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PROCEEDINGS

Cumberland - Shenandoah

Fruit Workers Conference

69TH ANNUAL MEETING

NOVEMBER 18-19, 1993
HARPERS FERRY, WEST VIRGINIA

Cumberland - Shenandoah Fruit Workers Conference -- Program Highlights

The 69th meeting of the Cumberland-Shenandoah Fruit Workers Conference was hosted by West Virginia (West Virginia University) at the Cliffside Inn in Harpers Ferry, WV. The meeting was held on Thursday and Friday, November 18-19, 1993, with 64 registered participants and 59 presented papers. Alan Biggs was the General Chair and Chair of the Plant Pathology Section, Henry Hogmire was Chair of the Entomology Section and Morris Ingle was Chair of the Horticulture Section. Alan Biggs appointed a nominating committee from New Jersey and South Carolina (Dean Polk and Eldon Zehr, respectively) to nominate officers for the 1994 meeting.

The Thursday morning session started with a "Call of the States", consisting of brief reports of crop conditions and pest summaries for the 1993 season. The General Session was devoted to the topic of regionalization of fruit research and extension programs in the PA-MD-WV-VA region. The session began with a presentation by Dr. Charles Krueger et al. and was followed by a panel presentation and then a broad general discussion among the members. Panel members were Paul Steiner (MD), Rick Heflebower (MD), Lynn Moore (MD), Bill Huehn (National Fruit Products Co., VA), Keith Yoder (VA), and Ed Rajotte (PA).

Following the General Session, three concurrent sessions were held on Thursday afternoon and two concurrent sessions were held on Friday morning. There were 8 presentations in Horticulture, 25 in Plant Pathology and 26 in Entomology. On Friday morning, Deborah Shaffer (USDA) and Win Cowgill (NJ) provided information on the use of Internet and the Apple Discussion Group on Internet. Their program was repeated for the entomologists prior to the Business Meeting.

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69th Cumberland-Shenandoah Fruit Workers Conference
Minutes of Business Meeting

John Sencindiver, Interim Director, WVU Division of Plant and Soil Sciences, formally **welcomed CSFWC participants** on behalf of the host state, West Virginia. He commended the group for providing the mechanism for informal cooperation among state and federal fruit crop research and extension personnel during the past 69 years.

Old Business:

George Greene moved and Rob Crassweller seconded that:
The **next CSFWC be held November 17 and 18, 1994** and that the officers for the 1994 meeting investigate new sites along I-81 (near Martinsburg). Motion carried.

Host states for the next conference are New Jersey and South Carolina. The nominating committee for the 70th conference selected the following officers for the 1994 meeting: Dean Polk, general chairperson; Bill Tieljen, Secretary-Treasurer; Clyde Gorsuch, Entomology Section Chairperson; Walker Miller, Plant Pathology Section Chairperson; Bill Olien, Horticulture Section Chairperson.

Secretary-Treasurer, Tara Baugher, reported that **64 individuals registered** for the 1993 meeting and that the current **treasury** balance was $1158.18. After paying Cliffside for breaks and preparing and mailing the proceedings, the final balance will be forwarded to New Jersey for the 1994 meeting.

Rob Crassweller moved and Bob Rouse seconded that:
On the **1994 registration form** a column be added for people who just want to order the proceedings. Motion carried.

Section Chairpersons, Morris Ingle (Horticulture), Alan Biggs (Plant Pathology), and Henry Hogmire (Entomology) gave reports on the concurrent sessions (individual papers in proceedings).

Alan Biggs reported that West Virginia followed through on the 1992 motion to investigate the cost of the "Steiner" **method of doing proceedings** vs the traditional method. The cost comparison was $25 vs $4, so the 1993 proceedings will be handled as in the past.

Ken Hickey moved and Larry Hull seconded that:
The CSFWC **Mission Statement** (printed inside of front cover) be adopted. Motion carried.

Alan Biggs reported that West Virginia also followed through on the 1992 motion to develop a **list of fruit workers in the Cumberland-Shenandoah region** and their major responsibilities. The list is published in these proceedings and **is to be updated by host states every two years.**

George Greene moved and Steve Miller seconded that:
Each state send a **written summary of the Call of the States** to West Virginia for inclusion in

the proceedings by December 15th. Motion carried.

Alan Biggs announced that uncollated papers should also be submitted no later than December 15th.

CSFWC participants discussed the possibility of organizing a committee to investigate **opportunities for cooperating with the SE fruit workers' group.** It was decided that this should be discussed further in 1994.

New Business:

There was a **moment of silence** to remember past members George Rock and Frank Huyettson.

Tara Baugher and Bill Kleiner reported on the outcome of the meeting on the **regional fruit school planning process.** Ten individuals responded to Rob Crassweller's questionnaire. Participants in the discussion reviewed questionnaire results and recommended that 1) the regional fruit school be held every two years rather than every year; 2) the audience include growers, county staff and industry consultants; 3) the hosts be Pennsylvania (1995), West Virginia (1997), Maryland (1999), New Jersey (2001) and Virginia (2003); 4) the dates and locations be decided by the planning committee but that ample advanced notice be given to potential participants; and 5) the planning committee (2 members/state) hold its first meeting one year in advance of the fruit school.

Larry Hull and Paul Steiner reported on subgroup meetings to address **how to form a CSFWC executive council on regionalization** of fruit research and extension programs. Considerable discussion ensued.

Ross Byers moved and Larry Hull seconded that:
A **committee be formed** to look into the feasibility of forming a CSFWC council to interact with administrators and growers about future regionalized efforts in tree fruits. Motion carried.

Paul Steiner moved and Rick Heflebower seconded that:
The **committee be composed of** 3 representatives (a horticulturist, an entomologist and a plant pathologist) from Virginia, West Virginia, Maryland and Pennsylvania and 1 representative from USDA and New Jersey. Motion carried.

George Greene moved and Ross Byers seconded that:
Each state/agency select their own representatives and send the list to Tara Baugher by December 15th. Motion carried. (List is printed inside of front cover of proceedings.)

Morris Ingle moved and Ross Byers seconded that:
George Greene convene the first meeting of the committee. Motion carried.

Alan Biggs called for **suggestions for the general session for the 1994 conference.** There was general agreement that the topic should once again be regionalization and that 1 key administrator from each institution and 1 representative from each horticultural society (preferably a steering committee member) be in attendance.

Ken Hickey moved and Morris Ingle seconded that:
The **meeting be adjourned**. Motion carried.

Future meetings and host states:

1994 - New Jersey and South Carolina
1995 - Virginia
1996 - Maryland and Delaware
1997 - North Carolina
1998 - USDA
1999 - Pennsylvania (75th anniversary)
2000 - West Virginia

Respectfully submitted,

Tara A. Baugher, Secretary-Treasurer

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FRUIT WORKERS IN THE CUMBERLAND-SHENANDOAH REGION

Fruit Worker	Discipline	Fruit Research	Fruit Extension	Fruit Teaching	Areas of Emphasis in Fruit Crops
		% of Total Appointment			
DELAWARE					
Mulrooney*	Plant Pathology		5		Disease ID In IPM
Whalen*	IPM		10		Tree Fruit IPM
MARYLAND					
Dively	Entomology	5	5		Strawberry, Tree Fruit IPM
Heflebower	Regional Horticulture Specialist		100		All Fruit
Rouse	Regional Horticulture Specialist		50		Small Fruit, Peach
Schlimme	Horticulture		20	10	Post Harvest, Peach Packaging
Steiner	Plant Pathology		50	50	All Fruit
Solomos*	Horticulture	33			Postharvest Physiology-Apples
Swartz	Horticulture	90		10	Small Fruit
Walsh*	Horticulture	30		10	All Fruit
NEW JERSEY					
Cowgill	Area Horticulture Specialist		50		All Fruit
Durner	Horticulture, Physiology	70			Peach, Apple
Vacant	Pomology				
Fiola	Horticulture	30	70		Strawberry, Grape, Raspberry
Vacant	Entomology				
Frecon	Horticulture Agent		70		All Fruit
Goffreda	Genetics/Breeding	70			Peach, Apricot, Apple
Majek*	Weed Scientist		25		All Fruit
Miller	Horticulture Agent		80		Apple, Peach, Tree Fruit
Pavlis	Horticulture Agent		90		Blueberry, Grape, Bramble
Polk	IPM Agent		100		Grape, Apple, Peach, Pear, Blueberry
Vacant	Plant Pathology	30	70		All Fruit
Tietjen	Pathology		50		Apple, Peach
Vorsa, L.	Horticulture Agent		30		Tree Fruit
Vorsa, N.	Breeding/Horticulture	70	30		Blueberry, Cranberry
NORTH CAROLINA					
Ballington	Horticulture	70		30	Blueberry, Bramble, Strawberry Breeding
Blankenship	Horticulture	80		20	Postharvest Apple
Mainland	Horticulture	20	80		Blueberry, Grape

*Tree Fruit commitment is less than 50%, but university indicated that contribution to tree fruit program was to significant that individual should be listed.

		% of Total Appointment			
Fruit Worker	Discipline	Fruit Research	Fruit Extension	Fruit Teaching	Areas of Emphasis in Fruit Crops
Meyer	Entomology	80		20	Peach, Small Fruit IPM
Parker	Horticulture	20	80		Orchard Management, Ground Cover Management
Poling	Horticulture	20	80		Plasticulture-Strawberry, Small Fruit
Ritchie*	Plant Pathology	20	15		Epidemiology, Control of Peach Diseases
Shelton*	Soil Science	35	10		Soil Science
Sorensen*	Entomology		30		Tree and Small Fruit, IPM
Sutton	Plant Pathology	60	20	20	Epidemiology, Control of Apple Diseases
Unrath	Horticulture	100			PGR, Fruit Physiology-Apple
Werner	Horticulture	70		30	Peach Breeding
Walgenbach	Entomology	35	25		Apple, IPM
Young	Horticulture	80		20	Rootstock Physiology-Apple
PENNSYLVANIA					
Crassweller	Horticulture	15	85		Tree Fruit
Daum*	Agricultural Engineering		15		Pesticide Application Technology and Mechanization
Goulart	Horticulture	25	75		Small Fruit
Greene	Horticulture	75	25		Tree Fruit, General Culture
Haeseler	Horticulture	75	25		Grape
Halbrendt	Plant Pathology	80	20		Tree Fruit (Nematology and Virus Diseases)
Hickey	Plant Pathology	85	15		Tree Fruit (Fungal & Bacterial Diseases)
Hull	Entomology	91	9		Tree Fruit Pest Management Resistance
Kleiner	Regional Extension Agent		100		Tree & Small Fruit
Rajotte	Entomology	15	85		All Fruit
Saunders	Entomology	25	25		Grape
Travis	Plant Pathology	15	85		All Fruit
SOUTH CAROLINA					
Caldwell	Horticulture	40		30	Small Fruit
Gorsuch	Entomology	15	30	7	Peach, Apple, Small Fruit
Head	Area Agent		100		Apple
King	Horticulture		100		Peach, Apple, Small Fruit
Miller	Plant Pathology	5	30		All Fruit
Newall	Research Associate	100			Peach Breeding

Fruit Worker	Discipline	% of Total Appointment Fruit Research	 Fruit Extension	 Fruit Teaching	Areas of Emphasis in Fruit Crops
Olien	Horticulture	75		25	Tree Fruit Cultural Practices & Physiology
Reighard	Horticulture	85	15		All Fruit
Scott	Plant Pathology	100			Peach, Fruit Viruses
Taylor	Area Agent		50		All Fruit
Vissage	County Agent		25		Apple
Watson	Plant Pathology	15	85		Peach
Zehr	Plant Pathology	75			Peach, Apple
USDA-BELTSVILLE, MD					
Faust	Plant Physiology	100			Dormancy, Bud Break
Galletta	Plant Genetics	100			Small Fruit Breeding
Hartung	Molecular Genetics	100			Citrus Bacterial Diseases
Korcak	Soil Science	100			Small Fruit Nutrition
Maas	Plant Pathology	100			Small Fruit Pathology
Rowland	Genetic Engineering	100			Blueberry Chilling
Zimmerman	Plant Physiology	100			Tissue Culture-Organogenesis
USDA-CHATSWORTH, NJ					
Ehlenfeldt	Genetics	100			Breeding, Genetics of Blueberry
Stretch	Plant Pathology	100			Diseases in Blueberry, Cranberry
USDA-KEARNEYSVILLE, WV					
Abeles	Postharvest	100			Postharvest Physiology
Bassett	Plant Physiology	100			Molecular Biology, Fruit Physiology
Bell	Horticulture	100			Pome Fruit Breeding
Brewster	Plant Pathology	100			Blueberry Diseases
Brown	Entomology	100			Biological Management of Apple Insect Pests
Callahan	Genetics	100			Fruit Germplasm Improvement, Molecular Biology
Cohen	Molecular Biology	100			Fruit Physiology
Glenn	Soil Science	100			Soil Science, Orchard Floor Management, Root Physiology
Horton	Horticulture	100			Stone and Pome Fruit Culture
Janisiewicz	Plant Pathology	100			Biological Control of Post-Harvest Diseases
Miller	Horticulture Pomology	100			Fruit Culture, Canopy Management
Peterson	Agricultural Engineering	100			Production and Harvesting Mechanization

Fruit Worker	Discipline	% of Total Appointment Fruit Research	Fruit Extension	Fruit Teaching	Areas of Emphasis in Fruit Crops
Puterka	Entomology	100			Host Resistance and Biocontrol of Pear and Peach Insects
Scorza	Horticulture	100			Stone Fruit Breeding, Genetics
Solar	Chemistry	50			Plant Physiology, Chemical Analysis
Takeda	Horticulture	100			Small Fruit Culture, Physiology
Tworkoski	Physiology	100			Orchard Floor Management, Tree Physiology
Upchurch	Agricultural Engineering	100			Technology for Measuring Postharvest Quality
Van der Zwet	Plant Pathology	100			Epidemiology, Control of Fire Blight
Wilson	Plant Pathology	100			Biological Control
Wisniewski	Physiology	100			Plant Physiology, Cytology
VIRGINIA					
Barden	Horticulture	70		30	Apple Rootstocks, Orchard Systems, Pruning
Byers	Horticulture	75	25		Vole Control, Plant Growth Regulators
Derr	Weed Science	25	75		Weed Management in Horticultural Crops Including Tree Fruit
Horsburgh	Entomology	40	60		Pest Management, Predator, Plant Interaction
Marini	Horticulture	25	75		Plant Growth Regulator Evaluation, Tree Training, Pruning
Pfeiffer	Entomology	75	25		Fruit Pest Management, Development of Alternative Control
Stiles	Horticulture	25	75		Small Fruit, Production Management
Wolf	Viticulture		100		Cultural Aspects of Viticulture, Grape Pest Management
Yoder	Plant Pathology	60	40		Disease Management
WEST VIRGINIA					
Baugher	Horticulture	30	70		Tree Fruit Culture, Intensive Orchard Management
Biggs	Plant Pathology	70	30		Biological Control of Diseases, Fruit Tree Defense Mechanisms
Elliott	Agricultural Engineering	50			Equipment for Intensive Orchard Systems, Peach Thinner
Hogmire	Entomology	30	70		Tree Fruit Pest Management, Containment Spraying
Ingle	Post-Harvest	40			Apple Scald Control, Prediction of Storage Behavior
Popenoe	Horticulture	40	30	30	Black Raspberry, Blueberry, Strawberry Culture

CALL OF THE STATES

Pennsylvania

by William C. Kleiner, George M. Greene, Ken Hickey, Larry Hull and Rob Crassweller

Weather. Pennsylvania's growing season started out cool and wet. The blizzard in March and 6.37 inches of rain in April kept the soils moist. The month of May was colder than average with only 2 inches of rain. June through August was hot and dry, although we had approximately 6 inches of rain during that time period. Along with the rain on June 8, July 3, 19, 29, August 6 and September 3, Adams County growers were hit with hail. Hail-hit orchards were found from one end of the county to the next. According to a number of growers and Knouse Foods field representatives, hail damage was more widespread than in previous history. September and October brought more rain which caused problems with the harvest season.

Apples:

Production. Apple crop estimates in July were around 13 million bushels for the entire state. Mid-way into the harvest season many growers were picking out short of their estimates. By October, Pennsylvania apple crop estimates were around 11 to 12 million bushels.

Quality. With most varieties, fruit size was below average. In south central Pennsylvania we had below normal temperatures in May during the time of cell development of apples. We feel this led to a lot of small apples this past season. A considerable amount of fruit drop throughout the state was recorded this growing season. A nice crop of Yorks was harvested from most growers' orchards. We saw a full crop of Golden and Red Delicious, but both varieties had small fruit. Thinning seemed to be a problem this year. Some growers didn't get enough fruit off the trees.

Insects. This year was a quiet year for insects except for the tentiform leafminer. This year has been the worst leafminer year that Pennsylvania has seen.

Diseases. There were 11 primary infection periods for apple scab and three secondary infection periods. Apple scab was not a major problem in most orchards. It was a good year for fire blight in the south central part of the state. An isolated case was observed in the northern part of Adams County. Surrounding orchards have not had a major problem with this disease in the past. The case will be checked to see if it is the susceptible strain of the organism.

Peaches:

Pennsylvania had a large peach and nectarine crop this year. Good size and quality were observed, considering the hot and dry weather in June and July. The major problems with peaches this year were hail and a sluggish market for most growers. Blossom blight was observed in a number of growers' blocks. One grower block in northern Adams County had a high incidence of blossom blight.

Sour Cherry:

Pennsylvania growers had a large sour cherry crop this year. Good size and quality were observed. Of course poor prices were the biggest problem with the cherry crop. Plum borer was documented for the first time in Adams County orchards. This insect will be monitored to see if it is going to become a major problem.

Maryland

by Richard F. Heflebower, Jr.

Weather and Fruit Development. The 1993 season began with a very cool, wet spring. This was followed by an extremely hot, dry summer. Many days with highs in the 90's were accompanied by six weeks of no measurable precipitation. Rain began to fall again in late August followed by record-setting heat in the first week of September.

The weather adversely affected peach size, particularly early maturing varieties. Apple size was small, but better than expected considering the extreme heat and drought conditions. Total packout averaged about 80 percent which pleased most growers. Hail was reported scattered throughout many locations in Maryland. No reports indicated severe crop damage but slight injury to peaches and apples was widespread.

Pest Problems. Conditions were conducive to apple scab early in the season, but most growers were able to control it well with the fungicides that are available. Codling moth trap catches were the highest they have been in Maryland for the past four years. The second generation of tufted apple budmoth was quite late. The peak flight did not occur until the first week of September.

West Virginia

by Morris Ingle, Tara A. Baugher, Alan R. Biggs and Henry W. Hogmire

Horticulture. Orchards escaped freezing temperatures in April and May, but in March, following the blizzard of '93 (morning of March 15th), the temperature dropped to -1 degree F in low elevations. At 550 ft elevation, bud survival was 28% in Loring, 48% in Blake, 81% in Cresthaven and 82% in Redhaven. Full bloom was 1 week later than average in peaches (4/20) and 3 days later than average in apples (4/30 to 5/4). Weather conditions were favorable for pollination, set and cell division, but fruit tree responses to chemical thinners were generally poor.

July and August were dry, and Hampshire and Morgan counties were declared eligible for disaster assistance. Hail was reported in a number of orchards, primarily in western counties. Harvest of peaches began 1 week later than normal but finished on a normal schedule. Harvest of apples was also later than normal, and there were problems with low soluble solids, premature fruit drop and fruit size.

Plant Pathology. With relatively high apple scab inoculum overwintering after the wet 1992 season and wet conditions at bud break preventing many growers from making an early fungicide application, early infections resulted on sepals and cluster leaves. Fruit scab was at unacceptable levels in some locations although economic losses due to scab were overshadowed by the effects of drought and hail. Incidence of powdery mildew was high on susceptible apple cultivars. Brown rot on stone fruits was not a problem in 1993.

Entomology. Prebloom insect emergence was about 10 days later than in 1992. Several orchards experienced high summer populations of spotted tentiform leafminer, resulting in above threshold incidence of mines. Despite the hot and dry weather in July and August, mites were not especially troublesome as there was a good predator response in most orchards. Rose leafhopper has continued to be an abundant pest of apple during July. The increased planting of dwarfing rootstocks has been accompanied by increased incidence of dogwood borer and American plum borer in burrknots.

Virginia

by Ross Byers

Fruit Development. In Virginia, apple bloom was about 7 days later than normal. Fruit growth was very rapid after bloom. Spur Delicious fruit was about 10 mm in size 10 days after full bloom. In a typical year, fruit reach 10 mm about 16 days after bloom. Very little cloudy weather occurred in the first 2 weeks after bloom. Since fruit grew very fast and growers were generally late with thinning sprays, fruit thinning responses were less than desirable. Most varieties were over-cropped in 1993, leading to small fruit size. No frosts reduced king fruit set, which is a cause of small fruit size in some years. Dry weather in July and August 1993 further reduced fruit size. Delicious prices were not good in 1993. Crop estimates in August 1993 indicated 10% higher potential than the average of the last 5 years. These estimates were reduced to 5% lower than the average by about November 1. The role of the production estimates in pricing of apples in 1993 was not known.

Pest Problems. Tentiform leafminer and leaf rollers were more numerous than in recent years. Additional and significant fruit drop appeared to be associated with leafminer injury. No unusual spring and summer disease problems were encountered during the 1993 season. Early ascospore maturity, an early scab infection period (April 1-2) and a heavy secondary infection period (May 4-5) resulted in a few scab problems on cultivars with early, unprotected tissue and poor protection for the secondary period.

Vole populations were heavier than last season, and increasing deer populations seem to cause more damage each year.

North Carolina

by James F. Walgenbach

Apples. 1993 was characterized by a dry, hot summer, with drought conditions prevailing from July through September. A heavy apple bloom was approximately two weeks later than normal, and most varieties were blooming simultaneously. The heavy crop (7.2 million bu) and dry weather conditions contributed to an abundance of small apples, many of which went to juice. Poor processing and juice prices resulted in a difficult year for many growers.

With the exception of a relatively high level of apple scab, disease pressure was low in 1993. Tufted apple budmoth and spotted tentiform leafminer populations were high in 1993. Tufted apple budmoth populations and resulting damage were the highest in recent memory. Spotted tentiform leafminer populations increased substantially between first and second generation. However, third generation populations were heavily parasitized, with 40-50% parasitism of mines common by late August.

Peaches. There was a good North Carolina peach crop in 1993, with approximately 38 million pounds harvested from 4,000 acres. In contrast to the apple crop, peach prices remained fairly good throughout the season, with the majority of the crop sold for local retail and wholesale markets. There were no unusual incidences of insect or disease problems in 1993.

South Carolina

by Walker Miller

Production. Apple production in 1993 was 60 million pounds, similar to 1992 and up from the 40 million pounds of 1991. The value of the apple crop was 3.6 and 7.5 million dollars in 1991 and 1992 respectively. The value of apples in 1993 is projected as low due to small size associated with low light levels just after bloom and drought.

Peach production was 250 million pounds in 1993, up from the 170 million in 1992 and down from the 310 million in 1991. The value of the peach crop was 42 million dollars in 1991 and 19 million dollars in 1992. Peach size was also small and is anticipated to impact the total crop value in 1993.

Disease and Insect Control. Excessive rainfall and cool temperatures in January and continuing through late April delayed the season and resulted in wide spread peach tree death in the Ridge area. Saturated soils during bloom and leaf out is attributed as the cause. By late May incipient drought followed by full drought in mid-June further delayed both the apple and the peach crop. The delay was as much as 14 to 28 days in some varieties. Fruit rots and scab were insignificant in both peaches and apples. Phomopsis canker and brown rot blossom blight, shortly after bloom, were the most evident disease problems in peaches. Growers are concerned over the loss of plant pharmaceuticals, especially in the area of summer rots in apples. It is unknown if improved sanitation efforts are going to be sufficient to provide control of summer rots in apples.

Severe drought made green June beetle and Japanese beetle emergence erratic and no special insect problems were noted in peaches. In apples, spotted tentiform leafminer jumped from a few mines per leaf in early July to 12 to 15 per leaf by late July in some areas. High levels of parasitism were noted in other areas, which suppressed spotted tentiform leafminer populations. In highly susceptible Red Delicious cultivars, Alternaria leaf spot caused some defolication. The combination of leafminer, Alternaria and drought has some growers concerned over return bloom. The Long Creek area of the state is suffering an outbreak of codling moth with growers indicating that they are not getting control despite increased spraying frequency. There were several complaints of poor fruit finish associated with the use of dimethoate especially where it was used with Bond, a spreader sticker. There are some indications that growers were using high rates of dimethoate. Growers had switched to dimethoate for aphid control because of price.

Grower Assessments of Problems. Apple acreage is anticipated to decline by 25% by the 1994 season. Peach acreage is at 28,000, down from over 40,000 about 10 years ago and will probably drop another 2000 acres. There is no significant apple acreage being planted. The mood of peach and apple producers is depressed. Direct marketing and value added enterprises were the most positive note for both commodities. The most significant problem identified by both groups of growers was marketing. Apple producers identified loss of chemicals and lack of a material to control Alternaria leaf spot as the second and third place problems. In peaches, control of red spot and pocket rots were identified as the second and third place problems.

New Jersey

by Dean Polk and Jerome L. Frecon

1993 was a good year for production throughout most of the state, but a poor year for marketing, especially for wholesale growers.

Fruit Set and Weather. Fruit set was good in most areas, except in isolated orchards in northern counties where frost took a heavy toll on peach production. Cold, blustery winds also reduced bud numbers in exposed sites. In southern counties which have the bulk of the peach production acreage, no frosts were experienced during bloom.

Dry weather was an important factor on the light soils in southern counties. The lack of rain in June and July reduced fruit size in early varieties grown in Cumberland County and on non-irrigated sites. Overall fruit quality, flavor, and color were excellent.

Pests. Disease pressure was light in most peach and apple orchards. Insect pressure on apples was higher than normal, with high levels of spotted tentiform leafminers. Several apple sites were seen that had fruit infestations of codling moth and European corn borer. Tufted apple budmoth was present on both apple and peach crops.

Marketing. Prices started at an acceptable level, but as Redhaven peaked, pressure from South Carolina supplies and the usual excellent California promotional program made it difficult to move New Jersey peaches. Even 2 1/2 inch peaches were selling below production costs during Loring season. Prices eventually increased, but movement of 2 1/4 inch or smaller fruit was difficult. It was obvious that only growers with good wholesale marketing plans and retail outlets moved peaches above production and marketing costs.

According to the 1992 tree fruit survey peach acreage has declined over two thousand acres since 1982. Nectarine acreage has increased about 350 acres. A comparison of wholesale prices relative to production costs makes it easy to understand why this has occurred.

Apple acreage has declined to about 4,000. Over 50% of the apple production goes to the processing market, which continues to offer low prices in comparison to production costs. Fresh market apple production centers around Delicious. Prices have been acceptable with most fresh market fruit being sold before Christmas.

Research and Extension. Fruit research and extension activities continue to be hurt by budget constraints and retirements. Dr. Stu Race, Extension Specialist in Entomology retired effective July 1, 1993 and Dr. Jack Springer, Extension Specialist in Plant Pathology retired effective September 1, 1993.

GENERAL SESSION

10/25/93

Discussion Paper on the Proposed Regionalization of Tree Fruit Research and Extension Programs in Maryland, Pennsylvania, Virginia, and West Virginia

Prepared as a follow up to the regional meeting with representatives of the tree fruit industry at Harpers Ferry, West Virginia, on June 30, 1993.

I. Introduction

To say that we are living in a period that can best be described as "times are a changing" is an understatement. What is interesting about this descriptive phase is not the word changing, but the word times. For agriculture, as well as its support entities (research and extension), change has been occurring for decades. However, the realization and/or commitment to deal with this change must occur now. This issue can no longer be delayed or ignored.

Throughout this century, farms have decreased in number, but have grown larger. Today, there are approximately 2.2 million farms, 10 percent of them accounting for nearly 75 percent of all production agriculture in the United States. In addition, to the changing scene in agriculture, the number of support professionals in research and extension activities has also declined. What has not declined have been the challenges that face agriculture which not only include issues of increasing production efficiency, but also deal with the environmental and social costs associated with productivity gains.

The tree fruit industry is a mirror of this changing scene in agriculture, especially in this four-state area. However, the leaders of federal and state research and extension programs in this region are beginning to seek ways to jointly deal with the issues of the tree fruit industry.

A tour of the tree fruit research and education centers in the Cumberland-Shenandoah Region was conducted on April 27-29, 1993. Participants were leaders from the USDA/Agricultural Research Service and the Agricultural Experiment Stations and Cooperative Extension Services in Maryland, Pennsylvania, Virginia, and West Virginia. The objectives of the tour were: to determine the scope and priorities of the research and extension programs at each location; to identify program and personnel strengths, weaknesses, and regional complementarity; to explore joint approaches to research and extension program development; and to identify opportunities that may exist for formal collaboration within the region.

A regional meeting was held on June 30, 1993, with industry representatives to hear their needs and priorities for tree fruit research and extension programs in the four-state area. In addition, the opportunities for and problems of regionalization of future research and extension activities were identified. An initiative that arose from this regional meeting was the formation of a subgroup to prepare a "discussion paper" on the issues at hand and to develop a proposed action plan. It is the guidance and direction of this "discussion paper" that will permit the tree fruit growers, processors, agri-business persons, researchers, extension specialists, and administrators in the four-state region to deal with the changing times in an effective and timely manner.

II. Industry Status and Trends

This analysis emphasizes apples and peaches since they are the major tree fruits grown in the four-state area. Three parameters were evaluated: bearing acreage, total production, and the value of utilized production.

Apple bearing acreage has decreased in Pennsylvania from 27,000 acres in 1982 to 24,000 acres in 1992; in Virginia from 22,400 acres in 1982 to 19,800 in 1992; and in West Virginia from 16,000 in 1982 to 13,100 in 1992 (Figure 1). Annual apple acreage data are not available for Maryland, but the number of acres has decreased from 5,660 in 1980 to 3,205 in 1992. Across the four states, this represents a decrease in acreage of 15 percent since the early 1980s. However, probably the most important measure of an industry is its productive capacity. Total apple production generally decreased in the late 1980s within the region (Figure 2). However, since 1989 or 1990, there appears to be a trend towards more production in the four states. The value of utilized production is generally lower today than a decade ago (Figure 3).

Peach bearing acreage has remained constant in Pennsylvania and decreased slightly in Virginia and West Virginia during the period 1982 through 1992 (Figure 4). Annual peach acreage data are not available for Maryland, but the number of acres has decreased from 2,500 in 1980 to 1,399 in 1992. The total production of peaches generally declined for all four states from 1982 until 1989 or 1990. The 1985 crop was severely reduced because of a winter freeze that was preceded by an unusually warm period. During the last 2-3 years, there has been a general increase in the total production of peaches in the four-state region (Figure 5). Since 1985 in Pennsylvania and since 1990 in Maryland, Virginia, and West Virginia, there has been a general increase in the value of utilized peach production (Figure 6).

A. Maryland

1. Status

In 1992, Maryland apple and peach growers produced approximately $8.2 million ($5.1 for apples and $3.1 for peaches) in fresh market and processed products. For apples, the value was about $1.6 million below the ten-year average value of $6.8 million. Approximately 524 thousand bushels of apples were produced for fresh market, and 667 thousand bushels were produced for fruit processing in 1992.

Since 1980, the number of apple orchards has decreased from 170 to 159, and apple acreage has decreased by 43 percent. The number of trees planted shows a smaller decrease from 382,360 to 344,439 in 1992. The number of peach orchards has remained constant (147 in 1992) while the acreage has decreased by 44 percent. The number of peach trees maintained for production has also decreased from 216,600 to 149,306.

2. Trends

Apple growers are diversifying their plantings by adding peaches and small fruits in response to the fresh market demands from Mid-Atlantic metropolitan areas. Growers have increased the density of their plantings from less than 100 trees per acre in the 1960s to 200-500 trees per acre today. Also, there is a reduction in apple production capacity with a major shift away from the

Cumberland-Shenandoah Valley. Most of the increases in new acreage result from intensive plantings in smaller blocks of land in southern Maryland, the Eastern Shore, and counties along the Pennsylvania border in the eastern part of the state.

B. Pennsylvania

1. Status

Pennsylvania is a major fruit producing state and usually ranks fourth in the nation with 34,329 acres of commercial orchards in the state. This compares with 44,714 acres in 1982 and 42,647 acres in 1987, showing a trend of declining acreage for the ten-year period. Of the approximately 2.4 million apple trees in the state in 1992, thirty-one percent were standard size and 69 percent were size controlled. Comparable figures for 1987 were 42 and 58 percent, respectively.

Since 1987, the acreages of apples, peaches, pears, cherries, plums, and prunes have decreased. Only the acreage of nectarines has increased. In 1992, the number of apple and peach trees set exceeded those removed. The total farmgate value of apples sold fresh or processed peaked at $63.7 million in 1990; the peak value of peaches sold was $22 million in 1990.

2. Trends

Acreage is declining, but the number of trees is increasing. Some of this can be attributed to more intensive management systems. Acreage will probably remain steady rather than decrease, and tree numbers will continue to increase. Peach acreage will decline slightly as will tart cherry acreage. Approximately 62 percent of the production of apples and nearly all the tart cherries are processed. However, only a small percent of the peaches are processed. The remainder of the tree fruit crops are sold fresh. A recent Mid-Atlantic Produce Marketing study showed there is a potential for increased fresh fruit sales in the Baltimore-Washington market. However, it will take improved quality, packing, and marketing.

C. Virginia

1. Status

Virginia produces an average annual apple yield of approximately 10 million bushels. Approximately 60 percent of the crop is processed into sauce, canned and frozen slices, vinegar, and juice. There are five fairly distinct fruit-producing areas in Virginia -- the Shenandoah Valley, Northern Piedmont, Central Piedmont, Roanoke Area, and the Southwestern Area. The Shenandoah Valley area is the largest in terms of acreage and number of trees.

2. Trends

Since 1982, there has been more than a 30 percent decline in the number of orchards engaged in commercial production and a 12 percent decrease in total acreage in apple production. However, since 1987, seven of the top 10 counties and 11 of the top 16 counties have expanded acreage. Fourteen of the top 16 Virginia counties expanded either acreage or tree numbers, or both, during the period 1987 to 1992. Virginia now has more total trees than in 1963 and more bearing trees than in 1956. The average orchard has expanded from 52 acres to 68 acres, and the average number of trees per orchard has increased from 31,300 to 45,300. There is an apparent trend towards adopting cultural practices that focus on smaller trees in higher density plantings. The peach industry has declined significantly in Virginia to the point where it is now intended primarily for retail sales. Many nonprofitable peach orchards on good sites are being replanted to apples, particularly in the Central Piedmont.

D. West Virginia

1. Status

The tree fruit industry in West Virginia is concentrated in four eastern panhandle counties which account for about 95 percent of the State's fruit crop. During the period 1987 to 1991, West Virginia produced an average of 4.3 million bushels of apples per year and ranked fifth among the eastern states in total production. Total production varied two fold between 1989 and 1992. Much of this variation was due to weather conditions, but the longer term trend in production has been downward. Between 1982 and 1986, total apple production exceeded 5.2 million bushels each year. Since 1986, there has been only one year, 1992, in which production reached that level.

2. Trends

In general, there has been a reduction in acres devoted to tree fruit, but the quantity of tree fruit produced has not decreased in proportion to the change in acreage. Orchardists are planting more trees on size controlling rootstocks and in higher densities per acre then previously. Management levels have intensified and yields have increased.

The proportion of the crop marketed through processors is highly variable. In general, when the crop is large, the proportion used for processing is higher than with smaller crops. This market feature is related to both the quality and availability of fruit. In 1992, a year in which there was a relatively large crop volume, 85 percent of the apples produced went for processing. Nationally about 50 percent of the apples went for processing in that same year. There has been a desire on the part of West Virginia producers to market a large proportion of their crop on the fresh market in order to increase profits. This desire has resulted in some shifts in varieties. There has been a reduction in the number of orchards and in the size of orchards as producers intensified management. The demand for land and difficulties with labor and environmental regulations have also contributed to a reduction in the number and size of orchards. These trends are apt to extend into the foreseeable future.

III. Funding Trends in the Universities/Colleges and the USDA/Agricultural Research Service/Appalachian Fruit Research Station

Funds used to support agricultural research and extension can be categorized into three major sources. First, federal funds are appropriated to land-grant universities through the Hatch Act for agricultural research and through the Smith-Lever Act for cooperative extension. The USDA/Agricultural Research Service receives a direct appropriation from the U.S. Congress for agricultural research. Second, state funds are appropriated to state land-grant universities for agricultural research and extension. The third category is a broad one that includes all grants, contracts, and gifts from public and private sources. Some of these are competitive; others are provided through the political process, especially at the federal level. In some states, income from the sale of excess products of research can be used to support further agricultural research. In general, the program of research and extension for the use of federal and state appropriated funds is decided by the receiving colleges and universities. In contrast, grants and contracts are for specific areas of research and extension, and cannot be shifted as needed to other areas.

The total agricultural research and extension funds for the five organizations and the period FY 1989 through FY 1993 (est.) has ranged from $167 million to $192 million per year (Table 1). Specific funding available for tree fruit programs has ranged from $8.0 million to $9.0 million. Total funding increased in FY 1990 and FY 1991, but since FY 1991 the funding has remained constant at approximately $192 million. The funding allocated for tree fruit research and extension has been level since FY 1991 at $8.0 million to $8.1 million.

During the last five years, the source of funding available for agricultural research and extension has been shifting from appropriated dollars to grants, contracts, and gifts (Table 1). In FY 1989, state and federal funding accounted for 78 percent of the total research and extension funding. By 1992, this had decreased to 73 percent. The reduction in appropriated funds has been made up in part by increases in grants and contracts. In the case of tree fruit funding, the allocation of state and federal funds to these programs by the five organizations has remained constant for the last three years, even though appropriated allocations have been decreasing. However, the amount of grant and contract funds has decreased during the same time. The decrease in total tree fruit funds has not been made up by additional grants and contracts in the tree fruit area.

The total funds and tree fruit funds for the four colleges and the USDA/Agricultural Research Service/Appalachian Fruit Research Station are noted in Table 2. This table also indicates the full-time equivalents directed toward tree fruit research and extension activities. The person capacity in the region has decreased by 16 percent since FY 1989.

IV. Major Issues Facing the Industry

There are many issues facing the tree fruit industry in the four-state region. Because fruit growers, support industries, extension, and research have different perspectives on the subject, a list of the major issues depends upon its origin. At the recent Harpers Ferry regional meeting, industry representatives provided some helpful insight into their current problems. Many of the problems identified were public policy issues (e.g., labor, laws and regulations, marketing, etc.). Cooperative Extension Services, State Agricultural Experiment Stations, and the USDA/Agricultural Research

Service must play a greater role in policy issues either as information input to the policy process or in response to policy initiatives.

The issues seen as "major" by the tree fruit industry representatives at the Harpers Ferry meeting on June 30 are listed in Table 3. The organizations involved in research and extension programs have estimated their current activities and/or capacity in each of the identified areas. If nothing is indicated, very little or no activities are in progress in the program area. In the future, it may be helpful to rank these issues for the allocation of resources. Not all on-going research and extension activities are listed.

V. Possibilities for the Future

A. Short-Term (To be achieved in <1-2 years)

1. Present this "Discussion Paper" at each of the state horticultural association meetings in early 1994. Encourage an open discussion on these "Possibilities for the Future."

2. Establish a Regional Advisory Council, e.g., Council for Sustaining the Tree Fruit Industry in Maryland, Pennsylvania, Virginia, and West Virginia. This council would advise the research and extension faculty/staff on needed programs in the region.

3. Build a strong tree fruit industry coalition within the region. This must be emphasized during the first several years, but should be an on-going activity. Some of the coalition partners identified at the joint meeting in June were universities, industry representatives (growers, processors, suppliers, etc.), government agencies (USDA, USEPA, etc.), environmental organizations (Chesapeake Bay Commission, The Nature Conservancy, etc.), and the news media.

4. Analyze the current research and extension activities in the region. Identify the areas of duplication and complementarity needed to serve the industry in the most effective and efficient manner. Use the Cumberland-Shenandoah Fruit Workers Conference which has been convening for 68 years as the lead in this effort.

5. Expand discussions on sharing research and extension resources (university/USDA personnel, funding, and programs) across state lines. One example of a major cooperative effort that is nearing completion is the production of an orchard monitoring guide which involves contributions from most entomologists, horticulturists, and plant pathologists in the region.

6. Request a joint four-state horticultural association strategy for funding research and extension programs on a regional basis. This must be developed so as to be a win-win situation for both industry and the public sector.

B. Mid-Term (To be achieved in 3-4 years)

1. Increase Regional Advisory Council membership as coalition partners are identified.

2. Encourage a joint annual meeting of the four state horticultural associations, testing the concept of meeting regularly as one regional organization. The New Jersey State Horticultural Society has been meeting with Pennsylvania and Maryland, and they should be included as well.

3. Facilitate an active involvement of the Regional Advisory Council in helping set the tree fruit research and extension agendas.

4. Develop and request funding for at least 1 regional research and/or extension project to serve the needs of the tree fruit industry in the four-state region.

C. Long-Term (To be achieved in 5-6 years)

1. Continue coalition building. Bring in new partners to the Council as new clientele are identified.

2. Increase the levels of regional funding for research and extension programs from public and private sources.

3. Expand the number of regional research and/or extension projects.

* * *

This discussion paper was prepared by the following persons:

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University of Maryland
Craig S. Oliver, Cooperative Extension
Thomas J. Sexton, Research

USDA/Agricultural Research Service/Appalachian Fruit Research Station
Stephen S. Miller, Research

Virginia Polytechnic Institute and State University
Gerald M. Jones, Cooperative Extension
Gerald L. Jubb, Jr., Research

West Virginia University
Barton S. Baker, Research
Rachel B. Tompkins, Cooperative Extension

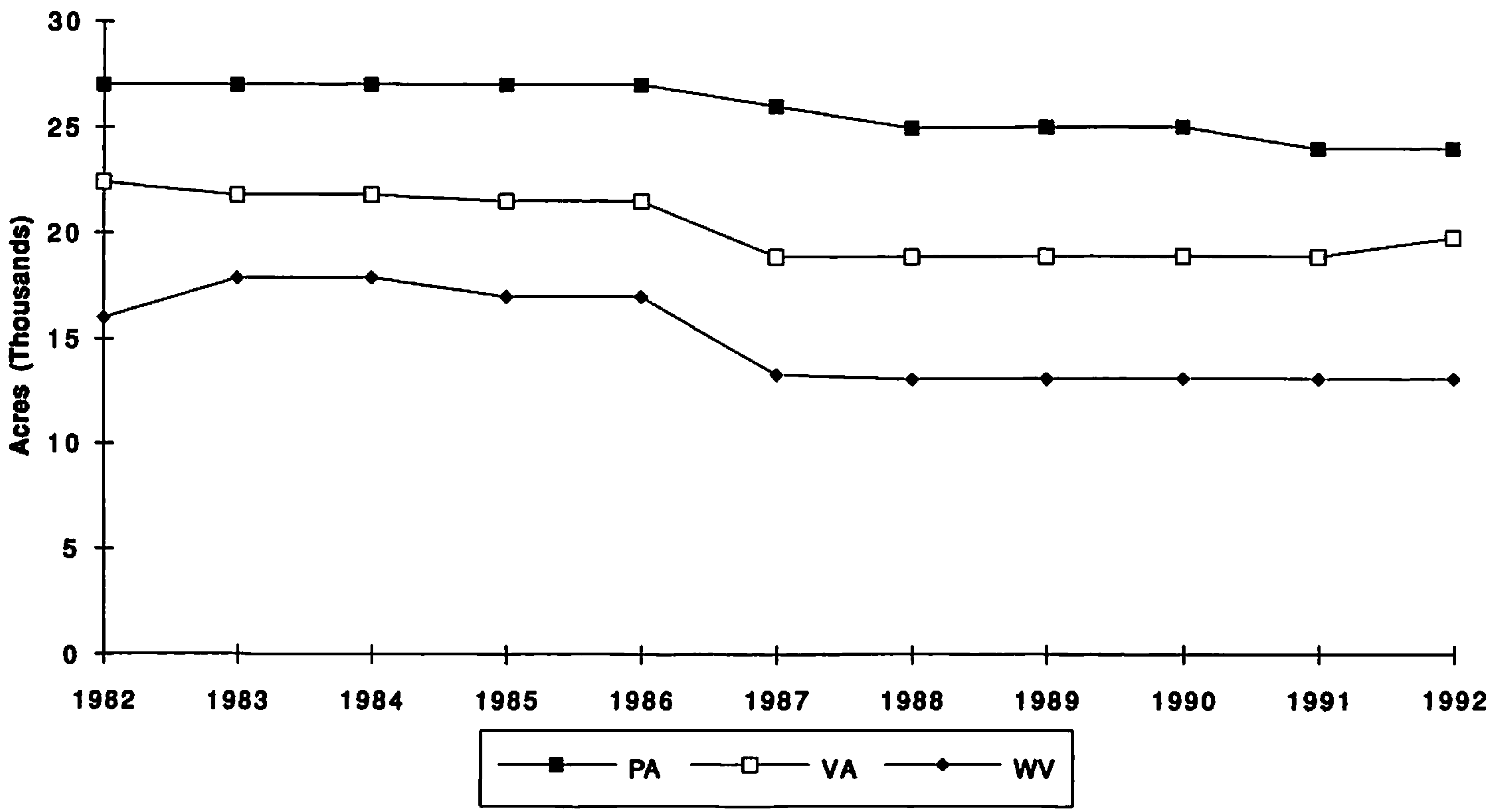

Figure 1. Bearing acreage for apples.

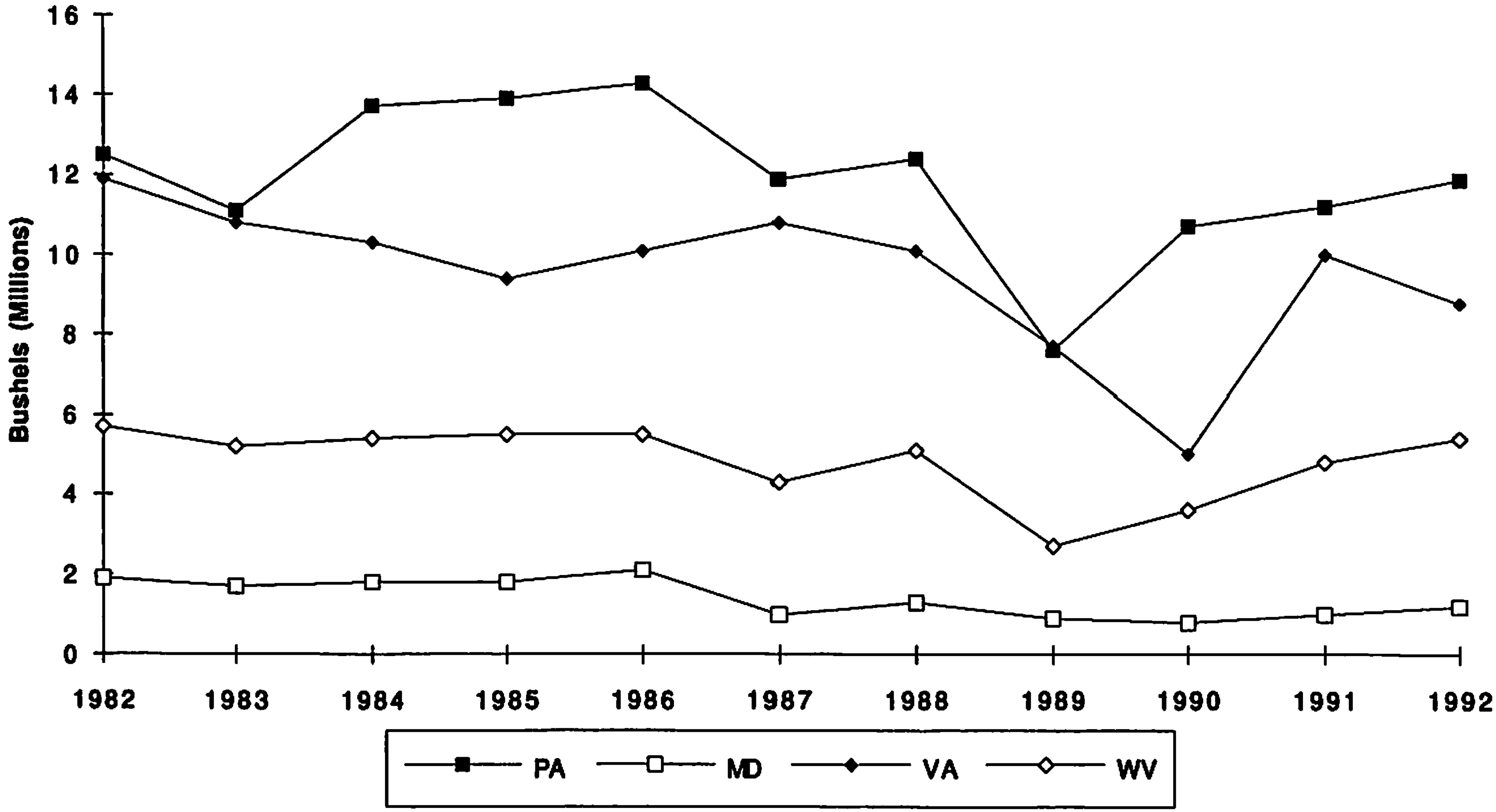

Figure 2. Total production for apples.

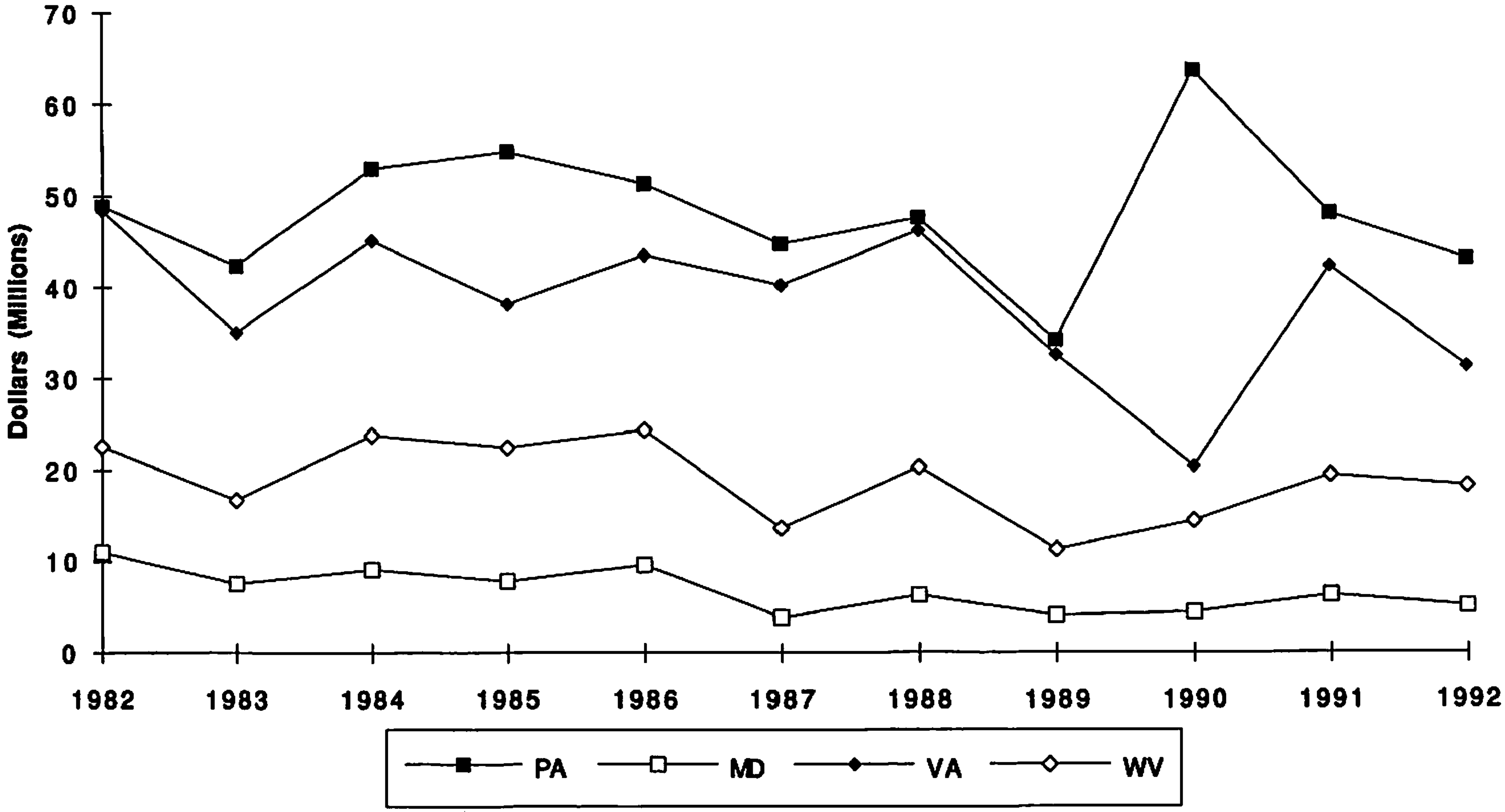

Figure 3. Value of utilized production for apples.

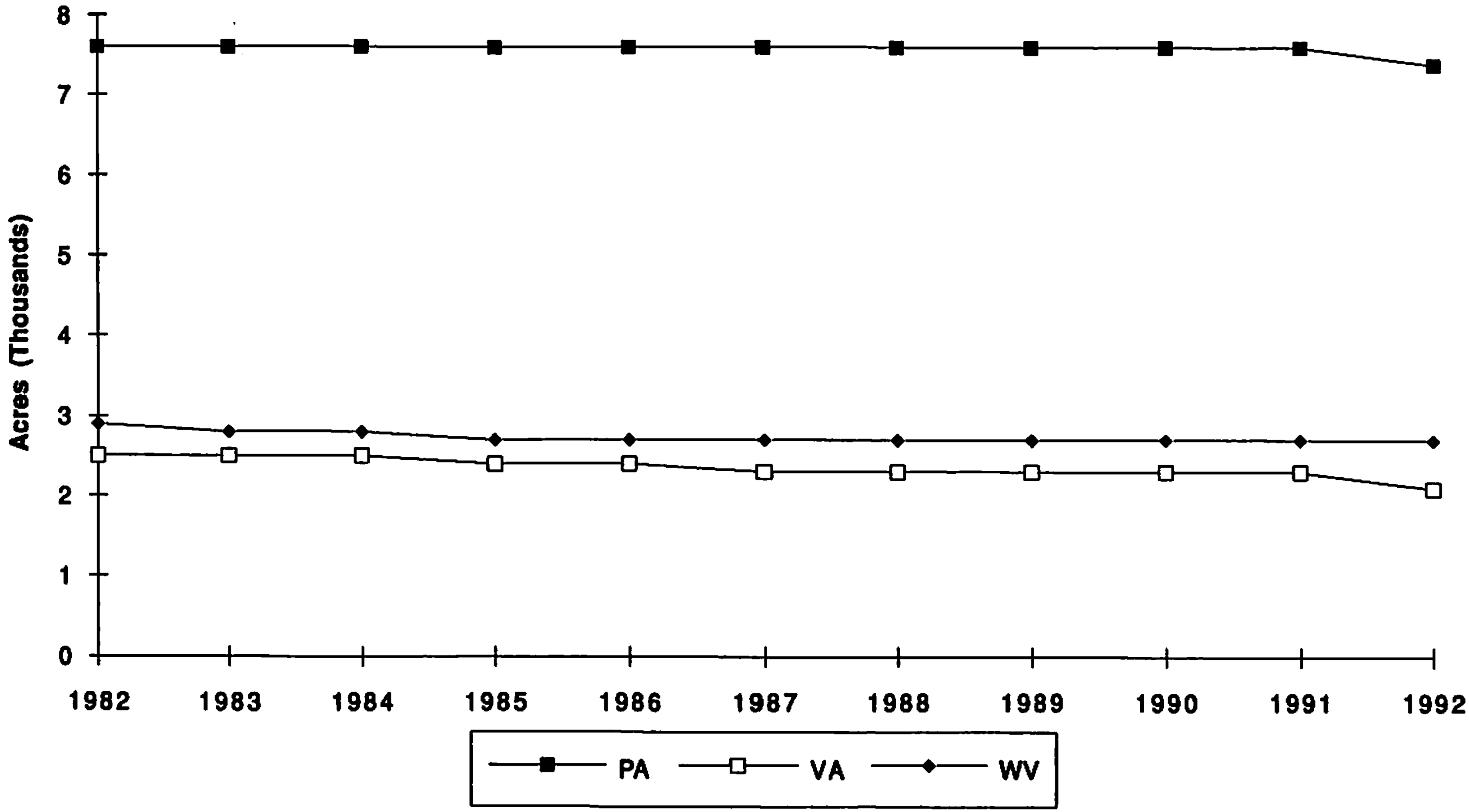

Figure 4. Bearing acreage for peaches.

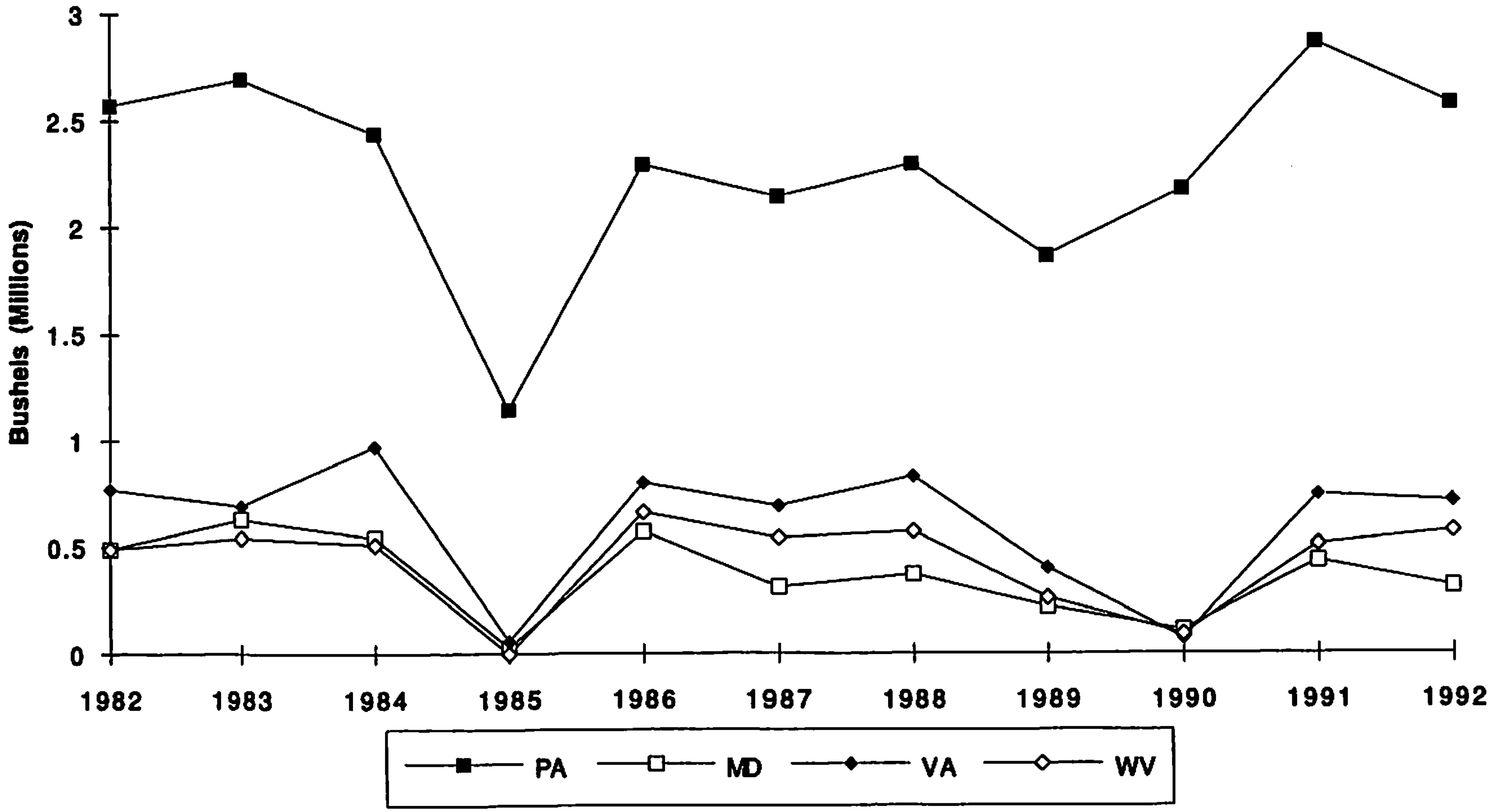

Figure 5. Total production for peaches.

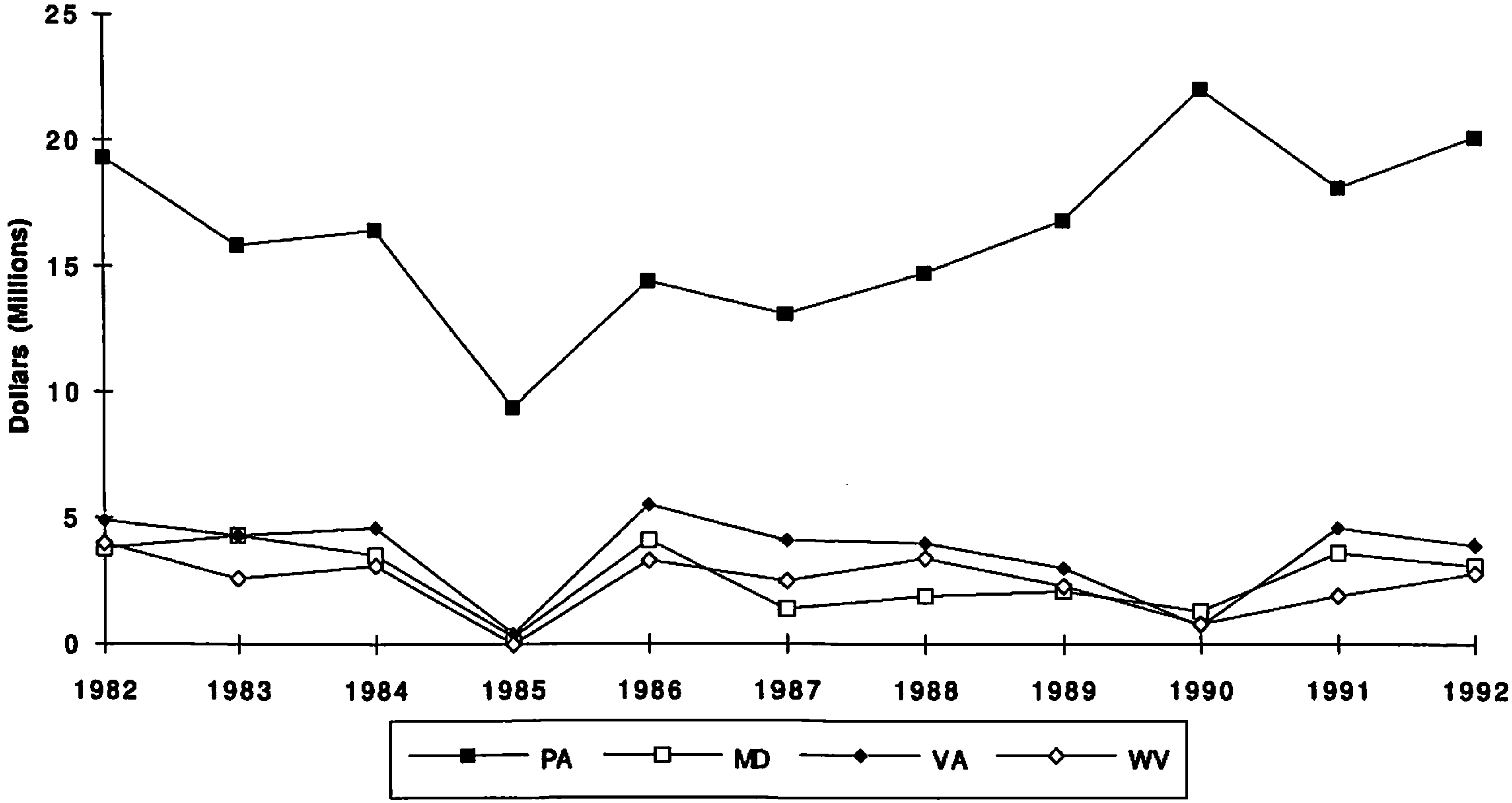

Figure 6. Value of utilized production for peaches.

Table 1. Summary of total agricultural research and extension funds for The Pennsylvania State University, University of Maryland, USDA/Agricultural Research Service/Appalachian Fruit Research Station, Virginia Polytechnic Institute and State University, and West Virginia University, and total agricultural research and extension funds for tree fruit programs in the four-state region.

