd	11 b-d
7	Topguard 125SC 13.0 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	39 a-c	4 a	28 bc	3 ab	0 a	50 b	7 a-c
8	Topguard 125SC 13.0 fl oz+ Dithane RSNT 75DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	35 ab	4 a	35 cd	4 b-d	5 a	55 bc	8 a-d
9	Topguard 125SC 26.0 fl oz	TC-7C	29 a	3 a	15 a	2 a	1 a	40 a	4 a
10	Flint 50WG 2 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	31 a	4 a	23 b	3 ab	0 a	42 a	4 a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Foliar counts based on eight shoots per rep 25 Jul (Idared); 7 Aug (Ginger Gold); or 15 Aug (Stayman). Fruit infection counted on a 25-fruit sample after harvest.
Fungicide application dates: Fungicide treatments were applied airblast at 100 gpa to both sides of the tree on each application date with a Swanson Model DA-400 airblast sprayer at 100 gal/A as follows: 18 Apr (TC, tight cluster); 2 May (petal fall); First -7th covers (1C-7C): 17 May, 31 May, 15 Jun, 28 Jun, 12 Jul, 26 Jul and 31 Aug (Stayman and Idared only).

Table 8. Evaluation of sooty blotch and flyspeck control on Stayman, Idared and Ginger Gold apples, Winchester VA, 2007.

			Sooty blotch, % fruit or % fruit area infected						Flyspeck, % fruit or fruit area infected				
			Stayman		Idared		Ginger Gold		Stayman		Idared		G. Gold
	Treatment, rate/A, and timing	Timing	fruit	area	fruit	area	fruit	area	fruit	area	fruit	area	fruit
0	No fungicide	---	100 c	20.8 c	100 d	25.8 d	80 e	9.9 e	89 f	6.3 e	78 d	4.8 f	32 d
1	Nova 40W 4.5 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	76 bc	7.1 b	58 bc	4.5 bc	13 bc	1.0 bc	52 e	2.9 d	26 c	1.3 e	4 bc
2	Nova 40W 4.5 oz + Dithane RSNT DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	22 a	1.3 a	17 a	1.0 a	0 a	0 a	2 a	0.1 a	1 a	0.1 ab	0 a
3	Topguard 125SC 3.5 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	63 ab	5.2 ab	54 bc	4.3 a-c	16 bc	0.9 a-c	48 de	2.7 cd	23 c	1.2 de	5 c
4	Topguard 125SC 3.5 fl oz + Dithane DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	48 ab	5.4 ab	32 ab	2.3 ab	7 a-c	0.5 a-c	19 b	1.0 b	10 a-c	0.5 b-d	0 a
5	Topguard 125SC 7.0 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	74 bc	8.3 b	54 bc	5.0 bc	16 cd	1.0 cd	45 c-e	2.5 cd	24 c	1.3 de	1 ab
6	Topguard 125SC 7 fl oz + Dithane DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	47 ab	3.8 ab	31 ab	2.3 ab	4 a-c	0.2 a-c	18 b	0.9 b	7 a-c	0.4 b-d	0 a
7	Topguard 125SC 13.0 fl oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	72 bc	6.1 b	54 a-c	5.1 a-c	12 bc	0.7 a-c	30 b-e	1.6 b-d	16 bc	0.8 c-e	0 a
8	Topguard 125SC 13 fl oz+ Dithane DF 3 lb Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	57 ab	4.0 ab	45 a-c	2.7 ab	11 bc	0.6 a-c	22 b-d	1.2 bc	6 ab	0.4 a-c	0 a
9	Topguard 125SC 26.0 fl oz	TC-7C	79 bc	8.9 b	77 c	7.8 c	41 d	2.8 d	22 bc	1.3 bc	1 a	0.1 ab	1 ab
10	Flint 50WG 2 oz Captan 80WDG 30 oz + Ziram 76DF 3 lb	TC-3C 4C-7C	46 ab	4.1 ab	29 ab	2.1 ab	3 ab	0.2 ab	14 b	0.7 b	0 a	0 a	0 a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Averages of 25-fruit samples from each of four single-tree replications.

Ginger Gold trees were harvested 15 Aug, and first rated 16 Aug and again for rots following 13 days' incubation at ambient temperatures 70-86°F (21-30°C), mean 77°F (25°C). Stayman trees were sampled 2 Oct and rated 3 Oct; Idared 26 Sep, and the 25-fruit samples were rated after storage at 1°C 28 days.

Treatment application dates: 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: 18 Apr (TC, tight cluster); 2 May (petal fall); First -7th covers (1C-7C): 17 May, 31 May, 15 Jun, 28 Jun, 12 Jul, 26 Jul and 31 Aug (Stayman and Idared only).

Table 9. Evaluation of Brooks spot and rot control and fruit finish on Stayman, Idared and Ginger Gold apples, Winchester VA, 2007.

	Treatment, rate/A, and timing		Brooks spot, % Stay-man	Brooks spot, % Idared	Any rot, % Idared	Any rot, % Ginger Gold	Bot rot, % inf., G. Gold	Russet rating * Stay-man	Russet rating * Idared	Russet rating * Ginger Gold	Opalescence* Stay-man	Opalescence* Idared
0	No fungicide	---	9 c	7 b	22 b	12 bc	8 cd	2.4 a	1.9 a	1.8 a	1.9 a	1.8 c
1	Nova 40W 4.5 oz	TC-3C	0 a	1 a				2.1 a	1.4 a	1.8 a	1.7 a	0.9 a
	Captan 80WDG 30 oz + Ziram 76DF 3 lb	4C-7C			1 a	11 bc	6 b-d					
2	Nova 40W 4.5 oz + Dithane RSNT 75DF 3 lb	TC-3C	0 a	0 a				1.8 a	1.7 a	1.3 a	1.6 a	1.1 ab
	Captan 80WDG 30 oz + Ziram 76DF 3 lb	4C-7C			1 a	8 a-c	5 a-d					
3	Topguard 125SC 3.5 fl oz	TC-3C	1 ab	1 a				2.3 a	1.5 a	1.5 a	1.8 a	1.1 ab
	Captan 80WDG 30 oz + Ziram 76DF 3 lb	4C-7C			0 a	3 ab	3 a-c					
4	Topguard 125SC 3.5 fl oz + Dithane 75DF 3 lb	TC-3C	0 a	0 a				2.0 a	1.5 a	1.3 a	1.8 a	1.2 ab
	Captan 80WDG 30 oz + Ziram 76DF 3 lb	4C-7C			0 a	3 a	1 a					
5	Topguard 125SC 7.0 fl oz	TC-3C	6 bc	3 ab				2.3 a	1.6 a	2.0 a	2.1 a	1.3 b
	Captan 80WDG 30 oz + Ziram 76DF 3 lb	4C-7C			2 a	19 c	14 d					
6	Topguard 125SC 7.0 fl oz + Dithane 75DF 3 lb	TC-3C	0 a	0 a				2.1 a	1.6 a	1.7 a	1.8 a	1.2 ab
	Captan 80WDG 30 oz + Ziram 76DF 3 lb	4C-7C			1 a	3 a	2 ab					
7	Topguard 125SC 13.0 fl oz	TC-3C	1 ab	0 a				2.0 a	1.6 a	1.6 a	1.8 a	1.1 ab
	Captan 80WDG 30 oz + Ziram 76DF 3 lb	4C-7C			3 a	11 bc	9 cd					
8	Topguard 125SC 13.0 fl oz+ Dithane 75DF 3 lb	TC-3C	1 ab	0 a				2.4 a	1.7 a	1.5 a	1.9 a	1.3 b
	Captan 80WDG 30 oz + Ziram 76DF 3 lb	4C-7C			1 a	4 ab	2 a					
9	Topguard 125SC 26.0 fl oz	TC-7C	2 ab	1 a	1 a	8 a-c	4 a-d	2.5 a	1.5 a	1.5 a	2.2 a	1.3 b
10	Flint 50WG 2 oz	TC-3C	0 a	0 a				2.0 a	1.7 a	1.8 a	1.5 a	1.3 ab
	Captan 80WDG 30 oz + Ziram 76DF 3 lb	4C-7C			0 a	5 ab	5 a-d					

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Averages of 25-fruit samples from each of four single-tree replications.

Ginger Gold trees were harvested 15 Aug, and first rated 16 Aug and again for rots following 13 days incubation at ambient temperatures 70-86°F (21-30°C), mean 77°F (25°C). Stayman trees were sampled 2 Oct and rated 3 Oct; Idared 26 Sep, and the 25-fruit samples were rated after storage at 1°C 28 days.

* 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: 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: 18 Apr (TC, tight cluster); 2 May (petal fall); First -7th covers (1C-7C): 17 May, 31 May, 15 Jun, 28 Jun, 12 Jul, 26 Jul and 31 Aug (Stayman and Idared only)

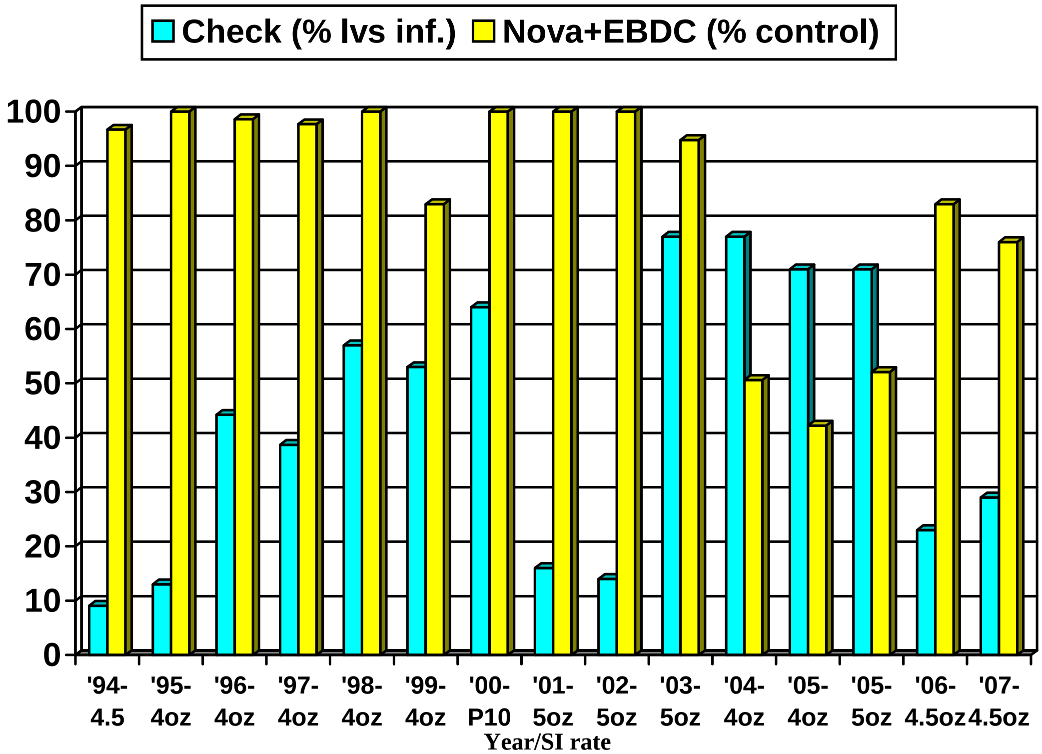

Figure 1. 14-yr history of foliar scab control with Nova + EBDC Stayman apple, Winchester, VA

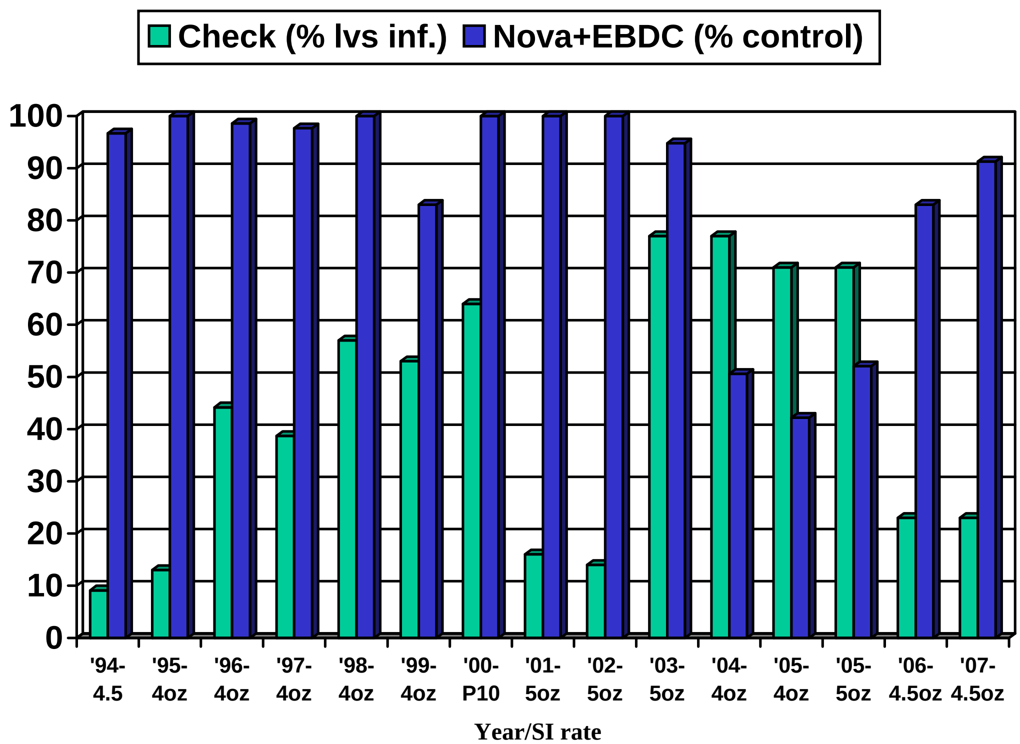

Figure 2. 14-yr history of fruit scab control with Nova + EBDC Stayman apple, Winchester, VA

APPLE (*Malus* x *domestica* ‘Golden Delicious', 'Red Delicious', and ‘Rome Beauty’)

Scab; *Venturia inaequalis*

Powdery mildew; *Podosphaera leucotricha*
Cedar-apple rust, *Gymnosporangium juniperi-virginianae*
Brooks fruit spot; *Mycosphaerella pomi*
Sooty blotch; disease complex
Flyspeck; *Zygophiala jamaicensis*
Rots (unidentified)
Fruit finish

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Test of Agri-Fos and conventional treatments for early and late season disease management on Red Delicious, Golden Delicious, and Rome apples, 2007.

Six conventional protectant treatments and two involving early season Agri-Fos trunk treatments were compared for season-long fungal disease control and fruit finish effects on three apple cultivars. Treatments were evaluated on 19-yr-old, three-cultivar tree sets in a four-replicate randomized block design. The Rome trees used in the test had not been in test in 2006 to allow stabilization of powdery mildew inoculum on test trees. Agri-Fos + Pentra-Bark trunk sprays were applied at green tip (3 Apr) with a single trunk wetting with a pump-up sprayer. The indicated mixture is for one gal of spray mix and included a defoamer (Fighter F), 15 ml/gal first added to water in all treatments specifying defoamer. These treatments were applied to the trunk area up to 36” above the soil line and also to 12” of any scaffold limbs below 36”. The regular dilute treatments were applied to the point of runoff with a single nozzle handgun at 400 psi as follows: 3 Apr (GT, green tip; trts #8 & 9 only); 19 Apr (TC, tight cluster; trts #1-6 only); 25 Apr (bloom; trts #1-6 only); 2 May (bloom-petal fall; trts #1-6 only); first to sixth covers (1C-6C), all treatments: 9 May, 23 May, 6 June, 21 June, 6 July, and 23 July. Maintenance sprays, applied separately with a commercial airblast sprayer, included Asana, Assail, Imidan, Lannate LV, and Provado. Inoculum of the following diseases was placed over each Golden Delicious test tree: Cedar rust galls 11 and 25 Apr; wild blackberry canes with the sooty blotch and flyspeck fungi 11 Apr, and bitter rot mummies 10 Aug. Other diseases developed from inoculum naturally present in the test area. Foliar data represent averages of counts of eight terminal shoots from each of four single-tree reps 10 Jul (Rome) or 31 Jul (Golden Delicious). Fruit counts are means of 25-fruit samples picked from each of four single-tree reps 24 Sep (Red Delicious), 25 Sep (Golden Delicious), or 10 Oct (Rome) and rated immediately after harvest. Percentage data were converted by the square root arcsin transformation for statistical analysis.

Early season weather and inoculum conditions were more favorable for mildew and rusts than for scab. Sulfur, applied in the tight cluster to third cover sprays provided the most effective mildew control. ProPhyt + Captan and ProPhyt + Serenade did not give significant mildew suppression. Agri-Fos + Pentra-Bark treatments (Trts. 8 & 9), applied to the trunk at green tip and followed by sulfur in the early covers, did not improve early season mildew control compared to sulfur without the green tip trunk treatment (Trt. 7). Scab incidence was light on foliage, but as high as 16% on Red Delicious fruit. (Table 10). Treatments involving Dithane or Captan gave adequate protection as expected; sulfur alone was noticeably less effective. ProPhyt + Serenade gave significant scab control on all cultivars. The Agri-Fos + Pentra-Bark trunk treatments followed by sulfur in the early covers (Trts. 8 & 9) did not improve fruit scab control compared to sulfur without the green tip trunk treatment (Trt. 7). Cedar-apple rust pressure was heavy in this test and weather conditions favored prolonged basidiospore discharge into early June. Dithane provided the best rust control, but Captan also gave significant suppression. Sulfur and the Agri-Fos + Pentra-Bark trunk treatments had little effect on cedar-apple rust; ProPhyt + Serenade was relatively ineffective although slight suppression occurred on Golden Delicious leaves. The primary objective for summer disease control was to study residual effects of ProPhyt in combination with Serenade or Captan compared to Captan alone. Sooty blotch and flyspeck were relatively slow to develop in this test block following the last treatment application 23 Jul. Control of sooty blotch and flyspeck by Captan under these conditions did not allow much opportunity for an additive effect by ProPhyt. Under these conditions ProPhyt + Serenade gave good sooty blotch and flyspeck control except for sooty blotch on Rome (Table 11). There was evidence of effects by the mid-season cover sprays as with Dithane in Trt. 1 or no early direct sprays as in treatments #7-9. All treatments gave significant control of unidentified rot spots on Golden Delicious. No treatment significantly affected fruit finish of any cultivar compared to non-treated trees (Table 12).

Table 10. Test of Agri-Fos and conventional treatments on early season diseases; Rome Beauty and Golden Delicious apples, 2007.

			Disease, % leaves infected at indicated leaf position or % leaf area or % fruit infected													
			Mildew, % leaves, leaf area or fruit						Scab,				C.-apple rust, % lvs		
			Rome				Golden Del.		Rome		R.Del.	G.Del.	Rome		G.Del
	Treatment and rate/100 gal dilute	Timing	lvs 1-12	all lvs	area	fruit	leaves	area	lvs 1-12	fruit	fruit	fruit	lvs 1-12	all lvs	all lvs
0	Non-treated control	---	28 a-c	60 c-e	40 d	10 a	62 bc	23 b	0.8 a	6 c	16 cd	9 c	56 d	60 c	45 e
1	Dithane 75DF 12 oz + Sulfur 3 lb Captan 80WDG 15 oz	TC-3C 4C-6C	21 a	53 ab	12 ab	3 a	47 ab	11 ab	0 a	0 a	1 a	1 ab	12 a	36 a	16 a
2	Captan 80WDG 15 oz	TC-6C	39 d	63 de	27 cd	7 a	65 c	20 ab	0 a	1 ab	2 ab	2 a-c	21 ab	37 a	20 ab
3	Sulfur 90W 3 lb ProPhyt 4.2E 1 pt + Captan 80WDG 15 oz	TC-3C 4C-6C	26 ab	56 bc	12 a	5 a	50 a-c	9 ab	0.3 a	2 ab	8 b-d	2 a-c	50 d	61 c	44 de
4	ProPhyt 4.2E 1 pt + Captan 80WDG 15 oz	TC-6C	37 cd	64 de	29 cd	5 a	58 a-c	12 ab	0 a	2 ab	1 a	3 a-c	30 bc	45 ab	28 bc
5	Sulfur 90W 3 lb Sulfur 90W 3 lb + Captan 80WDG 15 oz	TC-3C 4C-6C	24 a	49 a	10 a	2 a	44 a	7 a	0.5 a	4 bc	6 a-c	0 a	52 d	62 c	39 de
6	ProPhyt 4.2E 1 pt + Serenade Max 8 oz + Biotune 4 fl oz	TC-6C	41 d	65 e	26 b-d	12 a	60 a-c	15 ab	0 a	0 a	5 ab	2 ab	45 d	54 bc	35 cd
7	No fungicide treatment to first cover Sulfur 90W 3 lb Captan 80WDG 15 oz	--- 1C-3C 4C-6C	35 b-d	59 cd	11 a	6 a	56 a-c	13 ab	0.3 a	3 a-c	8 b-d	8 c	41 cd	54 bc	38 de
8	Pentra-Bark 3 oz +Agri-Fos 1 qt/gal Sulfur 90W 3 lb Captan 80WDG 15 oz	GT (trunk) 1C-3C 4C-6C	27 ab	54 a-c	10 a	7 a	52 a-c	10 ab	0.8 a	1 ab	5 ab	5 a-c	54 d	63 c	44 de
9	Pentra-Bark 3 oz +Agri-Fos 2 qt/gal Sulfur 90W 3 lb Captan 80WDG 15 oz	GT (trunk) 1C-3C 4C-6C	33 b-d	57 bc	16 a-c	7 a	54 a-c	10 ab	0.3 a	3 a-c	18 d	6 bc	46 d	56 bc	35 cd

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Counts of eight terminal shoots from each of four single-tree reps 10 Jul (Rome) or 31 Jul (Golden Delicious). Fruit counts are means of 25-fruit samples picked from each of four single-tree reps 24 Sep (Red Delicious) 25 Sep (Golden Delicious), or 10 Oct (Rome) and rated immediately after harvest.

Agri-Fos (green-tip) application protocol:
Trunk sprays applied as one trunk wetting with a pump-up sprayer 3 Apr (green tip). Measured trunk to 36” above soil line and applied to this line; also treated 12” of any scaffold limbs below 36”. Defoamer (Fighter F), 15 ml first added to water in all treatments specifying defoamer.
Regular treatment application schedule: dilute application to run-off: 3 Apr (GT, green tip; trts #8 & 9 only); 19 Apr (TC, tight cluster; trts #1-6 only); 25 Apr (bloom; trts #1-6 only); 2 May (bloom-petal fall; trts #1-6 only); first to sixth covers (1C-6C), all treatments: 9 May, 23 May, 6 June, 21 June, 6 July, and 23 July.
Maintenance applications: 30 Mar (Asana XL 14.5 oz); 9 May (Imidan WSB 3 lb + Assail 4 oz/A); 24 May (Imidan 3 lb + Lannate 1 qt/A); 7 Jun (Imidan 3 lb + Provado 8 fl oz/A); 22 Jun, 12 Jul and 27 Jul (Imidan 3 lb + Lannate LV 1 qt/A); 15 Aug (Imidan 3 lb + Provado 8 fl oz/A).

Table 11. Evaluation of sooty blotch, flyspeck and rot control on Red Delicious, Golden Delicious, and Rome Beauty apples, 2007

			Sooty blotch, % fruit or area inf.					Flyspeck, % fruit or area inf.					% fruit any rot spot	
			R.Del	G. Delicious		Rome		R. Del.	G. Delicious		Rome			
	Treatment and rate / 100 gal dilute	Timing	%fruit	fruit	area	fruit	area	% fruit	fruit	area	fruit	area	G.Del	Rome
0	Non-treated control	---	60 f	96 c	9.5 c	100 e	14.6 d	30 d	79 d	4.5 c	99 c	8.0 c	29 c	6 a
1	Dithane 75DF 12 oz + Sulfur 3 lb Captan 80WDG 15 oz	TC-3C 4C-6C	0 a	8 a	0.4 a	17 a	1.0 a	4 a-c	1 a	0.1 a	32 a	1.9 a	3 ab	3 a
2	Captan 80WDG 15 oz	TC-6C	4 a-d	12 a	0.7 a	22 ab	1.5 ab	9 c	16 b	1.0 b	41 a	2.5 ab	4 ab	3 a
3	Sulfur 90W 3 lb ProPhyt 4.2E 1 pt + Captan 80WDG 15 oz	TC-3C 4C-6C	2 ab	15 a	0.9 a	32 a-c	2.1 a-c	0 a	17 ab	1.0 ab	31 a	1.9 a	4 ab	0 a
4	ProPhyt 4.2E 1 pt + Captan 80WDG 15 oz	TC-6C	1 a	10 a	0.6 a	19 ab	1.1 a	1 ab	12 ab	0.7 ab	31 a	1.6 a	3 ab	1 a
5	Sulfur 90W 3 lb Sulfur 90W 3 lb + Captan 80WDG 15 oz	TC-3C 4C-6C	6 b-e	15 ab	0.7 a	34 a-d	2.7 bc	3 a-c	15 bc	0.8 b	39 a	2.1 a	5 ab	2 a
6	ProPhyt 4.2E 1 pt + Serenade Max 8 oz + Biotune 4 fl oz	TC-6C	3 a-c	14 ab	1.1 ab	46 cd	3.4 c	0 a	4 ab	0.2 ab	27 a	1.4 a	7 ab	1 a
7	No fungicide treatment to first cover Sulfur 90W 3 lb Captan 80WDG 15 oz	--- 1C-3C 4C-6C	12 e	8 a	0.6 a	32 a-c	2.2 a-c	8 c	12 ab	0.6 ab	31 a	1.9 a	10 b	5 a
8	Pentra-Bark 3 oz +Agri-Fos 1 qt/gal Sulfur 90W 3 lb Captan 80WDG 15 oz	GT (trunk) 1C-3C 4C-6C	10 de	31 b	2.2 b	53 d	3.6 c	6 c	38 c	2.6 c	60 b	3.6 b	5 ab	2 a
9	Pentra-Bark 3 oz +Agri-Fos 2 qt/gal Sulfur 90W 3 lb Captan 80WDG 15 oz	GT (trunk) 1C-3C 4C-6C	7 c-e	17 a	1.0 a	37 b-d	2.4 a-c	5 bc	16 ab	0.8 ab	40 a	2.3 ab	2 a	3 a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Counts of eight terminal shoots from each of four single-tree reps 10 Jul (Rome) or 31 Jul (Golden Delicious). Fruit counts are means of 25-fruit samples picked from each of four single-tree reps 24 Sep (Red Delicious), 25 Sep (Golden Delicious), or 10 Oct (Rome) and rated immediately after harvest.

Agri-Fos (green-tip) application protocol:
Trunk sprays applied as one trunk wetting with a pump-up sprayer 3 Apr (green tip). Measured trunk to 36” above soil line and applied to this line; also treated 12” of any scaffold limbs below 36”. Defoamer (Fighter F), 15 ml first added to water in all treatments specifying defoamer.
Regular treatment application schedule: dilute application to run-off: 3 Apr (GT, green tip; trts #8 & 9 only); 19 Apr (TC, tight cluster; trts #1-6 only); 25 Apr (bloom; trts #1-6 only); 2 May (bloom-petal fall; trts #1-6 only); first to sixth covers (1C-6C), all treatments: 9 May, 23 May, 6 June, 21 June, 6 July, and 23 July.
Maintenance applications: 30 Mar (Asana XL 14.5 oz); 9 May (Imidan WSB 3 lb + Assail 4 oz/A); 24 May (Imidan 3 lb + Lannate 1 qt/A); 7 Jun (Imidan 3 lb + Provado 8 fl oz/A); 22 Jun, 12 Jul and 27 Jul (Imidan 3 lb + Lannate LV 1 qt/A); 15 Aug (Imidan 3 lb + Provado 8 fl oz/A).

Table 12. Treatment effects on Brooks spot incidence and fruit finish of Red Delicious, Golden Delicious and Rome, 2007.

	Treatment and rate / 100 gal dilute	Timing	C-apple rust, %	Brooks spot, % fruit infected		Russet ratings or USDA grade *				Opalescence rating (0-5)*	
						Ratings (0-5)			G. Del. %		
			Rome	Rome	G. Del	R. Del.	Rome	G. Del.	fancy/x-fcy	R. Del.	Rome
0	Non-treated control	---	3 a	7 b	1 a	1.0 a	1.4 a	2.7 bc	62 ab	0.7 a	1.6 ab
1	Dithane 75DF 12 oz + Sulfur 3 lb Captan 80WDG 15 oz	TC-3C 4C-6C	0 a	0 a	0 a	0.9 a	1.3 a	2.1 a	78 bc	1.0 a	1.5 ab
2	Captan 80WDG 15 oz	TC-6C	1 a	0 a	0 a	0.8 a	1.1 a	2.2 ab	80 c	0.9 a	1.1 a
3	Sulfur 90W 3 lb ProPhyt 4.2E 1 pt + Captan 80WDG 15 oz	TC-3C 4C-6C	2 a	1 a	1 a	0.9 a	1.4 a	2.4 a-c	74 a-c	1.0 a	1.7 b
4	ProPhyt 4.2E 1 pt + Captan 80WDG 15 oz	TC-6C	0 a	0 a	0 a	0.8 a	1.1 a	2.5 a-c	76 a-c	0.8 a	1.3 ab
5	Sulfur 90W 3 lb Sulfur 90W 3 lb + Captan 80WDG 15 oz	TC-3C 4C-6C	2 a	1 a	1 a	1.0 a	1.5 a	2.3 ab	70 a-c	0.8 a	1.7 b
6	ProPhyt 1 pt + Serenade 8 oz + Biotune 4 fl oz	TC-6C	3 a	1 a	1 a	1.1 a	1.5 a	2.5 a-c	69 a-c	1.1 a	1.5 ab
7	No fungicide treatment to first cover Sulfur 90W 3 lb Captan 80WDG 15 oz	--- 1C-3C 4C-6C	5 a	0 a	3 a	0.9 a	1.2 a	2.1 a	81 c	0.9 a	1.3 ab
8	Pentra-Bark 3 oz +Agri-Fos 1 qt/gal Sulfur 90W 3 lb Captan 80WDG 15 oz	GT (trunk) 1C-3C 4C-6C	4 a	0 a	4 a	1.0 a	1.3 a	2.8 c	59 a	1.0 a	1.5 ab
9	Pentra-Bark 3 oz +Agri-Fos 2 qt/gal Sulfur 90W 3 lb Captan 80WDG 15 oz	GT (trunk) 1C-3C 4C-6C	3 a	1 a	1 a	0.9 a	1.2 a	2.7 bc	58 a	0.8 a	1.3 ab

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Counts of eight terminal shoots from each of four single-tree reps 10 Jul (Rome) or 31 Jul (Golden Delicious). Fruit counts are means of 25-fruit samples picked from each of four single-tree reps 24 Sep (Red Delicious), 25 Sep (Golden Delicious), or 10 Oct (Rome) and rated immediately after harvest.

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

Agri-Fos (green-tip) application protocol:
Trunk sprays applied as one trunk wetting with a pump-up sprayer 3 Apr (green tip). Measured trunk to 36” above soil line and applied to this line; also treated 12” of any scaffold limbs below 36”. Defoamer (Fighter F), 15 ml first added to water in all treatments specifying defoamer.
Regular treatment application schedule, dilute application to run-off: 3 Apr (GT, green tip; trts #8 & 9 only); 19 Apr (TC, tight cluster; trts #1-6 only); 25 Apr (bloom; trts #1-6 only); 2 May (bloom-petal fall; trts #1-6 only); first to sixth covers (1C-6C), all treatments: 9 May, 23 May, 6 June, 21 June, 6 July, and 23 July.
Maintenance applications: 30 Mar (Asana XL 14.5 oz); 9 May (Imidan WSB 3 lb + Assail 4 oz/A); 24 May (Imidan 3 lb + Lannate 1 qt/A); 7 Jun (Imidan 3 lb + Provado 8 fl oz/A); 22 Jun, 12 Jul and 27 Jul (Imidan 3 lb + Lannate LV 1 qt/A); 15 Aug (Imidan 3 lb + Provado 8 fl oz/A

APPLE (*Malus* x *domestica* 'Jonagold')
Scab; *Venturia inaequalis*

Cedar-apple rust, *Gymnosporangium juniperi-virginianae*
Powdery mildew; *Podosphaera leucotricha*
Sooty blotch; disease complex
Flyspeck; *Zygophiala jamaicensis*
Fruit finish

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Test of Agri-Fos trunk treatments for early season disease control on Jonagold apple, 2007.

This test was dedicated to evaluating early season trunk applications of Agri-Fos and Pentra-Bark treatments for early season disease control on 16-yr-old trees. Our primary objective was to test for an effect by an early season trunk application on disease suppression from green tip until first cover 9 May. The trunk sprays were applied at green tip 23 March (Trts. #1-4 only) with a single trunk wetting using a pump-up sprayer. The indicated mixture is for one gal of spray mix and included a defoamer (Fighter F, 15 ml/gal), which was first added to water in all treatments specifying defoamer. These treatments were applied to the trunk area up to 36 in. above the soil line and also to 12 in. of any scaffold limbs below 36 in. Follow-up cover spray treatments (first to sixth covers, 1C-6C) were applied dilute to the point of runoff with a single nozzle handgun at 300 psi 9 May, 23 May, 6 June, 20 June, 6 July, and 20 July. Maintenance sprays, applied separately with a commercial airblast sprayer, included Asana, Assail, Imidan, Lannate, Provado and Sevin. Cedar rust galls were placed over each test tree 25 Apr; other diseases developed from inoculum naturally present in the test area. Foliar data represent averages of counts of eight terminal shoots from each of four single-tree reps 18 Jul. Fruit counts are means of 25-fruit samples picked from each of four single-tree reps 27 Sep and rated immediately after harvest 28 Sep. Percentage data were converted by the square root arcsin transformation for statistical analysis.

Early season scab pressure was light; mildew and cedar-apple rust were heavy. Assessing the amount of diseases on the first ten leaves compared to all leaves on sampled shoots, indicated that mildew incidence increased with shoot growth beyond the tenth leaf. On the first ten leaves there was no significant difference in mildew incidence among treatments, indicating little or no effect by the trunk treatments compared to those trees first treated 9 May; however when considering all leaves on the shoots, there was a significant difference in mildew incidence between the 2 qt/gal Agri-Fos trunk rate (Trt. # 4) and those which had only Pentra-Bark in the trunk treatment (Trt. # 1), suggesting a possible effect, but neither of these was significantly different from those which had no treatment until the first cover spray 9 May. Under solid test pressure there was no significant difference in cedar-apple rust incidence among treated or non-treated trees indicating no effect by any trunk treatment. Scab incidence was too light and variable to make a statement about trunk treatment effects. There was no significant treatment effect in fruit russet compared to non-treated fruit; although there were some positive effects among treatments.