	SUMMARY*									
	College/Location					Tree Fruit				
FY	Federal Appro-priations	State Appro-priations	Total Appro-priations	Grants Contracts, Gifts, Sales	GRAND TOTAL	Federal Appro-priations	State Appro-priations	Total Appro-priations	Grants, Contracts, Gifts, Sales	GRAND TOTAL
	M$	M$	M$	M$	M$	M$	M$	M$	M$	M$
1989	37.7	92.6	130.3	36.6	166.9	4.4	3.1	7.5	1.1	8.6
1990	38.9	105.1	144.0	40.5	184.5	4.9	3.1	8.0	1.0	9.0
1991	40.4	107.0	147.4	44.7	192.1	4.6	2.7	7.3	0.7	8.0
1992	43.1	97.9	141.0	51.5	192.5	4.6	2.6	7.2	0.8	8.0
1993 (est.)	46.4	96.7	143.1	49.4	192.5	4.8	2.5	7.3	0.8	8.1

*Only research funds for the USDA/Agricultural Research Service/Appalachian Fruit Research Station and for the College of Agriculture and Life Sciences at Virginia Tech.

Table 2. Total agricultural research and extension funds for each organization from federal, state, and private sources, and total agricultural research and extension funds and person capacity for tree fruit programs in the four-state region.

FY	Penn State			Univ. of Maryland			USDA/ARS/AFRS*			Virginia Tech			West Virginia Univ.			TOTALS		
	College M$	Tree Fruit M$	TF** FTE	College M$	Tree Fruit M$	TF** FTE	Location M$	Tree Fruit M$	TF** FTE	College* M$	Tree Fruit M$	TF** FTE	College M$	Tree Fruit M$	TF** FTE	Loc./ College M$	Tree Fruit M$	TF** FTE
1989	61.7	1.8	11.8	36.5	1.2	6.8	3.7	3.6	21.4	41.4	1.7	13.6	23.6	0.3	3.0	166.9	8.6	56.6
1990	67.0	1.8	12.3	41.4	1.3	7.3	4.1	4.1	20.1	45.1	1.3	9.8	26.9	0.5	4.7	184.5	9.0	54.2
1991	70.1	1.6	9.6	44.1	1.1	5.2	4.4	3.9	18.1	43.0	1.0	9.4	30.5	0.4	4.8	192.1	8.0	47.1
1992	71.2	1.6	9.4	41.9	0.9	4.3	4.7	3.8	19.1	42.3	1.2	8.8	32.4	0.5	5.3	192.5	8.0	46.9
1993 (est.)	71.1	1.6	9.9	42.7	0.9	4.3	4.8	4.0	19.3	41.2	1.1	8.8	32.7	0.5	5.3	192.5	8.1	47.6

*Only research funds and research FTEs for the USDA/Agricultural Research Service/Appalachian Fruit Research Station and only research funds for the College of Agriculture and Life Sciences at Virginia Tech.

**TF = Tree Fruit. FTE = Full-time equivalents, M.S. and Ph.D. hard and soft funded person years.

Table 3. Major issues identified by the industry representatives who attended the meeting on June 30, and the estimated current research and extension capacity in the four-state region to address these issues.

ISSUE	Penn State		Univ. of Maryland		USDA/ARS/AFRS		Virginia Tech		West Virginia Univ.	
	Research	Extension	Research	Extension	Research	Extension	Research	Extension	Research	Extension
Labor										
Worker Safety Training	0.02*	0.12*					0.01*	0.05*		0.40*
Availability								0.02		
Dispute Resolution								0.01		0.30
Laws and Regulations		0.13					0.10	0.08		0.20
Housing										
Language Barriers										0.10
Regulations Affecting the Industry										
Pesticide (Use, Compliance, Recordkeeping, Consultation)	0.20	0.15					0.01	0.02		
Environmental		0.02					0.01			
OSHA		0.12								
Economics										
Marketing		0.15		0.10*			0.05	0.05		
Farm Enterprise Management	0.15	0.33								
Pesticides									0.10*	0.10
Use (Evaluation, Efficacy)	0.56	0.63			0.10*		0.45	0.40		
Storage and Handling	0.10	0.10					0.05	0.10		
Consumer Education	0.05	0.05					0.42	0.01		
Integrated Pest Management Procedures	1.00	0.63		1.30	0.70		0.65	0.46		
Biocontrol (Methods to Reduce the Use of Synthetic Pesticides)	0.50	0.53			1.60		0.30	0.15		0.40
Diseases										
Epidemiology	0.10	0.05	0.15*	0.50	0.90		0.10	0.10	0.20	0.10
Control (Other than Pesticides)	0.10	0.05	0.20		1.50		0.05	0.10	0.20	0.10
Resistance	0.05	0.05		0.10	0.20		0.10	0.01	0.20	0.10
Fruit Quality										
Affecting through Cultural Management	0.10	0.23			0.60		0.05	0.01	0.10	0.10
Controlling (Harvest and Postharvest)	0.05		0.10				0.10	0.02	0.10	
Evaluating (Nondestructive, Sensory)	0.20				1.00		0.05	0.01		

Table 3. (Continued)

ISSUE	Penn State		Univ. of Maryland		USDA/ARS/AFRS		Virginia Tech		West Virginia Univ.	
	Research	Extension	Research	Extension	Research	Extension	Research	Extension	Research	Extension
Postharvest Physiology	0.26	0.06	0.15					0.02	0.30	
Orchard Systems and Design	0.12	0.24			0.60		0.38	0.10	0.30	0.30
Breeding										
Apple										
Peach (Including other Stone Fruit)					1.90					
Pear					1.00					
Use of Plant Growth Regulators		0.13			0.10		0.10	0.05		
Plant Nutrition		0.10						0.05		
Host Plant		0.03			0.30				0.10	
Harvested Fruit	0.05				0.10				0.10	0.10
Biotechnology (Genetic Engineering and Molecular Biology)	0.10		0.10		4.00					
Rootstocks	0.35	0.23	0.10	0.10			0.10	0.05	0.10	
Mechanization					1.00				0.50	0.10
Weed Control and Herbicide Use		0.05			0.40			0.05		0.10
Ground Water Contamination	0.05				0.40				0.50	0.30
Virology (e.g., Tomato Ringspot Virus)	0.20	0.05			0.10		0.20	0.02		
Nematology (Nematode Detection and Control)	0.60	0.15							0.50	
Harvest Maturity (Indices)	0.05	0.13	0.10	0.20	0.20		0.05	0.02	0.10	0.10
Irrigation	0.02	0.07		0.15	0.30			0.01		
Information Systems	0.05	0.15								

*FTE = Full-time equivalents, M.S. and Ph.D. hard and soft funded person years.

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Noncitrus Fruits and Nuts: Final Estimates for 1982-87. Agricultural Statistics Board, National Agricultural Statistics Service, U.S. Department of Agriculture. Statistical Bulletin 809. May 1990.

Noncitrus Fruits and Nuts: 1990 Summary. Agricultural Statistics Board, National Agricultural Statistics Service, U.S. Department of Agriculture. July 1991.

Noncitrus Fruits and Nuts: 1991 Summary. Agricultural Statistics Board, National Agricultural Statistics Service, U.S. Department of Agriculture. July 1992.

Noncitrus Fruits and Nuts: 1992 Summary. Agricultural Statistics Board, National Agricultural Statistics Service, U.S. Department of Agriculture. July 1993.

Participants at Regional Tree Fruit Industry Meeting
Cliffside Inn, Harpers Ferry, West Virginia
June 30, 1993

Industry

Stanley Bauderman	Virginia Fruit Grower
Dave Benner	Pennsylvania Fruit Grower
C. Robert Binkley	Knouse Foods, Peach Glen, Pennsylvania
Daniel A. Boyer	Pennsylvania Fruit Grower
Bill Gardenhour	Maryland Horticultural Society
Clayton O. Griffin	Virginia Horticultural Society
Ed Hartman	President, West Virginia Horticultural Society
William G. Huehn	National Fruit Product Co., Inc., Winchester, Virginia
Lynn P. Moore	President, Maryland Horticultural Society
Kent Shelhamer	President, State Horticultural Association of Pennsylvania
H. Lee Showalter	Pennsylvania Fruit Grower
M. Everett Weiser	Pennsylvania Fruit Grower
Elizabeth L. White	President, Virginia Horticultural Society
Tom Whitham	Green, Inc., Winchester, Virginia

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Howard J. Brooks	USDA/ARS, National Program Staff, Beltsville, Maryland
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Kenneth D. Hickey	Penn State Fruit Research Laboratory
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Charles R. Krueger	Pennsylvania Agricultural Experiment Station
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Stephen S. Miller	USDA/ARS/AFRS Kearneysville, West Virginia
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Thomas J. Sexton	Maryland Agricultural Experiment Station
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Paul J. Wangsness	Penn State Cooperative Extension

HORTICULTURE

AN ALTERNATIVE PRICING METHOD FOR PROCESSING APPLES

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Introduction

Previous research by Harper and Greene (1993) has demonstrated that size is the most important quality factor affecting the price received for processing apples. From the standpoint of the apple processor, large apples are more valuable because there is higher product recovery (ie., the percentage of peeling waste and core is smaller for big apples compared to smaller apples) and higher peeler efficiency (pounds of apples peeled per unit of time) (Cooper 1992). The present pricing system used by processors, which only pays for apples in three size classes (<2 1/2", 2 1/2" to <2 3/4", and 2 3/4" up), does not provide sufficient economic incentive to grow apples over 2 3/4". Additional size classes (with price premiums) could be developed which would provide the economic incentive for producers which would in turn lead to efficiency gains for processors.

Methods

In the fall of 1991, a total of 12 samples containing a minimum of 52 apples each were taken for four size classes of 'York Imperial', 'Rome Beauty', and 'Golden Delicious'. Apples were sized using a template which simulated the sizing chains used by processors. For each variety, individual apples were weighed within the four size classes from which a mean unpeeled weight and standard deviation was calculated for each variety/size combination. Paired difference tests were conducted to determine if there is a significant difference in the mean weight of similarly sized apples of different varieties. Using published recovery rates for the Atlas Pacific peeler [Atlas Pacific Engineering Co., Pueblo, CO], average recovery weights for each size classes within each variety were calculated. From this data, the relative processing efficiency (average recovery weight of size class/average recovery weight of size standard) of the various size classes within varieties was calculated.

Using the calculated relative processing efficiency and 1993 prices from Knouse Foods Cooperative [Peach Glen, PA] and Duffy-Mott [Cadbury Schweppes Inc., Aspers, PA], the implicit value of processing apples for the three varieties and four size classes were calculated. These values were calculated in four ways for each processor's price schedule. First, using 2 1/2" fruit as the standard from which to compare processing efficiency, the 2 1/2" prices were used as the basis to calculate implicit value. Second, again using 2 1/2" fruit as the standard, the premium paid for 2 3/4" fruit was used as the basis to calculate implicit value. Third, using 2 3/4" fruit as the standard from which to compare processing efficiency, the 2 3/4" prices were used as the basis for calculating implicit value. Fourth, again using 2 3/4" fruit as the standard, the premium paid for 2 3/4" fruit was used as the basis to calculate implicit value.

Results

The mean weights and standard deviations of each size class within each variety can be found in Table 1. 'York Imperial' apples in each size class tended to weigh as much or more than those of the other two varieties. 'Rome Beauty' apples outweighed 'Golden Delicious' in all size categories except 2 3/4" to <3", where 'Golden Delicious weighed significantly more. These data argue that varieties can not be pooled together in determining relative efficiency data between size classes, but must be kept separately by variety. Using typical recovery figures for the Atlas Pacific peeler (recovery is the % of apples by weight which becomes final product) and the weight data, the average recovery per apple for each size class and variety were calculated (Table 1). This data is also expressed in terms of the number of apples of each size class and variety needed to make one pound of product (final column of Table 1). Atlas Pacific states that recovery percentage is difficult to determine exactly because of variability in plant operations, the variety of apples processed, and the condition of the fruit, as well as other factors, but these are not nearly as important as size variation.

Processing prices (1993) for the various size classes and varieties are shown in Table 2 for Knouse (column 2) and Duffy-Mott (column 3). Using the average recovery per apple data from Table 1, relative processing efficiencies were calculated for each apple variety using either 2 1/2" to <2 3/4" (column 4) or 2 3/4" to <3" apples (column 9) as the standard.

Using the 2 1/2" relative processing efficiency data and the 2 1/2" price as the basis (first method), implicit values for the other apple sizes were calculated (columns 5 and 7 of Table 2). For example, based on the 1993 Knouse price of $7.75/cwt. for 2 1/2" to <2 3/4" 'York Imperial' (column 2 of Table 2), 3" to <3 1/4" apples are worth $15.42/cwt. (column 5 of Table 2). This difference in price reflects the 99% gain in efficiency from using the larger apples ($7.75/cwt. x 1.99 processing efficiency). Implicit values for Duffy-Mott for the same size standard and price basis can be found in column 7 of Table 2.

Using the 2 1/2" relative processing efficiency data and the 2 3/4" price premium as the basis (second method), implicit values for the other apple sizes were calculated (column 6 and 8 of Table 2). For example, based on the 1993 Knouse price of $7.75/cwt. for 2 1/2" to <2 3/4" 'York Imperial' (column 2 of Table 2) and the $1.75 price premium for 2 3/4" to <3" apples, 3" to <3 1/4" apples are worth $11.31/cwt (column 6 of Table 2). Given that the present price structure indicates that the 49% increase in efficiency is worth $1.75/cwt. and assuming this is a linear relationship, each 1% change in efficiency is worth $0.0357/cwt. The $3.56/cwt. difference in price for the 3" to <3 1/4" size class reflects the 99% gain in efficiency ($7.75/cwt. + (99% x $0.0357). Implicit values for Duffy-Mott for the same size standard and price basis can be found in column 8 of Table 2.

Implicit prices were calculated in the same manner using 2 3/4" to <3" as the size standard and the 2 3/4" price as the basis. The results are found in columns 10-13 of Table 2. Compared to using 2 1/2" to <2 3/4" as the size standard and the 2 1/2" price as the basis, implicit prices were lower for this size standard. Implicit prices based on the premium are the same as previously because the value of the premium is unchanged and the efficiencies, although based on a different size standard, are of the same relative magnitude.

Further Research

The purpose of this paper is to generate discussion on possible alternatives to the present price schedule used by apple processors. None of the methods used in this paper to calculate implicit values is being put forward as the best or only way for pricing processing apples. Certainly, apple processors know their business and plant operating efficiencies better than we do. The question is what is efficiency worth and how does that translate into economic incentives for the producer. The objective of an expanded pricing schedule would be to encourage producers to grow larger apples which would in turn improve the overall processing efficiency for the processor. The next step would be to look at additional size classes (the maximum apple size for the Atlas Pacific peeler is 4 1/4") and measure recovery by apple size and variety.

References

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Cooper, J.W. 1992. "What Kind of Apples are Processors Looking For?" *Proc. 137th Annual Meeting NY State Hort. Soc.* 137(1992): 30-32.

Harper, J.K. and G.M. Greene II. 1993. "Fruit Quality Characteristics Influence Price Received for Processing Apples." forthcoming, *HortScience* 28(11).

Table 1. Mean unpeeled weights and product recovery for 'York Imperial', 'Rome Beauty', and 'Golden Delicious' apples of various sizes.

Apple variety & size range	Mean unpeeled weight (grams)	Std. dev.	Significant differences* York	Rome	Gold	Recovery** (percent)	Average recovery per apple (grams)	Number of apples to make pound of product
York Imperial								
2 1/4" to <2 1/2"	104.9	9.0	n/a	0	+	60%	62.9	7.21
2 1/2" to <2 3/4"	131.5	13.2	n/a	0	+	65%	85.5	5.31
2 3/4" to <3"	181.6	14.9	n/a	+	0	70%	127.1	3.57
3" to <3 1/4"	226.8	23.3	n/a	+	+	75%	170.1	2.67
Rome Beauty								
2 1/4" to <2 1/2"	104.8	8.0	0	n/a	+	60%	62.9	7.22
2 1/2" to <2 3/4"	134.5	11.1	0	n/a	+	65%	87.4	5.19
2 3/4" to <3"	171.1	12.6	-	n/a	-	70%	119.8	3.79
3" to <3 1/4"	218.6	15.4	-	n/a	+	75%	164.0	2.77
Golden Delicious								
2 1/4" to <2 1/2"	99.4	8.5	-	-	n/a	60%	59.6	7.61
2 1/2" to <2 3/4"	123.2	8.5	-	-	n/a	65%	80.1	5.66
2 3/4" to <3"	180.1	10.3	0	+	n/a	70%	126.1	3.60
3" to <3 1/4"	204.3	14.1	-	-	n/a	75%	153.2	2.96

* 0 : difference between means not significantly different from zero at the 5% level.
+ : difference between means significantly greater than zero at the 5% level.
- : difference between means significantly less than zero at the 5% level.

** Data from Atlas Pacific Engineering Co., Pueblo, CO.

Table 2. Processing prices (1993) and implicit values for 'York Imperial', 'Rome Beauty', and 'Yellow Delicious' apples of various sizes.

Apple Variety & Size Range Premium	1993 Knouse Prices	1993 Duffy-Mott Prices	Proc. Effic. 2 1/2" Basis	Knouse 2 1/2" Price	Knouse 2 3/4" Premium	Duffy-Mott 2 1/2" Price	Duffy-Mott 2 3/4" Premium	Proc. Effic. 2 3/4" Basis	Knouse 2 3/4" Price	Knouse 2 3/4" Premium	Duffy-Mott 2 3/4" Price	Duffy-Mott 2 3/4"
York Imperial												
2 1/4" to <2 1/2"	$4.00	$3.75	0.74	$5.71	$6.80	$5.34	$6.30	0.50	$4.70	$6.80	$4.46	$6.30
2 1/2" to <2 3/4"	$7.75	$7.25	1.00	$7.75	$7.75	$7.25	$7.25	0.67	$6.39	$7.75	$6.05	$7.25
2 3/4" to <3"	$9.50	$9.00	1.49	$11.53	$9.50	$10.78	$9.00	1.00	$9.50	$9.50	$9.00	$9.00
3" to <3 1/4"	$9.50	$9.00	1.99	$15.42	$11.31	$14.43	$10.81	1.34	$12.71	$11.31	$12.04	$10.81
Rome Beauty												
>2 1/4" to 2 1/2"	$4.00	$3.75	0.72	$4.85	$5.99	$4.67	$5.74	0.52	$4.07	$5.99	$3.94	$5.74
>2 1/2" to 2 3/4"	$6.75	$6.50	1.00	$6.75	$6.75	$6.50	$6.50	0.73	$5.66	$6.75	$5.47	$6.50
>2 3/4" to 3"	$7.75	$7.50	1.37	$9.25	$7.75	$8.90	$7.50	1.00	$7.75	$7.75	$7.50	$7.50
>3" to 3 1/4"	$7.75	$7.50	1.88	$12.66	$9.12	$12.19	$8.87	1.37	$10.61	$9.12	$10.27	$8.87
Golden Delicious												
>2 1/4" to 2 1/2"	$4.00	$3.75	0.74	$5.40	$6.47	$4.84	$5.72	0.47	$4.14	$6.58	$4.02	$5.61
>2 1/2" to 2 3/4"	$7.25	$6.50	1.00	$7.25	$7.25	$6.50	$6.50	0.64	$5.56	$7.25	$5.40	$6.50
>2 3/4" to 3"	$8.75	$8.50	1.57	$11.41	$8.75	$10.23	$8.50	1.00	$8.75	$8.75	$8.50	$8.50
>3" to 3 1/4"	$8.75	$8.50	1.91	$13.87	$9.64	$12.44	$9.68	1.22	$10.63	$9.64	$10.33	$9.68

NOT FOR CITATION
WITHOUT CONSENT

OBSERVATIONS ON ROOT PRUNING AND TRUNK SCORING FOR GROWTH CONTROL IN YOUNG BEARING APPLE TREES.

Stephen S. Miller
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INTRODUCTION - Research at the Appalachian Fruit Research Station to develop mechanical harvesting for free standing apple trees using over-the-row (OTR) equipment and trunk interia or trunk impact detachment methods demonstrated the need for a well anchored tree. Spur type trees, which generally yielded the highest percentage fresh market quality fruit from OTR harvesting, were often poorly anchored even on semi-dwarf rootstock. A more vigorous rootstock, such as MM.111 or seedling, provided tree vigor and the necessary anchorage. However, the combination of a vigorous rootstock and some spur cultivars presented a problem in maintaining the high density (HD) planting systems (= to or > 1122 trees/ha) desired. Non-spur type cultivars could not be maintained in a HD system without some means of growth control. Effective growth control is one of several problems in developing OTR mechanical harvesting. The loss of daminozide and a failure to obtain registration for paclobutrazol, both excellent growth regulators, compounded the problems for developing mechanical harvesting systems for HD, free standing apple plantings.

Root pruning reduces growth of young (Schupp and Ferree, 1987) and mature (Schupp and Ferree, 1988; Ferree, 1992) apple trees. Trunk scoring reduces terminal growth on young bearing apple trees (Greene and Lord, 1983). This report provides data and observations on root pruning and/or trunk scoring to affect the growth of vigorous young apple trees on M.7A rootstock in HD plantings.

MATERIALS and METHODS - General: Two studies were conducted: one was begun in 1988, and a second on a different group of trees in 1991. Trees were growing in a fertile, well drained Hagerstown/Frederick cherty silt loam soil. All trees were trained to a central leader (CL). Trees in the 1988 study were pruned annually and branches spread with liberal use of limb spreaders. Trees in the 1991 study had almost no pruning and training during the first two seasons and only minimal pruning and training thereafter to establish the CL and keep the canopy open to light. All cultivars used had a non-spur growth habit and were 3-years-old when treatments were initiated. I evaluated four treatments: root pruning (RP), trunk scoring (TS), root pruning + trunk scoring (RP + TS), and a non-treated control (-RP - TS). Roots were pruned in 1988, 1989, and 1990 to a depthof 45 - 55 cm with a sharpened subsoiler mounted on a tractor tool bar. A commercial root pruner (Phil Brown Welding Corp., Conklin, MI) was used for root pruning beginning in 1991. This subsoiler pruned to a depth of 30 - 35 cm. Schupp and Ferree (1988) previously reported no difference in response to root pruning between 25 and 50 cm pruning depth. Roots were pruned at full bloom ±14 days. Trunks were scored 10 - 14 days after full bloom as described below for the two studies. Trickle irrigation was applied to supplement rainfall during the growing season as needed based on soil tensiometer readings. The experiment was designed with 9 replications in randomized complete block in the 1988 study and 6 replications in the 1991 study. Treatments were applied to individual trees.

<u>1988 Study</u>: 'Smoothee Golden Delicious'/M.7A planted in 1985 in north - south oriented rows and spaced 2.5 x 5.25 m (761 trees/ha) were root pruned annually from 1988 through 1992. Roots were cut on two sides of the trees 75 cm from the trunk in 1988, 90 cm in 1989 and 1990, and 60 cm in 1991 and 1992. Trunks were scored 60 cm above the graft union with a knife making a single circumscribing cut through the bark on the trunk in 1988. The same location was scored again in 1989 and 1990. In 1991 and 1992 a spiral cut was made below the previous scoring cut with a hacksaw blade. The spiral cut was such that at any one vertical point on the trunk at least two scoring cuts existed one above the other, separated by 2.5-3.0 cm. Trunk circumference 30 cm above the graft union, the length of 20 terminal shoots selected at random around the tree periphery, and canopy width through the center of the tree parallel to the row were recorded during the dormant season. One limb per tree ranging from 10-15 cm in circumference was selected and measured for blossom clusters in 1989, 1990, and 1991. Data were subjected to analysis of variance and means separated by the Ryan-Einot-Gabriel-Welsch Multiple F Test at P = 0.05.

<u>1991 Study</u>: Three adjacent north-south rows, one each of 'Kidd's Gala', 'Empire', and 'Jonagold', all on M.7A rootstock planted in 1988 and spaced 1.8 x 4.8 m (1122 trees/ha) were root pruned beginning in 1991. Treatments were repeated on individual trees in the replicates for each cultivar in 1992 and 1993. RP cuts were made at a distance of 60 cm on two sides of the trunk in 1991 and 1992 and 45-50 cm from the trunk in 1993. TS was initiated in 1992 and consisted of a single cut through the bark circumscribing the trunk; TS was repeated in 1993. Trunk circumference and terminal shoot growth was measured in 1992 and 1993. Tree yields and fruit quality measurements (fruit diameter, weight, flesh firmness, soluble solids, and starch index) were recorded at harvest. Data were subjected to analysis of variance and means separated by Duncans Multiple Range Test at P = 0.05.

RESULTS and DISCUSSION - 1988 Study: Neither RP or TS affected terminal shoot growth of 'Smoothee Golden Delicious'/M.7A during the 5 years of this study (Table 1). The combined treatment of RP + TS reduced terminal growth over non-treated control trees each year except in 1990. The lack of effect in 1990 is likely due to the heavy crop on all trees that year (mean yield, 43.2 kg/tree) with abundant precipitation (52.3 cm) during the growing season (April through August). Treatments affected trunk circumference somewhat differently (Table 1). Trees that were TS and RP + TS reduced trunk growth more than RP or -RP-TS (control). Canopy width was not affected by any treatment in this study (data not shown). Canopy width exceeded the allotted space (250 cm) during the 6th growing season. Treatments applied two additional years did not contain canopy spread. The number of blossom clusters was greater on RP + TS trees compared to non-treated trees in 1990 (Table 2). No other treatment effects were observed on bloom.

In general treatment effects in this study show little practical value and are less pronounced than those reported by other researchers (Schupp and Ferree, 1987, 1988; Ferree, 1992; and Greene and Lord, 1983). Visually, effects of TS or RP + TS were more evident in the dormant season as shorter shoots and fewer long vegetative shoots especially in the upper canopy. Lack of response to RP might be due to several factors: 1) the RP cut might have been too far from the trunk to effectively reduce root volume; 2) irrigation in the tree row tends to confine the bulk of the root system to the center line of the row thus reducing athe effectiveness of RP; and 3) the deep fertile soils in this area encourage downward rather than lateral root development, especially in conjunction with trickle irrigation. Ferree (1992), in Ohio, showed a consistent reduction in shoot growth with root pruning on mature 'Jonathan'/M.26 except in years when moisture was abundant.

1991 Study: The only data collected in 1991 was yield and fruit size on 'Gala'. Yield and fruit size from RP trees tended to be less than -RP trees; but, differences were not significant (data not presented). Response to RP and/or TS in 1992 and 1993 varied and was inconsistent between years and among cultivars (Table 3 and 4). In 1992 terminal shoot growth was reduced by RP on 'Jonagold' and RP + TS on 'Empire' and 'Gala' (Table 3). In 1993 RP and RP + TS reduced terminal growth of 'Empire'; only the latter treatment reduced shoot growth on 'Jonagold'. Terminal growth was not affected by any treatment on 'Gala' in 1993. RP reduced trunk cross sectional area (TCSA) on 'Jonagold' trees both years; no other effects were observed on TCSA (Table 3). TS reduced 'Empire' yields compared to the non-treated trees in 1992 (Table 4). In 1993, yields were reduced only for RP 'Gala' trees; 'Empire' trees that were RP + TS had higher yields than controls (Table 4). Fruit diameter was reduced in 1992 by RP on 'Jonagold' and by RP + TS on 'Gala'. RP +

TS reduced fruit diameter of 'Empire' and 'Gala' and RP reduced diameter of 'Jonagold' in 1993 (Table 5). Treatments that reduced fruit diameter also reduced fruit weight (data not shown). Previous studies have shown root pruning reduces fruit size (Schupp and Ferree, 1987, 1988; Ferree, 1992). The small reduction in fruit size has practical implication: it represents a reduction of one tray-pack box size. Treatment had little effect on fruit quality, but was generally inconsistent (data not presented). Failure to observe a reduction in tree growth is surprising, since trees were vigorous and RP was placed where effects generally occur. Similar applications in other areas have consistently reduced tree growth.

CONCLUSIONS: Results from these studies are discouraging as a growth control in HD apple production, particularly since successes were reported elsewhere. RP was inconsistent and generally failed to reduce shoot growth or slow canopy spread to the extent that no practical advantage was recognized from this technique for young apple trees growing on a fertile site and trickle irrigated. Scoring alone was generally ineffective. A combination of RP and TS did reduce growth and in one year affected bloom clusters. These treatments might have been more effective if trees had not been irrigated and RP cuts had been made closer to the trunk. The lack of response to RP in these studies on apple are similar to those for root restriction studies on peach under similar edaphic and irrigation conditions (personal communication, D. M. Glenn). Based on my experiences, I cannot recommend RP as a cultural technique for growth control in young trees under similar growing conditions. Proper selection of rootstock and planting distances remain the best known approach to solve the problem of canopy crowding and excessive vegetative growth.

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Table 1. Effect of root pruning (RP) and trunk scoring (TS) on terminal growth and trunk circumference in young 'Smoothee Golden Delicious'/M.7A apple trees during 5 years[z].

	Average terminal shoot growth (cm):					Average trunk circumference (cm):				
Treatment[y]	1988	1989	1990	1991	1992	1988	1989	1990	1991	1992
Root Pruned	45ab[x]	30ab	38a	42ab	43ab	19.5ab	25.4a	28.2ab	33.4a	35.3a
Trunk Scored	42ab	28ab	42a	39ab	47ab	17.4c	22.8b	26.5b	28.7b	31.8b
RP + TS	36b	25b	36a	33b	39b	17.7bc	23.1b	26.5b	29.3b	31.2b
Control	51a	31a	39a	45a	48a	20.0a	25.8a	29.0a	33.4a	35.8a

z Three-year-old central leader, trickle irrigated trees in 1988.

y Applied in spring 1988 about full bloom and each year afterward.

x Means significantly different, Ryan-Einot-Gabriel-Welsch F-test, P=0.05.

Table 2. Effect of root pruning (RP) and trunk scoring (TS) on bloom clusters in young 'Smoothee Golden Delicious'/M.7A apple trees in 1989 - 1991.

	Blossom clusters per 10 cm limb circumference		
Treatment[z]	1989	1990	1991
Root Pruned	29.3a[y]	103.2ab	16.4a
Trunk Scored	29.6a	139.9ab	28.2a
RP + TS	25.4a	157.3a	29.6a
Control	54.7a	85.3b	10.9a

[z] Applied to 3-year-old central leader trees beginning in 1988 and each year after about full bloom.

[y] Means significantly different, Ryan-Einot-Gabriel-Welsch F-test, P=0.05.

Table 3. Effect of root pruning (RP) and trunk scoring (TS) on terminal shoot growth and trunk cross sectional area (TCSA) in several apple cultivars.

	Average terminal shoot growth (cm):						Average TCSA (cm^2):					
	'Gala'		'Empire'		'Jonagold'		'Gala'		'Empire'		'Jonagold'	
Treatment[z]	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993
Root Pruned	26ab[y]	22b	29bc	22c	26b	20ab	42b	55b	36ab	44ab	55b	64b
Trunk Scored	36ab	35a	44a	39ab	36ab	26ab	51a	72a	43a	54a	63ab	89ab
RP + TS	23b	29ab	24c	23bc	28ab	18b	47ab	56ab	35b	42b	62ab	72ab
Control	38a	20ab	42ab	41a	42a	30a	50ab	65ab	38ab	52ab	66a	96a

[z] Applied in 1991 to 3-year-old trees on M.7A rootstock. Repeated in 1992 and 1993. Root pruned at full bloom ± 14 days; trunk scored 10-14 days after full bloom.

[y] Mean separation by DMRT, P=0.05.

Table 4. Effect of root pruning and trunk scoring on yield of several apple cultivars.

	Average yield (kg/tree)					
	'Gala'		'Empire'		'Jonagold'	
Treatment[z]	1992	1993	1992	1993	1992	1993
Root Pruned	40.6ab[y]	26.8b	29.3ab	23.4ab	43.3b	51.5ab
Trunk Scored	42.7a	43.6ab	24.6b	30.5ab	64.1a	46.2b
RP + TS	33.8b	46.4ab	27.5ab	36.2a	56.1ab	60.4a
Control	34.2ab	50.6a	30.6a	17.6b	59.2ab	59.4ab

[z] Applied in 1991 to 3-year-old trees on M.7A rootstock. Repeated in 1992 and 1993. Root pruned at full bloom ± 14 days.

[y] Mean separation by DMRT, P=0.05.

Table 5. Effect of root pruning and trunk scoring on fruit diameter of several apple cultivars.

	Average fruit diameter (mm)					
	'Gala'		'Empire'		'Jonagold'	
Treatment[z]	1992	1993	1992	1993	1992	1993
Root Pruned	70.2ab[y]	65.7ab	74.0a	69.3ab	82.2b	74.0b
Trunk Scored	71.5ab	66.2ab	73.2ab	70.2ab	84.7ab	77.5ab
RP + TS	66.8b	63.8b	73.1b	69.0b	83.2ab	74.5ab
Control	73.7a	67.0a	73.9ab	70.8a	87.0a	77.8a

[z] Applied in 1991 to 3-year-old trees on M.7A rootstock. Repeated in 1992 and 1993. Root pruned at full bloom ± 14 days.

[y] Mean separation by DMRT, P=0.05.

Title: Storability of Apples as Influenced by Tufted Apple Bud Moth (TABM) Damage or Reduced Fungicide Programs[1]

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Introduction:

Tufted apple bud moth (TABM), *Platynota idaeusalis* (Walker), is presently the most serious direct pest of apples in the mid-Atlantic region of the U.S. TABM has become resistant to the organophosphate insecticides that have low toxicity to the major mite predator in Pennsylvania and the use of the remaining pesticides that are toxic to TABM would severely threaten successful biological control programs for European Red Mite. Hull and Rajotte (1988) evaluated the impact of TABM injury on the USDA grades of processing apples and measured quality changes in storage. Their results have raised a number of concerns within the industry about the storage of apples with insect injury. If apples with insect injury can be stored without a loss of quality, pesticides can be lowered which in turn would improve the opportunity for the use of parasitoids as biological control agents for TABM. More information is needed to assess the impact of TABM injury on the apple industry in the mid-Atlantic region. This project was developed to evaluate the impact of TABM injury on quality deterioration of several cultivars and to further examine the relationship between TABM injury and changes which occur in fruit quality during storage under various environmental fungicide rates, the full impact of reduced fungicide usage on the level of fruit decay at harvest and after storage is unknown. It may be difficult to measure this effect within one or two years because inoculum levels have been low due to regular fungicide usage during the last decade and the drought of 1991 in the mid-Atlantic region was unfavorable for rapid buildup. In view of historic fruit decay problems associated with the usage of relatively weak fungicide programs, it is likely that fruit decay will increase significantly with increased insect injury and decreased fungicide residues on fruit. Therefore, more research is needed to study the relationship between fungicide programs and the storability of apples.

This research project is funded by the USDA, at the urging of the IAI, with the following general objectives:

1. Establish experiments involving various fungicide and insecticide programs that will result in a range of pest damage severity levels.

2. Evaluate fruit quality and disease/insect incidence severity on fruit at harvest and following storage in varying environmental conditions.

3. Develop recommendations to 1) manage insects and diseases so that minimal losses occur in storage, while preserving IPM programs and minimizing pesticide usage and 2) optimize CA storage conditions that will result in minimal loss of fruit quality.

Materials and Methods:

Entomology Experiments (92/93): TABM damage categories were established based on the aggregate area of damage on the apple. There were 5 - 6 categories depending on the cultivar. The first 2 -3 categories were based on the USDA Fresh Market Grades while the upper categories were arbitrary categories.

ENT EXP 1 - 'Golden Delicious'

6 TABM Categories
- 1 = 0 (control)
- 2 = < 3 mm (USDA Extra Fancy)
- 3 = 3.1 - 5.0 mm (USDA Fancy)
- 4 = 5.1 - 10.0 mm
- 5 = 10.1 - 20.0 mm
- 6 = 20 - 40 mm

Storage Regimes
- 1 = Regular Air Storage
- 2 = CA (2.4% O_2 + 0% CO_2)

Storage Removals - 3, 6 and 9 months

ENT EXP 2 - 'Delicious'

5 TABM Damage Categories

1 = 0 (control)
2 = < 3 mm (USDA Extra Fancy)
3 = 3.1 - 5.0 mm (USDA Fancy)
4 = 5.1 - 10.0 mm
5 = 10.1 - 20.0 mm

6 CA Regimes

1 = 2.4% O_2 + 0% CO_2
2 = 2.4% O_2 + 4% CO_2
3 = 2.4% O_2 + 8% CO_2
4 = 1.0% O_2 + 0% CO_2
5 = 2.4% O_2 + 4% CO_2 for 21 days then cycle to 8% for 7 days
6 = 2.4% O_2 + 4% CO_2 for 21 days then cycle to 12% for 7 days

Storage Removals - 3 and 6 months

ENT EXP 3 - 'York Imperial'

5 TABM Damage Categories

1 = 0 (control)
2 = < 5 mm
3 = 5.1 - 10.0 mm
4 = 10.1 - 15 mm
5 = > 15 mm

3 Storage Regimes

1 = 2.4% O_2 + 0% CO_2
2 = 2.4% O_2 + 4% CO_2
3 = 1.0% O_2 + 0% CO_2

Storage Removals - 3, 6 and 9 months

Pathology Experiments (92/93): Several experiments were set up to examine the impact of different spray programs, both at the Fruit Research Laboratory and from grower orchards, on the storability of apples.

EXP 1 - 'Golden Delicious'

3 Spray Programs

- 5th cover with Benlate and Captan
- 5th - 7th cover with Benlate and Captan
- 5th - 8th cover with Benlate and Captan

3 CA Atmospheres
- 2.4% O_2 + 0% CO_2
- 2.4% O_2 + 4% CO_2
- 2.4% O_2 + 8% CO_2

1 Storage removal at approximately 5 months

<u>EXP 2 - 'Golden Delicious'</u>

3 Spray Programs
- Best Commercial
- Microzir
- Ziram

3 CA Atmospheres
- 2.4% O_2 + 4% CO_2
- 2.4% O_2 + 4% CO_2 for 21 days then 8% CO_2 for 7 days,repeated
- 2.4% O_2 + 4% CO_2 for 21 days then 12% CO_2 for 7 days, repeated

1 Storage removal at approximately 5 months

<u>EXP 3 - 'Golden Delicious'</u>

7 Spray Programs
-3 at the Fruit Research Lab
-4 at growers

2 Storage Treatments - Commercial CA vs Commercial RS

1 Storage removal for RS at approximately 5 months
Rots counted in CA at 4.5 months and storage removal at approximately 7 months

<u>EXP 4 - 'Delicious'</u>

3 Spray Programs
-2 at the Fruit Research Lab
-1 at a grower

2 Storage Treatments - Commercial CA vs Commercial RS

1 storage removal for RS at approximately 7 months
Rots counted in CA at 4 months and storage removal at 6.5 months

EXP 5 - 'York Imperial'

6 Spray Programs
- -2 at Fruit Research Lab
- -4 at growers

2 Storage Treatments - Commercial CA vs Commercial RS

1 storage removal for RS at 6.5 months
Rots counted in CA at 4.5 months and storage removal at 7 mo

EXP 6 - 'Delicious'

3 Spray Programs
- -Best Commercial
- -Microzir
- -Ziram

2 Storage Treatments - Commercial CA vs Commercial RS

1 storage removal from RS at 7 months
Rot counted in CA at 4 months and storage removal at 6.5 months

Results:

Entomology

At harvest tufted apple budmoth damaged 'Golden Delicious' apples were more mature based on the starch scores, however, there were no differences in starch scores for 'York Imperial' or 'Delicious' apples.

'York Imperial' apples in the highest damage category had higher soluble solids than the controls and those in lower damage categories at harvest, however, there was no effect of damage category on soluble solids in storage of any of the cultivars.

Weight loss and decay during storage tended to increase with increased TABM damage severity (see Figures 1-4). The percent decay was more than four times higher in the higher damage categories than in the controls in some cases. In EXP 2 there was significant internal damage in apples stored under high CO_2 levels (see Figure 5).

Pathology

The results from these experiments indicate that the spray programs had no significant effect on the storage life of the apples. There were differences in firmness, decay and weight loss for apples from different storage atmospheres in some experiments.

Conclusions and Further Research:

Entomology

In these experiments some effects on decay and weight loss were evident in apples in the higher damage categories. However, there was little quality loss during storage due to relatively minor TABM feeding damage.

Experiments for the 1993-94 season have been set up to further explore the storability of TABM damaged fruit and to deal with some of the problems we encountered last season. We artificially damaged fruit on the trees to mimic TABM damage in order to have some control over the number and distribution of damaged fruit. We are also studying the timing of the damage. In addition we will be inoculating some of the damaged fruit prior to storage in order to ensure the presence of rot potential.

Plant Pathology

The results from the results presented here indicate that the spray programs had little or no influence on the storage quality of the apples. However, these results may be indicative of a lack of inoculum and the results of several years of reduced fungicides may be a better indication of the real effects (see background).

Experiments for the 1993-94 season include postharvest inoculation of apples from different spray programs in order to ensure the presence of decay potential.

Percent Decay of Golden Delicious Apples with TABM Damage (ENT EXP 1)

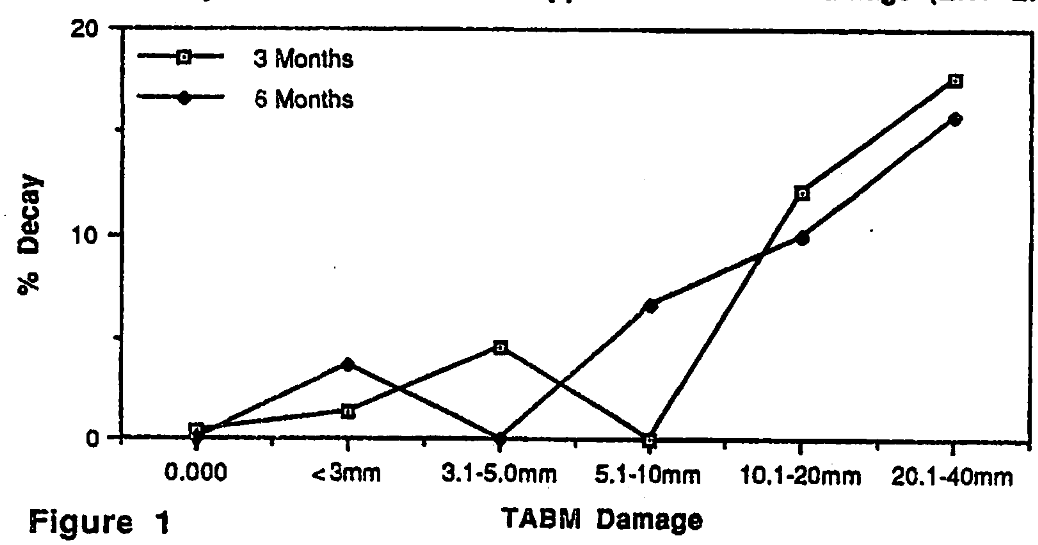

Figure 1

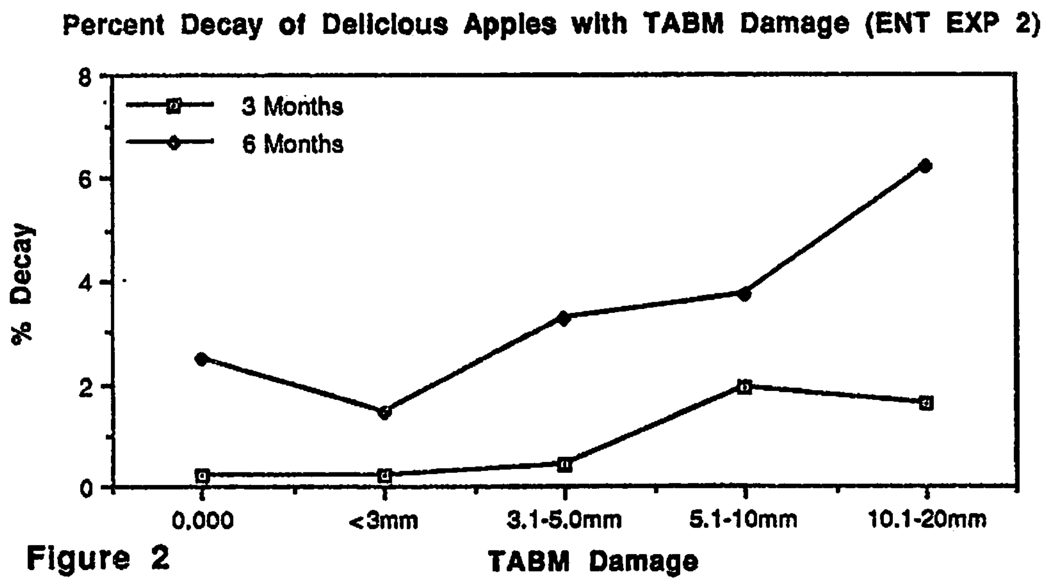

Figure 2

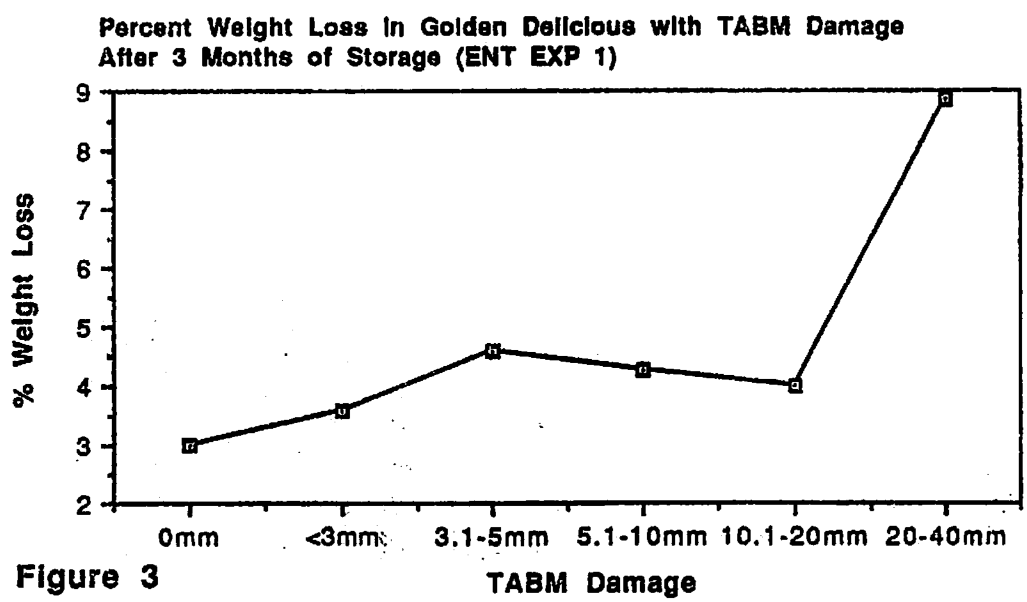

Figure 3

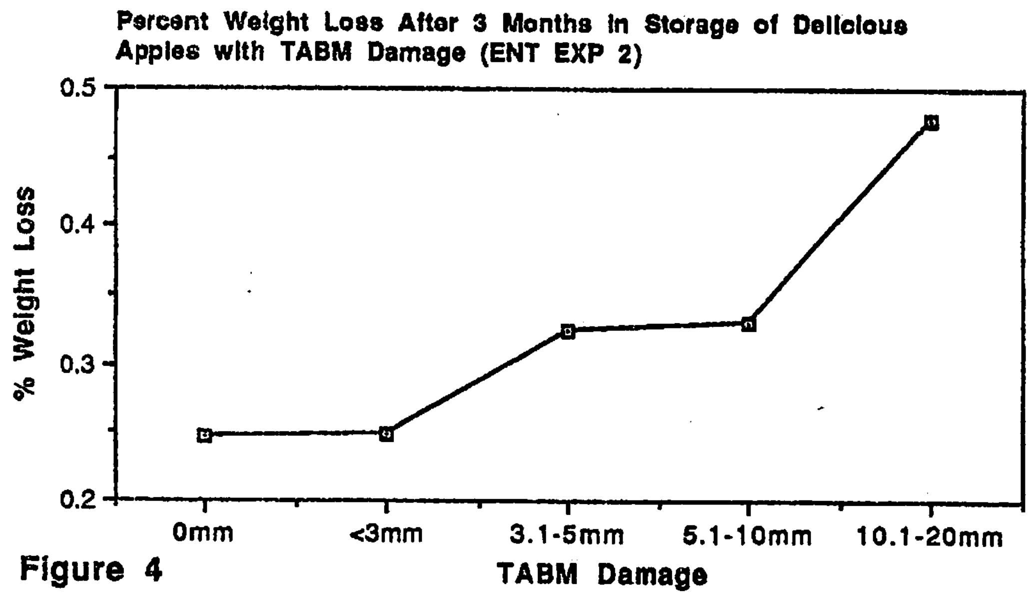

Figure 4

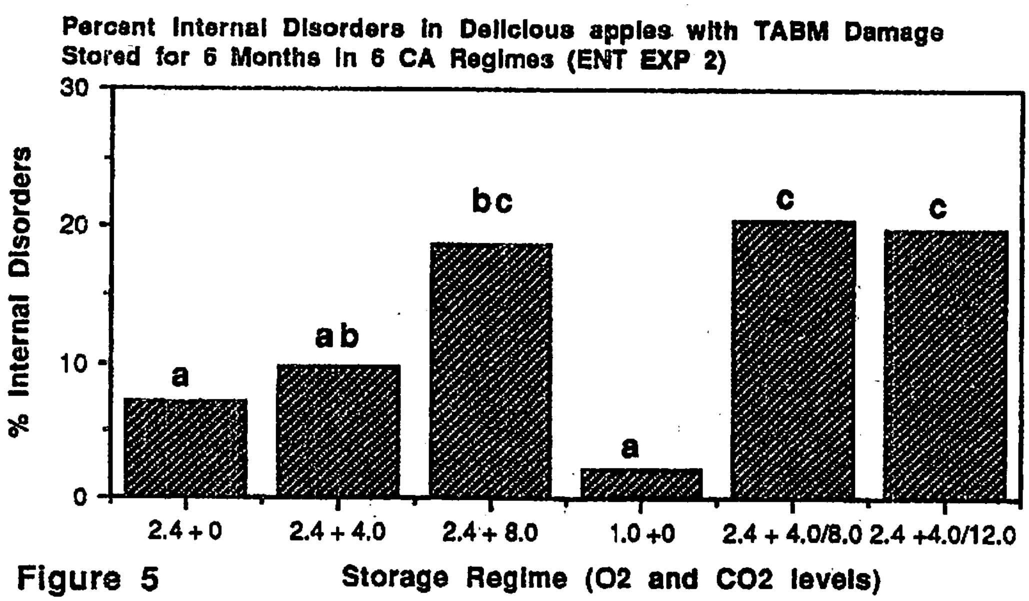

Figure 5

Title: Bloom Delay Techniques for Peach

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Spring frost damage frequently limits peach production in the Mid-Atlantic states. Delaying bloom by as little as 5 days would reduce the frost damage risk in many years. Our objective in this study was to evaluate the bloom delay potential of ethephon, a growth regulator, the practice of evaporative cooling, and their interactions prior to the bloom period. Treatments of: 1) fall applied ethephon, and 2) mist irrigation were applied to dormant, six-year-old 'Loring' peach trees, that had been trained to a free-standing 'Y', and spaced 2.5 x 4.5 m. The study was randomized in 5 replicates of a split-plot design with mist ± as the mainplot, and ethephon ± as the subplot (one tree per treatment). A border tree separated the mist plots. Ethephon at 100 PPM was applied at 1 1/2 gal/tree in the fall of 3 years at about 50% leaf fall. Mist irrigation was applied by a pulse system through emitters suspended within the tree canopy. Mist was started in late February and terminated after petal fall. There was 1 emitter/tree in 1991, two emitters/tree in 1992 and 4 emitters/tree in 1993. Each emitter delivered 0.5 gal/hour in pulses at 10 second intervals. Flower bud developmental rate was measured from bud swell to petal fall. The treatment effect on time of harvest, fruit number and size were evaluated. In 1991 and 1992 ethephon and ethephon + misting delayed bloom 3-5 days; however, these treatments also reduced yield. In 1993, mist from the increased number of emitters/tree and the ethephon + mist treatment delayed bloom 5 days, with no reduction in yield. We conclude that the concept of evaporatively cooling dormant peach buds has a viable potential to delay bloom and reduce the risk of frost damage without reducing fruit yield.

Effects of Combining ATS and Fungicide Bloom Sprays on Disease Control, Thinning, and Phytotoxicity of Peach.

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Abstract:

Spray application of ammonium thiosulfate (ATS) and fungicides as a tank mix during the bloom period would be beneficial to commercial peach production. Currently these sprays are applied separately because of uncertainties about compatibility and effects of combinations on peach trees. Observations in commercial peach orchards indicated that air blast sprayer application of ATS and triforine induced shoot dieback and gummosis when tank mixed, but not when applied in separate applications. A controlled orchard study was conducted to determine main and interaction effects of two levels of ATS (0 and 2%) with ten fungicide treatments (water, benomyl, chlorothalonil, captan, triforine, propiconazole, vinclozolin, iprodione, sulfur, and thiophanate-methyl) in a 9-year-old 'Redhaven' orchard with handgun spray application. Fruit load was affected only by ATS and number of blossom blight cankers/tree was affected only by fungicide. Interaction effects were significant on phytotoxicity to blooms and young shoots among ATSxFungicide combinations.

Introduction:

Growers must apply a variety of compounds to peach orchards during bloom in order to produce high quality fruit. Particularly important are applications of ammonium thiosulfate (ATS) for foliar fertilization and fruit thinning (Byers and Lyons, 1984, 1985; Havis 1962), and application of fungicides to control blossom blight canker induced by the brown rot fungus (*Monilinia fructicola*) (Bost, et al., 1993; Hendrix et al., 1993; Horton, 1993; Pfeiffer, 1993; Springer, 1993; Ritchie et al., 1993; Travis, 1993).

Application of ATS as a tank mix with fungicides would be advantageous, but chemical compatibility and interactive effects of these compounds on fruit load, blossom blight control, and phytotoxicity to flowers and young shoots are not known. Thus, growers have applied these compounds in separate spray applications, increasing the application cost. Critical timing at bloom is sacrificed by applying the compounds in separate sprays.

Of particular concern are observations of shoot injury in commercial peach orchards where ATS was tank mixed with some fungicides. This study was therefore established to test effects of ATS and fungicides applied separately and in tank mixed combinations on fruit thinning, blossom blight control, and phytotoxicity of peach trees.

Observations in Grower Orchards:

Observations were made in two South Carolina commercial peach orchards in 1993 where a comparison could be made of the effects of separate vs. tank mixed applications of ATS and Funginex. Both orchards were of mature bearing age, one a planting of 'Calred' and the other of 'Junegold'. Application was made by the grower with an air blast sprayer.

Several rows of each orchard had been treated with 3 gal ATS formulation/acre (= 3% ATS solution x 100 gal/acre spray) and Funginex (24 oz formulation/acre) in separate applications (not tank mixed). Another portion of each orchard had been sprayed with the same concentrations of ATS and Funginex but as a tank mix. All applications were made on the same day at full bloom. No phytotoxicity was noted where ATS and Funginex were applied separately. However, when these chemicals were tank mixed, severe dieback of young shoots and oozing gum was noted in both cultivars. Phytotoxicity associated with various ATS-fungicide tank mixes has also been noted in other peach orchards.

Controlled Study:

Materials & Methods:

The study was conducted in a 'Redhaven' orchard, located at the Musser Fruit Research Station, South Carolina Agricultural Experiment Station, Clemson University. The orchard was planted in 1985 and was trained to a central leader tree form. Tree spacing = 4 m (in row) x 4.5 m (between rows), for a tree density of 225 trees/acre. Trunk cross-sectional-area (CSA) averaged 108 ± 25 cm^2 across all trees and did not differ (5% level of significance) among replications or treatments. Treatment application was made at full bloom (March 29, 1993). Due to unusually cool spring temperatures, 1993 full bloom occurred two weeks later than normally expected in South Carolina.

Pretreatment of test orchard with brown rot spores. The orchard was inoculated with brown rot spores the evening prior to application of the chemical treatments, allowing approximately 20 hours for spore germination and infection. Inoculum solution was prepared by scraping 30 cultured plates into 30 gal water plus ca. 15 ml Turgitol F surfactant. Each tree was sprayed to drip (ca. 1.25 min) by handgun at a sprayer pressure of ca. 35 psi and flow rate ca. 2 liter/min (0.53 gal/min).

To determine the effectiveness of spore application, 12 open agar Petri dishes were hung in trees randomly throughout the orchard prior to application of the brown rot spore suspensions. These were collected the following morning, and returned to the laboratory for culture growth. *M. fructicola* grew out on all plates, indicating good coverage of the orchard with viable spores.

Chemical treatments and application. Treatment combinations were a factorial of two ATS treatments combined with ten fungicide treatments making 20 treatment combinations with four replications of single tree plots, for a total of 80 trees in the study. The experiment was conducted as a randomized complete block design. Chemical treatments were applied by handgun from a Berthoud 30 gal. plot sprayer operated at a pressure of ca. 90 psi and flow rate ca. 2.4

liter/min (0.63 gal/min). Each tree was sprayed for one minute (past drip) to assure uniform application of chemical to each tree. A portable shield ca. 8 x 10 feet was constructed of PVC pipe and plastic sheet to prevent drift contamination of adjacent trees during spray application.

ATS (60% ai, w/v) was applied at two levels (0 and 2% formulation, v/v). The 'No fungicide-No ATS' treatment was sprayed with water only. Air blast sprayer application (not used in this study) of a 2% ATS solution at 150 gal/acre, would deliver a dose of 3 gal of ATS formulation/acre. Actual ATS formulation applied in this study = (0.63 gal/min)(1.0 min /tree)(0.02 gal ATS/gal spray solution)(225 trees/acre) = 2.8 gal ATS formulation/acre. Bloom thinning activity of ATS is known to be greater when applied by hand gun than by air blast sprayer (Byers and Lyons, 1985). While single tree plots did not permit application by air blast equipment in this study, we used the airblast recommended rate of 2% ATS so that possible interaction effects of ATS with recommended fungicide rates could be tested.

The ten fungicide treatments were applied at a single recommended concentration each:

Chemical names and concentrations used.

Trade Name	Common Name	Manufacturer	Concentration Applied: Formulation (/100 gal)	Active Ingred. (ppm)	Active Ingred. (g/acre)
None	water control	------	------	------	------
Benlate 50WP	benomyl	Dupont	0.75 lb	450	240
Bravo 720 (g/ml)	chlorothalonil	ISK Biotech	1.38 pint	1240	660
Captan 50WP	captan	ICI Americas	1.5 lb	900	480
Funginex (18.2%)	triforine	Ciba-Geigy	12 oz fl	170	90
Orbit (41.6%)	propiconazole	Ciba-Geigy	2 oz fl	65	35
Ronilan DF (50%)	vinclozolin	BASF	2 lb	1200	640
Rovral 4F (lb/gal)	iprodione	Rhone-Poulenc	1 quart	1200	640
Uniflow Sulfur (74%)	sulfur	Uniroyal	3.5 pint	3240	1740
Topsin-M 70WP	thiophanate-methyl	ELF Atochem	0.75 lb	630	340
ATS (60%)	ammonium thiosulfate		2 gal. (=2.8 gal ATS formulation/acre)	12,000	6360

Handgun spray volume applied = 141.6 gal/acre = 2.4 liter/tree.

Results:

A. Control of blossom blight cankers (*Monilinia fructicola*):

Overall, the number of confirmed blossom blight cankers/tree were low, in spite of the pretreatment application of brown rot inoculum to the orchard. The highest number of blossom blight cankers observed was 7/tree. This was in a Captan+ATS tree. The highest number observed in the untreated control (No fungicide-No ATS) was 3/tree.

Incidence of confirmed blossom blight cankers/tree were affected by fungicide, but not by ATS or by ATSxFungicide combinations (ATS main effect and ATSxFungicide interaction effect were not statistically significant in analysis of variance). Therefore, results are presented only for fungicide main effects

(Figure 1). Fungicides statistically superior to control in reducing blossom blight cankers were: Benlate, Orbit, Ronilan, Rovral, and Topsin-M. These five fungicides were equally effective (no statistical differences). In contrast, Bravo, Funginex, and sulfur were not significantly different from controls in this test.

B. Effect on fruit load (fruit thinning effect):

Initial fruit load was rated four weeks after bloom (April 28 to May 3), and results were consistent with the count of fruit per tree at harvest (June 29). Fruit load per tree at harvest was analyzed both on a per tree and on a per trunk cross-sectional-area basis. On either basis, fruit load was affected only by application of ATS. There were no statistically significant interaction effects of ATS with fungicides, and no significant fungicide main effects. Thus, only ATS means across all fungicide treatments are presented below. Fruit load of ATS-treated trees was 55% of non-ATS-treated trees, on a per tree basis.

Effect of ATS on fruit load

ATS Treatment	Initial Fruit Load (rating)[z]	Fruit Load at Harvest: Fruit/tree (number/tree)	Fruit Load at Harvest: Fruit/TrunkCSA (fruit/cm^2)
None	2.8 a[y]	339 a	3.28 a
2% ATS	1.8 b	153 b	1.38 b

[z]Initial fruit load rating: 0=no fruit set, 1=slight, 2=moderate, 3=heavy.

[y]Means within columns followed by the same letter are not significantly different at the 5% probability level.

C. Effect on phytotoxicity (flower and shoot):

In contrast to blossom blight control and fruit load effects, phytotoxicity to flowers and shoots were significantly affected by the interaction of ATS with the various fungicides. Rating of chemically burned blossoms/tree was made four weeks after treatment (Figure 2). Slight blossom burn was noted in all fungicide treatments without ATS and sulfur+ATS (rating = 0.75 to 1.25 on a 0 to 3 scale). ATS alone caused considerable blossom burn (mean rating = 2.75). When combined with ATS, the fungicides Benlate, Funginex, Orbit, and Ronilan were no worse that ATS alone in blossom burn rating. Of special interest was the reduction in blossom burn effect of ATS when combined with the fungicides Bravo, Captan, Rovral, sulfur, and Topsin-M.

Number of one-year-old shoots suffering apparent dieback were counted per tree four weeks after treatment (Figure 3). Without ATS, all fungicides were equally as good as the water controls (No fungicide-No ATS), with 0.0 to 1.0 affected shoots per tree. ATS alone and Ronilan+ATS induced significantly more shoot dieback per tree than did water controls (mean of 3.0 and 3.25 dieback shoots/tree, respectively). Benlate+ATS resulted in more than twice the number of dieback shoots per tree than any other treatment (mean of 7.5 dieback shoots/tree). Some regrowth from lateral buds on affected shoots in all treatments was noted approximately six weeks after bloom.

Over all treatments, incidence of blossom burn and shoot dieback were highly correlated (r=0.97), but neither form of phytotoxicity were correlated with number of blossom blight cankers counted per tree (r<0.2). However, final fruit load, both per tree and per trunk CSA, was negatively correlated with rating of burned blossoms per tree (r = -0.89 and -0.88, respectively). Thus, apparent reduction in ATS phytotoxicity when ATS was applied in combination with some fungicides suggests that fruit thinning activity of ATS may also be reduced by these fungicides. Statistically significant differences in fruit load due to ATSxFungicide combinations were not observed in this study, but may occur under some conditions.

Conclusions:

Fruit thinning and blossom blight control were not affected by ATSxFungicide combinations in this study, suggesting that tank mixing these compounds would not adversely affect these management goals. However, we are concerned about the interaction effects of ATS and fungicides on phytotoxicity responses. For this reason, we would recommend caution in tank mixing ATS with fungicides. The authors recommend that the issue needs further study, especially using air blast spray application equipment and large plot size that more closely resemble grower conditions.

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Figure 1. Effect of fungicide on incidence of blossom blight canker. Means with lower case letters in common are not significantly different at P=0.05. Abbreviations: CON (Control, no fungicide), BRA (chlorothalonil), CAP (captan), FUN (triforine), ORB (propiconazol), RON (vinclozolin), ROV (iprodione), SUL (sulfur), TOP (thiophenate-methyl).

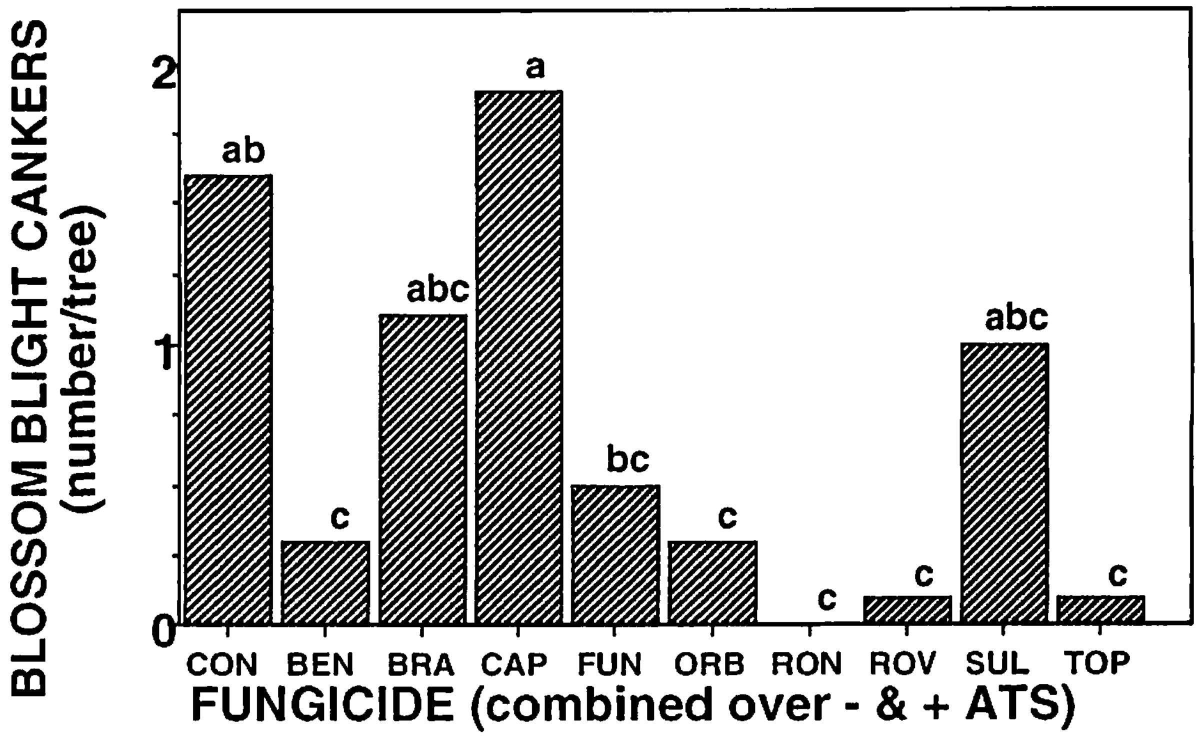


Figure 2. **Effect of fungicide x ATS combinations on blossom phytotoxicity.** Means with lower case letters in common are not significantly different at P=0.05. Abbreviations: "-" (without ATS), "+" (with ATS), CO (no fungicide), BR (chlorothalonil), CA (captan), FU (triforine), OR (propiconazol), RO (vinclozolin), RO (iprodione), SU (sulfur), TO (thiophenate-methyl).

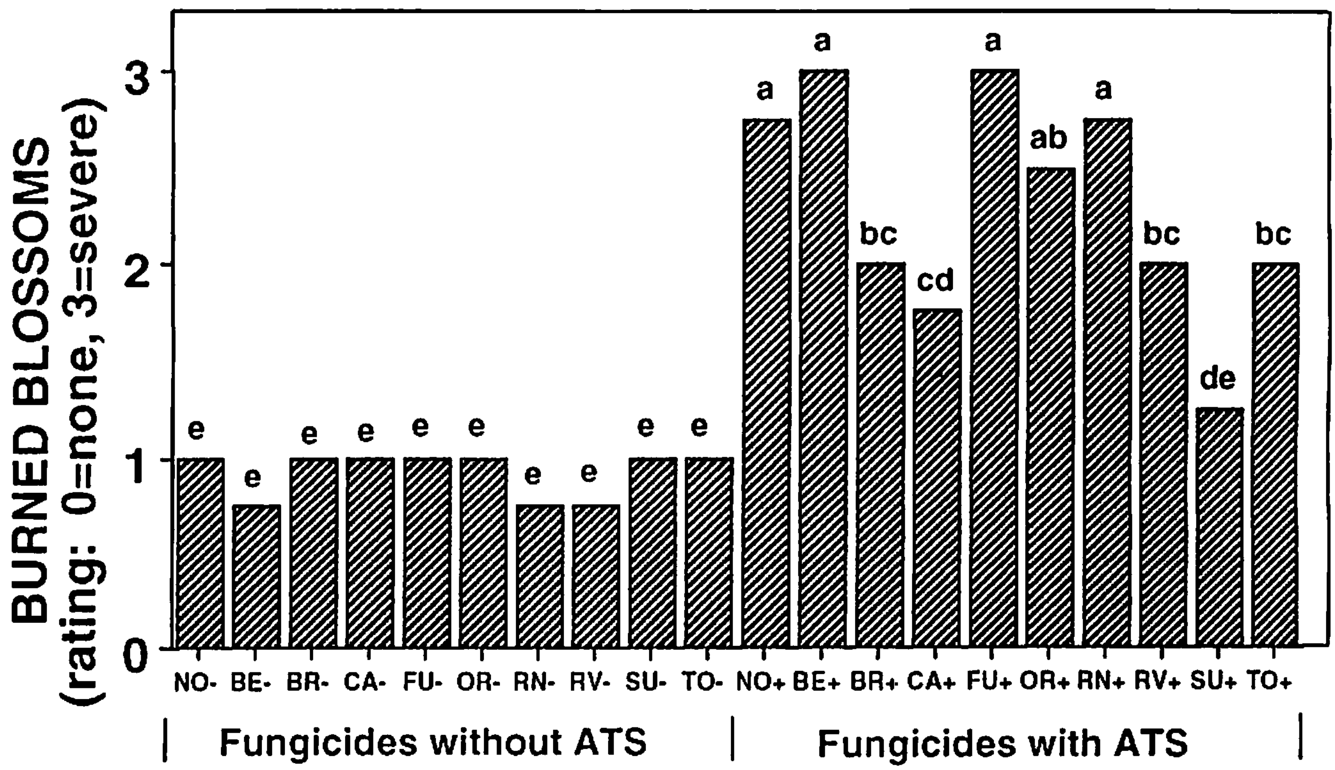
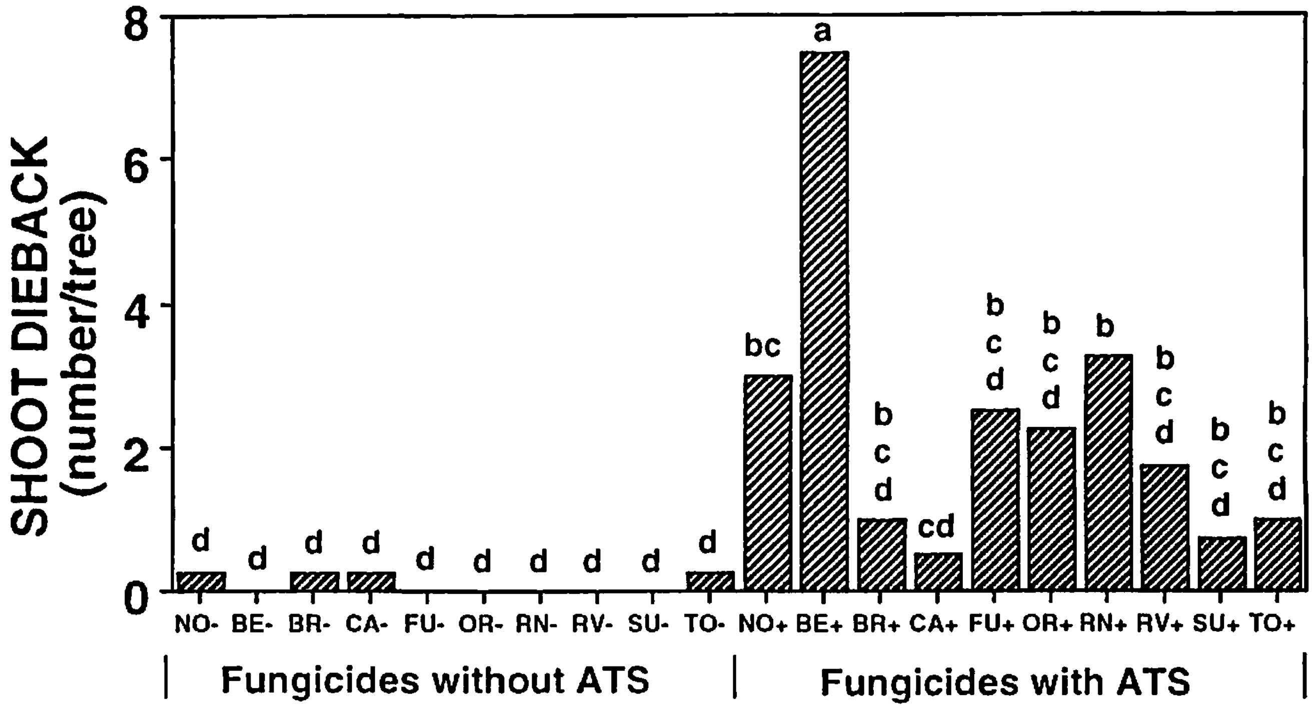


Figure 3. **Effect of fungicide x ATS combinations on shoot phytotoxicity.** Means with lower case letters in common are not significantly different at P=0.05. Abbreviations: "-" (without ATS), "+" (with ATS), CO (no fungicide), BR (chlorothalonil), CA (captan), FU (triforine), OR (propiconazol), RO (vinclozolin), RO (iprodione), SU (sulfur), TO (thiophenate-methyl).



EVALUATION OF CONVENTIONAL STRAWBERRY AND STRAWBERRY PLASTIC CULTURE IN MARYLAND AT WREC FOR 1993 PLANTING SEASON

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Objectives: Evaluation of Chandler strawberry plants grown on plastic to determine the ideal planting window for plastic culture, annual strawberry production and its economic feasibility under Maryland conditions in comparison to conventional strawberry production were also studied.

Treatments: A 1992 planting of Chandler plug plants was made September 17, September 22, and September 28. On September 29, a bare-rooted planting was made (rows 9-12). Chandler plants were planted double row on raised black plastic covered bed 72" apart. Rows on bed 14" apart in row plants 12" apart. Rows 3 through 12 fumigated with Vapam 8/30/92. Rows 4 through 12 fertility program. Broadcast at 500 lbs per acre 10-10-20. Sulphur coated urea banded under plastic at 350 lbs per acre. Rows 1 to 3 received compost as fertilizer source. Row 1 also received kelp and partial organic fertilizer supplement. Part of this trial was covered from December 16, 1992, to March 2, 1993. (A fall mid-September 1993 planting of plug plants will be made as a continuation of this project.)

A comparison planting of conventional June-bearers was made on April 25, 1993. Varieties in the planting include: Glooscap, Blomidon, Cavandish, Earliglow, Allstar, Lateglow, Jewel, Seneca, Annapolis, and three potential releases from USDA.

Results: This is the second year for the production of strawberries using annual plants at the Wye Research and Education Center. The 1992 yield was too low to be economical on a commercial basis. However, it was felt that the results were still inconclusive and that we needed to look at mid-September plantings with plug plants versus bare-rooted plants on a higher, firmer bed with better soil to plastic contact.

The system of annual strawberry production requires a more intensive management scheme utilizing both overhead and drip irrigation in a raised plastic covered bed. We should know more in regards to economic profitability of this system for our area with this spring's harvest. However, it is strongly felt that this system must be looked at for at least one more season, 1993-1994.

Spring 1993 harvest began May 17 and ended June 9. The following data was obtained.

Total yield Row 6, plug plants planted September 17, 1992, was 250.86 lbs from 361 plants or .69 lbs per plant.

Total yield Row 9, bare-rooted plants planted September 29, 1992, was 42.72 lbs from 300 plants or .14 lbs per plant.

Total yields from plug plant time of planting study were as follows:

Planting Date	lbs of Berries	lbs/Plant	lbs per acre
September 17	188.15	.83 lbs	14,342
September 22	181.46	.76 lbs	13,132
September 28	143.14	.63 lbs	10,886

Mark Apple Rootstock:
Field Performance and Responses to Controlled *Agrobacterium tumefaciens* Inoculations

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A number of new varieties may be well-adapted to Maryland's climate allowing apple growers to produce high-quality fruit despite high summer temperatures. In 1990, we planted two research orchards of GALA, BRAEBURN and FUJI on 4 size-controlling rootstocks. These plantings were set at University of Maryland farms located at Keedysville and Wye. The initial goal of this research was to test the adaptation of these cultivars to our climate. With time, we have shifted our emphasis toward monitoring tree decline and losses.

Recent reports from Ohio have shown that tree loss can be a major problem in orchards planted onto size-controlling rootstocks. With the aid of two industry grants, we closely followed the performance of these two research plantings to monitor early production and tree losses. The following table shows the effects of variety and rootstock on per-tree yield, fruit size and tree losses measured in 1992, and the number of fireblight strikes counted in July, 1993.

<u>Apple rootstock trials: with Gala, Braeburn and Fuji.</u> As expected, trees of these new varieties have come into production rapidly. Unfortunately, a number of problems have also been noted. Mark was the most precocious rootstock in the block. Third-leaf yields were greater, but fruit size was significantly smaller. This smaller fruit size was caused by overcropping, despite hand-thinning. At 400 trees per acre, a Mark block would have yielded about 200 bushels per acre in the third leaf at WyeREC. Conversely, a planting on M 111 rootstock at 120 trees per acre would have produced only 18 bushels per acre.

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We are indebted to the International Dwarf Fruit Tree Association and the Maryland State Horticultural Society for their support of this project.

Unfortunately, these high, early yields from trees budded onto Mark rootstock will not be sustained. In response to the 1982 crop, trees made little new growth in 1983. Significant swellings were also visible on the Mark rootstock shank, just below the soil line. Swellings are most pronounced on Braeburn/Mark but can also be found on some Gala/Mark and Fuji/Mark trees. This "tissue proliferation" may have begun to reduce vigor and fruit size in the third leaf.

Table 1. Effect of cultivar and rootstock on tree losses and yield in 1992 at WyeREC, fireblight strikes in 1993.

	1992			1993
Treatment	Dead Trees (%)	Yield per tree (kg)	Fruit Weight (grams)	Fireblight Strikes (number)
Cultivar				
GALA	5.5	4.4	145.2	5.4
BRAEBURN	8.2	6.9	194.5	6.8
FUJI	0	4.4	183.8	6.9
Rootstock				
MARK	14.8	8.7	161.5	3.5
M 26	11.0	5.5	181.6	6.7
M 7a	0	4.1	178.2	7.7
M 111	3.7	2.5	176.8	8.3

Table 1 shows the effects of cultivar and rootstock on per-tree yield, fruit size, percentage of dead trees in 1992, and the number of fireblight strikes in July, 1993. Mark was the most precocious rootstock in the block; third-leaf yields were greater, but fruit size was significantly smaller. The reduction of fruit size by Mark was caused by these factors: a heavy crop load and crown-tissue proliferation.

Significant fireblight damage was first noted in 1993. A dormant copper spray was applied; however, streptomycin was not used during bloom. Shoot blight was severe during May and early-June. Damage to flowers on one-year shoots (last season's growth) and succulent vegetative shoots appeared to have been the source of inoculum for the shoot-blight strikes. The fireblight epidemic can be traced to rainy weather during May 5-7 when the MARYBLYT model predicted that the risk was extremely high.

We found that the number of fireblight strikes counted per tree in 1993 was inversely proportional to the 1992 yield. However, the number of strikes per tree was not correlated with the known rootstock susceptibility. Weak trees on Mark rootstock had the fewest strikes, while vigorous trees on M 111 had the most strikes. Tolerance to fireblight in M 111 and M 7a may allow many of these trees to survive despite this heavy pressure.

"Why did my tree die?" is a question that is often asked by apple growers. The performance of trees in this block shows the dynamics involved in tree losses as a young orchard comes into bearing and sheds some light on the complexities involved in tree losses. The first tree losses occurred in response to high winds that caused "blow-out" at brittle unions in Mark and M 26. Prior to the onset of production and fireblight damage, Mark and M 26 tree losses exceeded 10 percent. Clearly, the decrease in vigor and tree losses occurred in Mark rootstocks prior to this year's fireblight infection. While fireblight can be a problem in Mark and M 26, tree decline began with cropping and preceded the 1993 fireblight epidemic.

Mark apple rootstock: testing its relative susceptibility to crown gall. Many apple growers have observed declining vigor in trees on Mark rootstock. Severely swollen trunk tissue at or below the soil surface is routinely found in these Mark plantings. While this abnormal tissue is not typical of crown gall in other species, there are sections that superficially resemble the galls incited by *Agrobacterium tumefaciens*. This part of our report deals with work directed determining the role that crown gall plays a role in this swollen trunk syndrome.

In 1992 we verified the reported susceptibility of Mark to crown gall through inoculation with *A. tumefaciens* strains representing each of the three principle biovars. Galls developed rapidly on virtually every site inoculated with strains of biovars 1 and 2. Initially no effect was observed from inoculations made with a biovar 3 strain that is highly virulent on grape; however, 1 of 40 sites had a small gall at 20 weeks after inoculation. At 15 weeks after inoculation the mean gall depth from inoculations with a biovar 1 strain (isolated from grape) was 16 mm and every inoculated site produced a gall. At 15 weeks after inoculation the mean gall depth from inoculations with a biovar 2 strain (isolated from raspberry) was 12 mm, and 94% of inoculated sites produced galls. No galls were observed from control inoculations with water or *A. radiobacter*. Inoculations with biovars 1 and 2 have produced some galls that continue to develop after 20 weeks. Most galls formed brown, lignified surfaces but many had young, actively-growing gall tissue adjacent to the initial galls.

Experiments are underway testing the hypothesis that diffusion of plant growth regulators from pockets of crown gall contribute to the development of the swollen crowns observed in Mark. Ten trees of each of five rootstock genotypes were inoculated with three strains of *Agrobacterium tumefaciens* biovar 1 and compared to controls that were uninoculated or inoculated with sterile deionized water. After one week, trees were re-potted so that the lowest inoculated site on each plant was below the soil line. Apparent crown gall formation was evaluated at fifteen weeks after inoculation (Table 2). All genotypes tested were quite susceptible to crown gall, but M9 and Mark were significantly more susceptible than the other genotypes in all categories except one. One hundred percent of the below ground inoculated sites formed galls in Mark rootstock; this was significantly greater than all other genotypes except M7a. Interestingly, 100% of the Mark trees inoculated with sterile deionized water also produced apparent galls at sites below the soil line although none of the above ground inoculations produced galls. Mark trees that were left as uninoculated controls showed no gall formation. Apparent gall formation in Mark water controls may represent extreme callus proliferation from wounding or could be actual crown gall from low levels of *A. tumefaciens* already present on the trees. No woody tissues characteristic of Mark swollen crowns were observed.

Table 2. Response of rootstock genotypes to inoculation with *Agrobacterium tumefaciens.*

	Above Soil		Under Soil	
Genotype	% Inoc. Sites Form Galls	Mean Gall Size mm	% Inoc. Sites Form Galls	Mean Gall Size mm
M9	76.7 a	7.72 a	71.4 b	15.3 a
Mark	72.9 a	6.68 ab	100.0 a	14.1 a
M26	60.9 b	3.57 d	73.3 b	5.2 b
MM111	60.7 b	6.02 bc	66.7 b	4.2 b
M7a	42.7 c	5.22 c	85.7 ab	9.7 b

These trees were transferred to the field where further tissue proliferations will be evaluated after an additional year of growth. Tissue proliferations from water inoculated controls and swollen crowns of Mark in growers orchards will be tested for presence of T-DNA through polymerase chain reaction using a primer from a conserved region of the *iaa-h* and *iaa-m* genes of *Agrobacterium tumefaciens.*

Field Observations of MARK plantings -- 1993 In July, we systematically monitored trees at WyeREC and Keedysville for insect and disease pests. Trunks were excavated to observe tissue proliferation, and bark was peeled to monitor necrosis. In September and October we monitored MARK plantings in western Maryland and the Hudson Valley, New York. This field survey again identified susceptibility to wood-rotting fungi, fireblight, woolly apple aphids and borers as additional problems with Mark.

Fireblight At Wye, trees showed evidence of the "Steiner Syndrome", where fireblight moves asymptomatically through the vascular tissue from the scion to the rootstock. This was evident in Mid-July, two months after initial strikes. M 26 appeared more susceptible than Mark to fireblight-induced decline. We expect high tree losses in the future in these infected stocks M 26 stocks.

Insect pests Tissue proliferation was noted at Wye. In this planting no woolly apple aphids (WAA) or borers were found. In older commercial plantings, these pests were found in association with "weepy" tissue proliferations. In one commercial orchard, WAA were more severe on M 26 stocks than Mark. These WAA-infested M 26 trees were quite healthy, however.

Tissue proliferation Above-ground symptoms of tree decline were evident when more than 2/3 of the rootstock diameter was affected with "tissue proliferation." The appearance of the proliferating tissue was slightly different from the typical crown galls formed after controlled inoculations with *A. tumefaciens.* Tissue proliferations typically began just at, or below the soil line. Proliferating tissue frequently appeared green, and actively expanding in our October observations.

Our preliminary conclusion is that tissue proliferation precedes damage by these secondary pests such as borers and WAA.

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Title: Video Productions: An Educational Tool for Extension and Research

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Introduction:

Videos have become a way of life for the average American. Look around you and you will see that most of the households in the United States already have VCR's. Good quality videos are in demand from the general public as well as the fruit industry clientele. To meet this demand for educating the consumer on fruit production, a video was produced in 1992-93 season by the Penn State Cooperative Extension in Adams County, PA. The idea for the project came out of an extension advisory board meeting, who saw a need for a project of this nature.

As a result of this production, many resources were tapped and developed to accomplish the goal of a consumer educational video on fruit production. The purpose of this paper has been to make known to other extension and research personnel the resources, techniques and equipment to accomplish this task.

Materials and Methods:

Funding - Extension went to the Adams County Fruit Growers Association (ACFGA) Board of Directors for support of this project. The video started as a $1500 production. After months of discussion with people who produce videos, the production developed into an $8,000 project. Extension presented a detailed budget for the production of the video to the ACFGA Board and they eventually funded the entire video. Extension also contacted a number of other organizations and companies to help fund the project. The Upper Adams Jaycees, Chemical Companies, and other fruit industry organizations were willing to help fund the project. The ACFGA Board decided to fund the entire project with no outside strings attached. After the production was completed Penn State University College of Agricultural Sciences presented $4,500 to the ACFGA Board to help with the production.

Script - The script was written by extension in approximately a 4 month period (March - June 1992). Adjustments were made to the script during the 12 month period of production. The audience for the video was the general public or consumer. The prime audience was school age children from 4th to 12th grade. The development of the script involved two parts, the video and audio sections. A two column format was used with the video scenes located in the left column and the audio script to accompany the video scenes in the right hand column (Refer to script at end of paper).

Video Production Companies - Bucher's Video/Sound Productions (1153 Biglerville Road, Gettysburg, PA 17325. (717)334-0038. Owner: Jeff Bucher) was used to produce the video. He provided cameras, microphones, and other equipment to shoot the different scenes. The music was scored by Ed Horst, a friend of Jeff Buchers from Atlanta, Georgia.

Narrator - Wendal Woodbury from Woodbury Productions in Lancaster, PA. provided the complete on-scene and off scene narration for the video. Wendall has a TV background who used to work with Channel 8 News, Lancaster, PA. Because of Wendall's television experience, he also served as a consultant for directing the video.

Director/Coordinator - Extension served as the director/producer/coordinator for the video. This involved lining up scenes and coordinating the entire script throughout the production. Wendal Woodbury assisted in the direction of the video.

Editing Video - The editing took about 6 twelve-hour days to complete at Bucher's Video/Sound Productions. Jeff Bucher, Wendall Woodbury and Bill Kleiner conducted the editing of the video.

Marketing of Video - The video is marketed by the ACFGA at a cost of $19.95. Marketing flyers and labels were made by the ACFGA to send to all the school districts and other organizations that might be interested. Articles were written by extension for the various trade journals and newspapers. The video was also marketed by the ACFGA to local educational channels.

Results and Discussion:

The production resulted in a 27 minute video tape designed to educate the consumer on apple production. An idea, which was born in extension's Fruit Advisory Board, became a reality. The Adams County Fruit Growers Association supplied the $8,000 to complete the project. Penn State University, after the project was completed, gave $4,500 toward the video production.

The average price to produce a good quality video is approximately $1,000/finished minute. For example the video was 27 minutes long x $1,000/finished minute = $27,000 to produce a typical video. This video only cost $8,000 to produce it due to a number of factors. One of those factors was Jeff Bucher from Buchers Video/Sound Productions. He charged $5,000 to shoot and edit the video. Buchers Video/Sound Productions is highly recommended for the following reasons:

- Jeff was raised in Adams County and around the fruit industry, so he knows the fruit people and industry to some degree.
- He presently has many orchard, processing company, and other fruit industry scenes that would fit into any video related to fruit. Many of these scenes can be used in other videos if permission is acquired by Knouse Foods Inc., Rice Fruit Co., Kimes Cider Mill, ACFGA, and Jeff Bucher.
- Most importantly, if you have to get bids for a job, Bucher's will probably be the most reasonable bid at $995/day for shooting and editing or you can work out a packaged deal for $5,000/video depending on the time factor. He does travel to other States to produce videos, so there might be some travel expense costs.
- Jeff has an up-to-date video production business which adds allot of flexibility and quality to the video.

The average price for a narrator was approximately $200 - $300/finished minute for a typical video. Another words, the 27 minute video would have cost $5,400 (27 minutes x $200 = $5,400). Wendal Woodbury from Woodbury Productions in Lancaster, PA. provided the complete on-scene and off scene narration for the video. Wendall cost approximately $110/finished minute. Wendall worked out to be about $250/day. Wendall had a lot of good qualities that helped this video to be produced. He had 30 years of television experience, a witty personality to keep things interesting and a nice deep, clear voice.

The script was probably the most difficult to do beside the editing of the video. Even though the video was written in approximately a 4 month period (March - June 1992), there were many adjustments made to the script during the 12 month period of production. The audience has to be defined in order to accomplish the goal of the video. The prime audience was school age children from 4th to 12th grade. The development of the script involved two parts, the video and audio sections. A two column format was used with the video scenes located in the left column and the audio script to accompany the video scenes in the right hand column. The more organized the script was with the video scenes the less expensive the video will be to produce. A well produced video needs a well organized script with the video scenes and an organized director/producer to get the job done.

The editing of the video is probably the most tedious and nerve-racking part of the entire production. Jeff Bucher, Wendall Woodbury and Bill Kleiner edited the video in 6 twelve hour days. Finishing touches were done by Jeff Bucher.

After the video was edited, a copy was sent to Ed Horst in Atlanta, Georgia. Ed, a native of Biglerville, PA and friend of many of the fruit growers, scored the music to the tape. He volunteered his time to the ACFGA to put the music to the scenes in the video. Ed has his own company who does background music for many TV shows such as the 1992 Olympics, Ted Turners CNN broadcast, various commercials, and the new TV show called In The Heat of the Night starring Carrol O'Conner. He is willing to work with anyone in the production of videos. Costs of his service are unknown at this time, but could be found out by calling his business in Atlanta.

When a video is completed, another area that one must consider is the marketing of the video. Now some Universities have a good video marketing system in place, but for those who don't, many other avenues can be researched. This video was marketed by the ACFGA at a cost of $19.95. Marketing flyers and labels were made by the ACFGA to send to all the school districts and other organizations that might be interested. Articles were written by extension for the various trade journals and newspapers. The video was also marketed by the ACFGA to local educational channels.

One thing to consider is who will actually own the video. This production is owned by the ACFGA and the Penn State University. The selling of the video is done by the ACFGA at $19.95/copy and the video is not copyrighted. If you are going to produce a video, make sure you receive the funding directly to you, and handle the expenses through a special fund. If you ever want to copyright the video, only one name can go onto the copyright.

Video Productions can be a valuable educational tool for extension and research. They can be used to educate the public on your research station, show your research or extension program to the fruit growers for a winter meeting, and many other ways. All of us in extension and research should be taking advantage of this technology to get our message out to the growers and general public. After all the majority of the people in the United States will have VCR's in their homes by the year 2,000.

For more information on ordering the "All American Apple" video, please contact the Adams County Fruit Growers Association at 717-677-7444 or write to the Adams County Fruit Growers Association, 33 Musselman Avenue, P.O. Box 515, Biglerville, PA 17307. The All American Apple Video cost $19.95 each plus $2.50 for shipping and handling.

The All American Apple

by William C. Kleiner

Video Scene	Audio
1. Apple - Montage - Tight shot of apple opening to an orchard scene with Wendall in it. T1-56:50	Music
2. T1-51:15 An orchard scene during harvest with Wendall looking over apples on trees T1-56:12 (T1 56:04)	Did you ever wonder how these beautiful juicy apples are grown and where they come from? Apples are one of the most popular, flavorful and healthful fruits in the world. Three-fourth's of America's population, both young and old, name apples as one of their favorite fruits for snacking.
3. T1-58:25 Map of US	Apple growing is an important industry in the United States. The state of Washington ranks first in the number of bushels grown, followed by New York, Michigan, California, Pennsylvania and various other states.
4. Map of World	Worldwide, the United States ranks second to Russia in apple production
5. Scene with young trees in field	The first U.S. apple trees were planted by the pilgrims in the Massachusetts Bay Colony.
6. T2-1:23:57 Apple Queen reading book on Johnny Appleseed - Johnny Appleseed - scene with him in orchard NAT Sound -T2-1:24:10	Apple Queen reading book - NATS In the early 1800s John Chapman, better known as Johnny Appleseed, traveled across the Ohio Valley carrying bags of apple seeds while accomplishing his missionary duties. Johnny was born,....
7. Scene with newly planted trees.	As he ventured westward, he planted seeds wherever he roamed to ensure that settlers living in the western frontier would have nutritious apples to eat.
8. Kimes Cider mill scene	When his supply ran out, he would make the long journey back to western Pennsylvania to get more from a cider mill.

PLANT PATHOLOGY

APPLE (Malus domestica 'Golden Delicious')
Scab; Venturia inaequalis
Powdery mildew; Podosphaera leucotricha
Sooty blotch: Gloeodes pomigena
Fly speck; Zygophiala jamaicensis
Rots
Fruit finish

K. S. Yoder, A. E. Cochran II,
W. S. Royston and S. W. Kilmer
Virginia Agricultural Experiment Station - Winchester
Virginia Polytechnic Institute and State University
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Winchester, VA 22601

DISEASE CONTROL BY CONCENTRATE APPLICATIONS OF EXPERIMENTAL AND REGISTERED FUNGICIDES ON GOLDEN DELICIOUS APPLE, 1993: Experimental and registered compounds and mixtures were compared for disease control and fruit finish effects on 21-yr-old trees at the VPI and SU Research Farm near Winchester, VA. 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: 24 Apr (TC, tight cluster), 6 May (Bl, bloom to petal fall); 1st through 5th covers (1C-5C), respectively: 20 May, 7 Jun, 22 Jun, 8 Jul and 29 Jul. Other applications applied to the entire test block with the same equipment included Ambush 2E, Dipel 2X, Agrimycin 17, Sevin XLR + NAA 800, Guthion 3F + Lannate L, and Penncap-M + Lannate L. Calcium chloride 6 lb/A was included with the last five insecticide applications 2 Jun, 17 Jun, 8 Jul, 29 Jul and 19 Aug. Cedar-apple rust galls, bramble canes infected with sooty blotch and fly speck fungi, and bitter rot mummies were placed in baskets over each test tree. Foliar data represent averages of counts of all leaves on 10 terminal shoots from each of four replicate trees 20-26 Jul. A 25-fruit sample from each replicate tree was harvested 22 Sep and rated after 4 wks storage at 2C.

The first treatments were applied 2 wks after the first light infection period. The second application was one day after the first possible secondary infection period. Scab infection was light on foliage and moderate on fruit. All treatments gave significant control. Scab control by fluazinam on foliage was somewhat weak and erratic, possibly related to the degree of bud development under heavy inoculum during the earliest infection period. Treatments involving RH-7592 and Nova gave excellent control of scab and powdery mildew under moderate mildew pressure. All treatments significantly reduced mildew infections. In formulation comparisons, Ziram 76 gave significantly stronger mildew control than Ziram Granuflo, but had a significantly higher incidence of fly speck. No significant differences were detected between the two captan formulations when tested alone, but at lower rates in combination with Nova (through 2C) and Topsin-M (3C-5C), Captan 50W had fewer fruit infected with sooty blotch than Captan 75 WDG at equivalent active rates. The combination of captan + ziram was also weaker for sooty blotch control but was significantly improved by the addition of Nu-Film-17. Fluazinam gave good control of fruit rots and fair control of sooty blotch and fly speck at the higher rate, but weakened significantly on sooty blotch at the lower rate. Overall, the treatment involving Nova-Dithane DF through second cover followed by Captan 50W, third through fifth covers, resulted in excellent summer disease control and fruit finish. RH-7592 75W also gave excellent control of sooty blotch, fly speck and rots. Although there were significant differences in fruit russet between some treatments, none caused a significant increase in russet compared to the untreated check and there were no significant formulation differences in russet ratings between the two formulations of ziram, captan or RH-7592.

Table 1. Disease control by concentrate applications of experimental and registered fungicides on Golden Delicious apple

Treatment and rate/A	Timing	Scab incidence (%)		Mildew infection		Sooty blotch		Fly speck (%)	Fruit rots (%)	Russet rating (0-5)*
		leaves	fruit	% of leaves	% leaf area	% fruit	% area			
No fungicide	----	27.1 c	53 b	31.9 g	14.8 e	100 e	31.8 c	97 e	31 b	3.0 c
RH 7592 75W 2 oz + Latron B-1956 4 fl oz	TC-5C	0 a	0 a	7.9 abc	1.8 ab	0 a	0 a	0 a	0 a	2.5 bc
RH 7592 2F 6 fl oz + Latron B-1956 4 fl oz	TC-5C	0.2 a	0 a	5.2 ab	1.1 a	10 a	1.2 a	6 ab	0 a	1.9 abc
Fluazinam 500 6.4 fl oz	TC-5C	1.6 ab	1 a	14.6 cde	2.8 abc	56 d	6.3 b	50 d	3 a	2.9 c
Fluazinam 500 12.8 fl oz	TC-5C	7.7 b	9 a	21.9 ef	4.9 cd	17 abc	0.8 a	30 a-d	6 a	2.3 abc
TD 2323-2 75.2W 6 lb	TC-5C	4.9 ab	9 a	20.0 def	4.3 bcd	3 a	0.1 a	4 ab	0 a	2.0 abc
Captan 50W 6 lb	TC-5C	1.6 ab	2 a	19.3 def	4.2 bcd	3 a	0.1 a	4 ab	1 a	1.5 ab
Captan 75WDG 4 lb	TC-5C	3.1 ab	7 a	23.8 f	6.3 d	0 a	0 a	3 ab	0 a	1.3 a
Nova 40W 5 oz + Captan 50W 3 lb	TC-2C	0 a	0 a	2.3 a	0.5 a	12 ab	0.7 a	12 abc	0 a	1.5 ab
Topsin-M 85WDG 8 oz + Captan 50W 3 lb	3C-5C									
Nova 40W 5 oz + Captan 75WDG 2 lb	TC-2C	0.2 a	2 a	1.1 a	0.4 a	42 cd	4.4 ab	33 bcd	0 a	2.1 abc
Topsin-M 85WDG 8 oz + Captan 75WDG 2 lb										
Ziram 76 6 lb	TC-5C	1.7 ab	7 a	6.0 ab	1.3 a	39 bcd	3.9 ab	39 cd	2 a	1.8 abc
Ziram Granuflo 76DF 6 lb	TC-5C	6.8 ab	9 a	22.2 ef	4.4 bcd	26 abc	2.0 ab	24 abc	1 a	1.6 ab
Nova 40W 5 oz	TC									
Nova 40W 3.5 oz + Dithane 75DF 3 lb	BI-2C	0.3 a	1 a	1.6 a	0.7 a	1 a	0.1 a	0 a	0 a	1.2 a
Captan 50W 6 lb	3C-5C									
Captan 50W 3 lb + Ziram 76 3 lb	TC-5C	1.2 ab	2 a	9.0 bcd	1.8 ab	55 d	5.0 ab	50 d	2 a	1.9 abc
Captan 50W 3 lb + Ziram 76 3 lb + Nu-Film-17 1 pt.	TC-5C	2.8 ab	12 a	12.5 abc	2.9 abc	26 abc	4.2 ab	28 a-d	0 a	2.2 abc

Counts of leaves on 10 terminal shoots from each of four single-tree replicates 20-26 Jul.
Mean separation by Duncan's Multiple Range Test (p = 0.05).
*Rated on a scale of 0-5 (0 = perfect finish; 5 = severe russet).

APPLE (Malus domestica 'Stayman Winesap, 'Idared', 'GingerGold')
Scab; Venturia inaequalis
Powdery mildew; Podosphaera leucotricha
Sooty blotch; Gloeodes pomigena
Fly speck; Zygophiala jamaicensis
Brooks spot; Mycosphaerella pomi
Fruit finish

K. S. Yoder, A. E. Cochran II,
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DISEASE CONTROL BY STEROL-INHIBITING AND PROTECTANT FUNGICIDES ON STAYMAN, IDARED AND GINGERGOLD APPLES, 1993: Twelve combination fungicide schedules were compared on seven-yr-old trees in a test conducted in a randomized block design with four three-cultivar replicate tree sets separated by untreated border rows. Treatment rows had not been treated with fungicides in 1992 to encourage heavy mildew inoculum pressure. Tree-row-volume was determined to require a 400 gal/A dilute base for adequate coverage. Treatments were applied at 100 gallons per acre from both sides of the tree on each application date with a Swanson Model DA-400 sprayer as follows: 20 Apr (tight cluster); 29 Apr (pink-bloom); 10 May (petal fall); 21 May (1st cover); 7 Jun (2nd cover). All treatment trees except "no fungicide" covered with Ziram 76 6 lb/A 22 Jun, 7 Jul, 23 Jul and 19 Aug (3C-6C, 3rd-6th covers). Insecticides applied separately to the entire test block with the same equipment included: Ambush 2E, Dipel 2X, Sevin XLR, Guthion 3F, Lannate L, and Penncap-M. Calcium chloride 6 lb/A was included with the last five insecticide sprays 2 Jun, 17 Jun, 6 Jul, 23 Jul and 19 Aug. Wild blackberry canes infected with sooty blotch and fly speck fungi and bitter rot mummies were placed in baskets over the Stayman tree of each three-cultivar tree set. Foliar data represent averages of counts of all leaves on 10 terminal shoots from each of four replicates 12-19 Jul (Stayman), 14 Jul (Idared) or 27 Jul (GingerGold). A 25-fruit sample from each Stayman and Idared replicate tree was harvested 23 Sep and rated after 4 wks storage at 2C. GingerGold fruit were not harvested or evaluated due to small sample size.

The first fungicide application was delayed until 11 days after the first scab infection period. The second set of treatments was applied 6 days before the first possible secondary infection period. Scab incidence on foliage was light on Idared and moderate on Stayman and GingerGold. Under light to moderate scab pressure Rubigan 9 fl oz + Dithane DF or Polyram, Nova 4.5 oz and Nova 4.5 oz + Polyram 3 lb all gave good control of scab on foliage and the only significantly weaker treatments were the lowest rates of PCC 520. A stronger scab control test was evident on fruit, particularly on Idared where Rubigan 9 fl oz gave significantly weaker control than Nova 4.5 oz and the lowest rate of Rubigan + Polyram was significantly weaker than the low rate of Nova + Polyram. The addition of Polyram to Rubigan 9 fl oz significantly improved fruit scab control. Powdery mildew pressure was high on foliage of all three cultivars. Nova 4.5 oz gave significantly better mildew control than Rubigan 9 fl oz and PCC 520 (all rates) on Idared and GingerGold. Russet presumed to be caused by mildew was moderate on untreated Idared fruit and was significantly reduced by all treatments. Incidence of the summer diseases sooty blotch, fly speck, and Brooks spot also reached moderate levels by late season. With all treatments covered by ziram after 22 Jun, the only observed treatment differences were with Brooks spot on Idared where addition of Polyram to Nova 4.5 oz significantly improved control compared to Nova alone and a significant weakness by the lowest rate of Rubigan + Polyram was evident. All treatments gave significant control of Brooks spot compared to the untreated check. No treatment caused a significant, deleterious fruit finish effect compared to the untreated check.

Table 2. Control of scab and powdery mildew by sterol-inhibiting and protectant fungicides

	Scab incidence (%)					Powdery mildew infection						
	Stayman		Idared		Ginger Gold	Stayman		Idared			GingerGold	
Treatment and rate/A through 2nd cover*	leaves	fruit	leaves	fruit	leaves	% leaves	% leaf area	% leaves	% area	% fruit	% leaves	% leaf area
No fungicide	28.3 d	50 b	12.4 b	60 d	43.0 c	60.9 f	78.5 b	64.4 h	90.3 d	29 b	63.4 h	86.5
Rubigan 1E 9 fl oz + Dithane 75DF 3 lb	0.6 a	4 a	0.1 a	8 abc	0.6 a	14.8 c	3.5 a	16.9 cd	5.2 ab	4 a	16.3 b	4.5
Nova 40W 4.5 oz + Polyram 80DF 3 lb	0.1 a	0 a	0.0 a	3 a	0.5 a	3.9 ab	1.2 a	9.0 ab	2.9 ab	2 a	8.7 a	2.6
Nova 40W 1.13 oz + Polyram 80DF 12 oz	2.5 ab	1 a	0.5 a	5 ab	3.0 a	8.0 ab	1.9 a	13.0 bc	3.6 ab	5 a	12.7 a	3.4
Rubigan 1E 9 fl oz + Polyram 80DF 3 lb	0.5 a	2 a	0.1 a	3 a	1.8 a	11.4 bc	2.2 a	15.3 bcd	3.6 ab	5 a	17.3 b	4.8
Rubigan 1E 4.5 fl oz + Polyram 80DF 1.5 lb	3.8 ab	3 a	0.3 a	10 abc	4.0 a	13.7 c	3.3 a	22.9 def	6.3 ab	0 a	26.1 d	8.6
Rubigan 1E 2.25 fl oz + Polyram 80DF 12 oz	3.0 ab	9 a	0.8 a	18 c	6.7 ab	26.2 e	6.2 a	25.0 efg	10.9 b	9 a	30.9 g	11.6
Rubigan 1E 9 fl oz	3.9 ab	10 a	0.6 a	19 c	3.1 a	9.6 ab	2.2 a	19.4 cde	5.0 ab	6 a	16.4 b	5.5
Nova 40W 4.5 oz	0.0 a	0 a	0.0 a	4 ab	0.7 a	1.4 a	0.4 a	2.8 a	1.0 a	3 a	5.2 a	1.5
Polyram 80DF 3 lb	3.7 ab	4 a	0.8 a	12 abc	6.1 ab	13.8 c	3.3 a	25.5 efg	5.5 ab	7 a	26.6 e	9.2
PCC 520 70.5W 3.5 lb	2.3 ab	5 a	0.2 a	4 ab	6.4 ab	9.5 ab	2.5 a	19.5 cde	5.5 ab	4 a	20.8 c	6.1
PCC 520 70.5W 1.75 lb	5.9 b	7 a	1.3 a	16 bc	4.6 a	16.6 cd	4.5 a	31.4 g	18.5 c	9 a	29.5 f	16.0
PCC 520 70.5W 14 oz	10.7 c	8 a	0.2 a	9 abc	11.9 b	24.2 de	5.4 a	29.8 fg	9.5 b	7 a	28.4 f	13.8

Averages of leaves from 10 terminal shoots 12-19 Jul (Stayman), 14 Jul (Idared), 27 Jul (GingerGold) or 25 fruit from each of four replicate trees 20 Oct (Stayman), 21 Oct (Idared).
Mean separation by Duncan's Multiple Range Test ($p = 0.05$).
*All treatments except "no fungicide" covered with Ziram 76 6 lb/A 22 Jun, 7 Jul, 23 Jul and 19 Aug.

Table 3. Summer diseases and fruit finish following SI-protectant fungicide schedules

Treatment and rate/A through 2nd cover and 3rd-6th cover	Fruit disease incidence (%)						Fruit finish rating (0-5)*			
	sooty blotch		fly speck		Brooks spot		russet		opalescence	
	Stayman	Idared	Stayman	Idared	Stayman	Idared	Stayman	Idared	Stayman	Idared
No fungicide	52 b	52 b	47 b	49 b	8 b	26 d	1.5 a	1.3 a	1.5 a	1.6 ab
Rubigan 1E 9 fl oz + Dithane 75DF 3 lb Ziram 76 6 lb 3C-6C	4 a	3 a	8 a	4 a	0 a	0 a	1.5 a	1.5 a	1.5 a	1.3 a
Nova 40W 4.5 oz + Polyram 80DF 3 lb Ziram 76 6 lb 3C-6C	2 a	1 a	9 a	1 a	0 a	0 a	1.7 a	1.6 a	1.7 a	1.5 ab
Nova 40W 1.13 oz + Polyram 80DF 12 oz Ziram 76 6 lb 3C-6C	4 a	5 a	17 a	5 a	0 a	2 ab	2.2 a	1.3 a	2.0 a	1.8 ab
Rubigan 1E 9 fl oz + Polyram 80DF 3 lb Ziram 76 6 lb 3C-6C	4 a	0 a	9 a	10 a	0 a	0 a	1.7 a	1.5 a	1.9 a	1.6 ab
Rubigan 1E 4.5 fl oz + Polyram 80DF 1.5 lb Ziram 76 6 lb 3C-6C	7 a	9 a	9 a	15 a	0 a	0 a	1.7 a	1.0 a	1.7 a	1.4 ab
Rubigan 1E 2.25 fl oz + Polyram 80DF 12 oz Ziram 76 6 lb 3C-6C	4 a	4 a	10 a	6 a	0 a	11 c	1.3 a	1.5 a	1.8 a	1.9 b
Rubigan 1E 9 fl oz Ziram 76 6 lb 3C-6C	6 a	6 a	21 a	7 a	0 a	6 abc	1.6 a	1.5 a	1.9 a	1.3 a
Nova 40W 4.5 oz Ziram 76 6 lb 3C-6C	4 a	5 a	9 a	10 a	0 a	9 bc	1.6 a	1.6 a	2.0 a	1.7 ab
Polyram 80DF 3 lb Ziram 76 6 lb 3C-6C	6 a	4 a	5 a	7 a	1 a	1 ab	1.6 a	1.5 a	1.5 a	1.8 ab
PCC 520 70.5W 3.5 lb Ziram 76 6 lb 3C-6C	5 a	3 a	14 a	5 a	0 a	0 a	1.5 a	1.5 a	1.7 a	2.0 b
PCC 520 70.5W 1.75 lb Ziram 76 6 lb 3C-6C	5 a	3 a	8 a	8 a	0 a	5 abc	1.7 a	1.6 a	2.0 a	1.8 ab
PCC 520 70.5W 14 oz Ziram 76 6 lb 3C-6C	9 a	9 a	12 a	15 a	1 a	7 abc	2.1 a	1.4 a	2.2 a	1.6 ab

Averages of 25 fruit from each of four replicate trees 20 Oct (Stayman) and 21 Oct (Idared).
Mean separation by Duncan's Multiple Range Test (p = 0.05).
*Rated on a scale of 0-5 excluding presumed mildew russet (0 = perfect finish; 5 = severe russet or opalescence).

APPLE (Malus domestica 'Nittany')
Scab; Venturia inaequalis
Powdery mildew; Podosphaera leucotricha
Fruit finish

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EARLY SEASON DISEASE CONTROL AND FRUIT FINISH EFFECTS BY COPPER FORMULATIONS ON NITTANY APPLE, 1993: Seven copper formulations were compared for early season disease control and fruit finish effects when applied at 1/2" green stage and twice during bloom applications. Rates of six formulations (indicated by asterisk below) were calculated to deliver 25.2 oz per acre of metallic copper in the 1/2" green application 15 Apr and 3.2 oz of copper per acre in applications 30 Apr (early bloom), and 7 May (late bloom). The test was conducted in a randomized block design with four single-tree replicates with border rows between test 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. No other fungicides were applied until mid-summer when Ziram 76 6 lb/A was applied to all treatment trees (not the untreated trees) 7 Jul, 22 Jul and 19 Aug. Insecticides, applied separately to the entire test block with the same equipment with indicated rates/A included Ambush 2E 12 fl oz + oil 6 gal/A (9 Apr); Dipel 2X 16 oz (3 May); Sevin XLR 2.8 pt + NAA 1 fl oz + Tween 20 8 fl oz (as thinner 14 May); Guthion 3F 1.5 pt + Lannate L 1.5 pt (21 May, 2 Jun, and 17 Jun); Guthion 3F 1.5 pt + Lannate L 3 pt (6 Jul); Penncap-M 2.5 pt + Lannate L 3 pt (22 Jul and 19 Aug). Calcium chloride 6 lb/A was included in the last five insecticide sprays. Fruit were harvested 13 Sep and rated 21 Sep.

The first ten terminal leaves (1-10) were rated separately as an indicator of fungicidal activity before the first secondary scab infection period. Compared to untreated trees, equivalent copper rates of the registered formulations gave significant ($p = 0.05$) control of scab on foliage and all of the copper treatments, supplemented by the three late-season ziram applications, gave significant control of scab on fruit. Kocide, Copper Count-N, Champ, Tenn-Cop and Tenn-Cop + Nu-Film-17 reduced early season incidence of powdery mildew on terminal leaves 1-10. Tenn-Cop + Nu-Film-17 significantly reduced mildew incidence in overall terminal shoot ratings. Basicop, Copper Count-N, Champ, Tenn-Cop and Tenn-Cop + Nu-Film-17 significantly reduced the percent area affected by mildew. The only treatments which did not significantly increase either the percent of fruit with russet or the mean percent fruit area russetted were COCS and the reduced copper rate of GX-306.

Table 4. Early season disease control and fruit finish effects by copper formulations on Nittany apple

			Scab (%)			Mildew, % lvs inf			Russet	
Treatment*	15 Apr (1/2"G)	30 Apr & 7 May (Bloom period)	terminal leaves 1-10	all terminal leaves	fruit	terminal leaves 1-10	all terminal leaves	Mildew % area infected	% of fruit	% fruit area
No fungicide	---	---	8.8 b	8.7 b	20 b	9.5 b	11.2 b	2.6 b	13 a	0.4 a
*Kocide 40DF	63.0 oz	7.9 oz	1.0 a	1.1 a	1 a	3.3 a	5.8 ab	1.5 ab	40 a-d	5.9 bcd
*Basicop 53W	47.2 oz	5.9 oz	2.3 a	2.4 a	3 a	2.8 ab	4.4 ab	1.1 a	44 bcd	4.6 bc
GX-306 35%	63.0 oz	7.9 oz	4.5 ab	6.0 ab	6 a	7.8 ab	9.0 ab	2.0 ab	56 bcd	7.6 cde
GX-306 35%	47.2 oz	5.9 oz	3.8 ab	4.0 ab	3 a	6.8 ab	8.5 ab	1.8 ab	32 abc	2.5 ab
*COCS 50WDG	50.4 oz	6.3 oz	2.3 a	1.8 a	3 a	5.3 ab	7.7 ab	2.1 ab	28 ab	3.0 ab
*Copper Count-N	2.0 gal	1.0 qt	1.0 a	1.0 a	2 a	2.8 a	5.1 ab	1.1 a	53 bcd	6.2 bcd
*Champ 2.3F	134.0 fl oz	16.8 fl oz	0.3 a	0.6 a	1 a	3.3 a	5.8 ab	1.3 a	64 d	8.3 de
Champ 2.3F	67.0 fl oz	8.4 fl oz	2.8 a	4.3 ab	3 a	2.8 a	4.9 ab	1.2 a	56 cd	10.7 e
*Tenn-Cop 5E	394.0 fl oz	49.3 fl oz	3.0 a	2.6 a	1 a	3.0 a	4.6 ab	1.2 a	47 bcd	6.0 bc
*Tenn-Cop 5E + Nu-film-17	394.0 fl oz +16.0 fl oz	49.3 fl oz + 16.0 fl oz	2.3 a	3.3 a	4 a	3.5 a	3.7 a	0.9 a	40 a-d	4.9 bcd

Averages of leaves on ten shoots (29-30 Jun) or 25 fruit (21 Sep) from each of four replicate trees.
Mean separation by Duncan's Multiple Range Test (p = 0.05).
*Rates of treatments marked by an asterisk were calculated to deliver 25.2 oz active Cu per acre at 1/2" green (15 Apr) and 3.2 oz in applications at early bloom (30 Apr) and late bloom (7 May). Ziram 76 6 lb/A applied to all reatment trees (not the untreated trees) 7 Jul, 22 Jul and 19 Aug.

APPLE (*Malus domestica* 'Rome Beauty', 'Golden Delicious')
Fireblight; *Erwinia amylovora*
Fruit finish

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EFFECTS OF PRE-INOCULATION OR POST-INOCULATION TREATMENTS ON FIREBLIGHT SHOOT INFECTION ON TWO APPLE CULTIVARS, 1993: Seven treatments involving streptomycin or Tenn-Cop in combination with adjuvants were tested for effectiveness when applied as protectants one day before shoot inoculation or as one-day post-inoculation treatments. Treatments were applied to pairs of adjacent 21-yr-old trees of each cultivar in four randomized blocks. Initial treatments were applied at bloom (4 May) with a Swanson Model DA-400 airblast sprayer at 100 gal/A. The indicated pink treatment was applied 30 Apr. Attempted inoculation by spraying 1 X 10^5 *E. amylovora* cells/ml into 10 Rome blossom clusters per tree 5 May failed to produce any infection. Repeat treatments indicated for 1 Jun were applied dilute to the point of runoff with a single nozzle handgun at 200 psi. On 31 May and 2 Jun 10 actively growing shoots per tree were inoculated into the last leaf node at the shoot tip with a No. 25 hypodermic syringe and one droplet of a bacterial suspension of 1 X 10^8 cells/ml. Shoot infections were assessed 15-16 Jun (Rome) and 16 Jun (Golden Delicious) and all inoculated shoots were removed. Treatments were repeated 17 Jun to test their effect on secondary blight spread but only a few additional strikes were observed. Fruit finish was based on a 25-fruit harvest sample from each test tree.

Generally, pre-inoculation treatments more effectively reduced the percent shoots infected and mean canker length on both cultivars. Under more severe pressure on Rome, all pre-inoculation treatments involving Agri-mycin significantly reduced % infection, with Agri-mycin 8 oz + Regulaid being the most effective. Post-inoculation treatments were comparatively less effective. Only Agri-mycin 8 oz significantly reduced percent infection. When all inoculated Rome shoots were considered, the addition of LI-700 or Regulaid to Agri-mycin 4 oz significantly reduced mean canker length compared to Agri-mycin 4 oz alone. Considering only infected Rome shoots, no treatments significantly reduced mean canker length. Tenn-Cop treatments initially included to observe their effect on blossom infection, did not have a significant effect on percent Rome shoots infected or mean canker length. Shoot blight infection was lower on Golden Delicious and all pre-inoculation treatments, including Tenn-Cop, gave significant control. Post-inoculation treatments of Agri-mycin 8 oz, Agri-mycin 8 oz + Regulaid and Agri-mycin 4 oz + LI-700 significantly reduced percent Golden Delicious shoots infected. When considering infected shoots only, no treatments significantly reduced mean canker length. When all inoculated shoots were considered, mean canker length was reduced by all pre-inoculation treatments and by post-inoculation treatments of Agri-mycin 8 oz, Agri-mycin 8 oz + Regulaid and Agri-mycin 4 oz + LI-700. Compared to untreated fruit, USDA fruit finish grade was significantly reduced by Agri-mycin 8 oz and Agri-mycin 4 oz + LI-700 on Rome. Some powdery mildew was present on the Rome trees and may have interfered with fruit finish assessment.

Table 5. Effect of pre-inoculation or post-inoculation treatments on fireblight shoot infection on Rome Beauty apple

		% shoots infected		Mean canker length (cm), infected shoots only		Mean canker length (cm), all inoculated shoots		Fruit russet**	
Bloom treatment/A (4 May)	Dilute rate/100 gal (1 Jun)*	pre-inoc treatment	post-inoc treatment	pre-inoc treatment	post-inoc treatment	pre-inoc treatment	post-inoc treatment	% Extra Fancy and Fancy	% Utility
No treatment	No treatment	94.4 d	96.9 b	16.5 a	22.4 a	15.6 c	21.7 a	93 a	2 a
Agri-Mycin 17 16 oz	Agri-Mycin 17 8 oz	55.0 ab	78.2 a	14.4 a	20.4 a	7.9 ab	16.3 a	66 c	13 b
Agri-Mycin 17 8 oz	Agri-Mycin 17 4 oz	77.6 bc	88.8 ab	14.4 a	20.2 a	11.2 bc	18.0 a	85 abc	6 ab
Agri-Mycin 17 8 oz + Regulaid 1 pt	Agri-Mycin 4 oz + Regulaid 1 pt	65.9 ab	81.1 ab	13.6 a	18.0 a	6.5 a	15.4 a	80 abc	6 ab
Agri-Mycin 17 8 oz + LI-700 1 pt	Agri-Mycin 17 4 oz + LI-700 1 pt	56.9 ab	86.0 ab	11.0 a	18.2 a	3.7 a	15.4 a	71 bc	6 ab
Tenn-Cop 5E 3 pt	Tenn-Cop 5E 12 fl oz	93.9 d	92.6 ab	13.8 a	20.5 a	12.9 c	18.5 a	86 ab	2 a
Tenn-Cop 5E 3 pt + Nu-Film-17 1 pt	Tenn-Cop 5E 12 fl oz + Nu-Film-17 4 fl oz	89.7 cd	95.0 ab	13.6 a	19.5 a	12.2 bc	18.6 a	87 ab	2 a
Agri-Mycin 17 16 oz (pink)	Agri-Mycin 17 8 oz + Regulaid 1 pt	46.8 a	87.5 ab	14.2 a	20.0 a	6.6 a	17.6 a	88 ab	2 a

Based on ten shoots on each of four replicate trees for both inoculation dates.
Mean separation of Duncan's Multiple Range Test (p = 0.05).
* Applied before or after shoot inoculations 31 May and 2 Jun.
** Percentage of fruit in indicated USDA grades after down-grading by russet.

Table 6. Effect of pre-inoculation or post-inoculation treatments on fireblight shoot infection on Golden Delicious apple

Bloom treatment/A (4 May)	Rate/100 gal (1 Jun)	% shoots infected: pre-inoc treatment	% shoots infected: post-inoc treatment	Mean canker length (cm), infected shoots only: pre-inoc treatment	Mean canker length (cm), infected shoots only: post-inoc treatment	Mean canker length (cm), all inoculated shoots: pre-inoc treatment	Mean canker length (cm), all inoculated shoots: post-inoc treatment	Fruit russet*: % Extra Fancy and Fancy	Fruit russet*: % Utility
No treatment	No treatment	54.9 b	62.9 d	23.9 a	25.8 a	12.9 b	16.2 b	66 ab	4 a
Agri-Mycin 17 16 oz	Agri-Mycin 17 8 oz	12.5 a	29.2 abc	19.4 a	23.8 a	3.2 a	6.7 a	79 ab	2 a
Agri-Mycin 17 8 oz	Agri-Mycin 17 4 oz	15.0 a	38.9 a-d	10.0 a	27.1 a	3.1 a	10.5 ab	82 a	3 a
Agri-Mycin 17 8 oz + Regulaid 1 pt	Agri-Mycin 4 oz + Regulaid 1 pt	8.1 a	41.7 bcd	11.5 a	23.6 a	1.2 a	10.4 ab	62 ab	10 a
Agri-Mycin 17 8 oz + LI-700 1 pt	Agri-Mycin 17 4 oz + LI-700 1 pt	5.0 a	23.9 ab	11.5 a	15.5 a	1.2 a	4.5 a	61 ab	6 a
Tenn-Cop 5E 3 pt	Tenn-Cop 5E 12 fl oz	30.6 a	50.3 cd	22.8 a	21.5 a	6.7 a	10.9 ab	44 ab	16 a
Tenn-Cop 5E 3 pt + Nu-Film-17 1 pt	Tenn-Cop 5E 12 fl oz + Nu-Film-17 4 fl oz	25.0 a	41.9 bcd	16.4 a	25.3 a	5.9 a	10.7 ab	33 b	16 a
Agri-Mycin 17 16 oz (pink)	Agri-Mycin 17 8 oz + Regulaid 1 pt	12.5 a	14.0 a	10.6 a	21.8 a	2.8 a	4.2 a	61 ab	8 a

Based on ten shoots on each of four replicate trees for both inoculation dates.
Mean separation of Duncan's Multiple Range Test (p = 0.05).
* Applied before or after shoot inoculations 31 May and 2 Jun.
** Percentage of fruit in indicated USDA grades after down-grading by russet.

APPLE (Malus domestica 'Golden Delicious')
Blue mold; Penicillium expansum
Bitter rot; Colletotrichum spp.

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POSTHARVEST TREATMENTS FOR CONTROL OF PENICILLIUM BLUE MOLD AND LATENT BITTER ROT, 1992-93: Fruit grown under a commercial spray schedule with captan as the fungicide were picked 29 Sep and stored in bins 12 wk in a commercial cold storage. Fruit indicated as chlorine pre-treatment (chlor pre-trt) were then dipped 60 sec in 200 ppm sodium hypochlorite and rinsed with clean tap water the day before fungicide treatments were applied. Fruit were selected for uniform size, firmness, and maturity and randomized into four replicates for each treatment. Each fruit was uniformly wounded in three locations by piercing the skin with a 4 mm-diam nail point to a depth of 5 mm. Individual replicates of 25 fruit were dipped 30 sec in the fungicide treatment, placed on fiber trays with the wounded surface up following treatment and allowed to dry. All trays were then bagged in polyethylene bags. Sets of fruit were inoculated by atomizing a suspension containing 20,000 benzimidazole-sensitive P. expansum conidia/ml onto the treated, dried, wounded surface. Fruit were then returned to the commercial storage (1 C) for 43 days, removed from cold storage and evaluated after six and nine days at 19 C. Test fruit were not specifically inoculated with the bitter rot fungus but mummified fruit were present in the trees from which test fruit were harvested. No bitter rot was evident on the fruit selected for the test following the initial 12-wk cold storage period.

Inoculation increased the blue mold incidence on untreated fruit and fruit treated with weaker treatments. Incidence also increased with extended incubation. On inoculated fruit, incidence was generally greater on fungicide-treated fruit that had not been pre-treated with chlorine than on fruit that had been pre-treated. However, inoculated fruit pre-treated with chlorine followed by the $CaCl_2$ treatment had significantly more blue mold than those pre-treated with chlorine and the water control, an effect not observed on fruit which were not pre-treated with chlorine. On inoculated fruit without chlorine pre-treatment all test treatments gave a significant ($p = 0.05$) reduction in blue mold incidence compared to the water dip treatment. The most consistently effective treatments were those involving Rovral and the combination of Mertect with Rovral or with captan. Bitter rot began to appear after test fruit were removed from cold storage and incubated at 65 F for rot assessment. The following treatments significantly inhibited the development of bitter rot after either the 6-day or the 9-day 65 F incubation period whether fruit were pre-treated with chlorine or not: Aliette, Aliette + Rovral, Rovral + Captan. The following treatments did not inhibit bitter rot development: Rovral, Mertect, Mertect + Rovral.

Table 7. Control of Penicillium blue mold and latent bitter rot by postharvest treatments on Golden Delicious

Treatment and rate per 100 gallons	Penicillium blue mold incidence (%)								Bitter rot incidence (%) on non-inoculated fruit after indicated incubation period after cold storage			
	Six days at 19C after cold storage				Nine days at 19C after cold storage							
	P. exp inoculated		no inoculation		*P. exp* inoculated		no inoculation		Six days at 19C		Nine days at 19C	
	Chlor. pre-trt	No pre-trt	Chlor. pre-trt	No pre-trt	Chlor. pre-trt	No pre-trt	Chlor. pre-trt	No pre-trt	Chlor. pre-trt	No pre-trt	Chlor. pre-trt	No pre-trt
Water dip only	18 c	45 f	4 a	8 b	26 bc	63 e	5 b	10 b	21 b	14 bc	30 cd	28 b
Aliette 80W 5 lb	8 ab	16 cd	1 a	0 a	18 b	24 cd	3 ab	0 a	4 a	3 a	10 abc	13 a
Aliette 80W 5 lb + Rovral 4SC 1 pt	0 a	3 ab	0 a	0 a	0 a	3 a	0 a	0 a	4 a	3 a	9 ab	14 ab
Rovral 4SC 1 pt	0 a	1 a	1 a	0 a	0 a	1 a	1 ab	0 a	18 ab	9 abc	28 bcd	19 ab
Rovral 4SC 1 pt + Captan 50W 1 lb	1 a	0 a	0 a	0 a	1 a	0 a	0 a	0 a	3 a	5 ab	5 a	11 a
Mertect 340F 1 pt + Captan 50W 1 lb	0 a	3 ab	0 a	0 a	0 a	4 ab	0 a	1 a	14 ab	8 abc	24 a-d	11 a
Mertect 340F 1 pt + Rovral 4SC 1 pt	4 a	6 abc	0 a	1 a	6 a	15 abc	0 a	1 a	13 ab	16 c	21 a-d	19 ab
Mertect 340F 1 pt	0 a	15 bcd	0 a	4 ab	3 a	23 bcd	1 ab	16 c	14 ab	14 bc	31 d	18 ab
Captan 50W 1 lb	15 bc	5 abc	0 a	1 a	24 b	10 ab	0 a	1 a	4 a	6 ab	14 a-d	16 ab
Stopit 6 1.35 gal	23 c	26 de	0 a	4 ab	35 c	35 d	1 ab	5 a	5 a	5 ab	25 a-d	14 ab
$CaCl_2$ flake 2.15 lb	35 d	30 e	0 a	3 ab	45 d	40 d	0 a	3 a	6 ab	5 ab	15 a-d	11 a

Averages of four replications, 25 fruit/replication. Mean separation by Duncan's Multiple Range Test (p = 0.05).