Table 13. Test of Agri-Fos and Pentra-Bark for early season disease control; Jonagold, 2007. Virginia Tech AREC, Winchester

	Green tip application; amount of material and mixing order / Covers sprays applied dilute to runoff	App. timing	Foliar disease ratings, based on leaves 1-10 or all leaves: Mildew infection %, 1-10	Mildew infection %, all lvs	Mildew infection area	Mildew infection fruit	Scab, % inf. lvs 1-10	Scab, % inf. all lvs	Scab, % inf. fruit	Cedar-apple rust %, 1-10	Cedar-apple rust %, all lvs	Fruit russet rating*
0	No fungicide	---	40 b	63 c	6.9 b	2 a	1.3 b	0.7 b	7 b	40 a	37 a	2.0 a-c
1	Water 4 qt + defoamer + Pentra-Bark 3 oz	GT										
	Dithane 75DF 1 lb + Sulfur 90W 3 lb/100 gal	1C-6C	30 ab	51 b	3.6 a	0 a	0 a	0.0 a	0 a	44 a	39 a	1.8 a-c
2	Water 2 qt + defoamer + Agri-Fos 2 qt	GT										
	Dithane 75DF 1 lb + Sulfur 90W 3 lb/100 gal	1C-6C	31 ab	48 ab	4.2 a	1 a	0 a	0.2 a	0 a	35 a	33 a	1.8 a-c
3	Water 3 qt + defoamer + Pentra-Bark 3 oz + Agri-Fos1 qt	GT										
	Dithane 75DF 1 lb + Sulfur 90W 3 lb/100 gal	1C-6C	30 ab	48 ab	3.2 a	1 a	1.3 b	0.7 b	2 ab	38 a	34 a	1.4 a
4	Water 2 qt + defoamer + Pentra-Bark 3 oz + Agri-Fos 2 qt	GT										
	Dithane 75DF 1 lb + Sulfur 90W 3 lb/100 gal	1C-6C	24 a	42 a	3.3 a	3 a	0 a	0.0 a	0 a	39 a	39 a	2.1 bc
5	No fungicide till first cover	---										
	Dithane 75DF 1 lb + Sulfur 90W 3 lb/100 gal	1C-6C	28 ab	48 ab	4.0 a	0 a	0.3 a	0.2 a	0 a	44 a	38 a	2.3 c
6	No fungicide till first cover	---										
	Sovran 1 oz + Sulfur 90W 3 lb	1C										
	Dithane 75DF 1 lb + Sulfur 90W 3 lb/100 gal	2C-6C	27 a	44 ab	3.7 a	1 a	0.7 ab	0.3 ab	2 ab	38 a	36 a	1.7 ab

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

Counts of all leaves on eight shoots from each of four single-tree replications 18 July. Data based on all leaves or leaves 1-10 only. Fruit counts are means of 25-fruit samples picked from each of four single-tree reps 27 Sep and rated immediately after harvest 28 Sep.

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

Agri-Fos application protocol:

1. Trunk sprays applied as one trunk wetting with a pump-up sprayer 23 March (green tip). Measured trunk to 36” above soil line and applied to this line; also treated 12” of any scaffold limbs below 36”.
2. A test run with defoamer (Fighter F) showed that 15 ml adequately reduced foaming in 1 gal of mix for treatment #4, so 15 ml was first added to water in all treatments specifying defoamer.
3. Measured trunk diameters (at 30 cm high) and recorded amount of mix used for each treatment.

Treatment application schedule:
23 March (trunk treatments only, trts. #1-4);
First to sixth covers (1C-6C): 9 May, 23 May, 6 June, 20 June, 6 July, 20 July.

Maintenance applications: 30 March (Asana XL 14.5 oz); 9 May (Imidan WSB 3 lb + Assail 4 oz/A); 24 May thinning spray (Ethrel 1.5 pt + Regulaid 11 fl oz/100 gal); 24 May (Imidan 3 lb + Lannate 1 qt/A); 7 Jun (Imidan WSB 3 lb + Provado 8 fl oz/A); 22 Jun, 12 Jul and 27 Jul (Imidan 3 lb + Lannate LV 1 qt/A); 15 and 31 Aug (Sevin XLR 6 pt/A).

APPLE (*Malus* x *domestica* 'Gala')
Scab; *Venturia inaequalis*

Powdery mildew; *Podosphaera leucotricha*

Cedar-apple rust; *Gymnosporangium juniperi-virginianae*
Sooty blotch; disease complex
Flyspeck; *Zygophiala jamaicensis*
Rots (unspecified)
Fruit finish

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Performance of Agri-Fos trunk treatments and an experimental biological material for early season disease control on Gala apple, 2007.

This test involved evaluation of early season trunk application treatments of Agri-Fos and Pentra-Bark and comparing these and protectant applications of a confidential experimental biological material (coded VA-1) to appropriate protectant standards for disease control on 6-yr-old trees. The test was set up on a randomized block design with five single-tree replications. The regular protectant treatments (#1-5) were applied as dilute sprays to the point of runoff with a single nozzle handgun 3 Apr (tight cluster, TC); 10 Apr (tight cluster, TC); 18 Apr (open cluster); 24 Apr (full bloom); 1 May (bloom-petal fall); First – 7th covers (1C-7C, Treatments #1-8): 9 May, 17 May, 25 May, 8 Jun, 25 Jun, 9 Jul, and 24 Jul. The objective of the trunk application was to test for an effect by an early season trunk application on disease suppression from green tip until first cover 9 May. The trunk sprays were applied at green tip 30 Mar (Trts. #7-8 only) with a single trunk wetting using a pump-up sprayer. The indicated mixture is for one gal of spray mix and included a defoamer (Fighter F, 15 ml/gal), which was first added to water in all treatments specifying defoamer. These treatments were applied to the trunk area up to 36 in. above the soil line and also to 12 in. of any scaffold limbs below 36 in. Follow-up cover spray treatments (first to seventh covers, 1C-7C) were applied dilute to the point of run-off with a single nozzle handgun at 300 psi with all of the treatments (#1-8) 9 May, 17 May, 25 May, 8 Jun, 25 Jun, 9 Jul, and 24 Jul. Maintenance sprays, applied separately with a commercial airblast sprayer, included Asana, Assail, Imidan, Lannate, Provado and Maxcel+ Sevin (as a fruit thinner) and NAA + Regulaid (as a stop-drop). All diseases developed from inoculum naturally present in the test area. Foliar data were collected by rating all of the leaves on six shoots from each of five single-tree replications 18-21 Jun. Foliar data were then focused on early season by tabulating infection evident on the first ten leaves or all of the leaves. Fruit counts are means of 25-fruit samples picked per single-tree replication 4 Sep and rated 5 Sep. Percentage data were converted by the square root arcsin transformation for statistical analysis.

Early season scab and cedar-apple rust pressure were light; mildew was moderate. Assessing the amount of diseases on the first ten leaves compared to all leaves on sampled shoots, indicated that mildew incidence increased while scab and rust decreased with shoot growth beyond the tenth leaf. On the first ten leaves there was no significant difference in mildew incidence among treatments, indicating little or no effect by the trunk treatments compared to those trees first treated 9 May. The experimental biological material VA-1gave significant control of scab on foliage and fruit, and cedar rust. Under heavier disease pressure VA-1 gave significant suppression of mildew at the higher rate, but was less effective than sulfur for mildew control. Mildew control by VA-1 was not improved by the inclusion of the adjuvant Tactic. Mildew provided the best test opportunity for comparison of the trunk treatments (Trt. # 7 & 8) compared to sulfur in Trt. #6, which was first applied at 1st cover. In assessing a possible effect of the Agri-Fos trunk treatments, considering all leaves, or just the first ten leaves on the shoots, there was no significant difference in incidence of mildew between either trunk rate, and those which had only the comparable sulfur/captan cover sprays, suggesting no effect on mildew by the trunk treatments. Similarly, there was enough scab that appeared on fruit to make a test comparison, but no difference in the amount of fruit scab incidence between either trunk rate and those which had only the comparable sulfur/captan cover sprays, or rust. Under light, late sooty blotch, flyspeck and rot development, all treatments, including VA-1, gave significant control. There was no significant treatment effect in fruit russet compared to non-treated fruit; although there were some slight differences among treatments.

Table 14. Performance of Agri-Fos and an experimental material for early season disease control; Gala apple, 2007.

		% leaves or fruit infected											Russet
		scab			mildew			cedar-apple rust		fly	sooty		rating*
Treatment and rate/ 100 gal dilute	Timing	lvs 1-10	all lvs	fruit	lvs 1-10	all lvs	lf. area	lvs 1-10	all lvs	speck	blotch	rots	(0-5)
0 Non-treated control	---	10 d	6.8 c	31 d	19 e	47.4 f	8.8 d	6 b	3.9 d	14 b	5 c	10 b	1.8 ab
1 Dithane 75DF 1 lb Captan 80WDG 10 oz	TC-4C 5C-7C	0 a	0.3 a	0 a	5 ab	21.2 cd	2.8 bc	1 a	0.5 ab	1 a	0 a	2 ab	1.6 a
2 Sulfur 90W 3 lb Captan 80WDG 10 oz	TC-4C 5C-7C	<1 ab	0.3 a	2 ab	2 a	10.4 ab	1.6 a	<1 a	0.3 a	0 a	0 a	9 ab	2.3 b
3 VA-1 1.0% 8.3 lb	TC-7C	1 a-c	0.8 ab	10 c	7 b-d	24.9 de	3.4 c	<1 a	0.6 a-c	1 a	0 a	3 ab	1.9 ab
4 VA-1 0.5% 4.15 lb + Tactic 4 fl oz	TC-7C	3 cd	2.0 b	8 bc	12 c-e	32.7 e	3.7 c	1 a	1.0 a-c	1 a	0 a	1 a	2.3 b
5 VA-1 1.0% 8.3 lb + Tactic 4 fl oz	TC-7C	3 bc	2.5 b	6 bc	14 de	24.8 d	2.8 bc	<1 a	0.5 ab	0 a	0 a	3 a	2.0 ab
6 No treatment to petal fall; Sulfur 90W 3 lb Captan 80WDG 10 oz	--- 1C-4C 5C-7C	1 a-c	0.8 ab	7 bc	7 bc	14.1 ab	2.2 ab	1 a	1.0 bc	1 a	1 b	5 ab	1.9 ab
7 Pentra-Bark 3 oz + Agri-Fos 1 qt/gal Sulfur 90W 3 lb Captan 80WDG 10 oz	GT (trunk) 1C-4C 5C-7C	2 a-c	1.1 ab	12 c	6 ab	8.7 a	1.6 a	<1 a	0.5 ab	0 a	0 a	1 a	1.8 ab
8 Pentra-Bark 3 oz + Agri-Fos 2 qt/gal Sulfur 90W 3 lb Captan 80WDG 10 oz	GT (trunk) 1C-4C 5C-7C	3 bc	1.8 ab	10 c	7 b-d	16.3 bc	2.4 b	2 a	1.6 c	0 a	0 a	3 ab	2.2 ab

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Counts of all leaves on six shoots from each of five single-tree replications 18-21 Jun. Fruit counts are means of 25-fruit samples picked per single-tree replication 4 Sep and rated 5 Sep.

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

Fungicide application dates:

30 March (green tip, GT, trunk spray trts. #7 & 8 only, included Fighter F 15ml/gal of water added first to both treatments); 3 Apr (tight cluster, TC,
#1-5 only); 10 Apr (tight cluster, TC, #1-5 only); 18 Apr (open cluster, #1-5 only); 24 Apr (full bloom, #1-5 only); 1 May (bloom-petal fall, #1-5 only); First – 7th covers (1C-7C, Treatments #1-8): 9 May, 17 May, 25 May, 8 Jun, 25 Jun, 9 Jul, 24 Jul.

Maintenance applications:

30 March (Asana XL 14.5 oz/A); 9 May (Imidan WSB 3 lb + Assail 4 oz/A); 10 May (Maxcel 3 pt + Sevin XLR 1 pt + oil 2 pt);24 May (Imidan 3 lb + Lannate LV 1 qt/A); 7 June (Imidan WSB 3 lb + Provado 8 fl oz/A)); 22 Jun and 12 Jul (Imidan 3 lb + Lannate LV 1 qt/A); 27 Jul (Imidan 3 lb + Lannate SP 12 oz/A); 15 Aug (Sevin XLR+ 6 pt/A); 17 Aug (stop-drop, NAA 10 ppm + Regulaid 1 pt/A).

**APPLE (*Malus domestica* 'Idared',
Fire blight; *Erwinia amylovora***

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Evaluation of dilute applications of antibiotics and trunk applications of Agri-Fos/ Pentra-Bark for blossom blight control on Idared apples, 2007.

Conventional dilute applications of the experimental antibiotics gentamicin (GWN 9350) and kasugamycin (Kasumin) and the standard, streptomycin (Agri-Mycin), and non-conventional trunk applications of Agri-Fos and Pentra-Bark were evaluated for fire blight blossom blight control on 26-yr-old trees. The test was conducted in a randomized block design with four single-tree replicates. The general test strategy was to apply the trunk treatments at half-inch green and pink growth stages and to apply foliar treatments at early to mid-bloom; and to inoculate selected branches after the first two foliar applications. Trunk treatments #7-12 were applied to 3 foot ht. of the lower trunk and one foot of lower scaffold limbs 30 Mar (1/4-1/2" green, HIG); trunk treatment #6 was applied 20 Apr (pink). A "defoamer", Fighter F; was first added to water (15 ml/gal) in all treatments specifying defoamer. All foliar treatments were applied in the morning of 23 Apr (most clusters with king bloom open), 25 Apr (full bloom) and again 2 May (late bloom). Two half-inch green trunk treatments (#11 & 12) also had the complete set of streptomycin foliar applications. Four selected branches per tree, each with 25 to 40 blossom clusters, were inoculated by spraying to wet with a bacterial suspension containing $1X10^6$ *E. amylovora* cells/ml in the evening of the first two foliar treatment applications 23 Apr and 25 Apr. The third foliar application (2 May) was made without a follow-up inoculation. Infection data were based on counts of the number of clusters on the inoculated branches 21 Apr and the number of clusters with infection on inoculated branches 8-9 May (two reps) and two reps 14 May. Maintenance sprays, applied to all test trees during fire blight test period, included: Asana XL 14.5 fl oz + oil 6 gal + Nova 5 oz + Dithane 3 lb/A (31 Mar), Nova 5 oz + Syllit 1 lb/A (18 Apr), and Nova 5 oz + Imidan 3 lb + Assail 4 oz/A (10 May).

Inoculation and weather conditions favored a strong fire blight test. Natural (*MaryBlyt*) infection periods occurred 24 and 25 Apr, in association with the treatment and inoculation period, and 27 Apr and 1-2 May, during the incubation period. Under these strong test conditions, all antibiotic treatments gave significant and commercially acceptable control of fire blight, ranging from 71-88% suppression. Kasumin was significantly less effective than the most effective streptomycin rate, the 4 oz rate, which was numerically better than the 8 oz rate in this test. Trt #5, which had streptomycin for the second application and low rates of C-O-C-S as the first and third applications, gave 70% suppression. Gentamicin gave control which was also comparable to streptomycin. All of the trunk treatments without the streptomycin follow-up gave slight but statistically significant suppression, including #7 which involved Pentra-Bark without Agri-Fos. There were no significant differences in control between Agri-Fos rates; the trunk treatment at pink provided numerically better results, but not significantly (p= 0>05) better control than the same treatment applied at half-inch green tip. Surprisingly, the two trunk treatments which received follow-up streptomycin applications at 4 oz both had statistically less control than streptomycin 4 oz without the trunk application. Although there was an indication of some inoculum drift to adjacent trees, there appeared to be little secondary infection spread within the test trees following initial infection. There was no significant treatment effect on fruit finish.

Table 15. Performance of Agri-Fos / Pentra-Bark and antibiotic treatments for blossom blight control; **Idared apple, Virginia Tech AREC, Winchester**

	Treatment and (for foliar app.)	Foliar app. # * 1	2	3	% clusters infected	% control
0	Non-treated control	--	--	--	85.4 e	---
	Foliar treatments, rate/ 100 gal dilute					
1	Agri-Mycin 17, 8 oz + Regulaid 1 pt	X	X	X	18.5 a-c	78
2	Agri-Mycin 17, 4 oz+ Regulaid 1 pt	X	X	X	10.4 a	88
3	Kasumin 2L 2 qt (100 ppm) + Regulaid 1 pt	X	X	X	19.2 bc	78
4	GWN 9350 10W 1 lb + Regulaid 1 pt	X	X	X	15.7 ab	82
5	C-O-C-S 50WDG 4 oz Agri-Mycin 17, 4 oz+ Regulaid 1 pt	X --	-- X	X --	25.6 c	70
	Trunk treatments, rate/ gal of treatment mix					
6	Water 2 qt + defoamer + Pentra-Bark 3 oz + Agri-Fos 2 qt/gal, 20 Apr (pink) only	--	--	--	61.1 d	28
7	Water 4 qt + defoamer+ Pentra-Bark 3 oz/gal, HIG	--	--	--	64.7 d	24
8	Water 2 qt + defoamer+ Agri-Fos 2 qt/gal, HIG only	--	--	--	71.2 d	17
9	Water 3 qt + defoamer + Pentra-Bark 3 oz + Agri-Fos 1 qt/gal, 30 Mar HIG only	--	--	--	70.2 d	18
10	Water 2 qt + defoamer + Pentra-Bark 3 oz + Agri-Fos 2 qt/gal, 30 Mar HIG only	--	--	--	65.6 d	23
11	Water 3 qt + defoamer + Pentra-Bark 3 oz + Agri-Fos 1 qt, 30 Mar HIG only; Agri-Mycin 17, 4 oz + Regulaid 1 pt, Bl-PF	-- X	-- X	-- X	24.6 bc	71
12	Water 2 qt + defoamer + Pentra-Bark 3 oz + Agri-Fos 2 qt/gal, 30 Mar HIG only; Agri-Mycin 17, 4 oz + Regulaid 1 pt, Bl-PF	-- X	-- X	X	19.7 bc	77

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

* Infection data based on counts of number of clusters 21 Apr and number of clusters with infection on inoculated branches 8-9 May (Reps A-C) and 14 May (Rep D).

Trunk treatments #7-12 applied 30 Mar (1/4-1/2" green, HIG); trunk treatment #6 applied 20 Apr (pink). A "defoamer", Fighter F; was first added to water (15 ml/gal) in all treatments specifying defoamer.

* Foliar treatment timing: #1 applied in the morning of 23 Apr (most clusters with king bloom open); #2, 25 Apr (full bloom); #3, 2 May (late bloom).

APPLE ***(Malus domestica*** **'Idared')**
Fire blight*; Erwinia amylovora*

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Evaluation of experimental antibiotics for blossom blight control on Idared apple, 2007.

A blossom blight test of two experimental antibiotics, gentamicin (GWN 9350) and kasugamycin (Kasumin) and the standard, streptomycin (Agri-Mycin), was established in four randomized blocks on 26-yr-old trees. A single biological control treatment involving Serenade Max (*Bacillus subtilis*) was included. All treatments were applied to both sides of the tree on the morning of 23 Apr (most clusters with king bloom open), 25 Apr (full bloom) and again 1 May (late bloom) using a Swanson Model DA-400 airblast sprayer at 50 gallons per acre. Four selected branches per tree, each with 25 to 40 blossom clusters, were inoculated by spraying to wet with a bacterial suspension containing $1X10^6$ E. amylovora cells/ml in the evening of the first two treatment days 23 Apr and 25 Apr. There was no inoculation after the last treatment application, 1 May. Infection data were based on counts of number of clusters on the inoculated branches 21 Apr and number of clusters with infection on inoculated branches 7-8 May. Maintenance sprays, applied to all test trees during fire blight test period, included: Asana XL 14.5 fl oz + oil 6 gal + Nova 5 oz + Dithane 3 lb/A (31 Mar), Nova 5 oz + Syllit 1 lb/A (18 Apr), and Nova 5 oz + Imidan 3 lb + Assail 4 oz/A (10 May).

Inoculation and weather conditions favored a strong fire blight test. Natural (*MaryBlyt*) infection periods occurred 24 and 25 Apr, in association with the treatment and inoculation period, and 27 Apr and 1-2 May, during the incubation period. Under these strong test conditions, all treatments gave significant fire blight suppression. Significant rate differences were noted with streptomycin and with gentamicin. Numerical suppression of blossom cluster infection by gentamicin-related treatments ranged from 55-73%; the streptomycin rates 59-86% suppression. Kasumin was significantly less effective than the most effective streptomycin and gentamicin rates and effectiveness was not improved by increased rates. Serenade, although providing some suppression, was less effective than all other treatments. Although there was an indication of some inoculum drift to adjacent trees, there appeared to be little secondary infection spread within the test trees following initial infection. Although Kasumin 3 qt/A had significantly less russet than the Serenade Max-treated fruit, there was no significant treatment russet effect compared to non-treated fruit.

Table 16. Blossom blight control by airblast applications on Idared apple

All treatments applied airblast at 50 gal/acre Treatment and rate/A (or /100 gal for Regulaid)	% clusters with infection	% control	Russet rating*
0 No treatment	77.4 f	---	1.4 ab
1 Agri-Mycin 17 12 oz/A + Regulaid 1 pt/100 gal	31.4 b-d	59.4	1.2 ab
2 Agri-Mycin 17 1.5 lb/A + Regulaid 1 pt/100 gal	11.0 a	85.8	1.5 ab
3 GWN 9350 10W 2.0 lb/A + Regulaid 1 pt/100 gal	35.2 cd	54.5	1.5 ab
4 GWN 9350 10W 2.5 lb/A + Regulaid 1 pt/100 gal	29.8 b-d	61.5	1.6 ab
5 GWN 9350 10W 3.0 lb/A + Regulaid 1 pt/100 gal	28.0 bc	63.8	1.4 ab
6 GWN 9350 10W 3.5 lb/A + Regulaid 1 pt/100 gal	20.9 b	73.0	1.3 ab
7 Kasumin 2L 3 qt/A + Regulaid 1 pt/100 gal	41.2 d	46.8	1.1 a
8 Kasumin 2L 6 qt/A + Regulaid 1 pt/100 gal	39.3 d	49.2	1.3 ab
9 Serenade Max 36 oz/A + Biotune 1 pt/100 gal	66.2 e	14.4	1.7 b

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

Means of four single-tree replications with border rows between treatment rows.

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

PEACH (*Prunus persica* 'Loring')
Nectarine: (*P. persica* var. *nucipersica* 'Redgold')
Scab; *Cladosporium carpophilum*
Brown rot; *Monilinia fructicola*
Rusty spot; *Podosphaera leucotricha*

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Evaluation of experimental fungicides for disease control on Loring peach and Redgold nectarine, 2007.

Several experimental fungicides were compared to registered programs for broad-spectrum disease control on 15-yr-old trees. The test planting is composed of 3-tree sets, each including Loring peach and Redgold nectarine, which were not treated with fungicides in 2006 to allow the buildup of scab inoculum, and Redhaven peach, which were left untreated in 2007. Dilute treatments were applied to the point of run-off (approximately 200 gal/A) with a single nozzle handgun at 300 psi in a randomized block design with four replications. 24 Apr (PF, petal fall-shuck split); 1st through 5th covers: 9 May, 23 May, 6 Jun, 20 Jun, and 6 Jul; 20 Jul (approx. 3 wk pre-harvest, 3PH); 3 Aug (approx. 1 wk pre-harvest, 1PH). Actual Loring harvest date was 8 Aug, 5 days after the last application. Commercial insecticides, applied to the entire test block at 2-3 wk intervals with a commercial airblast sprayer, included Asana XL, Imidan WSB, Lannate LV, Provado, and Sevin XLR. Leaf curl incidence was rated on 25 shoots per tree 27 May. Samples of 40 apparently rot-free fruit per replicate tree were harvested 8 Aug (Loring) and 14 Aug (Redgold), 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 10,000 *M. fructicola* conidia/ml. All fruit were incubated in polyethylene bags at ambient temperatures before rating rot development at the indicated intervals. Incubation temperatures were: Loring: 21-32C (mean 27.4C); Redgold: 22-30C (mean 25.8C).

Scab inoculum level 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 78% of untreated Loring and 96% of Redgold fruit infected with scab, Evito, LEM-17 and V-10116 applied in the petal fall to 2nd cover spray period gave excellent control (Table 17). Under moderate and variable rusty spot pressure, several treatments showed promise but differences were not statistically significant (p=0.05). Under moderately heavy brown rot pressure on non-inoculated fruit, and more severe on inoculated Loring peach (Table 18), both rates of Evito, applied throughout the cover and pre-harvest sprays, gave control comparable to or better than Indar and Pristine applied just in pre-harvest. LEM-17, also applied throughout the cover and pre-harvest sprays, held well for 5 days, but control was weakened significantly after 7 days incubation, compared to Evito, Indar and Pristine. Brown rot incidence was comparable on nectarine (Table 19) and peach, and degrees of control by treatments were similar although Evito was slightly less effective than Indar and Pristine at 7 days.

Table 17. Control of scab, and rusty spot on Loring peach and Redgold nectarine, 2007.

			Scab, % fruit inf. or lesions/fruit				Rusty spot, %
			Loring		Redgold		
	Treatment and rate/100 gal dilute	Timing	fruit	lesions	fruit	lesions	Loring
0	No fungicide	---	78 e	20 b	96 c	78 d	14 a
1	Microfine Sulfur 90W 3 lb	PF - PH	9 b-d	<1 a	65 b	8 a-c	9 a
2	Bravo Weather Stik 6F 1 pt Microfine Sulfur 90W 3 lb Indar 75W 1 oz+ B-1956 8 fl oz	PF -SS 1C - 5C 3 & 1PH	11 b-d	<1 a	59 b	9 a-c	9 a
3	Microfine Sulfur 90W 3 lb Indar 75W 1 oz+ B-1956 8 fl oz	PF - 5C 3 & 1PH	13 cd	<1 a	75 bc	27 c	13 a
4	Microfine Sulfur 90W 3 lb Pristine 38WDG 7.25 oz	PF - 5C 3 & 1PH	13 cd	<1 a	72 bc	19 bc	3 a
5	Captan 80WDG 20 oz	PF - PH	5 bc	<1 a	18 a	2 ab	9 a
7	Evito 480SC 3.8 fl oz + B-1956 1 pt	PF - PH	0 a	0 a	3 a	<1 a	6 a
8	Evito 480SC 2.85 fl oz + B-1956 1 pt	PF - PH	3 ab	<1 a	12 a	<1 a	8 a
9	LEM-17 200SC 7.5 fl oz	PF - PH	4 a-c	<1 a	8 a	<1 a	7 a
10	V-10116 50WG 1.25 Microfine Sulfur 90W 3 lb	PF - 2C 3C-PH	3 ab	<1 a	9 a	<1 a	7 a
11	V-10118 0.41EC 4.8 fl oz Microfine Sulfur 90W 3 lb	PF - 2C 3C-PH	19 d	1 a	67 b	13 a-c	6 a

Four single tree reps. Column mean separation by Waller-Duncan K-ratio t-test (p=0.05).
Treatment dates: 24 Apr (PF, petal fall-shuck split); 1st through 5th covers: 9 May, 23 May, 6 Jun, 20 Jun, 6 Jul; 20 Jul (3 wk pre-harvest, 3PH); 3 Aug (1 wk pre-harvest, 1PH). Actual Loring harvest date was 8 Aug, 5 days after the last application.
Harvest evaluations of 40 fruit per rep for scab and rusty spot (Loring, 8 Aug; Redgold 14 Aug).
Note: Data are aligned with the treatment timing most likely to have affected scab.

Table 18. Treatment effects on postharvest brown rot development on Loring peach, 2007.

			% fruit with brown rot after days incubation					
			Non-inoculated fruit			Inoculated fruit		
	Treatment and rate/100 gal dilute	Timing	3 days	5 days	7 days	3 days	5 days	7 days
0	No fungicide	---	4 a	56 d	86 d	8 b	61 e	96 e
1	Microfine Sulfur 90W 3 lb	PF - 1PH	1 a	19 c	38 c	4 ab	26 cd	58 d
2	Bravo Weather Stik 6F 1 pt Microfine Sulfur 90W 3 lb Indar 75W 1 oz+ B-1956 8 fl oz	PF -SS 1C - 5C 3 & 1PH	0 a	0 a	8 a	0 a	8 b	20 bc
3	Microfine Sulfur 90W 3 lb Indar 75W 1 oz+ B-1956 8 fl oz	PF - 5C 3 & 1PH	0 a	0 a	8 ab	1 ab	4 ab	13 ab
4	Microfine Sulfur 90W 3 lb Pristine 38WDG 7.25 oz	PF - 5C 3 & 1PH	0 a	1 ab	6 a	0 a	1 a	21 bc
5	Captan 80WDG 20 oz	PF - 1PH	1 a	6 a-c	25 bc	0 a	20 c	35 c
7	Evito 480SC 3.8 fl oz + B-1956 1 pt	PF - 1PH	0 a	0 a	6 a	0 a	0 a	8 ab
8	Evito 480SC 2.85 fl oz + B-1956 1 pt	PF - 1PH	0 a	0 a	3 a	0 a	0 a	4 a
9	LEM-17 200SC 7.5 fl oz	PF - 1PH	0 a	5 a-c	25 bc	1 ab	5 b	34 c
10	V-10116 50WG 1.25 Microfine Sulfur 90W 3 lb	PF - 2C 3C- 1PH	5 a	11 bc	35 c	1 ab	39 d	70 d
11	V-10118 0.41EC 4.8 fl oz Microfine Sulfur 90W 3 lb	PF - 2C 3C- 1PH	0 a	8 a-c	31 c	0 a	35 d	71 d

Four single tree replications. Column mean separation by Waller-Duncan K-ratio t-test (p=0.05).
Treatments applied dilute to runoff at 300 psi as follows: 24 Apr (PF, petal fall-shuck split); 1st through
5th covers: 9 May, 23 May, 6 Jun, 20 Jun, 6 Jul; 20 Jul (3 wk pre-harvest, 3PH); 3 Aug (1 wk pre-harvest, 1PH). Actual Loring harvest date was 8 Aug, 5 days after the last application.

Table 19. Effects of experimental fungicides on post-harvest brown rot development on Redgold nectarine, 2007.

	Treatment and rate/100 gal dilute	Timing	Non-inoc. fruit / days incubation: % fruit with brown rot 3 days	5 days	7 days	% rot-free 7 days	Inoculated fruit / days incubation: % fruit with brown rot 3 days	5 days	7 days	% rot-free 7 days
0	No fungicide	---	11 c	40 c	76 e	16 f	13 b	53 e	84 e	8 g
1	Microfine Sulfur 90W 3 lb	PF - 1PH	10 bc	31 bc	50 de	41 e	9 ab	33 de	56 d	11 fg
2	Bravo Weather Stik 6F 1 pt Microfine Sulfur 90W 3 lb Indar 75W 1 oz+ B-1956 8 fl oz	PF -SS 1C - 5C 3 & 1PH	0 a	0 a	6 a	76 a-c	0 a	5 a-c	10 b	78 a-c
3	Microfine Sulfur 90W 3 lb Indar 75W 1 oz+ B-1956 8 fl oz	PF - 5C 3 & 1PH	0 a	1 a	3 a	85 ab	0 a	0 a	0 a	90 a
4	Microfine Sulfur 90W 3 lb Pristine 38WDG 7.25 oz	PF - 5C 3 & 1PH	0 a	1 a	4 a	93 a	0 a	3 ab	9 b	89 a
5	Captan 80WDG 20 oz	PF - 1PH	0 a	1 a	10 a-c	85 ab	0 a	15 cd	28 c	70 bc
7	Evito 480SC 3.8 fl oz + B-1956 1 pt	PF - 1PH	0 a	3 a	5 a	91 ab	0 a	3 ab	13 bc	85 ab
8	Evito 480SC 2.85 fl oz + B-1956 1 pt	PF - 1PH	0 a	1 a	4 a	94 a	0 a	8 bc	14 bc	84 ab
9	LEM-17 200SC 7.5 fl oz	PF - 1PH	0 a	5 a	8 ab	75 b-d	0 a	0 a	22 bc	63 cd
10	V-10116 50WG 1.25 Microfine Sulfur 90W 3 lb	PF - 2C 3C- 1PH	3 ab	14 ab	38 cd	53 de	0 a	36 e	55 d	45 de
11	V-10118 0.41EC 4.8 fl oz Microfine Sulfur 90W 3 lb	PF - 2C 3C- 1PH	5 a-c	16 ab	31 b-d	55 c-e	4 ab	39 e	63 d	28 ef

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

Treatments applied dilute to runoff at 300 psi as follows: 24 Apr (PF, petal fall-shuck split); 1st through 5th covers: 9 May, 23 May, 6 Jun, 20 Jun, 6 Jul; 20 Jul (3 wk pre-harvest, 3PH); 3 Aug (1 wk pre-harvest, 1PH). Actual Redgold harvest date was 14 Aug, 11 days after the last application.

APPLE (*Malus* x *domestica* ‘Idared')
Sooty blotch; *disease complex*
Flyspeck; *Zygophiala jamaicensis*
Bitter rot; *Colletotrichum* spp.
White (Bot) rot; *Botryosphaeria dothidea*
***Alternaria* spp.**
Blue mold; *Penicillium expansum*
***Phomopsis* spp.**

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Summer disease and post-storage rot control by experimental fungicides on Idared apples, 2006-07.

Nine treatments involving experimental and registered fungicides were compared during the cover spray period on 25-yr-old trees. The test was conducted in a randomized block design with four single-tree replicates separated by untreated border rows between treatment rows. Tree-row-volume was determined to require a 400 gal/A dilute base for adequate spray coverage. Pre-test fungicides to suppress early season diseases were applied 2 Apr (Nova 5 oz + Dithane 3 lb/A) and 18 Apr (Nova 5 oz + Dithane 3 lb + Triadimefon 4 oz/A). Treatments were applied from petal fall to seventh cover to both sides of the tree on each application date with a Swanson Model DA-400 airblast sprayer at 100 gal/A. Dates of application and accumulated wetting hours (AWH) to that date were as follows: 9 May (petal fall, PF), 1st-7th covers (1C-7C): 25 May, 7 Jun, 28 Jun, 11 Jul, 25 Jul, 16 Aug, 7 Sep. Maintenance insecticides applied to the entire test block with the same equipment included Acramite, Asana, Intrepid, Lannate, Imidan, Sevin, Calypso, and Provado. The bitter rot fungus was inoculated into one fruit in each quadrant of each test tree 9 Aug. Other diseases developed from inoculum naturally present in the test area. A 25-fruit sample from each replicate tree was harvested 27 Sep and rated after 26 days storage at 1° C; the trees were re-sampled 23 Oct and all samples were evaluated 23-24 Oct. The same samples were returned to cold storage at 33F (1°C) and held for later post-storage counts (Table 21). The 27 Sep samples were held at 1°C for a total of 89 days before evaluating them after 21 days at 70F (21°C). The 23 Oct samples were held at 1°C for a total of 92 days before evaluating them after 22 days at 70F (21°C). Late fruit retention/drop was assessed by counting the number of fruit remaining on the trees 1 Dec. Percentage data were converted by the square root arcsin transformation for statistical analysis.

Sooty blotch and flyspeck pressure was moderately heavy in 2006, and incidence and area affected by both diseases increased between sampling dates on non-treated trees (Table 20). On treated trees, sooty blotch increased more than flyspeck between samplings. All treatments gave significant suppression of both diseases. Inspire 4 fl oz/A (difenoconazole) gave control comparable to the standard, Topsin-M + Captan, on both diseases; Enable (fenbuconazole) was slightly less effective on sooty blotch. No treatment significantly affected fruit finish compared to non-treated trees. Bitter rot and white (Bot) rot were the most common rots that developed following extended storage and post storage incubation at 21°C (Table 21). All treatments gave significant rot suppression. The most effective treatments appeared to be two applications of Inspire (at 2.75 or 4 fl oz) alternated with two applications of Topsin M + Captan. Following these, the next most effective treatments, with comparable control, were Topsin M + Captan and Inspire 4 fl oz. Bitter rot was likely controlled by the Captan component rather than Topsin M in the Topsin M + Captan treatment. Most treatments significantly increased retention of fruit compared to trees not treated after pink (Table 21). The most late fruit retention occurred on trees treated in all the cover sprays with Vangard 75WG + Inspire 2.5 fl oz. Among treated trees, fruit retention was lowest on trees treated throughout the covers with Topsin M + Captan.