APPLE (Malus domestica)
Cedar-apple rust;
Gymnosporangium juniperi-virginianae
Powdery mildew; Podosphaera leucotricha

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SUSCEPTIBILITY OF SCAB-RESISTANT APPLE CULTIVARS TO CEDAR-APPLE RUST AND POWDERY MILDEW, 1992-93: Scab-resistant apple cultivars and selections considered to have potential for the mid-Atlantic processing market were planted at the Virginia Tech Ag. Research and Extension Center near Winchester, VA in 1990. The long-term objective is to study susceptibility of these cultivars to other diseases, particularly powdery mildew, the rusts and summer diseases. The planting was established on M27 rootstock in four randomized blocks in two rows spaced at 30 ft. In-row spacing of the resistant cultivars is 10 ft. Two of the blocks were interplanted with Jonagold/M26 or GingerGold/M26 in 1991 to help stabilize mildew inoculum pressure. The test planting receives dormant copper sprays and streptomycin bloom sprays for fireblight control and routine insecticides, but has not had a fungicide during the growing season since planting. Disease developed from inoculum naturally present for mildew in the test area both test years and for rust in 1992. Rust galls were placed around each test tree in 1993. Disease ratings were conducted 13-14 Jul 92 and 9 Aug 93 by evaluating all the leaves on four terminal shoots from each replicate tree.

Under moderate rust inoculum pressure, the cultivars Redfree, Liberty and Williams Pride and several unnamed selections were highly resistant to foliar infection. Jonafree, Co-op 25, and Co-op 31 were moderately susceptible to foliar rust infection. Redfree, Jonafree, Williams Pride, Dayton and Enterprise were relatively resistant to mildew infection, but Co-op 29 and selections CLR13T40, CLR13T45, HFR31T91 and PAR9T70 were quite susceptible to foliar mildew infection. Dayton, Enterprise, HFR19T127, and PAR23T209 from the Purdue collection have had 10% or less of the leaves infected with cedar apple rust or powdery mildew in 1992 and 1993. Named cultivars or Co-op selections which had 20% or more of the leaves infected with powdery mildew in 1992 or 1993 were Liberty, Williams Pride, Co-op 25, Co-op 27, Co-op 29 and Co-op 31. The trees began to fruit in 1993 and, without artificial summer disease inoculum in the test area, no unusual susceptibilities to rots, sooty blotch or fly speck were recognized. Fruit susceptibility to these diseases will continue to be evaluated as the trees produce more fruit.

Table 8. Evaluation of scab-resistant apple cultivars for rust and mildew susceptibility

Cultivar/selection		Leaves with infection (%) cedar-apple rust 1992	cedar-apple rust 1993	mildew 1992	mildew 1993	Mildew % leaf area affected 1992	1993
1	HFR19T127	0 a	0 a	10 abc	3 a	3 a	1 a
2	HFR17T96	0 a	0 a	12 abc	11 ab	2 a	2 a
3	Redfree	0 a	0 a	7 a	15 ab	2 a	2 a
4	HCR23T113	0 a	0 a	6 a	20 abc	2 a	2 a
5	Jonafree	11 b-f	7 ab	4 a	2 a	2 a	1 a
6	Co-op 27	6 a-e	0 a	11 abc	28 a-f	4 a	7 a
7	CLR13T45	0 a	0 a	31 cde	55 g	11 a	60 c
8	HFR31T91	1 a	0 a	24 a-d	52 fg	19 ab	46 bc
9	Liberty	0 a	0 a	18 abc	21 a-d	4 a	2 a
10	HF Row 34	14 def	0 a	12 abc	34 b-g	4 a	10 a
11	Williams Pride	1 a	0 a	8 a	20 abc	2 a	3 a
12	OR53T43	14 def	16 d	12 abc	26 a-e	4 a	8 a
13	HER4T16	13 c-f	11 bcd	18 abc	47 d-g	9 a	33 abc
14	Co-op 29	1 a	0 a	47 e	45 c-g	39 b	22 ab
15	Co-op 25	18 f	11 bcd	11 abc	28 a-f	3 a	8 a
16	Co-op 31	13 c-f	9 bc	9 abc	33 b-g	3 a	24 ab
17	PAR23T209	7 a-e	7 ab	7 a	0 a	2 a	0 a
18	PAR9T70	15 ef	14 cd	30 b-e	48 efg	24 ab	33 abc
19	Dayton	4 abc	0 a	5 a	4 a	1 a	1 a
20	CLR13T40	7 a-e	14 cd	38 de	24 a-e	36 b	3 a
21	Enterprise (Co-op 30)	1 a	0 a	8 ab	9 ab	2 a	2 a
22	PWR36T242	3 ab	0 a	8 ab	28 a-f	3 a	11 a
25	HCR23T113	5 a-d	0 a	15 abc	10 ab	7 a	1 a
26	73334-35	1 a	0 a	12 abc	24 a-e	2 a	5 a
27	NY 75413-30	1 a	0 a	9 ab	21 a-d	2 a	4 a

Averages of all leaves on four shoots from two-four single tree replicates 13-14 Jul 92 and 9 Aug 93.
Mean separation by Duncan's Mutiple Range Test (p = 0.05).

APPLE (Malus domestica 'Golden Delicious')
Sooty blotch; Gloeodes pomigena
Fly speck; Zygophiala jamaicensis
Bitter rot; Colletotrichum spp.
White rot; Botryosphaeria dothidea

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EFFECT OF REDUCED EBDC FUNGICIDE SCHEDULES AND ALTERNATIVES ON SUMMER DISEASE AND POSTHARVEST ROT DEVELOPMENT ON GOLDEN DELICIOUS, 1992-93: Fungicide mixtures and schedules involving EBDC's and possible alternatives to EBDC fungicides were compared for disease control and fruit finish effects on 20-yr-old trees at the VPI and SU Research Farm near Winchester, VA. 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: 23 Apr (P, pink); 4 May (PF, petal fall); 1st through 6th covers (1C-6C), respectively: 13 May, 27 May, 10 Jun, 26 Jun, 10 Jul and 28 Jul. Other applications applied to the entire test block with the same equipment included Supracide 2E 3 qt + oil 6 gal/A, 10 Apr; Streptomycin 100 ppm dilute, 28 Apr; Lannate 3 pt + Guthion 3F 2 pt, 13 May; NAA 10 ppm + Tween 20 8.0 fl oz, 21 May; Lannate 3 pt + Guthion 3F 2 pt + Calcium chloride 6 lb/A, 28 May, 10 Jun, 25 Jun, 8 Jul, 25 Jul, 7 Aug and 25 Aug. Bramble canes infected with sooty blotch and fly speck fungi, and bitter rot mummies were placed in baskets over each test tree. A 25-fruit sample from each replicate tree was harvested 28 Sep and rated for sooty blotch and fly speck after 4 wks storage at 2C. Rot incidence was evaluated after 133 days at 2C and 14 days at 19C.

Under heavy sooty blotch and fly speck pressure all treatments except Captan 50W significantly reduced sooty blotch incidence and all treatments reduced percent area affected. Ziram, Captan 75 WDG and a combination of ziram + Captan 50W more effectively controlled sooty blotch than Captan 50W alone. Initial rot counts made after 4 wks cold storage showed that all treatments gave significant control of rots and early rot symptoms, at that time presumed to be Botryosphaeria (white) rot. Counts after 19 wks cold storage and 2 wks incubation at 19C showed the rots to be mostly a mixture of bitter rot and white rot and that some of the bitter rot was probably latent at the time of the first evaluation. Following the warm incubation period the only treatment which gave significant control of bitter rot, white rot and total rots combined was Captan 50W + ziram + Nu-Film-17. The only other treatment which gave significant rot control was the season-long schedule of Captan 50W 6 lb/A which controlled white rot and reduced total (combined) rots.

Table 9. Effect of reduced EBDC fungicide schedules and alternatives on summer disease and postharvest rot development on Golden Delicious, 1992-93

		Sooty blotch (%)		Flyspeck (%)		Postharvest rots (%)		
	Treatment, rate/A and timing	fruit	area	fruit	area	total rots	bitter rot	white rot
0	No fungicide	100 e	59 c	100 c	28 c	55 c	47 b	14 c
1	Nova 40W 5 oz (pink) Nova 40W 3.5 oz + Dithane 75DF 3 lb (PF-4C) Captan 50W 6 lb (5C, 6C)	77 abc	14 ab	73 a	4 a	25 abc	22 ab	3 ab
2	Rubigan 1E 8 fl oz (pink) Rubigan 1E 8 fl oz + Dithane 75DF 3 lb (PF-2C) Captan 50W 6 lb (3C-6C)	97 de	25 b	95 bc	13 b	38 abc	28 ab	12 bc
3	Nova 40W 4 oz (pink) Nova 40W 4 oz + Dithane 75DF 3 lb (PF-2C) Captan 50W 6 lb (3C-6C)	78 a-d	18 ab	73 a	6 a	29 abc	26 ab	5 abc
4	Syllit 65W 1.5 lb (pink) Rubigan 1E 8 fl oz + Polyram 80W 3 lb (PF-2C) Captan 50W 6 lb (3C-6C)	85 bcd	18 ab	87 ab	9 ab	41 abc	34 ab	10 abc
5	Rubigan 1E 6 fl oz + Captan 75WDG 2 lb (P-2C) Topsin-M 85WDG 8 oz + Captan 75WDG 2 lb (3C-6C)	75 ab	14 ab	66 a	5 a	47 bc	44 b	6 abc
6	Rubigan 1E 6 fl oz + Captan 50W 3 lb (P-2C) Topsin-M 85WDG 8 oz + Captan 75WDG 3 lb (3C-6C)	55 ab	12 a	62 a	5 a	27 abc	24 ab	6 abc
7	Captan 75WDG 4 lb (P-6C)	70 ab	15 ab	67 a	6 a	39 abc	36 ab	5 abc
8	Captan 50W 6 lb (P-6C)	94 cde	26 b	89 ab	9 ab	17 ab	17 ab	0 a
9	Ziram 76 6 lb (P-6C	52 a	10 a	67 a	7 a	51 c	46 b	12 bc
10	Captan 50W 3 lb + Ziram 76 3 lb (P-6C)	73 ab	11 a	62 a	6 a	40 abc	38 ab	4 abc
11	Captan 50W 3 lb + Ziram 76 3 lb + Nu-Film 17 1 pt (P-6C)	67 ab	9 a	69 a	6 a	10 a	10 a	1 a
12	Captan 50W 3 lb + Dithane 75DF 3 lb (P-2C) Captan 50W 6 lb (3C-6C)	75 ab	17 ab	74 a	7 ab	27 abc	22 ab	7 abc

Averages of four single-tree replicates. Mean separation by Duncan's Multiple Range Test (P = 0.05).

NECTARINE (Prunus persica var. nectarina 'Redgold')
PEACH (Prunus persica 'Loring')
Brown rot; Monilinia fructicola
Rhizopus rot

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DISEASE CONTROL ON REDGOLD NECTARINE AND REDHAVEN PEACH, 1993: Experimental and registered fungicides were tested on pairs of adjacent 14-yr-old peach and nectarine trees. The peach trees had not been treated with fungicides in 1992 to encourage carry-over scab inoculum. To standardize brown rot inoculum, three mummified fruit were placed in each tree before bloom. Dilute treatments were applied to the point of run-off (approximately 200 gal/A) with a single nozzle handgun at 200 psi in a randomized block design with four replicate pairs of trees as follows: 30 Mar (BS, bud swell); 14 Apr (P, pink); 20 Apr (bloom); 27 Apr (PF, petal fall); 11 May (SS, shuck split); 25 May, 9 Jun, 23 Jun (1C-3C, 1st-3rd covers for both Redhaven and Redgold). Preharvest applications for Redhaven were 12 Jul (1PH, 31 days pre-harvest); 23 Jul (2PH, 20 days pre-harvest); and 9 Aug (3PH, 3 days pre-harvest). Redgold received a 4th cover spray (4C) 12 Jul and pre-harvest applications 9 Aug (1PH, 17 days pre-harvest), 18 Aug (2PH, 8 days pre-harvest); and 23 Aug (3PH, 3 days pre-harvest). Commercial insecticides were applied at 2 wk intervals to the entire test block with a commercial airblast sprayer. After harvest (12 Aug, Redhaven; 26 Aug, Redgold) 25 apparently rot-free fruit per replicate tree were selected for uniform ripeness, placed on fiber trays, and misted with de-ionized water (indicated as no postharvest inoculation) or inoculated with a suspension containing 10,000 M. fructicola conidia/ml. All were incubated in polyethylene bags at ambient temperature (20-26C, Redhaven; 22-27C Redgold) for the indicated interval before assessing rot development.

Pre-harvest brown rot was relatively light and postharvest inoculation increased disease pressure on both peach and nectarine. All treatments gave significant control. RH-7592 2F + Latron B-1956 and Rovral 4SC + Latron CS-7 provided the most residual post harvest brown rot control overall. EXP 10370A, RH-7592 75W and Orbit were effective on non-inoculated fruit but were somewhat less effective under heavy inoculum conditions. Nova was significantly weaker than RH-7592 2F on inoculated fruit. Rhizopus rot appeared on "non-inoculated" fruit and was significantly suppressed by Rovral, EXP 10370A, Captan 50W, Nova, RH-7592 2F and Orbit. Leaf curl and scab incidence were light and variable and data are not included.

Table 10. Disease control on Redhaven peach after indicated postharvest incubation period

Treatment and rate/ 100 gal dilute	Timing	Brown rot (%), postharvest inoculation			No postharvest inoculation brown rot %			Rhizopus %
		4 days	5 days	8 days	4 days	5 days	8 days	8 days
No fungicide	---	39 b	65 c	86 c	26 b	43 b	78 b	10 b
Ziram 76 2 lb TD 2323-2 75.2W 3 lb	BS P-3PH	5 a	18 ab	40 ab	1 a	7 a	12 a	6 ab
Rovral 4SC 1 pt + Latron CS-7 1 pt Captan 50W 2 lb	SS, 1C, 1PH-3PH P-PF, 2C-3C	0 a	1 a	11 a	0 a	0 a	0 a	0 a
EXP 10370A 50WG 1 lb + Latron CS-7 1 pt Captan 50W 2 lb	SS, 1C, 1PH-3PH P-PF, 2C-3C	2 a	12 ab	24 ab	0 a	0 a	3 a	1 a
Captan 50W 2 lb	P-3PH	1 a	19 ab	41 ab	0 a	4 a	12 a	1 a
Captan 75WDG 1.33 lb	P-3PH	7 a	19 ab	21 ab	0 a	6 a	17 a	5 ab
Nova 40W 2.5 oz	P-3PH	7 a	28 b	51 ab	0 a	4 a	17 a	2 a
RH-7592 75W 1 oz + Latron B-1956 4 fl oz	P-3PH	4 a	18 ab	31 ab	0 a	2 a	12 a	4 ab
RH-7592 2F 3 fl oz + Latron B-1956 4 fl oz	P-3PH	0 a	0 a	11 a	0 a	0 a	2 a	1 a
Orbit 3.6E 2 fl oz	P-3PH	0 a	8 ab	33 ab	0 a	0 a	4 a	0 a

Averages of four single-tree replicates. Mean separation by Duncan's Multiple Range Test (p = 0.05).

Table 11. Brown rot control on Redgold nectarine

Treatment and rate 100 gal dilute	Timing	Brown rot (%) after indicated incubation period: postharvest inoculation, 4 days	5 days	7 days	no postharvest inoculation, 4 days	5 days	7 days
No fungicide	---	45 b	74 c	94 c	27 b	63 b	88 c
Ziram 76 2 lb TD 2323-2 75.2W 3 lb	BS P-3PH	1 a	8 ab	35 ab	0 a	3 a	13 ab
Rovral 4SC 1 pt + Latron CS-7 1 pt Captan 50W 2 lb	SS, 1C, 1PH-3PH P-PF, 2C-4C	2 a	7 ab	27 ab	0 a	1 a	5 a
EXP 10370A 50WG 1 lb + Latron CS-7 1 pt Captan 50W 2 lb	SS, 1C, 1PH-3PH P-PF, 2C-4C	3 a	17 b	30 ab	0 a	0 a	3 a
Captan 50W 2 lb	P-3PH	4 a	12 ab	31 ab	1 a	1 a	13 ab
Captan 75WDG 1.33 lb	P-3PH	3 a	15 ab	44 b	0 a	4 a	20 ab
Nova 40W 2.5 oz	P-3PH	7 a	19 b	45 b	5 a	10 a	28 b
RH-7592 75W 1 oz + Latron B-1956 4 fl oz	P-3PH	3 a	3 ab	19 ab	0 a	2 a	6 a
RH-7592 2F 3 fl oz + Latron B-1956 4 fl oz	P-3PH	0 a	0 a	8 a	0 a	0 a	0 a
Orbit 3.6E 2 fl oz	P-3PH	5 a	14 ab	31 ab	0 a	2 a	8 a

Averages of four single-tree replicates. Mean separation by Duncan's Multiple Range Test (p = 0.05).

1993 PRE-HARVEST FUNGICIDE TRIAL FOR CONTROL OF PEACH BROWN ROT

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The 1993 Ridge area fungicide trial was established in a commercial orchard on Theo Williams' farm near Edgefield S.C. The purpose of the trial was to evaluate the efficacy of several fungicides and various sequential applications for the control of peach brown rot caused by Monilinia fructicola. A block of approximately twelve year old 'Coronet' trees was used for the test. Single tree plots were replicated ten times in a random complete block design; nine treatments were included in the test.

Bloom and cover sprays were conducted according to Clemson University Extension Information Card 72 (1993 Commercial Peach Spray Guide). The commercial spray schedule consisted of a bloom spray of chlorothalonil and cover sprays consisting of either sulfur or captan plus an insecticide. Cover sprays were applied at 7 to 10 day intervals, depending on weather conditions, using a commercial FMC sprayer calibrated to deliver 100 gallons per acre until preharvest sprays were initiated on 6-24-93. Due to rains during bloom some blossom blight was present in the orchard. It was estimated that four or five blighted blossoms were present on each tree. Decaying fruit could be found throughout the orchard. Trees absent of either blighted blossoms or infected fruit were inoculated by inserting a needle into healthy fruit and injecting a conidial suspension of M. fructicola prior to applying preharvest treatments. Disease pressure, however, was light prior to harvest due to drought.

All preharvest fungicide applications were made by using a handgun calibrated at approximately 120 psi to deliver one (1) gallon of spray per minute. Each tree was sprayed for one minute.

Preharvest sprays were initiated using historical harvest data. Harvest in 1993 was approximately two weeks late, consequently, spray intervals were adjusted using IPM practices. Hence, preharvest spray intervals were lengthened.

Forty fruit per tree were harvested on 6-24-93 and placed in fiber apple trays so that individual fruit would not be in contact with adjacent fruit. Trays contained twenty fruit each. Each set of forty fruit were marked so individual replications could be identified for recording data.

Following the harvest on 6-24 fruit were evaluated for infection by M. fructicola on 7-1-93 and 7-7-93. Data reported for 7-7-93 is the total brown rot for the season. Note that table 1 is the mean number of infected fruit (per 40 fruit) for both dates and is not the percentage of infected fruit.

TREATMENTS

------------ Fungicide per application ------------

Date of application.

	5-28-93	6-8-93	6-21-93
(1) White	Funginex	Orbit	Orbit
(2) Orange	Funginex	Orbit Gel	Orbit Gel
(3) Yellow	Ronilan	Ronilan	Funginex
(4) Red	Elite	Elite	Elite
(5) Blue	RH-7592	RH-7592	RH-7592
(6) Black Stripe	Funginex	Funginex	Funginex
(7) Orange Stripe	Rovral	Rovral	Rovral
(8) Blue Stripe	Benlate	Ronilan	Orbit
(9) Red Stripe	Orbit	Rovral	Orbit

Rate (formulation) per acre.

		Abbreviation.
Orbit	4.0 oz.	Orb.
Orbit Gel	4.0 oz.	OrbG.
Funginex	32.0 oz.	Fun.
Ronilan	2.0 lbs.	Ron.
Rovral	2.0 lbs.	Rov.
Elite	6.0 oz.	Elt.
RH-7592	6.0 oz.	RH-7.
Benlate	1.0 lb.	Ben.

Table 1. Mean number infected fruit.

Treatment description.	# rotten fruit		% infected *
Fun., Orb., Orb.	2.5	a	12.5
Rov., Rov., Rov.	1.7	ab	8.5
Fun., Fun., Fun.	1.6	ab	8.0
Elt., Elt., Elt.	1.3	bc	6.5
Ron., Ron., Fun.	1.25	bc	6.5
Ben., Ron., Orb.	1.05	bc	5.25
Orb., Rov., Orb.	1.05	bc	5.25
Fun., OrbG., OrbG.	0.85	bc	4.0
RH-7.,RH-7., RH-7.	0.55	c	2.75

Treatments with the same letter are not significantly different, LSM (p=.05).

* Percentages are the result of cumulative number of rotten fruit as of 7-7-93.

Note also that there were no significant differences between treatments on 7-1, seven days postharvest. Differences were noted on 7-7, fourteen days postharvest.

Overall RH-7592 outperformed other treatments. The Orbit treatments were not significantly different, although, the gel formulation performed slightly better.

It must be noted that the final data was taken 17 days after the last preharvest spray was applied. This interval was longer than normal due to the dry season and may not reflect the efficacy of the different materials as well as it may reflect the persistence. Such persistence may be due to factors as resistance to UV light degradation.

NATURE AND CONTROL OF THE RED SPOT DISEASE OF PEACHES IN THE COASTAL PLAINS OF SOUTH CAROLINA

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Introduction. A new disease of peach fruits has become an increasingly urgent problem for peach growers in the Coastal Plains of South Carolina in recent years. The disease is characterized by numerous small (1-2 mm diameter), superficial, bright red spots scattered over the surface of affected fruits. The symptoms are similar to those induced on fruit by white peach scale, but no insects have been associated with the problem. The red spots often seem to be centered over stomata. Fruit size and eating quality are not affected, but the spots are so prominent that only a dozen or so are sufficient to affect USDA grade for market. The effect is to greatly reduce the market value of the crop. When the problem appears, it often affects almost all of the fruit in the orchard, so economic losses have been severe for those whose crop is affected.

The disease usually appears suddenly over a wide area in early to mid-June, affecting green fruits as well as those in the ripening phase of development. An *Alternaria* species has been isolated consistently from the red spots, but unaffected fruits and healthy tissues from affected fruits also yielded the same *Alternaria* species. Bacteria are not consistently associated with the problem. Using scanning electron microscopy, fungal hyphae sometimes were observed entering through stomata of affected fruits.

The sudden appearance of the problem over a wide area often coincides with stagnant air masses, leading us to suspect that an air quality problem might be the cause of the disorder. We therefore reasoned that coating materials to reduce the rate of gas exchange might be beneficial. We established two field experiments, including Vapor Guard, Nu-Film 17, and Crop Life as coating materials, two fungicides that might have potential for *Alternaria* control (Rovral and Ziram), and a bactericide (Mycoshield).

MATERIALS AND METHODS

Two experiments were established in commercial orchards in Allendale and Orangeburg Counties, respectively, where red spot was a serious problem in 1992. Each was designed as a randomized complete block replicated four times, single trees per replicate. Cultivars were Winblo in the Allendale location and Cresthaven at the Orangeburg site. Applications were made by handgun to runoff, ca. 2.0 gallons per tree, using a plot sprayer, on 18 and 31 May and 15 June at both locations. The test trees also were oversprayed with grower's regular maintenance schedule (sulfur and captan plus an insecticide. Evaluations of performance were made by counting the number of affected fruits per 100 at random per tree on 30 July at the Orangeburg site only.

RESULTS AND DISCUSSION

Weather at both locations was very dry through most of the growing season. Very little symptom development was observed at the Allendale location and no data on performance were collected. Some symptoms developed at the Orangeburg location (Table 1), but the number of fruits affected was less than in recent years.

None of the coating materials tested or Mycoshield reduced the number of fruits affected relative to the grower standard program (Table 1). Crop Life appeared to increase the number of fruits having symptoms. However, very or no little symptom development was found on fruits sprayed with either Ziram or Rovral. The absence of symptoms there suggests that *Alternaria* may indeed be the cause of the red spot problem on peaches. Larsen et al. (1) described a similar problem on apricots caused by *Alternaria alternata*, in which invasion of fruits resulted in small red spots with necrotic tan to brown centers. One of us (Miller) has sometimes seen necrosis associated with the problem in South Carolina, but necrosis is unusual. Other symptoms that Larsen et al. reported are almost identical to those we observed.

Based on the performance of Rovral and Ziram in suppressing this problem, the association of an *Alternaria* sp. with the disease, and the report of a similar problem on apricots, we shall investigate the *Alternaria* species associated with the problem to determine its identity and try to induce the symptoms in the field by inoculation of fruit with this fungus. Since both Rovral and Ziram are registered for use on peaches, there may be an option for immediate suppression of economic losses to red spot. Although results of a single experiment on disease suppression may be misleading, we expect to advise growers in the Coastal Plains to adjust their spray schedules in 1994 to accommodate the potential value of these fungicides to control red spot.

REFERENCE CITED

1. Larsen, H. J., R. P. Covey, Jr., and W. R. Fischer. 1980. A red spot fruit blemish in apricots. Phytopathology 70:139-142.

Table 1. Control of peach red spot disease on Cresthaven peach in 1993.

Treatment and rate per acre	% fruits affected 7/30/93
Vapor Guard 1 gallon[a]	2.2
Vapor Guard 1 gallon; Nu-Film 17 1 pint[b]	6.5
Nu-Film 17 1 pint[c]	2.5
Crop-Life 1 gallon[c]	16.5
Rovral 2.0 lb[d]	0.7
Ziram 76W 4.0 lb[d]	0.0
Mycoshield 1.5 lb[d]	4.2
Check (grower standard)	5.2
L.S.D. 0.05	5.3

[a]Applied May 18 only.
[b]Vapor Guard applied May 18, Nu-Film 17 on May 31.
[c]Applied May 18 and 31.
[d]Applied May 18, 31, and June 15.

CONTROL OF SCAB AND BROWN ROT ON NECTARINES WITH THE FUNGICIDE, BRC 519, IN 1993

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Seven-yr-old Redgold Nectarine trees were sprayed with five rates of the experimental fungicide, BRC 519, to test its effectiveness for control of scab (*Cladosporium carpophilum*) and brown rot (*Monilinia fructicola*). The trees, located at the S. C. Agricultural Experiment Station, Pendleton, sprayed to runoff with a handgun at 250 psi, 1.5 - 2 gallons per tree. Single-tree plots were replicated four times in a randomized complete block design. Application began at shuck split (16 Apr) and continued on 26 Apr, 11 and 25 May, 23 June, and 7, 16, and 23 July. Asana insecticide, 8 oz per acre, was applied separately by airblast sprayer on 30 April, 14 and 28 May, and 5 July. Carzol, 8 oz per acre, was applied during bloom to control thrips. At maturity (29 July), the percentage fruits per tree infected with *M. fructicola* was estimated. On 30 July, 100 fruits per tree were harvested, examined for scab, packed in fiber trays which then were placed in boxes and stored at 22 C in an air-conditioned room. Weather conditions were dry throughout much of the growing season -- rainfall totals were 3.34, 3.51, 0.80, and 1.60 inches for the April to July period. To encourage brown rot development, overhead irrigation (4-5 mm/hr) was applied twice for 15 hr each during the preharvest period.

Scab control was unsatisfactory even with the captan standard (Table 1), presumably as a result of equipment malfunction in the midseason cover sprays. BRC 519 at rates above 14.8 oz per acre was superior to captan for scab control, and was equal or superior to the Funginex standard for brown rot control at the three highest rates. Rates above 22.2 oz per acre did not improve brown rot control. No phytotoxicity was observed.

Table 1. Control of scab and brown rot on nectarine with the experimental fungicide, BRC 519.

Treatment and rate per acre	% scab	% postharvest brown rot at: 0 days	4 days	7 days
BRC 519 50WDG 1.5 oz	96.5	15.2	31.0	67.8
BRC 519 50WDG 2.9 oz	93.5	14.0	17.0	46.2
BRC 519 50WDG 4.4 oz	69.3	4.0	5.3	24.3
BRC 519 50WDG 5.8 oz	79.2	6.5	13.5	32.2
BRC 519 50WDG 7.4 oz	61.0	2.2	9.0	24.8
Captan 50W 4.0 lb cover sprays; Funginex 1.6E 24 oz preharvest	95.8	14.0	13.8	63.8
Check (insecticide only)	100.0	98.0	56.3	80.7
L.S.D. 0.05	12.4	15.3	16.3	33.2

FIELD TEST FOR CONTROL OF BLOSSOM BLIGHT IN PEACH, 1993

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Seven-yr-old Redskin peach trees at the S.C. Agricultural Experiment Station were sprayed in bloom for control of blossom blight caused by _Monilinia fructicola_. The test was established as a randomized complete block of single trees replicated four times. Sprays were applied to runoff using a handgun at 250 psi, approximately 1.5 gallons per tree. Dates of application were 24 March (20% bloom) and 30 March (full bloom). Numbers of infected flowers per tree were counted on 28 April.

Measureable rainfall was recorded on five days (4.10 inches) during the bloom period up to full bloom. All fungicides tested reduced the amount of blossom blight in this experiment. Orbit, Funginex, Rovral, and RH7592 were the most effective materials; Bravo (especially the dry flowable formulation) and Fluazinam were less effective than the Rovral standard, which had no blossom blight at all.

TABLE 1. Control of blossom blight on Redskin peach trees sprayed at 20% and full bloom

Treatment and rate per acre	No. blighted blossoms/tree
Rovral 50W 1.5 lb.	0.0
RH7592 2F 6.0 fl oz	0.2
Orbit 3.6E 4.0 fl oz	2.5
Orbit 3.6 GL 4.0 fl oz	1.2
Funginex 1.6E 24.0 fl oz	2.8
Bravo 720F 3.125 pt	3.8
Bravo 825 DF 2.85 lb	7.2
Fluazinam 500F 12.8 fl oz	4.0
Check (no fungicide)	14.8
L.S.D. 0.05	3.4

CONTROL OF BACTERIAL SPOT IN A FIELD TEST IN 1993

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Four-yr-old Summer Pearl peach trees were used in a test for control of bacterial spot caused by *Xanthomonas campestris* pv. *pruni*. Treatments were arranged in a randomized complete block design, four replicates of one tree each. Treatments were applied by handgun, spraying trees to runoff, approximately 1 gallon per tree, (less for the copper treatment applied before bud break). Dates of application were 4 and 11 March (Kocide only), 7 April (petal fall), 15 April (shuck split), 23 April (shuck fall), 4 and 17 May, 1, 14, and 29 June, and 13 July. Asana, 8 oz per acre, was applied separately by airblast sprayer for insect control on 19 and 30 April, and 14 and 28 May, Sevin 50W, 4 lb per acre, was applied 19 July. Irrigation was applied by overhead sprinklers at the rate of 4-5 mm per hour from 2 p.m. until 6 a.m. the following day once or twice weekly during dry periods in late April and May to encourage disease development. At maturity (3 August), 100 fruits per tree were harvested, and examined for scab and bacterial spot. On 4 August, 15 shoots per tree were collected, the number of leaves counted, percent defoliation determined, and numbers of spots per leaf were recorded.

Rainfall was light, especially late in the season -- totals of 3.34, 3.51, 0.80, and 1.60 inches in the April to July period. However, rains in the early season and the supplemental irrigation provided resulted in considerable bacterial spot. All treatments except Ziram and Syllit reduced the amount of fruit infection. Mycoshield applied full season was not superior to Kocide applied in two sprays at late dormancy for control of fruit infection. Mycoshield following Kocide only slightly improved the level of control relative to either antibiotic alone. Captan added to ziram or Syllit improved bacterial spot control on fruit. All treatments reduced the number of lesions per leaf and all except ziram decreased the amount of defoliation. Treatments containing captan controlled scab, but the others were less effective. However, captan plus Syllit resulted in many small necrotic lesions on leaves that were barely distinguishable from bacterial spot. Similar evidence of injury was not seen on fruit in this treatment.

Table 1. Control of bacterial spot and scab on Summer Pearl peach in 1993.

Treatment and rate per acre	Number leaves	% defoliated	Number spots/leaf	% fruit infected	% scab
Kocide 101 8 lb (2 sprays)	1099	10.8	0.8	10.0	--
Kocide 101 8 lb (2 sprays); Mycoshield 1.5 lb from petal fall	1038	16.5	0.4	7.8	--
Ziram 76W 4.0 lb	1112	21.2	1.2	22.0	92.2
Ziram 4 lb + sulfur 6 lb	1033	20.2	0.8	27.2	30.8
Mycoshield 1.5 lb full season	1152	15.8	0.4	10.2	--
Mycoshield 1.5 lb 1st 4 sprays only	1076	16.5	0.8	10.5	--
Syllit 2.0 lb	1086	17.5	0.8	31.0	29.0
Syllit 2.0 lb + Captan 50W 4.0 lb	1081	17.5	--[a]	15.0	6.2
Ziram 76W 4.0 lb + Captan 50W 4.0 lb	1118	15.0	0.8	12.5	16.8
Check	1161	26.5	2.2	30.2	100.0
L.S.D. 0.05		8.8	0.8	14.5	12.5

[a]Bacterial spot obscured by numerous similar leaf spots, presumably chemical injury.

FIELD TEST FOR CONTROL OF PEACH SCAB AND BROWN ROT, 1993

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The purpose of this experiment was to compare two formulations of Bravo for scab control and several other fungicides in preharvest sprays to control brown rot. Bravo 720 (flowable) and Bravo 825 (dry flowable) were applied at shuck split (19 Apr) and shuck fall (30 Apr), with additional cover sprays of wettable sulfur on 14 and 28 May. All other treatments received wettable sulfur in all cover sprays. Dates of preharvest applications were 7, 14, and 20 July. Treatments were applied by handgun (approximately 250 psi) to runoff (1.5 to 2.0 gallons per tree) on 7-yr-old Redglobe trees. Experimental design was a randomized complete block replicated four times, one tree per replicate. Asana, 4 oz/100 gallons, was applied separately by airblast sprayer for insect control on 19 and 30 Apr., 14 and 28 May, and 5 July. At maturity (22 Jul), 100 fruits per tree were harvested at random, examined for scab, packed in trays which were placed in cardboard boxes, and stored at 22C in an air-conditioned room.

Rainfall was light during most of the growing season--3.34, 3.51, 0.80, and 1.60 inches in April, May, June, and July, respectively. Only a few light showers were recorded during the preharvest period. Although inoculum arising from infected flowers was present in the orchard, little brown rot was observed at harvest, and amounts postharvest were relatively light. Fluazinam appeared to be less effective for brown rot control than Orbit or Funginex. Gel and EC formulations of Orbit were comparable for brown rot control and no benefit of adding captan to Orbit was observed. Scab control was not satisfactory, presumably because an equipment failure occurred in the cover sprays after shuck fall. No phytotoxicity was observed.

Table 1. Fungicide test on Redglobe peach for scab and brown rot control in 1993.

Treatment and rate per acre	% scab	% postharvest brown rot 4 days	% postharvest brown rot 7 days
Bravo 720 F 4.125 pt shuck split, shuck fall; wettable sulfur 12 lb cover; Funginex 24 oz preharvest	59.0	2.0	7.5
Bravo 825 DF 3.75 lb (schedule for other sprays as above)	71.5	2.0	6.0
Wettable sulfur 12 lb; Fluazinam 26 oz preharvest	90.2	5.0	17.5
Wettable sulfur 12 lb; Fluazinam 26 oz + Nu-Film 17 8 oz preharvest	90.0	2.0	12.8
Wettable sulfur 12 lb; Nova 6 oz preharvest	-	1.5	9.8
Wettable sulfur 12 lb; Orbit EC 4 oz preharvest	-	2.5	5.5
Wettable sulfur 12 lb; Orbit GL 4 oz preharvest	-	3.2	7.5
Wettable sulfur 12 lb; Orbit EC 4 oz + Captan 50W 4 lb preharvest	-	4.0	9.0
Check (shuck split and shuck fall sprays omitted)	93.5	8.5	29.0
L.S.D. 0.05	16.2	4.5	8.9

Differential suppression of plant parasitic nematodes by rapeseed cultivars.

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INTRODUCTION

A number of studies have indicated that cruciferous plants (oilseed rape, mustards, canola, rapeseed, henceforth referred to here as rapeseed) can be used to control plant parasitic nematodes (Mojtahedi et al., 1991; Johnson et al., 1992). In these studies rapeseed cultivars were selected either on availability or knowledge of toxic compounds known to be present in these plants. These compounds known as glucosinoloates (GS) are thioglycosides which are separated in the intact plant from the endogenous enzyme thioglucosidase (myrosinase, EC 3.2.1). Hydrolysis of GS by myrosinase produces toxic by-products. About 100 different forms of GS are found in the plant *Brassicaceae*. The chemical structure of GS indicates that nematode toxic by products are produced only by some GS. This study presents data which shows the variation in GS concentration in different rapeseed plants and their toxic effects on nematodes.

Glucosinolates in rapeseed.

The total GS in rapeseed was quantified for seeds and four week-old-plants (foliage and roots) of selected rapeseed cultivars. GS-containing extracts were prepared by a method for glucosinolate extraction (Buchner, 1987). Chopped plant parts were heated in hot 80% methanol-water mixture for 10 minutes. Extracts were prepared from these material by grinding the tissue, centrifuging at 3000 x *g* for 10 minutes and concentrating the supernatant by heating below 40 C on a hot plate. Volume of extract was adjusted to 1ml /g of tissue used. Two hundred and fifty microliters of each extract each were then pipetted into two clean test tubes. Five hundred microliters of 50 mM sodium citrate (pH 5.5) were added to each test tube. Fifty microliter of a commercial preparation of myrosinase was added to one test tube while 50 µl of buffer was added to the other. Tubes were then incubated in a water bath at 37 C for 30 minutes. Each tube was analyzed for total glucose by using a glucose specific test (Sigma Chemical Company, 510-A). In this test 200 µl of the contents of each tube were added to 1800 µl of distilled water in separate clean test tubes and vortexed. Two hundred microliters of a glucose standard solution (27.78 mmol/L in .1% benzoic acid solution) were used for comaparison while 2 ml of distilled water were used as the blank for reference. One milliliter of barium hydroxide and zinc sulfate were then added sequentially and vortexed after each addition. Samples were centrifuged to precipitate any solid materials. Five hundred microliters of the supernatant of each tube were transferred to clean test tubes. To each tube 5 ml of Combined Enzyme-Colored Reagents solution (100 ml of PGO enzymes and 1.6 ml of Colored Reagent Solution, Sigma Chemical Company) were added. All tubes were then incubated at 37 C for 30 minutes. At the end of incubation period, all tubes were removed from bath. The absorbance [A] of the standard (glucose standard) and test were read at 450 nm using the blank as a reference. All readings were completed within 30 minutes. A new blank and standard were prepared each time the test was done. Extracts not treated with myrosinase accounted for background glucose level. Glucose concentration released from GS was calculated as follows:

$$\text{Glucose (mg/dL)} = A_{test} / A_{standard} \times 100$$

and

$$\text{glucose (mM/L)} = \text{Glucose (mg/dL)} / 18.$$

[A] is directly proportional to the concentration of glucose for a glucose concentration of 0-30 mg/l.

The concentration of glucose in each extract was equivalent to the concentration of GS because they react in equimolar amounts. The concentration of GS g^{-1} tissue was therefore determined by taking into account the dilution factor for volume of extract used to determine glucose concentration, the total volume of extract and the weight of the plant tissue used.

Nematode Bioassay:
Mixed stages of the plant parasitic nematode, *Xiphinema americanum* were used to bioassay extracts. The tests were performed in autoanalysis cups (1 ml) with 10 nematodes per cup and eight cups per concentration. Four of the replicate treatment cups received 50 µl of 10 mg/ml of myrosinase while the others were not treated. Concentrations ranging from one where all nematodes were alive regardless of treatment with myrosinase to one where all nematodes died after addition of myrosinase but were alive with no addition. At least six concentrations were used within this range and nematodes were incubated in the dark for a maximum of twenty four hours. At the end of the incubation period, dead nematodes were counted in each of the cups. Death was defined as total lack of movement in response to a probing needle. Controls included buffer alone and buffer plus thioglucosidase. Mortality data were analyzed using a POLO - PC program (LeOra Software, Berkeley California) that converts dosage response data to probits. The lethal dose that killed 50 % of the nematodes (LD_{50}) and slopes of the dosage response curves were then compared for each nematode and extract used in the bioassay. Extracts of 4 cultivars were selected and bioassayed with *C. elegans* following the same procedure. Results of the *X. americanum* and *C. elegans* bioassays were compared.

Greenhouse Soil Amendment Test:
Based on the results of the bioassay, two rapeseed cultivars (*Brassica napus* cv. Humus and *B. campestris* cv. Parkland) were selected and used in a greenhouse soil amendment test. Other plants included in this study were sudangrass and wheat . Controls included two nematicides (vydate and Busan 1020) and a fallow treatment. Plants were grown on a sterilized soil mix and fertilized according to recommendations. After six weeks, plants were harvested at the soil line and chopped into 3-5 cm pieces. One hundred grams of each plant were placed in alternate layers with 1200 g of naturally infested soil with *Pratylenchus penetrans* as the predominant nematode (187 / 100 cc soil). Treatments were arranged in a completely randomized design with 6 replicates. Pots were covered with two sheets of folded paper towels and mist watered every other day. One hundred grams of soil were taken from each pot every week for extraction and counting of nematodes.

RESULTS

Total Glucosinolate:
Total GS content of rapeseed varied widely (Table 1). Seeds of all cultivars tested had the higher GS concentrations than four-week-old foliage and roots (fresh weight). However, on a dry weight basis, the foliage of cv Ochre, Ceres and Rangi Rape had the higher concentrations relative to seeds and roots (fresh weight only). There was not enough root mass to measure dry weight but apparently the dry weight values were higher than the fresh weight.. Roots of four week old plants had a higher level of GS than foliage on a fresh weight basis.

Nematode bioassay:
Extracts treated with myrosinase caused nematode mortality in excess of that found in the control within a concentration that ranged from 0% to 100% mortality. Toxicity of extracts from cultivars tested could be separated into three categories based on the relative toxicity of each extract compared to extracts from cv Tobin, considered the most potent: Relative toxicity of , 0.14-0.15 (Humus, Westar, Parkland, Cutlass, Ceres and Dwarf Essex) 0.2-0.22 (Rangi Rape, Swede, Forge, and Rondo Turnip) 0.5-1 (wild mustard, Tobin. Liborius, Ochre). There were no significant differences among the slopes.

There were big differences in the response of the plant parasitic nematodes *X. americanum* and the free living nematode *C. elegans* to dilutions of extracts treated with myrosinase (Table 3). The lethal dose that killed 50% of the nematodes in the test (LD_{50}) was consistently higher for *C. elegans* compared to *X. americanum*. Whereas an increase in concentration of extracts did not affect the way the plant parasitic nematode responded for all the cultivars tested, there was a marked difference in the way *C. elegans* responded to increases in dosage as evident from the significant difference in slopes (Table 3).

Soil amendment:
Figure 1 shows a decline in nematode numbers from week one to week six on all treatments except the fallow which remained high. The decline was occured during the first week but nematode numbers remained relatively constant thereafter. The order of nematode suppression was wheat < sudangrass < B. campestris cv Parkland < B. napus cv Humus ≤ vydate ≤ Busan 1020. Nematode suppression in monocot amended soil was significantly less than for the two rapeseed cultivars and chemical treatment. Cultivar Parkland was less suppressive than cv. Humus. The latter was however not significantly different from the two chemical treatment by the second week. Although the plant parasitic nematode population was decreased, there was a large increase in the population of free living nematodes (data not presented). This increase in the free living nematode population was greater in rapeseed treated pots than pots amended with sudangrass or wheat.

DISCUSSIONS

These data show variation in the level of GS in different rapeseed plants. Levels of up to 75-100 μmoles g^{-1} of GS within seeds collected from the wild have been reported. Indian mustard (cv. Cutlass) and Humus have levels within this range. Humus was bred for a high glucosinolate content but this information was not available for cv. Cutlass. The very low levels of GS in some of the cultivars was the result of rape breeding programs throughout the last two decades aimed at reducing GS levels in the seeds. Cultivars Tobin, Parkland and Liborius are canola varieties that are used for the productions of almost glucosinolate-free oil. Thus the breeding program reduced their glusosinolate levels to as low as 3.2 to 6 μmole g^{-1} as obtained in this study.

These data demonstrate an in vitro nematicidal action of toxic by products obtained from enzymatic hydrolysis of extracts from various rapeseed plants (Table 2). The LD_{50} is the concentration of extracts required to kill 50% of the nematodes under test while the slope of the dosage response curve is the nematode inhibiting properties of the extracts under conditions of changing dosage. A small LD_{50} and a steep slope indicates a very potent extract. These two parameters have no correlation with total gluocsinolate concentration in the extracts. Over 100 different GS are known to exist in cruciferous plants. Production of toxic by products is determined by their chemical structure. In this study cv. Tobin with a very small LD_{50} ironically has a very small GS concentration in the seeds comapared to cv. Cutlass. This must be due to the nature of GS present in the plant. Not all GS have structures that will favor the production of toxic by products upon degradation. In a study with purified GS, Lazzeri *et al* (1993) showed that only some GS can produce toxic metabolites. Although a high level of GS is important when selecting cultivars for possible management strategies, toxicity of the individual GS is very important.

The differences in sensitivity to the toxins observed between *X. americanum* and *C. elegans* shows variation in the nematodes' tolerance. Isothiocyanates, the major toxic by product, produced after enzymatic degradation is very toxic and has general biocidal properties as a result of interaction with proteins (Wood, 1975, Kawakishi and Kaneko, 1987). It may be postulated that *C. elegans* can detoxify these compounds or in some other way escape their effect.

The greater decline in nematode population amended with rapeseed shoots relative to the two grasses can be linked to GS degradation. Because the grasses also reduced the number of nematodes, other nematode reducing agents other than GS may be involved. Stimulation of nematode biocontrol agents is a possibility. Surprisingly, the level of free living nematodes in the amendment, especially with rapeseed amended soils surged. Free living nematodes feed on bacteria and incorporation of plant material would increase the bacterial population thus increasing the food source for these nematodes. The effect of glucosinolate degradation products on the free living nematode should be very mild as evident from the data presented. Adoption of glucosinolate containing plants as part of integrated pest management strategy should be environmentally sound because populations of the free living nematodes which are involved in nutrient cycling will increase while the population of the plant parasitic nematodes will decline.

CONCLUSION

Our data show that planting rapeseed as a cover crop should play an important role in reducing the impact of nematodes in orchards. Better still, planting and subsequent incorporation of rapeseed into the soil as a green manure source will not only provide greater nematode control than a rotation alone but will add to the organic matter of the orchard. Such a practice should integrate well with other management practices when starting a new orchard or replanting an old one. Choice of cultivar to be used must be based on knowledge of the GS level in the plant and the degree of toxicity upon degradation of the GS.

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Table1. Glucosinolate concentration (µmoles) per gram of *Brassica* tissue

Cultivar	Four-wk-old foliage (FW)	Four-wk-old foliage (DW)	Four-wks-old roots (FW)	Seeds
Rondo Turnip	1.4 ± .03	15.12	4.30 ± .10	33.6 ± 2.0 †
Wild Mustard	3.6 ± .09	29.77	-	33.6 ± 1.0
Humus	2.1 ± .1	20.5	24.6 ± .30	78.4 ± 2.5
Westar	4.3 ± .90	36.9	9.40 ± .01	25.6 ± 1.0
Parkland	-	-	-	6.4 ± .70
Tobin	-	-	6.40 ± .3	3.2 ± .02
Liborius	2.6 ± .50	25.63	7.40 ± .4	3.2 ± .02
Rangi Rape	5.1 ± .30	56.96	16.5 ± .10	43.2 ± 1.0
Swede	1.5 ± .04	15.66	20.2 ± 1.0	54.4 ± 3.1
Cutlass	2.1 ± .30	23.65	3.40 ± .20	99.2 ± 3.4
Dwarf Essex	4.6 ± .60	53.26	13.99 ± 10	64.0 ± 1.9
Ceres	2.1 ± .07	22.77	12.6 ± .90	16.0 ± .98
Ochre	25.8 ± 2	242.3	17.01 ± 2	48.0 ± 2.1
Forge	6.2 ± .10	59.4	11.0 ± .1	64.0 ± 3.3

Results are the averages of two trials with two replications per trial.
FW = Fresh weight; DW = Dry weight.
† Standard deviation
- Glucosinolate level was too small to be determined with precision

Table 2. Glucosinolate (GS) concentration of *Brassica* seeds and their lethal effects on *Xiphinema americanum*

Cultivar	GS / gram seed (µmoles)	LD 50 ppm (95 % C.L)	Slope (+/- S.E)
Rondo Turnip	33.6†	1.930 (1.16-2.70)	3.00a (0.47)
Wild Mustard	33.6	0.202 (0.10-0.30)	2.60a (0.41)
Humus	78.4	1.320 (1.05-1.59)	2.79a (0.36)
Westar	25.6	1.350 (0.82-1.88)	2.89a (0.42)
Parkland	6.4	1.340 (1.08-1.16)	3.73a (0.61)
Tobin	3.2	0.188 (0.08-0.30)	2.15a (0.29)
Liborius	3.2	0.193 (0.14-0.24)	2.75a (0.31)
Rangi Rape	43.2	0.854 (0.66-1.05)	3.03a (0.48)
Swede	54.4	0.880 (0.63-1.13)	2.38a (0.25)
Cutlass	99.2	1.360 (0.87-1.85)	2.06a (0.34)
Dwarf Essex	64.0	2.020 (1.21-2.83)	2.44a (0.34)
Ceres	16.0	1.360 (0.91-1.81)	2.72a (0.39)
Ochre	48.0	0.387 (0.31-0.47)	2.78a (0.32)
Forge	64.0	1.071 (0.79-1.35)	2.78a (0.32)

Results are the averages of two trials with four replications each with 10 nematodes.
† Slopes followed by the same letter are not significantly different ($P \leq 0.05$) from each other according to the Tukey-Kramer Test.
240 nematodes were tested for each cultivar
Control mortality out of 40 nematodes ranged from 0-2.

Table 3. Glucosinolate (GS) concentration of *Brassica* seeds and their lethal effects on *Xiphinema americanum* and *Caenorhabditis elegans*

Cultivar	GS /g seed (µmoles)	LD 50 ppm (95 % C.L.)		Slope† (+/- S.E.)	
		X. amer.	*C. elegans*	*X. amer.*	*C. elegans*
Humus	78.40	1.33 (1.05-1.63)	4.00 (3.65-4.29)	2.70ab (0.36)	11.78d (1.53)
Tobin	3.20	0.19 (0.08-0.33)	2.59 (1.52-3.32)	2.15a (0.29)	5.81bc (0.89)
Cutlass	99.20	1.37 (0.87-1.98)	4.81 (4.20-5.41)	2.06a (0.27)	8.34cd (1.07)
Ochre	48.00	0.39 (0.31-0.48)	3.52 (3.04-3.98)	2.78ab (0.36)	6.02bc (0.74)

Results are the averages of two trials with four replications each with 10 nematodes.
† Slopes followed by the same letter are not significantly different ($P \leq 0.05$) from each other according to the Tukey-Kramer Test..
240 nematodes were tested for each cultivar
Control mortality out of 40 nematodes ranged from 0-2.

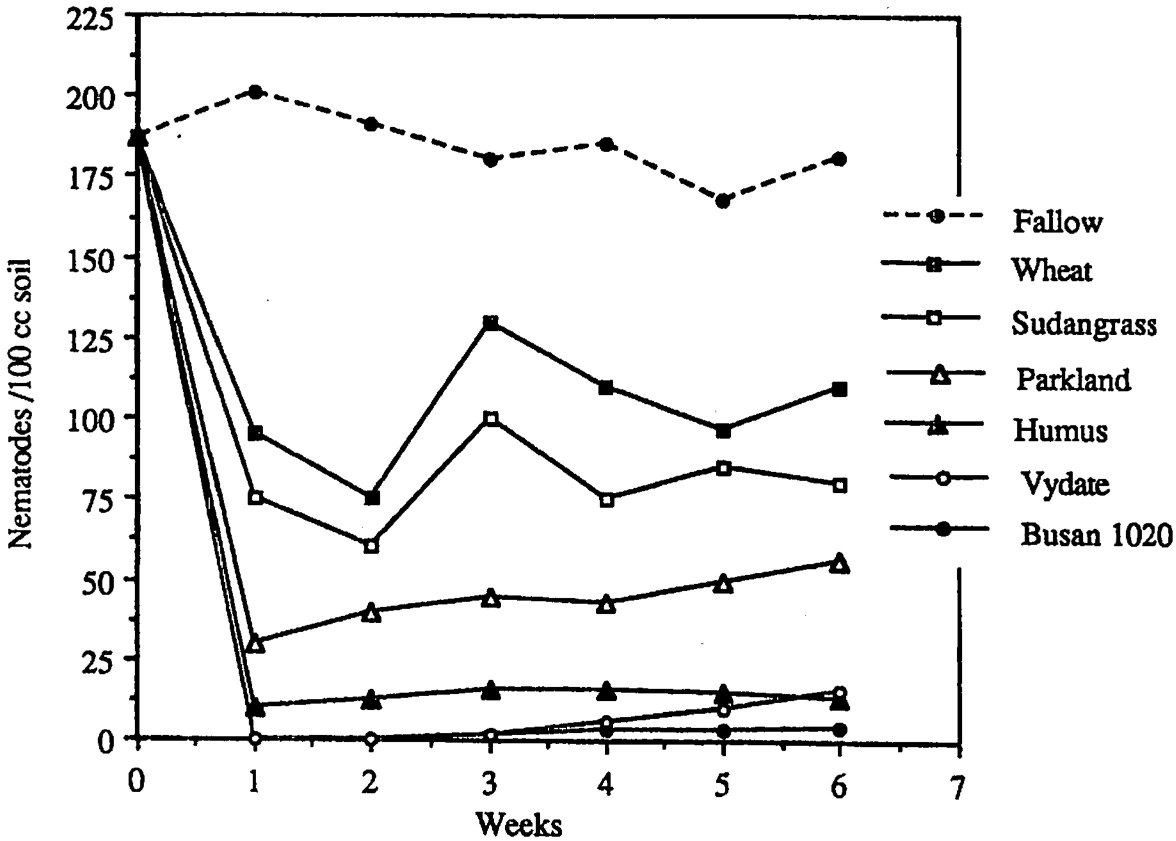

Fig 1. Results of incorporating plant material in Pratylenchus infested soil (100 g tissue / 1200 cc soil with 6 replicates per treatment)

APPLE: *Malus domestica* ('Rome Beauty')
Apple scab; *Venturia inaequalis*
Powdery mildew; *Podosphaera leucotricha*
Sooty blotch; *Gloeodes pomigena*
Fly speck; *Zygophiala jamaicensis*

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DISEASE INCIDENCE ON FUNGICIDE PROGRAMS APPLIED AT 55 AND 66 PERCENT TRV RATES, 1993: Fungicide programs applied with an airblast sprayer were evaluated when rates were adjusted to match specific tree size and recommended amounts. Specific fungicides or combinations were applied during various tree phenophases when infections of different pathogens occurred. The test orchard was composed of mature well-pruned trees of 'Rome Beauty'/seedlings planted 25 x 30 ft and pruned to a height of 12 ft. Trees were 18 ft wide and the calculated tree-row volume (TRV) was 313,632 ft^3 or 55% of a standard orchard (trees 18 ft high, 22 ft wide, and planted 30 ft between rows, TRV 574,992 ft^3). Fungicide rates used were adjusted at 55% of standard recommended rates for Pennsylvania in six fungicide programs and at 66% in six additional identical treatments. Test plots consisted of double trees arranged in a randomized complete block design with four replicates bordered by nontreated plots between and adjacent to the treated trees. The fungicides were applied as concentrate sprays at 50 gals/A with a commercial orchard airblast sprayer (Metters Model 36) operated at 2.5 mph with a manifold pressure of 200 psi. Sprays were applied under still air and low evaporation conditions to minimize spray drift and improve coverage. The treatments were applied as complete protective sprays at 5-8 da intervals between half-inch green and first cover phenophases and at 12-14 da intervals during the cover sprays, except in programs where the third and fourth cover sprays were omitted. The interval between the last spray (seventh cover) and harvest (18 Oct) was 63 da. Apple scab and powdery mildew inoculum levels were moderate to high in the test orchard and environmental conditions were favorable for high disease incidence. There were 11 primary apple scab infection periods that occurred between 16 Apr (1/4" Green) and 1 Jul (fourth cover) as determined by a Neogen apple scab predictor using the Modified Mills Predictive model. Five infections occurred before first cover. A dry period between 4 Jul and 28 Jul (0.59 in of rainfall) was unfavorable for disease development. The return of above normal rainfall and warm temperatures (means 70.8° F) in Aug and Sep was favorable for development of sooty blotch and fly speck on fruit. Scab and mildew incidence on terminal leaves was determined by observing all leaves on 10 vegetative terminals/tree on 28-30 Jun. Vegetative terminals observed were flagged and the youngest unfolded leaf marked on 25 May to distinguish the periods up to and after first cover. Disease incidence on fruit was determined by observing 100 fruits/replicate at harvest on 18 Oct. All data obtained were analyzed by analysis of variance using appropriate transformations and the Tukey-Kramer HSD test for significance ($P \leq 0.05$).

Scab incidence was relatively high under the favorable rainy conditions that occurred during Apr and May. Nontreated terminal leaves showed 85% infection by the first cover period (25 May) with additional infections occurring through the third cover. Most fungicide programs provided fair to good scab control at TRV rates of 55 and 66% of recommended rates. There was no significant difference in scab control between the two rates among the six programs on leaves and fruit. The weakest programs for scab and mildew was the mancozeb plus Topsin-M. This failure was probably due to the presence in the test orchard of a strain of *Venturia inaequalis* resistant to the benzimidazoles. The program containing ziram as the protectant with Nova provided fair control of scab. Mildew control was commercially adequate on all treatments of either Nova or Rubigan, but the level of control was significantly higher on some of the Nova treatments. Fruit scab levels were higher than desirable on most treatments, but all would likely provide acceptable commercial control under low inoculum conditions. Sooty blotch and fly speck incidence was relatively high on the nontreated trees with fly speck being higher in this and other orchards in 1993. Control of these diseases can be attributed to the captan, ziram, or the combination of captan plus a benzimidazole used during the sixth and seventh cover sprays. All proved acceptable levels of control considering the long interval (63 da) between the last application and harvest.

Table 1. Disease Incidence on 'Rome Beauty' Sprayed with Seasonal Fungicide Programs Applied Concentrate at Tree Row Volume Rates of 55 Percent in 1993. Penn State Fruit Research Laboratory. Biglerville, PA.

		Percent Disease Incidence						
		Apple Scab				P. mildew	Fruit	
55% TRV Rates	Applic	Terminal Leaves			Fruit at	Term. lvs.	Sooty	Fly
Fungicides and Rate/A*	Timing	GT -1C	2C - 3C	GT - 3C	Harvest	GT - 3C	blotch	speck
Syllit 65W 9.9 oz + Spray Oil 6E 2.75 gal	1/2"-Green							
Nova 40W 2.2 oz + Syllit 65W 9.9oz	Open-cluster							
Nova 40W 2.2 oz	Bloom							
Nova 40W 2.2 oz + Polyram 80W 1.6 lb	PF, 1C, 2C							
Captan 50W 3.3 lb	6C, 7C	6.3a**	2.4a	5.1a	6.3a	1.7ab	2.0a	7.8a
Dithane 75DF 1.6 lb + Spray Oil 6E 2.75 gal	1/2"-Green							
Nova 40W 2.2 oz + Dithane 75DF 1.6 lb	OC, B, PF, 1C, 2C							
Captan 50W 3.3 lb	5C, 6C, 7C	9.9ab	1.9a	7.8ab	6.3a	3.6abc	20.0a	7.0a
Penncozeb 75DF 1.6 lb + Spray Oil 6E 2.75 gal	1/2"-Green							
Topsin-M 85WDG 3.3 oz + Penncozeb 75DF 1.6 lb	OC, B, PF, 1C, 2C							
Ziram 76W 3.3 lb	5C, 6C, 7C	31.5e	14.0cd	27.1e	21.3a	24.4e	0.5a	5.0a
Syllit 65W 9.9 oz + Spray Oil 6E 2.75 gal	1/2"-Green							
Rubigan 1E 4.4 fl oz + Syllit 65W 9.9 oz	OC							
Rubigan 1E 4.4 fl oz + Polyram 80W 1.6 lb	B, PF, 1C, 2C							
Ziram 76W 3.3 lb	6C, 7C	7.9ab	2.4a	6.6ab	7.8a	11.4d	1.3a	5.0a

55% TRV Rates Fungicides and Rate/A*	Applic Timing	Percent Disease Incidence: Apple Scab: Terminal Leaves GT -1C	2C - 3C	GT - 3C	Fruit at Harvest	P. mildew Term. lvs. GT - 3C	Fruit: Sooty blotch	Fly speck
Ziram 76W 1.6 lb + Spray Oil 6E 2.75 gal	1/2"-Green							
Ziram 76W 1.6 lb + Nova 40W 2.2 oz	OC, B, PF, 1C, 2C							
Captec 4F 13.2 fl oz	5C							
Captan 50W 1.6 lb + Benlate 50W 1.6 lb	6C, 7C	19.7c	7.2a-d	16.4bcd	20.3a	3.3a-d	0.0a	2.8a
Nontreated	....	85.1f	76.2e	82.8f	86.5b	48.0f	27.0b	44.8b

* Rates adjusted to 55% of recommended amounts based on tree row volume of 313,632 ft^3 and applied at 50 GPA concentrate (airblast) in complete sprays at 5-8 day intervals through petal-fall and 14 day intervals during cover sprays.