Table 20. Summer disease control and fruit retention by experimental cover spray treatments on Idared apples, 2006

		% fruit or fruit area infected at indicated sampling date								Fruit retention: # of fruit on tree 1 Dec
		Sooty blotch, %				Flyspeck, %				
		27 Sep		23 Oct		27 Sep		23 Oct		
Treatment and rate/A	Timing	fruit	area	fruit	area	fruit	area	fruit	area	
0 No fungicide after pink	PF - 7C	78 c	6.2 c	100 e	13.4 e	33 c	1.7 c	84 c	4.6 c	3.5 d
1 Topsin M 70W 8 oz + Captan 80WDG 60 oz	PF - 7C	4 a	0.2 a	13 ab	0.7 ab	3 b	0.2 b	3 b	0.2 b	15.5 cd
2 Inspire 250EC 4 fl oz	PF - 7C	7 a	0.4 a	22 a-c	1.2 a-c	1 ab	0.1 ab	1 ab	0.1 ab	45.0 ab
3 Inspire 250EC 2.75 fl oz	PF - 7C	9 a	0.5 a	33 cd	2.5 cd	2 ab	0.1 ab	5 b	0.3 b	37.5 a-c
4 Inspire 250EC 4 fl oz Topsin M 8 oz + Captan 60 oz	PF, 1, 4, 5C 2, 3, 6, 7C	10 a	0.5 a	16 a-c	0.8 ab	1 ab	0.1 ab	5 b	0.3 b	25.5 b-d
5 Inspire 250EC 4 fl oz Topsin M 8 oz + Captan 60 oz	PF, 2, 4, 6C 1, 3, 5, 7C	6 a	0.3 a	17 a-c	0.9 ab	1 ab	0.1 ab	2 ab	0.1 ab	49.3 ab
6 Inspire 250EC 2.75 fl oz Topsin M 8 oz + Captan 60 oz	PF, 1, 4, 5C 2, 3, 6, 7C	10 a	0.5 a	28 a-d	1.8 bc	0 a	0 a	0 a	0 a	30.5 a-c
7 Inspire 250EC 2.75 fl oz Topsin M 8 oz + Captan 60 oz	PF, 2, 4, 6C 1, 3, 5, 7C	5 a	0.3 a	11 a	0.5 a	0 a	0 a	1 ab	0.1 ab	35.8 a-c
8 Vangard 75WG 3.5 oz + Inspire 250EC 2.5 fl oz	PF - 7C	10 a	0.6 a	29 b-d	1.8 b-d	2 ab	0.1 ab	2 ab	0.1 ab	52.3 a
9 Enable 2F 8 fl oz	PF - 7C	33 b	2.1 b	47 d	3.6 d	4 b	0.2 b	5 b	0.3 b	40.3 a-c

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Counts of 25 fruit from each of four reps.
Samples from 27 Sep were stored 26 days at 4°C before evaluation; another set of samples was taken and both were evaluated 23-24 Oct.
Treatment app. dates: 9 May (PF), 1C-7C: 25 May, 7 Jun, 28 Jun, 11 Jul, 25 Jul, 16 Aug, 7 Sep.

Table 21. Post-storage rot incidence following experimental cover spray treatments on Idared apples, 2006-07

	Treatment and rate/A		sampled 27 Sept Any rot	sampled 27 Sept Bitter rot	% fruit infected; sampled 23 Oct '06 Any rot	Bitter rot	Bot rot	Alternaria	Blue mold	Phomopsis
0	No fungicide after pink	PF - 7C	45 e	45 e	62 e	54 d	10 b	3 a	1 a	1 a
1	Topsin M 70W 8 oz + Captan 80WDG 60 oz	PF - 7C	4 a	4 a	17 a-d	15 bc	1 a	0 a	0 a	1 a
2	Inspire 250EC 4 fl oz	PF - 7C	17 b-d	17 b-d	19 b-d	17 bc	2 a	1 a	0 a	0 a
3	Inspire 250EC 2.75 fl oz	PF - 7C	24 cd	23 cd	29 cd	28 c	1 a	1 a	0 a	1 a
4	Inspire 250EC 4 fl oz Topsin M 8 oz + Captan 60 oz	PF, 1, 4, 5C 2, 3, 6, 7C	24 cd	23 cd	10 ab	9 ab	0 a	0 a	1 a	0 a
5	Inspire 250EC 4 fl oz Topsin M 8 oz + Captan 60 oz	PF, 2, 4, 6C 1, 3, 5, 7C	14 bc	14 bc	20 b-d	14 bc	0 a	3 a	1 a	2 ab
6	Inspire 250EC 2.75 fl oz Topsin M 8 oz + Captan 60 oz	PF, 1, 4, 5C 2, 3, 6, 7C	4 a	4 a	6 a	3 a	1 a	1 a	2 a	0 a
7	Inspire 250EC 2.75 fl oz Topsin M 8 oz + Captan 60 oz	PF, 2, 4, 6C 1, 3, 5, 7C	8 ab	8 ab	15 a-c	11 b	1 a	1 a	3 a	0 a
8	Vangard 75WG 3.5 oz + Inspire 250EC 2.5 fl oz	PF - 7C	22 cd	21 b-d	30 d	25 c	2 a	0 a	1 a	6 b
9	Enable 2F 8 fl oz	PF - 7C	32 de	32 de	30 d	28 c	1 a	2 a	0 a	1 a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Counts of 25 fruit.

Treatment application dates: 9 May (PF), 1C-7C: 25 May, 7 Jun, 28 Jun, 11 Jul, 25 Jul, 16 Aug, 7 Sep.

The post-storage counts are means of 25-fruit samples picked from each of four reps 27 Sep or a second sample 23 Oct and placed in cold storage at 33F (1C). The 27 Sep samples were held at 1C for 89 days before evaluating them after 21 days at 70F (21C). The 23 Oct samples were held at 1C for 92 days before evaluating them after 22 days at 70F (21C).

APPLE (*Malus* x *domestica* 'Idared')
Sooty blotch; *disease complex*
Flyspeck; *Zygophiala jamaicensis*
Bitter rot; *Colletotrichum* spp.
White (Bot) rot; *Botryosphaeria dothidea*
***Phomopsis* spp.**
Fruit finish

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Summer disease control by experimental fungicides on Idared apples, 2007.

Nine treatments involving experimental and registered fungicides were compared during the cover spray period on 26-yr-old trees. The test was conducted in a randomized block design with four single-tree replicates separated by untreated border rows between treatment rows. Tree-row-volume was determined to require a 400 gal/A dilute base for adequate spray coverage. Pre-test fungicides to suppress early season diseases were applied 31 Mar (Nova 5 oz + Dithane 3 lb/A), 18 Apr (Nova 5 oz + Syllit 1 lb/A); and 31 May (Bayleton 4 oz/A). Treatments were applied as second cover to seventh covers to both sides of the tree on each application date with a Swanson Model DA-400 airblast sprayer at 100 gal/A. Dates of application for 2nd-7th covers (2C-7C) and accumulated wetting hours (AWH) after 13 May to that date were as follows: 16 Jun (2C, AW=166); 30 Jun (3C, AW=250); 12 Jul (4C, AW=317); 26 Jul (5C, AW=422); 15 Aug (6C, AW=510); 5 Sep (7C, AW=735). Maintenance insecticides applied to the entire test block with the same equipment included: Asana, Imidan, Lannate, Sevin, Calypso, and Provado. The bitter rot fungus was inoculated into two fruit in each quadrant of each test tree 7 Aug. Other diseases developed from inoculum naturally present in the test area. A 25-fruit sample from each replicate tree was harvested and rated 4 Oct and then stored at 1° C; the trees were re-sampled 29 Oct and rated 1 Nov. After this date both sets of samples were incubated 32 days at 70° F (21C) for post-storage rot counts. Percentage data were converted by the square root arcsin transformation for statistical analysis.

Sooty blotch and flyspeck pressure was moderate and rather slow to develop in 2007, but incidence and area affected by both diseases increased between sampling dates on non-treated trees (Table 22). On treated trees, sooty blotch increased more than flyspeck between samplings. All treatments gave significant suppression of both diseases. While it might be assumed that the later cover sprays would have the most effect on sooty blotch, flyspeck, and rot development, differences in control related to the 2nd-3rd cover sprays were apparent: treatments #1,3, 4 and 7 all had the same late season schedule 4C-7C, but among these treatments, Trt. 7 which had Nova at 2C-3C, was significantly weaker for control of sooty blotch, flyspeck, and rots than were those treated with Inspire (difenoconazole) or A16001. Omega (trt. 5) was significantly weaker than Inspire or A16001 for flyspeck in the second sampling, although the rate of captan was slightly higher than in Trts. 1, 2 & 4. Captan alone, applied in all test sprays, was also significantly weaker for flyspeck in the second sampling than Trts. 1,3 and 4 which involved various combinations of Topsin-M + Captan, Inspire and A16001, and trt. 2 which involved Omega. Trt. #8, which involved an alternating schedule of Captan with Pristine, had significantly more flyspeck in the second sampling than Trts. 1, 2, & 4. Following further incubation of the two sets of samples at 70° F (21C), more rot developed in the sample taken 29 Oct than in the first sample, and all treatment schedules significantly reduced the number of rots in the samples after 32 days incubation (Table 23). The most prominent rots were bitter rot and Bot (white) rot. Pristine, alternated three times with captan provided generally superior rot suppression. Late fruit retention seemed to be related to materials that were applied as early as 2C-3C. Several treatment schedules gave significantly more fruit retention than non-treated trees. Trees with the most fruit in late November had been treated with Inspire + Agri-mek at 2C then Inspire alone at 3C. No treatment significantly affected fruit finish compared to non-treated fruit.

Table 22. Experimental Summer disease treatments on Idared apple; Virginia Tech AREC, Winchester, 2007

			% fruit or fruit area infected at indicated sampling date										Fruit retention:
			Sooty blotch, %				Flyspeck, %				% fruit infected with any rot		# fruit/tree
			4 Oct		29 Oct		4 Oct		29 Oct				
	Treatment and rate/A	Timing	fruit	area	fruit	area	fruit	area	fruit	area	4 Oct	29 Oct	26 Nov
0	No fungicide after petal fall	--	80 d	9.8 e	92 d	8.3 e	58 c	3.5 d	80 e	5.3 e	4 b	29 d	16.3 c
	Inspire 250EC 4 fl oz	2C-3C											
1	Captan 80WDG 3.5 lb	4C-5C											
	Captan 80WDG 2 lb + Topsin M 70W 1 lb	6C-7C	10 a-c	0.6 a-d	15 a	1.0 ab	2 ab	0.1 ab	4 a	0.2 a	0 a	1 a	62.5 ab
	Inspire 250EC 4 fl oz	2C-3C											
2	Captan 80WDG 3.5 lb	4C-5C											
	Omega 4SC 13.7 fl oz	6C-7C	4 a	0.2 a	30 ab	1.6 a-c	1 a	0.1 ab	1 a	0.1 a	0 a	0 a	47.5 bc
	A16001 336SE 8.5 fl oz	2C-3C											
3	Captan 80WDG 3.5 lb	4C-5C											
	Captan 80WDG 2 lb + Topsin M 70W 1 lb	6C-7C	6 ab	0.3 a-c	32 ab	2.2 c	0 a	0 a	4 ab	0.2 ab	1 a	3 ab	53.8 ab
	Inspire 250EC 4 fl oz+												
	Agrimek 0.15 EC 12 fl oz + oil 1 qt/100 gal	2C											
4	Inspire 250EC 4 fl oz	3C											
	Captan 80WDG 3.5 lb	4C-5C											
	Captan 80WDG 2 lb + Topsin M 70W 1 lb	6C-7C	9 ab	0.5 ab	15 a	0.8 a	1 a	0.1 ab	1 a	0.1 a	0 a	1 a	85.0 a
	Omega 4SC 13.7 fl oz	2C-3C											
5	Captan 80WDG 3.5 lb	4C-5C											
	Captan 80WDG 3.75 lb +Topsin M 70W 1 lb	6C-7C	18 c	1.0 cd	34 b	1.8 bc	5 ab	0.3 bc	15 c	0.8 c	0 a	3 ab	41.3 bc
6	A16001 336SE 8.5 fl oz	2C, 4C, 6C											
	Omega 4SC 13.7 fl oz	3C, 5C, 7C	18 c	0.9 b-d	27 ab	1.5 a-c	1 a	0.1 ab	3 ab	0.2 a	0 a	2 a	59.3 ab
	Nova 40W 4 oz	2C-3C											
7	Captan 80WDG 3.5 lb	4C-5C											
	Captan 80WDG 2 lb + Topsin M 70W 1 lb	6C-7C	18 c	1.1 d	55 c	3.7 d	2 ab	0.1 ab	34 d	1.7 d	0 a	15 c	31.3 bc
8	Captan 80WDG 3.75 lb	2C, 4C, 6C											
	Pristine 38WG 14.5 oz	3C, 5C, 7C	13 bc	0.8 b-d	25 ab	1.7 a-c	3 ab	0.2 a-c	12 bc	0.6 bc	0 a	3 ab	29.5 bc
9	Captan 80WDG 3.75 lb	2C-7C	9 a-c	0.5 a-d	31 ab	1.9 bc	7 b	0.4 c	20 cd	1.0 cd	0 a	7 bc	39.0 bc

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Counts of 25 fruit from each of four reps. First samples picked and rated 4 Oct; another set of samples was taken 29 Oct and rated 1 Nov and both were incubated at 70° F (21C) for further rot development after 22 or 32 days.

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

Sprays applied airblast at 100 gpa to both sides of the test row on each application date as 2nd-7th covers (2C-7C) at indicated accumulated wetting hours (AW) since May 13: 16 Jun (2C, AW=166); 30 Jun (3C, AW=250); 12 Jul (4C, AW=317); 26 Jul (5C, AW=422); 15 Aug (6C, AW=510); 5 Sep (7C, AW=735).

Maintenance applications: Nova 5 oz + Dithane 3 lb/A (31 Mar); Nova 5 oz + Syllit 1 lb/A (18 Apr), 31 May (Bayleton 4 oz/A); and insecticides; 24 May (Imidan WSB 3 lb + Lannate LV 1 qt/A); 7 Jun (Imidan 3 lb + Provado 8 fl oz/A); 22 Jun (Imidan 3 lb + Lannate LV 1 qt/A).

Table 23. Post-storage rot incidence following experimental cover spray treatments on Idared apples, 2007

			% fruit infected after indicated warm incubation period at 70° F (21C)									
			Sampled 4 Oct		sampled 29 Oct							
			Any rot		Any rot		Bitter rot		Bot rot		Phomopsis rot	
	Treatment and rate/A		22 days	32 days	22 days	32 days	22 days	32 days	22 days	32 days	22 days	32 days
0	No fungicide after petal fall	--	13 b	18 b	13 b	42 c	3 a	16 b	7 a	17 c	1 a	7 b
1	Inspire 250EC 4 fl oz Captan 80WDG 3.5 lb Captan 80WDG 2 lb + Topsin M 70W 1 lb	2C-3C 4C-5C 6C-7C	6 ab	8 b	13 b	20 b	1 a	2 a	8 a	11 bc	1 a	2 ab
2	Inspire 250EC 4 fl oz Captan 80WDG 3.5 lb Omega 4SC 13.7 fl oz	2C-3C 4C-5C 6C-7C	5 ab	12 b	13 b	26 b	0 a	3 a	8 a	15 bc	2 a	3 ab
3	A16001 336SE 8.5 fl oz Captan 80WDG 3.5 lb Captan 80WDG 2 lb + Topsin M 70W 1 lb	2C-3C 4C-5C 6C-7C	5 ab	11 b	6 ab	14 b	0 a	3 a	3 a	6 ab	0 a	1 a
4	Inspire 250EC 4 fl oz+ Agrimek 0.15 EC 12 fl oz + oil 1 qt/100 gal Inspire 250EC 4 fl oz Captan 80WDG 3.5 lb Captan 80WDG 2 lb + Topsin M 70W 1 lb	2C 3C 4C-5C 6C-7C	4 ab	6 ab	12 b	19 b	1 a	3 a	5 a	8 bc	2 a	2 ab
5	Omega 4SC 13.7 fl oz Captan 80WDG 3.5 lb Captan 80WDG 3.75 lb +Topsin M 70W 1 lb	2C-3C 4C-5C 6C-7C	2 ab	6 b	10 b	16 b	0 a	1 a	7 a	11 bc	0 a	0 a
6	A16001 336SE 8.5 fl oz Omega 4SC 13.7 fl oz	2C, 4C, 6C 3C, 5C, 7C	8 b	15 b	8 ab	18 b	2 a	6 ab	4 a	8 bc	0 a	0 a
7	Nova 40W 4 oz Captan 80WDG 3.5 lb Captan 80WDG 2 lb + Topsin M 70W 1 lb	2C-3C 4C-5C 6C-7C	4 ab	7 b	11 b	23 b	1 a	2 a	6 a	14 bc	1 a	2 a
8	Captan 80WDG 3.75 lb Pristine 38WG 14.5 oz	2C, 4C, 6C 3C, 5C, 7C	0 a	0 a	2 a	2 a	0 a	0 a	1 a	1 a	1 a	1 a
9	Captan 80WDG 3.75 lb	2C-7C	10 b	12 b	11 b	22 b	2 a	2 a	7 a	13 bc	2 a	2 a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Counts of 25 fruit per replication . First samples picked and rated 4 Oct; another set of samples was taken 29 Oct and rated 1 Nov and both were incubated at 70° F (21C) for further rot development after 22 or 32 days.

Treatments applied as 2nd-7th covers (2C-7C): 16 Jun, 30 Jun, 12 Jul, 26 Jul, 15 Aug, and 5 Sep.

APPLE (*Malus* x *domestica* 'Fuji')
Bitter rot; *Colletotrichum* spp.
White (Bot) rot; *Botryosphaeria dothidea*
***Alternaria* spp.**
Blue mold; *Penicillium expansum*

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Effect of in-orchard fungicides and postharvest dip treatments on storage decay in Fuji apples, 2006-07.

Fruit from trees last treated with fungicides 7 July '06, were dipped in postharvest treatments to assess the relative effect of pre-harvest and postharvest treatments on rot development during and after storage. Treatments, tested mainly for scab control, were applied dilute to run-off with a single-nozzle handgun at 400 psi in a randomized block design with four single-tree replicates 12 Apr (tight cluster-pink), 19 Apr (50% bloom); 1 May (petal fall); 30 May and 7 July '06. Fruit were harvested 24 Oct '06. Fruit without visible rot symptoms were drenched with 200 ppm sodium hypochlorite 25 Oct and randomized into four 25-fruit replications. Each fruit was wounded in three places with the tip of a nail to a depth of 5 mm. Replicated samples were dipped in the indicated treatment for 30 sec on 31 Oct, placed in open-sided plastic storage crates and held in a commercial apple storage at 4°C 119 days until 27 Feb '07. Samples were then incubated at ambient temperatures (66-76°F) 14 days until the final rating 12 Mar.

Both the pre-harvest and the postharvest treatment regimes significantly affected post-storage rot development. Wounding the fruits increased the likelihood of rot occurrence, even by those generally considered to be pre-harvest rots. Among pre-harvest treatments, Pristine generally had the fewest rots, particularly at wounds, where bitter rot was the predominant pre-harvest rot, as well as Alternaria, and blue mold, presumed to have infected and developed in storage. The postharvest Scholar treatment was the most significant factor in overall post-harvest rot development, providing excellent reduction of blue mold, Alternaria and bitter rot. Postharvest treatment with captan was significantly less effective than Pristine, but gave significant reductions compared to the water treatment, particularly on those fruit which had been treated preharvest with Pristine.

Table 24. Effect of in-orchard fungicides and postharvest treatments on storage decay.

Treatment, rate/100 gal*		% fruit infected with indicated rot at wound or other location								
	Post-	any rot		Bitter rot		Alternaria rot		Blue mold		Bot rot
In-orchard treatment	harvest	wound	other	wound	other	wound	other	wound	other	wound
1 Nova 1.25 oz	Water dip only	82 e	51 de	62 d	19 bc	25 e	13 bc	15 c	3 a	4 ab
2 Vangard 50WG 1.25 oz		79 de	43 de	61 d	13 a-c	17 c-e	11 bc	22 c	2 a	0 a
3 Pristine 38WDG 3.6 oz		65 cd	38 cd	45 c	17 a-c	19 e	16 c	15 bc	5 a	1 ab
4 Nova 1.25 oz	Scholar 230SC 9.6 fl oz	2 a	24 b	1 a	9 a-c	1 a	8 b	0 a	0 a	0 a
5 Vangard 50WG 1.25 oz		2 a	11 a	0 a	3 a	0 a	3 a	2 a	2 a	0 a
6 Pristine 38WDG 3.6 oz		8 a	9 a	2 a	6 ab	4 ab	2 a	2 a	1 a	0 a
7 Nova 1.25 oz	Captan 80WDG 1.6 lb	38 b	43 de	28 b	24 c	8 b-d	10 bc	5 bc	1 a	2 ab
8 Vangard 50WG 1.25 oz		57 c	53 e	46 c	20 bc	16 de	14 bc	0 a	1 a	5 b
9 Pristine 38WDG 3.6 oz		31 b	27 bc	22 b	8 ab	7 bc	9 bc	2 a	0 a	1 ab

Column mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four single-tree replications.
* In-orchard treatments: Trees minimally treated with a fungicide in '06; applied dilute to run-off with a single nozzle handgun at 400 psi 12 Apr (tight cluster-pink), 19 Apr (50% bloom); 1 May (petal fall),
30 May and 7 July.

PHOSPHITE FUNGICIDES: A NEW TOOL FOR APPLE DISEASE CONTROL?

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Background: Phosphite fungicides (phosphorous acids) are marketed under numerous trade names and have been used extensively to control some downy mildews and *Phytophthora* diseases. They have been used extensively in Australia to combat invasive *Phytophthora* species in forest preserves and in California to control sudden oak death caused by *Phytophthora ramorum*. Previous work in the United States suggested that phosphite fungicides might be useful for controlling apple scab, sooty blotch, and flyspeck on apples. Phosphite fungicides were evaluated in four field trials at the Hudson Valley Lab in 2007.

Trial #1—Scab control with ProPhyt applied as a ground spray: ProPhyt (54.5% potassium phosphite; 4.2 lb/gal phosphorous acid equivalent) was evaluated in an orchard established in 1991. The orchard contained two-tree plots of 'Jerseymac' and 'Ginger Gold' on M.9 rootstocks. All treatments were replicated four times. Treatments were applied on dates shown in Table 1 by spraying trees to drip using a high-pressure sprayer and a handgun at 200 psi except that one ProPhyt treatment was applied 31 Mar to the soil within the herbicide strip beneath trees. The intent of the soil-applied treatment was to simulate an application that might occur if ProPhyt were mixed with herbicides that are typically applied in spray volumes of 30 gal per acre of treated surface area. Therefore, ProPhyt was mixed in a 1:9 ratio with water and delivered to the 8-ft by 8-ft herbicided area beneath each tree using timed applications from a Solo backpack sprayer that ensured delivery of the equivalent of 3 gal of ProPhyt per sprayed acre. Trees in this treatment and also in the treatment that received two early-season sprays of ProPhyt-plus-Damoil were then left unsprayed until petal fall. Tree bud stages were 1 Apr - silver tip, 12 Apr - green tip, 25 Apr - early tight cluster, 28 Apr - tight cluster, 2 May - pink, 4 May - king bloom, 9 May - full bloom, 15 May - petal fall. Primary apple scab infection periods occurred 27-28 Apr (28 hr, 50 °F), 16-18 May (29 hr, 57 °F), 19-20 May (27 hr, 52 °F), 25-26 May (12 hr, 66 °F), 28 May (10 hr, 65 °F), 31 May-5 Jun (78 hr, 66 °F). There were four additional secondary infection periods in June and 10 in July. On 21 Jun, an airblast sprayer was used to apply a cover spray of Flint 50WDG 1 oz/A plus Elite 45DF 1.1 oz/A to the entire block, including control plots. No other fungicides were applied thereafter. Scab pressure was very light due to extended dry periods from 12-25 Apr and from 28 Apr to 16 May. Details of rating methods are provided in table footnotes. Data was analyzed using SuperANOVA software from Abacus Concepts.

None of the treatments provided complete control of apple scab. Treatments on 17 May were applied more than 16 hr after the start of rains on 16 May, and Dithane could not arrest infections established near the start of the 16 May wetting period. Similarly, the 31 May applications occurred roughly 80 hr after the start of rains on 28 May, and Dithane again failed to arrest infections that were initiated prior to that spray. The ground spray of ProPhyt applied on 31 Mar and then left unsprayed until 17 May provided better control of leaf scab than the Dithane standard #2 and was comparable to the Dithane standard #1 where trees were sprayed on 10 May. Dithane standard #1 was intended to match the timings used for the ProPhyt ground spray program, but we erred by spraying that plot on 10 May when we sprayed other treatments in this block that are not included in this report. ProPhyt applied as a ground spray or in combination with Damoil failed to adequately control fruit scab on Jerseymac, although it was comparable to both of the Dithane standards. Mildew pressure was very light. Neither of the Dithane treatments nor the ProPhyt-plus-Damoil treatment provided any control of mildew. None of the treatments caused any phytotoxicity or fruit russetting. The most interesting result from this trial was the effectiveness of ProPhyt for controlling scab when it was applied as a ground spray at silver tip. Although this was a light scab year with minimal scab pressure prior to petal fall, the results from this trial suggest that ground sprays of ProPhyt deserve further attention as supplements to scab fungicide programs.

Table 1. Application schedule and incidence of scab on early terminal leaves.

Fungicide and rate of formulated product per 100 gal	Spray schedule						Early terminal leaves with scab (%) [z]		
	31 Mar	20 Apr	1 May	10 May	17 May	31 May	Jersey-mac 20 Jun	Ginger Gold 20 Jun	Grand means: both cultivars
Control..	....	....	....	....	....	....	13.9 d[y]	16.5 c	15.2 d
Dithane 75DF 1 lb (Standard #1) .	D[x]	....	....	D	D	D	3.5 bc	3.0 b	3.3 b
Dithane 75DF 1 lb (Standard #2) .	D	D	D	....	D	D	6.8 c	4.5 b	5.7 c
ProPhyt 3 gal/A ground spray	X								
Dithane 75DF 1 lb.................	....	....	....	....	D	D	2.3 ab	2.9 b	2.6 b
ProPhyt 21.3 fl oz + Dithane[w]	X	X	X	X	X	X	1.1 a	0.7 a	0.9 a

See footnotes below table 2.

Table 2. Application schedule and incidence of scab on fruit.

Fungicide and rate of formulated product per 100 gal	Spray schedule						Fruit with scab (%) [v]		
	31 Mar	20 Apr	1 May	10 May	17 May	31 May	Jersey-mac 20 Jun	Ginger Gold 20 Jun	Grand means: both cultivars
Control..	....	....	....	....	....	....	57.0 c[y]	24.0 b	40.5 c
Dithane 75DF 1 lb (Standard #1) .	D[x]	....	....	D	D	D	1.5 ab	0.0 a	0.8 ab
Dithane 75DF 1 lb (Standard #2) .	D	D	D	....	D	D	2.5 ab	0.5 a	1.5 ab
ProPhyt 3 gal/A ground spray	X								
......................................Dithane 7	....	....	....	....	D	D	3.5 b	1.5 a	2.5 b
ProPhyt 21.3 fl oz + Dithane[w]	X	X	X	X	X	X	0.0 a	0.5 a	0.3 a

[z] Fifteen terminals per tree were collected 20 Jun and all leaves on each terminal were rated for scab.
[y] Means separations were determined by applying Fisher's Protected LSD test ($P \leq 0.05$) to results from the split-plot analysis of two cultivars. The angular transformation was used for the analysis of percentage data, but the arithmetic means are reported.
[x] D indicates dates where Dithane 75DF 1 lb/100 gal was applied alone.
[w] Dithane 75DF 1 lb.
[v] Fifty Jerseymac fruit per tree were rated 25 July. Fifty Ginger Gold fruit per tree were rated on 7 Aug 2007.

Trial #2—Scab control with phosphites applied in trunk sprays: Treatments were established to determine if phosphite fungicides applied to trunks of apple trees at bud break could suppress apple scab during the entire period between bud break and petal fall. We evaluated trunk sprays of Agri-Fos (53.6% mono- and di-potassium salts of phosphorous acid; 3.35 lb/gal phosphorous acid equivalent), ProPhyt (54.5% potassium phosphite; 4.2 lb/gal phosphorous acid equivalent), and Phostrol (53.6% mono- and dibasic sodium, potassium, and ammonium phosphites; 4.32 lb/gal phosphorous acid equivalent). Sovran was also applied as a trunk spray to provide a comparison between the phosphites and a non-phosphite fungicide. All of the trunk sprays were applied in combination with Pentra-Bark (99.8% alkylphenol ethoxylate, polysiloxane polyether copolymer, propylene glycol), an adjuvant that has been reported to enhance uptake of phosphite fungicides through tree bark. The trunk sprays were also compared to a standard foliar spray program of contact fungicides (Dithane-Captan combination) and to Agri-Fos applied as a foliar spray.

Treatments were replicated four times using two-tree replicates in a randomized block design in a 9-yr-old orchard containing trees on MM.111 rootstocks with M.9 interstems. Each plot consisted of one Golden Delicious tree and one tree on which the lower scaffolds were McIntosh and the upper portion of the tree had been grafted to Ginger Gold. The foliar sprays were applied 31 Mar, 20 Apr, 1, 10 and 17 May by spraying trees to drip using a handgun and a high-pressure sprayer set at 200 psi. The trunk sprays were applied 30 Mar when trees were at silver tip. The product rates per gallon noted in Table 3 were mixed with cold water

(ca. 35 °F) to a final volume of 1 gal. A CO_2 sprayer was used to treat the lower 3 ft of each apple tree plus 1 ft of scaffold limbs that branched from the trunk anywhere below 3 ft. The sprays were applied to run-off. Trunks in this orchard averaged 4.35 inches in diameter at 1 ft above ground and required approximately 6.4 fl oz of solution per tree for complete wetting of the bark. All of the spray mixtures involving 64 fl oz of phosphite fungicide per gallon (treatments 8, 9, 10) developed thick flocculent foam during the mixing process, and treatment 12 had both foam and a sediment that would not remain in suspension. Thus, for those four treatments, some of the active ingredient may have been trapped in the foam or sediment, thereby resulting in application of less than the intended rate.

Tree bud stages were 30 Mar - silver tip, 12 Apr - green tip, 25 Apr - early tight cluster, 28 Apr - tight cluster, 2 May - pink, 4 May - king bloom, 9 May - full bloom, 15 May - petal fall. Primary apple scab infection periods occurred 27-28 Apr (28 hr, 50 °F) and 16-18 May (29 hr, 57 °F). Although we initially intended to begin cover sprays at petal fall, the cover spray program was not initiated until 22 May, a week after petal fall, because the prebloom period was so dry. The entire block, including the control trees, received a regular schedule of cover sprays to limit the possibility of continued disease spread after 22 May. Cover sprays were applied with an airblast sprayer adjusted to deliver 100 gal of spray solution per acre. Dates and rates per acre for cover sprays were 22 May — Dithane 75DF 3 lb; 28 May — Dithane 75 DF 2 lb plus Flint 50W 2 oz; 5 Jun — Dithane 75DF 3 lb plus Topsin M 70WSB 12 oz; 21 Jun — Flint 2 oz; 7 Jul and 21 Jul — Topsin M 70WSB 12 oz plus Captan 80WDG 2 lb.

On 28 Jun, a low level of leaf scab was observed on Ginger Gold and Golden Delicious trees, but the McIntosh controls had 20 percent of terminal leaves infected (Table 3). The standard Dithane-Captan combination treatment provided excellent control of apple scab, but none of the other treatments provided acceptable control of scab on McIntosh. On McIntosh, some of the trunk spray treatments had significantly less scab than the control trees, but there was no apparent rate effect for trees treated with four different rates of Agri-Fos. Pentra-Bark applied alone was just as effective as treatments involving phosphite fungicides. Results from this trial indicate that phosphite fungicides applied as trunk sprays at bud break will not provide acceptable control of apple scab in commercial orchards.

Table 3. Effects of trunk and foliar sprays on incidence of apple scab on terminal leaves and fruit

Material and rate of formulated product per 100 gal (for foliar sprays) or per gal of final spray solution (for trunk sprays)	Terminal leaves with scab (%) [z] McIntosh 28 Jun	Ginger Gold 28 Jun	Golden Delicious 10 July	Grand means for 3 cultivars	Fruit with scab (%) [y] Mc-Intosh 13 Sep	Ginger Gold 15 Aug
1. Untreated control	20.3 f [x]	1.2 bc [x]	0.8 bc [x]	7.4 cd [x]	1.0 [w]	0.3 [w]
Conventional foliar sprays [v]						
2. Dithane 75DF 1 lb + Captan 80 WDG 10 oz	0.2 a	0.0 a	0.0 a	0.1 a	0.3	0.0
3. Agri-Fos 3.35L 21.3 fl oz	4.8 b	1.0 ab	0.8 abc	2.2 b	0.7	0.0
Trunk sprays applied 30 Mar						
4. Pentra-Bark 3 fl oz	9.3 cd	2.4 bc	1.0 bc	4.3 cd	1.3	0.7
5 Agri-Fos 3.35L 8 fl oz	13.0 cde	1.9 bc	0.4 ab	5.1 cd	2.0	0.3
6. Agri-Fos 3.35L 16 fl oz	15.5 ef	1.4 bc	0.8 abc	5.9 cd	1.4	0.0
7. Agri-Fos 3.35L 32 fl oz	12.8 cde	1.3 bc	0.6 abc	4.9 c	1.7	0.3
8. Agri-Fos 3.35L 64 fl oz	8.7 c	2.6 c	1.1 bc	4.1 cd	2.3	0.7
9. ProPhyt 4.2L 64 fl oz	14.2 def	2.8 c	2.1 c	6.4 d	1.8	0.0
10. Phostrol 4.32L 64 fl oz	12.0 cde	2.5 bc	0.3 ab	4.9 c	2.1	1.0
11. Sovran 50WG 4 oz	16.7 ef	1.4 bc	0.3 ab	6.1 cd	2.0	0.3
12. Sovran 50WG 4 oz + Agri-Fos 3.35L 64 fl oz	14.7 def	2.1 bc	0.6 abc	5.8 cd	3.0	1.0
Grand means for cultivars	11.9 C	1.7 B	0.1 A			

[z] All leaves on 10 terminals per tree for McIntosh and Ginger Gold (collected 28 Jun 07) and for 15 terminals per tree for Golden Delicious (collected 10 Jul 07) were evaluated for the presence of scab and cedar apple rust

[y] Ratings from 75 fruit/tree.

[x] Mean separations: Fishers Protected LSD test ($P \leq 0.05$) applied to results of split plot analysis for three cultivars. The angular transformation was used for data analysis but arithmetic means are reported. *P*-values of treatment effects, cultivar effects, and treatment-cultivar interactions were all <0.001.

[w] There were no significant differences among treatments ($P \leq 0.05$) as determined by applying Fisher's Protected LSD.

[v] Sprays were applied 31 Mar, 20 Apr, 1, 10 and 17 May.

Trial #3—Interactions among phosphites and spray adjuvants in a late summer spray. This experiment was designed to determine if spray adjuvants or ProPhyt would enhance the activity of either Captan or Captan-Topsin M combinations when the products are applied in late summer to control flyspeck. Products tested in combination with Captan or with a Captan-Topsin M combination included ProPhyt, LI-700 (a surfactant and acidifier containing an 80% mixture of phosphatidylcholine, methylacetic acid and alkyl polyoxyethylene ether), and Tactic (a sticker-surfactant-deposition agent containing 63.4% synthetic latex and organosilicone surfactant fluid)

Treatments were applied to 9-yr-old Golden Delicious trees growing on MM.111 rootstocks with M.9 interstems. Trees were maintained with routine fungicide sprays during the first half of the season. The last cover spray prior to application of test products was on 21 Jul and included Topsin M 70WSB 5 oz/A, Captan 80WDG 2 lb/A, and LI-700 16 fl oz/A. Test fungicides were applied 1 Sep using a handgun to spray trees to drip. Treatments were replicated four times using single-tree plots in a randomized block design. This triangular block has poor air drainage, is surrounded by woodlots on two sides, and therefore has perennially high disease pressure for summer diseases. Treatments were designed so that results could be subjected to a two-way analysis involving three traditional fungicide treatments (none, Captan alone, Captan-plus-Topsin M) and four "adjuvant" treatments (none, ProPhyt, LI-700, Tactic).

The pH of treatment solutions was measured immediately after treatments were mixed in the spray tank and again (using residual spray solution in the tank) after treatments had been applied. The interval between the two measurements was roughly 20 minutes. Spray water pH was 7.4. LI-700 consistently buffered the spray solutions down to a pH of 4.5 or 4.6, and the pH remained constant during the 20-min period when sprays were being applied. ProPhyt treatments had starting pH values of 6.35 to 6.38 and ending pH values of 6.53 to 6.55. Treatments involving Captan and the Captan-Topsin combination, either alone or with combined with Tactic, had starting pH values of 7.57 to 7.67 and ending pH values of 7.85 to 8.01. Furthermore, the pH meter required more than two minutes to stabilize when measuring the latter treatments whereas the meter stabilized very quickly when measuring treatments involving ProPhyt and LI-700.

Time of fungicide depletion following the cover spray on 21 Jul was estimated using the assumption (from previous observations) that Topsin M protects fruit from flyspeck infection for the shorter of either 21 days or the time required to accumulate more than 2 in. of rainfall. When calculated according to this assumption, fungicide protection was depleted by 8 Aug and fruit in the test orchard had been exposed to 138 hr of accumulated wetting between 8 August and 1 Sep when test treatments were applied. We therefore assumed that fruit were heavily infected with sooty blotch and flyspeck at the time that treatments were applied. We opted to harvest fruit 3 days after treatments were applied and incubated them so as to determine what proportion of the existing infections were eradicated by the fungicide treatments.

A second harvest was made 33 days after treatments had been applied to further evaluate effects of treatments on incidence of flyspeck at harvest. Another 175 hr of accumulated leaf wetting were recorded between the time treatments were applied on 1 Sep and harvest on 3 Oct. Thirty-five Golden Delicious fruit were harvested from each tree in three of the four replications on 4 Sep. The trees not sampled on 4 Sep had a light crop, and fruit were therefore left on the tree until the final harvest. The fruit harvested on 4 Sep were placed into polyethylene garbage bags, a wet paper towel was added before the bag was sealed, and fruit were then incubated at 70 °F and 100% relative humidity until 21 Sep. Fruit were then removed from bags and evaluated for incidence of flyspeck and sooty blotch to determine if treatments had any short-term effects on survival of flyspeck infections that were presumed to be present at the time the fungicides were applied. Seventy-five additional fruit (or all available fruit) were harvested from each tree in all four replications on 3 Oct. Fruit harvested 3 Oct were rated immediately for incidence of flyspeck and sooty blotch to determine if the incidence of these diseases at harvest would be similar to that observed on incubated fruit from 4 Sep.

ProPhyt alone, Captan, and the Topsin/Captan combination were all equally effective on fruit harvested 4 Sep, and all had less flyspeck than untreated control (Table 4), whereas LI-700 and Tactic used alone provided no control of flyspeck. Control with Captan was not improved by the addition of ProPhyt, LI-700, or Tactic, whereas Topsin/Captan combination was more effective when applied with ProPhyt or Tactic than when applied with LI-700. For fruit harvested on 3 Oct, treatments that included ProPhyt (grand mean) were better than treatments that included LI-700 (Table 5) and the same would have been true for treatments that included Tactic except that Tactic tended to improve the performance of the Topsin/Captan combination. Incidence of sooty blotch and of fruit out-of-grade was generally lower, but treatment effects followed the same trend that was noted for flyspeck at harvest. The Captan-ProPhyt combination and the Topsin-Captan combination alone, with ProPhyt, and with Tactic were the only treatments that provided commercially acceptable levels of control based on percentages of fruit that were out-of-grade (Table 7), but these treatments were not statistically different from ProPhyt alone and all of the treatments involving Captan. Results clearly show that the effect of ProPhyt is not simply related to acidification of the spray water since it performed better than LI-700 when both products were applied either alone or in combinations with fungicides. Similarly, ProPhyt is not acting simply as a spray adjuvant because response to ProPhyt and Tactic were considerably different.

Table 4. Effects of treatments on flyspeck incidence on Golden Delicious fruit harvested 4 Sep (three days after treatment) and then held at 100% relative humidity for 17 days.

Fungicide and rate of formulated product applied per 100 gal of dilute spray	Fruit with flyspeck (%)				
		Combination products			Grand means for effects of fungicides
	Fungicide alone	ProPhyt 4.2E 20 fl oz	LI-700 16 fl oz	Tactic 8 fl oz	
Control	86.7 c*	49.5 ab	61.6 bc	60.0 bc	64.6 B
Captan 80WDG 15 oz	47.0 ab	40.0 ab	35.6 ab	49.8 ab	43.4 A
Topsin M 70WSB 4 oz plus Captan 80WDG 15 oz	36.2 ab	20.8 a	64.3 bc	16.2 a	31.7 A
Grand means	56.6 A	32.6 A	52.5 A	42.0 A	

*Simple means followed by the same lower-case letter are not significantly different ($P \leq 0.05$), and grand means within the last column or the bottom row that are followed by the same capital letter are not significantly different ($P \leq 0.05$) as determined by applying Fisher's Protected LSD test to results from a 3x4 analysis of fungicides and combination products. Analysis includes data from three replications. *P*-values for effects of fungicides, combination products, and the their interactions are 0.013, 0.147, and 0.222, respectively.

Table 5. Effects of treatments on flyspeck incidence on Golden Delicious fruit at harvest on 3 Oct as determined by observing 75 fruit per tree.

Fungicide and rate of formulated product applied per 100 gal of dilute spray	Fruit with flyspeck (%)				
		Combination products			Grand means for effects of fungicides
	Fungicide alone	ProPhyt 4.2E 20 fl oz	LI-700 16 fl oz	Tactic 8 fl oz	
Control...	96.4 e	46.7 b	83.6 de	74.1 cd	77.1 C*
Captan 80WDG 15 oz..................	42.2 ab	30.9 ab	44.6 b	45.1 b	41.4 B
Topsin M 70WSB 4 oz plus Captan 80WDG 15 oz ..	25.6 ab	21.3 ab	46.6 bc	13.9 a	24.0 A
Grand means................................	54.7 B*	31.8 A	60.6 B	44.4 AB	

* Details of statistical analyses are shown in the footnote to Table 4. *P*-values for effects of fungicides, combination products, and interactions are <0.001, 0.010, and 0.059, respectively.

Table 6. Effect of treatments on sooty blotch incidence on Golden Delicious fruit at harvest on 3 Oct as determined by observing 75 fruit per tree.

Fungicide and rate of formulated product applied per 100 gal of dilute spray	Fruit with sooty blotch (%)				
		Combination products			
	Fungicide alone	ProPhyt 4.2E 20 fl oz	LI-700 16 fl oz	Tactic 8 fl oz	Grand means for effects of fungicides
Control	73.2 f	24.7 cd	52.2 ef	37.4 de	48.4 C*
Captan 80WDG 15 oz...................	10.0 abc	3.5 ab	10.3 abc	12.1 bc	9.4 B
Topsin M 70WSB 4 oz plus Captan 80WDG 15 oz ...	2.5 ab	1.9 ab	2.6 abc	0.3 a	1.7 A
Grand means	28.6 B*	9.2 A	25.5 B	16.6 AB	

* Details of statistical analyses are shown in the footnote to Table 4. *P*-values for effects of fungicides, combination products, and interactions are <0.001, 0.015, and 0.77, respectively.

Table 7. Effects of treatments on incidence of Golden Delicious harvested 3 Oct that were out-of-grade for USDA Extra Fancy due to sooty blotch and flyspeck.

Fungicide and rate of formulated product applied per 100 gal of dilute spray	Fruit out of grade for USDA Extra Fancy (%)				
		Combination products			
	Fungicide alone	ProPhyt 4.2E 20 fl oz	LI-700 16 fl oz	Tactic 8 fl oz	Grand means for effects of fungicides
Control	60.0 d	11.1 a	34.2 c	31.0 bc	35.6 B*
Captan 80WDG 15 oz..................	14.0 ab	2.1 a	8.9 a	10.1 a	9.2 A
Topsin M 70WSB 4 oz plus Captan 80WDG 15 oz ...	2.9 a	1.9 a	9.0 ab	0.3 a	2.8 A
Grand means	25.7 C*	4.7 A	19.0 BC	13.8 AB	

* Details of statistical analyses are shown in the footnote to Table 4. *P*-values for effects of fungicides, combination products, and interactions are <0.001, 0.002, and 0.008, respectively.

Trial #4—Effectiveness of ProPhyt for controlling summer diseases: A 3x4 factorial design was used to compare effectiveness of Captan, Topsin M, and Pristine applied either alone or with two different rates of ProPhyt. The commercial standard of Topsin M 4 oz/100 gal plus Captan 80WDG 10 oz/100 gal was included as a 13th treatment but was not included in the statistical analysis. All treatments were replicated four times in three-tree plots that contained one tree of each cultivar. The test orchard was planted in 2001 and contained Cameo trees on Bud.9 rootstocks and Honeycrisp and Royal Court trees on EMLA.111 rootstocks with M.9 interstems. Trees in this orchard were maintained during the early part of the season using standard combinations of DMI and mancozeb fungicides applied with an airblast sprayer. The last fungicide spray applied to the entire block was on 17 May and consisted of 2.2 lb/A Dithane, 3.7 oz/A Nova, 9 oz/A FireWall, 16 fl oz/A Regulaid.

Test treatments were applied using a high-pressure handgun at 250 psi on 7 Jun, 3 Jul, 23 Jul, and 14 Aug. Fruit were harvested at commercial maturity as follows: 40 Honeycrisp fruit per tree on 5 Sep, 75 Royal Court fruit per tree on 18 Sep, and 40 Cameo fruit per tree on 29 Oct. Accumulated rainfall between the last spray on 14 Aug and harvest dates for the respective cultivars totaled 1.0, 3.0 and 7.5 inches. The accumulated hours of leaf wetting for those same preharvest intervals were 97, 184, and 454, respectively.

Both the Honeycrisp and Royal Court fruit were rated for sooty blotch, flyspeck, and summer fruit rots or lenticel spots immediately after harvest. Fruit with rots or lenticel spots were discarded. Twenty-five Honeycrisp and 50 Royal Court fruit from each tree were then wounded and incubated to allow infection by surviving wound-decay pathogens present on the fruit surface at harvest and development of flyspeck and sooty blotch infections that were not yet visible. Fruit were wounded on a single face using a cork with three nails three-eighth in. apart in a triangular pattern that created wounds approximately one-eighth in. deep by one-sixteenth in. diameter. The wounded fruit were placed into plastic crates, water-soaked paper towels were added, the crates were enclosed in polyethylene bags, and fruit were incubated at 100% relative humidity and 70 °F for 14 (Royal Court) or 18 (Honeycrisp) days to allow development of incubating infections on the fruit surface and/or of wound decays from naturally occurring inoculum present on fruit surfaces. At the end of the incubation period, disease incidence was evaluated again. Cameo fruit were harvested several weeks later than normal commercial harvest dates and were not incubated after harvest.

To assist in visualizing results for sooty blotch and flyspeck, the effectiveness of adding ProPhyt to the fungicide treatments is summarized in Table 8. The ten data sets in Tables 9 and 10 were arranged in order of increasing severity based on a "test severity index" that was calculated for each data set by adding fruit disease incidence from the untreated control and from the treatment involving Captan alone, and then dividing by two. Under conditions in the Hudson Valley, flyspeck is more difficult to control than is sooty blotch, and disease control decreases with increasing time from the last spray.

The test severity index provided a way to integrate both factors into a single table. The following conclusions can be drawn from Table 8:

1. At both rates tested, ProPhyt used alone significantly reduced disease incidence for all data sets except those involving the late-harvested Cameo fruit.
2. Under low test-severity (e.g., data sets 1 and 2), adding ProPhyt to Captan, Topsin, or Pristine had no value because the fungicides were very effective when applied alone.
3. Adding ProPhyt to fungicides did not improve disease control for Cameo that were harvested 2.5 months after the last treatment whereas Captan, Topsin M and Pristine still suppressed flyspeck and sooty blotch on Cameo;
4. In the mid-range of test severities, ProPhyt produced the most consistent benefits when combined with Captan, although it also improved activity of Topsin M in data sets 4 and 9 and of Pristine in data set 9;
5. The patterns of improved activity for comparisons involving ProPhyt at 8 fl oz and at 16 fl oz are identical except that the high rate was more effective than the low rate for combinations with Captan in data sets 5 and 6.

Table 8. Summary of the 10 datasets shown in Tables 9 and 10 arranged in order of increasing severity of the test and showing effects of ProPhyt on control of flyspeck and sooty blotch.

	Dataset, cultivar, evaluation time, and disease evaluated[z]									
	1	2	3	4	5	6	7	8	9	10
	HC	RC	HC	RC	HC	HC	Cameo	RC	RC	Cameo
ProPhyt treatment	hvst	hvst	incu	incu	hvst	incu	hvst	hvst	incu	hvst
comparisons	SB	SB	SB	SB	FS	FS	SB	FS	FS	FS
Test severity index[y]	8	19	22	28	39	48	56	70	91	91
ProPhyt 8 fl oz —										
Better than unsprayed	X[x]	X	X	X	X	X	O	X	X	O
Improved Captan	--	--	X	X	O	O	X	X	X	O
Improved Topsin M	--	--	--	X	--	--	O	O	X	O
Improved Pristine	--	--	--	--	--	--	--	O	X	O
<u>ProPhyt 16 fl oz —</u>										
Better than unsprayed	X	X	X	X	X	X	O	X	X	O
Improved Captan	--	--	X	X	X	X	X	X	X	O
Improved Topsin M	--	--	--	X	--	--	O	O	X	O
Improved Pristine	--	--	--	--	--	--	--	O	X	O

[z] HC = Honeycrisp; RC = Royal Court; hvst = at harvest; incu = after postharvest incubation; SB = sooty blotch; FS = flyspeck.

[y] Test severity index = mean of disease incidence in unsprayed control plus disease incidence for Captan alone.

[x] X = comparisons where the addition of ProPhyt caused reductions (*P*≤0.05) in disease incidence compared to the unsprayed control (top line in each group) or to fungicides used alone.

-- = Incidence for the fungicide used alone was less than 5%; ProPhyt did not improve performance.

O = comparisons where neither of the previous criteria were met and ProPhyt provided no benefit.

Table 9. Effects of treatments on incidence of flyspeck (%) for five different combinations of cultivars and dates.

Fungicide and rate of formulated product applied per 100 gal of dilute spray	Honeycrisp at harvest 5-6 Sep[z]	Honeycrisp incubated 24 Sep[z]	Royal Court at harvest 18 Sep[y]	Royal Court incubated 8 Oct[y]	Cameo at harvest 29 Oct[x]
Captan 80WDG 10 oz					
+ Topsin M 70 WDG 4 oz	0.7 [x]	5.8 [x]	33.1 [x]	49.7 [x]	nd [x]
Fungicides: No fungicide	66.3 d [w]	79.4 d	88.3 d	95.0 j	100.0 g
Captan 80WDG 10 oz	11.9 c	16.9 c	51.7 d	87.0 ij	81.2 ef
Topsin M 70WDG 4 oz	1.3 ab	2.8 ab	26.5 c	57.5 fg	28.2 abc
Pristine 38WDG 5 oz	1.9 ab	2.6 ab	11.4 ab	28.5 c	13.8 ab
ProPhyt 4.2E 8 fl oz	9.3 c	17.3 c	47.6 d	81.5 hi	95.0 fg
+ Captan 80WDG 10 oz	6.3 bc	8.5 bc	22.2 bc	50.0 ef	59.4 de
+Topsin M 70WDG 4 oz	1.9 ab	4.6 ab	16.3 bc	38.0 cde	44.3 cd
+ Pristine 38WDG 5 oz	0.0 a	2.0 ab	5.9 a	15.4 b	13.1 ab
ProPhyt 4.2E 16 fl oz	5.8 bc	14.2 c	44.4 d	72.5 gh	96.4 g
+ Captan 80WDG 10 oz	1.3 ab	0.7 a	18.4 bc	44.1 def	57.6 de
+Topsin M 70WDG 4 oz	3.5 abc	2.2 a	19.8 bc	35.0 cd	33.1 bcd
+ Pristine 38WDG 5 oz	0.0 a	1.9 a	4.0 a	6.0 a	12.6 a
Grand means, fungicide effects:					
No fungicide..................................	29.1 Z [w]	39.0 Z	60.1 Z	83.0 Z	97.1 Z
Captan 80WDG 10 oz	6.5 Y	8.7 Y	30.8 Y	60.4 Y	66.1 Y
Topsin M 70WDG 4 oz	2.0 X	3.1 XY	21.3 X	43.5 X	35.4 X
Pristine 38WDG 5 oz	0.6 X	2.2 X	7.1 W	16.6 W	13.2 W
Grand means, ProPhyt effects:					
No ProPhyt....................................	20.3 B [w]	25.4 C	42.2 B	67.0 C	55.8 A
ProPhyt 4.2E 8 fl oz	4.4 A	8.1 B	23.4 A	46.2 B	52.9 A
ProPhyt 4.2E 16 fl oz	2.3 A	4.2 A	21.7 A	39.4 A	51.1 A
P-value for fungicide X ProPhyt interaction	<0.001	<0.001	0.010	0.245	0.413

[z] Harvested 5-6 Sep 07 and evaluated, then incubated at 70 °F and 100% RH for 18 days prior to the second evaluation.

[y] Harvested 19 Sep and evaluated, then incubated at 70 °F and 100% RH for 20 days prior to the second evaluation.

[x] The Captan-plus-Topsin M treatment was not included in statistical analyses and included no evaluations on Cameo fruit.

[w] Simple means within columns followed by the same small letter are not significantly different ($P \leq 0.05$) as determined by applying Fisher's Protected LSD to results from a 3x4 two-way analysis. Similarly, grand means within columns for either fungicide effects or for ProPhyt effects that are followed by the same capital letter are not significantly different ($P \leq 0.05$). The angular transformation was used for the analysis of percentage data, but the arithmetic means are reported.

The addition of ProPhyt to standard fungicides failed to improve protection against summer fruit decays and lenticel spots (Table 11). Most of the fruit decays and lenticel spots were caused by *Botryosphaeria* species, but incubated fruit occasionally developed decays caused by *Colletotrichum, Botrytis, Penicillium,* and *Monilinia*. Decays from all causes were grouped together for data analyses. ProPhyt used alone did not reduce incidence of decays and lenticel spots in any of the five data sets, and it actually resulted in increased disease incidence in two cases (Table 11). Adding ProPhyt to Captan did not provide any advantage over using Captan alone for controlling decays and lenticel spots (Table 11). For Cameo, both rates of ProPhyt improved the performance of Pristine and the high rate improved the performance of Topsin M (Table 11).

Table 10. Effects of treatments on incidence of sooty blotch as for five different combinations of cultivars and evaluation dates.

Fungicide and rate of formulated product applied per 100 gal of dilute spray	Honeycrisp at harvest 5-6 Sep[z]	Honeycrisp incubated 24 Sep[z]	Red Court at harvest 18 Sep[y]	Red Court incubated 8 Oct[y]	Cameo at harvest 29 Oct
Captan 80WDG 10 oz + Topsin M 70 WDG 4 oz	0.0 [x]	0.7 [x]	3.0 [x]	4.5 [x]	nd [x]
Fungicides: No fungicide	14.4 b [w]	37.9 c	32.4 d	41.0 g	96.9 d
Captan 80WDG 10 oz	0.6 a	5.5 b	5.0 c	15.0 ef	14.7 b
Topsin M 70WDG 4 oz	0.0 a	1.4 ab	2.7 abc	7.5 de	5.6 ab
Pristine 38WDG 5 oz	0.0 a	0.0 a	0.3 ab	1.0 abc	0.0 a
ProPhyt 4.2E 8 fl oz	1.3 a	2.2 ab	6.4 c	15.0 e	72.5 c
+ Captan 80WDG 10 oz	0.0 a	1.5 ab	4.0 bc	9.0 de	0.6 a
+Topsin M 70WDG 4 oz	0.0 a	0.0 a	0.9 abc	0.5 ab	8.1 ab
+ Pristine 38WDG 5 oz	0.0 a	0.0 a	0.0 a	0.9 ab	0.6 a
ProPhyt 4.2E 16 fl oz	0.0 a	3.7 b	3.1 abc	27.0 f	85.9 cd
+ Captan 80WDG 10 oz	0.0 a	0.0 a	0.7 abc	3.4 bcd	4.3 ab
+Topsin M 70WDG 4 oz	0.0 a	0.9 ab	1.6 abc	5.5 cd	3.3 ab
+ Pristine 38WDG 5 oz	0.0 a	0.0 a	0.0 a	0.0 a	0.6 a
Grand means, fungicide effects:					
No fungicide.................................	5.7 Z [w]	15.6 Z	13.9 Z	27.7 Z	85.1 Z
Captan 80WDG 10 oz	0.2 Y	2.3 Y	3.2 Y	9.1 Y	6.6 Y
Topsin M 70WDG 4 oz	0.0 Y	0.8 Y	1.8 XY	4.5 X	5.9 XY
Pristine 38WDG 5 oz	0.0 Y	0.0 Y	0.1 X	0.6 W	0.4 X
Grand means, ProPhyt effects:					
No ProPhyt...................................	3.8 B [w]	11.2 B	10.1 B	16.1 B	29.3 A
ProPhyt 4.2E 8 fl oz	0.3 A	0.9 A	2.9 A	6.4 A	20.5 A
ProPhyt 4.2E 16 fl oz	0.0 A	1.0 A	1.3 A	9.0 A	24.9 A
P-value for fungicide X ProPhyt interaction:.......................	0.110	<0.001	0.086	0.016	0.232

[z, y, x] See footnotes at end of Table 9.

Results from this trial show that Pristine is the most effective fungicide for protecting fruit from flyspeck and sooty blotch when there are long intervals between the last spray and harvest. The combinations of ProPhyt at either 8 or 16 fl oz/100 gal with Captan were usually just as effective as Topsin M for controlling sooty blotch and flyspeck, but Topsin M was more effective than Captan alone or than the Captan/ProPhyt combinations for controlling fruit decays and lenticel spots.

Table 11. Effects of treatments on incidence of fruit decays and lenticel spots for five different combinations of cultivars and evaluation dates.

Fungicide and rate of formulated product applied per 100 gal of dilute spray	Honeycrisp at harvest 5-6 Sep[z]	Honeycrisp incubated 24 Sep[z]	Red Court at harvest 18 Sep[y]	Redcourt incubated 8 Oct[y]	Cameo at harvest 29 Oct
Captan 80WDG 10 oz + Topsin M 70 WDG 4 oz	5.0 [x]	18.4 [x]	2.7 [x]	9.5 [x]	nd [x]
Fungicides: No fungicide...............	16.2 ab [w]	15.6 bcd	6.7 bcd	10.8 cde	18.2 bc
Captan 80WDG 10 oz...............	21.1 bc	20.1 cd	8.9 cd	18.5 ef	17.6 bc
Topsin M 70WDG 4 oz	8.1 ab	9.2 abc	1.7 a	5.0 abc	15.9 b
Pristine 38WDG 5 oz.................	10.2 ab	6.6 ab	2.3 a	4.5 abc	28.4 c
ProPhyt 4.2E 8 fl oz	33.0 c	29.0 d	6.3 bcd	14.5 def	17.5 bc
+ Captan 80WDG 10 oz	13.9 ab	12.1 abc	4.3 abc	17.5 ef	26.5 c
+Topsin M 70WDG 4 oz	7.8 a	9.2 ab	3.0 ab	7.0 bcd	13.6 abc
+ Pristine 38WDG 5 oz	9.7 ab	8.3 abc	2.0 a	3.8 ab	4.4 ab
ProPhyt 4.2E 16 fl oz	17.4 abc	20.8 cd	14.4 d	21.5 f	22.2 c
+ Captan 80WDG 10 oz	15.1 ab	13.8 bcd	6.7 bcd	24.0 f	17.9 bc
+Topsin M 70WDG 4 oz	10.5 ab	5.2 ab	6.1 abc	8.0 bc	1.7 a
+ Pristine 38WDG 5 oz	5.3 a	2.6 a	3.6 ab	2.0 a	7.7 ab
Grand means, fungicide effects:					
No fungicide..............................	22.6 Z [w]	21.9 Z	9.1 Z	15.6 Z	19.3 Z
Captan 80WDG 10 oz...............	16.7 YZ	15.3 Z	6.6 Z	20.0 Z	20.7 Z
Topsin M 70WDG 4 oz	8.7 XY	7.1 Y	3.7 Y	6.7 Y	13.5 Y
Pristine 38WDG 5 oz.................	8.4 X	5.8 Y	2.6 Y	3.4 X	11.2 Y
Grand means, ProPhyt effects:					
No ProPhyt................................	13.9 A [w]	12.9 A	4.9 A	9.7 A	20.0 A
ProPhyt 4.2E 8 fl oz...................	16.1 A	14.0 A	3.9 A	10.7 A	15.5 A
ProPhyt 4.2E 16 fl oz.................	11.8 A	10.2 A	7.7 A	13.9 A	13.1 A
P-value for fungicide X ProPhyt interaction	0.343	0.456	0.320	0.203	0.164

[z, y, x] See footnotes at end of Table 9.

CAN PREHARVEST FUNGICIDE SPRAYS CONTROL POSTHARVEST DECAYS OF APPLES?

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Background: For the past 40 years, apple storage decays caused by *Botrytis cinerea* and *Penicillium* species have been controlled by drenching fruit with fungicides immediately after harvest. In addition to fungicide(s), the postharvest drench usually contains diphenylamine (DPA), an antioxidant that is used to control the physiological disorder known as superficial scald. However, the recycling drenches are problematic because they accumulate and recycle inoculum for apple decay pathogens and could potentially cross-contaminate huge quantities of fruit with human pathogens such as *E. coli.* The need for drenching fruit with DPA to control scald may be disappearing because, for some cultivars, scald can be prevented by using a postharvest treatment of 1-MCP followed by low-oxygen storage. More scald-sensitive cultivars may eventually be treated by using foggable formulations of DPA that are being labeled in the U.S. Thus, packinghouse operators may be able to abandon postharvest drenching if alternative methods can be devised for controlling postharvest decays during long-term (> 5 months) controlled atmosphere storage. Field trials were conducted both at the Hudson Valley Lab and in a commercial NY orchard to determine if fungicides applied within several weeks of harvest could be used to control postharvest apple decays.

Trial #1— Preharvest sprays for controlling postharvest decays on Cortland apples, 2006-2007. Postharvest activity from preharvest sprays of Pristine, Scala, Flint, and Topsin M were compared in a trial involving two preharvest intervals. For one of those intervals, effectiveness of the fungicides was also compared for the fungicides applied alone or in combination with Captan. The treatments were applied to 5-yr-old Royal Court apple trees growing on EMLA.111 rootstocks with M.9 interstems. The trial involved a randomized complete block design with four replications for each fungicide treatment. In addition, each replication included an unsprayed control plot. Trees in this orchard were maintained during the early part of the season using routine fungicide applications. All plots received fungicides as follows: 20 Apr and 18 May– Dithane 75DF 3 lb/A; 1 Jun– Penncozeb 75DF 3 lb/A + Nova 40W 3.8 oz/A; 8 Jun– Polyram 80DF 2.7 lb/A + Nova 3.3 oz/A. No other fungicides were applied except for the treatments described below. Preharvest treatments were applied to drip using a handgun. Test fungicides were applied on either 18 Aug with no further sprays prior to harvest or on 18 Aug and again on 12 Sep. Fruit were harvested at commercial maturity.

To ensure that all fruit would have uniformly high numbers of *P. expansum* spores on their surfaces at harvest, fruit were inoculated approximately 5 hr after the last spray was applied on 12 Sep and one day prior to harvest. A spore suspension was generated by washing *P. expansum* spores from 12-day-old cultures of the benzimidazole-resistant isolate P-301 that had been grown on acidified potato dextrose agar. The suspension was adjusted to 4×10^4 spores/ml using a hemacytometer and one hundred gallons of the spore suspension were applied to the 56 Red Court trees. This resulted in delivery of 6.8×10^7 spores of *P. expansum* to each tree.

On 13 Sep, an arbitrarily selected sample of 60 fruit were harvested from each test tree. As they were harvested, each fruit was wounded on a single face using a cork with 3 nails three-eighth in. apart in a triangular pattern. Wounds on the fruit were approximately one-eighth in. deep by one-sixteenth in. diameter. The wounded fruit were placed into storage crates and were moved to a cold air storage room within four hours of harvest. After 24 hr of cooling, the crates of fruit were enclosed in polyethylene garbage bags, 100 ml of water were added to the bottom of each bag, and bags were closed to ensure that fruit would be held at 100% relative humidity. The polyethylene bags were removed on 2 Oct and fruit were exposed to normal air in the storage room thereafter. Fruit were held at 38 °F until 3 Jan 07 when all fruit were removed from cold storage and evaluated for decays. The causes of decays were tallied based on fruit symptoms. Most, but not all, of the decays originated at the nail punctures we created at harvest. Fruit that developed decay at any position on the fruit were counted as decayed fruit, and fruit with decays at multiple locations were not differentiated from those that had a single decay.

Captan and Flint were relatively ineffective at both of the spray timings used, but Pristine and Scala were significantly more effective when applied on both 18 Aug and 12 Sep than when applied only on 18 Aug (Table 1). Rainfall between 18 Aug and 12 Sep totaled 4.6 in., so it is surprising that sprays applied only on 18 Aug provided any suppression at all for decays initiated in fruit that were wounded at harvest. Fruit from trees treated with a combination of Flint + Captan had significantly less decay than fruit from trees treated with Flint alone (Table 2). Combining Topsin M with Captan also boosted performance, although differences between these two treatments were not significantly different. The combination of Captan and Scala was significantly better than any of the other fungicide combination treatments as measured by control of both blue mold decay and total decays. Although Pristine and Scala provided similar levels of disease control when applied alone, the addition of Captan boosted the performance of Scala more than it did the performance of Pristine.

This was a severe test of fungicide efficacy given that inoculum was applied to trees after the last fungicide application and just prior to harvest, and also because the fruit were purposely wounded at harvest and were then held for 112 days at relatively warm storage temperatures. (Cortland apples would normally be stored at 32-35 °F.) The fact that preharvest sprays of Pristine and Scala, either alone or in combination with Captan, reduced blue mold decay by 83 to 98% suggests that under normal commercial conditions these preharvest sprays would prove highly effective. Since Scala is not registered for preharvest applications in the U.S., Pristine would be the logical choice for growers choosing to use preharvest sprays to minimize postharvest disease losses. However, most growers will find it inconvenient to apply sprays immediately prior to harvest, and sprays applied more than a few days prior to harvest may always be subject to wash-off from rains. Thus, the practicality of preharvest sprays for controlling postharvest decay may limit this approach for controlling postharvest decays.

Table 1. Effectiveness of preharvest fungicides applied for controlling decay in Royal Court fruit harvested on 13 Sep 2006 and held in cold storage at 38.0 °F for 112 days (until 3 Jan 2007).

Fungicide and rate of formulated product per 100 gal drench	Percent control of blue mold[z] Treatments dates			Percent control for all decays combined[z] Treatments dates		
	18 Aug	18 Aug & 12 Sep	Grand mean	18 Aug	18 Aug & 12 Sep	Grand mean
Captan 80W 10 oz	58 a[y]	49 b	54 B	49 a[y]	27 b	38 B
Pristine 38W 4.8 oz	36 ab*	83 a	60 AB	35 ab*	72 a	54 AB
Scala 230SC 3.3 fl oz	46 ab*	92 a	69 A	36 ab*	76 a	56 A
Flint 50W 0.8 oz................	11 b	21 b	17 C	7 b	13 b	10 C
Grand mean	39 B	61 A		33 B	47 A	

[z] For control plots, blue mold incidence was 48.4% and incidence for all decays was 51.5%.

[y] Simple means within columns that are followed by the same lower-case letter, or grand means followed by the same capital letter, are not significantly different ($P \leq 0.05$) as determined by applying Fisher's Protected LSD test to results from a 2x4 analysis of fungicides and application dates. Asterisks following letter separations indicate significant differences between simple means for the same fungicide applied on different dates. *P*-values from the analysis of treatment effects on blue mold incidence were 0.001, 0.002, 0.014 for effects of fungicides, treatment dates, and interactions, respectively, whereas the respective *P*-values from the analysis of incidence of all decays were 0.002, 0.027, and 0.020.

Table 2. Effect of fungicides applied either alone or in combinations on reductions in decay incidence in Cortland fruit that were harvested on 13 Sep 2006 and stored at 38.0 °F for 112 days (until 3 Jan 2007).

Fungicide and rate of formulated product per 100 gal drench [x]	Percent control of blue mold [z]			Percent control for all decays combined [z]		
	Fungicide alone	Fungicide combinations [y]	Grand mean	Fungicide alone	Fungicide combinations [y]	Grand mean
Captan 80W 10 oz	49 b [w]	77 b	63 BC	27 b [w]	61 b [a]	44 C
Pristine 38W 4.8 oz	83 a	76 b	80 B	72 a	69 b	71 B
Scala 230SC 3.3 fl oz ...	92 a	98 a	95 A	76 a	94 a	85 A
Flint 50W 0.8 oz..........	21 b*	58 b	40 C	13 b*	49 b	31 C
Grand mean	61 B	77 A		47 B	68 A	

[z] For unsprayed control plots, blue mold incidence was 48.4% and incidence for all decays was 51.5%.

[y] Topsin M was added to Captan; all other treatments had Captan added to the main fungicides.

[x] All treatments were applied on 18 Aug and again on 12 Sep.