** Means followed by the same letter(s) are not significantly different according to Tukey-Kramer HSD ($P \leq 0.05$).

Table 2. **Disease Incidence on 'Rome Beauty' Sprayed with Seasonal Fungicide Programs Applied Concentrate at Tree Row Volume Rates of 66 Percent of Recommended Amounts in 1993. Penn State Fruit Research Laboratory. Biglerville, PA**

Rates at 66% of Recommendations Fungicides and Rate/A*	Applic Timing	Percent Disease Incidence Apple Scab Terminal Leaves GT -1C	 2C - 3C	 GT - 3C	 Fruit at Harvest	 P. mildew Term. lvs. GT - 3C	 Fruit Sooty blotch	 Fly speck
Syllit 65W 11.9 oz +								
Spray Oil 6E 3.3 gal	1/2"-Green							
Nova 40W 3.3 oz +								
Syllit 65W 11.9oz	Open-cluster							
Nova 40W 3.3 oz	Bloom							
Nova 40W 3.3 oz +								
Polyram 80W 2.0 lb	PF, 1C, 2C							
Captan 50W 4.0 lb	6C, 7C	6.8ab**	3.6ab	6.1a	6.0a	1.8a	4.2a	9.5a
Dithane 75DF 2.0 lb +								
Spray Oil 6E 3.3 gal	1/2"-Green							
Nova 40W 3.3 oz +								
Dithane 75DF 2.0 lb	OC, B, PF, 1C, 2C							
Captan 50W 4.0 lb	5C, 6C, 7C.......	8.5ab	2.3a	7.1ab	7.0a	2.9abc	1.3a	6.3a
Penncozeb 75DF 2.0 lb +								
Spray Oil 6E 3.3 gal	1/2"-Green							
Topsin-M 85WDG 6.6 oz +								
Penncozeb 75DF 2.0 lb	OC, B, PF, 1C, 2C							
Ziram 76W 4.0 lb	5C, 6C, 7C.......	29.6de	11.5bcd	25.3de	13.0a	26.9e	0.0a	1.8a
Syllit 65W 11.9 oz +								
Spray Oil 6E 3.3 gal	1/2"-Green							
Rubigan 1E 5.0 fl oz +								
Syllit 65W 11.9 oz	OC							
Rubigan 1E 5.0 fl oz +								
Polyram 80W 2.0 lb	B, PF, 1C, 2C							
Ziram 76W 4.0 lb	6C, 7C	10.2ab	4.0a-d	8.8ab	10.3a	7.0bcd	1.5a	3.8a
Polyram 80W 2.0 lb +								
Spray Oil 6E 3.3 gal	1/2"-Green							
Rubigan 1E 6.6 fl oz +								
Polyram 80W 2.0 lb	OC, B, PF, 1C, 2C							
Captec 4F 26.4 fl oz	5C							
Captec 4F 26.4 fl oz +								
Topsin-M 85WDG 7.9 oz	6C, 7C..........	6.6a	3.3a-d	5.8a	11.5a	8.3cd	0.3a	2.5a

Rates at 66% of Recommendations Fungicides and Rate/A*	Applic Timing	Percent Disease Incidence Apple Scab Terminal Leaves GT -1C	 2C - 3C	 GT - 3C	 Fruit at Harvest	 P. mildew Term. lvs. GT - 3C	 Fruit Sooty blotch	 Fly speck
Ziram 76W 2.0 lb +								
Spray Oil 6E 3.3 gal	1/2"-Green							
Ziram 76W 2.0 lb +								
Nova 40W 3.3 oz	OC, B, PF, 1C, 2C							
Captec 4F 26.4 fl oz	5C							
Captan 50W 2.0 lb +								
Benlate 50W 2.0 lb	6C, 7C	21.5cd	14.3d	19.8cde	21.0a	7.4a-d	0.0a	1.3a
Nontreated	....	85.1f	76.2e	82.8f	86.5b	48.0f	27.0b	44.8b

* Rates adjusted to 66% of recommended amounts commonly used in Pennsylvania orchards and applied at 50 GPA concentrate (airblast) in complete sprays at 5-8 days intervals through petal-fall and 14-day intervals during cover sprays.

** Means followed by the same letter(s) are not significantly different according to Tukey-Kramer HSD ($P \leq 0.05$).

APPLE: *Malus domestica* ('Golden Delicious', 'Red Delicious', 'Commander York')
Scab; *Venturia inaequalis*
Powdery mildew; *Podosphaera leucotricha*
Sooty blotch; *Gloeodes pomigena*
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EVALUATION OF FUNGICIDES AT TRV RATES IN HIGH DENSITY APPLE PLANTINGS, 1993: Tree-row volume rates of fungicides applied in a seasonal spray program for control of apple scab, sooty blotch, and fly speck were evaluated under favorable conditions for disease development. Two recommended rates of Nova 40W (4.0 and 6.0 oz/A), used in combination with Dithane 75DF (3.0 lbs/A) for scab control and two rates of Captan 50W (3.0 and 4.0 lbs/A) combined with Topsin-M 85WDG (12.0 oz/A) during the summer sprays for sooty blotch and fly speck control were evaluated. The two fungicide programs were applied in a 16-year old high density experimental orchard which consisted of 10 one-half acre plots of 5 tree-planting systems (2 replicated blocks of each system). One or two entire rows of trees in each half-acre block was not sprayed for the entire season and served as the nontreated control. The randomized half-acre plots of each planting system served as five replicates for each of the treatments. Each plot was planted to 'Commander York', 'Red Chief Delicious', and 'Golden Delicious' which were well-pruned and the orchard floor well managed. Fungicide rates were adjusted to match tree size and were applied as concentrate sprays from alternate-row middles with a conventional orchard airblast sprayer (Metters Model 36) adjusted at a manifold pressure of 200 psi. Eighteen alternate-side applications (one side only) were made between 15 Apr (1/4" green) and 24 Aug (7th cover, 2nd half) at 4-7 da intervals (mean 6.3 da). The sprayer was calibrated to deliver 50 gal/A (both sides) when operated at a ground speed of 2.5 mph. Adjustments in manifold pressure or nozzle size were made when necessary to change delivery rate to match variable tree row spacing among the half-acre plots in order to provide for the proper amount in each plot. Tree-row volume of the five systems varied somewhat, but all were approximately 227,952 ft^3 requiring 40% of recommended amounts. The incidence and severity of apple scab was determined on each of the cultivars. Incidence of infection on cluster leaves of 'Delicious' was determined on 27-28 May by observing all leaves on five non-fruiting spurs (clusters) on each of 10 single trees/plot. Infection on terminal leaves was determined by observing on 23-26 Jul ('Delicious') and 12-13 Aug ('York') all leaves on five terminals from each of 10 trees/plot (same trees used for cluster counts, 'Delicious'). Incidence of scab on fruit was determined by observing 500 fruits on each of five replicates (50 fruits/tree on 10 trees) on 29 Sep ('Delicious') and 25-26 Oct ('York'). Disease counts on 'Golden Delicious' and the nontreated rows of each plot was on 200 fruits/replicate. Scab severity per fruit was determined by counting all lesions on 20 of the most severely infected fruits/replicate. Sooty blotch and fly speck incidence on 'Golden Delicious' was obtained on the same fruit sample used for scab observations. All disease observation data collected were analyzed for significance between treatments by utilizing the T-test comparison (P=0.05).

The fungicide programs evaluated provided fair to good control of apple scab under moderately high disease pressure. Sooty blotch and fly speck incidence was low on the nontreated trees and the treatments provided near complete control. Differences in control of all diseases between the two programs were not significant. The level of scab control was below that acceptable by commercial apple producers, but the disease pressure was much higher than in commercial orchards. Scab level differences between the two Nova 40W rates among the five planting systems having variable tree rows/plot (5-9) were not significant. Scab incidence was higher on three of the planting systems receiving the higher rate. Scab levels were higher in this orchard in 1993 than on similar programs applied in 1992 under lower disease pressure.

Disease Incidence on Apple Treated with Fungicide Spray Programs Applied Concentrate at Tree Row Volume Rates in a High Density Orchard in 1993. Penn State Fruit Research laboratory.

		Percent Apple Scab Incidence						Percent Disease on 'G. Del'	
	Application	Cluster Lvs	Terminal Lvs		Fruit			Sooty	Fly
Fungicide and Rate/A	Timing	'Delicious'	'Del'	'York'	'Del'	'York'	'G. Del'	blotch	speck
TRV Rates at 40% of Recommendations									
Dithane 75DF 19.2 oz +									
Spray Oil 6E 2.0 gal	1/2"-Green								
Nova 40W 1.6 oz +									
Dithane 75DF 19.2 oz	TC,OC,B,PF,1C,2C								
Nova 40W 1.6 oz	3C								
Captan 50W 19.2 oz	5C								
Captan 50W 19.2 oz +									
Topsin-M 85WDG 4.8 oz	6C,7C	16.8a*	6.7a	6.6a	7.8a	2.9a	5.9a	0.3a	0.2a
Dithane 75DF 19.2 oz +									
Spray Oil 6E 2.4 gal**	1/2"-Green								
Nova 40W 2.4 oz** +									
Dithane 75DF 19.2 oz	TC,OC,B,PF,1C,2C								
Nova 40W 2.4 oz	3C								
Captan 50W 25.6 oz**	5C								
Captan 50W 25.6 oz +									
Topsin-M 85WDG 4.8 oz	6C,7C	18.0a	7.6a	2.4a	12.3a	2.2a	6.7a	0.9a	0.5a
Nontreated	....	32.2b	51.0b	83.2b	65.6b	24.1b	50.0b	23.2b	16.2b

* Means within columns followed by the same letter(s) do not differ signficantly, T-test Comparison (P=0.05).
** Rate calculated from recommended rates of 6.0 gal Superior Oil, 6.0 oz Nova 40W and 4.0 lb Captan 50W.

APPLE: (*Malus domestica* 'Rome Beauty', 'Golden Delicious', 'Delicious', 'Stayman', 'Cortland')
Scab; *Venturia inaequalis*
Powdery mildew; *Podosphaera leucotricha*
Sooty blotch; *Gloeodes pomigena*
Fly speck; *Zygophiala jamaicensis*

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APPLE DISEASE CONTROL WITH REDUCED TRV FUNGICIDE RATES APPLIED AS COMPLETE OR ALTERNATE-SIDE SPRAYS, 1993: Efficacy of fungicide programs applied seasonally as protective concentrate sprays was determined in an 8-year old semi-dwarf orchard. The experimental orchard, five acres in size, was divided into four 5-row sections which were treated separately. Each section contained 20 plots, each consisting of one tree of each of five cultivars planted 3 m apart in sequence along the row separated by a 15 m space between plots. Spacing between tree rows was 9 m which allowed for a minimum of spray drift. The inoculum level for the apple scab pathogen was high and environmental conditions were highly favorable for infection with 11 primary infection periods between 16 Apr and 1 Jul. Favorable conditions for powdery mildew incidence was moderate to light because of low density tree canopy, low inoculum levels, and only moderately favorable environmental conditions. The fungicide treatments consisted of two rates of a fungicide program commonly used in Pennsylvania which were applied in complete sprays from both sides of the tree or in alternate-side applications. One rate was calculated to match the tree row volume of the test orchard which was determined to be 186,686 ft^3 or 32% of the standard recommended rates. This rate was compared to rates calculated to be 50% of the standard recommendations. All fungicide treatments were applied at 50 gals/A (both sides) with a Metters Model 36 airblast sprayer operated at 2.5 mph and a manifold pressure of 200 psi. One half of the treatments were applied from alternate sides with only one side of the sprayer in operation. These applications were made at more frequent intervals than the complete sprays applied from both sides. Application dates and phenological stages for the treatments applied as complete sprays were: 15 Apr (1/2" green), 24 Apr (tight-cluster), 4 May (pink), 10 May (bloom), 18 May (petal-fall) 28 May (1st cover), 12 Jun (2nd cover), 24 Jun (3rd cover), 4th cover omitted, 23 Jul (5th cover), 5 Aug (6th cover), and 19 Aug (7th cover). Intervals between sprays were 6-10 da from 1/2" green through petal-fall and 13-15 days between covers, except for the omission of the 4th cover producing a 29 da interval. Spray applications from alternate sides were made at 4-8 da intervals through the entire season except for a 21 da interval between the 3rd and 5th covers. Disease incidence was measured on both leaves and fruit of 3-5 cultivars. Apple scab incidence during the pre-bloom period was determined on cluster leaves of 'Stayman' by observing all leaves on 20 nonfruiting spurs (clusters) per tree (5 reps/treatment) on 24-26 May. Incidence was also recorded on 10 vegetative terminals/single tree on 16-19 Jul ('Rome Beauty'), 2 Aug ('Golden Delicious'), and 18-19 Aug ('Delicious'). Powdery mildew incidence on 'Rome Beauty' was also recorded when scab counts were made. Scab incidence on fruit was determined at harvest by examining 100 fruits/replicate on 1 Sep ('Delicious'), 6 Oct ('Stayman'), 14 Oct ('Cortland'), 5 Oct ('Golden Delicious') and 24 Oct ('Rome'), respectively. Scab severity was determined by counting all lesions on 10 of the most severely infected fruit/replicate. Presence of sooty blotch and fly speck was also recorded on 'Golden Delicious'. All data collected were analyzed for significance between disease incident means by utilizing the T-test comparisons ($P = 0.05$).

Because of high inoculum levels and favorable environmental conditions scab incidence on all nontreated cultivars ranged between 61 and 98% on leaves and 61 and 90% on fruit ('Cortland' not shown in Table). The fungicide programs applied in alternate-side sprays (4-8 da intervals) at TRV rates 32% of standard recommendations was significantly inferior for scab control on fruit to the same program applied in complete sprays (6-10 da, pre-petal fall and 13-15 da in cover sprays). The most effective treatment was the fungicide program applied in complete sprays at the 50% of recommended rates. This treatment was significantly superior to the TRV 32% rates (complete sprays) on the fruit of 'Delicious' and the terminal leaves of 'Delicious' and 'Rome'. The mean number of lesions on the most severely infected fruit was 2-13 on treated trees compared to 19-94 on nontreated trees. Differences in lesion numbers were generally not significant among fungicide treatments. Incidence of sooty blotch and fly speck was 25.5% and 33% for nontreated trees, respectively. All treatments allowed less than 1.0% infection.

Incidence of Scab and Powdery Mildew on Apple Leaves Treated with Seasonal Fungicide Programs Applied Concentrate as Alternate-Side (AS) or Complete (BS) Sprays at Reduced Tree Row Volume Rates in 1993. Penn State Fruit Research Farm, 5C Block, Biglerville, PA

	Application		Percent Apple Scab Incidence						% P. mildew
			Cluster Lvs	Terminal Lvs		Fruit			Term. Lvs
Fungicide and Rate/A	Timing	Method	'Stayman'	'Del'	'Rome'	'Del'	'Stayman'	'Rome'	'Rome'
TRV Rates at 32% of Recommendations									
Syllit 65W 5.8 oz +									
Spray Oil 6E 1.6 gal	1/2"-Green	AS							
Syllit 65W 5.8 oz	Tight-cluster	AS							
Syllit 65W 5.8 oz +									
Nova 40W 1.6 oz	Open-cluster	AS							
Nova 40W 1.6 oz +									
Dithane 75DF 15.4 oz	P,B,PF,1C,2C	AS							
Dithane 75DF 15.4 oz	3rd Cover	AS							
Captan 50W 20.5 oz +		AS							
Topsin-M 85WDG 3.8 oz	5C,6C,7C	....	40.4b*	22.3c	10.7b	51.8d	44.4c	9.2b	7.1ab
Syllit 65W 5.8 oz +									
Spray Oil 6E 1.6 gal	1/2"-Green	BS							
Syllit 65W 5.8 oz +									
Nova 40W 1.6 oz	Tight-cluster	BS							
Nova 40W 1.6 oz +									
Dithane 75DF 15.4 oz	P,B,PF,1C,2C	BS							
Dithane 75DF 15.4 oz	3C	BS							
Captan 50W 20.5 oz	5C,6C,7C	BS.....	25.6ab	8.7b	6.6b	21.0b	19.6ab	6.4ab	2.9a

Table - continued

Fungicide and Rate/A	Application Timing	Application Method	Percent Apple Scab Incidence: Cluster Lvs 'Stayman'	Terminal Lvs 'Del'	Terminal Lvs 'Rome'	Fruit 'Del'	Fruit 'Stayman'	Fruit 'Rome'	% P. mildew Term. Lvs 'Rome'
Rate at 50% of Recommendations									
Syllit 65W 9.0 oz + Spray Oil 6E 2.5 gal	1/2"-Green	AS							
Syllit 65W 9.0 oz	Tight-cluster	AS							
Syllit 65W 9.0 oz + Nova 40W 2.5 oz	Open-cluster	AS							
Nova 40W 2.5 oz + Dithane 75DF 24.0 oz	P,B,PF,1C,2C	AS							
Dithane 75DF 24.0 oz	3C	AS							
Captan 50W 32.0 oz + Topsin-M 85WDG 6.0 oz	5C,6C,7C	AS....	26.4ab	5.9ab	7.0b	33.2c	29.6b	7.4b	2.1a
Syllit 65W 9.0 oz + Spray Oil 6E 2.5 gal	1/2"-Green	BS							
Syllit 65W 9.0 oz + Nova 40W 2.5 oz	Tight-cluster	BS							
Nova 40W 2.5 oz + Dithane 75DF 24.0 oz	P,B,PF,1C,2C	BS							
Dithane 75DF 24.0 oz	3C	BS							
Captan 50W 32.0 oz + Topsin-M 85WDG 6.0 oz	5C,6C,7C	BS....	13.1a	2.3a	1.7a	7.0a	6.0a	2.4ab	1.4a
Nontreated..			79.6c	97.8d	86.4c	89.5c	81.6d	82.6c	20.5b

* Means within columns followed by the same letter(s) do not differ signficantly, T-test Comparison (P = 0.05).

APPLE: Malus domestica ('Golden Delicious', 'Red Delicious', 'Rome Beauty')
Scab; Venturia inaequalis
Powdery mildew; Podosphaera leucotricha
Sooty blotch; Gloeodes pomigena
Fly speck; Zygophiala jamaicensis

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EFFICACY OF SEASONALLY APPLIED DILUTE FUNGICIDE SPRAYS, 1993: The efficacy of seasonal fungicide spray programs in reducing apple disease incidence was measured under favorable environmental conditions for disease development. Inoculum for apple scab was heavy and frequent early-season rain periods resulted in 11 primary scab infection periods between 16 Apr and 1 Jul. Rain continued into July with three additional secondary infections on 5, 17, and 19 Jul. Overwintering powdery mildew was light coupled with relatively cool temperatures through petal-fall resulted in low mildew infections. Sooty blotch and fly speck was favored by rain periods in August and September. The experimental site was a mature block of semi-dwarf trees planted 30 x 35 ft and pruned to a height of 10-12 ft. Each plot consisted of three trees, one of each cultivar planted in a group at each tree site. The treatments were arranged in a randomized complete block design with four replicates. Treatments to developing leaves and fruit were applied as protective dilute sprays timed at 6-8 day intervals from half-inch green through petal-fall and at 12-15 days during the post-bloom period. Sprays were applied to the point of "complete wetness" with a high pressure sprayer operated at 400 psi and equipped with a 9-nozzle boom which delivered 2.8 gal/tree (280 gal/A). Application dates and phenological stages of leaf development were: 19 Apr (1/2" green), 26 Apr (open-cluster), 4 May (bloom), 11 May (petal-fall), 1st through 6th Cover sprays on 24 May, 7 and 21 Jun, 6 and 19 Jul, and 2 Aug, respectively. Scab development on early-season leaves was recorded on 'Starking Delicious' cluster leaves by observing on 3-4 Jun all leaves on 20 non-fruiting clusters/replicate tree. Total scab and mildew incidence on leaves was obtained on 'Rome Beauty' by observing on 13-14 Jun all leaves on 15 vegetative terminals/ tree. Disease incidence on fruit was recorded at harvest on 100 fruit/replicate. To measure the protectiveness of fungicide residues for sooty blotch and fly speck control, the interval between last application and observation date was 53 days. Scab severity was measured by counting total lesions on up to 10 of the most severily infected fruit per replicate sample. Fruit russet on 'Golden Delicious' was determined by the Horsfall-Barratt rating scale using 20 fruits/replicate. All data obtained were analyzed by analysis of variance using appropriate transformations and significance between means was determined by the Tukey-Kramer HSD test ($P \leq = 0.05$).

Scab incidence on leaves and fruit was moderate to high on non-treated trees. All fungicide treatments provided good to excellent control and differences among treatments were generally small. TD-2323 provided good control of scab but the level was somewhat lower, but not significantly different, from the sterol-inhibitors plus protectant treatments. Fluazinam used alone or in combination with Nova provided excellent control. The mean number of scab lesions/fruit on the most severely infected fruits was 26 for the nontreated and ranged between 3.9 and 14.2 among treatments and was not significantly different. The level of sooty blotch and fly speck control obtained can be attributed to the fungicides used during the 5th and 6th cover sprays. Several treatments utilized either Benlate or Topsin-M during this period, thus, incident levels were not greatly different. Fluazinam appeared to be very effective. Fruit russet on 'Golden Delicious' was very low on all treated plots averaging 4.2% of the surface affected on non-treated fruit and ranged between 1.2 and 2.8% among the treatments. Only the TD-2323 treatments used alone were significantly better than the check.

Disease Incidence on Apple Treated with Fungicides Applied as Protective Dilute Sprays in 1993. Penn State Fruit Research Laboratory. Biglerville, PA

		Percent Disease Incidence						
		Apple Scab				Summer Diseases		P. mildew
		'Starking Delicious'		'Rome Beauty'		'G. Delicious'		'Rome'
Fungicide and Rate/100 gal	Application Timing	Cluster Lvs Inf	Fruit	Terminal Lvs inf	Fruit	Sooty blotch	Fly speck	Terminal lvs
TD 2323-2 75.2W 21.0 oz	1/2"-Green thru 6C.......	8.0bc*	3.5a	9.3abc	1.0ab	10.0a	37.9ab	8.5a-d
TD-2323-2 75.2W 32.0 oz	1/2"-Green thru 6C.......	10.1c	4.3a	8.5abc	1.6ab	3.4a	20.5ab	10.3b-e
TD-2323-2 75.2W 21.0 oz + LI 203-542 8.0 fl oz	1/2"-Green thru 6C.......	8.6bc	5.0a	15.6bc	0.5ab	8.2a	32.0ab	10.9cde
Nova 40W 1.67 oz +	1/2"-Green thru 2C							
Dithane 75DF 1.0 lb	B,PF,1C,2C							
Captan 50W 1.5 lb	3C,4C							
Topsin-M 85WDG 4.0 oz + Captan 50W 1.0 lb	5C,6C....................	8.1bc	1.8a	2.3a	0.8ab	11.5a	48.5bc	2.2ab
Nova 40W 1.3 oz + Dithane 75DF 1.0 lb	1/2"-G,OC,B,PF,1C,2C							
Captan 50W 1.5 lb	3C,4C							
Topsin-M 85WDG 4.0 oz + Captan 50W 1.0 lb	5C,6C....................	1.7ab	1.3a	2.7a	0.3ab	17.0a	47.3bc	4.9abc
Captan 50W 2.0 lb	1/2"-G,OC,1C,2C							
Aliette 80W 26.7 oz	B,PF							
Captan 50W 1.5 lb	3C,4C							
Benlate 50W 4.0 oz + Captan 50W 1.0 lb	5C,6C....................	8.1bc	8.0a	22.0c	3.0ab	14.7a	31.8ab	15.3de
Rubigan 1E 3.0 fl oz + Captan 50W 1.0 lb	1/2"-G,OC,1C,2C							
Aliette 80W 13.3 oz	B,PF							
Captan 50W 1.5 lb	3C,4C							
Benlate 50W 4.0 oz + Captan 50W 1.0 lb	5C,6C....................	2.7abc	1.6a	10.6abc	1.3ab	8.6a	28.2ab	5.3abc

Fungicide and Rate/100 gal	Application Timing	Percent Disease Incidence: Apple Scab, 'Starking Delicious', Cluster Lvs Inf	Apple Scab, 'Starking Delicious', Fruit	Apple Scab, 'Rome Beauty', Terminal Lvs inf	Apple Scab, 'Rome Beauty', Fruit	Summer Diseases, 'G. Delicious', Sooty blotch	Summer Diseases, 'G. Delicious', Fly speck	P. mildew, 'Rome', Terminal lvs
Fluazinam 500F 12.8 fl oz	1/2"-G thru 6C	4.9bc	4.2a	2.9ab	1.2ab	3.0a	17.7ab	9.6b-e
Fluazinam 500F 12.8 fl oz + Nova 40W 1.3 oz Benlate 50W 4.0 oz	1/2"-G thru 6C 1/2"-G,OC,B,PF,1C,2C 5C,6C	2.0ab	2.5a	2.3a	0.0a	1.8a	6.8a	2.2ab
Fluazinam 500F 6.4 fl oz + Nova 40W 1.3 oz Benlate 50W 4.0 oz	1/2"-G thru 6C 1/2"-G,OC,B,PF,1C,2C 5C,6C	0.0a	0.8a	2.1a	0.0a	0.8a	10.3a	2.5a
Rubigan 1E 3.0 fl oz + Captan 50W 1.0 lb Captan 50W 1.5 lb Benlate 50W 4.0 oz + Captan 50W 1.0 lb	1/2"-G,OC,B,PF,1C,2C 3C,4C 5C,6C	5.3bc	4.2a	8.0abc	0.3ab	4.6a	23.8ab	6.7a-d
Nontreated		47.3d	68.8b	75.1d	53.3c	90.8b	96.0c	20.3e

* Means within columns followed by the same letter(s) do not differ significantly, Tukey-Kramer HSD ($P \leq 0.05$).

APPLE: <u>Malus domestica</u> ('Golden Delicious', 'Red Delicious', 'Rome Beauty')
Scab; <u>Venturia inaequalis</u>
Powdery mildew; <u>Podosphaera leucotricha</u>
Sooty blotch; <u>Gloeodes pomigena</u>
Fly speck; <u>Zygophiala jamaicensis</u>

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EVALUATION OF THE EFFECT OF FUNGICIDE FORMULATION OR THE ADDITION OF A SURFACTANT ON DISEASE CONTROL, 1993: The effect of Captan formulation or the combination of the surfactant LI 203-542 with either captan or ziram was evaluated under favorable environmental conditions for scab and summer disease development in an experimental block having heavy scab inoculum. The fungicide treatments were applied as dilute sprays to trees in a mature block of semi-dwarf trees planted 20 x 35 ft and pruned to a height of 10-12 ft. Experimental plots consisted of three trees, one of each cultivar planted in a group at each tree site. The experimental design was a randomized complete block with four replicates. Treatments were applied to the point of "complete wetness" with a high pressure sprayer operated at 400 psi and equipped with a 9-nozzle boom which delivered 2.8 gal/tree (280 gal/A). Applications were made on: 15 Apr (1/2" green), 21 Apr (tight-cluster), 28 Apr (open-cluster), 6 May (bloom), 13 May (petal-fall), 1st through 6th cover sprays on 25 May, 7, 22 Jun, 7, 20 Jul, and 3 Aug, respectively. Intervals ranged from 6-8 days before petal-fall and 12-15 days during the cover sprays. Scab incidence during the period through petal-fall was determined on 6 Jun on cluster leaves of 'Delicious' by observing all leaves on 25 non-fruiting clusters/replicate. Terminal leaves infected with scab and powdery mildew was determined on 20-21 Jul by observing all leaves on 15 vegetative terminals/tree. Scab, sooty blotch, and fly speck incidence on fruit was obtained by observing 100 fruit at harvest on 27 Sep ('G. Delicious'), 2 Oct ('Del'), and 20 Oct ('Rome'). Scab severity was checked by counting all lesions on the 10 most severely infected fruits/treatment sample. Fruit finish on 'Golden Delicious' at harvest was determined by the Horsfall-Barratt rating scale for percent surface affected with russet. Data obtained were analyzed by analysis of variance using appropriate transformations and significance between means was determined by the Tukey-Kramer HSD($P \leq 0.05$).

All of the fungicide treatments provided highly significant control of scab on leaves and fruit under conditions highly favorable for scab development. Frequent rains resulting in 11 primary infection periods provided ample pressure for the protective treatments. Ziram 76W 2.0 lbs/100 gal allowed significantly more scab to develop on terminal leaves, but the level on cluster leaves and fruit was not significantly different from other treatments. All treatments provided equal control of fruit scab. The mean number of lesions on the most severely infected fruit was 40 for the nontreated 'Delicious' fruit and ranged between 1.5 and 7.5 among treatments. Differences among treatments were not significant. Differences in control of sooty blotch and fly speck were not significant among the treatments. The incidence level on nontreated fruit was 84 and 97% for sooty blotch and fly speck, respectively. The incidence of fly speck on most treatments was somewhat higher than that of sooty blotch in this test. The interval between the last application and observations at harvest was 55 days which contributed to the poor performance for late season disease control. There appeared to be no difference in performance of the two captan formulations and the addition of LI 203-542 spray adjuvant did not improve the performance of captan or ziram. Fruit russet on 'Golden Delicious' was only 2.3% of the surface affected on the nontreated check which was higher than any of the treatments.

Incidence of Disease on Apple Treated with Dilute Fungicide Protective Sprays in 1993. Penn State Fruit Research Laboratory. Biglerville, PA.

		Percent Disease Incidence						
		Apple Scab				P. mildew	Summer Diseases	
		'Rome Beauty'		'Delicious'		'Rome'	'G. Delicious'	
Fungicide and Rate/100 gal	Application Timing	Terminal Lvs Inf	Fruit	Cluster Lvs Inf	Fruit	Terminal Lvs Inf	Sooty blotch	Fly speck
Ziram 76W 2.0 lb	1/2"-Green thru 6C.......	15.7c*	3.3a	9.3a	6.8a	28.1b	9.0ab	31.8a
Captan 50W 2.0 lb	1/2"-Green thru 6C.......	3.5a	1.3a	10.5a	11.8a	18.5b	29.2b	59.4ab
Captan 75WDG 1.33 lb	1/2"-Green thru 6C.......	5.1ab	1.0a	14.5a	7.1a	24.7b	14.7ab	54.2ab
Captan 50W 1.0 lb + Nova 40W 1.3 oz Captan 50W 1.5 lb Topsin-M 85WDG 4.0 oz	1/2"-G,OC,B,PF,5C,6C 1/2"-G,OC,B,PF 1C,2C,3C,4C 5C,6C....................	1.7a	0.5a	6.0a	0.7a	5.8a	5.7ab	25.3a
Captan 75WDG 10.7 oz + Nova 40W 1.3 oz Captan 75WDG 1.0 lb Topsin-M 85WDG 4.0 oz	1/2"-G,OC,B,PF,5C,6C 1/2"-G,OC,B,PF 1C,2C,3C,4C 5C,6C....................	2.1a	0.3a	11.2a	3.8a	5.8a	5.6ab	20.5a
Captan 50W 2.0 lb LI 203-542 8.0 fl oz Captan 50W 1.5 lb	1/2"-G,OC,B,PF,1C,5C,6C 1/2"-G thru 6C 2C,3C,4C.................	3.9a	1.5a	14.0a	4.9a	15.2ab	21.6ab	57.5ab
Ziram 76W 2.0 lb LI 203-542 8.0 fl oz Ziram 76W 1.5 lb	1/2"-G,OC,B,PF,1C,5C,6C 1/2"-G thru 6C 2C,3C,4C.................	13.7bc	3.8a	15.0a	11.8a	20.5b	4.3a	20.0a
Nontreated		70.5d	58.8b	73.0b	86.8b	24.6b	83.8c	96.8b

* Means within columns followed by the same letter(s) do not differ significantly, Tukey-Kramer HSD ($P \leq 0.05$).

APPLE: (*Malus domestica* 'Rome Beauty')
Fire Blight; *Erwinia amylovora*

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EVALUATION OF BACTERICIDES FOR CONTROL OF FIRE BLIGHT BLOSSOM INFECTIONS, 1992-93: The efficacy of bactericidal sprays applied during bloom for preventing fire blight blossom blight was evaluated in two experiments in 1992 and 1993 in a block of mature 'Rome Beauty' trees located near Fairfield, PA. Fire blight occurred annually in this block previously for five or more years. Trees were heavily pruned during dormancy to remove previously infected branches. Treatment units consisted of 2-tree plots arranged in a randomized complete block design with four or five replicates. Bactericides were suspended in water and applied to the point of "complete wetting" at 3.0 gallons/tree (300 gpa) with a single-nozzle spray gun at 400 psi. Blossom inoculations were made 24 (1993) and 48 (1992) hours after the last application and consisted of swabbing all open blossoms in each of five (1992) or 10 (1993) blossoming clusters/tree with a suspension of *E. amylovora*. Inoculum was prepared by suspending cells from 1-day old cultures grown on nutrient agar into phosphate buffer and adjusting to 1×10^8 cfu/ml in 1992 and 1×10^4 in 1993. Blossom clusters were terminally located and marked for easy identification. The percentage of inoculated blossoms which developed typical blight symptoms was determined 2-3 weeks after inoculation. The length of blighted stem area resulting from inoculations was determined 28 (1992) and 40 (1993) days after inoculation. Treatments were applied in 1992 on 23 Apr (open-cluster), 28 Apr (pink), and 4 May (full-bloom), 17, 8, and 2 days before inoculations, respectively. Applications in 1993 were made on 1 May (pink) and 5 May (full-bloom), 6 and 1 days before inoculations, respectively. A determination of the number of naturally occurring blossom infections on each tree in each of the two experiments was made on 2 Jul (1992) and 14 Jun (1993). All data were subjected to the analysis of variance using appropriate transformations and differences between means were tested using Tukey-Kramer HSD ($P \leq 0.05$).

In Experiment 1, temperatures during the blossoming period were generally below 60° F, but two rain periods favorable for blight development with temperatures 65° F or above occurred during late-bloom on 13 and 15-17 May. Natural blossom blight infections on nontreated trees in 1992 were low with only 1.0 infection/tree. In this experiment, 85% of the nontreated inoculated blossom clusters became infected. The percent blighted blossom clusters on Aliette 80W treated trees (78-81%) was not significantly different from nontreated trees, while only 12.5% of the inoculated clusters blighted in trees treated with streptomycin. The length of the blighted area on shoots treated with three sprays of Aliette at 20 oz/100 gal was significantly less than on the nontreated shoots. Blossom development in 1993 was very rapid with only five days between and pink and full-bloom stages. Petal-fall was evident on some of the blossoms during inoculation which was only six days after the pink spray was applied. A highly favorable fireblight infection period occurred on 5 May, starting three hours after the full-bloom application was finished and one day before inoculation. Temperatures ranged from 65-79° F during the 24 hour period following blossom inoculation. Even though favorable conditions occurred, only a mean of 1.0 natural infections/tree occurred. Only 22.5% of nontreated inoculated blossoms showed shoot infection. Infections from inoculated clusters on treated trees were not significantly different from the check. The length of the blighted area on infected shoots was not significantly different among the treatments in 1993. Results obtained in these tests during two seasons strongly suggest that Aliette had no significant effect in preventing blossom infections and subsequent colonization of shoots when used in two or three blossom applications. Inoculum levels used were optimum in 1992 and marginal for blossom infection in 1993. Natural infection was light during both seasons, and inadequate to evaluate treatments effects on natural field inoculum levels.

Incidence of Fire Blight on 'Rome Beauty' Apple Trees Sprayed with Blossom Treatment in 1992-93. Penn State Fruit Research Laboratory.

Bactericide and Rate/100 Gal	Application Timing	% Cluster Infected Inoculated[2]	% Cluster Infected Natural	Length of blight (cm)[4]
Experiment 1 (1992)				
Aliette 80W 10.0 oz	P, B	80.5b[5]	1.1a	4.2abc
Aliette 80W 20.0 oz	P, B	80.5b	0.9a	2.9ab
Aliette 80W 20.0 oz	OC, P, B	77.5b	0.6a	2.1a
Agri-Mycin 17 8.0 oz	P, B	12.5a	0.9a	4.3abc
Nontreated		85.0b	1.0a	4.8bc
Experiment 2 (1993)				
Aliette 80W 10.0 oz	P	28.8a	0.5a	11.8a
Aliette 80W 20.0 oz	P, B	37.5a	1.4a	12.6a
Aliette 80W 20.0 oz	P	32.5a	1.4a	10.1a
Agri-Mycin 17 8.0 oz	P, B	42.5a	1.0a	12.7a
Water Sprayed	P, B	22.5a	1.0a	10.1a

1 Applied at phenological stages: open-cluster (OC), pink (P), and full-bloom (B).
2 Blossom cluster inoculated by swabbing E. amylovora onto open blossoms.
3 Total number of blighted shoots per tree.
4 Length of blighted stem area 28 days (1992) and 40 days (1993) after inoculation.
5 Means followed by the same letter(s) are not significantly different, Tukey-Kramer HSD ($P \leq 0.05$).

APPLE: Malus domestica ('Red Delicious', 'Rome Beauty')
Apple scab; Venturia inaequalis

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EVALUATION OF THREE PREDICTIVE APPLE SCAB MODELS FOR TIMING POST-INFECTION FUNGICIDE SPRAYS IN 1992-93. The effectiveness of post-infection sprays of Nova 40W plus Captan 50W when applied as directed by three apple scab infection models were evaluated in the same orchard in 1992 and 1993. The experiment was conducted in a mature block of trees planted 30 X 36 ft and well-pruned to a height of 15 ft. Each tree was grafted to each of three cultivars which composed approximately 1/3 of the tree. Treatments were arranged in a randomized complete block design with four 3-tree replicates (each with the three cultivars). The fungicide treatments were applied as dilute sprays to the point of "complete wetness" with a high pressure sprayer operated at 400 psi and equipped with a 9-nozzle boom which delivered 2.8 gal/tree (280 gal/A). The three apple scab models were built into the Neogen Envirocaster and were as follows: Standard Mills (Mills 1951), based on temperature and length of leaf wetness; Modified Mills (Jones, 1980), based on temperature, wetness, and relative humidity; and Revised Mills (MacHardy, 1989), same as Modified except wetting periods that began during the nocturnal period (2100-0500 hr) were not counted in wetness duration. The Nova 40W rate was determined by the level of scab severity predicted by each model and was used at 1.5 oz/100 gal when infection periods were low to moderate, and was increased to 2.0 oz/100 gal when the infection periods were high. The scab inoculum level was high in the experimental orchard and environmental conditions were favorable for scab infections. In 1992 eight infection periods occurred from 1/2" green thru 5th cover and all but two were rated high. In 1993, five post-infection sprays were applied to cover for nine infectin periods that occured from 1/2" green thru 3rd cover and the Nova 40W rate was 1.25 oz/100 gal in three of the five applications. Application timing ranged form 40 to 125 hours from the beginning of the infection period, but most sprays were applied at 70-98 hours post-infection. Infectins that occurred within five days following an application were considered protected against by the previous spray. Protective fungicide treatments were applied for the remainder of the season. Scab incidence on leaves and fruit was determined to measure both the efficacy of post-infection applications and seasonal differences in the models. Incidence on cluster leaves of 'Delicious' was determined on 15 (1992) or 25 (1993) non-fruiting spurs by examining all leaves on 9 Jun (1992) or 21-23 Jun (1993). Scab incidence on terminal leaves of 'Rome Beauty' was determined on 15 vegetative terminals/tree on 5 Aug (1992) and 30 Jul (1993). Fruit infection at harvest with scab was determined by observing 100 fruit/tree on: 'Delicious', 10 Sep (1992) and 7 Oct (1993); 'Rome Beauty', 10 Sep (1992) and 19 Oct (1993). Incidence of scab on leaves and fruit treated with a protective spray schedule of Nova plus captan was determined in an adjacent orchard for comparison between the two programs. The data were analyzed by analysis of variance using appropriate transformations and significance between means was determined by the Tukey-Kramer HSD tests ($P = \leq 0.05$).

Scab incidence on leaves and fruit was similar for the three scab models. In 1992 all models predicted the same level of infection at each infection period except one period on 20 Jul (5th cover when the Standard Mills predicted a moderate infection and the Modified and Revised Mills predicted a high infection. Differences in scab control among the models were not significant. Scab infection periods in 1993 were less severe with only two rated as high. Only five post-infection applications were applied thru 3rd cover and Nova 40W 1.25 oz plus Captan 50W 1.0 lb was used in all post-infection applications except two. Scab control on cluster leaves of 'Delicious' was poor ranging from 20.3 to 42.5% infection among the models. The level of terminal leaf infection on 'Rome Beauty' was similar to 1992. Differences on 'Rome Beauty' fruit were not significant and the level of control was acceptable considering the high inoculum level in the test orchard. The level on 'Delicious' was higher than on 'Rome Beauty'. Nova 40W used along in post-infection applications provided scab control that was significantly lower than when combined with Captan 50W. The incidence of scab on terminal leaves and fruit of 'Rome Beauty' in an adjacent orchard treated with a protective program of Nova 40W plus a protectant at similar rates in seven applications was 2.1% and 0.3%, respectively. With a similar program in 1992 using nine protective sprays, scab incidence on terminal leaves and fruit on 'Rome Beauty' was 3.4 and 1.3%, respectively. The results in these experiments show that differences among the three apple scab models in predicting infection periods were seldomly different and generally not significant.

Scab Incidence on Apple Treated with Post-Infection Sprays of Nova 40W Plus Captan 50W Timed with a Neogen Envirocaster Equipped with Three Predictive Apple Scab Infections Models in 1992-93. Penn State Fruit Resarch Laboratory. Biglerville, PA.

Fungicide	Rate/100 gal 1992*	Rate/100 gal 1993**	Scab Models for Predicted Sprays***	Percent Scab Incidence: Cluster Lvs 'Delicious' 1992	Cluster Lvs 'Delicious' 1993	Terminal Lvs 'Rome' 1992	Terminal Lvs 'Rome' 1993	Fruit 'Delicious' 1992	Fruit 'Delicious' 1993	Fruit 'Rome' 1992	Fruit 'Rome' 1993
Nontreated	-	-	--	80.0b	69.5c	98.9b	77.1c	100.0d	99.8d	100.0b	88.8c
Nova 40W + Captan 50W	2.0 oz 1.0 lb	1.25 oz 1.0 lb	Standard	1.5a	42.5bc	12.4a	9.9ab	16.0ab	18.0ab	22.0a	8.0a
Nova 40W + Captan 50W	2.0 oz 1.0 lb	1.25 oz 1.0 lb	Modified	3.0a	20.3a	13.2a	4.4a	13.8a	11.0a	24.5a	8.5a
Nova 40W + Captan 50W	2.0 oz 1.0 lb	1.25 oz 1.0 lb	Revised	5.3a	40.5ab	9.5a	9.7ab	31.8bc	24.5b	19.3a	7.0a
Nova 40W	2.0 oz	1.25 oz	Modified	1.8a	42.0bc	21.7a	21.5b	43.8c	59.0c	34.8a	26.3b

* Nova 40W 1.25 oz was applied when predicted infection periods were rated moderate or low on 29 May (1st cover and 20 Jul (5th cover).

** Nova 40W 2.0 oz was applied on 7 May (bloom) and 20 May (petal-fall) when a high and moderate infection period occurred, respectively.

*** Scab infection models used were: Standard Mills, based on temperature and length of leaf wetting; Modified Mills, based on temperature, wetting, and relative humidity; and Revised Mills, same as Modified Mills except wetting periods that began during the nocturnal period (2100-0500 hours) were note counted in duration of leaf wetness.

PEACH: (*Prunus persica* 'Redhaven', 'Sunhigh')
NECTARINE: (*Prunus persica* var nectarina 'Summer Beaut')
Brown rot; *Monilinia fructicola*
Rhizopus rot; *Rhizopus sp.*

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FRUIT DECAY INCIDENCE ON PEACH AND NECTARINE TREATED WITH FUNGICIDE SPRAYS, 1993: Fungicide treatments were evaluated for control of brown rot and Rhizopus rot when applied as dilute sprays. Treatments were applied to well-pruned 7 year old trees planted 30 ft between rows in an experimental planting consisting of 3-tree plots (one of each cultivar of 'Redhaven' and 'Sunhigh' peach and one 'Summer Beaut' nectarine). Trees were spaced 10 ft in the row with the nectarine planted between the two peach. Natural inoculum was light, but *Monilinia fructicola* conidia (2×10^5 conidia/ml) were atomized on open blossoms of all plots in late bloom on 5 May. Fungicides were applied as dilute sprays to the point of "complete wetness" using two gallons/tree (200 gal/A) with a high pressure sprayer equipped with a 6-nozzle boom and operated at 400 psi. Some treatments were made in 12 spray applications, while others were applied at critical times for brown rot development at pink (24 Apr), bloom (29 Apr), petal-fall (5 May), 7 da (3 Aug, 'Redhaven' and 17 Aug ('Sunhigh') and 1 da (9 Aug, 'Redhaven' and 24 Aug, 'Sunhigh') before harvest. Sulfur 90W 5.0 lbs/100 gal was applied during the cover period after petal-fall on plots receiving limited applications. Incidence of brown rot and Rhizopus rot was determined on separate fruit samples of "firm ripe" fruit at harvest. Two sets of 20 uniformly ripe fruit/replicate were harvested on 10 Aug ('Redhaven' and 'Summer Beaut') and 25 Aug ('Sunhigh') and placed stem-end down on paper packing trays and located in separate holding areas. Fruit samples from all plots were inoculated with each of the brown rot and Rhizopus pathogens. Conidia of *Monilinia fructicola* were removed from frozen peach halves previously inoculated with an isolate sensitive to the test fungicides, suspended in deionized water at 6×10^4 conidia/ml, and uniformly atomized over all fruit samples. Rhizopus inoculum was collected from sporulating fruit previously inoculated with a local culture and prepared similarly and applied at 1×10^5 conidia/ml. Inoculated fruit were incubated under polyethylene tarp at 74-83° F (mean 78° F) and RH 82-100% (mean 90%) before incidence readings were made at 2, 4, and 6 da for brown rot and 4, 6, and 9 da for Rhizopus. Infected fruit showing sporulation were removed after each observation to prevent additional inoculations and spread. The data were subjected to analysis of variance using appropriate transformations and the significance among means was determined by the Tukey-Kramer HSD test ($P \leq 0.05$).

Only a few brown rot blossom blight infections were found on all trees in the test orchard, although the rain period following inoculation on 5 May was 24 hours duration at 60° F. On fruit, brown rot developed progressively between observations made on the 2nd, 4th, and 6th da after inoculation. Disease levels were somewhat similar for the three cultivars. At 2 da (not shown for 'Redhaven' and 'Summer Beaut'), incidence was low on all treatments including the nontreated check. Differences among treatments at 4 and 6 da were not significant on 'Redhaven'. Captan 50W, Rovral 4F, Botran 75WDG, and the combination of Botran plus captan performed poorly on the 'Sunhigh' with differences among means being not significant from the nontreated check. These treatments, however, provided significant reduction in brown rot on the 'Summer Beaut' nectarine. Orbit 41.8 Gel, and RH-7592 provided the highest level of brown rot control and was the most consistent in performance across the three cultivars. There was no treatment effect against Rhizopus on the 'Sunhigh' samples. Significantly lower incidence of Rhizopus at 6 da incubation occurred on 'Redhaven' treated with Orbit, RH-7592, and Rovral and all treatments were better than the check 9 da after inoculation.

Brown Rot and Rhizopus Rot on Peach/Nectarine Fruit Treated with Fungicide Spray Programs Applied Dilute in 1993. Penn State Fruit Research Laboratory. Biglerville, PA.

	Percent Fruit Decay Following Variable Incubation Periods (Days)									
	Brown Rot						Rhizopus Rot			
	'Redhaven'		'Summer Beaut'		'Sunhigh'		'Sunhigh'		'Redhaven'	
Fungicide and Amt/100 gal	4 da	6 da	4 da	6 da	3 da	6 da	3 da	6 da	6 da	9 da
Orbit 41.8 Gel 2.0 fl oz[1] Sulfur 90W 5.0 lb[2]........	4.0a[4]	12.0a	7.0a	12.0abc	3.0abc	20.0ab	29.0a	85.0a	9.0a	21.0a
RH-7592 2F 3.0 fl oz + Latron B-1956 3.0 fl oz[3]........	1.0a	5.0a	1.0a	2.0ab	0.0a	13.0a	9.0a	63.0a	0.0a	9.0a
RH-7592 75W 1.0 oz + Latron B-1956 3.0 fl oz[3]........	1.0a	4.0a	1.0a	1.0a	1.0ab	14.0a	13.0a	67.0a	2.0a	13.0a
Botran 75WDG 1.3 lb[1] Sulfur 90W 5.0 lb[2]........	13.0ab	21.0ab	19.0a	31.0c	12.0d	49.0bc	6.0a	79.0a	10.0ab	35.0a
Botran 75WDG 12.0 oz + Captan 75WDG 12.0 oz[1] Sulfur 90W 5.0 lb[2]........	15.0ab	23.0ab	22.0a	34.0cd	11.0cd	64.0c	13.0a	84.0a	13.0ab	27.0a
Rovral 4F 8.0 fl oz + CS-7 4.0 fl oz[1] Sulfur 90W 5.0 lb[2]........	9.0ab	17.0ab	15.0a	24.0bc	15.0d	56.0c	13.0a	62.0a	9.0a	32.0a
Captan 50W 2.0 lb[3]........	2.0a	13.0a	25.0a	32.0c	8.0bcd	45.0bc	10.0a	55.0a	12.0ab	39.0a
Nontreated........	36.0b	55.0b	68.0b	72.0d	24.0d	73.0c	10.0a	75.0a	36.0b	81.0b

1 Fungicide treatment applied at the pink, bloom, and petal-fall stages and at 7 and 1 da before harvest.
2 Fungicide treatment applied at the shuck-split, shuck-fall, and five cover sprays.
3 Fungicide treatment applied for entire season in 12 applications from pink through one day of harvest.
4 Means followed by the same letter(s) are not significantly different according to the Tukey-Kramer HSD ($P \leq 0.05$).

CHERRY: (RED TART *Prunus ceraus* 'Montmorency')
Brown rot; *Monilinia fructicola*
Cherry leaf spot; *Coccomyces hiemalis*
Powdery mildew; *Podosphaera clandestina*

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BROWN ROT, LEAF SPOT, AND POWDERY MILDEW CONTROL ON TART CHERRY WITH FUNGICIDE TREATMENTS, 1993: Fungicide treatments applied seasonally in nine applications were evaluated for control of brown rot, leaf spot, and cherry powdery mildew. Environmental conditions were moderate to highly favorable for disease development during the growing season. Inoculum levels were moderately high in the experimental orchard which consisted of a 14-year old block planted 30 x 30 ft and well-pruned to a height of 12 ft. Fungicide treatments were applied to single trees arranged in a randomized complete block design with four replicates. Applications were made as seasonal protective dilute sprays applied to "complete wetness" with a high pressure (400 psi) sprayer equipped with a 9-nozzle boom which delivered 2.8 gals/tree (280 gal/A). Spray dates and corresponding phenological stages were as follows: 28 Apr (white-bud), 4 May (full-bloom), 12 May (petal-fall), 21 May (1st cover), 2 Jun (2nd cover), 14 Jun (3rd cover), 30 Jun (4th cover), 8 Jul (harvest), and 23 Jul (post-harvest). Brown rot incidence on fruit at harvest from natural inoculum was determined on 8-9 Jul by observing all fruit on 10 small branches/tree (100-282 fruits/tree observed). Additionally, a random sample of 100 fruits/tree was harvested 1-hr after the harvest spray was applied (8 Jul). Fruits were placed stem-end down on paper plates and inoculated with *Monilinia fructicola* conidia atomized at 2×10^5 conidia/ml. After inoculation fruit were incubated at 67-100° F (mean 81.0° F) and 50-100% RH (mean 78%) for 4-11 da (first day under polyethylene tarp). The percent soluble solids in fruit juice taken from a separate 50-fruit sample/tree was determined with a Atago PR-1 refractometer at harvest. Cherry leaf spots and powdery mildew incidence on leaves was determined in Jun, Jul, and Aug by observing all leaves on 10 vegetative terminals/replicate. Determination of the level of defoliation from leaf spot was made on 19 Oct by observing the same vegetative terminals used in incidence readings. All data obtained were subjected to an analysis of variance using appropriate transformations and significance between means was determined by the Tukey-Kramer HSD test ($P \leq 0.05$).

Natural brown rot incidence on blossoms was not evident, but nontreated fruit at harvest showed 37% infection. All treatments were significantly better than the nontreated, but brown rot incidence on trees treated with Nova was significantly higher than other treatments. Brown rot on inoculated nontreated fruit ranged from 3.3% at 4 da to 75% at 11 da after inoculation. RH-7592, Orbit, and Rovral provided excellent control even after 11 da incubation. The Nova and Benlate plus captan treatments were not significantly different from the nontreated. All fungicides tested provided good to excellent control of leaf spot through the harvest period, but differences were apparent on 18 Aug. Rovral treated trees at this date had 49.5% leaf infection which was significantly higher than the Orbit or RH-7592 treatments and in the same range with Nova and Benlate plus captan. Leaf defoliation on 19 Oct caused by leaf spot was 98-100% on trees receiving Rovral, Benlate plus captan, and nontreated treatments. Only 3.0% defoliation occurred on the RH-7592 treated trees and 43% and 83% defoliation was observed on the Nova and Orbit treatments, respectively. Nova and Orbit provided the best control of powdery mildew with RH-7592 providing a slightly lower level but not significantly different. Rovral and Benlate plus captan were not significantly from the nontreated check.

Brown Rot, Leaf Spot, and Powdery mildew Incidence on Montmorency Cherry Sprayed with Dilute Fungicide Treatments in 1993. Penn State Fruit Research Laboratory. Biglerville, PA.

		Percent Brown Rot on Fruit Inoculated at harvest Incubation Days				Percent leafspot Incidence			Defol-iation	% P. mildew	
Fungicide and Rate/100 Gal	Non-inoc. @ harv.	4	6	8	11	24 Jun	15 Jul	18 Aug	19 Oct	24 Jul	15 Jul
Nova 40W 2.0 oz................	16.4b*	5.0b	25.8c	41.0c	54.0bc	1.5a	13.0a	28.2ab	43.0ab	15.2a	22.2a
RH-7592 2F 2.5 fl oz + Latron B-1956 2.5 fl oz......	0.5a	0.0a	0.3a	0.3a	0.3a	0.9a	7.1a	21.2a	3.3a	30.7bc	36.5b
Orbit 41.8 Gel 2.0 fl oz.......	0.8a	0.0a	0.0a	0.3a	0.8a	1.0a	8.3a	21.7a	82.5bc	21.2ab	31.1ab
Rovral 4F 8.0 fl oz + CS-7 4.0 fl oz...............	1.5a	0.3ab	2.8ab	4.8ab	5.0a	1.6a	19.0a	49.5b	100.0c	44.1d	51.8c
Bravo 720 16.0 fl oz** Benlate 50W 2.0 oz + Captan 50W 1.5 lb............	1.9a	1.0abc	14.5bc	25.8bc	35.3b	1.0a	11.1a	33.0ab	98.0c	42.6cd	51.3c
Nontreated...................	36.6c	3.3bc	24.0c	55.3c	75.0c	3.8b	99.1b	99.8c	100.0c	50.1d	56.7c

* Means followed by the same letter(s) are not significantly different according to the Tukey-Kramer HSD ($P \leq 0.05$).

** Applied in the bloom and petal-fall sprays only.

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APPLE (Malus domestica 'Jerseymac','Redcort','Smoothee')
Scab; Venturia inaequalis
Powdery mildew; Podosphaera leucotricha
Cedar apple rust; Gymnosporangium juniperi-virginianae
Fly speck; Zygophiala jamaicensis
Fruit finish

EFFECTS OF VARIOUS FUNGICIDES AND FUNGICIDE FORMULATIONS ON APPLE DISEASES AND MITE POPULATIONS, 1993. Treatments were replicated four times in an 8-yr-old orchard on M.9 rootstock. Each plot contained one tree of each cultivar. Plots within rows were separated by cedar trees which provided inoculum for cedar apple rust. A buffer row was maintained between each row of trees receiving treatments. The buffer row was sprayed 12 May with Benlate 50W 3 oz plus Captan 50W 1 lb and again on 3 June with Benlate 50W 4 oz plus Captan 50W 2 lb. Fungicide treatments were sprayed to runoff using a handgun on 24 Apr (tight cluster on Jerseymac), 3 May (king bloom), 12 May (petal fall), 24 May, 8, 25 Jun, 15 Jul, and 6 Aug. Moderate levels of apple scab inoculum were present from the previous year's treatments. Effectiveness of the fungicide treatments was evaluated by determining the incidence of various diseases on leaves on 25 clusters and 25 terminals, and on 100 mature fruit per tree (if available) on the dates indicated in the data tables. Evaluations for powdery mildew were made using only the eight youngest leaves on each terminal whereas all of the terminal leaves on the selected terminals were evaluated to determine the incidence of scab and rust. Primary infection periods for apple scab occurred 16 Apr (moderate), 5 May (heavy), 12 May (moderate), 18 May (heavy), 28 May (light), 31 May (moderate), 5 Jun (heavy), 9 Jun (heavy). The first primary scab lesions were noted 3 May. There were seven secondary scab infection periods in May, six in June, two in July, and three in Aug. The summer was exceptionally dry. Mite populations were assessed 28 Jul by brushing 25 leaves per tree from the Jerseymac trees. Treatments (and rate per 100 gallons) which may have impacted mite populations included 2% oil applied 19 April; Asana XL 5.8 fl oz applied 29 April (early pink) for aphids; 12 oz applied with NAA 18 May for fruit thinning; Carbaryl 50WP 1.5 lb applied 20 June for leafhopper; Vydate L 1.5 pt applied 17 July for leafminer.

The infection period which occurred 16 Apr when trees were at green-tip caused severe cluster leaf and fruit infection on Jerseymac and Redcort. For treatments involving only contact fungicides, most of the fruit scab at harvest is attributable to the 16 Apr infection period. Treatments involving Nova provided acceptable control of scab cluster leaves and fruit. The high rate of Fluazinam provided some eradicant activity against apple scab: it was better than Captan but less effective than Nova for controlling scab on cluster leaves and fruitlets. The low rate of Fluazinam provided scab control on leaves similar to that provided by Captan, but it was less effective than Captan for protecting fruit. Fluazinam failed to control powdery mildew or fruit decays caused by *Botryosphaeria* species. Incidence of fruit decays reported for the fluazinam plots may lower than the actual incidence because some of the decayed fruit dropped from the trees prior to harvest. Trees treated with Fluazinam showed less bronzing from mites in September than did trees receiving other treatments. Activity of TD-2323-2 (which contains Topsin M) was compromised by presence in the test orchard of scab isolates with resistance to benzimidazole fungicides. Incidence of fruit scab on Jerseymac was higher in the plots receiving Nova alone through petal fall than in plots receiving the Nova-Dithane combination. The Nova-Captan combinations provided better control of fruit scab on Jerseymac than did the Nova-Dithane combinations.

Material and rate of formulated product per 100 gal	% cluster lvs. with scab Jersymac 2 Jun	% cluster lvs. with scab Redcort 7 Jun	% terminal leaves with scab Jerseymac 15 Jun	% terminal leaves with scab Redcort 15 Jun	% terminal leaves with scab Jerseymac 3 Aug	% terminal leaves with scab Redcort 3 Aug	% fruitlets with scab Jerseymac 15 Jun	% fruitlets with scab Redcort 16 Jun
Control	50.0 d	44.7 d	86.1 e	70.3 f	89.5 e	99.5 e	100.0 g	83.8 d
Fluazinam 0.4 pt	17.8 c	9.6 b	13.2 d	8.3 de	15.3 d	17.5 d	49.6 f	10.6 c
Fluazinam 0.8 pt	7.1 b	1.7 a	5.3 c	5.2 cd	5.5 c	5.4 c	18.1 d	0.9 ab
TD 2323-2 1 lb	23.2 c	19.0 c	12.1 d	9.0 de	15.7 d	15.7 d	21.7 d	0.9 ab
Ziram 76WG 2 lb	23.6 c	18.9 c	14.5 d	11.9 e	19.1 d	21.5 d	37.4 ef	11.4 c
Captan 50W 2 lb	21.1 c	11.8 bc	3.7 c	2.8 bc	3.8 bc	3.6 c	11.6 cd	2.8 b
Captan 75WG 1.33 lb	21.2 c	11.5 bc	4.6 c	1.8 abc	1.4 ab	3.0 bc	11.8 cd	0.8 ab
Captan 50W 1 lb plus — Nova 40W 1.33 oz [through 8 Jun] Topsin M 85WDG 3 oz [summer]	0.2 a	1.2 a	0.0 a	2.8 bc	0.1 a	<0.1 a	0.5 a	0.0 a
Captan 75WG 0.67 lb plus — Nova 40W 1.33 oz [through 8 Jun] Topsin M 85WDG 3 oz [summer]	0.0 a	0.2 a	<0.1 a	0.1 a	1.0 ab	<0.1 a	1.5 ab	0.1 ab
Nova 40W 1.25 oz & Dith. DF 1 lb to 8 Jun Captan 75WG 0.67 lb & Topsin M 85WDG 3 oz	1.0 a	0.6 a	1.0 b	1.0 ab	1.4 ab	0.1 a	6.8 bc	0.9 ab
Nova-Dith. as above, except Nova 1.5 oz applied alone 24 Apr, 5, 12 May Captan 50W 1 lb & Topsin M 85WDG 3 oz	0.6 a	0.4 a	1.0 b	0.4 ab	0.3 a	0.5 ab	23.0 de	0.0 a

Mean separations were determined using Fisher's Protected LSD (P = 0.05). The arcsin transformation was used for statistical analyses.

Material and rate of formulated product per 100 gal	% Redcort terminal lvs. with powdery mildew 16 Jun	24 Jun	% Smoothee terminal leaves with cedar apple rust 14 Jul	% fruit with scab at harvest: Jerseymac 2 Aug	Redcort	Smoothee	Grand mean for three cultivars*
Control	8.5 f	7.1 c	42.3 d	100.0 g	89.3 f	69.0 c	90.8 e
Fluazinam 0.4 pt	1.5 cd	2.0 b	1.9 a	47.1 f	16.3 e	5.7 ab	20.6 d
Fluazinam 0.8 pt	3.6 de	4.6 b	1.8 a	18.4 cd	6.7 cd	5.7 ab	9.7 c
TD 2323-2 1 lb	1.2 bc	2.8 b	5.6 ab	28.1 de	5.1 bc	3.6 ab	10.3 c
Ziram 76WG 2 lb	3.9 e	1.9 b	2.5 a	39.5 ef	14.3 de	11.7 b	20.7 d
Captan 50W 2 lb	1.5 cd	4.8 b	19.1 c	10.8 bc	4.4 abc	10.4 b	8.2 c
Captan 75WG 1.33 lb	1.5 cd	3.2 b	13.1 bc	12.0 c	6.8 cd	7.0 a	8.5 c
Captan 50W 1 lb plus — Nova 40W 1.33 oz [through 8 Jun] Topsin M 85WDG 3 oz [summer]	0.1 a	0.1 a	3.6 a	4.7 ab	0.9 ab	2.4 ab	2.4 ab
Captan 75WG 0.67 lb plus — Nova 40W 1.33 oz [through 8 Jun] Topsin M 85WDG 3 oz [summer]	0.2 ab	0.0 a	<3.1 a	4.0 a	0.7 a	0.6 a	1.5 a
Nova 40W 1.25 oz & Dith. DF 1 lb to 8 Jun Captan 75WG 0.67 lb & Topsin M 85WDG 3 oz	0.1 a	0.0 a	1.9 a	11.6 bc	3.2 abc	3.6 ab	5.7 bc
Nova-Dith. as above, except Nova 1.5 oz applied alone 24 Apr, 5, 12 May Captan 50W 1 lb & Topsin M 85WDG 3 oz	0.0 a	0.0 a	2.4 a	21.7 d	3.3 abc	3.0 ab	7.7 c

The arcsin transformation was used in statistical analyses. Mean separations were determined using Fisher's Protected LSD (P=0.05). Grand means are for split-plot analyses of data from multiple cultivars.

* The cultivar-treatment interaction was significant (P≤0.05).

Material and rate of formulated product per 100 gal	% Smoothee fruit with: fly-speck	Botryosphaeria rots: large decays	Botryosphaeria rots: lenticel spots	russetting rated ≥ 3*	Mean number of mites per leaf on Jerseymac as determined by brushing leaves on 28 Jul: ERM**	ERME**	ARM**
Control	47.9 b	11.8 d	28.5 c	39.0 c	11.7 c	3.7 a	111.4 c
Fluazinam 0.4 pt	0.3 ab	3.9 bc	5.6 ab	28.2 bc	0.9 a	0.9 a	29.6 a
Fluazinam 0.8 pt	0.0 a	7.4 cd	6.5 ab	21.8 abc	2.2 ab	1.0 a	29.9 ab
TD 2323-2 1 lb	3.9 b	0.9 ab	4.3 ab	24.4 abc	—	—	—
Ziram 76WG 2 lb	1.2 ab	3.9 abc	9.1 b	32.5 bc	8.9 bc	9.0 a	58.4 c
Captan 50W 2 lb	0.1 a	0.7 ab	2.8 a	11.4 a	10.7 bc	5.4 a	60.8 c
Captan 75WG 1.33 lb	0.4 ab	1.3 ab	3.8 ab	12.0 a	10.3 bc	6.6 a	66.6 c
Captan 50W 1 lb plus — Nova 40W 1.33 oz [through 8 Jun] Topsin M 85WDG 3 oz [summer]	1.0 ab	1.2 ab	6.1 ab	27.7 bc	14.7 c	5.7 a	<71.5 c
Captan 75WG 0.67 lb plus — Nova 40W 1.33 oz [through 8 Jun] Topsin M 85WDG 3 oz [summer]	0.6 a	0.6 a	2.4 a	17.2 ab	12.0 c	3.8 a	47.8 abc
Nova 40W 1.25 oz & Dith. DF 1 lb to 8 Jun Captan 75WG 0.67 lb & Topsin M 85WDG 3 oz	1.2 ab	1.2 ab	6.0 ab	24.1 abc	6.7 bc	6.0 a	51.5 bc
Nova-Dith. as above, except Nova 1.5 oz applied alone 24 Apr, 5, 12 May Captan 50W 1 lb & Topsin M 85WDG 3 oz	0.2 a	2.7 ab	4.0 ab	38.3 c	—	—	—

Mean separations were determined using Fisher's Protected LSD ($P = 0.05$). The arcsin transformation was used for statistical analyses. The $\log_{10}$ transformation was used for statistical analyses of mite data.