[w] Simple means that are followed by the same lower-case letter, or grand means followed by the same capital letter, are not significantly different ($P \leq 0.05$) as determined by applying Fisher's Protected LSD test to results from a 2x4 analysis of fungicides and application dates. Asterisks following letter separations indicate significant differences between simple means for the same fungicide applied on different dates. *P*-values from the analysis of treatment effects on blue mold incidence were 0.001, 0.029, 0.195 for effects of fungicides, treatment dates, and interactions, respectively, whereas the respective *P*-values from the analysis of incidence of all decays were <0.001, 0.014 and 0.342.

Trial #2— Preharvest sprays to control postharvest decays on Cameo apples, 2006-2007. Postharvest activity from preharvest sprays of Pristine, Scala, Flint, and Topsin M were compared in a trial involving two preharvest intervals. Treatments were applied to 5-yr-old trees of Cameo on Budagovski 9 rootstocks. The trial involved a randomized complete block design with four replications for each fungicide treatment. In addition, each replication included an unsprayed control plot. Trees in this orchard were maintained during the early part of the season using routine fungicide applications. All plots received fungicides as follows: 20 Apr and 18 May– Dithane 75DF 3 lb/A; 1 Jun– Penncozeb 75DF 3 lb/A + Nova 40W 3.8 oz/A; 8 Jun– Polyram 80DF 2.7 lb/A + Nova 3.3 oz/A. No other fungicides were applied except for the treatments described below. Test fungicides were applied on either 25 Sep with no further sprays prior to harvest or on 12 Sep and again on 2 Oct. Preharvest treatments were applied to drip using a handgun. Fruit were harvested at commercial maturity. Rainfall between 25 Sep and 5 Oct when fruit were harvested totaled 0.63 in. Rainfall from 12 Sep to 2 Oct totaled 3.06 inches, with no additional rainfall between 2 Oct and harvest on 5 Oct.

To ensure that all fruit would be exposed to high inoculum during the harvesting process, fruit were inoculated on 3 Oct using conidia of *P. expansum* and *B. cinerea* produced in lab cultures. Conidia of *B. cinerea* were collected from 35-day-old cultures growing on calcium enriched V-8 juice agar and conidia of *P. expansum* were from 12-day-old cultures growing on acidified potato dextrose agar. The spore suspension applied to trees contained 4×10^4 spores/ml for *P. expansum* and 157 spores/ml for *B. cinerea.* Approximately 1.25 gal of spore suspension were sprayed on each tree using a handgun and a high-pressure sprayer, so each tree received approximately 4.73×10^7 and 7.45×10^5 spores/tree for *P. expansum and B. cinerea*, respectively.

On 5 Oct, an arbitrarily selected sample of 60 fruit were harvested from each test tree. As they were harvested, each fruit was wounded on a single face using a cork with 3 nails three-eighth in. apart in a triangular pattern. Wounds on the fruit were approximately one-eighth in. deep by one-sixteenth in. diameter. The wounded fruit were placed into storage crates and were moved to a cold air storage room within four hours of harvest. After 24 hr of cooling, the crates of fruit were enclosed in polyethylene garbage bags, 100 ml of water were added to the bottom of each bag, and bags were closed to ensure that fruit would be held at 100% relative humidity. The polyethylene bags were removed on 30 Oct and fruit were exposed to normal air in the storage room thereafter. Fruit were held at 36 °F throughout the cold storage period. Fruit were evaluated for decays on 4 Jan and again on 9 Mar. The causes of decays were tallied based on fruit symptoms. Most, but not all, of the decays originated at the nail punctures we created at harvest. Fruit that developed decay at any position on the fruit were counted as decayed fruit, and fruit with decays at multiple locations were not differentiated from those with a single decay.

The incidence of decays remained relatively low throughout the storage period with a maximum of only 17.5% decay in unsprayed control fruit after 155 days of cold storage. There was no difference between the two treatment date regimes for either of the two observation dates. On the final observation date, when grand means for both treatment dates were compared, Pristine and Scala provided significantly better disease control than either of the other two treatments. Although differences were not significant, a single application of Pristine was often more effective than the two-spray treatment, whereas Scala generally performed better when applied twice. Treatment with Topsin caused a higher incidence of decay than was present in controls for many of the treatment/observation date combinations, presumably because the isolate of *P. expansum* used as inoculum was benzimidazole resistant and growth of resistant strains is sometimes enhanced in the presence of the benzimidazole residues. The fact that Captan was applied in the place of Topsin M on 12 Sep helps to explain why trees treated with Topsin on 25 Sep generally had more decay than trees sprayed on two dates prior to harvest.

This was a severe test of fungicide efficacy given that inoculum was applied to trees after the last fungicide application and also because the fruit were purposely wounded at harvest and were then held for 155 days at relatively warm storage temperatures. (Cameo fruit would normally be stored at 32-33 °F.) The fact that preharvest sprays of Pristine and Scala reduced decay by more than 80% suggests that under normal commercial conditions these preharvest sprays would prove highly effective. Since Scala is not registered for preharvest applications in the U.S., Pristine would be the logical choice for growers choosing to use preharvest sprays to minimize postharvest disease losses.

Table 3. Effects of preharvest sprays and spray dates on control of decays in Cameo fruit harvested on 5 Oct 2006 and held in cold storage at 36.0 °F for 91 days (until 4 Jan 2007).

Fungicide and rate of formulated product per 100 gal drench	% control of blue mold in Cameo[z]: Treatment dates 25 Sep	12 Sep, 2 Oct	grand mean	% control of all decay in Cameo[z]: Treatment dates 25 Sep	12 Sep, 2 Oct	Grand mean
Topsin M 70W 4 oz[y]	-56 c[x]	-21 b	-38 C	-17 b[x]	3 b	-7 C
Pristine 38W 4.8 oz	100 a	85 a	93 A	87 a	87 a	87 A
Scala 230SC 3.3 fl oz	75 ab	93 a	85 AB	69 ab	85 a	77 AB
Flint 50W 0.8 oz	49 bc	71 ab	60 B	37 b	63 ab	50 BC
Grand mean	42 A	58 A		44 A	59 A	

[z] For the unsprayed control plots, blue mold incidence was 7.3% and incidence for all decays was 11.5%.

[y] Captan was applied alone on 12 Sep. Topsin was applied on 25 Sep and 2 Oct.

[x] Simple means within columns that are followed by the same lower-case letter, or grand means followed by the same capital letter, are not significantly different ($P \leq 0.05$) as determined by applying Fisher's Protected LSD test to results from a 2x4 two-way analysis of fungicides and application dates. *P*-values from the analysis of treatment effects on blue mold incidence were 0.001, 0.344, 0.579 for effects of fungicides, treatment dates, and interactions, respectively, whereas the respective *P*-values from the analysis of incidence of all decays were 0.005, 0.254, and 0.876.

Table 4: Effects of preharvest sprays and spray dates on control of decays in Cameo fruit harvested on 5 Oct 2006 and held in cold storage at 36.0 °F for 155 days (until 9 Mar 2007).

Fungicide and rate of formulated product per 100 gal drench	% control of blue mold in Cameo[z] Treatment dates 25 Sep	12 Sep, 2 Oct	grand mean	% control of all decay in Cameo[z] Treatment dates 25 Sep	12 Sep, 2 Oct	Grand mean
Topsin M 70W 4 oz[y]	-57 c[x]	13 b	-22 B	-15 c[x]	23 b	4 B
Pristine 38W 4.8 oz	100 a	63 ab	81 A	87 a	69 ab	78 A
Scala 230SC 3.3 fl oz	84 ab	92 a	88 A	77 ab	85 a	81 A
Flint 50W 0.8 oz..................	32 bc	63 ab	47 B	30 b	64 ab	47 B
Grand mean	40 A	57 A		45 A	60 A	

[z] For unsprayed control plots, blue mold incidence was 11.2% and incidence for all decays was 17.5%.

[y] Captan was applied alone on 12 Sep. Topsin was applied on 25 Sep and 2 Oct.

[x] Simple means within columns that are followed by the same lower-case letter, or grand means followed by the same capital letter, are not significantly different ($P \leq 0.05$) as determined by applying Fisher's Protected LSD test to results from a 2x4 two-way analysis of fungicides and application dates. *P*-values from the analysis of treatment effects on blue mold incidence were <0.001, 0.480, 0.114 for effects of fungicides, treatment dates, and interactions, respectively, whereas the respective *P*-values from the analysis of incidence of all decays were 0.003, 0.234, and 0.617.

Trial #3— Postharvest decay control with preharvest sprays in a commercial orchard, 2006-07.

Treatments were applied in a large block of mature Empire trees on M.7 rootstock in an orchard near Albion, NY where fruit were harvested on 29 Sep. The grower divided the orchard into six "plots" containing multiple rows so that three treatments could each be replicated two times. Treatments were applied using an airblast sprayer calibrated to deliver 90 gal/A. Untreated controls received their last fungicide spray of the season on 18 Aug when the grower applied Flint at 1.6 oz/A to the entire block including the sections that later received the Pristine and the Topsin/Captan preharvest sprays. Earlier in August, the entire block was sprayed with Topsin M 70WDG 6.6 oz/acre and Captan 80WDG 1.6 lb/A on 8 Aug. The interval between the last regular-season spray 18 Aug and application of test treatments on 19 Sep included 13 days with rainfall that totaled 6.3 inches. From 20-29 Sep (from the date of the last spray until harvest), there were 7 days with rains that totaled 1.0 inch.

The grower harvested fruit in this block on 29 Sep 2006. For each treatment and replicate, two bins of harvested fruit were marked and moved into controlled atmosphere (CA) storage without receiving any postharvest treatment. The filled CA room was treated with 1-MCP on 6 Oct and the room was sealed on 7 Oct. The oxygen level was below 5% by 10 Oct. The CA room was held at 34 °F with O_2 and CO_2 both averaging 2.0% throughout the storage period. The room was opened on 21 April, and the fruit in the 12 marked bins were then held at 34 °F until they were rated 27 Apr 2007. Ratings were completed by removing and observing 1,000 fruit from each bin (roughly half of the fruit in each bin) and then scanning the remaining exposed fruit in the bin for decays. Decays visible in the bin after 1000 fruit had been removed were added to the totals for numbers of decays per bin. The causes of decays were identified based on signs (visible sporulation) and symptoms observed on the fruit. Results were expressed as the number of decayed fruit observed per bin.

The number of decayed fruit observed per bin after CA storage was significantly lower for fruit treated with Topsin/Captan than for fruit from unsprayed controls. Pristine had an intermediate effect on total numbers of decayed fruit, but Pristine was just as effective as the Topsin/Captan combination for controlling blue mold. Nearly 20% of the decays (3.8 out of 18.3 total decays) in the unsprayed controls were caused by *Mucor* whereas no *Mucor* decays were found in the Topsin/Captan treatment. Because not all fruit in each of the 12 test bins were counted, the incidence of decays cannot be accurately converted to percentages. However, because roughly 400 additional fruit in the lower half of each bin were scanned after 1000 fruit had been removed and counted, we can estimate percentages of decayed fruit based on observation of 1400 fruit per bin. Using this approach, we estimate that incidence of total decays ranged from 0.4% for the Topsin/Captan treatment to 1.3% for the unsprayed controls. The incidence of blue mold decay ranged from 0.3 to 0.9%. Both Pristine and Topsin/Captan reduced the incidence of blue mold decays in CA-stored fruit less than 6 fruit per bin compared to 12.5 fruit per bin in the control plots.

Neither of the treatments provided control of gray mold caused by *Botrytis*. *Botrytis* decays that developed during storage in this trial probably resulted from latent sepal infections that occurred during or shortly after bloom. The Topsin/Captan treatment provided complete control of decays caused by *Mucor* whereas the Pristine treatment did not. In retrospect, it seems likely that most of the decays we listed as "unknowns" were also attributable to *Mucor*, so failure of Pristine to control this pathogen probably explains why the total number of decays detected in Pristine-treated fruit was not significantly different from that found in the untreated controls. Although preharvest sprays reduced postharvest decays in this trial, none of the sprays were completely effective.

Table 5. Numbers of decayed fruit observed after fruit had been stored from 29 Sep 06 to 27 Apr 07.

Fungicides, rates, and spray timing	Total number of decayed fruit observed/bin[z,y]	No. fruit per bin with decay attributable to:[z] Penicillium	Botrytis	*Mucor*	Unknown
Untreated control	18.3 b[x]	12.5 b	6.8	3.8	0.3
Pristine 38DF 1 lb/A 19 Sep 07.................	11.5 ab	5.8 a	4.5	1.8	0.3
Topsin M 70WDG 6.6 oz/A + Captan 50W 3 lb/A 19 Sep.................	6.3 a	4.5 a	3.3	0.0	0.0
P-values	0.036	0.022	0.271.	0.163	0.586

[z] 1000 fruit/bin were counted and observed for decay, then any additional decayed fruit that had been exposed among the remaining apples in the bottom half of the bins were removed and counted.

[y] Some apples had more than one kind of decay, so adding decays caused by different fungi may result in a total that exceeds the actual number of fruit with decay as shown in the first data column.

[x] Mean separations ($P \leq 0.05$) based on ANOVA of 2 replications per treatment with 2 subsamples per replicate.

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Reduced Program for Control of Apple Diseases

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Reduced cost fungicide programs with Sulfur/Captan/Mancozeb and an organic program were evaluated along with conventional programs with strobilurin (Trt. 2) and demethylation inhibitor (DMI) fungicides (Trt. 3) for control of apple scab. The test was conducted at the Penn State Fruit Research and Extension Center research orchards on mature 'Rome Beauty', 'Golden Delicious', 'Stayman', 'Cortland', and 'Red Delicious' trees on Malling 26 rootstocks spaced at 35 x 10 x 8 ft. Treatments were arranged in a randomized complete block design with 4 replications. Treatments were applied dilute to both sides of the trees with a boom sprayer at 400 psi, which delivered 100.0 gal/A. Spray programs were applied on 10-14 day intervals from 11 Apr (1/2" green) to 23 Aug (7C). A standard maintenance program for insects was applied with an airblast sprayer at 100.0 gal/A at 400 psi. Weather monitoring and primary scab infection periods were recorded with a Field Monitor and Spectrum weather systems using the Mills Modified apple scab infection model. Rainfall for Apr, May, Jun, Jul, and Aug was 3.81", 1.91", 2.34", 1.49", and 4.87", respectively.

Several scab infection periods occurred during the primary period, 15 Mar to 15 Jun. There were 6 moderate and 9 severe infection periods. Scab disease infection pressure in the test orchard was relatively light due to dry weather conditions. Disease incidence on shoots and fruit was recorded by observing leaves on 25 shoots and 25 fruit on 'Rome Beauty' and 'Golden Delicious' trees (4 replicates/treatment) on 23 Jul. Data obtained were analyzed by analysis of variance using appropriate transformations and significance between means was determined by the Fisher's Protected, LSD ($P \leq 0.05$).

Scab incidence on nontreated 'Rome Beauty' and 'Golden Delicious' shoot leaves was 96.0 and 51.0 % on 23 Jul, respectively. Fruit infection on nontreated 'Rome Beauty' and 'Golden Delicious' was 80.0 and 24.0 % on Jul 23, respectively. All conventional, as well as the reduced cost programs and one of the organic treatments (Trt. 9) significantly controlled shoot and fruit scab incidence on 'Rome Beauty' and 'Golden Delicious' compared to the nontreated check. In a low scab pressure year, even the reduced cost organic program (Trt. 8 cost at $81.00/A/season) that had received one copper spray at ¼" GT through 1C followed by 1% Lime Sulfur (2C-4C) and Kocide + MicroSulf (5C-7C) provided acceptable fruit scab control on 'Golden Delicious" and 'Rome Beauty' at 60.0 and 95.%, respectively. None of the treatments caused phytotoxicity to leaves or fruit.

Acknowledgements: The project was supported by the Pennsylvania State University Pennsylvania, and the State Horticultural Association of PA. We also thank the Penn State Fruit Research and Extension Center technical service for maintaining the orchard.

Table1. Disease incidence on ‘Rome Beauty’, 2007.

		% Scab Incidence				Approx, Fungicide Cost/
	Application	Shoot Leaves[y]		Fruit[x]		A/Season
Treatment and Rate/A	Timing[z]	23 Jul	% Control[w]	23 Jul	% Control[w]	($)
1. Nontreated Ck …………….		96.0 e[v]	- -	80.0 b	- -	
Conventional Program						
2. Nova 40WP 5.0 oz + Dithane 75DF 3.0 lb Captan 80WDG 3.5 lb Captan 80WDG 2.0 lb Topsin M 70WP 1.0 lb.….	½” GT, TC, B, PF 1C-5C 6C-7C 6C-7C …………...	22.0 bc	77.0	2.0 a	97.0	290.00
Reduced Program						
3. MicroSulf 10.0 lb Captan 80WDG 3.0 lb + MicroSulf 3.0 lb Captan 80WDG 3.5 lb Topsin M 70WP 1.0 lb ….	½” GT-1C 6C-7C 6C-7C …………..	43.0 bc	55.0	2.0 a	97.0	201.00
4. Dithane 75DF 3.0 lb + Captan 80WDG 3.0 lb + MicroSulf 3.0 lb MicroSulf 6.0 lb Captan 80WDG 3.5 lb Topsin M 70WP 1.0 lb ….	½” GT-1C 2C-5C 6C-7C 6C-7C …………..	26.0 bc	73.0	1.0 a	98.0	231.00
5. MicroSulf 10.0 lb Dithane 75DF 3.0 lb + Captan 80WDG 3.0 lb + MicroSulf 3.0 lb MicroSulf 6.0 lb Kocide 3000 8.0 oz Lime Sulfur 1% 1.0 gal ...	½” GT-1C P-1C 2C-4C 5C-6C 7C ……………..	2.0 a	98.0	61.0 b	24.0	157.00
6. Dithane 75DF 3.0 lb + MicroSulf 3.0 gal MicroSulf 6.0 lb Kocide 3000 4.0 oz rot. w/ Lime Sulfur 1% 1.0 gal...	½” GT-1C 2C-4C 5C-7C ……………………	18.2 ab	81.0	2.0 a	97.0	116.00
7. MicroSulf 10.0 lb Dithane 75DF 3.0 lb + MicroSulf 3.0 lb MicroSulf 6.0 lb Kocide 3000 4.0 oz + MicroSulf 6.0 lb ……….	½” GT-TC PF-1C 2C-5C 5C-7C ……………………	19.0 ab	80.0	1.0 a	98.0	113.00
Organic Program						
8. Champion WP Lime Sulfur 1% 1.0 gal Kocide 3000 4.0 oz + MicroSulf 6.0 lb ………..	¼” GT 2C-4C 5C-7C …………………….	75.0 d	22.0 d	32.0 a	60.0	81.00
9. MicroSulf 10.0 lb Lime Sulfur 1.5% 1.5 gal Lime Sulfur 1.5% 1.5 gal MicroSulf 6.0 lb Kocide 3000 8.0 oz rot. w/ Lime Sulfur 1% 1.0 gal ….	½” GT-TC PF PF + 5 da 1C-4C 5C-7C …………………….	18.3 ab	81.0	1.0 a	98.0	123.00

z Timing: 1 = ½” green (11 Apr); 2 = TC (20 Apr); 3 = Pink Bloom (30 Apr); 4 = Bloom –Petal fall (7 May); 5 = 1C (21 May); 6 = 2C (4 Jun); 7 = 3C (15 Jun); 8 = 4C (28 Jun); 9 = 5C (13 Jul); 9 = 6C (30 Jul); 10 = 7C (23 Aug.).

y Incidence on 25 shoots/tree – replicate.

x Incidence on 25 fruit and fruit cluster/tree – replicate

w Percent control = control of disease incidence over that of the water-treated check

v Means marked with the same letter(s) are not significantly different, Fisher’s Protected LSD, P $\leq$ 0.05.

Table 2. Disease incidence on 'Golden Delicious', 2007.

Treatment and Rate/A	Application Timing[z]	% Scab Incidence: Shoot Leaves[y] 23 Jul	Shoot Leaves % Control[w]	Fruit[x] 23 Jul	Fruit % Control[w]	Approx. Fungicide Cost/ A/Season ($)
1. Nontreated Ck ……………		51.0 d[v]	- -	24.0 b	- -	
Conventional Program						
2. Nova 40WP 5.0 oz + Dithane 75DF 3.0 lb Captan 80WDG 3.5 lb Captan 80WDG 2.0 lb Topsin M 70WP 1.0 lb ….	½" GT, TC, B, PF 1C-5C 6C-7C 6C-7C ……………	18.0 abc	65.0	0.0 a	100.0 a	290.00
Reduced Program						
3. MicroSulf 10.0 lb Captan 80WDG 3.0 lb + MicroSulf 3.0 lb Captan 80WDG 3.5 lb Topsin M 70WP 1.0 lb …..	½" GT-1C 6C-7C 6C-7C ……………	12.0 a	76.0	0.0 a	100.0	201.00
4. Dithane 75DF 3.0 lb + Captan 80WDG 3.0 lb + MicroSulf 3.0 lb MicroSulf 6.0 lb Captan 80WDG 3.5 lb Topsin M 70WP 1.0 lb ….	½" GT-1C 2C-5C 6C-7C 6C-7C ……………	6.0 a	88.0	0.0 a	100.0	231.00
5. MicroSulf 10.0 lb Dithane 75DF 3.0 lb + Captan 80WDG 3.0 lb + MicroSulf 3.0 lb MicroSulf 6.0 lb Kocide 3000 8.0 oz Lime Sulfur 1% 1.0 gal ….	½" GT-1C P-1C 2C-4C 5C-6C 7C ………………	14.0 ab	73.0	0.0 a	100.0	157.00
6. Dithane 75DF 3.0 lb + MicroSulf 3.0 gal MicroSulf 6.0 lb Kocide 3000 4.0 oz rot. w/ Lime Sulfur 1% 1.0 gal...	½" GT-1C 2C-4C 5C-7C …………………..	10.0 a	80.0	0.0 a	100.0	116.00
7. MicroSulf 10.0 lb Dithane 75DF 3.0 lb + MicroSulf 3.0 lb MicroSulf 6.0 lb Kocide 3000 4.0 oz + MicroSulf 6.0 lb ………	½" GT-TC PF-1C 2C-5C 5C-7C ……………………	15.0 abc	71.0	0.0 a	100.0	113.00
Organic Program						
8. Champion WP Lime Sulfur 1% 1.0 gal Kocide 3000 4.0 oz + MicroSulf 6.0 lb ………	¼" GT 2C-4C 5C-7C ……………………	34.0 cd	33.0	1.0 a	95.0	81.00
9. MicroSulf 10.0 lb Lime Sulfur 1.5% 1.5 gal Lime Sulfur 1.5% 1.5 gal MicroSulf 6.0 lb Kocide 3000 8.0 oz rot. w/ Lime Sulfur 1% 1.0 gal …..	½" GT-TC PF PF + 5 da 1C-4C 5C-7C ……………………	19.0 abc	63.0	1.0 a	95.0	123.00

[z] Timing: 1 = ½" green (11 Apr); 2 = TC (20 Apr); 3 = Pink Bloom (30 Apr); 4 = Bloom –Petal fall (7 May); 5 = 1C (21 May); 6 = 2C (4 Jun); 7 = 3C (15 Jun); 8 = 4C (28 Jun); 9 = 5C (13 Jul); 9 = 6C (30 Jul); 10 = 7C (23 Aug.).

[y] Incidence on 25 shoots/tree – replicate.

[x] Incidence on 25 fruit and fruit cluster/tree – replicate

[w] Percent control = control of disease incidence over that of the water-treated check

[v] Means marked with the same letter(s) are not significantly different, Fisher's Protected LSD, $P \leq 0.05$.

Evaluation of Organic Alternatives for Control of Brown and Rhizopus Rots on Peach and Nectarine, 2007

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Organic alternative and synthetic / conventional spray programs were evaluated for control of brown rot caused by *Monilinia fructicola* and Rhizopus rot caused by *Rhizopus stolonifer* in a mature 'Loring' and 'Redskin' peach and 'SunGlo' nectarine orchard located at a Penn State Fruit Research & Extension Center in Arendtsville, PA. Treatments were applied with a boom sprayer (100 gal/A spray volume at 400 psi) on each side of the tree. Four replications of each treatment were applied to a randomized complete block design, with each plot consisting of a tree each of 'Loring' and 'Redskin' peach and 'SunGlo' nectarine. Except for the untreated check, each plot received 6lb/A of MicroSulf as follows: Two bloom applications were made on 4 and 23 Apr, followed by two post bloom applications on 4 and 11 May, while preharvest applications were made on 20 Jul for cv. 'SunGlo', 2 Aug, for cv. 'Loring' and 13 Aug for cv 'Redskin'. Applications were also made at the day of harvest on, 2 Aug, 13 Aug, and 31 Aug for cv. 'SunGlo', 'Loring' and 'Redskin' respectively. Maintenance sprays for 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 during bloom. At maturity, 50 fruit were harvested from each plot for assessments. Fruits were harvested on 2 Aug ('SunGlo'), 13 Aug ('Loring') and 31 Aug ('Redskin') and placed on fiber produce trays and incubated at 70 ^{o}F in a temperature-controlled room. Brown rot and Rhizopus rot were assessed at 4, 7 and 10 days after harvest (DAH).

Due to dry weather conditions in mid to late summer, risk for brown rot infection was low. Many of the treatments were not significantly different in brown rot control. Some control differences were observed in brown rot at 10 days after harvest (DAH). AT 10 DAH, all conventional/synthetic programs provided significant suppression of brown rot when compared to nontreated 'Loring" and 'Redskin" peach and 'SunGlo' nectarine trees. Among the organic alternative treatments, only Microsulf significantly controlled brown rot on 'Loring' at 10 DAH as compared to nontreated fruits (Table 1). Microsulf with Citrex significantly reduced brown rot on 'SunGlo' at 10 DAH compared to the nontreated check (Table 2). Microsulf applied in combination with Citrex, Vigor Cal Phos and Citrex plus Kocide significantly controlled brown rot on 'Redskin" at 10 DAH compared to the nontreated fruits (Table 3). None of the treatments controlled Rhizopus rot. However, some of the treatments resulted in more Rhizopus rot than the untreated fruit. 'SunGlo' had the lowest incidence of Rhizopus rot between the cultivars. 'Loring' had the lowest incidence of brown rot while 'Redskin' had the highest incidence of brown and Rhizopus rots at 10 DAH. No phytotoxicity was observed.

Table 1. Disease Incidence on ‘Loring’, 2007.

Treatment	Rate/A*	Disease Incidence (% Infected fruit)					
		Brown Rot			Rhizopus Rot		
		4 DAH	7 DAH	10 DAH	4 DAH	7 DAH	10 DAH
Nontreated check ………..		3.5 ab**	11.3 abc	19.2 bc	8.2 a	15.5 a	38.2 a
MicroSulf ……………….	10.0 lb	1.5 a	2.9 a	5.5 a	23.9 abc	40.4 bc	54.3 ab
MicroSulf +	10.0 lb						
Vigor Cal Phos ……….	1.0 gal	10.5 b	14.9 c	18.9 bc	35.4 c	49.3 c	70.7 b
Citrex +	12.0 oz						
MicroSulf …………….	10.0 lb	6.5 ab	13.5 bc	22.9 c	17.8 ab	31.2 abc	49.6 ab
MicroSulf +	10.0 lb						
Lime Sulfur 1.5% …….	1.5 gal	9.4 ab	13.9 bc	20.4 bc	27.5 bc	47.3 c	69.8 b
Sulfur +	10.0 lb						
Citrex +	12.0 oz						
Kocide 3000 ………….	2.0 oz	7.3 ab	11.6 abc	18.8 bc	16.5 ab	28.2 abc	59.1 ab
Citrex …………………….	12.0 oz	6.0 ab	8.9 abc	11.9 ab	21.8 abc	33.2 abc	58.4 ab
<u>Conventional check</u>							
Bravo 82.5 WDG	3.0 lb						
Captan 80WDG +	3.0 lb						
MicroSulf	10.0 lb						
Indar 75WSP +	6.0 oz						
Captan 80WDG ……….	5.0 lb	1.5 a	3.0 a	5.1 a	9.1 a	20.3 ab	52.5 ab
Endura 75WDG …………..	5.6 oz	3.0 ab	5.0 ab	6.5 a	15.0 ab	27.5 abc	52.0 ab
Pristine 38WG ……………	14.5 oz	3.5 ab	6.0 abc	8.0 a	16.5 ab	29.5 abc	50.4 ab

* 100 GPA. ‘Loring’ trees also received two post bloom applications of MicroSulf at 6.0 lb/A.

** Means marked with the same letter(s) are not significantly different, Fisher’s Protected LSD, $P \leq 0.05$.

Table 2. Disease Incidence on ‘Sunglo’, 2007.

Treatment	Rate/A*	Disease Incidence (% Infected fruit)					
		Brown Rot			Rhizopus Rot		
		4 DAH	7 DAH	10 DAH	4 DAH	7 DAH	10 DAH
Nontreated check ……….		17.3 ab	33.8 a	47.2 cd	8.8 abc	19.8 c	23.6 ab
MicroSulf ………………	10.0 lb	5.1 a	14.1 a	35.0 a-d	4.1 ab	5.9 abc	16.7 ab
MicroSulf +	10.0 lb						
Vigor Cal Phos …………	1.0 gal	15.5 ab	33.4 a	49.7 cd	13.8 c	18.2 bc	34.7 bc
Citrex +	12.0 oz						
MicroSulf ………………	10.0 lb	4.0 a	15.5 a	30.0 abc	3.5 ab	4.5 ab	23.0 ab
MicroSulf +	10.0 lb						
Lime Sulfur 1.5% ………	1.5 gal	12.4 ab	27.3 a	41.1 bcd	7.9 abc	11.1 abc	24.7 ab
Sulfur +	10.0 lb						
Citrex +	12.0 oz						
Kocide 3000 ……………	2.0 oz	12.2 ab	27.6 a	45.6 cd	7.8 abc	11.7 abc	26.3 ab
Citrex ……………………...	12.0 oz	30.0 b	50.6 a	62.7 d	11.0 abc	15.9 abc	29.1 ab
<u>Conventional check</u>							
Bravo 82.5 WDG	3.0 lb						
Captan 80WDG +	3.0 lb						
MicroSulf	10.0 lb						
Indar 75WSP +	6.0 oz						
Captan 80WDG ……….	5.0 lb	0.5 a	4.9 a	11.9 a	2.4 ab	6.4 abc	21.5 ab
Endura 75WDG …………..	5.6 oz	0.5 a	8.3 a	15.5 ab	11.3 bc	11.3 abc	54.9 c
Pristine 38WG ……………	14.5 oz	0.7 a	5.8 a	10.6 a	2.2 a	3.3 a	11.7 a

* 100 GPA. ‘Sunglo’ trees also received two post bloom applications of MicroSulf at 6.0 lb/A
** Means marked with the same letter(s) are not significantly different, Fisher’s Protected LSD, P $\leq$ 0.05.

Table 3. Disease Incidence on ‘Redskin’, 2007.

		Disease Incidence (% Infected fruit)					
		Brown Rot			Rhizopus Rot		
Treatment	Rate/A*	4 DAH	7 DAH	10 DAH	4 DAH	7 DAH	10 DAH
Nontreated check…………		57.7 d	78.6 e	80.2 f	16.9 abc	31.9 a	33.4 a
MicroSulf …………………	10.0 lb	32.3 bc	61.4 cde	62.9 def	27.7 c	55.2 abc	58.2 bc
MicroSulf +	10.0 lb						
Vigor Cal Phos …………	1.0 gal	21.8 ab	50.5 b-e	52.0 cd	19.1 abc	53.4 abc	54.9 abc
Citrex +	12.0 oz						
MicroSulf ………………	10.0 lb	21.5 ab	56.5 b-e	61.0 de	17.5 abc	56.0 abc	63.0 bcd
MicroSulf +	10.0 lb						
Lime Sulfur 1.5% ………	1.5 gal	38.8 bcd	66.1 de	71.6 ef	22.3 bc	48.9 abc	55.9 abc
Sulfur +	10.0 lb						
Citrex +	12.0 oz						
Kocide 3000 ……………	2.0 oz	21.5 ab	57.0 b-e	58.5 de	23.5 bc	63.5 bc	68.0 b-d
Citrex ……………………..	12.0 oz	44.8 cd	73.2 e	75.7 ef	16.8 abc	44.0 ab	46.5 ab
<u>Conventional Ck</u>							
Bravo 82.5 WDG	3.0 lb						
Captan 80WDG +	3.0 lb						
MicroSulf	10.0 lb						
Indar 75WSP +	6.0 oz						
Captan 80WDG ……….	5.0 lb	2.1 a	32.7 abc	39.9 bc	10.7 ab	57.1 abc	71.2 cd
Endura 75WDG …………..	5.6 oz	1.0 a	17.6 a	17.5 a	25.0 bc	73.0 c	85.0 d
Pristine 38WG ……………	14.5 oz	3.6 a	38.9 a-d	46.6 cd	5.6 a	51.5 abc	64.7 bcd

* 100 GPA. ‘Redskin’ trees also received two post bloom applications of MicroSulf at 6.0 lb/A.
** Means marked with the same letter(s) are not significantly different, Fisher’s Protected LSD, P $\leq$ 0.05.

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HARVEST ROT MANAGEMENT ON GRAPES, 2007

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Harvest rots can cause loss of fruit quality and yield reduction to grapes grown throughout the Northeastern U.S. Botrytis can cause infections that remain latent until berries begin to ripen. Sour rot infects injured berries and seriously reduces wine quality. Ripe rot also causes latent infections and has become a major problem in some areas of the Northeast. Research conducted at the Penn State Fruit Research & Extension Center in south-central PA in 2007 focused on materials for better management of these harvest rots.

A fungicide trial was conducted at the Penn State Fruit Research & Extension Center (FREC) research vineyards to determine the effectiveness of materials to control cluster rots on vinifera and hybrid grapes. Ten treatments specifically for Botrytis control were applied to 1.5 acre vinifera test plot consisting of 'Pinot Noir', 'Riesling', 'Chardonnay', and 'Cabernet Franc'. Five treatments for ripe rot control were applied to a 1.5 acre hybrid test plot consisting of 'Traminette', 'Chancellor', 'Vidal Blanc', and 'Chambourcin'. Botrytis treatments consisted of the experimental fungicide DPX-LEM17, Vangard and Vangard/ProGibb, Endura, Pristine, Captan/Pristine and a no Botrytis fungicide control. Ripe rot treatments consisted of two late season Pristine applications, two early season Pristine applications, Captan alternated with Ziram, organically approved materials (Kocide 3000, lime sulfur, Micro Sulf, and Armicarb), and an unsprayed control. Maintenance sprays were applied to all treatments with the exception of the organic and unsprayed treatment to control other diseases.

Botrytis pressure was high, sour rot was moderate, and ripe rot pressure was low at the Fruit Research and Extension vinifera vineyard in 2007. The incidence and severity of Botrytis on the control treatments was 71.9 and 39.1%, respectively. All treatments significantly reduced Botrytis incidence and severity compared to the control. Overall, Vangard, Pristine, the Pristine/Captan combination, and Endura were the most effective at reducing Botrytis severity. The incidence of ripe rot and sour rot on the control treatments was 15.6 and 8.1%, respectively. The Pristine and Captan treatments provided excellent control of ripe rot, while the two lower rates of DPX-LEM17 significantly reduced ripe rot compared to the control treatment. The control treatment had the lowest incidence of sour rot which was likely due to the high incidence of Botrytis on that treatment (Table 1).