* Fruit russeting was evaluated at harvest by rating 100 fruit per plot on a scale of 1-5 (1 = no russet, 2 = rough or enlarged lenticels, 3 = slight russetting between lenticels, 4 = moderate russet, 5 = severe russet). Fruit in categories 3, 4, and 5 are out of grade for U.S. Fancy and U.S. Extra Fancy packages.

** ERM - European red mite (*Panonychus ulmi* Koch); ERME - European red mite eggs ; ARM - apple rust mite (*Aculus schlechtendali* Nalepa)

ENTOMOLOGY

Effect of Varying European Red Mite Densities on Severity of Alternaria Blotch, Yield and Quality of Apples

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Introduction

In recent years, Alternaria blotch of apple, caused by Alternaria mali Roberts, has become established as an important disease of 'Delicious' apples in North Carolina (Filajdic & Sutton 1991). The disease is most serious in Henderson County, which is also the primary apple production area in the state. Currently, no fungicides registered for use on apple control this disease. Iprodione (Rovral), which does provide effective control of the disease (Filajdic & Sutton 1992), was available under an emergency exemption (Section 18) in 1991, but it was not available in 1992. Its availability in future years is unknown.

The severity of Alternaria blotch and its effects on yield and quality of apple can be intensified in the presence of indirect arthropod pests. Filajdic et al. (1991) demonstrated that disease severity, defoliation, fruit drop, yield and fruit characteristics (i.e., size, firmness, soluble solids and color) are all negatively affected under high European red mite densities (>6,000 cumulative mite days) even under protective sprays of Rovral. They also demonstrated that in the absence of Rovral, moderate mite densities (ca. 3,000 cumulative mite days) significantly decreased yield and soluble solids.

In these previous studies where significant interactions were detected between ERM and Alternaria blotch (Filajdic et al. 1991), ERM populations occurred at extremely high densities. The moderate mite density treatment accumulated approximately 3,000 mite days, which is a high mite population for most orchards. Hence, the objective of this study was to determine the effects of a range of lower mite densities on the severity of Alternaria blotch, and their interactive effects on the yield and quality of apples.

Materials and Methods

This study was conducted in a commercial orchard in Henderson Co, and utilized an approximately 10-yr-old block of 'Delicious' apple with a history of Alternaria blotch. The experimental design consisted of 4 x 2 factorial design, where mite density (4 levels) and Alternaria disease level (2 levels) were the factors. Varying ERM densities were created by applying dicofol (Kelthane 50WP @ 2 lb/A) at threshold levels of 3 (23 June), 10 (7 July) and 20 (14 July) mites/leaf, and an untreated control. The two different Alternaria disease levels were created by applying Rovral 4F (1/2 pt/100 gal) and no Rovral. The Rovral treatments received 3 applications at two-wk intervals on 23 June, 7 and 21 July. The first Rovral application was timed to coincide with approximately 65% incidence of Alternaria blotch. Plots consisted of single-tree treatments, and each treatment was replicated six times in a randomized complete block design. All treatment applications were made with a handgun sprayer operating at 175 psi and delivering 100 gpa (tree-row-volume). All plots received the same insecticide (Penncap-M) and fungicide (Captan) program throughout the season. In addition, all plots were treated with Sevin 50WP (4 lbs/A) on 2 June.

Mite populations were monitored at approximately weekly intervals from 25 May to 16 August by counting the number of ERM on 10 leaves per treatment (60 leaves total per 6 reps) after placing them through a mite brushing machine. The intensity of mite populations was expressed as cumulative mite days. The severity of Alternaria blotch was assessed at two-wk intervals from 9 June to 8 Sept, by estimating the percentage of leaf area affected with Alternaria lesions on a scale of 0 to 5 (0 = 0% leaf area affected, 1 = 1-3%, 2 = 3-6%, 3 = 6-12%) on each leaf of four terminals per tree. Percentage defoliation was estimated on 8 September by recording the number of leaves that had fallen off each terminal (% defoliation = 100*(missing leaves/total leaves).

Fruit drop was measured by counting the number of apples that dropped from each tree at 7- to 10-day intervals from 23 August to 20 October. Percentage fruit drop was determined by dividing number of fruit drop for each week by total number of fruit. On 13 September, 20 randomly-selected apples per tree were removed for fruit quality analysis. Fruit characteristics measured included diameter, weight per fruit, number fruit per tree, % commercial color, % soluble solids and % firmness. All data were analyzed for main and interactive effects of mite density, Rovral applications, and mites x Rovral applications.

Results and Discussion

European red mite populations were of moderate intensity in this trial, with populations in the untreated control peaking at approximately 27 mites/leaf on 6 July (Julian day 188 in Fig. 1). Populations remained above 20 per leaf until 19 July, after which populations decreased to less than 2 per leaf in all treatments. Shown in Fig. 2 are cumulative mite days occurring in each of the four mite density treatments. A season total of 46, 322, 393 and 630 mite days accumulated in the 3 mite, 10 mite, 20 mite and control, respectively.

The severity of Alternaria blotch was considerably less in 1993 compared with studies in 1991 (Filajdic et al. 1991). In 1991, severity ratings and percentage defoliation on non-Rovral treated apples averaged 4.2 and 57.2%, respectively. In these studies, severity ratings and percentage defoliation in non-Rovral treated plots averaged only 2.8 and 5.7%, respectively. The relatively low mite populations and decreased severity of Alternaria blotch in 1993 are exemplified by the fact that fruit drop was not affected by mites (Fig. 3) and only marginally affected by Alternaria (Fig. 4).

Shown in Table 1 is the analysis of variance for Alternaria severity and fruit yield and quality characteristics. Rovral treatments were the only factor to affect either Alternaria severity or defoliation. The absence of a significant interaction between mite density x Rovral applications indicates that the mite densities occurring in this trial did not affect the severity of Alternaria severity.

In terms of fruit yield characteristics, there was no significant mite x Rovral effect for fruit diameter, weight or number of fruit per tree. However, fruit weight was affected by both mites and Alternaria. A significant decrease in fruit weight was observed in both the 20 mite/leaf threshold (=393 mite days) and control (=630 mite days) (Table 3).

The only fruit quality characteristic affected by mites or Alternaria alone was percent commercial color, where color was slightly reduced in the untreated mite population (Table 4). However, there was a significant mite x Rovral interaction for percent soluble solids, although neither mites nor alternaria alone affected this parameter. These results suggest that a mite population of approximately 630 cumulative mite days in combination with a moderate intensity of Alternaria (severity rating of 2.8) can reduce percent soluble solids.

Summary

The interactive effect of Alternaria blotch and European red mite populations on the yield and quality of apple was greatly minimized under the low to moderate mite density in 1993 compared with high densities observed in 1991. To date, the minimum mite population observed to increased the severity of Alternaria blotch and/or defoliation has been approximately 3,000 cumulative mite days. The only fruit quality parameter affected by the interactive effects of mite injury and Alternaria blotch in 1993 was soluble solids, and only when mite populations exceeded 600

cumulative mite days. The currently recommended mite thresholds 7 to 10 mites/leaf appear to be sufficient for management of mites on Alternaria blotch infested apples.

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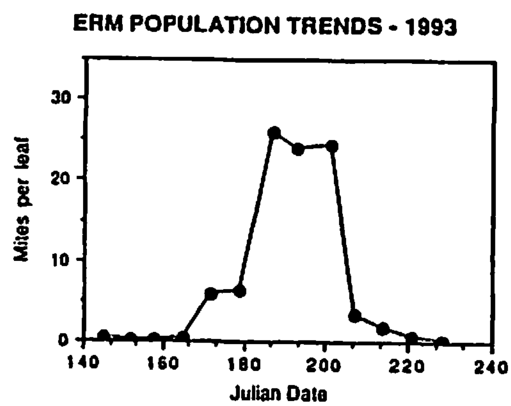

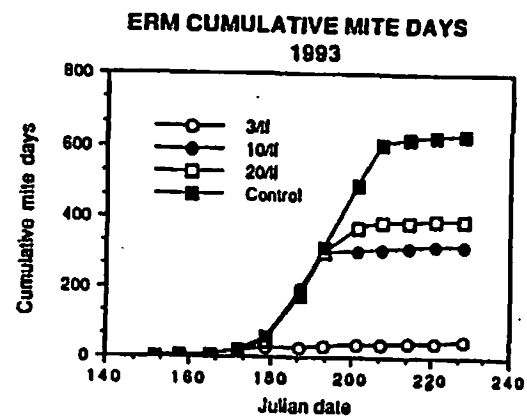

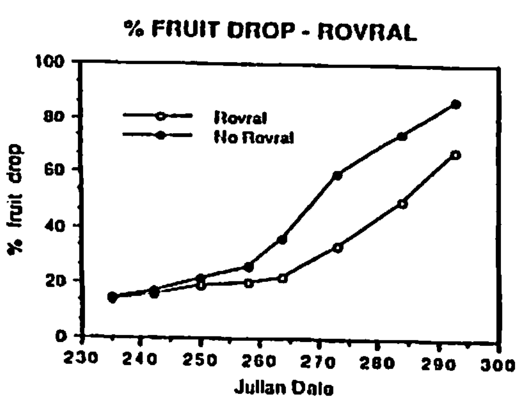

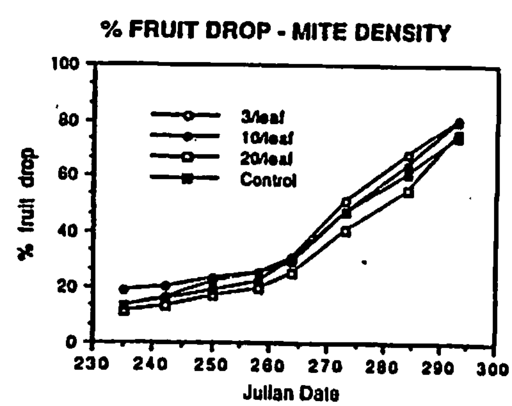

Table 1. Analysis of variance of Alternaria blotch severity, percentage defoliation, and fruit yield and quality characteristics of 'Delicious' apples treated and untreated with iprodione (Rovral) and supporting various European red mite densities. Dana, NC 1993.

Variable	Factor	df	F	P
Alternaria severity	Mite density	3	0.53	0.66
	Rovral applic.	1	169.99	<0.01
	Mite x Rovral	3	0.55	0.65
Percent defoliation	Mite density	3	0.21	0.89
	Rovral applic.	1	4.97	0.03
	Mite x Rovral	3	0.93	0.44
Number fruit	Mite density	3	0.44	0.72
	Rovral applic.	1	26.99	<0.01
	Mite x Rovral	3	0.31	0.82
Fruit diameter	Mite density	3	2.67	0.06
	Rovral applic.	1	3.16	0.08
	Mite x Rovral	3	1.11	0.36
Fruit weight	Mite density	3	8.18	<0.01
	Rovral applic.	1	6.32	0.02
	Mite x Rovral	3	1.94	0.14
Percent commercial color	Mite density	3	3.46	0.03
	Rovral applic.	1	2.28	0.14
	Mite x Rovral	3	0.76	0.52
Percent Soluble solids	Mite density	3	3.93	0.16
	Rovral applic.	1	0.28	0.60
	Mite x Rovral	3	3.34	0.03
Firmness	Mite density	3	1.01	0.40
	Rovral applic.	1	2.72	0.11
	Mite x Rovral	3	2.36	0.09

Table 2. Severity ratings of Alternaria blotch and percentage defoliation of 'Delicious' apples treated and untreated with Rovral, and supporting various European red mite densities. Dana, NC 1993.

Mite Threshold	No rovral	Rovral treated	Mite mean
	Severity Rating[1] (8 Sep)		
3/leaf	2.78	1.22	2.00 a
10/leaf	2.68	1.37	2.03 a
20/leaf	2.92	1.38	2.15 a
Control	2.83	1.07	1.95 a
	----	----	
Rovral mean	2.80 a	1.26 b	
	Percent Defoliation (8 Sep)		
3/leaf	6.2	1.3	3.7 a
10/leaf	5.2	1.7	3.5 a
20/leaf	3.7	4.3	4.0 a
Control	7.7	2.3	5.0 a
	---	---	
Rovral mean	5.7	2.4	

Mite means within the same column and Rovral means within the same row followed by the same letter are not significantly different (P = 0.05).

[1]Severity ratings based on a modified Horsfall-Barratt scale, where 0 = 0% leaf area affected, 1 = 1-3%, 2 = 3-6%, 3 = 6-12%, 4 = 12=25% and 5 = 25-50%.

Table 3. Fruit yield and quality characteristics of 'Delicious' apples treated and untreated with Rovral, and supporting various European red mite densities. Dana, NC 1993.

Mite Threshold	No rovral	Rovral treated	Mite mean
		Number of fruit	
3/leaf	344.5	311.2	327.8 a
10/leaf	418.2	392.3	405.2 a
20/leaf	365.2	301.8	333.5 a
Control	411.7	343.7	377.7 a
	----	----	
Rovral mean	384.9 a	337.3 b	
		Fruit diameter (in.)	
3/leaf	2.67	2.72	2.70 a
10/leaf	2.68	2.67	2.68 a
20/leaf	2.63	2.64	2.64 a
Control	2.48	2.65	2.57 a
	---	---	
Rovral mean	2.62 a	2.67 a	
		Fruit weight (gm)	
3/leaf	140.4	153.0	146.7 a
10/leaf	140.8	139.0	139.9 ab
20/leaf	132.7	135.6	134.2 bc
Control	117.0	133.6	125.3 c
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Rovral mean	132.7 a	140.3 a	

Mite means within the same column and Rovral means within the same row followed by the same letter are not significantly different (P = 0.05).

Table 4. Fruit yield and quality characteristics of 'Delicious' apples treated and untreated with Rovral, and supporting various European red mite densities. Dana, NC 1993.

Mite Threshold	No rovral	Rovral treated	Mite mean
		% Commercial Color	
3/leaf	48.3	49.7	49.0ab
10/leaf	49.7	50.0	49.9b
20/leaf	48.4	49.8	49.1ab
Control	47.6	47.3	47.5b
	----	----	
Rovral mean	48.5	49.2	
		% Soluble Solids	
3/leaf	13.27	12.80	13.04 a
10/leaf	13.10	12.57	12.84 a
20/leaf	12.85	12.77	12.81 a
Control	11.43*	12.60	12.02 a
	---	---	
Rovral mean	12.66 a	12.69 a	
		% Firmness	
3/leaf	15.92	15.72	15.82 a
10/leaf	16.08	15.78	15.93 a
20/leaf	15.57	15.88	15.73 a
Control	16.37	15.70	16.04 a
	---	---	
Rovral mean	15.98 a	15.77 a	

Mite means within the same column and Rovral means within the same row followed by the same letter are not significantly different (P = 0.05).

*For % soluble solids, the mite x Rovral interaction is signficant, and 11.43 is signficantly less than all other values.

Evaluation of Bt Rates and Application Intervals for Tufted Apple Bud Moth Control

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Introduction

Increasing levels of tufted apple bud moth (TABM) resistance to organophosphate insecticides in North Carolina is necessitating that alternative control strategies be used to relax selection pressure for cross resistance to currently effective OP insecticides. The use of Bacillus thuringiensis based products for control of one or both TABM generations is a potentially useful alternative. However, the relatively short persistence of these materials will undoubtedly required that shorter application intervals be made to obtain acceptable levels of control. Penncap-M and Lorsban are currently the most effective OP insecticides against TABM in NC, and it is recommended that 2 to 3 applications be made 10 days apart during periods of oviposition. For the first generation, applications are typically made between cover sprays 2 to 4 (late May through June), while applications against the second generation should begin in mid August and continue until two weeks before harvest.

The purpose of this trial was to compare two different rates of MVP applied at 7- and 10-day intervals against with the industry standard of Penncap-M applied at 10-day intervals. In addition, an experimental Bt (MYX 0837), based on a protein toxin from Bt. subsp. aizawai was evaluated at a 10-day interval.

Materials and Methods

This trial was conducted in a commercial orchard in Henderson County in which TABM populations have been documented to exhibit 40X resistance to azinphosmethyl. The experimental block consisted of 13-year old 'Delicious' trees with an estimated tree-row-volume of 225 gpa. All trees were treated with the same insecticides through the first cover spray, after which the following treatments were established: MVP (2 qts/A) applied at 7- and 10-day intervals, MVP (3 qts/A) at 7- and 10-day intervals, MYX 0837 (1.67 qt/A) applied at 10-day intervals, and Penncap-M 2F (2 qt/A) applied at 10-day intervals. Applications were timed to coincide with TABM oviposition, which was monitored by conducting a 1-hour search of foliage each week.

Plots consisted of three adjacent trees spaced 15 ft apart within rows, and each treatment and an untreated control were replicated three times in a RCBD. All applications were made with a hand gun sprayer operating at 175 psi and delivering 200 gpa. Triton B-1956 at 4 oz/100 gal was added as a spreader sticker to spray solutions. Treatments were evaluated for first generation damage on 3 August, when 300 apples per treatment (100 per tree) were inspected for feeding damage. Harvest data was obtained on 13 September, when again 300 fruit per treatment were inspected for damage. Percentage damage was transformed using $\sqrt{x}$ prior to two-way ANOVA, and means were separated by LSD (P = 0.05).

Results and Discussion

TABM pressure was extremely high in 1993. Pheromone trap catches indicated that first generation males peaked approximately one week later than normal, while the unusually warm summer resulted in a second generation flight that was similar in occurrence to previous years (Fig. 1).

Against the first TABM generation, four and three insecticide applications were made in the 7- and 10-day interval treatments, respectively. Damage caused by first generation larvae was high, with 13.0% damage in the untreated (Table 1). Although all treatments significantly reduced damaged compared with the untreated control, Penncap-M had significantly less damaged fruit than all Bt treatments. When applied at 7-day intervals, there was no difference in the level of damage between the 2 and 3 qt/A rate; however, when applied at 10-day intervals the 2 qt/A rate had significantly more damage than the 3 qt/A rate. There was no difference in damage between the 7- and 10-day interval when used at 3 qt/A.

Against second generation TABM, the 7- and 10-day interval treatments received 5 and 3 applications, respectively. TABM damage recorded at harvest, which represents damage caused by both first and second generation larvae, was again significantly reduced in all treatments compared to the untreated, and all Bt treatments resulted in significantly higher levels of damage compared to Penncap-M. Although there was no significant difference among Bt treatments, the 3 qt/A rate applied at 7 days had less damage than all other Bt treatments. The decreased performance of the 10-day interval applications of MVP at 3 qts and MYX 0837 may have been related to the extended interval between the last application of materials (30 August) and harvest (13 August). This 14 day PHI occurred when oviposition and egg hatching was still occurring. Considering that early instar second generation TABM larvae have a greater tendency to feed on fruit compared to first generation larvae, the 14-day interval between the last application and harvest may have been too long.

None of the Bt treatments provided commercially acceptable levels of control when used against both first and second generation populations. It should be noted, however, that the population intensity occurring in this trial was unusually high. From an insecticide resistance management perspective, use of a Bt against one of two generations per season may, in the long term, be valuable for extending the effectiveness of OP's. Because of the greater difficulty in controlling first compared with second generation larvae, the use of Bt's against first generation populations would appear to be more practical.

Tufted Apple Bud Moth Pheromone Trap Catches
Henderson Co. - 1993

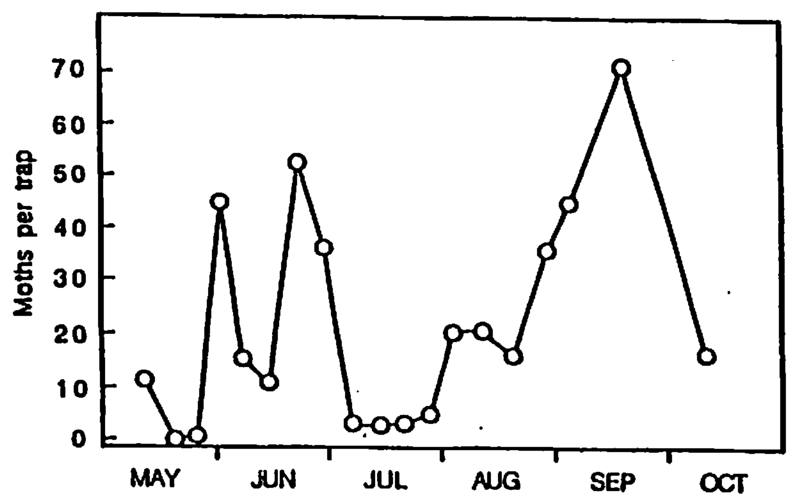

Table 1. Tufted apple bud moth damage on 'Delicious' apples. Henderson Co., NC 1993.

			First generation		Second generation	
Insecticide	rate/A	Applic. interval	Applic. dates	% damage[a]	Applic. dates	% damage at harvest[a]
MVP	2.0 qt	7-day	June 7, 14, 22, 29	5.2b	Aug 9, 16, 23, 30, Sep 7	10.9b
MVP	3.0 qt	7	June 7, 14, 22, 29	5.2b	Aug 9, 16, 23, 30, Sep 7	8.3b
MVP	2.0 qt	10	June 7, 17, 28	8.7c	Aug 9, 19, 30	12.0b
MVP	3.0 qt	10	June 7, 17, 28	4.9b	Aug 9, 19, 30	10.2b
MYX 0837	1.67 qt	10	June 7, 17, 28	3.3b	Aug 9, 19, 30	13.3b
Penncap-M	4.0 pt	10	June 7, 17, 28	1.9a	Aug 9, 19, 30	2.4a
Untreated	-	-	none	13.0d	none	26.1c

[a]Numbers in the same column followed by the same letter are not significantly different by LSD (P = 0.05). First generation damage assesed on 3 August, and second generation damage assessed on 13 August. Percentage data was transformed using √x prior to ANOVA, but back transformations are shown in Table.

A Sampling Method for Detecting Root-feeding Woolly Apple Aphids

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The sampling method that I have used in my research on woolly apple aphids has been to uproot trees. This is an efficient method for research but not for pest management programs, for obvious reasons. To determine if some form of treatment is needed a sampling method must be quick and easy enough for people to use with minimum training. Unfortunately, I have been unable to find any samples of above-ground woolly apple aphids that correlates with abuncance of root-feeding populations. The method described in this paper is based on woolly apple aphid biology. During spring, first instar nymphs migrate up the tree from overwintering populations on roots to recolonize above-ground portions of the tree (Hoyt and Madsen, 1960). Trapping these migrating woolly apple aphid nymphs should give an indication of the presence and intensity of root infestation.

A two inch (5 cm) wide strip of masking tape was placed around the trunk of apple trees, one to two feet (30-60 cm) above the ground but below the lowest scaffold limb. The tape was placed on the smoothest section of trunk available. A continuous barrier, about 1/8 inch (0.3 cm) deep and one inch (2-3 cm) wide, of Tangle-trap™ was applied in the center of the masking tape. A portion of the masking tape band was exposed both above and below the Tangle-trap barrier. The trees that were used in this study were planted in 1985 at 308 trees per acre (760 trees/ha). The block contained 'Frazier Goldspur', 'Smoothee Golden Delicious', both on M.7A, and 'Bisbee Spur Delicious' on EMLA.7. The orchard was located at the Appalachian Fruit Research Station in Kearneysville, West Virginia, and was managed using standard commercial practices.

Trees were banded to coincide with specific tree phenologies from green tip to first cover, as shown in Table 1. Examination of the tape bands was with the unaided eye, using a hand lens only to verify questionable nymph sightings. On May 25 the trees were uprooted, the number of woolly apple aphid colonies on roots was recorded and the amount of root galling was evaluated on a scale of 0 to 1. The root gall rating scale incorporated both the proportion of the root system with root galls and the intensity of galling on those roots infested. It can be thought of as the proportion of the root system affected by woolly apple aphids from none (0) to complete infestation (1).

Few aphid nymphs were trapped between green tip and half inch green; five trees had one nymph each (Table 1). These early nymphs were black and had little wax (the characteristic white woolly covering), whereas the typical form for first instar nymphs is light purple with a waxy covering over the body and obvious tufts of wax. There was no relationship between these early migrants and the degree of root infestation. No nymphs were trapped during the half inch green to pink sample period.

Eleven trees that had the tape traps removed at petal fall were re-banded to further investigate the timing of migration since it seemed that all nymphs that had been trapped were done so recently. In all eleven trees, those that had nymphs trapped on bands prior to petal fall also had nymphs after petal fall and those that did not have nymphs trapped on bands did not have any after petal fall. From these results, I conclude that the majority of root migration takes place within a few days before and after petal fall. All three samples, therefore, that included petal fall were pooled and analyzed as one sample because the presence or absence of migrating nymphs, not the number of nymphs, was used as the predictor variable.

From traps on the 75 trees in the pooled sample (the eleven trees sampled 11 to 21 May are included among earlier samples), fifteen (20%) had first instar woolly apple aphid nymphs. The median number of nymphs per trap was 8 but ranged from 1 to 2883. A median test was used to determine if trapped nymphs were correlated with either the number of root colonies on the tree or the root infestation rating. (The median test is a chi-square contingency table that compares the presence or absence of migrating nymphs with the frequency of trees with either higher than the median versus those with the median or lower number of root colonies or root infestation.) A t-test was also used to test if trees with migrating nymphs had a higher number of root colonies or root infestation than trees that did not have migrating nymphs (one-sided t-test).

The median test was highly significant ($P<0.001$) for both the number of root colonies and root infestation rating (Table 2). Trees that had traps with migrating nymphs clearly had a larger number of root colonies and a more severe root infestation than trees without migrating nymphs. For trees on which nymphs were trapped there was a 4:1 ratio of trees with root colonies versus with no root colonies. The ratio was the same using median root gall infestation rating (0.21) as the dependent variable. Trees that did not have migrating nymphs had a 4:1 ratio in the opposite direction. As further proof of the usefulness of the barrier traps as a sampling method, the mean number of root colonies (4.13 ± 2.19; mean $\pm$ 95% confidence interval) and root infestation (0.33 ± 0.08) were significantly higher on trees with migrating nymphs than trees without nymphs (0.53 ± 0.41 root colonies and 0.16 ± 0.04 root infestation rating).

The presence of nymphs migrating up the tree from roots during petal fall is an indication of the size of the woolly apple aphid population on the roots of that tree. Masking tape with a Tangle-trap™ barrier was successful in trapping these migrating nymphs. By sampling an orchard, one can estimate the number of trees that have serious woolly apple aphid root infestations by comparing the number of trees with migrating nymphs versus those without. One could also identify portions of an orchard that may have a woolly apple aphid problem and take action.

More trials of this sampling method are needed, especially to test regions outside the Shenandoah Valley. This study showed that presence of migrating nymphs indicates trees that are highly likely to have root-feeding aphids. Further trials will enable a more quantitative prediction using the number of nymphs trapped and determination of a treatment threshold number of trees infested per acre. Cooperators are currently being sought in the U. S. and Canada to help refine this sampling method.

Literature Cited

Hoyt, S.C. and H.F. Madsen. 1960. Dispersal behavior of the first instar nymphs of the woolly apple aphid. Hilgardia 30:267-299.

Table 1. Sample periods and data for woolly apple aphid migrating nymphs to predict root infestations.

Sample date	Tree phenology	No. trees with trapped nymphs	No. trees with root colonies	Average root rating[a]
7-19 April	Green tip-1/2 inch green	5	3[b]	0.24[b]
19-27 April	1/2 inch green-Pink	0	--[c]	----[c]
27 April-10 May	Pink-Petal fall	3	3	0.19
7 April-10 May	Green tip-Petal fall	9	12	0.22
10-21 May	Petal fall-First cover	3	8	0.18
11-21 May[d]	Petal fall-First cover	6	7	0.31

[a] Root rating is on a scale of 0 to 1 and reflects the proportion of the root system infested with woolly apple aphids.
[b] Only 16 trees of the 25 sampled were uprooted, 5 with nymphs and 11 without.
[c] Not uprooted because no nymphs were trapped.
[d] Eleven trees that had been sampled in the green tip to petal fall (5) or pink to petal fall (6) sample period.

Table 2. Chi-square analysis of woolly apple aphid nymph trap results with number of root colonies and degree of root infestation.

Variable	No. trees with nymphs	No. trees without nymphs	Chi-square value
Root Colonies			
> 0 root colonies	12	12	
0 root colonies	3	48	
			18.48 ($P<0.001$)
Root Infestation			
> 0.21 rating	11	13	
≤ 0.21 rating	4	47	
			13.57 ($P<0.001$)

Title: Evaluation of Mite Control on Apples with Fluazinam Fungicide

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Introduction: The twospotted spider mite, *Tetranychus urticae* Koch, and the European red mite, *Panonychus ulmi* (Koch), are a constant threat to apple production. The fungicide Dikar provided mite suppression when it was used on a regular basis for disease control. Loss of Dikar has made mite management much more difficult for apple producers. Use of even a single application of pyrethroid insecticides prior to bloom results in higher mite populations during the middle of the season. Only a limited number of miticides are still registered for use on apples. Development of a fungicide with mite suppressant activity, to replace Dikar, will greatly enhance mite management. The new fungicide, fluazinam, was evaluated for mite suppressant activity.

Materials and Methods: The following treatments were applied to Red Delicious and Golden Delicious trees located at the Simpson Agricultural Experiment Station: 1. Fluazinam, 0.4 pt product/100 gallons; 2. Fluazinam, 0.8 pt product/100 gallons; 3. Untreated Check. All treatments were sprayed with a full season insecticide program using Asana XL at 0.025 lb ai/acre. Fluazinam was applied at green tip, 2 April; tight cluster, 8 April; early bloom, 15 April; cover sprays, 27 April, 10 and 24 May, 8 and 28 June, and 12 and 26 July. There was almost no rain after the middle of May. Mite populations were monitored during May and June by visual inspection of the foliage. On 2 July, samples of 10 leaves per tree were collected from the Red Delicious trees, placed in paper bags and returned to the lab in a cooler containing blue ice packs. The leaves were brushed onto a glass plate in a mite brushing machine. The motile mites and mite eggs were counted with the aid of a dissecting microscope. Separate counts of twospotted spider mites and European red mites were made.

Results and Discussion: A definite visual difference between the checks and the two fluazinam treatments was noted when the leaf samples were taken. Red Delicious trees receiving only the insecticide check had very noticeable mite damage to the foliage. The Golden Delicious trees had very low levels of mite activity. The results from the leaf samples are shown in Table 1. Samples from three replicates were taken for the low rate of fluazinam and for the insecticide check. Only two replicates of Red Delicious trees were present in the high rate of fluazinam. Yates' missing plot analysis was used to estimate the missing values. Mite populations were considerably lower in one replicate of the insecticide check. Drought conditions plus full season use of a pyrethroid insecticide provided a favorable environment for mites. Treatment plots were well separated so there should have been no possibility of spray drift from an adjacent plot. There is no explanation for the low population levels in this plot.

Table 1. Average number of eggs and motile mites on trees treated with fluazinam and from untreated checks.

Treatment	Rate pt/100	Mite Eggs	Twospotted Spider Mite	European Red Mite
Fluazinam	0.4	0.33 a	0.10 b	0.03 b
Fluazinam	0.8	0.05 a	0.00 b	0.00 b
Check	--	77.90 a	40.17 a	10.33 a

Means followed by the same letter do not significantly differ (P=.05, LSD)

Conclusion: Full season use of fluazinam provides excellent control of both species of mites on apples. If this product receives full registration for use on apples, mite management will gain a valuable tool.

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THE EFFECTS OF INSECT GROWTH REGULATORS ON STETHORUS PUNCTUM

APPLE: *Malus domestica* Borkh.
Mite predator: *Stethorus punctum* (LeConte)

The following experiment summarized several seasons worth of experiments that investigated the utility of using insect growth regulator insecticides in tree fruit and their effects on beneficial insects such as the coccinellid mite predator *S. punctum*. All insecticides tested were formulated product in aqueous solution.

Ovicide Bioassay. Recommended field rates of various insecticides were applied topically to *S. punctum* eggs which were collected from experimental research plots at the Penn State Fruit Research Laboratory, Biglerville, PA in 1992. Eggs were collected from trees receiving only fungicide applications of Captan 50WP and Benomyl 50DF during the collection period and no azinphosmethyl applications 7 d prior to collection. Eggs were located on the apple leaves using OptiVisor binocular headpiece magnifiers. Leaves with eggs were picked whole and brought into the laboratory for treatment. The eggs were treated by dipping the entire leaf into aqueous solutions of each compound for 5 s. The leaves were then allowed to air dry in the laboratory for 1 h and were placed separately into plastic petri dishes (100 X 15 mm) with a damp paper towel to maintain high humidity. All petri dishes were placed into large plastic bags and stored at $20 \pm 2\,^{\circ}C$ and a photoperiod of 16:8 (L:D). Eggs were evaluated every 2-3 d for hatch. Larval mortality was assessed by determining if the larva that hatched from a particular egg was alive at the next evaluation. A randomized complete block design was used with each of the 5 collection dates (3,5,9,14, and 17 Aug) used as blocks. On each collection date, at least 10 eggs were treated with each compound and each egg served as a replicate. At least 50 eggs were treated per concentration. The concentrations chosen were the proposed field rates for experimental compounds or the maximum label rate in the case of azinphosmethyl.

Larval and adult bioassays. Mid-instar larvae and adults of *S. punctum* were collected from experimental research plots at the Penn State Fruit Research Laboratory, Biglerville, PA in 1991 for dry film contact bioassays in petri dishes. None of the plots used for the collection of these adults and larvae had received any insecticide applications within 10 d prior to collection and only fungicide applications of captan 50WP and benomyl 50DF were made during the collection period. Adults and larvae were collected during 14-30 Jul.

The surfactant Tween-20 was added to all treatments at a rate of 300 ppm to increase adhesion of insecticides to the plastic petri dishes and to uniformly distribute the residues. All compounds were evaluated at 1X, 1/2X, and 1/10X recommended field rates. One ml of solution was dispensed into tightly fitting 50 mm X 9 mm clear plastic petri dishes using a Labsystems Finnpipette repeating dispenser. The halves of the petri dishes were then snapped together and the solutions swirled within for about 10 s. The dishes were then separated and the remaining solution was divided evenly between the top and bottom halves. The dishes were allowed to air dry in the laboratory until completely dry (3-4 h). During the drying period, the remaining solution in each half of the dishes was redistributed every 15 min to ensure uniform deposition of the insecticide residues. Treated petri dishes were either used for evaluations immediately or stored in a freezer for up to 3 d.

Adults for each trial were collected directly from the orchard using aspirators. They were temporarily transferred to large, well-ventilated, clear plastic containers with fresh apple foliage for transport back to the laboratory. Mid-instar larvae were collected and transferred directly into treated petri dishes with camel hair brushes while still in the orchard to reduce handling. Adults were transferred to treated petri dishes only in the laboratory because of their mobility. The collected adults and larvae, as well as the treated petri dishes, were stored in coolers during collection and transport. Five *S. punctum* adults or larvae were placed into each petri dish for evaluation. At least 50 adults or larvae were evaluated for each concentration in 10 replicates of 5 individuals. A minimum of 60 adults or larvae were used as controls in dishes treated with only 300 ppm of Tween-20. All petri dishes were held at $20 \pm 2\,^{o}$ C and a photoperiod of 16:8 (L:D). A second bioassay was conducted with adults from the same orchard in August. Concurrently 3-5 additional concentrations of azinphosmethyl, methomyl, and abamectin and controls were evaluated under the same conditions on collected adults and larvae and pooled with the results form the previous bioassay to develop dose/mortality curves using the probit option of POLO.

After 24 h, larval or adult mortality in the petri dishes was assessed and surviving individuals were transferred by brush to a pair of 9.5 X 9.5 X 7 cm clear plastic Plantcon plant tissue culture container bottoms that had been taped together for form a tightly fitting clear plastic cage. Good airflow was insured by a 2.5 cm square hole covered with a very fine mesh cloth screen in the top. An apple spur with 4-6 leaves heavily infested with European red mites from an unsprayed orchard were added as food for the larvae or adults. A second mortality reading was taken 3 d after initial exposure and the mite infested spur was replaced. A final mortality reading was then taken 7 d after initial exposure.

Field Evaluations. Various insect growth regulators and azinphosmethyl were applied to 2 tree plots each consisting of a 'Golden Delicious' and a 'Rome Beauty' tree and were replicated 4 times. The trees were 30 years old and planted at a spacing of 7.3 m X 10.7 m. Treatments were blocked according to a pre-count of the European red mite populations on the 'Golden Delicious' tree on 10 Jul. Treatments were applied with a truck-mounted John Bean sprayer equipped with a handgun to thoroughly wet the trees. Approximately 23 liters of spray were applied per replicated tree (3.75 kl/ha). Treatments were applied at 14 d intervals on 13 and 28 Jul and 11 and 25 Aug. During the season, regular maintenance fungicides were applied to all plots. European red mite populations were evaluated weekly by counting 25 leaves/tree (100 leaves/treatment from the four replicate 'Golden Delicious' trees only) with a leaf brushing machine. The effect of treatments on *S. punctum* were evaluated only on the 'Golden Delicious' trees by weekly, separate 3 min counts around the periphery of the tree for the adults, larval, and pupal stages. Only pupae that had not yet eclosed were counted. Pupal mortality was evaluated by collected leaves with approximately 200 non-eclosed pupae from the 'Rome Beauty' trees of each treatment on 28 Aug. Pupae were returned to the laboratory and maintained under natural light conditions in large plastic containers during the evaluation period. These pupae were evaluated every 2-3 d over a 14 d period for adult eclosion or mortality. Each pupa from each treatment, regardless of the collection tree, was considered a replicate for analysis.

Mortality and population field counts were analyzed using analysis of variance (ANOVA) and treatment means were separated by Fisher's Protected Least Squared Denominator (LSD) multiple range test. Mean separations were done using log (x + 1) transformed values.

Results.

Ovicide Bioassay. The juvenile hormone analog, fenoxycarb, was the most toxic compound tested on *S. punctum* eggs and also affected the survival of larvae from eggs that did hatch (Table 1). The organophosphate azinphosmethyl was less toxic to eggs than fenoxycarb, but it also reduced survival of hatching larvae. The chitin synthesis inhibitor teflubenzuron and the ecdysone agonist tebufenozide were not toxic to eggs, but larval survivorship was reduced upon hatching for both compounds (Table 1).

Larval Bioassay. Abamectin and azinphosmethyl caused larval mortality in excess of that found in the control at most concentrations and evaluation dates (Table 2). Abamectin was the only material that caused appreciable mortality during the 24 h exposure period. Mortality from abamectin increased after the initial exposure period and, by the 3 d mortality reading it was extremely toxic at all rates tested. Probit analysis indicated that abamectin was 6.3 times more toxic to *S. punctum* larvae 3 d after initial exposure than at the end of the 24 h exposure period (Table 3). Azinphosmethyl did not cause significant mortality during the 24 h exposure period, but larval survivorship was reduced at most concentrations by the 3 and 7 d readings (Table 2). Fenoxycarb reduced larval survivorship only at the highest rate after 7 d (Table 2). All 3 rates of tebufenozide caused larval mortality only on the last evaluation date. Low relative humidity in the growth chambers may have stressed the larvae and contributed to the high mortality in the control and insecticide treatments by the 7 d mortality reading.

Adult Bioassay. Methomyl and abamectin caused adult mortality in excess of that found in the control at most concentrations and evaluation dates (Table 4). All concentrations of both compounds were very toxic by the 3 d mortality reading and the highest two rates of both compounds (1X & 1/2X rates) caused high adult mortality during the initial 24 h exposure period. Probit analysis indicated that methomyl and abamectin continued to cause additional adult mortality after exposure was terminated (Table 3). Methomyl was almost 15 times more toxic at the LC_{50} at 3 d than at 1 d and abamectin was 14 and 37 times more effective at the 3 d and 7 d mortality readings, respectively, than at the 1 d reading. Of the OPs tested, only micro-encapsulated methyl parathion at the 1X and 1/2X rates caused appreciable adult mortality, and only after 24 h (Table 4). Diflubenzuron was slightly toxic at all concentrations after 3 d, but only at the field rate (1X) after 7 d. Fenoxycarb and tebufenozide did not affect adult survivorship during the entire assay period. Again, low relative humidity in the growth chambers may have stressed the adults and contributed to the high mortality in the control and insecticide treatments by the 7 d mortality reading.

Field Evaluations. Fenoxycarb was very toxic to *S. punctum* pupae when mortality was assessed on pupae brought into the laboratory after being treated in the field (Table 5). Teflubenzuron and azinphosmethyl were somewhat less toxic with teflubenzuron being more toxic than azinphosmethyl. Tebufenozide did not cause pupal mortality.

Discussion

Organophosphate and Carbamate Insecticides. All stages of *S. punctum* were found to be tolerant to the widely used orchard organophosphate, azinphosmethyl. The

LC_{50} of the adults was almost twice the maximum field rate (300 ppm) for this compound 3 d after initial exposure (Table 3, Fig. 1). The eggs and neonate larvae of *S. punctum* appear to be the most susceptible stages to azinphosmethyl (Table 1). The mortality to neonate larvae is thought to be due to contact with residues on the leaf surface rather than delayed mortality from exposure during the egg stage. The carbamate methomyl was extremely toxic to adult *S. punctum* even at the 24 h reading (Table 4). Mortality increased with time so that methomyl was almost 15 times more lethal at the LC_{50} level at the 3 d reading than at 1 d (Table 3, Fig. 2). Carbamates are recommended only at low rates for tufted apple bud moth control in Pennsylvania due to this extreme toxicity to *S. punctum*.

Insect growth regulators. The juvenile hormone analog, fenoxycarb, was the most toxic insect growth regulator to the eggs, larvae and pupae of *S. punctum*. this compound was quite ovicidal to field collected eggs and reduced the survivorship of neonate larvae (Table 1). Fenoxycarb was not toxic to mid instar larvae in the laboratory except at the highest rate and only at the last mortality reading on day 7 (Table 2). At the time of this reading, many of the larvae had already developed to the final instar and were beginning to pupate. Most of the mortality in this treatment occurred at this molt. The toxicity of fenoxycarb to *S. punctum* late instar larvae and pupae was also evident in the field. Pupae which had been continually exposed to fenoxycarb in all previous life stages suffered the highest amount of mortality of any of the compounds evaluated (Table 5).

The chitin synthesis inhibitor, teflubenzuron, was not toxic to the eggs of *S. punctum* (Table 1) but it reduced the survivorship of hatching neonate larvae. Pupal mortality in the field was also higher where preceding life stages had been exposed to teflubenzuron (Table 5). Diflubenzuron was only slightly toxic to the adults (Table 4), while neither compound was tested on the larval stages directly.

The ecdysone agonist, tebufenozide, appears to be the least disruptive and toxic compound tested on *S. punctum*. It was non-toxic to both egg (Table 1) and adult stages (Table 3), and only slightly toxic to neonate and mid-instar larvae (Tables 1 & 2). In the field, this compound did not cause additional mortality in the pupal stage (Table 5).

Avermectins. Abamectin is an ecologically selective compound relying on a short residual activity and low contact activity for control. As an agonist of the neurotransmitter GABA, it is physiologically toxic to almost all insect orders, but it is especially effective as a miticide. Dry film bioassays, however, have shown abamectin to be extremely toxic to *S. punctum* adults and mid instar larvae (Tables 3 & 4, Fig. 3). Abamectin was the most toxic compound tested on the adults (Fig. 4) and continued to cause additional mortality to *S. punctum* even after the exposure period as life stages died form starvation due to the onset of paralysis. Mid instar larvae were slightly less susceptible than the adults at the 3 d mortality reading (Table 3). This difference may be due to increased exposure through ingestion in the adults because of a tarsal and antennal grooming behavior that is not found in the larvae. Abamectin is probably less toxic to the life stages of this predator in the field since the half life of residues in sunlight is only about 12 h and unsprayed refugia are available for the adults. It has been difficult to determine e the effect of abamectin on *S. punctum* populations in the field due to its strong miticidal activity. This activity quickly reduces mite populations which, in turn, affects the predator populations.

Table 1. Contact activity of various insect growth regulator insecticides and azinphosmethyl on the eggs and hatching larvae of *S. punctum*.

Treatment	Rate (ppm)	n	% egg mortality	No. larvae that hatched	% larval mortality
Azinphosmethyl 35WP	300	50	32.0b (7.0)	34	44.1b (8.6)
Teflubenzuron 0.15SC	30	50	20.0ab (6.0)	40	37.5b (7.8)
Tebufenozide 2F	92	50	26.0ab (6.0)	37	27.0b (7.4)
Fenoxycarb 25WP	40	52	51.9c (7.0)	25	36.0b (9.8)
Check		55	12.7a (5.0)	48	8.3a (4.0)

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

Table 5. Effect of various insect growth regulators and azinphosmethyl on laboratory reared pupae of *S. punctum* when treated as larvae in the field.

Treatment	Rate (ppm)	# pupae reared	% Mortality
Tebufenozide 2F + Latron B-1956	60 312	229	24.0a
Fenoxycarb 25WP	40	149	85.2d
Teflubenzuron 15SC	30	212	67.9c
Azinphosmethyl 3F	300	158	56.3b
Check		205	28.8a

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

Table 2. Contact activity of abamectin, various insect growth regulator insecticides, and azinphosmethyl on field collected middle instar larvae of *S. punctum*.

Treatment	Rate (ppm)	n	% mortality 24 h	3 d	7 d
Azinphosmethyl 35WP	300	50	2ab	32d	94def
	150	50	0a	20bcd	80cdef
	30	50	14bc	28cd	72bc
Tebufenozide 2F	90	55	9ab	24bcd	69bc
	45	60	0a	12ab	75bcd
	9	55	0 a	15 abc	70bc
Abamectin 0.15EC	7.5	50	46e	94f	98f
	3.75	50	34de	86f	96ef
	0.75	50	22cd	64e	72bc
Fenoxycarb 25WP	40	50	2ab	10ab	76bcde
	20	50	0a	10ab	70abc
	4	50	0a	2a	58ab
Check (Tween 20)	300	220	2ab	11ab	48a

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

Table 3. Response of field collected adults and mid-instar larvae of *S. punctum* to various insecticides after contact exposure to dry film residues for 24 h.

Chemical	Time of mortality reading[a]	n[b]	c[c]	slope (±SE)	LC_{50}, ppm (95% CL)	LC_{90}, ppm (95%CL)
				Adults		
Azinphosmethyl 35WP	1 d	300	1.0	--	--	--
	3 d	300	4.0	6.85 (1.48)	575.8 (493.7-654.9)	886.0 (743.3-1,595.7)
	7 d	300	30.0	8.54 (2.56)	551.7 (426.2-606.6)	779.5 (688.9-1,296.1)
Methomyl 1.8L	1 d	300	15.5	0.63 (0.13)	34.4 (10.9-95.2)	3,712.4 (646.1-8.6X10^5)
	3 d	300	33.7	1.53 (0.25)	2.3 (0.6-4.5)	16.0 (8.7-44.1)
	7 d	300	39.3	--	--	--
Abamectin 0.15EC	1 d	300	14.7	1.52 (0.47)	6.1 (4.0-19.0)	42.4 (15.5-8,784.1)
	3 d	385	30.0	1.83 (0.23)	0.43 (0.24-0.64)	2.2 (1.5-3.7)
	7 d	300	36.8	2.51 (0.64)	0.17 (0.06-0.27)	0.56 (0.39-0.93)
				Larvae		
Abamectin 0.15EC	1 d	200	4.0	3.04 (0.59)	7.5 (5.6-14.5)	19.7 (11.4-114.2)
	3 d	300	16.0	1.80 (0.24)	1.2 (0.8-1.7)	6.2 (4.1-12.0)
	7 d	300	34.0	--	--	--

a Mortality observations made at 1, 3, and 7 d after initial exposure.
b Number of adults tested.
c Control mortality.
d Fiducial limits not reported because g>0.50 (LeOra Software 1987).

Table 4. Contact activity of insecticides on field collected adults of *S. punctum*.

			July trial - % mortality		
Treatment	Rate (ppm)	n	24 h	3 d	7 d
Azinphosmethyl 35WP	300	50	6abc	12abc	32bc
	150	50	10abc	20bc	22abc
	30	50	8abc	14abc	22abc
Malathion 0.57EC	1500	50	6abc	26c	28bc
	750	50	2ab	16abc	18ab
	150	50	4abc	16abc	34c
Tebufenozide 2F	90	50	2ab	8ab	38c
	45	50	10abc	10ab	26bc
	9	50	4abc	10ab	24abc
Abamectin 0.15EC	7.5	50	72e	98e	100d
	3.75	50	36d	98e	100d
	0.75	50	12bc	62d	98d
Fenoxycarb 25WP	40	50	14c	20bc	28bc
	20	50	0a	4a	6a
	4	50	12bc	22bc	22abc
Check (Tween 20)	300	225	6abc	12abc	34c

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

Table 4a. Contact activity of insecticides on field collected adults of *S. punctum*.

Treatment	Rate (ppm)	n	August trial - % mortality 24 h	3 d	7 d
Diflubenzuron 25WP	63	50	22 abc	58 c	90 bc
	32	50	18 ab	50 bc	76 a
	6	50	32 bcd	52 bc	82 ab
Methomyl 1.8L	270	50	98 e	100 d	100 c
	135	50	48 d	98 d	100 c
	27	50	40 cd	98 d	100 c
Micro-encapsulated	300	50	24 abc	46 bc	92 bc
methyl parathion 2FM	150	50	32 bcd	44 bc	82 ab
	30	50	28 abcd	40 ab	90 bc
Check (Tween 20)	300	60	15 a	28 a	76 a

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

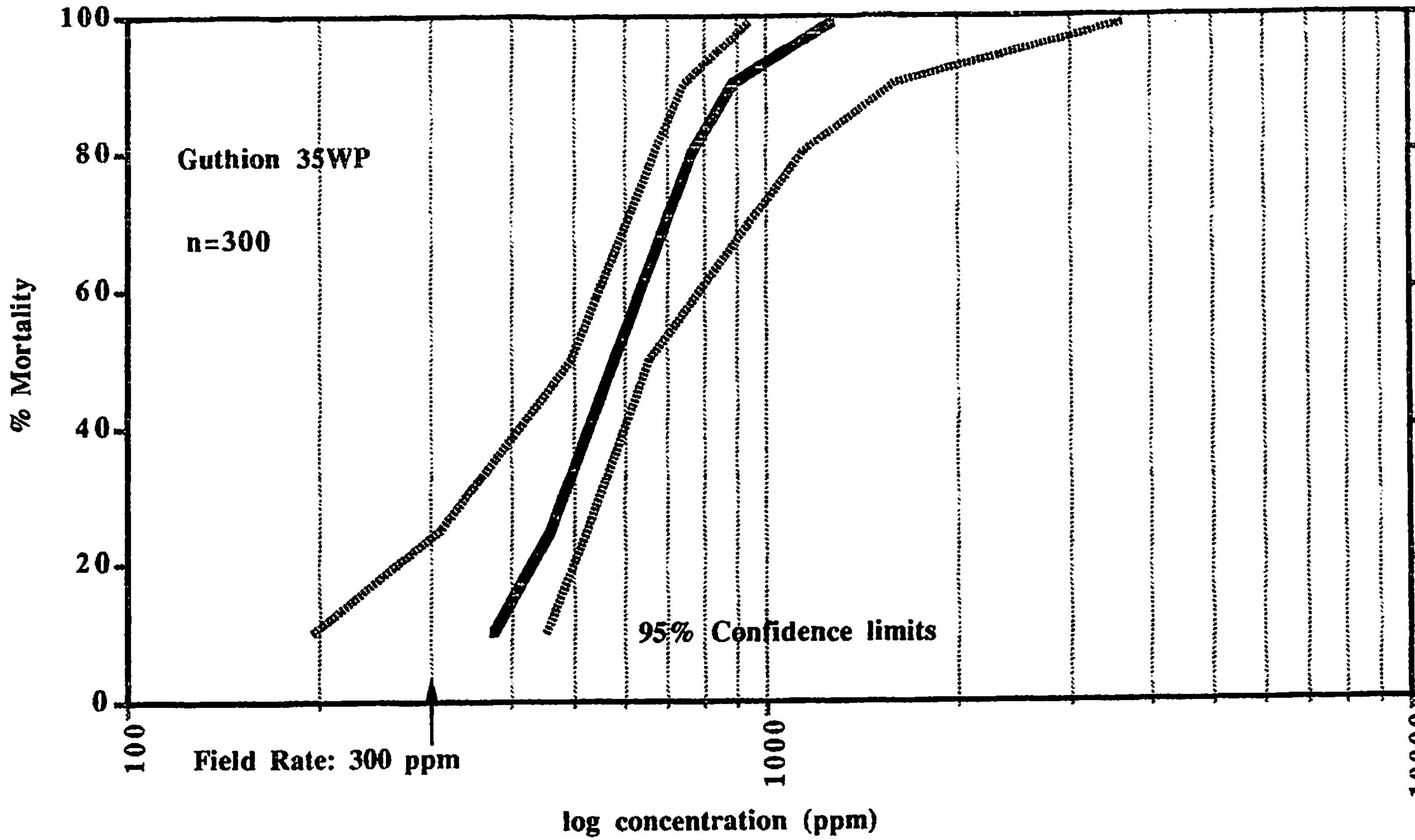

Figure 1. Toxicity of Guthion to *Stethorus punctum* adults exposed to dry film residues for 24 hours and evaluated for mortality 3 days after initial exposure

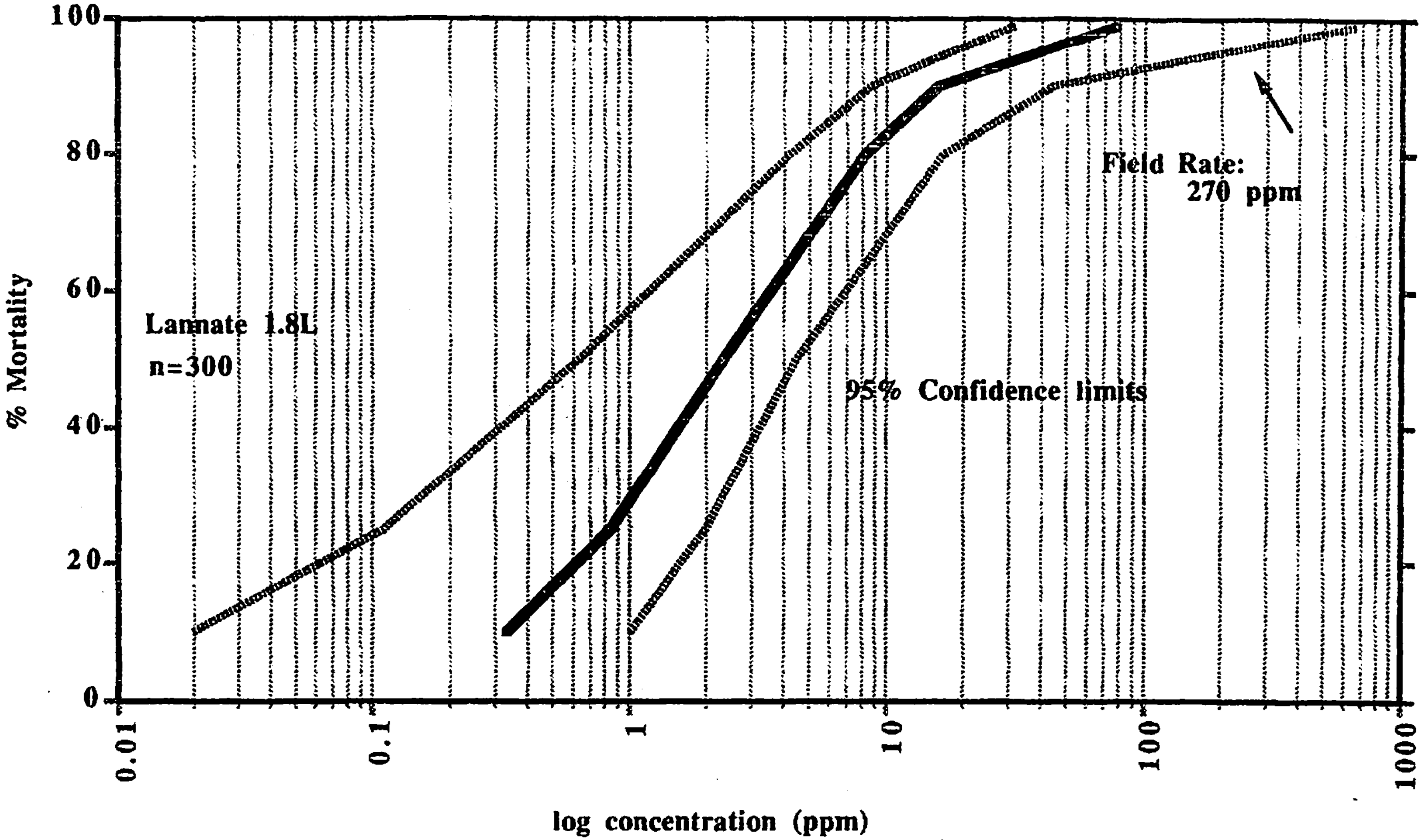

Figure 2. Toxicity of Lannate to *Stethorus punctum* adults exposed to dry film residues for 24 hours and evaluated for mortality 3 days after initial exposure

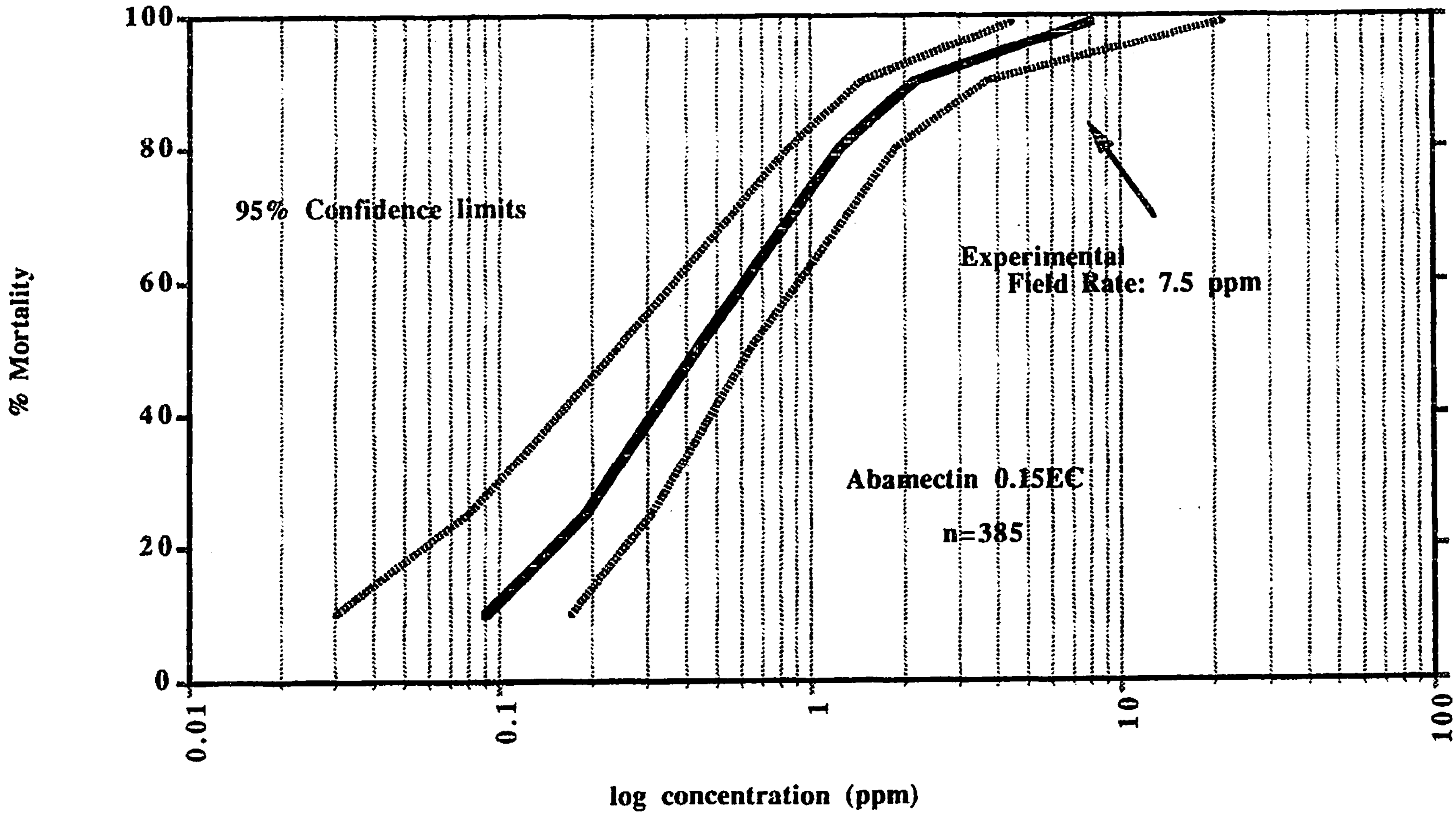

Figure 3. Toxicity of various compounds to *Stethorus punctum* adults exposed to dry film residues for 24 hours and evaluated for mortality 3 days after initial exposure

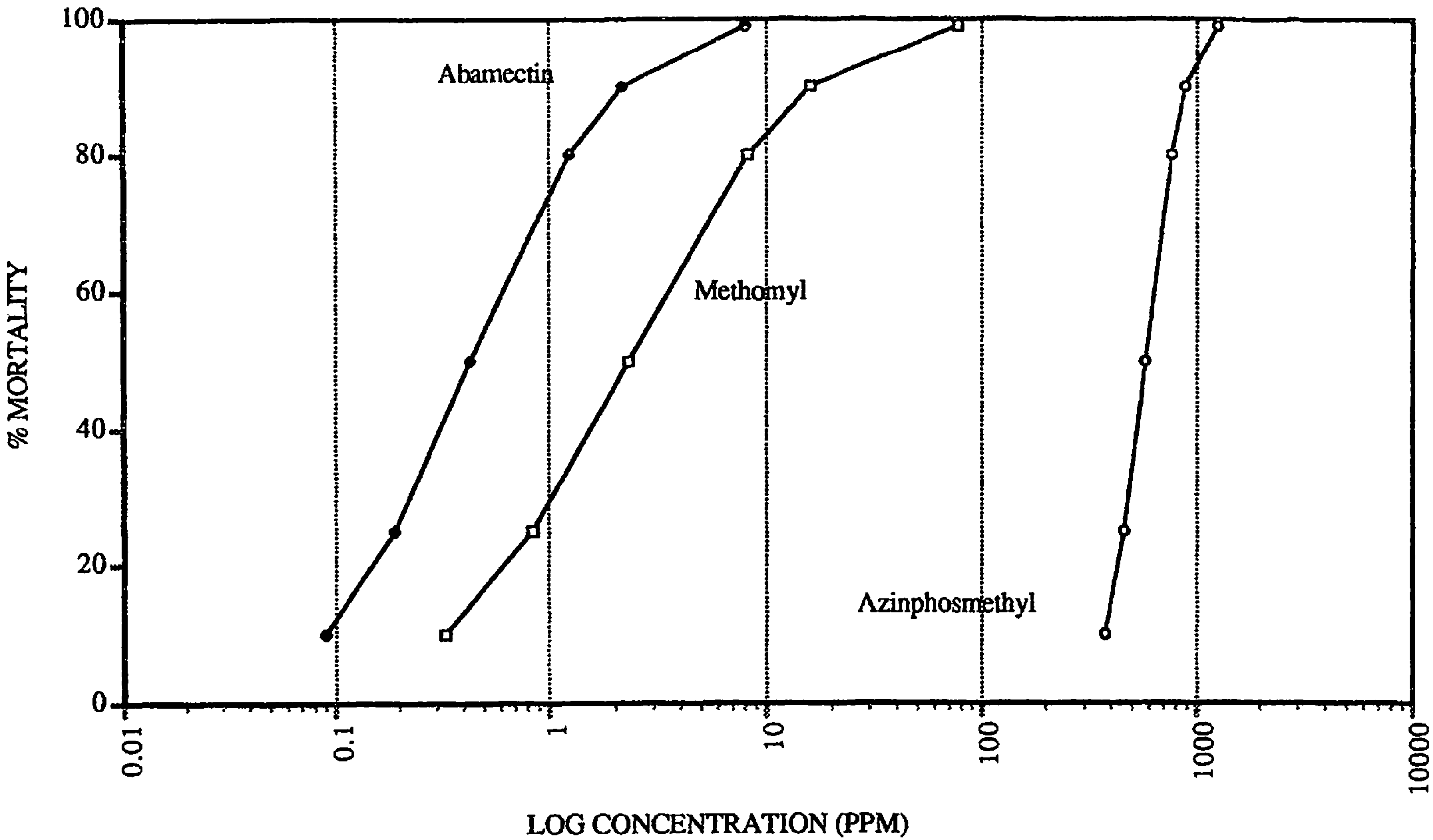

Figure 4. Toxicity of various compounds to *Stethorus punctum* adults exposed to dry film residues for 24 hours and evaluated for mortality 3 days after initial exposure

APPLE: *Malus domestica* Borkhauser 'Ida Red'
European red mite (ERM); *Panonychus ulmi* (Koch)
European red mite egg (ERME); *Panonychus ulmi* (Koch)
Predator (SP); *Stethorus punctum* (LeConte)
Predator (SPA); *Stethorus punctum* (adult)
Predator (SPE); *Stethorus punctum* (egg)
Insidiosus flower bug (OI); *Orius insidiosus* (Say)
Black hunter thrips (LM); *Leptothrips mali* (Fitch)
Predator mite (ZM); *Zetzellia mali* (Ewing)
Predator mite (ZME); *Zetzellia mali* egg (Ewing)
Phytoseiid mite (P); Phytoseiidae
Phytoseiid egg (PE); Phytoseiidae
Apple aphid (AA); *Aphis pomi* DeGeer
Spirea aphid (SA); *Aphis spiraecola* Patch
Green lacewing (CHL); Chrysopidae (larvae)
Green lacewing (CHE); Chrysopidae (egg)
White apple leafhopper (WALH); *Typholcyba pomaria* McAtee
Tufted apple bud moth (TABM); *Platynota idaeusalis* (Walker)
Rosy apple aphid (RAA); *Dysaphis plantaginea* (Passerini)
Rose leafhopper (RLH); *Edwardsiana rosae* (L.)

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APPLE, INSECTICIDE EVALUATIONS, 1993: Insecticides were applied to 10 year old 'Ida Red' apple trees on MM III rootstocks. Five three row plots were randomly selected and one was assigned to each treatment. The two outside rows served as guard rows. Data were collected from four or five replicate trees randomly selected from the middle rows in each plot. Treatments were applied with a power take off driven FMC (model 252S) sprayer calibrated to deliver 50 gal/acre (76.62 liters/ha.). This is a 6X concentration for this orchard. Treatments were applied on 27 Apr., 21 May and 6 Jul. and consisted of a water sprayed control, Guthion 35W (2 lb/A) + NTN33893 (6.4 oz./A), Sevin XLR (1 lb./A), Sevin XLR (.5 lb./A), and a standard Lannate 1.5 L (42 oz./A) + Guthion 35W (2 lb./A). Other insecticide sprays included a delayed dormant spray of superior oil (60 sec.) applied to the control and the Lannate + Guthion plots on 8 Apr. Also note that Guthion 35W (2 lb./A) was added to all sprays (including the 6 Jul. treatment) on the NTN33893 plot on and after 18 Jun. All other materials used for orchard maintenance are given later in a table. Insect predators were counted by visual observation around the tree, from the ground, for a three minute period. RAA & AA (complex of AA & SA) were counted as number of infested terminals in 10/replicate, or number of infested water sprouts in 10/replicate, or number in 10 terminals/replicate on which the terminal leaf was infested. Tentiform leafminer and white apple leafhopper data indicates the number of leaf mines or leafhoppers/leaf present when ten leaves/replicate were examined. Mite data were generated using the Henderson McBurnie method of brushing 20 leaf samples from each replicate tree on each sample date and examination with a binocular microscope. Data were transformed to either log10 +1 or sq. rt. X + .5 for analysis.

Aphid and leafhopper data collected 6 May clearly indicated that all treatments were superior to the control for RAA suppression both inside and on the outside of the tree canopy. Similar suppression of RAA, AA, and WALH was also evident on 24 May. After the 24 May data was taken a shift in the composition of the leafhopper complex occurred so that by the time of the 9 Jul. count it was composed of 82% rose leafhopper and 18% white apple leafhopper. The Guthion + NTN33893 treatment had significantly more leafhoppers present than the other treatments and the control on 9 Jul. Analysis of RAA & AA data taken on 16, 20, and 22 Jun. showed that (a) differences between treatments and the control were not significant when total number of leaves/terminal, number of infested leaves/terminal, or terminals with any of the tip 3 leaves infested were compared 16 Jun. (b) there were significantly fewer AA (AA + SA) on terminals where NTN33893 had been applied than on the other treatments or the control and also that there were no significant differences in the infestations when tender water shoots were examined 20 Jun. (c) when numbers of aphids/terminal were counted (22 Jun.) analysis of data revealed that there were significantly more aphids/terminal on the control plot than the other plots. Also the Sevin XLR (.5 lb.) plot had significantly more aphids than the three remaining plots. The Sevin XLR 1 lb., Lannate + Guthion and NTN33893 treatments had significantly fewer aphids/terminal than either the control or the Sevin XLR .5 lb. treatments. Fruit damage by RAA was evaluated on 9 Jun. and the analysis showed that fruit in the control plot suffered significantly more damage than occurred in any of the other treatments. Tentiform leafminer data was collected on 7 Jun. & 12 Jul. The 7 Jun. data, when analyzed showed significantly more mines were present on foliage of the control than any of the treatments. The fewest mines occurred on the Guthion + NTN33893 and Guthion + Lannate plots. By 12 Jul. differences in second generation mines were also significant with more mines/leaf occurring on the Sevin XLR (1 lb.) plots than on any other treatment or the control. Counts of European red mites and eggs as well as several predators of mites/leaf were made on 23 Jun., 9 Jul., 12 Jul., 16 Jul., 23 Jul., 27 Jul., 30 Jul. and 9 Aug. Analysis of counts of ERM & ERME on 23 Jun. both revealed significant differences with the .5 lb. rate of Sevin XLR being the more severely infested. This trend continued into the 9 Jul. data but further separation of the means was apparent. The high count of Phytoseiid mites in the control undoubtedly aided in ERM & ERME suppression on 9 Jul. The numbers of ERM & ERME remained low on the control and the Guthion + Methomyl treatments through to 23 Jul. Both the early use of oil and number of predatory mites present may have played a role in maintaining the lower numbers. By 9 Aug. mite and mite egg numbers had dropped significantly on all plots however statistically significant differences between means were still apparent. Analysis of data accumulated during three min. observations of each of four replicate trees per treatment showed significant differences between means of treatments on 12 Jul. for SP, CHL, CHE and OI. On 27 Jul. significant differences were found for SPA, SPL, & CHE. Other predators observed occasionally for which no significant differences in mean numbers/treatment were revealed by the data analysis were: CHL, CHE, ZM, ZME, PE, SPA and SPE. All treatments eliminated fruit damage by aphids while 6.5% of the fruit was damaged in the control. No instances of phytotoxicity were observed that were attributable to the pesticide treatments.

1993 SPRAY SCHEDULE (IDA RED ORCHARD)
Virginia Agricultural Experiment Station - Winchester

Date	Comment	Treatment	Rate/A in 50 gal water
April 7	Treatments 1 & 3	Nova	5 oz
April 8	Treatments 2 & 4	Oil + Nova	6 gal + 5 oz
April 20	Entire block	Polyram + Rubigan	3 lb + 9 oz
April 27	All treatments applied		
May 3	Entire block	Streptomycin	24 oz
May 7	Entire block	Streptomycin	24 oz
May 10	Entire block	Thiram + Rubigan	3.25 lb + 9 oz
May 14	Entire block	NAA 800 + Regulaid	1 oz + 1 pt
May 18	Entire block	Bayleton + Solubor	4 oz + 5 lb
May 21	All treatments applied		
June 2	Entire block	Bayleton + Rubigan	2 oz + 9 oz
June 2	Entire block	Etherel	2 pt
June 16	Entire block	Ziram + Solubor	6.5 lb + 5 lb
June 18	All treatments applied		
June 29	Entire block	Captan + Solubor	5 lb + 5 lb
July 6	All treatments applied		
July 13	Entire block	Ziram + Solubor	6.5 lb + 5 lb
July 29	Entire block	Captan + Solubor	5 lb + 5 lb
August 18	Entire block	Captan + Solubor	5 lb + 5 lb

Treatment/form	Rate per 76.62 liter/hectare (50 gal/A)	Aphid[1] and leafhopper[2] data[4,6] 6 May RAA (out)	6 May RAA (in)	24 May RAA	24 May AA	24 May WALH	9 Jul[5] WALH + RLH
NTN 33893 + Guthion 35W	6.4 oz + 2 lb	0.06 b	0.24 b	.00 b	.00 b	.12 b	1.36 a
Control (water)	50 gal.	0.84 a	2.89 a	.88 a	.88 a	1.44 a	0.00 b
Sevin XLR	16 fl oz	0.00 b	0.00 b	.00 b	.00 b	.00 b	0.00 b
Sevin XLR	8 fl oz	0.00 b	0.24 b	.00 b	.00 b	.08 b	0.00 b
Guthion 35W + Lannate 1.8L	2 lb + 48 oz	0.06 b	0.44 b	.00 b	.00 b	.00 b	0.08 b

1 Aphid colonies per minute of observation.
2 WALH per leaf.
3 The control and methomyl + Guthion plots treated with oil (6 gal/A) 8 Apr. All treatments applied 27 Apr, 21 May and 6 Jul.
4 Means in any given column followed by the same letter are not significantly different (p = .05, DMRT).
5 Prior to 18 Jun, NTN 33893 was applied alone. On 6 Jul Guthion was added to the treatment spray. On and after 18 Jun Guthion was applied to the plot in all maintenance sprays.
6 Data transformed to square root of X + 1 for analysis. Back transformed data is tabulated.

Treatment	Rate /acre	Rate /hectare	Aphid infestation of terminals and shoots[8,9] 16 Jun NLVS[1,2]	16 Jun LI[3,7]	16 Jun Tip[3,7]	20 Jun AAT[4]	20 Jun AASP[5]	22 Jun AAT[6]
Guthion 35W [1,10] + NTN 33893	32 oz + 6.4 oz	367.28 g + 73.46 g	1.05 ab	.34 b	.08 a	7.78 b	9.80 a	1.49 c
Sevin XLR	16 oz	191.55 ml	1.18 ab	.31 b	.09 a	9.38 a	10.00 a	3.11 c
Sevin XLR	8 oz	95.78 ml	1.04 ab	.23 b	.09 a	9.38 a	10.00 a	24.10 b
Lannate 1.8L + Guthion 35W	48 oz + 32 oz	574.65 ml + 367.28 g	1.22 a	.22 b	.10 a	9.39 a	9.80 a	7.73 c
Water	50 gal	71.30 liters	1.15 ab	.73 b	.07 a	10.03 a	10.00 a	44.21 a
P			.1093	.0184	.2461	.0015	.5696	.0001

1 Number of leaves on current years terminal shoot growth.
2 Number of leaves infested on current years terminal shoot growth.
3 Number of terminals with the terminal leaf infested.
4 AAT = infested terminals (10 terminals examined/replicate, 5 replicates/treatment).
5 AASP = infested water sprouts (10 sprouts examined/replicate, 5 replicates/treatment).
6 AAT = infested terminals (10 terminals examined/replicate, 4 replicates/treatment).
7 Includes RAA and AA.
8 Means in any given column followed by the same letter are not significantly different (p = .05, DMRT).
9 Data transformed to square root of X + .5 for analysis. Back transformed data tabulated.
10 Prior to 18 Jun, NTN 33893 was applied alone. On 6 Jul Guthion was added to the treatment spray. On and after 18 Jun, Guthion was used in all maintenance sprays in this plot.

Treatment[1]	Rate /acre	Rate /hectare	9 Jun[2,3] Aphid apples/100 fruit
Guthion 35W [1] + NTN 33893	32 oz + 6.4 oz	367.28 g + 73.46 g	0.00 b
Sevin XLR	16 oz	191.55 g	0.00 b
Sevin XLR	8 oz	95.78 g	0.00 b
Lannate 1.8L + Guthion 35W[2]	48 oz + 32 oz	574.65 ml + 367.28 g	0.00 b
Water[2]	50 gal	71.30 liters	6.51 a
P			.0001

[1] The control and Guthion + Lannate plots were treated with oil (6 gal/A) on 8 Apr. All other treatments were applied 27 Apr, 21 May and 6 Jul.
[2] Means in any given column followed by the same letter are not significantly different (p = .05, DMRT).
[3] Data transformed to square root of X + .5 for analysis. Back transformed data is tabulated.

Treatment	Rate /acre	Rate /hectare	Tentiform leafminer/leaf[4,5] 7 Jun TLM[1]	12 Jul TLM 1[2]	12 Jul TLM 2[3]
Guthion 35W [1,6]+ NTN 33893	32 oz + 6.4 oz	367.28 g + 73.46 g	.39 c	.00 b	.00 b
Sevin XLR	16 oz	191.55 ml	.16 b	.08 a	.75 a
Sevin XLR	8 oz	95.78 ml	.06 bc	.04 ab	.09 b
Lannate 1.8L + Guthion 35W	48 oz + 32 oz	574.65 ml + 367.28 g	.39 c	.00 b	.08 b
Water	50 gal	71.30 liters	.43 a	.02 ab	.08 b
P			.0001	.0982	.0001

[1] 10 leaves per replicate examined (5 replicates/treatment).
[2] First generation leafminer mines/leaf.
[3] Second generation leafminer mines/leaf.
[4] Data transformed to square root of X + .5 for analysis. Back transformed data tabulated.
[5] Means in any given column followed by the same letter are not significantly different (p = .05, DMRT).
[6] Prior to 18 Jun NTN 33893 was applied alone. Guthion was added to all maintenance sprays after 18 Jun including the 6 Jul treatment application.

	Rate[1]		Mite eggs and predators/leaf[4,5]							
			23 Jun		9 Jul			16 Jul		
Treatment[3]	/acre	/hectare	ERM	ERME	ERM	ERME	P	ERM	ERME	P
Guthion 35W[1] + NTN 33893	32 oz + 6.4 oz	367.28 g + 73.46 g	.60 b	1.60 b	10.12 b	16.50 b	0.00 a	14.3 a	68.5 a	.00 b
Sevin XLR	16 oz	191.55 g	.24 b	1.08 b	3.17 c	5.65 c	2.16 a	5.64 b	29.7 b	.18 ab
Sevin XLR	8 oz	95.78 g	4.17 a	5.35 a	21.46 a	37.78 a	9.00 a	14.1 a	66.8 a	.39 a
Lannate 1.8L + Guthion 35W[2]	48 oz + 32 oz	574.65 ml + 367.28 g	.48 b	.48 b	2.64 c	6.87 c	.78 a	3.32 b	24.3 bc	.12 a
Water[2]	50 gal	71.30 liters	.94 b	1.92 b	4.07 c	8.57 c	16.78 a	5.64 b	18.3 c	.37 a
P			.0004	.0011	.0001	.0001	.5935	.0001	.0001	.03

[1] On 27 Apr and 21 May, NTN 33893 was applied alone. On 18 Jun and all maintenance sprays thereafter Guthion was applied to this plot. Guthion was combined with NTN 33893 on 6 Jul.
[2] Sprayed with delayed dormant application of 6 sec oil (6 gal/A) on 8 Apr.
[3] Treatments applied 27 Apr, 21 May and 6 Jul.
[4] Data transformed to square root of X + .5 for analysis. Back transformed means are tabulated.
[5] Means in any given column followed by the same letter are not significantly different (p = .05, DMRT).

Treatment	Rate /acre	Rate /hectare	Predators of European red mite/3 minute observation/replicate[1,2,3] 12 Jul SP	12 Jul CHL	12 Jul CHE	12 Jul OI	27 Jul SPA	27 Jul SPL	27 Jul CHL	27 Jul CHE	27 Jul OI
Guthion 35W + NTN 33893	32 oz + 6.4 oz	367.28 g + 73.46 g	.00 b	1.05 b	.00 b	.25 c	20.28 a	10.22 a	.42 a	1.88 a	1.63 ab
Sevin XLR	16 oz	191.55 ml	.00 b	1.05 b	.00 b	1.68 abc	11.63 b	2.47 bc	.57 a	5.08 a	4.42 a
Sevin XLR	8 oz	95.78 ml	10.93 a	.15 b	.15 ab	2.24 ab	17.25 ab	6.20 ab	.86 a	4.98 a	4.54 a
Lannate 1.8L + Guthion 35W	48 oz + 32 oz	574.65 ml + 367.28 g	.32 b	.32 b	.78 a	.78 bc	7.77 c	1.91 ab	.19 a	5.32 a	2.81 ab
Water	50 gal	71.30 liters	.00 b	5.32 a	.64 ab	3.68 a	9.40 c	1.28 c	.57 a	3.60 a	1.11 b
P			.0001	.0001	.0428	.0119	.0036	.0288	(NS)	.7372	.0818

[1]Data transformed to log X + 1 for analysis. Back transformed data is tabulated.

[2]Means in any given column followed by the same letter are not sigificantly different (p = .05, DMRT).

[3]Prior to 18 Jun, NTN 33893 was applied alone. On 6 Jul Guthion was added to the treatment spray. On and after 18 Jun, Guthion was used in all maintenance sprays in this plot.

Treatment[3]	Rate[1]		Mite eggs and predators/leaf[4,5]										
			23 Jul					30 Jul			9 Aug		
	/acre	/hectare	ERM	ERME	P	PE	SPE	ERM	ERME	P	ERM	ERME	PE
Guthion 35W[1] + NTN 33893	32 oz + 6.4 oz	367.28 g + 73.46 g	7.24 ab	24.12 ab	.06 a	.00 a	.11 a	3.47 a	17.37 a	.00 a	.49 a	1.47 ab	.00 b
Sevin XLR	16 oz	191.55 g	8.82 a	34.56 a	.22 a	.06 a	.23 a	6.11 a	22.44 a	.29 a	.11 b	0.61 b	.17 b
Sevin XLR	8 oz	95.78 g	4.92 ab	23.10 ab	.11 a	.11 a	.17 a	.45 b	3.73 b	.68 a	.06 b	0.63 b	.11 b
Lannate 1.8L + Guthion 35W[2]	48 oz + 32 oz	574.65 ml + 367.28 g	3.70 bc	13.45 bc	.37 a	.18 a	.12 a	.96 b	4.37 b	.81 a	.63 a	2.00 a	.60 a
Water[2]	50 gal	71.30 liters	1.72 c	7.22 c	.18 a	.00 a	.00 a	.31 b	2.28 b	.00 a	.00 b	1.19 ab	.00 b
P			.007	.007				.0001	.0001		.0074	.0294	.0037

[1] On 27 Apr and 21 May, NTN 33893 was applied alone. On 18 Jun and all maintenance sprays thereafter Guthion was applied to this plot. Guthion was combined with NTN 33893 on 6 Jul.
[2] Sprayed with delayed dormant application of 6 sec oil (6 gal/A) on 8 Apr.
[3] Treatments applied 27 Apr, 21 May and 6 Jul.
[4] Data transformed to square root of X + .5 for analysis. Back transformed means are tabulated.
[5] Means in any given column followed by the same letter are not significantly different (p = .05, DMRT).

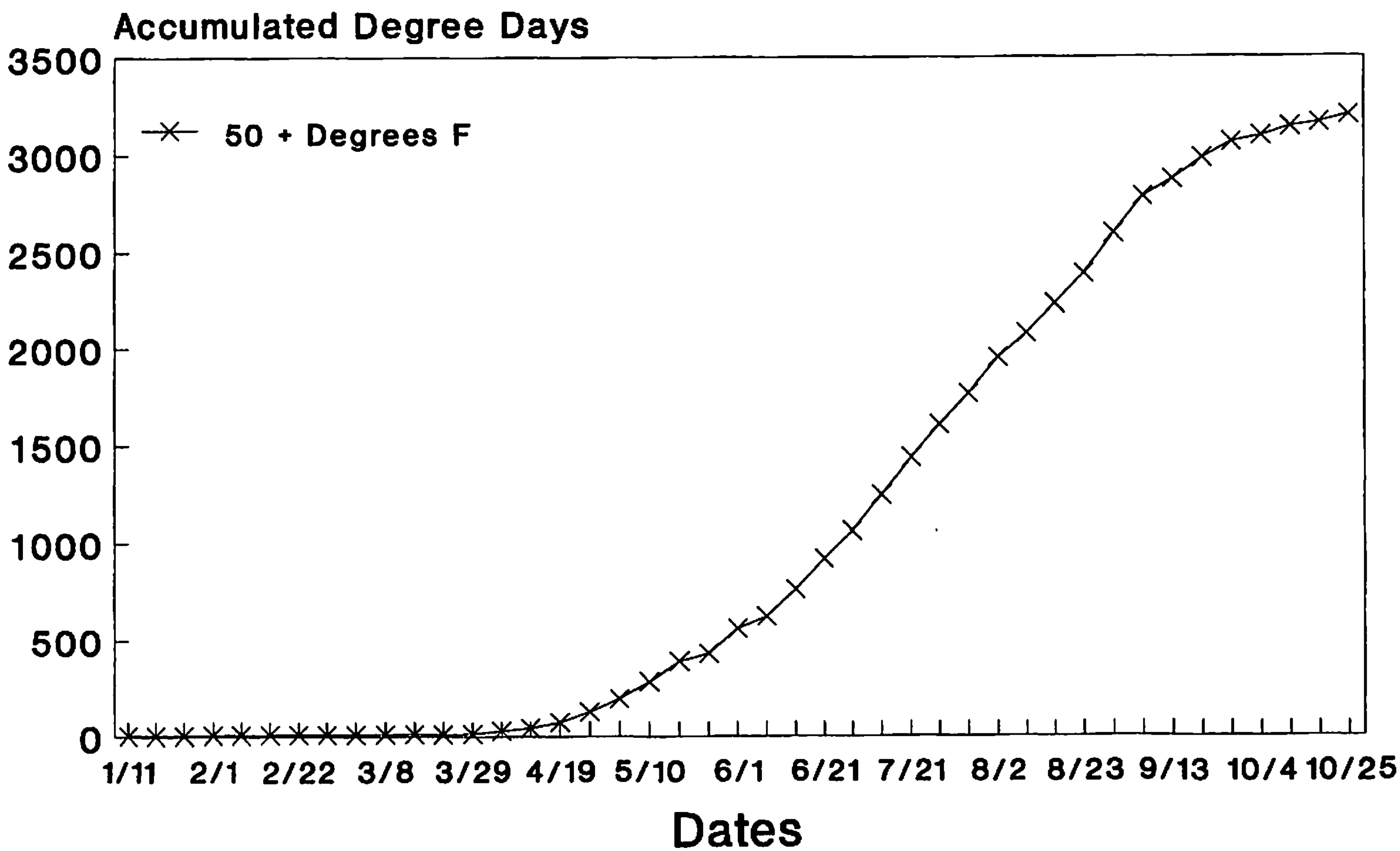
Treatment/form	Rate per 76.62 liter/hectare (50 gal/A)	Predators/3 minute count 7/12/93[1,2]			
		SP	CH	CHE	0I
NTN 33893 + Guthion 35W[3]	6.4 oz + 2 lb	0.0 b	1.05 b	0.0 b	0.25 c
Control	---	0.0 b	5.32 a	0.64 ab	3.68 a
Sevin XLR	32 oz	0.0 b	1.05 b	0.00 b	1.68 abc
Sevin XLR	16 oz	10.93 a	0.15 b	0.15 ab	2.24 ab
Guthion 35W + Lannate 1.8L	2 lb + 48 oz	0.32 b	0.32 b	0.78 a	0.8 bc
P		.0001	.0001	.0428	.0119

[1]Data transformed to log X + 1 for analysis. Back transformed data is tabulated.
[2]Means in any given column followed by the same letter are not sigificantly different (p = .05, DMRT).
[3]Prior to 18 Jun, NTN 33893 was applied alone. On 6 Jul Guthion was added to the treatment spray. On and after 18 Jun, Guthion was used in all maintenance sprays in this plot.

Treatment/form	Rate per 76.62 liter/hectare (50 gal/A)	Predators/3 minute count 7/27/93[1,2]						
		TSPA (S)	TSPL (S)	TCHL (NS)	TCHE (NS)	OI (NS)	LT (NS)	CECC (NS)
NTN 33893 + Guthion 35W[3]	6.4 oz + 2 lb	20.28 a	10.22 a	.42 a	1.88 a	1.63 ab	.19 a	.00 a
Control	---	9.40 c	1.28 c	.57 a	3.60 a	1.11 b	.57 a	.19 a
Sevin XLR	32 oz	11.63 b	2.47 bc	.57 a	5.08 a	4.42 a	.00 a	.00 a
Sevin XLR	16 oz	17.25 ab	6.20 ab	.86 a	4.98 a	4.54 a	.00 a	.00 a
Guthion 35W + Lannate 1.8L	2 lb + 48 oz	7.77 c	1.94 bc	.19 a	5.32 a	2.81 ab	.00 a	.00 a
P		.0036	.0288	.7372	.2923	.0818	.1720	.4388

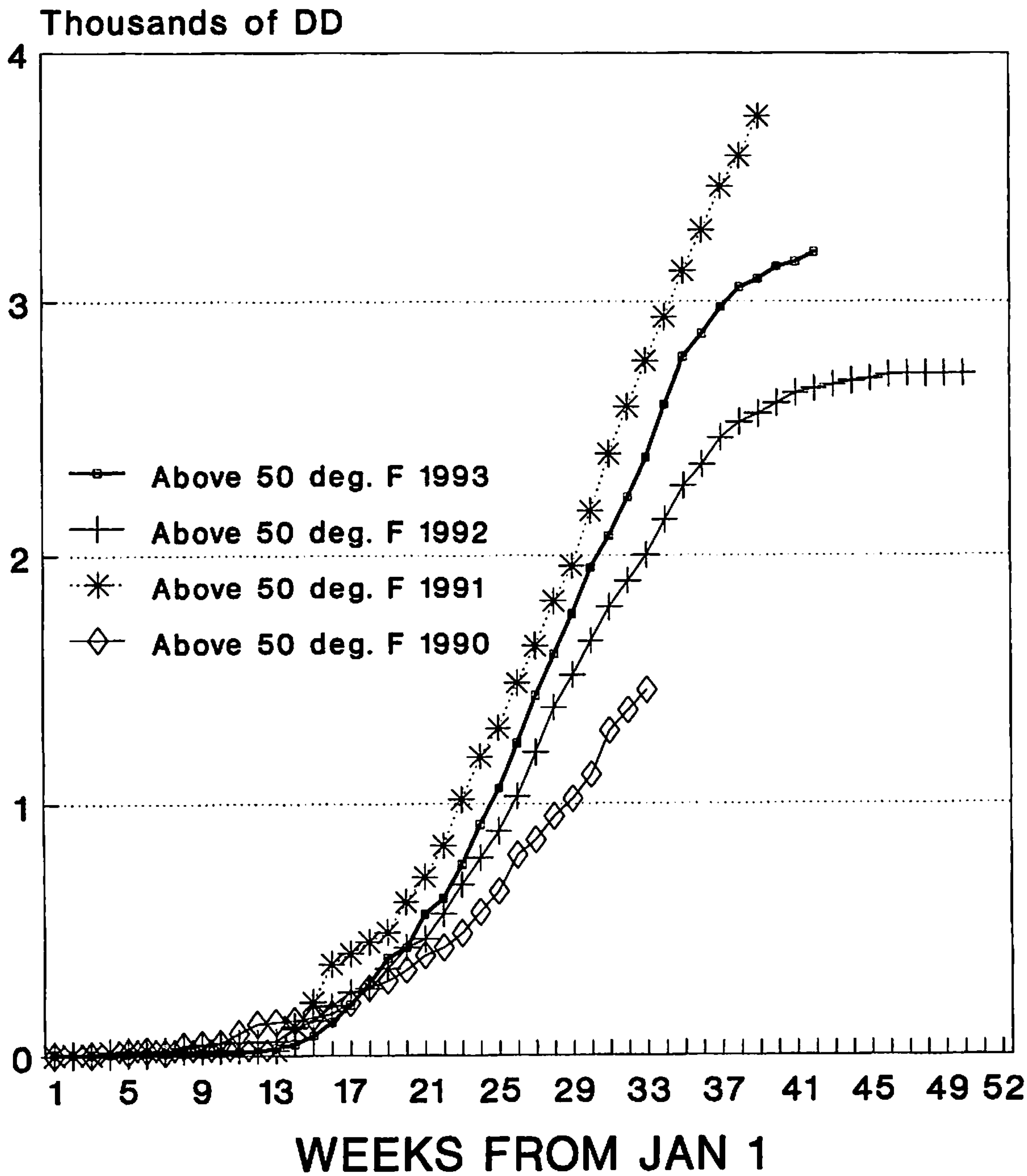
[1]Data transformed to log X + 1 for analysis. Back transformed data is tabulated.
[2]Means in any given column followed by the same letter are not sigificantly different (p = .05, DMRT).
[3]Prior to 18 Jun, NTN 33893 was applied alone. On 6 Jul Guthion was added to the treatment spray. On and after 18 Jun, Guthion was used in all maintenance sprays in this plot.

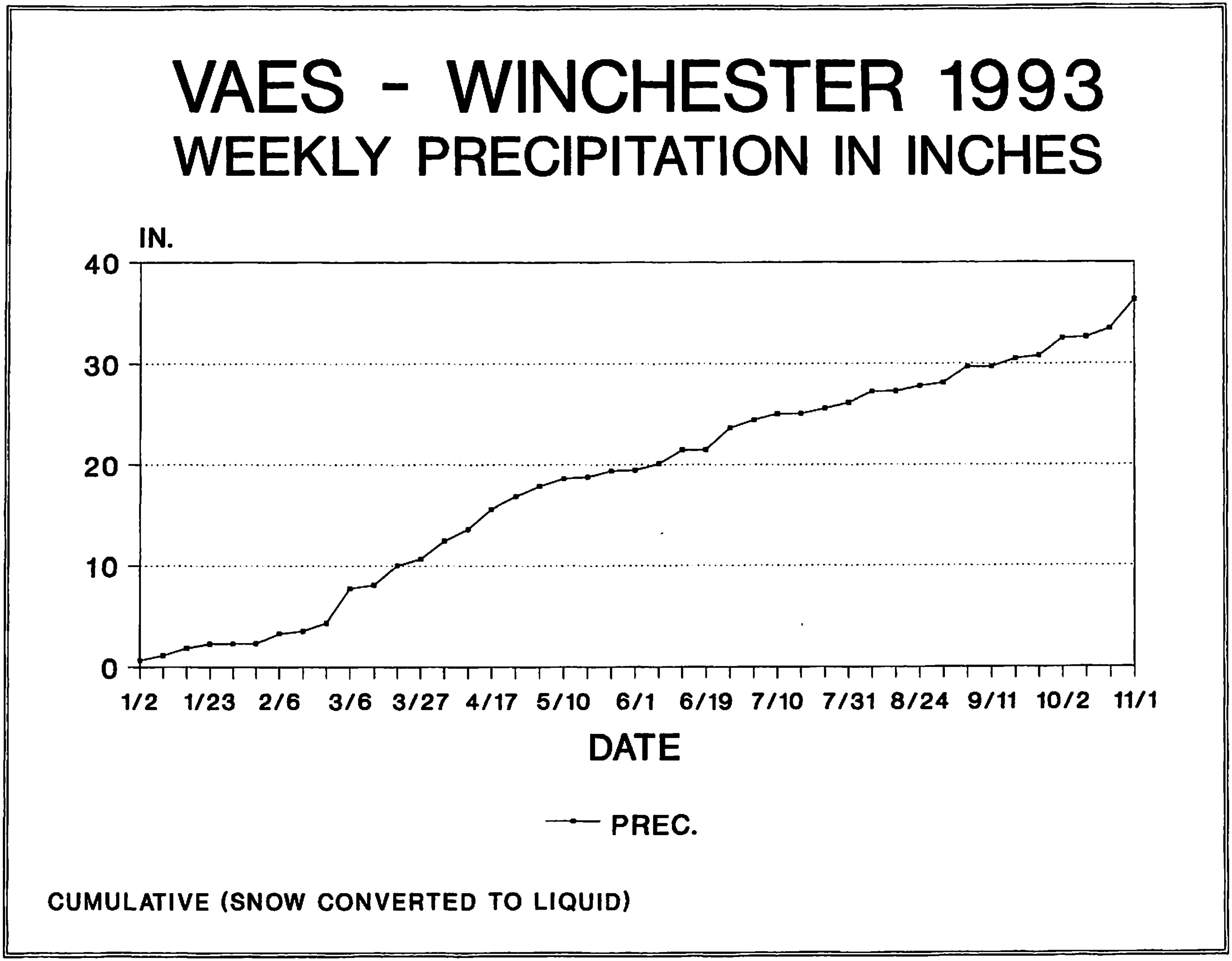
ACCUMULATED DEGREE DAYS
VAES - Winchester - 1993

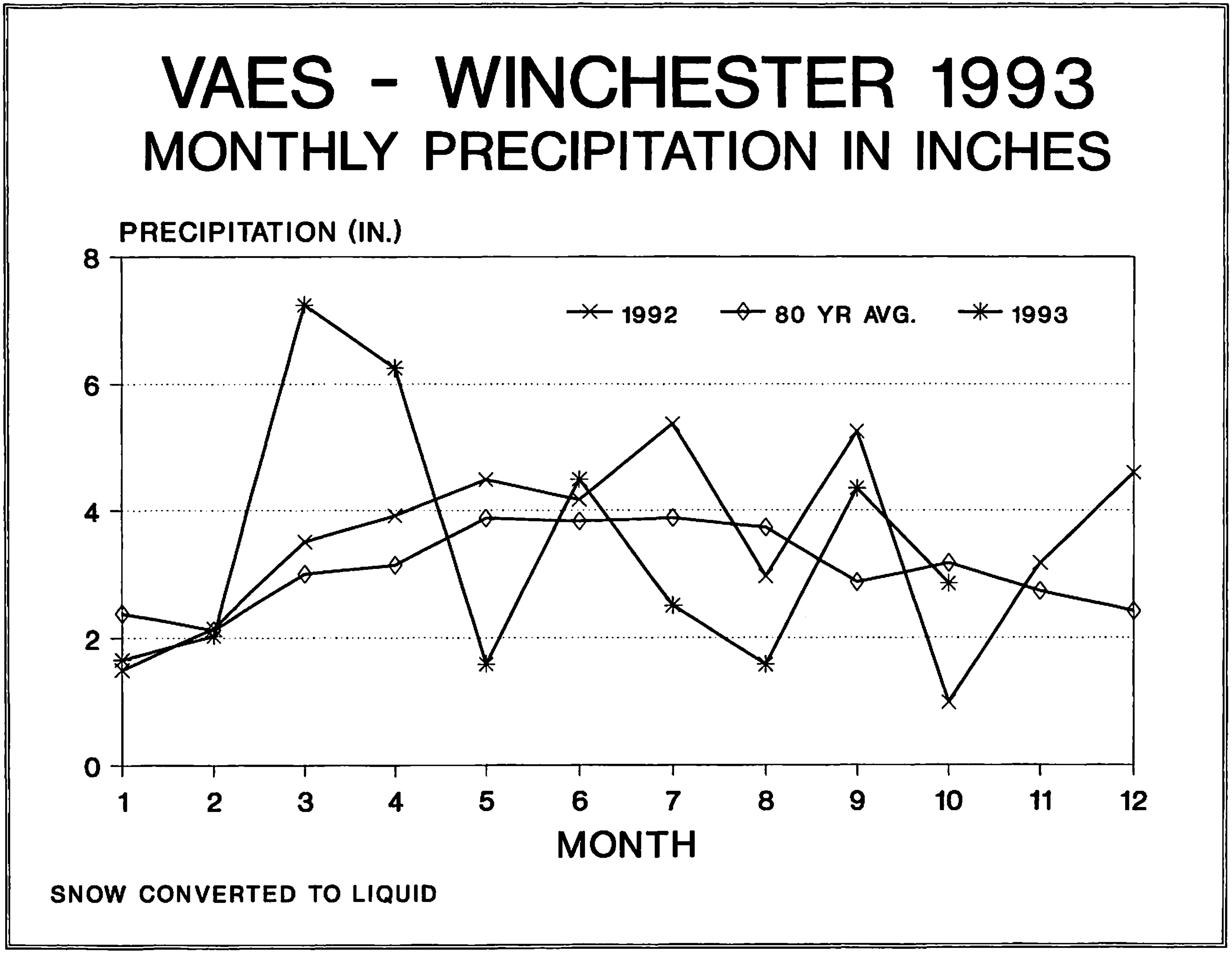


Base = 50 F

ACCUMULATED DEGREE DAYS
VAES - Winchester - (1990-91-92-93)




VAES - WINCHESTER 1993
WEEKLY PRECIPITATION IN INCHES
IN.
40
30
20
10
0
1/2
1/23
2/6
3/6
3/27
4/17
5/10
6/1
6/19
7/10
7/31
8/24
9/11
10/2
11/1
DATE
PREC.
CUMULATIVE (SNOW CONVERTED TO LIQUID)


VAES - WINCHESTER 1993
MONTHLY PRECIPITATION IN INCHES
PRECIPITATION (IN.)
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6
4
2
0
1992
80 YR AVG.
1993
1
2
3
4
5
6
7
8
9
10
11
12
MONTH
SNOW CONVERTED TO LIQUID

APPLE: Malus domestica Borkhauser
Tufted apple budmoth (TABM);
Platynota idaeusalis (Walker)
Bacillus thuriengensis (I) (Bt)

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APPLE, INSECTICIDE DIP TEST (TABM vs. INSECTICIDES), 1993: A large commercial apple grower reported failure in attempts to control TABM with airblast applications of Penncap M (2 pt/acre) combined with methomyl (3 pt/acre). At the time of the grower applications larval hatch had begun and most larvae were in the first or second instar. By the time larvae were entering the third instar (10 days after spray application) it was apparent that commercially acceptable control had not been achieved. In 1992 this grower also had poor control when Penncap M was applied to suppress redbanded leafroller and experiments showed that tolerance of Penncap M was present in the resident RBLR population (Horsburgh et. al. 1992). This laboratory test was begun on 3 Sept. to determine if 1) tolerance to Penncap M was also present in the TABM population and 2) if any of several other insecticides tested held promise for control of the pest. Seven treatments (including a water control) were selected and rates calculated on the basis of 300 gal of spray being applied per acre. The appropriate dosage of pesticide for each treatment was mixed with 1 gallon of 77 degree F water in clean 1 gallon battery jars. Twenty plastic petri dishes containing moistened filter paper were prepared and served as individual cages for twenty 3 rd. instar larvae per treatment. The larvae, on single leaves, were immersed in the appropriate solutions for five seconds and the leaf placed on the moist filter paper. The petri dish cover was put in place and the cages held at room temperature (80 F) for the duration of the test. All larvae were examined at 24 hour intervals and mortality was recorded. Death was assumed when no movement could be observed when the larvae were gently prodded with a blunt steel probe. The treatments in this test included [1] Guthion 50W 1.5 lb./acre (.6 g/liter), [2] methomyl 3 pt./acre (1.25 ml/liter), [3] Penncap M 3 pt./acre (1.25 ml/liter), [4] Bt = Dipel 2X 1 lb./acre (.4 g/liter), [5] Bt = Xentari 1 lb./acre (.4 g/liter), [6] Pyrellin EC 1.5 pt./acre (.63 ml/liter) and [7] water control.

Twenty four hours after treatment 100% of the larvae in the Pyrellin treatment were dead and 90% were dead in the methomyl treatment.At this time mortality in the remaining treatments was 10% or less. No deaths were observed in the water control until 72 hours post treatment. Over the next 96 hours mortality on the other treatments increased but none provided a degree of control that would be acceptable to commercial apple growers.

		Percent larval mortality (X hours after treatment)				
Material	Rate	24 hours	48 hours	72 hours	96 hours	120 hours
Guthion 50 W	1.5 lb/A	10	30	30	30	30
Lannate L	3.0 pt/A	90	95	95	95	95
Penncap M	3.0 pt/A	5	30	40	40	50
Dipel 2X	1.0 lb/A	5	15	25	30	35
XenTari	1.0 lb/A	5	10	30	50	55
Pyrellin EC	1.5 pt/A	100	100	100	100	100
Water	300 gal/A	0	0	5	5	5

		Percent larval mortality (X hours after treatment)		
Material	Rate	144 hours	168 hours	192 hours
Guthion 50W	1.5 lb/A	35	35	35
Lannate L	3.0 pt/A	95	100	100
Penncap M	3.0 pt/A	55	70	70
Dipel 2X	1/0 lb/A	55	55	55
XenTari	1.0 lb/A	60	70	75
Pyrellin EC	1.5 pt/A	100	100	100
Water	300 Gal/A	5	5	5

NOTE: Data 3 Sept. to 11 Sept., 1993.

APPLE: Malus domestica Borkhauser
Tufted apple budmoth (TABM);
Platynota idaeusalis (Walker)
Bacillus thuriengensis (I) (Bt)

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APPLE, INSECTICIDE DIP TEST (TABM vs. INSECTICIDES), 1993: A large commercial apple grower reported failure in attempts to control TABM with airblast applications of Penncap M (2 pt/acre) combined with methomyl (3 pt/acre). At the time of the grower applications larval hatch had begun and most larvae were in the first or second instar. By the time larvae were entering the third instar (10 days after spray application) it was apparent that commercially acceptable control had not been achieved. In 1992 this grower also had poor control when Penncap M was applied to suppress redbanded leafroller and experiments showed that tolerance of Penncap M was present in the resident RBLR population (Horsburgh et. al. 1992). This laboratory test was begun on 3 Sept. to determine if 1) tolerance to Penncap M was also present in the TABM population and 2) if any of several other insecticides tested held promise for control of the pest. Seven treatments (including a water control) were selected and rates calculated on the basis of 300 gal of spray being applied per acre. The appropriate dosage of pesticide for each treatment was mixed with 1 gallon of 77 degree F water in clean 1 gallon battery jars. Twenty plastic petri dishes containing moistened filter paper were prepared and served as individual cages for twenty 3 rd. instar larvae per treatment. The larvae, on single leaves, were immersed in the appropriate solutions for five seconds and the leaf placed on the moist filter paper. The petri dish cover was put in place and the cages held at room temperature (80 F) for the duration of the test. All larvae were examined at 24 hour intervals and mortality was recorded. Death was assumed when no movement could be observed when the larvae were gently prodded with a blunt steel probe. The treatments in this test included [1] Guthion 50W 1.5 lb./acre (.6 g/liter), [2] methomyl 3 pt./acre (1.25 ml/liter), [3] Penncap M 3 pt./acre (1.25 ml/liter), [4] Bt = Dipel 2X 1 lb./acre (.4 g/liter), [5] Bt = Xentari 1 lb./acre (.4 g/liter), [6] Pyrellin EC 1.5 pt./acre (.63 ml/liter) and [7] water control.

Twenty four hours after treatment 100% of the larvae in the Pyrellin treatment were dead and 90% were dead in the methomyl treatment.At this time mortality in the remaining treatments was 10% or less. No deaths were observed in the water control until 72 hours post treatment. Over the next 96 hours mortality on the other treatments increased but none provided a degree of control that would be acceptable to commercial apple growers.

		Percent larval mortality (X hours after treatment)				
Material	Rate	24 hours	48 hours	72 hours	96 hours	120 hours
Guthion 50 W	1.5 lb/A	10	30	30	30	30
Lannate L	3.0 pt/A	90	95	95	95	95
Penncap M	3.0 pt/A	5	30	40	40	50
Dipel 2X	1.0 lb/A	5	15	25	30	35
XenTari	1.0 lb/A	5	10	30	50	55
Pyrellin EC	1.5 pt/A	100	100	100	100	100
Water	300 gal/A	0	0	5	5	5

		Percent larval mortality (X hours after treatment)		
Material	Rate	144 hours	168 hours	192 hours
Guthion 50W	1.5 lb/A	35	35	35
Lannate L	3.0 pt/A	95	100	100
Penncap M	3.0 pt/A	55	70	70
Dipel 2X	1/0 lb/A	55	55	55
XenTari	1.0 lb/A	60	70	75
Pyrellin EC	1.5 pt/A	100	100	100
Water	300 Gal/A	5	5	5

NOTE: Data 3 Sept. to 11 Sept., 1993.

APPLE: *Malus domestica* Borkhauser 'Spur Red'
European red mite (ERM); *Panonychus ulmi* (Koch)
European red mite eggs (ERME); *Panonychus ulmi* (Koch)
Predator (SP); *Stethorus punctum* (LeConte)
Predator (SPA); *Stethorus punctum* adults (LeConte)
Insidiosus flower bug (OI); *Orius insidiosus* (Say)
Phytoseiid mite (P); Phytoseiidae
Phytoseiid mite eggs (PE); Phytoseiidae
Green lacewing (CH); Chrysopidae
Green lacewing egg (CHE); Chrysopidae
Green lacewing larva (CHL); Chrysopidae
Apple rust mite (RM); *Aculus schlechtendali* (Nalepa)

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APPLE, MITICIDE EVALUATIONS, 1993: The experiment was conducted in an orchard block of 16 year old 'Spur Red' Delicious apple trees on MM106 roots. Treatments were placed in alternating rows with the intervening unsprayed rows serving as guard rows to minimize spray drift between replicates. Treatments were arranged in a randomized complete block design in the selected treatment rows. Each replicate (4 per treatment) consisted of three adjacent trees in the row and data was only taken from the center tree of each replicate. The treatments were applied with a power take off driven FMC (model 252S) airblast sprayer calibrated to deliver 50 gallons / acre (76.62 liters/ha). Delayed dormant 60 sec. oil treatments (6 gal./acre) were applied to two treatments on 27 Apr. One treatment was oil alone but the other had Kinetic EC (16 oz./acre) added to it. Two control plots were established, one of which received two inoculations of European red mite (ERM) and one which did not. The inoculations made to all plots except as noted above consisted of taping 10 mite infested apple shoots (collected in a heavily infested commercial orchard) to limbs on the periphery of each replicate tree. The inoculations were made on 24 May and 4 Jun. All other treatments were applied on 21 Jun and 28 Jun and consisted of Omite 6E (32 oz/A), TD2336 (16 oz/A), Kelthane 50W (3.5 lb/A) + Latron 44M (8 oz/A) = pH 6.0, Pyrellin EC (16 oz/A) + Omite 6E (24 oz/A), and Omite 30W (6 lb/A). Predator data (16 Jul) was collected during a three minute observation period of the canopy of the center tree of each replicate plot. Mite data was developed by collecting leaf samples (20 leaves) and following the standard Henderson-McBurnie mite brushing procedure.

Analysis of European red mite (ERM) and mite egg (ERME) data taken 17 May did not reveal significant differences between the treatments. However it appears that the two treatments that received dormant oil sprays had fewer mites and mite eggs present than the two controls. Kinetic added to dormant oil did not significantly reduce the population of mites or their eggs in this experiment. ERM and ERME counts/leaf on 24 Jun (72 hrs. post-treatment) showed no significant differences when analyzed. However apple rust mite (RM) differences between means were significant with the greatest number occurring on the control and the fewest on the Kelthane + Latron treatment. By 1 Jul (72 hrs. post second treatment) differences between ERM and ERME numbers were significant. There were more mites and eggs on the control than on the treatments and the fewest mites were found on the Omite 6E treatment. The fewest number of eggs were found on the Omite 30W treatment but the differences were only significant between this treatment and the control and the Kelthane + Latron plot. A few predators of mites ((Phytoseiid mites (P), Phytoseiid eggs (PE), *Stethorus punctum* eggs (SPE), and Chrysopid eggs (CHE)) were counted on 1 Jul but differences between means of the control and the treatments were not significant. One week later (8 Jul) the situation with ERM and ERME essentially remained the same as on 1 Jul except that the numbers were lower overall. However, there were significantly greater numbers of Phytoseiid mites (P) on the control than on any of the treatments. By 15 Jul no significant differences in ERM were detected but ERME continued higher on the control and the Kelthane + Latron plots than on the other treatments. There were more Phytoseiid eggs (PE) on the control than on any of the other treatments on 15 Jul. Significant differences were revealed by the analyses on 22 Jul (P) and 5 Aug (ERME). Timed (3 min.) predator counts on 16 Jul were analyzed and significant differences were indicated for *Stethorus punctum* adults (SPA) and eggs (SPE). Both SPA and SPE were most numerous on the control and the lowest number of SPA occurred on the Pyrellin + Omite treatment. The fewest SPE were found on the Omite 30W treatment on 16 Jul. No phytotoxic effects on foliage or fruit were observed as a consequence of the treatments applied in this experiment.

1993 SPRAY SCHEDULE (RED SPUR MITE TEST)
Virginia Agricultural Experiment Station - Winchester

Date	Comment	Treatment	Rate/A in 50 gal water
April 7	Entire block	Nova	5 oz
April 20	Entire block	Polyram + Rubigan + Sevin	3 lb + 9 oz + 6 lb
April 27	Treatments 1 & 2 applied		
April 29	Entire block	Rubigan + Ziram + Streptomycin	9 oz + 3.25 lb + 24 oz
May 3	Entire block	Streptomycin	24 oz
May 6	Entire block	Streptomycin	24 oz
May 10	Entire block	Rubigan + Thiram + Dipel	9 oz + 3.25 lb + 1.2 lb
May 11	Entire block	NAA 800 + Regulade	1 oz + 1 pt
May 17	Entire block	Nova + Swat	5 oz + 4 oz
May 24	Mites planted in test trees		
June 2	Entire block	Rubigan + Bayleton + Solubor	9 oz + 2 oz + 5 lb
June 3	Heavy fruited trees	Etherel	4 pt
June 4	Mites planted in test trees		
June 16	Entire block	Lannate + Ziram + Solubor	1.5 qt + 6.5 lb + 5 lb
June 21	Treatments 4,5,6,7,8 applied		
June 28	Treatments 4,5,6,7,8 applied		
June 29	Entire block	Lorsban + Captan + Solubor	2 lb + 5 lb + 5 lb
July 13	Entire block	Guthion 35W + Ziram + Solubor	2 lb + 6.5 lb + 5 lb
July 29	Entire block	Lorsban + Captan + Solubor	2 lb + 5 lb + 5 lb
August 18	Entire block	Guthion 35W + Captan + Solubor	2 lb + 5 lb + 5 lb

Treatment	Rate /acre	Rate /hectare	European red mites and eggs/leaf[1,2] 17 May ERM	ERME	RM
Superior oil[3,4] (inoculated)	6 gal	9.2 liters	2.36 a	6.40 a	69.30 a
Superior oil[3,4] + Kinetic (inoculated)	6 gal + 16 oz	9.2 liters + 194.32 ml	1.08 a	2.62 a	45.24 a
Control 1 (no red mite inoculation)	---	---	8.98 a	19.99 a	111.20 a
Control 2 (inoculated with red mites)	---	---	8.98 a	38.81 a	114.61 a
P			.09	.09	.10

[1] Data transformed to log 10 (X + 1) for analysis. Back transformed means are tabulated.
[2] Means in any given column followed by the same letter are not significantly different (p = .05, DMRT).
[3] Ten terminals infested with ERM and ERME were taped randomly to limbs on all replicates on 24 May and 4 Jun.
[4] Sprayed with 60 sec oil, 6 gal/A on 5 May and 4 Jun.

Treatment	Rate /acre	Rate /hectare	Spur red block, predators/3 minute[1,2] 16 Jul SPA (S)	SPL (S)	CHL (NS)	CHE (NS)	OI (NS)
Control (water)	50 gal	76.62 liters	39.83 a	39.74 a	.41 a	1.71 a	.00
Omite 6E	32 fl oz	388.64 ml	4.77 bc	1.45 bc	.29 a	3.45 a	.00
TD 2336	16 oz	194.32 ml	1.38 c	.19 c	.19 a	.78 a	.00
Kelthane 50W + Latron 44 (pH 6)	3.5 lb + 8 oz	.64 Kg + 97.16 ml	14.49 ab	5.46 b	.29 a	2.97 a	.71
Pyrellin EC + Omite 6E	16 fl oz + 24 fl oz	194.32 ml + 279.32 ml	.86 c	.68 c	.19 a	3.84 a	.71
Omite 30WP	6 lb	1.10 Kg	3.79 bc	0.00 c	.00 a	1.59 a	.00
P			.0006	.0002	.6027	.5013	

[1] Data transformed to log 10 (X + 1) for analysis. Back transformed means are tabulated.
[2] Means in any given column followed by the same letter are not significantly different (p = .05, DMRT).

Mites and predators of mites/leaf [1,2]

Treatment	Rate [3] /acre	Rate [3] /hectare	24 Jun (72 hrs post treatment) ERM (NS)	ERME (NS)	RM (S)	1 Jul ERM (S)	ERME (S)	P (NS)	PE (NS)	SPE (NS)	CHE (NS)
Control (water)	50 gal	76.62 liters	13.00 ab	78.80 a	428.5 a	42.65 a	323.34 a	.06 a	.00 a	.30 a	.23 a
Omite 6E	32 fl oz	388.64 ml	7.93 ab	45.13 a	270.6 ab	0.57 c	35.14 b	.00 a	.36 a	.00 a	.00 a
TD 2336	16 oz	194.32 ml	9.86 ab	40.78 a	328.6 abc	4.79 b	71.61 ab	.11 a	.11 a	.24 a	.12 a
Kelthane 50W + Latron 44 (pH 6)	3.5 lb + 8 oz	.64 Kg + 97.16 ml	18.50 a	76.10 a	129.0 d	6.35 b	231.27 a	.00 a	.00 a	.00 a	.00 a
Pyrellin EC + Omite 6E	16 fl oz + 24 fl oz	194.32 ml + 279.32 ml	3.10 b	23.32 a	167.2 cd	1.63 bc	25.30 b	.00 a	.00 a	.00 a	.00 a
Omite 30WP	6 lb	1.10 Kg	5.00 ab	22.28 a	230.2 bcd	1.39 bc	15.94 b	.06 a	.06 a	.00 a	.06 a
P			.1474	.2565	.0032	.0001	.0030	.665	.338	.1168	.0267

[1] Data transformed to log 10 (X + 1) for analysis. Back transformed means are tabulated.
[2] Means in any given column followed by the same letter are not significantly different (p = .05, DMRT).
[3] Treatments applied 21 Jun and 28 Jun.

Treatment	Rate [3] /acre	Rate [3] /hectare	Mites and predators of mites/leaf [1,2] 8 Jul ERM (S)	8 Jul ERME (S)	8 Jul P (S)	15 Jul ERM (NS)	15 Jul ERME (S)	15 Jul PE (S)	15 Jul SPE (NS)
Control (water)	50 gal	76.62 liters	92.11 a	154.24 a	.66 a	5.16 a	101.57 a	.73 a	.11 a
Omite 6E	32 fl oz	388.64 ml	0.94 b	15.11 b	.06 b	1.56 ab	25.0 bc	.00 b	.06 a
TD 2336	16 oz	194.32 ml	0.80 b	19.05 b	.00 b	0.79 b	11.8 c	.17 b	.00 a
Kelthane 50W + Latron 44 (pH 6)	3.5 lb + 8 oz	.64 Kg + 97.16 ml	3.32 b	101.33 a	.17 b	3.31 ab	80.1 ab	.06 b	.36 a
Pyrellin EC + Omite 6E	16 fl oz + 24 fl oz	194.32 ml + 279.32 ml	1.51 b	19.18 b	.17 b	2.20 ab	26.5 bc	.06 b	.06 a
Omite 30WP	6 lb	1.10 Kg	1.20 b	8.80 b	.00 b	1.40 ab	16.9 c	.12 b	.00 a
P			.0001	.0001	.0221	.1243	.0112	.0002	.4068

[1] Data transformed to log 10 (X + 1) for analysis. Back transformed means are tabulated.

[2] Means in any given column followed by the same letter are not significantly different (p = .05, DMRT).

[3] Treatments applied 21 Jun and 28 Jun.

	Rate [3]		Mites and predators of mites/leaf [1,2]									
			22 Jul				29 Jul			5 Aug		
Treatment	/acre	/hectare	ERM (NS)	ERME (NS)	P (S)	PE (NS)	ERM (NS)	ERME (NS)	P (NS)	ERM (NS)	ERME (S)	P (NS)
Control (water)	50 gal	76.62 liters	0.11 a	12.2 ab	.78 a	.28 ab	.00 a	2.21 ab	.39 a	.00 b	2.16 a	.41 ab
Omite 6E	32 fl oz	388.64 ml	1.39 a	6.39 b	.24 bc	.12 ab	.00 a	.68 c	.06 a	.06 ab	.35 b	.69 a
TD 2336	16 oz	194.32 ml	0.58 a	8.5 ab	.35 b	.00 b	.00 a	.87 bc	.06 a	.22 ab	1.00 ab	.12 b
Kelthane 50W + Latron 44 (pH 6)	3.5 lb + 8 oz	.64 Kg + 97.16 ml	1.68 a	16.38 a	.00 c	.00 b	.12 a	2.50 a	.06 a	.22 ab	2.36 a	.06 b
Pyrellin EC + Omite 6E	16 fl oz + 24 fl oz	194.32 ml + 279.32 ml	1.34 a	6.09 b	.24 bc	.41 a	.98 a	1.52 abc	.06 a	.47 a	.57 b	.26 ab
Omite 30WP	6 lb	1.10 Kg	1.20 a	5.79 b	.12 bc	.17 ab	.97 a	1.06 abc	.06 c	.15 ab	.56 b	.75 a
P			.2457	.0791	.0019	.0679	.3485	.0358	.1828	.1974	.0229	.0551

[1] Data transformed to log 10 (X + 1) for analysis. Back transformed means are tabulated.
[2] Means in any given column followed by the same letter are not significantly different (p = .05, DMRT).
[3] Treatments applied 21 Jun and 28 Jun.

Diversity of Carabidae Communities in Mating Disruption versus Conventionally Managed Apple Orchards

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Introduction: Carabid beetles or ground beetles are quite abundant in most terrestrial environments and are easily collectable. As a result many papers have been written about how communities are analyzed using carabid beetles. Carabids can be indicators on how ecologically balanced a particular environment is. Consequently, determining the effect of pheromone use over conventional insecticides, on apple orchards, can be done by using carabids.

Materials and Methods: Carabid beetles were collected by means of pitfall traps. Two 270 ml plastic cups were placed at six sites about the orchard. They were placed directly next to each other. The cups were filled with water and a small amount of formaldehyde (Bell, 1990). Formaldehyde acts as a deterrent for rodents. The cups were then covered over allowing a crawling space for the carabids. The sites were sampled weekly. Three different orchards were sampled in 1992. All had a pheromone and a control environment. One orchard, Tyro, was undergoing pheromone treatment for the first time that year. The other two, Daleville and Fincastle, have undergone five and four years respectively, of pheromone treatment.

Results and Discussion: Initially, orchards were analyzed using various diversity and similarity indices.

Table 1. Diversity Indices

	Block					
	Daleville		Fincastle		Tyro	
Statistics	Pheromone	Control	Pheromone	Control	Pheromone	Control
Number of Species	13	4	19	13	9	8
Number of Individuals	109	14	253	38	55	29
Simpson Diversity	0.835	0.571	0.803	0.906	0.716	0.791
Shannon Diversity	0.846	0.430	0.934	1.00	0.687	0.746
Evenness						
Simpson Diversity	0.896	0.707	0.844	0.956	0.791	0.872
Shannon Diversity	0.759	0.715	0.730	0.898	0.720	0.826

Simpson diversity and Shannon diversity take both species richness (number of individuals) and evenness in to regards. As the value approaches 1 the more diverse the community is.

In the Daleville block, the pheromone is more diverse than the control. Both the Fincastle and Tyro controls have a higher diversity than the pheromone. While this is explainable with the Tyro blocks due the new pheromone treatment, the Fincastle block data can not be fully understood using these indices. The same trend is seen in the evenness of both Simpsons and Shannon's diversities.

Table 2. Similarity

Statistics	Orchard
	Daleville Pheromone and Control
Percent Similarity	23.3%
Morisita Index	0.178
	Fincastle Pheromone and Control
Percent Similarity	43.1%
Morisita Index	0.594
	Tyro Pheromone and Control
Percent Similarity	81.5%
Morisita Index	0.969
	Block
	Daleville and Fincastle Pheromone
Percent Similarity	20.3%
Morisita Index	0.169
	Daleville and Fincastle Control
Percent Similarity	15.8%
Morisita Index	0.382

Morisita index (more similar as it approaches one) and percent similarity between blocks of the three different orchards increases in relationship to the number of years each orchard has been treated with pheromones. Thus supporting the hypothesis that an orchard treated with pheromones will begin to become more ecologically diverse. The similarity between like block is very low. This indicates that blocks, even though they might undergo the same pheromone treatment, can have drastically different fauna. This is especially significant when comparing blocks that are quite distant to each other.

After comparing these orchards, using standard diversity and similarity statistics, other statistical methods may be used. Cluster analysis is one method. Both mean euclidean distance and percent dissimilarity are frequently used clustering methods (Krebs, 1989). Each method may lead to slightly different results. This is also true if the data is log transformed. This lessens the effect one commonly collected individual species has upon the clustering process.

Clustering using mean euclidean distance for both the non-log and log data indicate that both the Daleville pheromone and Fincastle pheromone are least related to the control and the new pheromone treated blocks [see graphs]. When comparing blocks using non-log data and percent dissimilarity, it can be seen that the two long established pheromone block (Daleville and Fincastle) are removed from the other cluster. Using the log data still separates the two pheromone blocks but includes the Fincastle control [see graphs].

Lastly, principle component analysis or PCA can also be used to separate and determine the relationships of the various orchard blocks. PCA has an appeal as an ecological ordination method due to its multivariate eigenanalysis method (Ludwig & Renynolds, 1988). Simply looking at either the non-log or log data PCA it can easily be seen how the different blocks separate apart. It is very similar to the results obtained by using cluster analysis.

In conclusion, by looking at the results of several different statistical methods, the hypothesis that pheromone use will cause an increase of diversity is not directly proven. It can be stated although that there does exist a definite difference between the conventionally managed orchards and pheromone treated ones.