Ripe rot pressure was moderately high throughout the hybrid vineyard in 2007 with incidence and severity of control treatment being 66.9 and 19.4%, respectively. The late Pristine treatments significantly reduced ripe rot incidence and severity more than any other treatment followed by the early Pristine treatment and the Captan/Ziram treatment, respectively. The organic treatment significantly reduced the severity (but not the incidence) of ripe rot compared to the control. Sour rot and Botrytis incidence were lower than the control in both treatments where Pristine was applied, but they were not significantly different (Table 2).

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Table 1. Incidence of Botrytis, ripe rot, and sour rot on 'Pinot Noir', 'Riesling', 'Chardonnay' and 'Cabernet Franc' combined in 2007.

Treatment and Rate @ 50 gal/A	Applic. Timing[z]	Botrytis % inc[y]	ripe rot % inc	sour rot % inc	Botrytis % sev[x]
DPX-LEM17 200SC 16.8 fl oz….	1,2,3,4	58.1 cd[w]	7.8 bc	11.3 abcd	11.4 c
DPX-LEM17 200SC 20.6 fl oz….	1,2,3,4	59.4 d	2.8 ab	12.5 abcd	10.7 bc
DPX-LEM17 200SC 24.0 fl oz….	1,2,3,4	59.4 d	10.9 cd	13.8 bcd	10.8 c
Vangard 75WG 10.0 oz………….	1,2,3,4	48.1 b	18.4 ef	14.4 cd	5.3 ab
Vangard 75WG 10.0 oz………….	2,3	52.2 bc	20.6 e	13.8 bcd	7.2 abc
Vangard 75WG 10.0 oz ProGibb 40% 0.7 oz…………….	2,3 1	55.9 cd	23.1 f	9.4 ab	8.6 abc
Endura 70WDG 8.0 oz…………..	1,2,3,4	46.9 b	16.3 de	15.6 d	6.6 abc
Pristine 38WG 12.5 oz…………...	1,2,3,4	40.0 a	2.8 ab	8.8 a	4.8 a
Pristine 38WG 12.5 oz Captan 80WDG 2.5 lb…………...	1,2 3,4	46.3 ab	0.6 a	10.6 abc	6.9 abc
Control (no Botrytis fungicides)…		71.9 e	15.6 de	8.1 a	39.1 d

[z] Application timing: 1 = early bloom – bloom (25 May); 2 = Preclosure (27 Jun); 3 = Verasion (27 Jul); 4 = Preharvest (24 Aug).
[y] Botrytis, sour rot , and ripe rot incidence and severity were evaluated on 20 fruit clusters per replication.
[x] Severity rating is based on Horsfall-Barratt system. % inc = percent incidence; % sev = percent severity.
[w] Means followed by the same letter(s) are not significantly different according to Fisher's Protected LSD test ($\alpha < 0.05$).

Table 2. Incidence and severity of ripe rot, sour rot, and Botrytis on 'Traminette', 'Chancellor', Vidal Blanc', and 'Chambourcin' combined in 2007.

Product and Rate/200gal/A	Applic[z]. Timing	ripe rot % inc[y]	sour rot % inc	Botrytis % inc	ripe rot % sev[x]
Captan 80 WDG 2.5 lb Pristine 38WG 10.5 oz……	5,6,7, 9,10	24.6 a[w]	15.2 a	7.5 a	1.9 a
Captan 80 WDG 2.5 lb Pristine 38WG 10.5 oz……	5,6,7, 10 5,6	36.3 b	14.0 a	8.5 a	4.0 b
Captan 80 WDG 2.5 lb Ziram 76DF 4.0 lb………..	7, 9 6, 8, 10	47.5 c	21.7 b	14.4 b	8.6 c
Kocide 3000 1.75 lb. Lime Sulfur 1% Micro Sulf WP 5.0 lb. Armicarb 100 5.0 lb………	1,2, 8, 10 3,4, 9 5,6,7,8 10	61.3 d	19.8 b	17.5 b	12.7 d
Untreated…………………		66.9 d	18.3 ab	12.7 ab	19.4 e

[z] Application timing: 1 = 3-4" shoot growth (5/7), 2 = 8-12" shoot growth (5/16), 3 = pre-bloom (5/24), 4 = Early bloom (6/6) , 5 = Bloom (6/14), 6 = Post-bloom 1 (6/26), 7 = Post-bloom 2/pre closure (7/12), 8 = Post-bloom 3 (7/24), 9 = Post-bloom 4 (8/9), 10 = Post-bloom 5 (8/28).

[y] Ripe rot, sour rot, and Botrytis incidence and severity was evaluated on 20 fruit clusters per replication.

[x] Severity rating is based on Horsfall-Barratt system. % inc = percent incidence; % sev = percent severity.

[w] Means followed by the same letter(s) are not significantly different according to Fisher's Protected LSD test ($\alpha \leq 0.05$).

Management of Peach Brown Rot, Scab, and Rusty Spot: Efficacy and Comparison of Experimental Fungicides

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Commercial and experimental fungicides were examined for their efficacy against the full spectrum of peach diseases encountered during the growing season. Of particular interest were: (1) full season tests and comparison of the experimentals, USF2010 (trifloxystrobin + tebuconazole) and USF2014 (trifloxystrobin + pyrimethanil) to each other and to GEM (trifloxystrobin); (2) test for efficacy of DPX-LEM17 on brown rot; (3) full season test for Evito, a fungicide which is registered on field crops and vegetables; (4) full season test of the experimental V-10116; and (5) comparison of the tebuconazoles Elite and Tebuzole at bloom and pre-harvest.

MATERIALS AND METHODS

Treatments. The experiment was conducted during the spring and summer of the 2007 growing season. The test block consisted of an 11-year-old 'Jerseyglo' peach orchard planted at 25 ft x 25 ft spacing.

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.

Fungicide applications were made on the following dates and tree growth stages: 23 Apr (B, bloom); 4 May (SS, shuck split); and 14, 25 May, 8, 21 Jun, 6, 19 Jul, 2 Aug (1C-7C, 1st through 7th cover). During the ripening period in August, three pre-harvest sprays for fruit rot control were applied on 13, 22 and 29 Aug (17, 8, 1 DPH, days preharvest). All trees in the block received Ziram 76DF at 6.0 lb/A on March 19th for leaf curl control. Insecticides and miticides were applied as needed to the entire block using a commercial airblast sprayer.

Environment. Total rainfall for the growing season (April – August) was 16.86 inches, which was 2.64 inches below the 30-year average. Rainfall was below average for all months except for April which had 7.88 in of precipitation, more than double the monthly average of 3.58 in (Fig. 1). May, June, July, and August each had rainfall below average (30-year normal) with 1.49 (4.07), 2.34 (3.37), 2.02 (4.30), and 3.13 (4.18) inches, respectively. These months had a combined deficit of 6.94 inches below average. Average monthly temperatures this growing season were near normal (30-year average): Apr, 49.8ºF (52ºF); May, 63.7ºF (62ºF); Jun 71.4ºF (71ºF); Jul 74.8ºF (76ºF); and Aug 74.4ºF (75ºF).

Conditions were unfavorable for blossom blight due to low temperatures and/or lack of rain during the susceptible stages of pink and bloom during April. The pink phase was delayed due to well below average temperatures in late March and early April. Bloom occurred over a relatively long period, with flowers opening throughout much of April. Consequently, distinct “pink” and “petal fall” stages never occurred; thus, sprays were not applied for these stages. The overall warm and dry weather during the susceptible stages of PF through 2C (May) were favorable for rusty spot development, although the cool and wet conditions in early April may have reduced inoculum. The conditions for scab were unfavorable due to the below average rainfall that occurred during the period from SS to 40-days preharvest. The number of rain days with over 0.10 inch accumulation following each spray were: B, 1; SS, 2; 1C, 1; 2C, 2; 3C, 1; 4C, 2; 5C, 1; 6C, 1; 7C, 3. Overall, conditions for brown rot and other harvest rots were not favorable due to the lack of rain during the ripening period. Six rainfall periods in early to mid August, while fruit were just starting to ripen, resulted in some brown rot inoculum. The number of rain days following each pre-harvest spray was: 17 DPH, 3; 8 DPH, 0 and 1 DPH, 0.

Assessment. Rusty spot (*Podosphaera leucotricha*) was evaluated on 18 Jun by examining 40 fruit per tree. Trees with an insufficient number of fruit were excluded from the rusty spot evaluation. All treatments had at least three replications evaluated for rusty spot. Scab (*Fusicladosporium carpophilum*) was evaluated at harvest on 27 Aug by examining 40 fruit per tree. Brown rot (*Monilinia fructicola*), Rhizopus rot (*Rhizopus* spp.), Anthracnose rot (*Colletotrichum gloeosporioides / acutatum*), and other rots were evaluated at harvest on 30 Aug by examining all fruit on four or more branches per replicate tree; either a minimum of 100 fruit/tree or all fruit on trees containing less than 100 fruit were examined. For post-harvest evaluations, 40 asymptomatic mature fruit were harvested from each tree and placed on benches in two greenhouses (ave. air temp. = 25.2 and 26.8ºC). All fruit were inoculated two days after harvest with a suspension of *Monilinia fructicola* conidia at 50,000 spores/ml. Brown rot, Rhizopus rot, Anthracnose rot, and other rots were assessed at 4 and 7 days postharvest (dph).

RESULTS AND DISCUSSION

Blossom Blight. Canker incidence was extremely low on non-treated control trees. Thus, no assessment was performed on treated trees.

Rusty Spot. Non-sprayed control trees had 40.0% infected fruit and an average of 0.48 lesions per fruit (Table 1). All treatments significantly reduced rusty spot incidence and severity.

GEM and both rates of USF2010 provided rusty spot control equivalent to the Nova standard (four treatments had the standard Nova program). Trifloxystrobin, an active ingredient in both these fungicides, has been shown to be effective against rusty spot in previous studies. USF2014, which also contained trifloxystrobin, had significantly higher rusty spot than the standard. This is probably because the trifloxystrobin in USF2014 was at a lower rate than in either GEM or USF2010; also, USF2014’s other component, pyrimethanil, is ineffective in controlling rusty spot. The other active ingredient of USF2010, tebuconazole, has been shown to have some rusty spot control. USF2014, Evito, V-10116, and Tebuzole provided significantly less control than Nova for both incidence and severity. The only exception was that Evito was not significantly different in severity than one of the four standard Nova standard treatments.

Scab. The orchard had a high amount of inoculum (twig lesions), but relatively few rain periods which resulted in low levels of fruit scab as compared to previous seasons. Control trees had 45% fruit infection with the majority of infected fruit having fewer than 10 lesions (Table 2). Only 9 rain periods (>0.10 in) occurred from SS to 40 days prior to harvest (Fig. 1). In 2006, 17 rainfall periods (>0.10 in) occurred and 93.5% of fruit on control trees had scab with the majority of infected fruit having > 10 lesions.

All treatments except for V-10116 significantly reduced scab incidence. The Bravo/Captan standards provided between 76.4% and 97.1% control of scab and did not differ significantly from one another. GEM, USF2010 at 6 and 8 oz, USF2014, and Evito provided 68%, 83.6%, 91.3%, and 72% control, respectively, and did not differ significantly from the Bravo/Captan standard.

With the exception of V-10116, all treatments provided equivalent control of scab severity. These treatments had ≤ 2.5% of fruit with more than 10 lesions. Although V-10116 provided less control of scab severity than the other treatments, it significantly reduced the number of fruit with >10 lesions (relative to the control).

Brown Rot. Disease pressure was fairly light due to lack of rain through most of the pre-harvest period. Control trees had 25.6% infected fruit at harvest (Table 3). Post-harvest brown rot development was fairly high, most likely due to the inoculation. Non-treated fruit had 36.3% and 56.9% infection after 4 and 7 days, respectively.

All fungicide treatments significantly reduced brown rot incidence at harvest. No differences in brown rot levels were observed among treatments. However, numerically, USF2014 had more than twice as much rot as the standard Elite, providing only 57.4% verses 83.6% control, respectively.

In the postharvest study, no significant differences were observed among the treatments after 4 days incubation. Only USF2014, which had the highest level of fruit infection, did not significantly reduce brown rot levels from that of the non-treated. After 7 days, fruit sprayed with GEM, USF2010 at 6 oz, Evito, and DPX-LEM17 at 20.61 fl oz had significantly less infection than the non-sprayed control. Although no treatments provided outstanding control of brown rot during the postharvest period, this outcome might be expected under high disease pressure from inoculation.

Fruit with large amounts of scab lesions are believed to be more susceptible to brown rot. Tebuconazole (Elite and Tebuzole) and DPX-LEM17, which provide poor scab control, were tested for brown rot control in conjunction with a standard scab (Bravo/Captan) program. Both these materials provided a greater percentage of control of brown rot at harvest in this study than in previous studies when these materials were tested alone full season. This same phenomenon was previously observed with boscalid (Endura). Additional data are needed with DPX-LEM17 embedded in a commercial scab program to confirm its brown rot efficacy.

Rhizopus Rot. The amount of Rhizopus rot was negligible at harvest (Table 4). After 4 days postharvest, fruit from all treatments except Evito developed Rhizopus. After 7 days incubation, Rhizopus rot levels ranged from 0.8%-13.1% with no significant differences between the non-sprayed and the treatments. The amount of infection often varied greatly from one replicate to another within the same treatment.

Anthracnose Rot. The levels of anthracnose at harvest and throughout postharvest were very low (Table 5). This is most likely due to the dry weather conditions that occurred during the summer and ripening period.

Other Rots. This category consists of unidentified, typically minor fruit rots. Possible pathogens include species of *Phomopsis*, *Botryosphaeria*, and *Geotrichum* (sour rot). The majority of rots in this category were either *Phomopsis* or *Botryosphaeria* which have similar symptoms.

These rots formed a firm, flattened or slightly sunken brown lesion, mostly on the suture of the fruit. Older lesions often had black pycnidia which produced white tendrils containing spores.

Levels of other rots were low at harvest; non-treated fruit had 4% infection and most treatments had less (Table 6). At 4 and 7 dph, rot levels reached 6.3% and 16.3% on the non-treated fruit respectively. All treatments except V-10116 provided significant control of these rots at both assessments.

TABLE 1. Peach Rusty Spot Incidence and Severity [1]				
Treatment	**Rate / A**	**Timing**	**% Inf. Fruit[2]**	**# Lesions/Fruit[2]**
Nontreated Control	-----------------	-----------------	40.0 a	0.48 a
Elite 45 WP **Nova 40WP** + Bravo Ultrex 82.5WDG **Nova 40WP** + Captan 80WDG Captan 80WDG Elite 45WP	6 oz **4 oz** + 3.8 lb **4 oz** + 3.75 lb 3.75 lb 6 oz	B **SS** **1C, 2C** 3C-7C 17, 8, 1 DPH	7.3 e	0.08 e
GEM 500SC	**3 fl oz**	B, **SS, 1C, 2C,** 3C-7C, 17, 8, 1 DPH	15.0 cde	0.18 cde
USF2010 50WG	**6 oz**	B, **SS, 1C, 2C,** 3C-7C, 17, 8, 1 DPH	11.9 de	0.14 de
USF2010 50WG	**8 oz**	B, **SS, 1C, 2C,** 3C-7C, 17, 8, 1 DPH	8.8 e	0.10 e
USF2014 480SC	**18 fl oz**	B, **SS, 1C, 2C,** 3C-7C, 17, 8, 1 DPH	19.2 bcd	0.28 b
Evito 480SC + Induce	**5.7 fl oz + 16 fl oz**	B, **SS, 1C, 2C,** 3C-7C, 17, 8, 1 DPH	22.3 bc	0.23 bcd
DPX-LEM17 1.67SC **Nova 40WP** + Bravo Ultrex 82.5WDG **Nova 40WP** + Captan 80WDG Captan 80WDG DPX-LEM17 1.67 SC	14.38 fl oz **4 oz** + 3.8 lb **4 oz** + 3.75 lb 3.75 lb 14.38 fl oz	B **SS** **1C, 2C** 3C-7C 17, 8, 1 DPH	10.6 e	0.12 e
DPX-LEM17 1.67SC **Nova 40WP** + Bravo Ultrex 82.5WDG **Nova 40WP** + Captan 80WDG Captan 80WDG DPX-LEM17 1.67 SC	20.61 fl oz **4 oz** + 3.8 lb **4 oz** + 3.75 lb 3.75 lb 20.61 fl oz	B **SS** **1C, 2C** 3C-7C 17, 8, 1 DPH	8.2 e	0.08 e
DPX-LEM17 1.67SC + Elite 45WP **Nova 40WP** + Bravo Ultrex 82.5WDG **Nova 40WP** + Captan 80WDG Captan 80WDG DPX-LEM17 1.67 SC + Elite 45WP	14.38 fl oz + 3 oz **4 oz** + 3.8 lb **4 oz** + 3.75 lb 3.75 lb 14.38 fl oz + 3 oz	B **SS** **1C, 2C** 3C-7C 17, 8, 1 DPH	10.8 e	0.13 de
V-10116 50WG	**2.5 oz**	B, **SS, 1C, 2C,** 3C-7C, 17, 8, 1 DPH	23.4 b	0.26 bc
Tebuzole 45 WDG **Tebuzole 45WDG** + Bravo Ultrex 82.5WDG **Tebuzole 45WDG** + Captan 80WDG Captan 80WDG Tebuzole 45WDG	6 oz **6 oz** + 3.8 lb **6 oz** + 3.75 lb 3.75 lb 6 oz	B **SS** **1C, 2C** 3C-7C 17, 8, 1 DPH	19.2 bcd	0.26 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 (α=0.05, *K*=100).

TABLE 2. Scab Incidence and Severity[1]			**% Fruit**[2]		
Treatment	**Rate / A**	**Timing**	**Infected**	**1-10 lesions**	**>10 lesions**
Nontreated Control	-----------------	-----------------	45.0 a	27.5 a	17.5 a
Elite 45 WP Nova 40WP + **Bravo Ultrex 82.5WDG** Nova 40WP + **Captan 80WDG** **Captan 80WDG** Elite 45WP	6 oz 4 oz + **3.8 lb** 4 oz + **3.75 lb** **3.75 lb** 6 oz	B **SS** **1C, 2C** **3C-5C**, 6C, 7C 17, 8, 1 DPH	10.6 bc	10.0 bc	0.6 c
GEM 500SC	**3 fl oz**	B, **SS, 1C-5C**, 6C, 7C, 17, 8, 1 DPH	14.4 b	11.9 b	2.5 c
USF2010 50WG	**6 oz**	B, **SS, 1C-5C**, 6C, 7C, 17, 8, 1 DPH	7.4 bc	7.4 bc	0.0 c
USF2010 50WG	**8 oz**	B, **SS, 1C-5C**, 6C, 7C, 17, 8, 1 DPH	3.9 bc	3.9 bcd	0.0 c
USF2014 480SC	**18 fl oz**	B, **SS, 1C-5C**, 6C, 7C, 17, 8, 1 DPH	9.4 bc	8.8 b	0.6 c
Evito 480SC + Induce	**5.7 fl oz + 16 fl oz**	B, **SS, 1C-5C**, 6C, 7C, 17, 8, 1 DPH	12.6 bc	12.6 b	0.0 c
DPX-LEM17 1.67SC Nova 40WP + **Bravo Ultrex 82.5WDG** Nova 40WP + **Captan 80WDG** **Captan 80WDG** DPX-LEM17 1.67 SC	14.38 fl oz 4 oz + **3.8 lb** 4 oz + **3.75 lb** **3.75 lb** 14.38 fl oz	B **SS** **1C, 2C** **3C-5C**, 6C, 7C 17, 8, 1 DPH	5.6 bc	5.6 bcd	0.0 c
DPX-LEM17 1.67SC Nova 40WP + **Bravo Ultrex 82.5WDG** Nova 40WP + **Captan 80WDG** **Captan 80WDG** DPX-LEM17 1.67 SC	20.61 fl oz 4 oz + **3.8 lb** 4 oz + **3.75 lb** **3.75 lb** 20.61 fl oz	B **SS** **1C, 2C** **3C-5C**, 6C, 7C 17, 8, 1 DPH	1.3 c	1.3 d	0.0 c
DPX-LEM17 1.67SC + Elite 45WP Nova 40WP + **Bravo Ultrex 82.5WDG** Nova 40WP + **Captan 80WDG** **Captan 80WDG** DPX-LEM17 1.67 SC + Elite 45WP	14.38 fl oz + 3 oz 4 oz + **3.8 lb** 4 oz + **3.75 lb** **3.75 lb** 14.38 fl oz + 3 oz	B **SS** **1C, 2C** **3C-5C**, 6C, 7C 17, 8, 1 DPH	8.8 bc	6.9 bcd	1.9 c
V-10116 50WG	**2.5 oz**	B, **SS, 1C-5C**, 6C, 7C, 17, 8, 1 DPH	38.1 a	30.0 a	8.1 b
Tebuzole 45 WDG Tebuzole 45WDG + **Bravo Ultrex** Tebuzole 45WDG + **Captan 80WDG** **Captan 80WDG** Tebuzole 45WDG	6 oz 6 oz + **3.8 lb** 6 oz + **3.75 lb** **3.75 lb** 6 oz	B **SS** **1C, 2C** **3C-5C**, 6C, 7C 17, 8, 1 DPH	2.5 bc	2.5 cd	0.0 c

[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 3. Brown Rot Harvest and Post-harvest Incidence[1]			**% Fruit Infected**[2]		
Treatment	**Rate / A**	**Timing**	**Harvest**	**4-dph**	**7-dph**
Nontreated Control	-----------------	-----------------	25.6 a	36.3 a	56.9 a
Elite 45 WP Nova 40WP + Bravo Ultrex 82.5WDG Nova 40WP + Captan 80WDG Captan 80WDG **Elite 45WP**	6 oz 4 oz + 3.8 lb 4 oz + 3.75 lb 3.75 lb **6 oz**	B SS 1C, 2C 3C-7C **17, 8, 1 DPH**	4.2 b	12.5 b	40.6 ab
GEM 500SC	**3 fl oz**	B, SS, 1C, 2C, 3C-7C, **17, 8, 1 DPH**	2.6 b	9.4 b	26.9 b
USF2010 50WG	**6 oz**	B, SS, 1C, 2C, 3C-7C, **17, 8, 1 DPH**	1.8 b	7.6 b	19.5 b
USF2010 50WG	**8 oz**	B, SS, 1C, 2C, 3C-7C, **17, 8, 1 DPH**	3.9 b	13.3 b	36.0 ab
USF2014 480SC	**18 fl oz**	B, SS, 1C, 2C, 3C-7C, **17, 8, 1 DPH**	10.9 b	23.1 ab	40.6 ab
Evito 480SC + Induce	**5.7 fl oz + 16 fl oz**	B, SS, 1C, 2C, 3C-7C, **17, 8, 1 DPH**	6.0 b	12.3 b	21.8 b
DPX-LEM17 1.67SC Nova 40WP + Bravo Ultrex 82.5WDG Nova 40WP + Captan 80WDG Captan 80WDG **DPX-LEM17 1.67 SC**	14.38 fl oz 4 oz + 3.8 lb 4 oz + 3.75 lb 3.75 lb **14.38 fl oz**	B SS 1C, 2C 3C-7C **17, 8, 1 DPH**	3.1 b	12.5 b	34.4 ab
DPX-LEM17 1.67SC Nova 40WP + Bravo Ultrex 82.5WDG Nova 40WP + Captan 80WDG Captan 80WDG **DPX-LEM17 1.67 SC**	20.61 fl oz 4 oz + 3.8 lb 4 oz + 3.75 lb 3.75 lb **20.61 fl oz**	B SS 1C, 2C 3C-7C **17, 8, 1 DPH**	4.6 b	8.1 b	32.5 b
DPX-LEM17 1.67SC + Elite 45WP Nova 40WP + Bravo Ultrex 82.5WDG Nova 40WP + Captan 80WDG Captan 80WDG **DPX-LEM17 1.67 SC + Elite 45WP**	14.38 fl oz + 3 oz 4 oz + 3.8 lb 4 oz + 3.75 lb 3.75 lb **14.38 fl oz + 3 oz**	B SS 1C, 2C 3C-7C **17, 8, 1 DPH**	4.4 b	16.3 b	42.5 ab
V-10116 50WG	**2.5 oz**	B, SS, 1C, 2C, 3C-7C, **17, 8, 1 DPH**	3.2 b	10.0 b	38.1 ab
Tebuzole 45 WDG Tebuzole 45WDG + Bravo Ultrex Tebuzole 45WDG + Captan 80WDG Captan 80WDG **Tebuzole 45WDG**	6 oz 6 oz + 3.8 lb 6 oz + 3.75 lb 3.75 lb **6 oz**	B SS 1C, 2C 3C-7C **17, 8, 1 DPH**	3.3 b	14.8 b	41.9 ab

[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 4. Rhizopus Harvest and Post-harvest Incidence[1]			% Fruit Infected [2]		
Treatment	**Rate / A**	**Timing**	**Harvest**	**4-dph**	**7-dph**
Nontreated Control	-----------------	-----------------	0.0 a	3.8 ab	6.3 a
Elite 45 WP Nova 40WP + Bravo Ultrex 82.5WDG Nova 40WP + Captan 80WDG Captan 80WDG **Elite 45WP**	6 oz 4 oz + 3.8 lb 4 oz + 3.75 lb 3.75 lb **6 oz**	B SS 1C, 2C 3C-7C **17, 8, 1 DPH**	0.0 a	8.1 ab	11.3 a
GEM 500SC	**3 fl oz**	B, SS, 1C, 2C, 3C-7C, **17, 8, 1 DPH**	0.0 a	4.4 ab	7.5 a
USF2010 50WG	**6 oz**	B, SS, 1C, 2C, 3C-7C, **17, 8, 1 DPH**	0.0 a	0.6 ab	3.3 a
USF2010 50WG	**8 oz**	B, SS, 1C, 2C, 3C-7C, **17, 8, 1 DPH**	0.3 a	3.7 ab	6.5 a
USF2014 480SC	**18 fl oz**	B, SS, 1C, 2C, 3C-7C, **17, 8, 1 DPH**	0.0 a	2.5 ab	5.0 a
Evito 480SC + Induce	**5.7 fl oz + 16 fl oz**	B, SS, 1C, 2C, 3C-7C, **17, 8, 1 DPH**	0.0 a	0.0 b	0.8 a
DPX-LEM17 1.67SC Nova 40WP + Bravo Ultrex 82.5WDG Nova 40WP + Captan 80WDG Captan 80WDG **DPX-LEM17 1.67 SC**	14.38 fl oz 4 oz + 3.8 lb 4 oz + 3.75 lb 3.75 lb **14.38 fl oz**	B SS 1C, 2C 3C-7C **17, 8, 1 DPH**	0.3 a	2.5 ab	5.6 a
DPX-LEM17 1.67SC Nova 40WP + Bravo Ultrex 82.5WDG Nova 40WP + Captan 80WDG Captan 80WDG **DPX-LEM17 1.67 SC**	20.61 fl oz 4 oz + 3.8 lb 4 oz + 3.75 lb 3.75 lb **20.61 fl oz**	B SS 1C, 2C 3C-7C **17, 8, 1 DPH**	0.0 a	3.8 ab	3.8 a
DPX-LEM17 1.67SC + Elite 45WP Nova 40WP + Bravo Ultrex 82.5WDG Nova 40WP + Captan 80WDG Captan 80WDG **DPX-LEM17 1.67 SC + Elite 45WP**	14.38 fl oz + 3 oz 4 oz + 3.8 lb 4 oz + 3.75 lb 3.75 lb **14.38 fl oz + 3 oz**	B SS 1C, 2C 3C-7C **17, 8, 1 DPH**	0.0 a	9.4 a	13.1 a
V-10116 50WG	**2.5 oz**	B, SS, 1C, 2C, 3C-7C, **17, 8, 1 DPH**	0.0 a	5.0 ab	9.4 a
Tebuzole 45 WDG Tebuzole 45WDG + Bravo Ultrex Tebuzole 45WDG + Captan 80WDG Captan 80WDG **Tebuzole 45WDG**	6 oz 6 oz + 3.8 lb 6 oz + 3.75 lb 3.75 lb **6 oz**	B SS 1C, 2C 3C-7C **17, 8, 1 DPH**	0.0 a	3.1 ab	5.0 a

[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).

TABLE 5. Anthracnose Harvest and Post-harvest Incidence[1]			**% Fruit Infected** [2]		
Treatment	**Rate / A**	**Timing**	**Harvest**	**4-dph**	**7-dph**
Nontreated Control	-----------------	-----------------	0.4 a	0.6 a	0.0 a
Elite 45 WP Nova 40WP + Bravo Ultrex 82.5WDG Nova 40WP + Captan 80WDG **Captan 80WDG** **Elite 45WP**	6 oz 4 oz + 3.8 lb 4 oz + 3.75 lb **3.75 lb** **6 oz**	B SS 1C, 2C 3C-5C, **6C, 7C** **17, 8, 1 DPH**	0.0 a	0.0 a	0.0 a
GEM 500SC	**3 fl oz**	B, SS, 1C, 2C, 3C-5C **6C, 7C, 17, 8, 1 DPH**	0.0 a	0.0 a	0.0 a
USF2010 50WG	**6 oz**	B, SS, 1C, 2C, 3C-5C **6C, 7C, 17, 8, 1 DPH**	0.0 a	0.0 a	0.0 a
USF2010 50WG	**8 oz**	B, SS, 1C, 2C, 3C-5C **6C, 7C** , **17, 8, 1 DPH**	0.3 a	0.0 a	0.0 a
USF2014 480SC	**18 fl oz**	B, SS, 1C, 2C, 3C-5C **6C, 7C, 17, 8, 1 DPH**	0.3 a	0.6 a	0.6 a
Evito 480SC + Induce	**5.7 fl oz + 16 fl oz**	B, SS, 1C, 2C, 3C-5C **6C, 7C, 17, 8, 1 DPH**	0.0 a	0.0 a	0.8 a
DPX-LEM17 1.67SC Nova 40WP + Bravo Ultrex 82.5WDG Nova 40WP + Captan 80WDG **Captan 80WDG** **DPX-LEM17 1.67 SC**	14.38 fl oz 4 oz + 3.8 lb 4 oz + 3.75 lb **3.75 lb** **14.38 fl oz**	B SS 1C, 2C 3C-5C, **6C, 7C** **17, 8, 1 DPH**	0.0 a	0.0 a	0.0 a
DPX-LEM17 1.67SC Nova 40WP + Bravo Ultrex 82.5WDG Nova 40WP + Captan 80WDG **Captan 80WDG** **DPX-LEM17 1.67 SC**	20.61 fl oz 4 oz + 3.8 lb 4 oz + 3.75 lb **3.75 lb** **20.61 fl oz**	B SS 1C, 2C 3C-5C, **6C, 7C** **17, 8, 1 DPH**	0.2 a	0.0 a	0.6 a
DPX-LEM17 1.67SC + Elite 45WP Nova 40WP + Bravo Ultrex 82.5WDG Nova 40WP + Captan 80WDG **Captan 80WDG** **DPX-LEM17 1.67 SC + Elite 45WP**	14.38 fl oz + 3 oz 4 oz + 3.8 lb 4 oz + 3.75 lb **3.75 lb** **14.38 fl oz + 3 oz**	B SS 1C, 2C 3C-5C, **6C, 7C** **17, 8, 1 DPH**	0.0 a	0.0 a	0.0 a
V-10116 50WG	**2.5 oz**	B, SS, 1C, 2C, 3C-5C **6C, 7C, 17, 8, 1 DPH**	0.2 a	0.0 a	1.3 a
Tebuzole 45 WDG Tebuzole 45WDG + Bravo Ultrex Tebuzole 45WDG + Captan 80WDG **Captan 80WDG** **Tebuzole 45WDG**	6 oz 6 oz + 3.8 lb 6 oz + 3.75 lb **3.75 lb** **6 oz**	B SS 1C, 2C 3C-5C, **6C, 7C** **17, 8, 1 DPH**	0.2 a	0.0 a	0.0 a

[1]Anthracnose 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. Other Rots Harvest and Post-harvest Incidence[1]			% Fruit Infected [2]		
Treatment	**Rate / A**	**Timing**	**Harvest**	**4-dph**	**7-dph**
Nontreated Control	-----------------	-----------------	4.0 abc	6.3 a	16.3 a
Elite 45 WP Nova 40WP + Bravo Ultrex 82.5WDG Nova 40WP + Captan 80WDG **Captan 80WDG** **Elite 45WP**	6 oz 4 oz + 3.8 lb 4 oz + 3.75 lb **3.75 lb** **6 oz**	B SS 1C, 2C **3C-7C** **17, 8, 1 DPH**	1.8 bcd	0.6 b	2.5 d
GEM 500SC	**3 fl oz**	B, SS, 1C, 2C, **3C-7C,** **17, 8, 1 DPH**	1.2 cd	1.3 b	3.1 d
USF2010 50WG	**6 oz**	B, SS, 1C, 2C, **3C-7C,** **17, 8, 1 DPH**	2.2 abcd	2.0 b	9.9 bc
USF2010 50WG	**8 oz**	B, SS, 1C, 2C, **3C-7C,** **17, 8, 1 DPH**	1.9 bcd	1.3 b	2.5 d
USF2014 480SC	**18 fl oz**	B, SS, 1C, 2C, **3C-7C,** **17, 8, 1 DPH**	4.3 ab	1.3 b	5.6 cd
Evito 480SC + Induce	**5.7 fl oz + 16 fl oz**	B, SS, 1C, 2C, **3C-7C,** **17, 8, 1 DPH**	1.7 bcd	2.0 b	6.8 cd
DPX-LEM17 1.67SC Nova 40WP + Bravo Ultrex 82.5WDG Nova 40WP + Captan 80WDG **Captan 80WDG** **DPX-LEM17 1.67 SC**	14.38 fl oz 4 oz + 3.8 lb 4 oz + 3.75 lb **3.75 lb** **14.38 fl oz**	B SS 1C, 2C **3C-7C** **17, 8, 1 DPH**	0.5 d	0.6 b	1.9 d
DPX-LEM17 1.67SC Nova 40WP + Bravo Ultrex 82.5WDG Nova 40WP + Captan 80WDG **Captan 80WDG** **DPX-LEM17 1.67 SC**	20.61 fl oz 4 oz + 3.8 lb 4 oz + 3.75 lb **3.75 lb** **20.61 fl oz**	B SS 1C, 2C **3C-7C** **17, 8, 1 DPH**	0.7 d	0.0 b	1.3 d
DPX-LEM17 1.67SC + Elite 45WP Nova 40WP + Bravo Ultrex 82.5WDG Nova 40WP + Captan 80WDG **Captan 80WDG** **DPX-LEM17 1.67 SC + Elite 45WP**	14.38 fl oz + 3 oz 4 oz + 3.8 lb 4 oz + 3.75 lb **3.75 lb** **14.38 fl oz + 3 oz**	B SS 1C, 2C **3C-7C** **17, 8, 1 DPH**	1.1 d	0.0 b	2.5 d
V-10116 50WG	**2.5 oz**	B, SS, 1C, 2C, 3C-7C, **17, 8, 1 DPH**	4.8 a	5.6 a	15.0 ab
Tebuzole 45 WDG Tebuzole 45WDG + Bravo Ultrex Tebuzole 45WDG + Captan 80WDG **Captan 80WDG** **Tebuzole 45WDG**	6 oz 6 oz + 3.8 lb 6 oz + 3.75 lb **3.75 lb** **6 oz**	B SS 1C, 2C **3C-7C** **17, 8, 1 DPH**	0.2 d	0.6 b	1.3 d

[1]Cover and preharvest sprays important for control of most other rots.
[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).

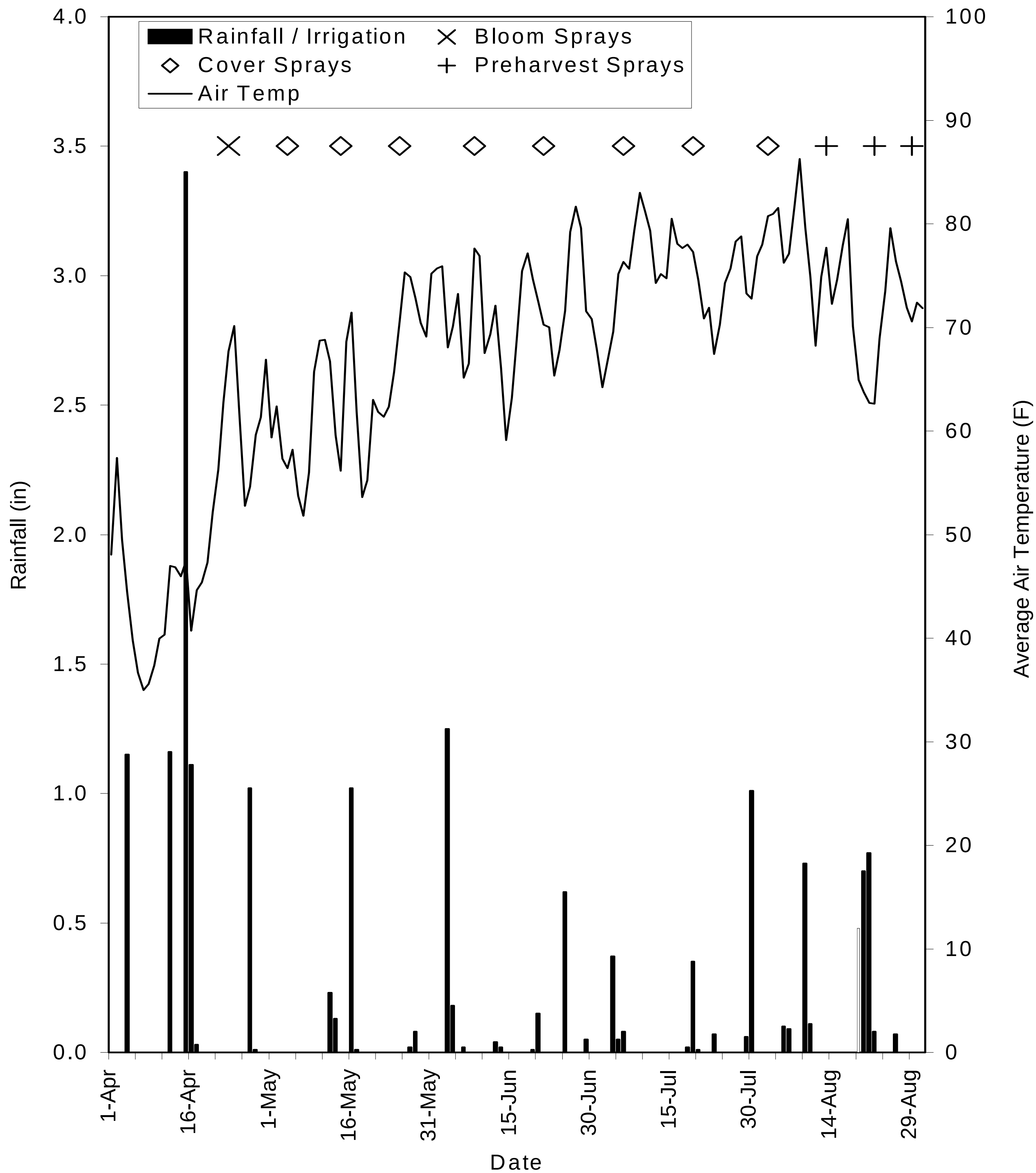

Figure 1. Rainfall, air temperature, and fungicide application timing on 'Jerseyglo' peach during the 2007 growing season, Rutgers Agricultural Research and Extension Center, Bridgeton, NJ. X, diamond, and + symbols represent application timing for bloom (B), shuck-split through seventh cover (SS-7C), and pre-harvest (PH) fungicide sprays, respectively.

Bacterial Spot of Stone Fruit: Efficacy of Copper Hydroxide, Kasugamycin, and Phosphorous Acid

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When environmental conditions are favorable, the bacterial spot pathogen *Xanthomonas arboricola* pv. *pruni* can cause much destruction on fruit and foliage of susceptible peach and nectarine cultivars. Although fruit are considered most susceptible during the four to six week period following shuck split, recent studies have shown that fruit remain susceptible throughout the season.

In this study, efficacy of the antibiotic kasugamycin (Kasumin) was tested in combination with both Regulaid and Captan for control of bacterial spot. In a prior study, Kasumin alone was observed to reduce bacterial spot incidence and severity, but not significantly. Other research has shown that Kasumin's efficacy may be improved when used in combination with these materials.

The use of inorganic copper hydroxide has been limited to the dormant season. However, recently published results showed limited phytotoxicity by copper hydroxide bactericides when applied during the growing season. In this study, a new formulation of a copper hydroxide product, Kocide 3000, was examined at two different rates and spray intervals during the post bloom period.

Other materials examined in this study include *Bacillis subtilis* QST 713 (Serenade MAX) and a phosphorous acid salt (Agri-Fos) applied as a trunk drench using Pentra-Bark. Oxytetracycline (FlameOut) and an organometallic copper (Tenn-Cop) were included as standards.

MATERIALS AND METHODS

EXPERIMENT 1 – O'Henry

Treatments. Experiment 1 was conducted during the 2007 growing season at the Rutgers Agricultural Research and Extension Center. The test block consisted of highly susceptible O'Henry peach trees 2 to 4 years old planted at 25 ft x 25 ft spacing. Three-to-four year old trees with the most bloom were selected for the study. Treatment trees, arranged in a RCBD with 4 replicates, 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 of all treatments except Agri-Fos. A handgun sprayer was used to deliver the single application of Agri-Fos and Pentra Bark, a surfactant that promotes absorption into the bark, to the trunk and limbs of the trees.

Most treatments were scheduled for a 7-day application interval beginning at <5% shuck-split (SS). Actual spray intervals ranged from 6-10 days with a total of eleven applications for the season. Dates of application for the shuck split and 10 cover sprays were 9, 17, 24, 31 May, 7, 14, 20, 28 Jun, 9, 17, and 24 Jul (SS-10C). Two Kocide treatments were scheduled for 14-day intervals; applications for these treatments were on 9, 24 May, 7, 20 Jun 9 and 24 Jul. No Kasumin treatments were applied from 7C-10C due to a lack of material. Agri-Fos was applied at bloom (B) on 24 Apr. Insecticides and miticides were applied as needed using a commercial airblast sprayer.

Environment. Some aspects of the weather conditions were favorable to bacterial spot development while other aspects were not (Fig. 1). Due to below average temperatures in the beginning through the middle of April, bud development was delayed and bloom and shuck split occurred later than it had in other years. Weather was warm and rainfall was below average during the six weeks following shuck split, when fruit are thought to be most susceptible. Nevertheless, warm temperatures coupled with rainy periods during this time created favorable conditions for bacterial spot development. A total of six rain periods on days when temperatures reached at least 70ºF occurred during the six weeks following shuck split. The months of May, June, July, and August had below average rainfall; therefore a below average number of infection periods occurred during the summer. The number of rain days with >0.10 in accumulation each month were: May, 3; Jun, 4; Jul, 3; and Aug, 6. Average monthly temperatures this growing season were: May, 63.7ºF; Jun 71.4ºF; Jul 74.8ºF and Aug 74.4ºF.

Assessment. Bacterial spot on fruit was assessed mid-season on 2 Jul by examining 10 tagged fruit on each replicate tree. The total number of lesions was counted on each fruit. From these data, disease incidence (% infected fruit) and lesion density (# lesions/fruit) were calculated. A second assessment was performed during the pre-harvest period on 1 Aug on the tagged fruit using the same approach. Because of their young age and poor fruit set, some trees had fewer than 10 fruit. A weighted analysis of variance was performed to accommodate the unequal numbers of observations among treatment trees.

The defoliation assessment was performed mid-season on 6 Jul by tagging and examining 10 shoots per tree. The number of leaves present and defoliated was counted. A pre-harvest assessment was performed on 6 Aug by examining the tagged shoots.

EXPERIMENT 2 - Suncrest

Treatments. Experiment 2 was conducted during the 2007 growing season at the Rutgers Fruit Research and Extension Center, Cream Ridge, NJ. The test block consisted of mature, 12-year-old moderately susceptible ‘Suncrest’ peach trees planted at 25 ft x 25 ft spacing. Treatments were replicated four times in a randomized complete block design with single tree plots. Treated trees were surrounded on all sides by non-sprayed buffer trees. A Durand-Wayland airblast sprayer calibrated to deliver 100 gal/A at 150 psi traveling at 2.17 mph was used for applications.

Most treatments, scheduled for 7-day intervals, had a total of ten applications (SS-9C). Actual dates of application were 9, 21, 29 May, 6, 13, 22, 30 Jun, 12, 18, and 26 Jul. Two Kocide treatments, scheduled for 14-day intervals, were applied on 9, 29 May 13, 30 Jun and 18 Jul. Agri-fos and Pentra Bark were applied to tree trunk and limbs with a handgun sprayer at bloom (B) on 25 Apr.

Environment. Although rainfall during the growing season was below average, several periods of warm wet weather created moderately favorable conditions for bacterial spot development (Fig. 2). As in experiment 1, temperatures well below average in early April delayed bloom until late April and shuck split until early May. Weather was generally warm during the six weeks following shuck split and there were nine days with at least 0.10 in rainfall and a high temperature of at least 70ºF. Although rainfall was below average following the six week period after shuck split, several warm wet periods favorable for bacterial spot development occurred during this time. Rainfall in June was average while May, July, and August were below average. The number of rain days in each month with ≥0.10 inches was: May, 5; Jun, 7; Jul, 6; and Aug, 5.

Assessment. Bacterial spot on fruit was assessed mid-season on 9 Jul by examining 40 fruit per replicate tree. The total number of lesions was counted on each fruit. A pre-harvest assessment was performed on 2 Aug using the same approach. A defoliation assessment was performed at pre-harvest on 10 Aug by examining 10 shoots per tree and counting the number of leaves present and defoliated.

Fruit disease incidence and severity (lesions density) was calculated from the raw data. Mean lesion density often varied greatly among replicates in the same treatment because some replicates had a few fruit with very high numbers of lesions. Therefore, the percentage of fruit with 1-10 lesions and with > 10 lesions was also examined as a categorical dependent variable.

RESULTS AND DISCUSSION

EXPERIMENT 1 - O'Henry

Control and Standards. At mid-season in early July, 72.5% of non-treated fruit were infected with an average of 12.2 lesions per fruit (Table 1). By early August, fruit disease incidence reached nearly 100% on the control trees. Lesion density had increased to 89.7 lesions per fruit, a 7.4 fold increase in severity. The standard FlameOut had significantly lower fruit disease incidence and severity at both assessments, reducing lesion density by 68% and 88%, respectively. Tenn-Cop also reduced disease incidence and severity, but the difference was only significant at pre-harvest.

Kocide. All Kocide treatments, regardless of the application rate and interval, provided statistically similar levels of control (Table 1). In general, Kocide reduced incidence and severity levels, but most treatment means were not significantly different from the control. Only lesion densities at pre-harvest were significantly lowered. Nevertheless, the level of control with Kocide was statistically equivalent to the copper standard, Tenn-Cop. Indeed, the high rate / 7-day interval Kocide treatment compared favorably with Tenn-Cop, especially at pre-harvest.

Kasumin. Although the two Kasumin treatments did not significantly lower disease incidence at mid-season, considerable reductions in disease severity were observed (Table 1). At mid-season and pre-harvest, the Kasumin treatments reduced lesion density by 70-89% and 91-92%, respectively. In general, disease control by the Kasumin treatments was statistically equivalent to FlameOut throughout the season. The efficacy of Kasumin at the pre-harvest assessment was especially impressive since it was last applied over a month before the final assessment due to lack of material. However, July was fairly dry and few infection periods likely occurred during this time.

Agri-Fos. The single bloom application of Agri-Fos to tree trunks and scaffold limbs lowered disease incidence and severity at mid-season by not significantly (Table 1). Very little bactericidal effect was observed at pre-harvest.

Defoliation. Leaf drop can be caused by either bacterial spot lesions or phytotoxicity from some of the materials used to control bacterial spot. The non-treated control had 37.8% defoliation at the first assessment (Table 2). Both Kasumin treatments and Kocide @ 2.86 oz applied weekly had significantly higher levels of defoliation than the non-treated at the mid-season assessment. Because the Kasumin treatments provided good control of bacterial spot on the fruit, the defoliation from these treatments may be due to phytotoxicity. FlameOut, Tenn-Cop, and Kocide @ 1.43 oz applied weekly had significantly less defoliation than the controls. This was probably due to a combination of these materials providing bacterial spot control and not being highly phytotoxic to the plant. At the pre-harvest assessment, only the standards, Flame-Out and Tenn-Cop had significantly less defoliation than the non-treated control.

EXPERIMENT 2 - Suncrest

Control and Standards. The non-treated control trees had 46.3% infected fruit with an average of 2.2 lesions per fruit at the mid-season assessment (Table 3). By pre-harvest, fruit disease incidence increased to 82.5% with an average of 42.4 lesions per fruit (Table 4). Although the standard FlameOut had numerically lower disease levels than the control, none of the differences were significant.

Kocide. In general, the Kocide treatments lowered disease incidence and severity, but in most cases the reductions were not significant (Tables 3 & 4). Kocide applied bi-weekly at the 2.86 oz/A was the exception. This treatment significantly reduced disease incidence at both assessment times and provided a 74% reduction in lesion density at pre-harvest. The 2.86 oz/A rate of Kocide at the 7-day interval had similar results mid-season, but did not perform as well at pre-harvest. None of the Kocide treatments on Suncrest were observed to increase phytotoxicity as measured by defoliation (Table 5).

Kasumin. Kasugamycin + Captan performed very well at mid-season, yielding the lowest disease incidence and lowest percentage of fruit with 1-10 lesions compared to all other treatments (Tables 3 & 4). However, this level of control was not observed at pre-harvest, as both incidence and severity were not significantly different from the non-treated control. In contrast to the O'Henry results, no phytotoxicity was observed on Suncrest (Table 5).

Serenade. Serenade MAX slightly lowered disease levels, but none of the treatment means were significantly different from the control means.

Agri-Fos. The single bloom application of Agri-Fos applied with Pentra-Bark to the trunks and scaffold limbs reduced disease levels to a greater extent than Serenade. However, as with Serenade, Agri-Fos treatment means were not significantly lower than the non-treated control means.

Defoliation. The non-treated control had 46.5% defoliation at pre-harvest (Table 5). None of the treatments differed significantly from the control.

CONCLUSIONS

Kocide. Although only one Kocide treatment significantly reduced disease incidence in both experiments, all eight treatments consistently lowered lesion density at the final pre-harvest assessment. On highly susceptible O'Henry peach, lesion densities were reduced by 57-83% while on moderately susceptible Suncrest, reductions ranged from 56-74%. Furthermore, most Kocide treatments did not exhibit foliar phytotoxicity (defoliation) and provided statistically equivalent control to the Tenn-Cop standard. These results indicate that Kocide may be a useful addition to the post-bloom disease control program. Further research is needed to examine Kocide under normal (non-drought) conditions, during which more frequent rains should aid in release and redistribution of the copper ions more effectively. We suspect that the lack of separation of the four Kocide treatments (2 rates x 2 spray intervals) was due to the unusually dry 2007 weather conditions.

Kasumin. Kasugamycin + Regulaid and/or Kasugamycin + Captan performed as well as, and in some cases, better than the oxytetracycline standard. Furthermore, the Kasumin treatments provided some of the greatest reductions in disease severity, as measured by lesion density. The number of lesions per fruit were reduced by 70-92% with these Kasumin mixtures, while in 2006 Kasumin alone reduced lesion density by only 33%. However, the 2007 results also indicated a potential for foliar phytotoxicity. Further research is needed to test Kasumin mixtures under normal (non-drought) conditions, at different application intervals, different rates, and possibly with different mixture partners.

Agri-Fos. A single early season trunk application of Agri-Fos did not significantly reduce bacterial spot incidence or severity in either experiment. However, it did numerically reduce bacterial spot incidence and severity in both assessments on Suncrest and in the mid-season assessment on O'Henry. Further testing is needed to determine if Agri-Fos can significantly reduce bacterial spot with more applications or in combination with other treatments.

Weather and Efficacy. The efficacy of a bactericide can depend on weather conditions and frequency of sprays. Weather conditions for experiment 1 were very dry and all but one spray was applied at 8-day intervals. The antibiotics, Flameout and Kasumin, and Tenn-Cop were the only materials able to significantly control bacterial spot incidence. In both assessments, the antibiotic treatments consistently had less incidence and severity than any of the Kocide treatments. Experiment 2 had more rain periods than Experiment 1. Although most sprays were applied within 8 days, there were two periods when sprays were applied 12 days apart. A total of five potential infection / rain events occurred during these two extended spray intervals. Although there were very few significant differences between the treatments in experiment 2, numerically the four Kocide treatments and Kasumin had lower disease levels than the other treatments. Contrary to experiment 1, FlameOut consistently had a higher amount of disease than Kocide. The greater efficacy of the antibiotics in the first experiment may be due to a combination of closer spray intervals and fewer infection periods. Antibiotics generally have a short residual effectiveness and should be applied just prior to an infection period. The greater relative efficacy of Kocide in the second experiment may have resulted from the extended spray intervals and greater number of infection periods; many copper materials have a much longer residual because they are formulated to release copper slowly. Since applications were applied at 7-day intervals throughout the experiment, the standard FlameOut was applied at a 12 oz/A rate (typical range is 12-24 oz/A). Use of the lower rate may have contributed to its lack of effectiveness under higher disease pressure in Experiment 2.

Spring vs Summer Disease Development. As observed in previous bacterial spot studies, the majority of lesions were formed on both cultivars of fruit after the six week period following shuck split. Although the number of infection periods was below average following this ‘susceptible period’, the number of lesions on both varieties increased several-fold from the mid-season to pre-harvest assessments.

TABLE 1. Incidence and severity of bacterial spot on O'Henry peach fruit at mid-season and just prior to harvest.						
			Mid-season (2 Jul)		**Pre-harvest (1 Aug)**	
Treatment	**Rate/A**	**Timing (Interval)**	**% Fruit infected**[1]	**# Lesions per fruit**[1]	**% Fruit infected**[1]	**# Lesions per fruit**[1]
Non-treated	--------	-------	72.5 a	12.2 a	97.4 a	89.7 a
FlameOut 17WP	12 oz	SS, 1C-9C (7 days)	32.3 b	3.9 b	58.6 c	10.6 b
Tenn-Cop 5E	8 fl oz	SS, 1C-9C (7 days)	41.7 ab	5.0 ab	59.1 c	16.6 b
Kocide 3000 30DF	1.43 oz	SS, 1C-9C (7 days)	61.3 ab	7.0 ab	83.3 abc	28.8 b
Kocide 3000 30DF	2.86 oz	SS, 1C-9C (7 days)	71.0 a	7.5 ab	66.7 abc	15.5 b
Kocide 3000 30DF	1.43 oz	SS, 2C, 4C, 6C, 8C (14 days)	72.0 a	12.2 a	78.3 abc	38.8 b
Kocide 3000 30DF	2.86 oz	SS, 2C, 4C, 6C, 8C (14 days)	67.7 ab	7.7 ab	76.7 abc	21.3 b
Kasumin 2L + Regulaid	2 qt + 1 pt	SS, 1C-6C (7 days)	56.0 ab	3.6 b	62.5 bc	7.3 b
Kasumin 2L + Captan 80WDG	2 qt + 3 lb	SS, 1C-6C (7 days)	43.5 ab	1.3 b	59.1 c	8.4 b
Agri-Fos 5.17F + Pentra-Bark	2qt + 3 fl oz in 2 qt water	B	50.0 ab	6.2 ab	94.1 ab	83.7 a

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

TABLE 2. Defoliation on O'Henry peach trees at mid-season and pre-harvest.				
			Mid-season (6 Jul)	**Pre-Harvest (6 Aug)**
Treatment	**Rate/A**	**Timing (Interval)**	**% Defoliation [1]**	**% Defoliation [1]**
Non-treated	--------	-------	37.8 cd	45.4 ab
FlameOut 17WP	12 oz	SS, 1C-9C (7 days)	29.5 f	35.7 cd
Tenn-Cop 5E	8 fl oz	SS, 1C-9C (7 days)	30.9 ef	35.1 d
Kocide 3000 30DF	1.43 oz	SS, 1C-9C (7 days)	29.6 f	37.1 bcd
Kocide 3000 30DF	2.86 oz	SS, 1C-9C (7 days)	45.7 b	50.4 a
Kocide 3000 30DF	1.43 oz	SS, 2C, 4C, 6C, 8C (14 days)	36.0 de	41.3 abcd
Kocide 3000 30DF	2.86 oz	SS, 2C, 4C, 6C, 8C (14 days)	32.2 def	39.5 bcd
Kasumin 2L + Regulaid	2 qt + 1 pt	SS, 1C-6C (7 days)	54.1 a	46.2 ab
Kasumin 2L + Captan 80WDG	2 qt + 3 lb	SS, 1C-6C (7 days)	42.3 bc	42.0 abcd
Agri-Fos 5.17F + Pentra-Bark	2 qt + 3 fl oz in 2 qt water	B	37.5 cd	45.3 abc

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

TABLE 3. Incidence and severity of bacterial spot on 'Suncrest' at mid-season (9 Jul).

Treatment	Rate/A	Timing (Interval)	% Fruit infected[1]	# Lesions per fruit[1]	% Fruit 1-10 lesions[1]	% Fruit >10 lesions[1]
Non-treated	--------	-------	46.3 a	2.2 a	40.6 a	5.6 a
FlameOut 17WP	12 oz	SS, 1C-9C (7 days)	33.1 abc	1.6 a	30.0 ab	3.1 a
Kocide 3000 30DF	1.43 oz	SS, 1C-9C (7 days)	31.3 abc	3.4 a	23.8 bc	7.5 a
Kocide 3000 30DF	2.86 oz	SS, 1C-9C (7 days)	29.4 abc	1.6 a	25.0 bc	4.4 a
Kocide 3000 30DF	1.43 oz	SS, 2C, 4C, 6C, 8C (14 days)	29.4 abc	2.6 a	23.1 bc	6.3 a
Kocide 3000 30DF	2.86 oz	SS, 2C, 4C, 6C, 8C (14 days)	26.9 bc	1.8 a	20.0 bc	6.9 a
Kasumin 2L + Captan 80WDG	2 qt + 3 lb	SS, 1C-9C (7 days)	20.0 c	2.0 a	16.3 c	3.8 a
Serenade MAX 14.6WP + Biotune	2 lb + 1 pt	SS, 1C-9C (7 days)	40.6 ab	3.3 a	30.0 ab	10.6 a
Agri-fos 5.17F + Pentra-Bark	2qt + 3 fl oz in 2 qt water	B	31.3 abc	1.5 a	28.1 abc	3.1 a

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

TABLE 4. Incidence and severity of bacterial spot on ‘Suncrest’ at pre-harvest (2 Aug).						
Treatment	**Rate/A**	**Timing (Interval)**	**% Fruit infected[1]**	**# Lesions per fruit[1]**	**% Fruit 1-10 lesions**	**% Fruit >10 lesions**
Non-treated	--------	-------	82.5 a	42.4 a	25.0 ab	57.5 a
FlameOut 17WP	12 oz	SS, 1C-9C (7 days)	65.6 ab	35.0 a	27.5 ab	38.1 a
Kocide 3000 30DF	1.43 oz	SS, 1C-9C (7 days)	66.3 ab	18.2 a	31.3 ab	35.0 a
Kocide 3000 30DF	2.86 oz	SS, 1C-9C (7 days)	65.6 ab	17.0 a	41.9 a	23.8 a
Kocide 3000 30DF	1.43 oz	SS, 2C, 4C, 6C, 8C (14 days)	59.4 ab	18.5 a	29.4 ab	30.0 a
Kocide 3000 30DF	2.86 oz	SS, 2C, 4C, 6C, 8C (14 days)	44.4 b	10.9 a	22.5 b	21.9 a
Kasumin 2L + Captan 80WDG	2 qt + 3 lb	SS, 1C-9C (7 days)	67.5 ab	19.6 a	39.4 ab	28.1 a
Serenade MAX 14.6WP + Biotune	2 lb + 1 pt	SS, 1C-9C (7 days)	79.4 a	31.4 a	35.0 ab	44.4 a
Agri-Fos 5.17F + Pentra-Bark	2qt + 3 fl oz in 2 qt water	B	68.8 ab	25.7 a	29.4 ab	39.4 a

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

TABLE 5. Defoliation on Suncrest at pre-harvest (10 Aug).

Treatment	Rate/A	Timing (Interval)	% Defoliation [1]
Non-treated	--------	-------	46.5 ab
FlameOut 17WP	12 oz	SS, 1C-9C (7 days)	40.7 ab
Kocide 3000 30DF	1.43 oz	SS, 1C-9C (7 days)	46.9 a
Kocide 3000 30DF	2.86 oz	SS, 1C-9C (7 days)	44.1 ab
Kocide 3000 30DF	1.43 oz	SS, 2C, 4C, 6C, 8C (14 days)	42.9 ab
Kocide 3000 30DF	2.86 oz	SS, 2C, 4C, 6C, 8C (14 days)	44.1 ab
Kasumin 2L + Captan 80WDG	2 qt + 3 lb	SS, 1C-9C (7 days)	41.2 ab
Serenade MAX 14.6WP + Biotune	2 lb + 1 pt	SS, 1C-9C (7 days)	45.0 ab
Agri-Fos 5.17F + Pentra-Bark	2 qt + 3 fl oz in 2 qt water	B	40.4 b

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

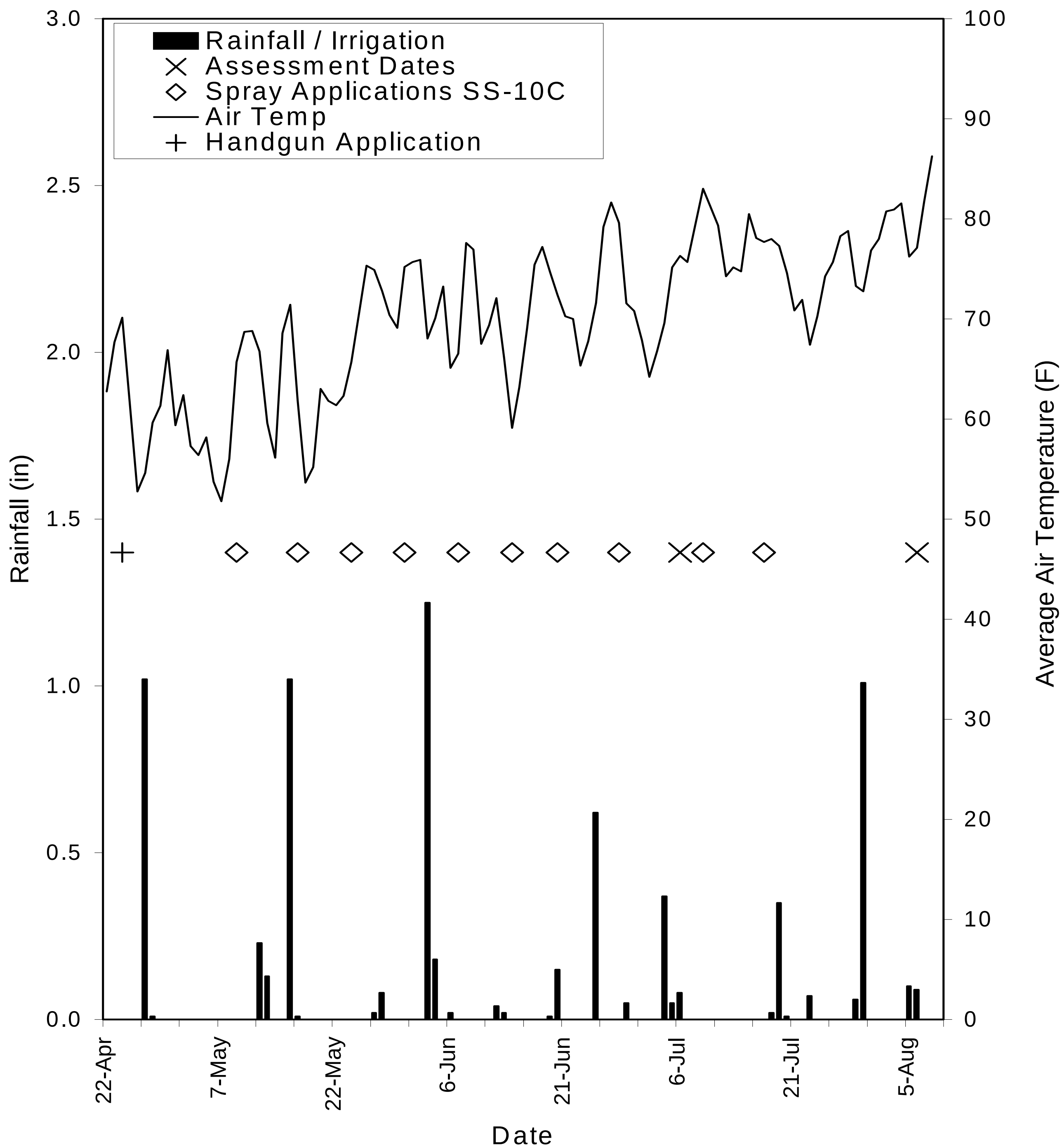

Figure 1. Rainfall, air temperature, fungicide application timing, and assessment time on 'O'Henry' peach during the 2007 growing season, Rutgers Agricultural Research and Extension Center, Bridgeton, NJ. The diamond symbol represent spray application timing (SS-10C), the + represents the Agri-Fos application, and the X symbol represents fruit assessment timing.

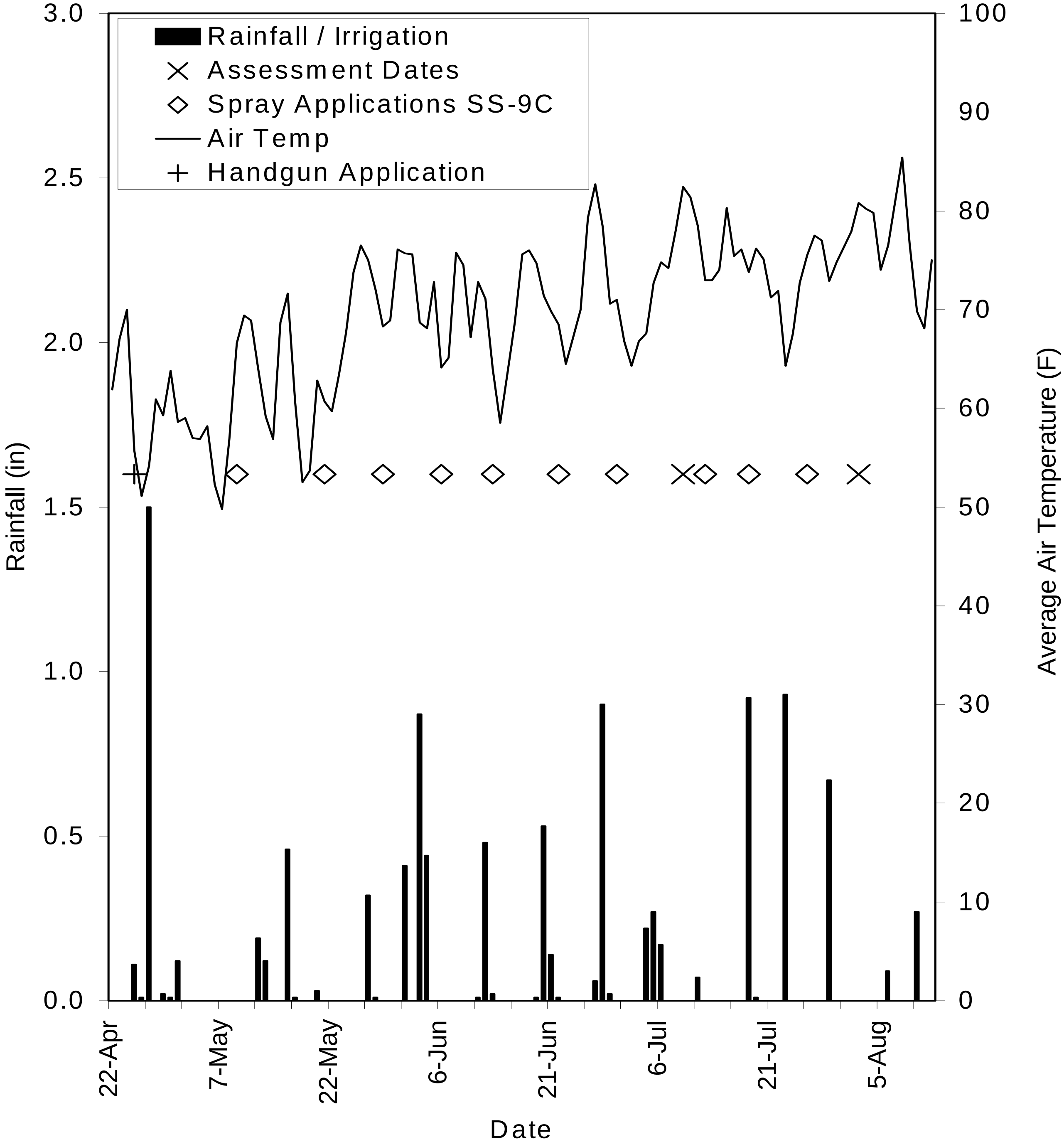

Figure 2. Rainfall, air temperature, fungicide application timing, and assessment time on 'Suncrest' peach during the 2007 growing season, Rutgers Fruit Research and Extension Center, Cream Ridge, NJ. The diamond symbol represent spray application timing (SS-9C), the + represents the Agri-fos application, and the X symbol represents fruit assessment timing.

Mechanism of DMI fungicide resistance in *Monilinia fructicola* and implications for brown rot control

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Commercial peach producers in South Carolina and Georgia must grow high quality fruit to remain competitive in todays markets. Despite the implementation of several IPM practices, the use of chemicals for insect and disease control remains an important part of modern peach production. The application of efficacious fungicides for control of brown rot is necessary to prevent pre and postharvest rot. Over the past two to three decades, preharvest applications of DMI fungicides (such as Orbit, Propimax, Indar, Elite) have done an excellent job of controlling pre- and postharvest brown rot. But those times are likely over. In 2003, Georgia growers suffered severe losses due to DMI fungicide resistance. We estimate that the production loss was $9.8 million (due to direct disease losses and cost of fungicide applications), which amounted to >75% of all combined disease-related losses in the peach crop (Williams-Woodward, 2004).

Laboratory studies confirmed that isolates from Georgia orchards with documented control failures were able to cause significantly more disease on detached fruit which were sprayed with labeled rates of Orbit (Schnabel et al., 2004). In 2005, field studies in Georgia confirmed lab observations (Brannen et al., 2005). At this point, DMI-resistant populations cannot be adequately controlled with existing labeled rates of DMI fungicides in numerous locations in Georgia, and our latest research shows that DMI resistance is not restricted to Georgia alone. We have now collected resistant isolates in other states, including South Carolina, Ohio, and New York (data not shown). In other words, DMI-resistance is becoming a wide-spread problem, and we need to deal with it as a reality for peach production in the eastern U.S.

Table 1. Relative expression of the *MfCYP51* and *MfABC1* genes in *M. fructicola* field isolates

Relative growth (%)[a]	Propiconazole sensitivity phenotype[b]	Relative expression of *MfCYP51*[c]				Relative expression of *MfABC1*			
		Untreated		Treated with 0.3 µg/ml propiconazole		Untreated		Treated with 0.3 µg/ml propiconazole	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
29.7	R	11.2	0.0	10.8	1.4	1.6	1.0	1.7	0.7
30.8	R	7.3	1.0	7.6	1.6	1.5	1.1	2.2	0.1
29.5	R	10.1	0.8	9.5	1.4	1.6	0.1	2.2	0.9
35.0	R	9.1	1.6	7.5	0.9	1.2	0.1	2.1	0.0
36.3	R	10.3	1.5	10.0	0.7	0.6	0.3	1.9	0.9
21.8	R	5.2	0.8	4.6	0.4	1.4	0.5	1.8	0.5
0	S	1.9	0.5	1.3	0.3	2.6	0.7	1.5	0.0
0	S	3.4	0.2	1.9	0.4	2.8	0.3	1.1	0.6
3.1	S	1.2	0.1	1.8	0.3	2.0	0.4	1.1	0.1
5.0	S	2.3	1.0	1.8	0.0	1.0	0.0	1.6	0.9
1.3	S	1.0	0.1	1.6	0.5	2.0	0.4	2.5	0.4
0.4	S	1.0	0.2	0.9	0.4	2.2	0.1	2.5	0.4

[a] Relative growth was calculated by expressing the growth of isolates on 0.3 µg/ml propiconazole-amended medium as a percentage of the growth on non-amended medium.

[b] An isolate was considered resistant (R) when the relative mycelial growth on 0.3 µg/ml propiconazole-amended medium was equal of greater than 20 %; an isolate was considered sensitive (S) when it did not grow or when it's relative growth was less than 5 % on 0.3 µg/ml propiconazole-amended medium.

[c] The expression of the *MfCYP51* or *MfABC1* genes was normalized using the *MfActin* gene expression levels and then calibrated to the normalized *MfCYP51* or *MfABC1* mRNA value from the isolate with the lowest amount of *MfCYP51* or *MfABC1* mRNA. Mean and SD indicated the average value and standard deviation of relative expression between two independent biological experiments. Relative expression was determined in isolates subjected to water or 0.3 µg/ml propiconazole one h before mRNA isolation.

Isolates from the four mentioned states are genetically closely related, but not identical. Moreover, they share a common mechanism of resistance, the overproduction of an enzyme called lanosterol 14-α demethylase (Table 1). DMI fungicides bind to this enzyme, killing the fungus by destabilizing the fungal membrane. Resistant isolates produce much more of this enzyme, requiring the application of higher concentrations of a DMI fungicide to be effective. Increasing the rate of Indar, for example, will control populations that are resistant to the 'normal' rate (data not shown). Elite and some other formulations of tebuconazole can be used legally by South Carolina and Georgia growers at a high rate of 8 ozs per acre for the control of DMI resistant populations. Another approach to making DMI fungicides more effective are tank mixtures of a DMI with a protectant such as sulfur or captan. Under controlled conditions, the addition of sulfur to a DMI fungicide has shown an additive to slightly synergistic effect when controlling DMI resistant isolates (Holb and Schnabel, 2007). However, this effect was not substantiated in a one-time field trial. In the same trial, the mixture of a DMI fungicide with captan showed more promising results (P. M. Brannen, unpublished data).

Several active ingredients representing respiration inhibitor (**RI**) fungicides have been labeled in previous years for brown rot control, including azoxystrobin, pyraclostrobin, and boscalid (the first two belong to the quinone outside inhibitor [**QoI**] fungicide subgroup). DMI-resistant populations can be effectively controlled with Pristine and we do recommend rotating DMI fungicides with Pristine in our 2008 spray guide. However, these active ingredients are single-site inhibitors and, as such, they are also at high risk of resistance development. In 2007, during routine monitoring of fungicide sensitivity at the Ridge in South Carolina, we came across isolates that appeared unusually resistant to QoI fungicides in Petri dish tests. That did not concern us at first, because *in vitro* sensitivities of baseline isolates (isolates that have never been treated with QoI fungicides) can vary quite a bit. However, when we inoculated detached fruit with those 'suspicious' isolates, we found them to cause 100% disease on peaches sprayed with Abound. The same isolates caused some disease (15%) on fruit treated with Pristine. Baseline isolates were completely inhibited by the Abound and Pristine treatments (data not shown).

What does this mean? Are Abound and Pristine already becoming ineffective in some areas? We do not know for sure since control failure has not been reported yet; but our findings certainly indicate that growers should not rely on one single class of fungicides alone. For example, growers should not spray Pristine exclusively because it has worked well in the past few years. Growers would select for resistance and experience control failure once resistant isolates have multiplied to a high enough number for an epidemic.

Literature

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Epidemiology of Cherry Leaf Spot in Pennsylvania

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Introduction

Cherry leaf spot caused by *Blumeriella jaapii* is one of the most important diseases of cherries in the US. Diseased leaves drop prematurely, and severely affected trees may defoliate by mid-summer resulting in poor fruit yield and quality, increased susceptibility to winter injury, and reduced yield the following year. Although the general epidemiology of cherry leaf spot has been described (1,2), there is a paucity of specific information on: 1) temporal disease progress; 2) the relationships between disease severity (i.e. number of spots per leaf) and defoliation; 3) relationship between the timing of defoliation and susceptibility to winter injury; and 4) relationship between defoliation and yield. The objectives of this study were to describe the temporal progress of cherry leaf spot in Pennsylvania and to model the relationship between cherry leaf spot severity and the timing of tree defoliation.

EXPERIMENTAL PROCEDURES

An experiment was set up in a tart cherry (cv. Montmorency) orchard near the Penn State University Fruit Research and Extension Center, Biglerville, PA. Seven trees were selected at random and six shoots, three in each of the lower and upper sections of the tree canopy, were tagged in early May before appearance of visible disease symptoms. Each shoot was further divided into four sections from the distal to proximal end; each section contained 4 to 6 individual leaves. For each leaf on a tagged shoot, disease severity (number of spots per leaf), was noted at 5 to 10 day intervals throughout the season or until the leaf abscised. The time of individual leaf abscission was also recorded. Data on disease progress were analyzed by means of non-linear regression models while an accelerated failure time model was used to analyze data on time to leaf abscission.

RESULTS AND DISCUSSION

I. Temporal progress of cherry leaf spot in PA orchards

Cherry leaf spot was observed starting on June 20th and increased throughout the season. Disease progress was characterized by sigmoid curves typical of polycyclic diseases suggesting secondary infection occurred during the season. The non-linear forms of the Gompertz and logistic models were compared for their ability to summarize the disease progress. Based on percent variance accounted for (R^2 values) from 48 disease progress curves, the logistic model was identified as the most suitable for comparison of disease progress curves. Further analysis using parameters derived from the logistic model allowed us to evaluate the effects of leaf age (based on the position of the leaf on an individual shoot) and leaf position within the tree canopy on disease progress.

Table 1. Parameter estimates of non-linear logistic regression models describing the progress of cherry leaf spot on leaves from different sections on a shoot (i.e. different time of emergence) at Biglerville, PA 2006

	Parameters				
Shoot section[x]	Relative rate[y]	Maximum number of spots[y]	Absolute rate of progress[yz]	Time to five spots[y]	Number of spots at onset of defoliation[y]
A	0.142a	31.8a	3.33b	196.8b	20.02b
B	0.171a	31.5a	4.76a	197.4b	26.43a
C	0.151a	24.3b	3.15b	201.8a	19.35bc
D	0.159a	18.4b	3.07b	201.6a	16.86c
Mean	0.156	26.5	3.67	199.4	20.66
LSD (α = 0.05)	0.0626	6.29	1.202	3.27	3.44

[x]A= distal end i.e. first to emerge, followed by B and C and D being last to emerge (i.e. youngest of the leaves)

[y]Mean of 12 disease progress curves for each section; values followed by same letter within a column not significantly different

[z]Includes information on the rate and maximum number of spots (upper asymptote)

Results showed that whereas leaf age significantly ($0.036 \leq P \leq 0.001$) affected disease progress, leaf position in the tree canopy had no effect ($P = 0.139 \leq P \leq 0.874$). Leaves that emerged earlier (i.e. sections A and B on the distal end of a shoot), had higher rates of disease progress and more severe disease at the time of defoliation than those that emerged later (sections C and D; Table 1).

II. Survival analysis of time to leaf abscission

Preliminary analysis revealed there is a wide variation in the number of spots with which a diseased leaf can abscise. However, leaves with fewer spots survived longer than those with many spots.

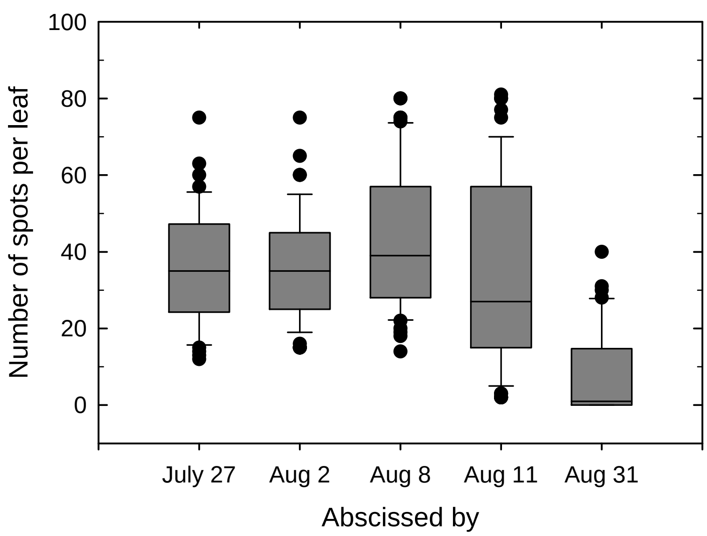

Fig 1. Box plots showing the distribution of disease severity values for leaves (n = 672) that abscised at different times. Values of disease severity are from the last assessment date prior to abscission, or last assessment date for leaves that did not abscise by the end of the study (n = 292).

Time to abscission of individual leaves was modeled using a survival analysis approach (3). The response variable was minimum time to abscission (TAB) while the explanatory variables were: (i) initial disease status ([ID], i.e. whether a leaf had less than 3 or more spots on June 21), (ii) leaf position in the canopy (LP), (iii) leaf age ([LA], or section on the shoot) and leaf disease status category (DG).

Table 2: Parameter estimates from accelerated failure time model relating time to leaf abscission with initial disease status and disease severity group

Parameter	DF	Estimate	SE	Wald χ^2	P> χ^2
Intercept	1	4.441	0.0207	4584.9	<0.0001
Initial disease	1	-0.018	0.0025	55.3	<0.0001
Position	1	0.0192	0.0192	1.6	0.2089
Disease group	1	-0.266	0.0115	537.4	<0.0001

Results indicated that time to abscission (TAB) is significantly affected by initial disease status (ID) and leaf disease category (DG), but not leaf position (LP) or leaf age (LA; [Table 2]). The fitted model describing this relationship is: logit (TAB) = 4.441– 0.018 ID – 0.0266 DG. The negative value of the estimate of ID (Table 2) indicates that leaves with higher initial disease (i.e. >3 spots) were at a greater risk of abscising compared with those with <3 spots.

CONCLUSIONS

1. Leaf age significantly affected progress of cherry leaf spot whereby disease progressed faster on older leaves resulting in higher disease at the end of the season.
2. There is a wide variation in the number of spots with which a diseased leaf can abscise suggesting factors other than disease severity affect the duration of leaf survival.
3. Disease severity (i.e. number of spots per leaf) and initial disease status significantly affected the risk of abscission of individual cherry leaves.
4. Leaf position within the canopy is not an important factor in the epidemiology of cherry leaf spot. It does not affect the rate of disease progress or the timing of leaf abscission.

References

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EVALUATION OF PRODUCTS FOR BACTERIAL SPOT CONTROL

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The test was carried out in a mature Sunhigh peach orchard with a history of bacterial spot near Lancaster, PA. Trees received fungicide and insecticide applications according to standard commercial practice for the northeastern U.S., but early-season (dormant through bloom) copper sprays were omitted to allow build-up of bacterial inoculum for the test. Treatments included two copper formulations (Tenn Cop 5E or Kocide 3000) applied either alone or in rotation with Mycoshield, a grower stand program (Mycoshield and Nutri-Phite mixture), a Mycoshield-only treatment and an untreated check for comparison. The experimental design was a randomized complete block with seven replicates. Treatments were applied using a commercial air-blast sprayer at a rate of 100 gal/A and 150 psi on 10, 16, 24, 31 May, 7, 16, 25 Jun, and 4, 13 Jul. Plots were rated for defoliation and phytotoxicity on a 1-to-5 scale (1=no phytotoxicity; 5=severe phytotoxicity) on 18 Jul. For each treatment plot, leaf disease severity (the number of spots per leaf on 50 arbitrarily selected leaves) and fruit disease incidence (based on a random sample of 50 fruit) were assessed on 8 Aug. Fifteen infected fruit from each treatment were scored for disease severity on a 1-to-5 scale whereby 1= no disease and 5=severe infection. Data were subjected to analysis of variance, and means were compared with Fisher's Protected LSD test (α=0.05).

Weather was conducive for bacterial spot development and moderate levels of leaf infections occurred at the trial site. All treatments significantly reduced ($P < 0.001$) leaf disease severity over the untreated control with Mycoshield providing the best level of control. Low rates of Tenn Cop and Kocide 3000 provided the best level of fruit disease control when used alone or in rotation with Mycoshield. There were no differences between treatments in the severity of phytotoxicity and defoliation. The results indicate that copper products can be applied effectively during the cover sprays as an alternative to or in rotation with Mycoshield at a rate of 0.5 oz/A metallic Cu. Additional research is warranted to confirm the effectiveness of low rates of these copper products under high disease pressure, as they may be useful as a Mycoshield rotation partner for resistance management.

Table 1. Effect of Kocide 3000 DF and Tenn Cop 5E applications during cover sprays for control of bacterial spot on cv Sunhigh peach at Lancaster county 2007.

Treatment and rate/A	Leaf disease severity (%)[y]	Phytotoxicity index[y]	Fruit disease incidence (%)[y]	Fruit severity index[yz]
Mycoshied 17 WP 12 oz ----------	9.5 ±0.96 d	3.6 ±0.47 a	21.3 ±3.53 a	70.5 ± 20.66 ab
Mycoshied 12 oz plus Nutri-Phite 1 qt in alternate row middle --------	13.5 ±1.01 bc	3.9 ±0.40 a	11.0 ±1.34 b	30.3 ± 5.71 bc
Kocide 3000 1.667 oz -------------	13.7 ±0.96 bc	3.0 ±0.39 a	9.7 ±1.09 b	27.4 ± 4.77 c
Kocide 3000 1.667 oz rotated with Mycoshield WP 12 oz -----------	10.9 ±0.69 cd	3.1 ±0.41 a	10.2 ±1.27 b	29.5 ± 5.63 c
Tenn Cop 5E 8.0 oz --------------	15.1 ±1.03 b	3.6 ±0.34 a	9.8 ±1.99 b	28.3 ± 9.04 c
Tenn Cop 5E 8.0 oz rotated with Mycoshield WP 12 oz ------------	13.2 ±0.53 bc	3.7 ±0.33 a	13.1 ±2.37 b	31.0 ± 6.00 bc
Untreated check ---------------------	26.4 ±1.65 a	4.1 ±0.35 a	24.9 ±4.78 a	105.3 ± 27.19 a
LSD	4.64	2.01	7.34	40.21

[y]Values are means and standard errors based on seven replicate single-tree plots. Means followed by same letter(s) are not significantly different according to Fisher's Protected LSD test (α = 0.05)

[z]Arithmetic product of disease incidence and severity.

PEACH DISEASE CONTROL WITH DPX-LEM17, 2007.

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DPX-LEM17 20SC was evaluated for peach (*Prunus persica* 'Bounty') disease control in a 5-yr-old research orchard spaced 16 ft x 24 ft. The test was conducted in a completely randomized design with four single-tree replications per treatment. Nonsprayed buffer trees were placed between treated trees in the row and between rows. Treatments were applied from both sides of the row with a Swanson model DA-500 airblast sprayer (100 gal/A) as follows: 30 Apr (shuck-split/shuck-fall; SS/SF), 15 May (first cover; 1C), 25 Jul (sixth cover; 6C), and 2 Aug (pre-harvest; PH). Additional cover sprays were applied and utilized Captan 80WDG at 2.5 lb/A from 2C through 5C on the following dates: 24 May; 7 and 21 Jun; and 10 Jul. Maintenance insecticide sprays were applied separately with the same equipment. Wetting periods initiated by rain occurred on 23-25 Mar, 11-12 Apr, 14-15 Apr, 26-27 Apr, 10-11 May, 12-13 May, 16-17 May, 18-19 May, 1–2 Jun, 3-4 Jun, 12-13 Jun, 13-14 Jun, 21-22 Jun, 27-28 Jun, 28-29 Jun, 28-29 Jun, 4-5 Jul, 5-6 Jul, 27-28 Jul, 28-29 Jul, and 5-6 Aug. Total precipitation in April, May, June, July, and August was 2.5, 0.9, 2.8, 1.8 and 0.7 inches (to 6 Aug), respectively. Overwintering levels of brown rot inoculum were low and weather conditions were unfavorable for disease development in the field. Fruit were assessed for scab, rusty spot, and brown rot on 6 Aug by examining visually 25 fruit from each tree and then calculating the percent of infected fruit. On 6 Aug, 25 fruit per tree were harvested, placed on paper fruit trays in plastic containers, and inoculated with 1 x 10^4 conidia/ml of *Monilinia fructicola* and then sealed in plastic bags for 4 days. The containers were kept indoors under ambient conditions (approximately 75 to 82° F). Fruit were assessed for percent of brown-rotted fruit on 10 Aug. Data were analyzed with analysis of variance after using the arcsine transformation.

All treatments had lower incidence of scab than the nonsprayed trees, except for treatment 3, which was similar (Table 1). LEM17 at the 3 oz a.i. rate provided control of scab that was similar to the 4.3 oz a.i. rate (treatments 1 and 2). All treatments had lower incidence of rusty spot than the nonsprayed trees. Incidence of rusty spot also was similar with both rates of DPX-LEM 17; however, trees treated with DPX-LEM 17 + Elite had the lowest incidence of rusty spot. Natural incidence of brown rot was extremely low and there were no differences among the treatments and nonsprayed trees. In the postharvest test with inoculated fruit, all treated fruits exhibited less brown rot than the nontreated fruits (Table 1). Brown rot incidence was lowest on fruit treated with DPX-LEM17 + Elite, although this treatment was not significantly different from the others. The highest level of brown rot observed on treated fruits was with LEM17 at 3 oz a.i. (treatment 1). Rhizopus rot was not observed in this experiment. No phytotoxicity due to DPX-LEM 17 applications to fruit and foliage was observed in this study.

Table 1. Incidence of scab, rusty spot, and brown rot on peach fruit treated with DPX-LEM17.

		Infected fruit (%) *			
		Scab	Rusty spot	Brown rot (Harvest)	Brown rot (4-d Postharvest)
Treatment and rate/A	Timing	6 Aug	6 Aug	6 Aug	10 Aug
DPX-LEM17 20SC 15 oz	SS/SF, 1C, 6C, PH	3.0 b	37.0 bc	0.0	9.5 b
DPX-LEM17 20SC 21.5 oz	SS/SF, 1C, 6C, PH	4.0 b	44.0 b	0.0	9.0 b
DPX-LEM17 20SC 15 oz + Elite 45DF 3 oz	SS/SF, 1C, 6C, PH	9.0 ab	24.0 c	0.0	4.5 b
Elite 45DF 6 oz	SS/SF, 1C, 6C, PH	5.0 b	28.0 bc	0.0	9.0 b
Nonsprayed control	Not Applicable	20.0 a	70.7 a	0.0	43.0 a

* Different letters in columns denote significant differences among transformed means (arcsine transformation) according to the Waller Duncan K-ratio t-test (K=100; α=0.05); data shown are actual, non-transformed means.

IMPORTANCE OF EARLY-SPRING-PRUNING COPPER SPRAYS IN MANAGING BACTERIAL CANKER OF SWEET CHERRY

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Bacterial canker is a serious disease of sweet and tart cherry that limits orchard life and tree productivity. New York tree fruit growers ranked the need for research on bacterial canker biology and management in the top ten. Currently, copper sprays are used to manage the disease, however, the effectiveness and timing of copper sprays for bacterial canker is unknown under NY conditions. The occurrence of copper-resistant bacteria and negative impacts of copper on soils underscore the need for alternative management strategies. Recent work on sweet cherry tree-training systems has shown promise of leaving a 15-cm-long pruning stub as an aid in managing the lethal canker phase of the disease.

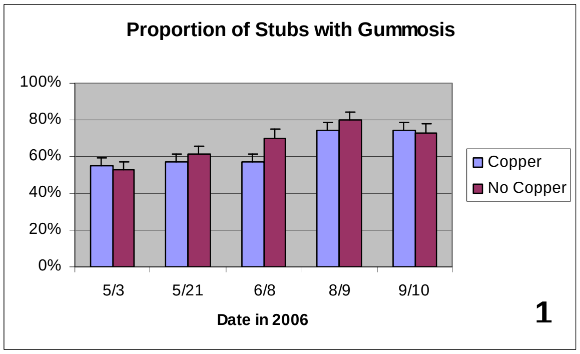
We studied the effectiveness of the 15-cm pruning stub and the spring pre- and post-pruning copper sprays. The vulnerability of six planting systems (Modified Central Leader, Spanish Bush, Marchant, Perpendicular V System, Vogel Slender Spindle, and Vertical Axis) to canker will also be assessed this fall. Our specific objectives are as follows:

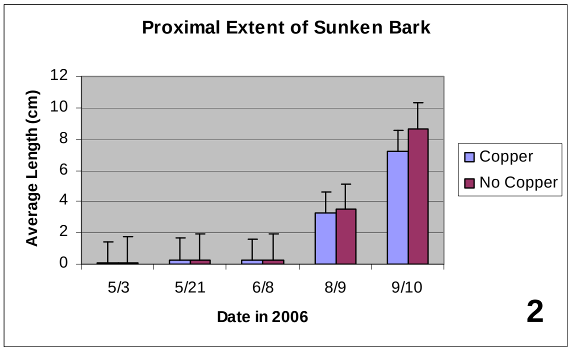
1. Ascertain if copper sprays protect pruning wounds from infection.
2. Determine the fate of bacterial inoculations on 15-cm stub and flush pruning wounds.
3. Assess the six sweet cherry orchard planting systems for predisposition to bacterial canker.

The results of this study should significantly improve our understanding of bacterial canker management. Preliminary results are reported here.

To determine whether copper sprays protect spring pruning wounds from bacterial canker infection, the cv Hedelfingen, trained to a Vertical Axis System, in 3 replicate blocks, 15 trees/block, were sprayed with copper, timed just before and just after pruning. Two (3- to 5-cm diam) branches per tree, were pruned and the pruned zone on one of the branches was shielded during copper sprays by wrapping with plastic. Treated and untreated pruning stubs were assessed for gummosis symptoms and extent of canker.

Copper treatment of uninoculated pruning stubs, compared to untreated pruning stubs,

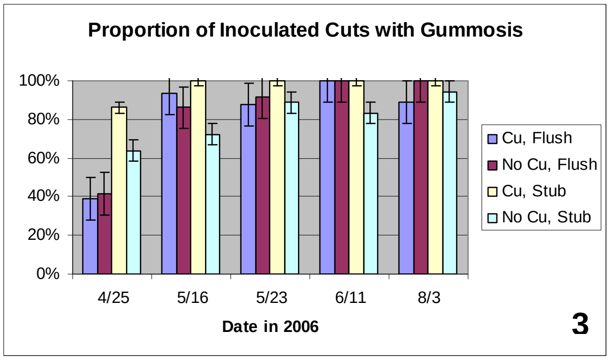


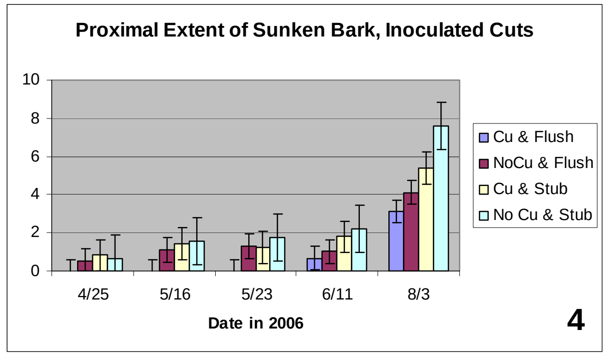


did not reduce gummosis (Fig 1) or extent of canker (sunken bark) (Fig 2). Bars show standard error.

To determine the fate of bacterial inoculations on stub vs. flush pruning cuts, 16 Hedelfingen trees (Vertical Axis) in 3 rows, were inoculated (3.4×10^8 cfu/ml) immediately after pruning with a *Pseudomonas syringae* pv. *syringae* (Pss) isolate from sweet cherry. Two branches on each tree were flagged, and each was pruned to a stub leaving a lateral that was then flush cut. One branch with the stub and flush cuts was shielded during copper treatments as described above. Samples to re-isolate the pathogen were taken at 2 and 6 weeks post-inoculation. Inoculated pruning treatments were assessed for gummosis and extent of canker.

Pss was recovered from 89% of stub cuts and from 94% of flush cuts, indicating no benefit from the stub in preventing Pss infection. No benefit from copper treatment in preventing infection by Pss was found. Pss was recovered from 95% of copper treated and 88% of untreated pruning wounds. Copper treatment may stimulate gummosis on inoculated stub cuts





as compared to untreated stub cuts (Fig 3). Copper treatment may decrease extent of sunken bark on stub cut as the season progresses (Fig 4). Bars show standard error.

Inoculated branch stubs were cut from half of the trees and the bark removed to measure the internal extent of discoloration. As shown in the table below, the copper treatment did not reduce the extent of discoloration. Though the extent of discoloration is less for flush cuts, this may be an artifact of the smaller diameter of the lateral branches that were pruned flush.

Dissected Inoculated Branches			
Treatment	**Extent Discoloration**	**Avg Diam**	**Extent / Diam**
Copper/Stub	14.7 cm	2.4 cm	6.1
No Copper/Stub	13.2 cm	2.5 cm	6.0
Copper/Flush	8.2 cm	1.3 cm	8.9
No Copper/Flush	8.3 cm	1.2 cm	8.1

Pre- and post-pruning treatment with copper did not reduce gummosis, canker or fate of Pss. Both inoculated stubs and flush cuts developed bacterial canker and Pss was recovered from both. Copper sprays may stimulate gummosis on inoculated stubs. As the season progresses, the spring-pruning copper treatment may inhibit the proximal extent of canker on pruning stubs. These results suggest copper sprays and stubs may not affect infection by Pss directly, but by some other mechanism. For instance, pruning stubs may impact bacterial canker disease primarily by ‘distancing’ the main trunk from pathogen invasion. However, further research is required to determine the pruning and copper treatment strategy’s effectiveness on long term management of the disease.

PERFORMANCE OF FOUR SPRAY PROGRAMS FOR GRAPE DISEASE CONTROL

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A trial of four spray programs for control of fungal diseases of wine grapes was conducted in a research vineyard of 6-year-old, Vertical Shoot Position-trained grapevines at the University of Maryland's Lower Eastern Shore Research and Education Center (LESREC), Salisbury. The trial was a split-block design with four replicates. The five main plot (row) treatments comprised an optimal program incorporating newer fungicides and frequent rotations among fungicide classes, two programs adapted from 2006 grower programs that successfully controlled grape diseases in eastern Maryland (Grower 1) and the Piedmont region (Grower 2), a "soft" program using only one application of a conventional fungicide, and an unsprayed control. Treatments, which were timed to the phenology of 'Chardonnay', the earliest cultivar, were applied as follows: 1 = 27 Apr (0–1 in. shoot), 2 = 4 May (3–5 in. shoot), 3 = 10 May (10–12 in. shoot), 4 = 17 May (12–17 in. shoot), 5 = 24 May (pre-bloom), 6 = 31 May (bloom), 7 = 7 Jun (post-bloom), 8 = 14 Jun (1^{st} cover), 9 = 25 Jun (2^{nd} cover), 10 = 5 Jul (3^{rd} cover/bunch closing), 11 = 16 Jul (4^{th} cover), 12 = 26 Jul (5^{th} cover/veraison), 13 = 7 Aug (6^{th} cover), 14 = 21 August (pre-harvest). Two border rows and an unused row in the trial area received a complete fungicide program to manage all diseases. Fungicide treatments were applied with an over-the-row shielded boom sprayer using six TeeJet Twin Flat Spray 608004VS tips delivering 40 gpa at 45 psi. Subplots consisted of 3-vine panels of four standard wine grape cultivars—'Cabernet Franc', 'Cabernet Sauvignon', 'Chardonnay', and 'Merlot'—arranged in a randomized complete block design. The entire vineyard received a season-long maintenance program for weed control and was treated with Sevin XLR (1qt/A) on 3 Jul and 25 Jul for Japanese beetle control. Disease severity ratings were made on 5 Sep for 'Chardonnay' and 'Merlot' and on 19 Sep for 'Cabernet Franc' and 'Cabernet Sauvignon', approximately one week before fruit matured. In each plot, a visual evaluation was made of the percentage of the area infected on each of three shoots and the percentage of fruit infected on each of three clusters. Rainfall amounts at LESREC were 5.60, 0.97, 2.44, 2.03, 4.10, and 0.91 inches for Apr, May, Jun, Jul, Aug, and Sep, respectively.

Disease pressure was light to non-existent for all diseases except black rot. Despite favorable weather from budbreak through veraison, no powdery mildew was seen until 5 Sep, when lesions appeared on scattered shoots of 'Chardonnay' in the control and "soft" treatments, but not on the fruit. Phomopsis fruit rot was observed on a few 'Chardonnay' clusters in the Grower 2 and "soft" treatments, though not enough to analyze. There were high levels of black rot on untreated shoots and clusters. Because there was a significant interaction between cultivar and treatment for black rot, the cultivars were analyzed separately. All treatments significantly reduced the severity of black rot on clusters of all cultivars compared to the control. The optimal and Grower 1 programs, which included a fungicide that was effective against black rot (Manzate, Captan, Nova, Pristine, or Abound) in every application from budbreak through post-bloom, numerically reduced the severity of black rot on clusters in all but one case, though they were not statistically different (P =0.05) from other treatments.

		Severity of black rot by cultivar							
		Cabernet Franc		Cabernet Sauvignon		Chardonnay		Merlot	
Treatment and rate/A	Timing[z]	Shoot[y]	Fruit[x]	Shoot	Fruit	Shoot	Fruit	Shoot	Fruit
Optimal program									
Yellow Jacket Wettable Dusting Sulfur II 90% 4.0 lb	1–4, 6, 8–12								
Manzate ProStick 75WDG 4.0 lb	1–4, 6								
Manzate ProStick 75WDG 3.0 lb	5, 7								
Nova 40W 5.0 oz	5, 7								
Quintec 2.08SC 4.0 fl oz	6, 8								
Pristine 38WG 12.5 oz	9, 10								
ProPhyt 4.2L 2.5 pt/100 gal	5–14								
Elevate 50WDG 1.0 lb	5, 6, 12								
Vangard 75WG 10.0 oz	11, 14	0.2 b[w]	0.4 b	0.5 b	0.1 b	0.3 b	1.7 c	0.2 b	0.4 c
Grower 1 program									
Yellow Jacket Wettable Dusting Sulfur II 90% 2.0 lb	1–6								
Yellow Jacket Wettable Dusting Sulfur II 90% 3.0 lb	8–10								
Captan 50WP 2.0 lb	1, 3, 7								
Captan 50WP 4.0 lb	9								
Captan 50WP 1.0 lb	10								
Manzate ProStick 75WDG 4.0 lb	2, 4								
Pristine 38WG 12.0 oz	5								
Nova 40W 4.0 oz	6								
Abound 2.08F 12.0 fl oz	7, 14								
Tenn-cop 5E 2.0 qt	8, 10								
Elevate 50WDG 0.5 lb....................	10	1.3 ab	0.9 b	2.2 ab	5.7 b	2.2 ab	2.7 c	1.1 b	1.0 bc
Grower 2 program									
Yellow Jacket Wettable Dusting Sulfur II 90% 3.0 lb	1, 3, 4, 7, 10, 11								
Yellow Jacket Wettable Dusting Sulfur II 90% 4.0 lb	2								
Manzate ProStick 75WDG 3.0 lb	1–4								
Nova 40W 5.0 oz	4, 10								
ProPhyt 4.2L 2.5 pt/100 gal	6, 10–14								
Pristine 38WG 12.5 oz	5, 7, 10								
Elevate 50WDG 1.0 lb	6, 14								
Captan 50WP 4.0 lb	12, 13								
Armicarb 100 85% 5.0 lb/100 gal....	12–14	0.8 ab	0.8 b	1.4 ab	9.3 b	0.8 b	13.3 c	0.6 b	3.2 bc
"Soft" program									
Yellow Jacket Wettable Dusting Sulfur II 90% 5.0 lb	1–11								
Captan 50WP 3.0 lb	2								
Armicarb 100 85% 5.0 lb/100 gal	5–7, 11–14								
ProPhyt 4.2L 2.5 pt/100 gal	5–14	0.4 b	3.2 b	1.7 ab	7.1 b	1.4 b	47.2 b	0.4 b	6.2 b
Untreated		4.3 a	19.7 a	5.7 a	85.4 a	7.1 a	100.0 a	9.8 a	88.7 a

[z] Dates and phenological stages of 'Chardonnay' for spray applications: 1 = 27 Apr (0–1 in. shoot), 2 = 4 May (3–5 in. shoot), 3 = 10 May (10–12 in. shoot), 4 = 17 May (12–17 in. shoot), 5 = 24 May (pre-bloom), 6 = 31 May (bloom), 7 = 7 Jun (post-bloom), 8 = 14 Jun (1st cover), 9 = 25 Jun (2nd cover), 10 = 5 Jul (3rd cover/bunch closing), 11 = 16 Jul (4th cover), 12 = 26 Jul (5th cover/veraison), 13 = 7 Aug (6th cover), 14 = 21 August (pre-harvest).
[y] Percentage of leaf area infected.
[x] Percentage of fruit in cluster infected.
[w] Data were arcsin-transformed before analysis; actual data are shown. Means followed by the same letter are not significantly different at *P*=0.05 according to the Bonferroni (Dunn) t-test, which controls for experimentwise error.