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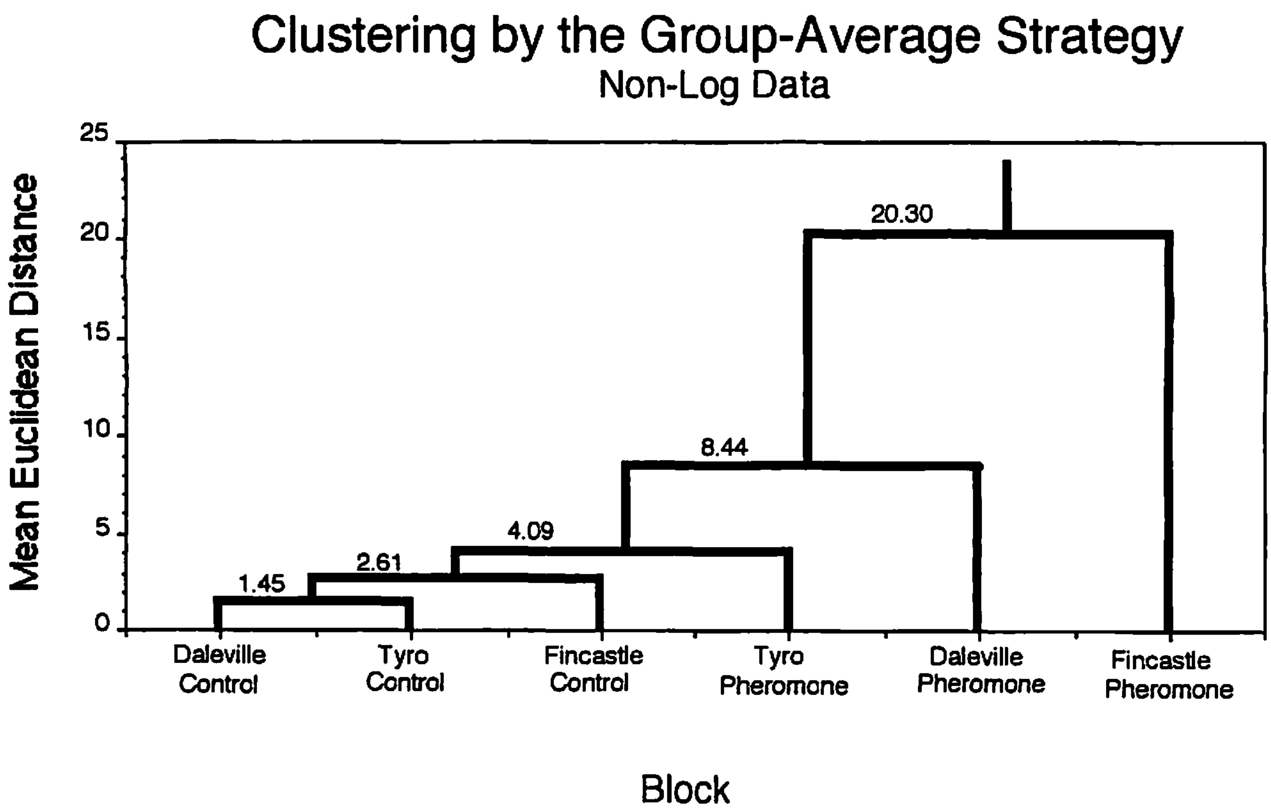
Clustering by the Group-Average Strategy
Non-Log Data
Mean Euclidean Distance
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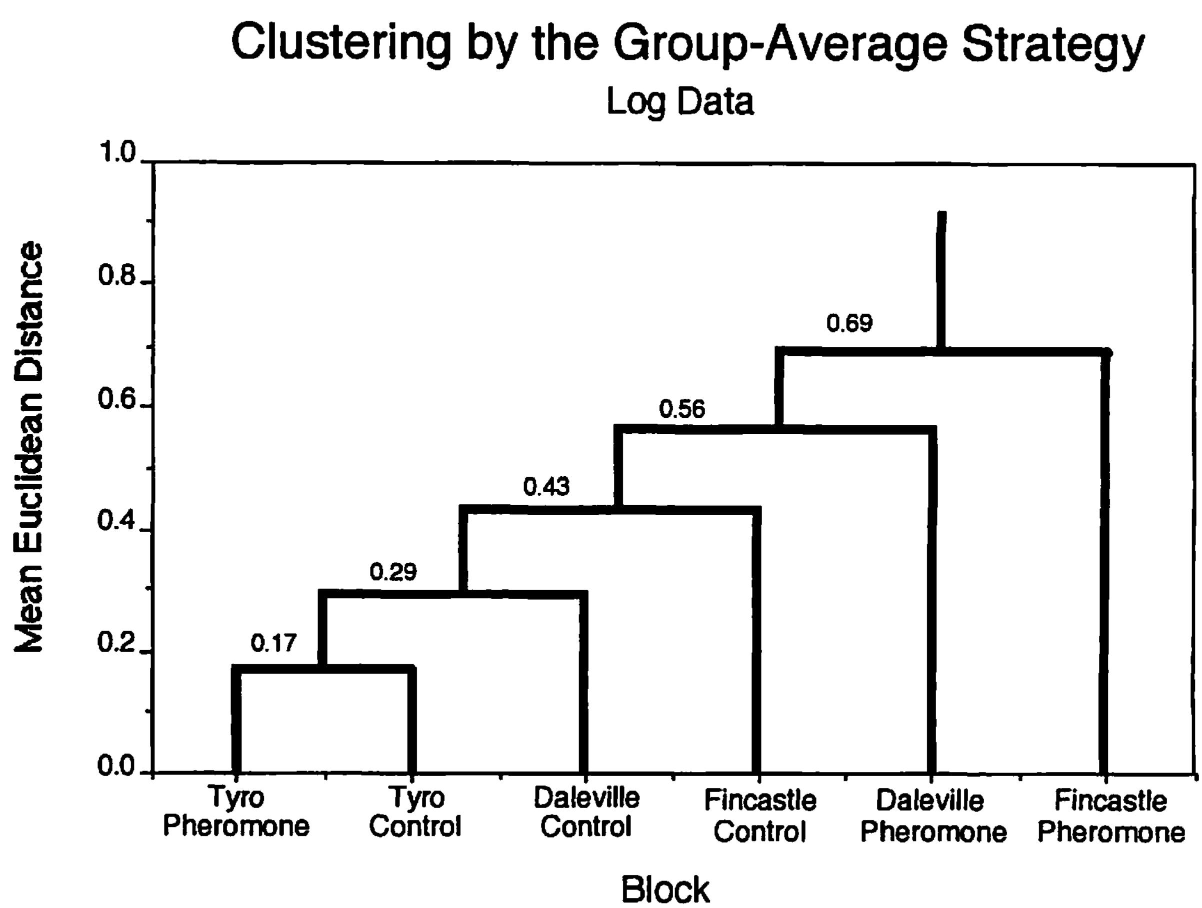
20
15
10
5
0
20.30
8.44
4.09
2.61
1.45
Daleville Control
Tyro Control
Fincastle Control
Tyro Pheromone
Daleville Pheromone
Fincastle Pheromone
Block


Clustering by the Group-Average Strategy
Log Data
Mean Euclidean Distance
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0.8
0.6
0.4
0.2
0.0
0.69
0.56
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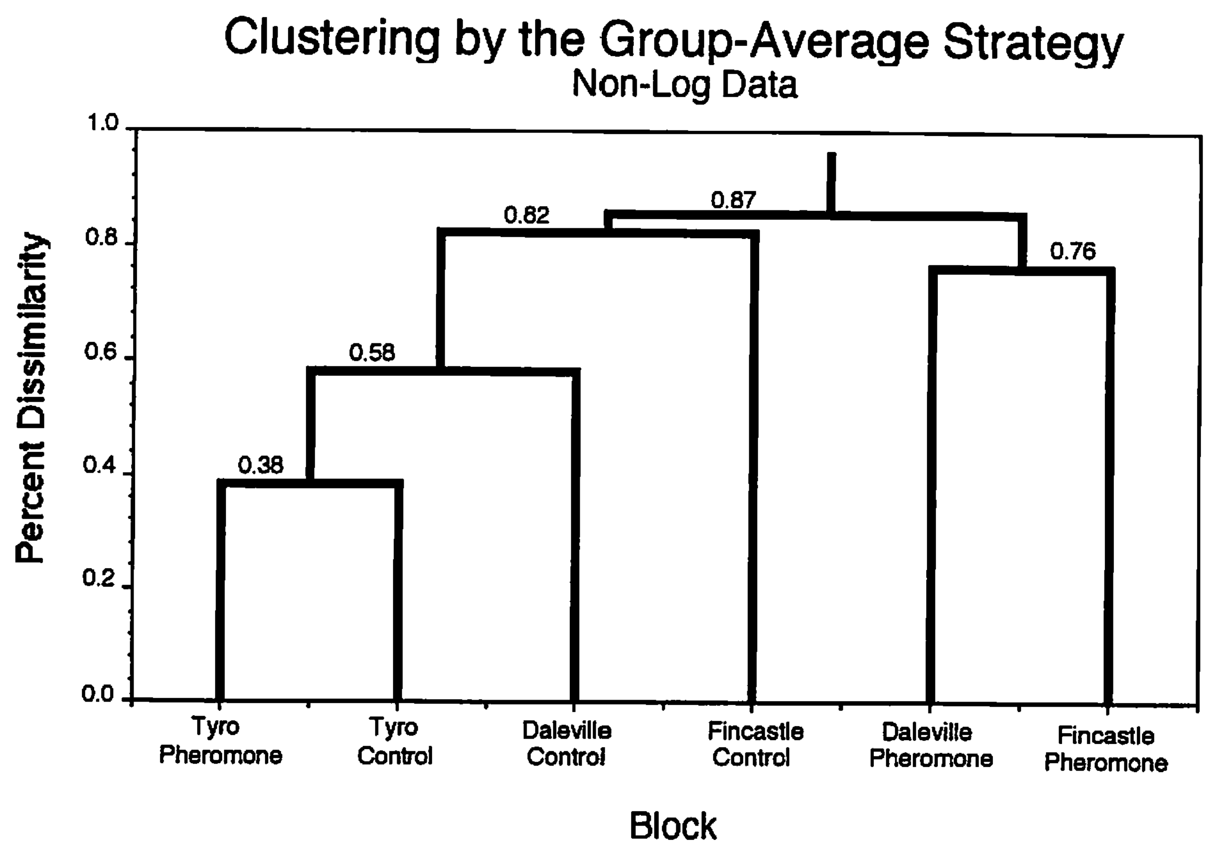
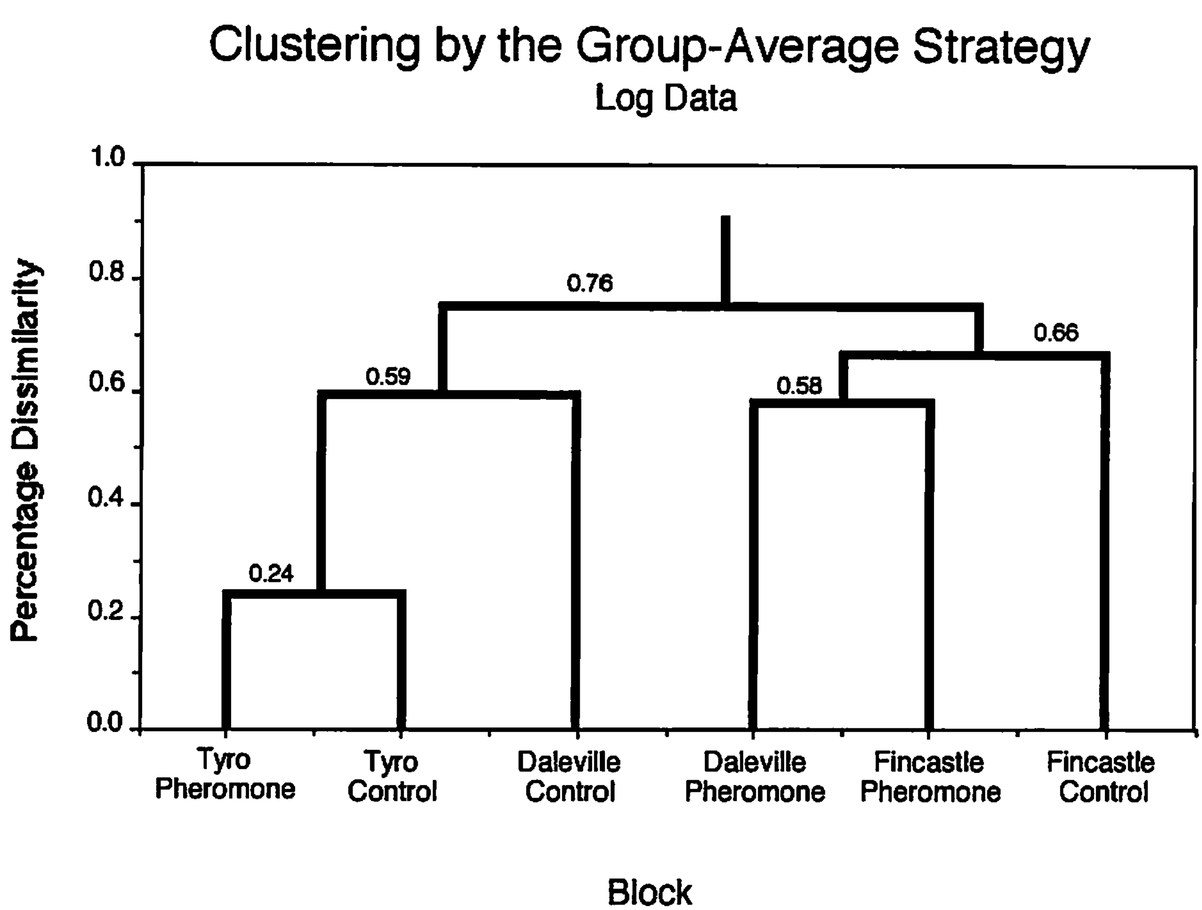
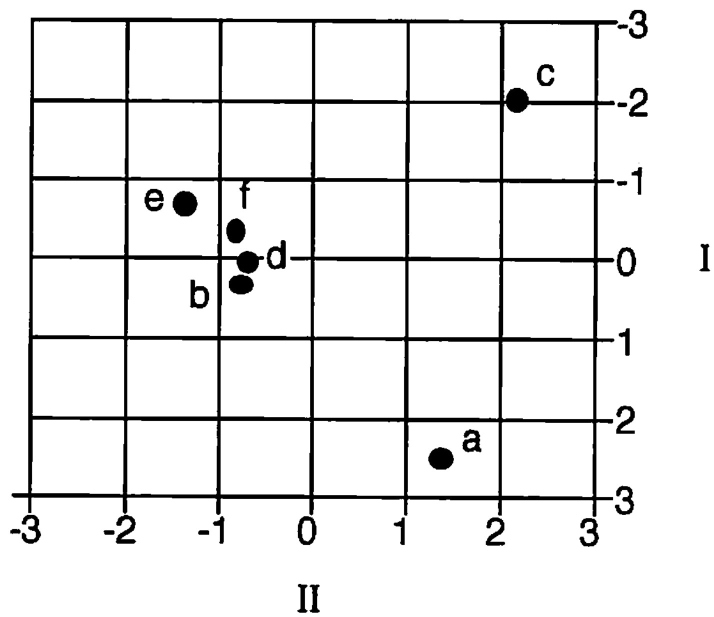
Fincastle Pheromone
Block


Clustering by the Group-Average Strategy
Non-Log Data
Percent Dissimilarity
1.0
0.8
0.6
0.4
0.2
0.0
0.87
0.82
0.76
0.58
0.38
Tyro Pheromone
Tyro Control
Daleville Control
Fincastle Control
Daleville Pheromone
Fincastle Pheromone
Block

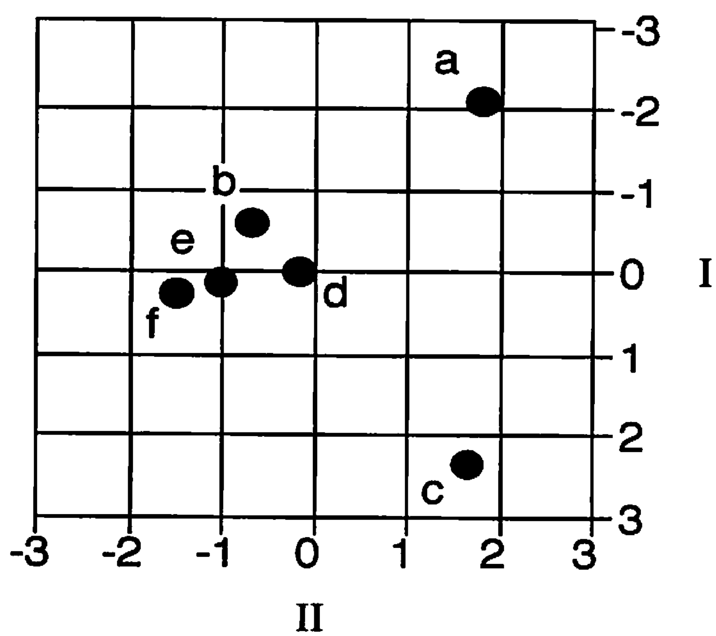

Clustering by the Group-Average Strategy
Log Data
Percentage Dissimilarity
1.0
0.8
0.6
0.4
0.2
0.0
0.76
0.66
0.59
0.58
0.24
Tyro Pheromone
Tyro Control
Daleville Control
Daleville Pheromone
Fincastle Pheromone
Fincastle Control
Block

Principle Component Analysis
Two Dimensions

Non-Log Data



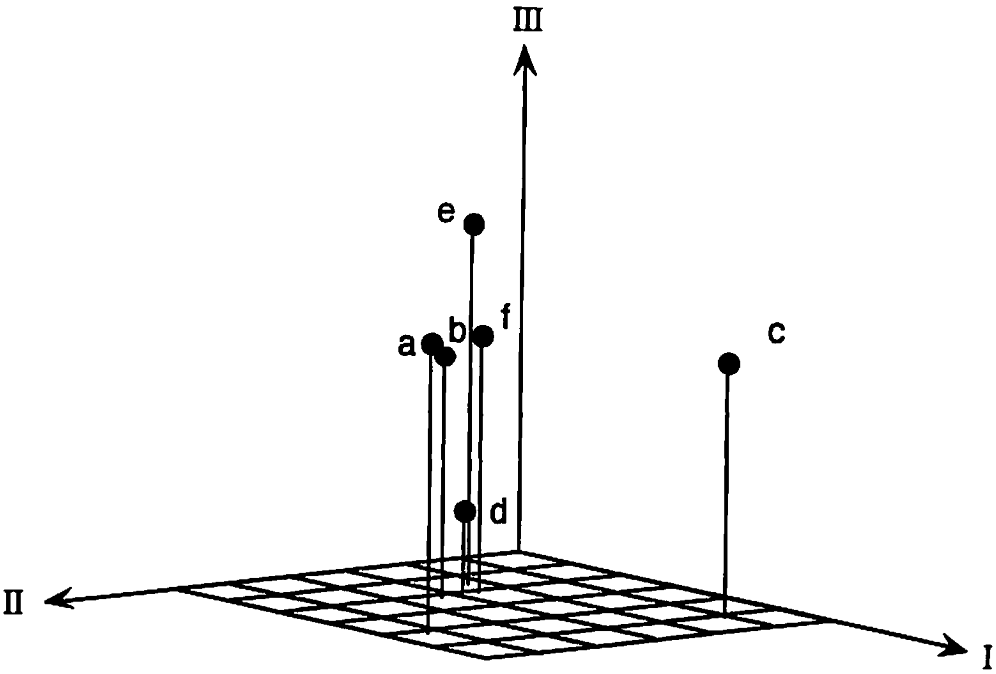
Log Data



a = Daleville Pheromone
b = Daleville Control
c = Fincastle Pheromone
d = Fincastle Control
e = Tyro Pheromone
f = Tyro Control

Principle Component Analysis
Three Dimensions

Non-Log Data



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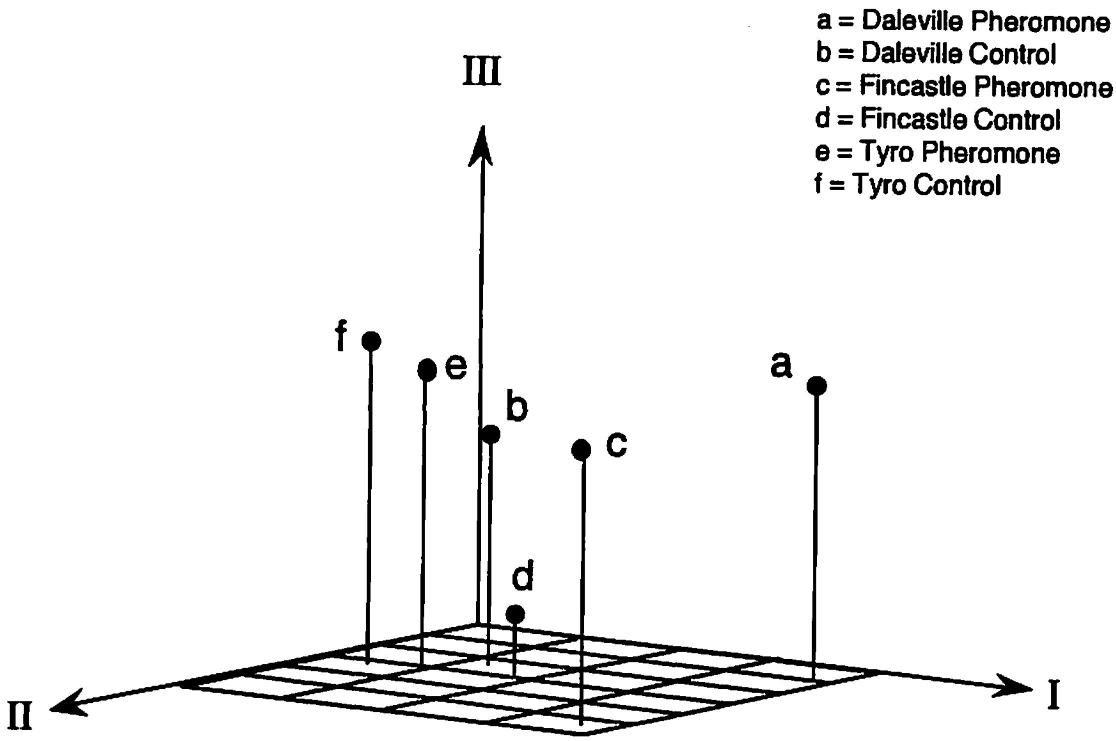

Diversity of Spider Communities in Mating Disruption versus Conventionally Managed Apple Orchards

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I. Introduction: Mating disruption has received increased attention in recent years for the control of pests in orchards and other cropping systems. Unfortunately, the cost of pheromone dispensers is high for some species relative to the amount of insecticide used to control the target insect that would be replaced by disruption. In order to better define the cost:benefit relation, the effects of the differing strategies on non-target organisms should be better understood.

Spiders have also received increased attention recently, because of their role as generalist predators in many systems (Reichart & Lockley 1984). In orchards they have been reported as important predators of leafrollers and codling moth (Falcon & Huber 1991, Mills & Carl 1991) and for such indirect pests as aphids (Sunderland 1988) and spotted tentiform leafminer (Corrigan & Bennett 1987). Spiders were surveyed in Virginia apple orchards by McCaffrey & Horsburgh (1980). A preliminary report of spider species collected in mating disruption blocks versus conventionally managed orchards was given by Harris et al. (1992). A more complete description of those collections, with diversity analysis, is given here.

II. Materials and Methods: In 1992, pitfall traps were established in three orchards: Daleville (fourth year of mating disruption for codling moth and leafrollers), Fincastle (third year of mating disruption) and Tyro (first year of mating disruption). Each pheromone-treated block was matched with a similar conventionally managed control block. Each block contained six trapping stations, each of which consisted of two pitfall traps. Traps were serviced weekly during the season.

Spiders in the orchard canopy were sampled using beating trays (69 x 69 cm) on a tree adjacent to each pitfall station. The tray was held beneath a limb and the limb was tapped three times with a rubber mallet. Sampling was performed every two weeks (sampling was initially weekly but frequency was decreased because of the lack of spiders in early samples). After initial processing at VPI&SU (Blacksburg), spider samples were brought to Hampton University (Hampton) for taxonomic analysis and comparisons of diversity (Brower & Zar 1984).

III. Results and Discussion: The distribution of spiders across families captured in pitfall traps and beating trays (summed over all blocks) is shown in Table 1. In pitfall traps, wolf spiders (Lycosidae) were the predominant family, followed by 11 other families. Wolf spiders are common in epigeal habitats. In pitfall traps, ca. 47 species were collected; the most common are listed in Table 2. Many spiders are very difficult to identify as juveniles, hence only those collected as adults are listed. The genus *Pirata* was the largest component of Lycosidae, followed by *Lycosa*. In beating tray samples, jumping spiders (Salticidae) were most common, ca. four times more common than the next most frequently collected family. After salticids, anyphaenids, thomisids, areneids and philodromids were the most common families in beating tray samples (Table 1). The latter result agrees with McCaffrey & Horsburgh (1980). The most common species in beating tray samples were the salticids *Eris marginata* and *Hentzia palmarum* (Table 2). *Phidippus* spp. are not listed because they were not collected as adults; nevertheless, they were an abundant component of the spider fauna.

Table 3 contains data on spider populations in pitfall traps. In the orchards with multiple years of mating disruption, species richness was greater in pitfalls in mating disruption blocks than in conventional blocks. There was no trend in evenness. Shannon-Weaver diversity, reflecting both richness and evenness, was greater in mating disruption than conventional blocks. Total abundance of spiders was also greater in long-standing mating disruption blocks. There was no clear effect of pheromone program during the first year of mating disruption (Tyro). There was an apparent tendency for the epigeal spider population in the pheromone and conventional blocks to become less similar with increasing duration of mating disruption.

Table 4 presents data on spider populations collected on beating trays. There was no clear trend in Shannon-Weaver diversity. Richness was greater in all pheromone blocks, as was total spider abundance. Evenness was often higher in conventional blocks, especially with greater duration of mating disruption. This would tend to inflate diversity, but in this case probably is an artifact of increasing evenness by lowering abundance of all species. Thus it is important to rely not only on the Shannon-Weaver index in describing diversity. There was no apparent trend in % similarity related to duration of mating disruption.

In conclusion, spiders were more common in disruption blocks than in insecticide-treated blocks; this was most pronounced after blocks had been in mating disruption programs for multiple years. Greater spider populations in disruption blocks were seen in both pitfall and beating tray samples, both for the number of individual spiders and the number of spider species. These generalist predators are favored by the low-spray orchard management allowed in mating disruption programs, and should be evaluated further in evaluating the cost:benefit relations of this approach.

Table 1. Spiders families ranked by frequency of capture in mating disruption and conventional orchards - 1992.

Collected in Pitfall Traps		Collected in Beating Trays	
Lycosidae	167	Salticidae	81
Gnaphosidae	54	Anyphaenidae	22
Clubionidae	23	Thomisidae	19
Salticidae	23	Araneidae	19
Agelenidae	21	Philodromidae	16
Linyphiidae	16	Dictynidae	3
Micryphantidae	14	Tetragnathidae	1
Amourobiidae	3	Pisauridae	1
Antrodiaetidae	2		
Anyphaenidae	2		
Theridiidae	1		
Philodromidae	1		
Unknown	1		

Table 2. Spider species captured as adults in mating disruption and conventional orchards - 1992.

	Pitfall Traps			Beating Trays	
Family	Species[1]	Number	Family	Species	Number
Clubionidae	*Phrurotimpus alarius*	20	Salticidae	*Eris marginata*	13
Gnaphosidae	*Drassyllus dixinus*	33		*Hentzia palmarum*	10
Lycosidae	*Lycosa frondicola*	48		*Metaphidippus galathea*	2
	Pirata aspirans	67		*Peckhamia picata*	1
	Pirata sp. A	40			
	Schizocosa ocreata	37	Thomisidae	*Ozyptila sincera oraria?*	1
Micryphantidae	sp. A	12		*Synema parvula*	4
Salticidae	*Marpissa lineata*	22		*Xysticus ferox*	1
Thomisidae	*Xysticus ferox*	19		*Xysticus funestus*	1

[1]Common families only are listed for pitfall traps; i.e. those with more than 10 spiders collected.

Table 3. Abundance and diversity of adult spiders collected in pitfall traps in mating disruption versus conventional orchards - 1992

	Daleville		Fincastle		Tyro	
	Pheromone	Control	Pheromone	Control	Pheromone	Control
No. of individuals	70	10	127	52	37	57
No. of species	23	6	26	11	8	12
Heip evenness	0.73	0.89	0.49	0.39	0.44	0.38
Shannon-Weaver	1.23	0.74	1.12	0.69	0.62	0.72
% Similarity	24.3		34.8		59.1	

Table 4. Abundance and diversity of adult spiders collected on beating trays in mating disruption versus conventional orchards - 1992

	Daleville		Fincastle		Tyro	
	Pheromone	Control	Pheromone	Control	Pheromone	Control
No. of individuals	18	10	59	21	17	11
No. of species	8	5	17	11	11	6
Heip evenness	0.72	0.88	0.42	0.83	0.80	0.78
Shannon-Weaver	0.78	0.65	0.89	0.97	0.95	0.69
% Similarity	57.9		39.1		50.3	

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Burr Knot Borer Activity and Control by Mating Disruption in 'Gala' Apples - 1993

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I. Introduction:

Synanthedon scitula (Harris), commonly known as the dogwood borer (DB), is a relative newcomer to the list of indirect pests of apple (Riedl et al. 1985, Warner & Hay 1985). It bores into and develops within burr knots which are primarily adventitious root primordia. 'Gala' is somewhat unique among apple varieties in that the trunk (scion) has a tendency toward the formation of burr knots. The semi-dwarfing M26 rootstock to which 'Gala' are often grafted also has a tendency to form burr knots. Consequently, the problem of burr knot borers becomes amplified.

Engelhardt (1946) reported DB as having the broadest host range of any member in the family Sesiidae. It is a primary pest of flowering dogwood (Taft et al. 1991), and a secondary pest of many hardwood trees and shrubs including oak, beech, birch, hickory, pecan, cherry, mountain ash, and willow. It ranges from southeastern Canada and New England, west to Ohio and Minnesota, and south to Texas. A single, protracted generation is thought to occur (Potter & Timmons 1983, Riedl et al. 1985, Warner & Hay 1985). However, some studies show two flight peaks; the phenological significance is unclear (Potter & Timmons 1985). Larvae overwinter in galleries beneath the tree bark.

As the popularity of 'Gala' continues to increase, so too will the problem of burr knot borers. Chronic infestations may cause a decline in vigor and yield, occasionally killing the tree. Due to difficulties involved in controlling any borer, mating disruption may be the most viable and economical means of control. Mating disruption has been shown by Pfeiffer et al. (1991), to be more effective than standard insecticides for control of lesser peachtree borer (LPTB), Synanthedon pictipes (Grote and Robinson). There are no commercial pheromones presently available for control of DB, but the similarity in pheromone composition of the peachtree borer (PTB), Synanthedon exitiosa (Say), to a complex of sesiids that includes DB, may offer a ready alternative. Mating disruption is now registered for PTB control.

II. Materials and Methods:

The pheromone-treated area consisted of a 2-ha (5-acre), rectangular block of 'Gala' located in Piney River (Nelson County); it was bordered on two sides by apple and two sides by pasture. Ropes (Pacific Biocontrol, Davis CA) containing the sex pheromone of PTB [(Z,Z)-3,13-ODDA], were placed on 21 April 1993 at the rate of 250/ha. The control area was another 2-ha, rectangular block of 'Gala' adjacent to the pheromone-treated block; it was bordered on three sides by apple and one side by pasture. Both blocks were treated with a conventional spray program.

As a means for determining disruption, three commercially available pheromone traps for DB were placed in each block on 22 April; lures were replaced on 6 July.

To observe effects of the PTB pheromone on related sesiids, three pheromone traps for Podosesia syringae (Harris), the lilac borer (LB), and two pheromone traps for LPTB were placed in each block on 22 April; three traps for PTB were placed in each block on 6 July. Septa for LB and LPTB were replaced on 6 July. All traps were checked weekly and adults removed.

Damage was evaluated between 24 Sept and 15 Oct by searching 100 tree trunks per block (10 groups of 10 trees, the groups spread uniformly in the block) for infested (as indicated by the presence of frass, exuviae or larvae) and non-infested burr knots. All pupal exuviae and larvae were counted and removed.

III. Results and Discussion:

Flight data: Catch data for male DB in DB and LB traps are shown in Fig. 1. Flight occurred from May through October with a large peak in flight activity in late July - early August. In Michigan, emergence starts in mid-June, peaking in mid-July, and ending in September (Riedl et al. 1985). In Ontario, activity extends from late June until early August (Warner & Hay 1985). Snow et al. (1985) reported multiple generations of DB with the first generation occurrence in April-May (in Georgia). However, there are other cases of univoltine sesiids exhibiting a bimodal emergence pattern, e.g., grape root borer (Snow et al. 1991). The second peak of DB in our study is more likely to reflect infestation of apple rather than dogwood (Potter & Timmons 1983). DB showed a preference for traps baited with LB pheromone [(Z,Z)-3,13 ODDA], over those baited with DB pheromone [(E,Z)-2,13-ODDA/(Z,Z)-3,13-ODDA (100:1)], as indicated by the difference in trap captures.

Orientation of DB males to DB pheromone traps was totally suppressed in the treatment block after placement of PTB pheromone dispensers. Suppression of orientation of DB males to LB pheromone traps was 99.4%; one male was captured on 6 July, and two were captured on 20 August.

Damage data: Number of burr knots, percent infestation, exuviae, and larvae are presented in Table 1. Average number of burr knots infested in the control and treatment blocks was 68 and 64 percent, respectively. If two generations occur in our area, then the lower number of larvae counts in the treatment block may indicate disruption of mating in the first generation.

Disruption of Orientation in other sesiids: In addition to DB and LB, males of five other sesiid species [Synanthedon acerni (Clemens), the maple callus borer (MCB); Paranthrene simulans (Grote), the oak borer (OB); Carmenta ithacae (Beutenmüller); PTB; and Vitacea polistiformis (Harris), the grape root borer (GRB)], were attracted to both LB and DB pheromone traps. With the exception of one LB captured in the LB pheromone trap on 12 Aug, and the capture of DB in the LB pheromone traps as stated above, orientation of all sesiid males to both DB and LB traps was totally suppressed after placement of PTB dispensers.

In addition to LPTB, males of two other sesiid species [Synanthedon rileyana (Hy. Edwards), Riley's clearwing (RC); and PTB], were attracted to LPTB pheromone traps. Orientation of all males was totally suppressed after placement of PTB dispensers.

No PTB males were captured in PTB pheromone traps.

Pheromone composition of selected sesiid species is shown for comparison in Fig. 2. The sex pheromone of Synanthedon pyri (Harris), the apple bark borer (ABB), is identical to that of DB; however, no ABB were found in our traps.

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Table 1. Number of burr knots in 2 m of trunk, % infested burr knots, % burr knots with exuviae, and % burr knots with larvae.[1]

Treatment	Burr knots /10 trees	% burr knots Infested	% burr knots Exuviae	% burr knots Larvae
Control:	58.0 (12.6)	68.5 (11.4)	4.3 (3.1)	26.2 (12.0)
Pheromone:	68.3 (22.3)	64.1 (4.7)	6.7 (4.1)	18.8 (7.3)

[1]Counts based on 10 groups of 10 trees each. Numbers in parentheses represent standard errors.

Fig. 1

Dogwood Borer Captures in Piney River Orchard Lilac Borer versus Dogwood Borer Traps
1993

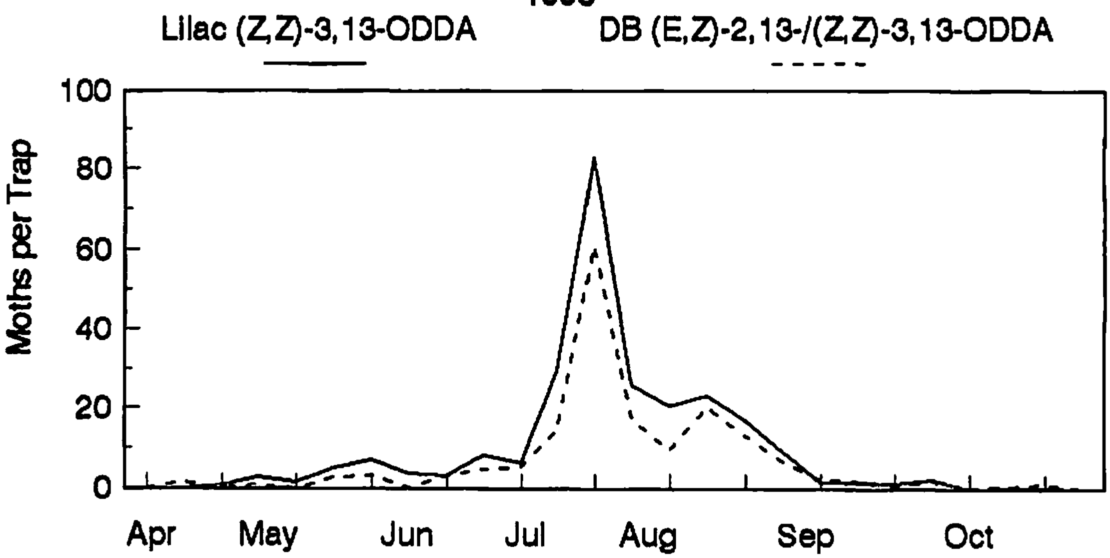
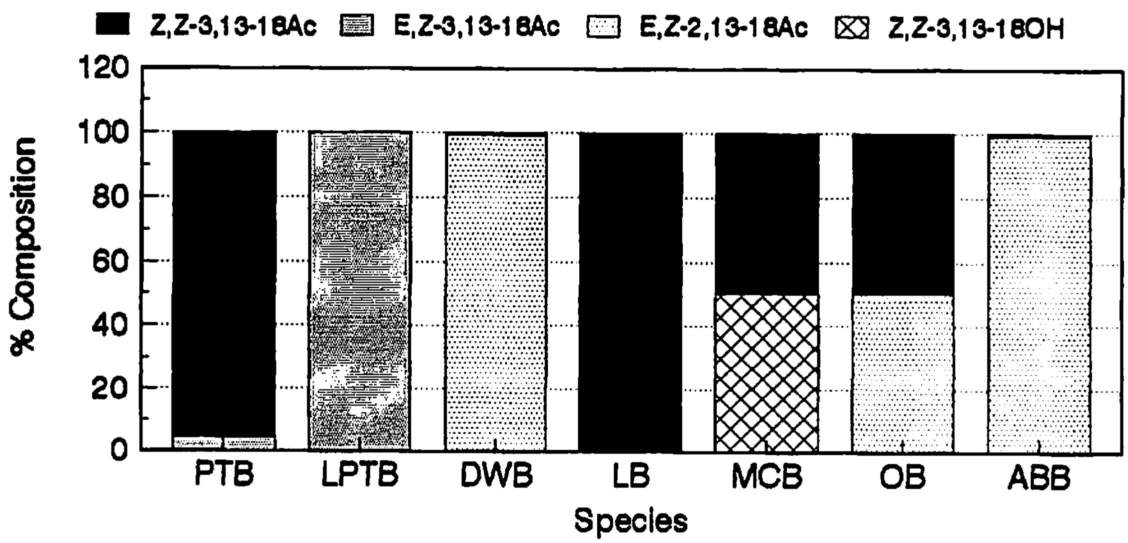


Fig. 2

Pheromone Composition of Selected Sesiid Species



Mating Disruption of Grape Berry Moth and Redbanded Leafroller in Virginia Vineyards - 1993

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I. Introduction: Mating disruption has been performed for grape berry moth since 1990. Most work done previously in this system has been performed in vineyards in New York and other northern areas (Dennehy et al. 1990, Trimble et al. 1991). The technique has worked fairly well in Virginia but with some exceptions that confirm the need for regional testing.

Both single and two component dispensers provided effective control of GBM (Pfeiffer & Wolf 1992). Z-11-tetradecen-1-yl acetate (Z11-14:Ac) is the lesser component in the two-component GBM dispenser. Z11-14:Ac is a major pheromone component of redbanded leafroller (RBL), an occasional pest in vineyards in our region (Jubb 1975, Pfeiffer & Schultz 1986). Our laboratory has achieved successful mating disruption of RBL using this component alone (Pfeiffer et al. 1991). Perhaps by using the two component dispenser, control of more than one pest could be achieved. Further research using the commercial dispenser was suggested by Pfeiffer & Wolf (1992).

II. Materials and Methods: In 1993, three blocks were treated with Shin Etsu dispensers at the full label rate of 400 dispensers per acre (1000/ha). Each dispenser contained 69 mg of Z-9-dodecen-1-yl acetate (90%)/ Z-11-tetradecen-1-yl acetate (10%). A 10-acre block at Rapidan River Vineyard (Madison Co.) consisted of `Riesling' vines; a 5-acre block at Redlands Vineyard (Albemarle Co.) of `Cabernet Franc' and `Chardonnay', and a 5-acre block at Ladd Vineyard (Augusta Co.) of `Concord' vines. Dispensers were placed on 18 and 24 May at Rapidan River, 2 June at the Ladd vineyard and 3 June at Redlands. Each block was associated with a conventionally treated control block of similar varietal composition.

All blocks were adjacent to mixed deciduous woodland. Three commercially available pheromone traps were placed in each block and monitored weekly to determine disruption of orientation to point sources of pheromone. Damage by the first generation of GBM was assessed by counting the percent infested clusters in at least 200 clusters in two rows each at block edges and middles. Percent infested clusters were determined periodically in June, July and August.

Percent infested berries were estimated by retrieving 20 clusters from each block edge and center, and separating individual berries for examination in the laboratory. Harvest dates were 3 September at Rapidan River, 3 September at Redlands and 10 September at Ladd.

III. Results and Discussion: Trap captures of GBM were almost totally eliminated in all pheromone-treated vineyards. However, GBM flight activity as reflected in pheromone trap catches, was very low in all blocks in 1993. RBL captures were almost totally suppressed in GBM pheromone-permeated blocks at both Rapidan River (Fig. 1) and the Ladd vineyard (Fig. 2).

Early season percent cluster data indicated successful control. At Rapidan River, harvest injury from GBM in the center and edge of the pheromone-treated block was 0.5%

and 5.4% (1134 and 1107 berries), respectively, and in the control block center and edge, 0% and 7.8% (1062 and 1303 berries), respectively. RBL injury in the pheromone block center and edge was 0% and 2.0%, and in the control center and edge was 0.2% and 2.4%, respectively.

At Redlands, percent injured berry data for the harvest samples are as follows: Pheromone block center and edge were 0.1% and 1.3%, respectively (2090 and 1692 berries). The control contained 0.1% and 0.05% injured berries in the center and edge, respectively (1703 and 2197 berries). RBL injury was negligible at Redlands.

At Ladd, the pheromone block center and edge were 1.6% and 14.5% (919 and 834 berries); in the control, 2.1% and 17.0%, respectively (1024 and 912 berries). The Ladd block is a high risk site, with a history of high GBM injury (Pfeiffer & Wolf 1991, 1992). The need for border row sprays is demonstrated by these data. A similar vineyard but in lower risk surroundings, Banjo Shack, contained 0.1% and 1.4% in the center and edge (896 and 961 berries). RBL injury at Ladd in the pheromone block was 0% and 0.5% in the center and edge. In the control block, RBL injury was 0% in both center and edge.

Mating disruption continued to provide control of GBM. Damage was higher in the edge of both pheromone-treated and conventionally managed blocks, as in past years. Based on trap catch data and limited injury data, the two-component pheromone dispenser for GBM may also provide control for RBL. Further work on reproduction by RBL in GBM-treated vineyards is planned.

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Grape Berry Moth Pheromone Dispenser Release Rates

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Introduction: In the preceding year, research was conducted on the release rate of two various grape berry moth dispensers, Biocontrol and Agrisense (Gronning & Pfeiffer, 1992). It was shown that the Biocontrol dispenser ceased releasing pheromone near day 90. This is quite early for the vineyard to lose pheromone protection. Late summer outbreaks of GBM could result. Therefore, Biocontrol developed a "long life" GBM pheromone dispenser in order to alleviate this problem.

Materials and Methods: Ten dispensers of each design (normal GBM and long life GBM) were tied to screw eyes attached to a 1.5m by 0.75m plywood board. This board was placed in a partially shaded balcony. The dispensers were recovered and weighed at periodic intervals.

Results and Discussion: Both dispensers exhibited the same release rate for the first 35 days. After which the normal GBM dispenser displayed gradual reduction in its release rate until day 95 where its release level out. Indicating that the dispenser ceased releasing pheromone in to the environment. The long life GBM dispenser's release rate continued on the same slope until day 90, Thereby maintaining a constant amount of pheromone being permeated in to the environment. Past ninety days the long life GBM's slope shallowed but continued to release more pheromone than the normal GBM. Even up to day 136 the long life dispenser's weight was still dropping significantly more than the normal GBM dispenser at day 75.

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Gronning, E. K. & D. G. Pfeiffer. 1992. Effect of shading and dispenser design upon pheromone release rates. 68th Cumberland-Shenandoah Fruit Workers Conference Proceedings, Harper's Ferry WV. Nov. 19-20.

Fig. 1

Effects of Grape Berry Moth Pheromone Permeation on Redbanded Leafroller Pheromone Trap Captures
Rapidan River - 1993

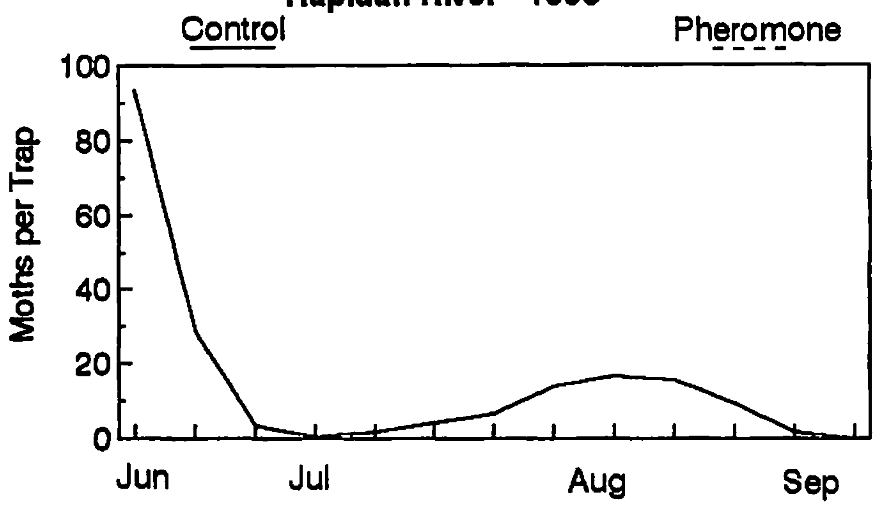
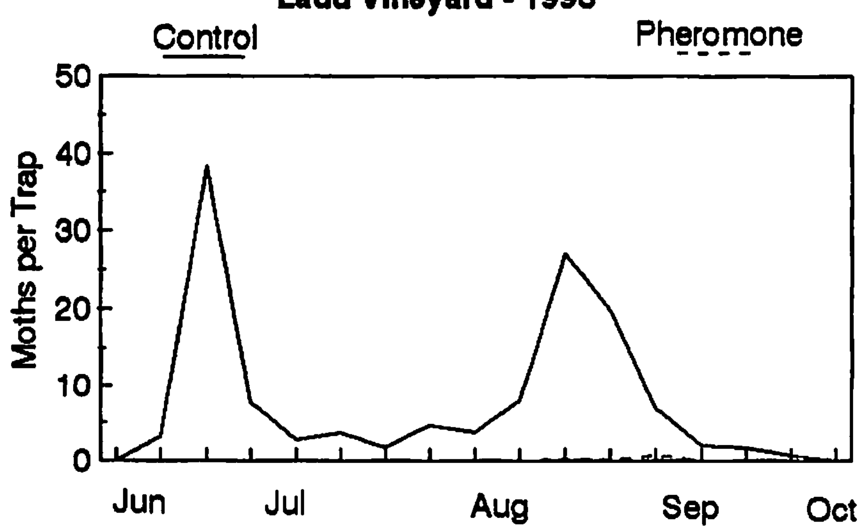


Fig. 2

Effect of Grape Berry Moth Pheromone Permeation on Redbanded Leafroller Pheromone Trap Captures
Ladd Vineyard - 1993



Control of European Red Mite on Grapevines with Pyrellin and Kelthane

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Department of Entomology
Virginia Polytechnic Institute & State University

GRAPE: *Vitis vinifera* `Riesling'
European red mite (ERM): *Panonychus ulmi* (Koch)

GRAPE, ACARICIDE TRIAL, 1993: Kelthane 50W and Pyrellin 1.1EC (0.60% pyrethrins, 0.50% rotenone) were applied to grapevines on 9 September. Although late in the season, populations were late in appearing in the vineyard and were still growing. Applications were made with a Kioritz backpack sprayer. Each treatment was applied to four single vine replications. Pretreatment counts were made on four leaves per vine. Post-treatment counts were made on 13, 20, 27 September and 4 October.

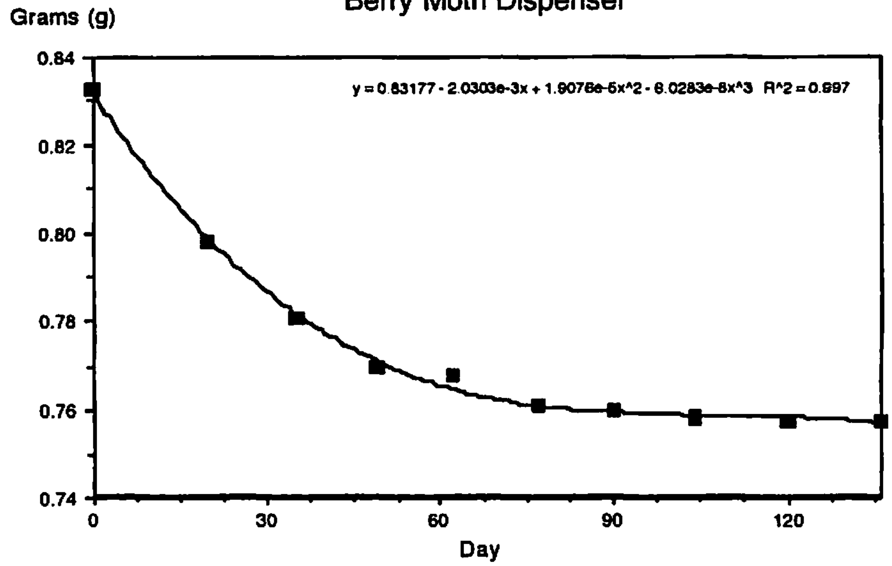
Pyrellin reduced densities of ERM, but not to the degree of Kelthane, the main acaricide now available. Pyrellin was usually intermediate in performance, significantly different from neither the control nor Kelthane. It may nevertheless have a place in grape pest control recommendations, for two reasons. The first relates to resistance management. If additional acaricides are available to growers, less selection pressure will be exerted on ERM for development of resistance to Kelthane. This has been a problem in other fruit crops. When resistance becomes established, it is stable for several years after the elimination of Kelthane sprays. The second factor relates to days-to-harvest restrictions. Kelthane may not be used after 7 days before harvest. The other registered acaricide in our region is Vendex, may not be applied within 28 days of harvest. Therefore, a further advantage of Pyrellin is that it may be the best product for late infestation, since it may be used until harvest. A disadvantage of Pyrellin is its short residual life. It does not maintain effective levels as long as Kelthane, and must be reapplied every 7 days while mite populations persist.

Table 1. Average numbers[1] of European red mite and eggs on grapevines (four leaves per vine, four replications) following applications of Kelthane and Pyrellin.

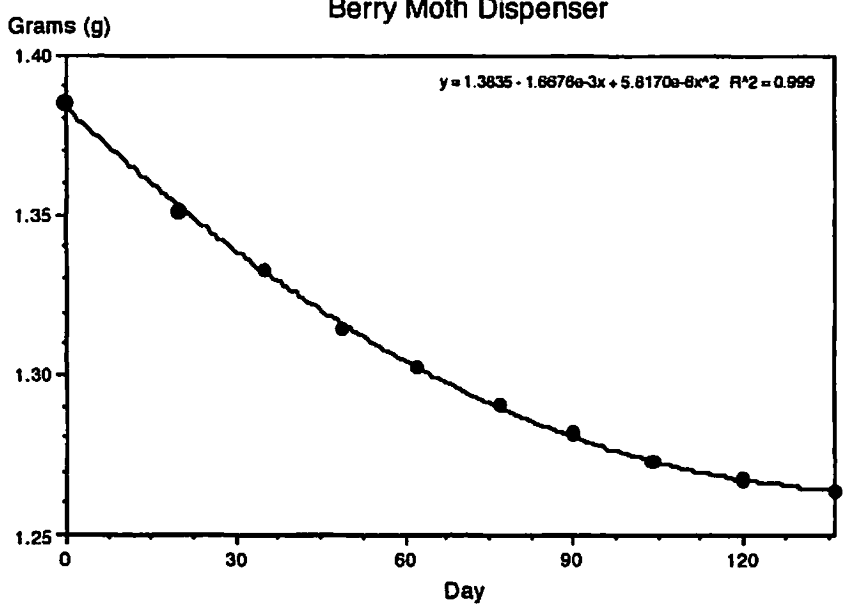
Material,	9 Sep		13 Sep		20 Sep		27 Sep		4 Oct	
AI/100L	ERM	RME	ERM	RME	ERM	RME	ERM	RME	ERM	RME
Kelthane 50W 59.9 g	342a	42a	30a	22a	6a	14a	1.2a	1.5a	1.2a	0a
Pyrellin 1.1EC 1.2 g	203a	70a	130ab	38a	80b	8a	11.5ab	1a	9.2a	3.5a
Pyrellin 1.1EC 2.3 g	310a	40a	102ab	18a	52b	4a	11.8ab	1.5a	4a	0a
Control	256a	40a	162b	34a	120c	20a	17a	1.2a	6.2a	0.8a

[1]Data transformed for analysis $[(x+0.5)^{0.5}]$. Numbers in a column followed by the same letter are not significantly different (Duncan's multiple range test, $P \leq 0.05$).

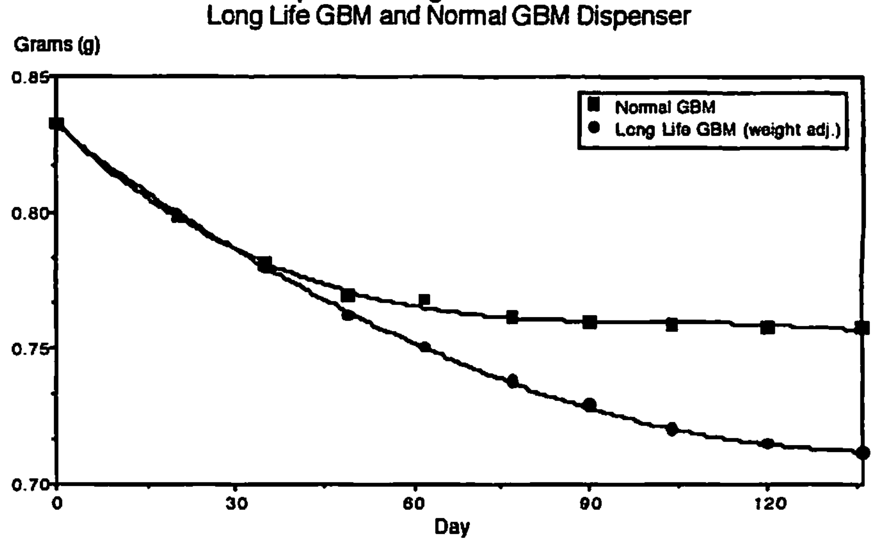
Weight Loss of Normal Grape
Berry Moth Dispenser



Weight Loss of Long Life Grape
Berry Moth Dispenser



Comparison Weight Loss Between
Long Life GBM and Normal GBM Dispenser



Mating Disruption of Leafrollers and Codling Moth - 1993

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Blacksburg VA 24061
Mary Washington College, Fredericksburg VA 22401

I. Introduction: The leafroller complex in the mid-Atlantic states includes several species, primarily variegated leafroller (VLR), *Platynota flavedana* (Clemens), tufted apple bud moth (TBM), *P. idaeusalis* Walker, and redbanded leafroller (RBL), *Argyrotaenia velutinana* (Walker). The leafroller complex is more diverse in our area than elsewhere in North America (Weires & Riedl 1992). Research has been performed on mating disruption for this complex in recent years (Pfeiffer et al. 1993b); further results are reported here.

Codling moth (CM), *Cydia pomonella* (L.), has been the subject of mating disruption in Virginia since 1987; this work has become more intensive since 1989. Results have been promising to date (Pfeiffer et al. 1993a). However, in some orchards damage has been higher than conventionally acceptable, especially in orchard edges. Further work is needed to determine how best to integrate mating disruption with chemical pest control.

II. Materials and Methods: <u>Tyro Orchard</u> - A 6-ha (15-acre) leafroller and CM disruption block was located in an orchard at Tyro (Nelson Co.). Shin-Etsu CM dispensers (Pacific Biocontrol, Davis CA) were placed on 4 May at the rate of 1000/ha (400/A). The pheromone blend contained in the dispensers was 192 mg of (*E,E*)-8,10-dodecadien-1-ol (63%)/ dodecenol (31%)/ tetradecenol (6%). Scentry TBM dispensers were placed at the same density on 11 May. The control block was treated with conventional insecticide program. Four pheromone traps (Trécé Inc., P.O. Box 6278, Salinas, Ca.) each for VLR, TBM, RBL, OBL and CM were placed in each block and monitored weekly. This orchard has had low levels of CM damage historically. Damage was assessed periodically during the season. Harvest samples were collected on 7 September, when 150 fruit of both `Red Delicious' and `Golden Delicious' were harvested both from the edge and center of each block (600 per block).

<u>Batesville Orchard</u> - Leafrollers and CM was the target of mating disruption in a 4-ha (10-acre) block, primarily `Winesap', at Batesville (Crown Orchard, Albemarle Co.). The control block, also primarily `Winesap'. was about 0.4 km (0.25 mi) away from the pheromone-treated block. CM dispensers were placed at 1000/ha on 3 May. TBM dispensers (Scentry) were not available for the first generation of *Platynota* spp.; they were placed on 4 August at the rate of 1000/ha. Four pheromone traps for VLR, TBM, RBL, OBL and CM were placed in both pheromone-treated and control blocks and checked weekly. The grower agreed to refrain from all insecticide sprays after first cover until recommended otherwise.

Harvest injury was assessed on 12 October in this `Winesap' block, when 150 fruit were harvested from the edge and center of each block (300 per block).

<u>Spring Valley</u> - A 4-ha (10-acre) block at Spring Valley (Albemarle Co.) was treated with Shin-Etsu CM pheromone dispensers at 1000/ha on 30 April. TBM dispensers (Scentry) were not available for the first generation and were placed on 3 August at the rate of 1000/ha. A conventional insecticide program was followed through first cover. A control block of similar varietal representation was located about 50 m away. Four pheromone traps each for VLR, TBM, RBL, OBL and CM were placed in each block and monitored weekly. Harvest injury was assessed on 7 September. At that time, 150 fruit of

both `Red Delicious' and `Golden Delicious' were harvested both from the edge and center of each block (600 per block).

Fincastle Orchard - A block near Fincastle (Botetourt Co.) was treated with clear Shin Etsu CM dispensers on 29 April, at 1000/ha. This block was 1.8 ha (4.5 acres), composed of `Red Delicious' (67%) and `Golden Delicious' (33%). Tree density was 325 trees/ha (130/acre). A standard insecticide program was followed through first cover, after which no further insecticides were applied unless conditions warranted them. Scentry TBM dispensers were place on 17 May at 1000/ha. The control block, of similar varietal composition, was about 0.4 km (0.25 mi) away from the block treated with pheromone; a conventional insecticide program was followed. Three pheromone traps each for VLR, TBM, RBL, OBL and CM were placed in each block and monitored weekly. Injury was assessed periodically as in the Daleville block. Harvest injury was assessed on 31 August.

Daleville Orchard - Mating disruption of leafrollers and CM was performed in a 1.9-ha (4.7-acre) block at Daleville (Botetourt Co.), primarily composed of `Red Delicious', also including `Golden Delicious'. The block treated with pheromone was isolated, but with a small abandoned block about 50 m away. Shin-Etsu CM pheromone dispensers were used in this block. Dispensers were placed on 29 April at the rate of 1000/ha (400/acre). Tree density was 300 trees/ha (120/acre). After the first cover spray the grower agreed to withhold all insecticide sprays until pest conditions required action. Dispensers for leafrollers were not available for the first generation of *Platynota* spp. Dispensers containing pheromone for TBM (Scentry) were placed on 6 August. The control block, treated with a conventional spray program, was about 1.6 km (1 mi) away, and was surrounded by additional commercial apple orchard.

Three pheromone traps each for CM. VLR, TBM, RBL and OBL were placed in the blocks treated with pheromone and with conventional sprays and were monitored weekly. Damage was assessed periodically by examining at least 200 fruit in the pheromone-treated, control, and abandoned blocks. At the harvest count (31 August), 150 fruit of both `Red Delicious' and `Golden Delicious' were sampled from the edge and center of both the disruption and control blocks (600 fruit per block). Fruit were examined *in situ* until the final count, when fruit were removed from the trees for closer examination.

III. Results and Discussion: Flight Data: Trap capture data for VLR in the five orchards are presented in Fig. 1. VLR catch was largely suppressed in both generations where TBM dispensers were placed in the spring (Tyro and Fincastle). Crown Orchard had unexplained low catches even before dispenser placement. Spring Valley had no clear effect on VLR captures. The Daleville orchard, where only the second generation was treated, exhibited complete trap shutdown.

Trap capture data for TBM in the five orchards are presented in Fig. 2. TBM dispensers caused almost complete trap shutdown of TBM whether placement was in time for both generations or second generation alone.

Trap capture data for RBL in the five orchards are presented in Fig. 3. TBM dispensers caused almost complete trap shutdown of RBL regardless of timing of dispenser placement.

Captures of CM and OBL in 1993 were extremely low at all sites.

Damage Data: No injury from leafrollers (either *Platynota* spp or RBL) was detected at Tyro. At Crown, no CM or RBL injury was found in the pheromone block. In the center of the pheromone block, 0.7% injury (1 fruit) was injured by *Platynota*; none were found in the edge. No fruit injured by leafrollers or CM were found in the center of the control block at Crown; in the edge of the control block, 1.3% and 0.7% were injured by CM and *Platynota*, respectively.

At Spring Valley, 0.3% were injured by CM in the center of the pheromone block, none at the edge. No leafroller injury was found in the pheromone block center, while 1.3% were injured by *Platynota* in the edge. No CM or RBL injury was found in the Spring Valley control; 0.7% were injured by *Platynota* in the control center.

No fruit injury was found in the Fincastle pheromone block from either leafrollers or CM; a single fruit injured by RBL was found in the edge of the control. At Daleville, 1.7% injury from CM was found in the center of the pheromone block; none was found in the edge. No leafroller injury was found in the pheromone block. Neither leafroller nor CM injury was found in the Daleville control block.

IV. References Cited:

Pfeiffer, D. G., W. Kaakeh, J. C. Killian, M. W. Lachance, and P. Kirsch. 1993a. Mating disruption for control of damage by codling moth in Virginia apple orchards. Entomol. Exp. Applic. 67: 57-64.

Pfeiffer, D. G., W. Kaakeh, J. C. Killian, M. W. Lachance, and P. Kirsch. 1993b. Mating disruption to control damage by leafrollers in Virginia apple orchards. Entomol. Exp. Applic. 67: 47-56.

Pfeiffer, D. G., J. C. Killian, M. W. Lachance, L. F. Ponton & B. A. Ang. 1991. Mating disruption of the leafroller complex in apple - 1991. Proc. 67th Cumberland-Shenandoah Fruit Workers' Conf., Harper's Ferry WV. Nov. 21-22.

Weires, R. & H. Riedl. 1991. North American species. p. 413-434. *In* L. P. S. van der Geest & H. H. Evenhuis (eds). World Crop Pests. vol. 5. Tortricid Pests: Their Biology, Natural Enemies and Control. Elsevier, N.Y.

Fig. 1

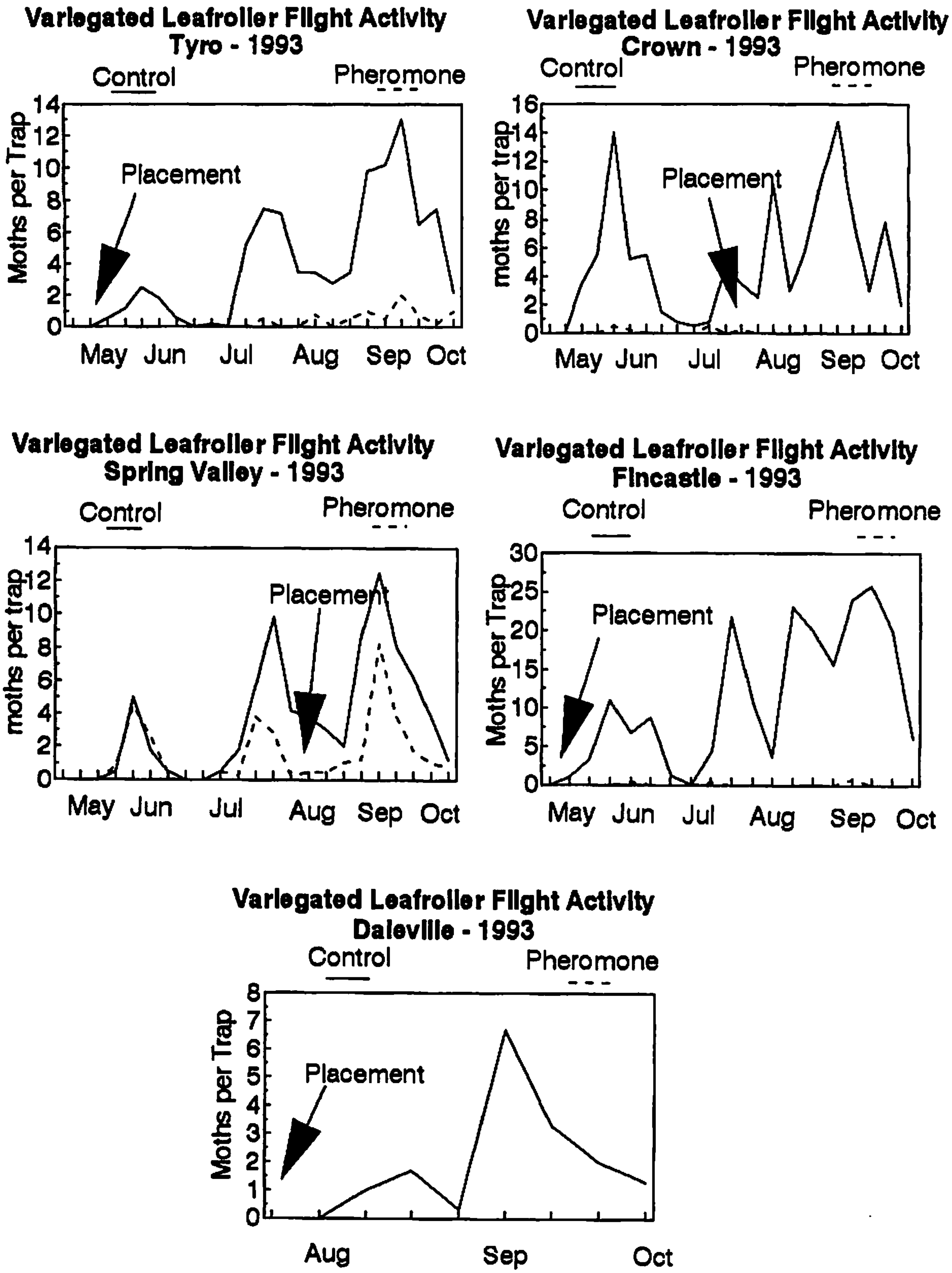
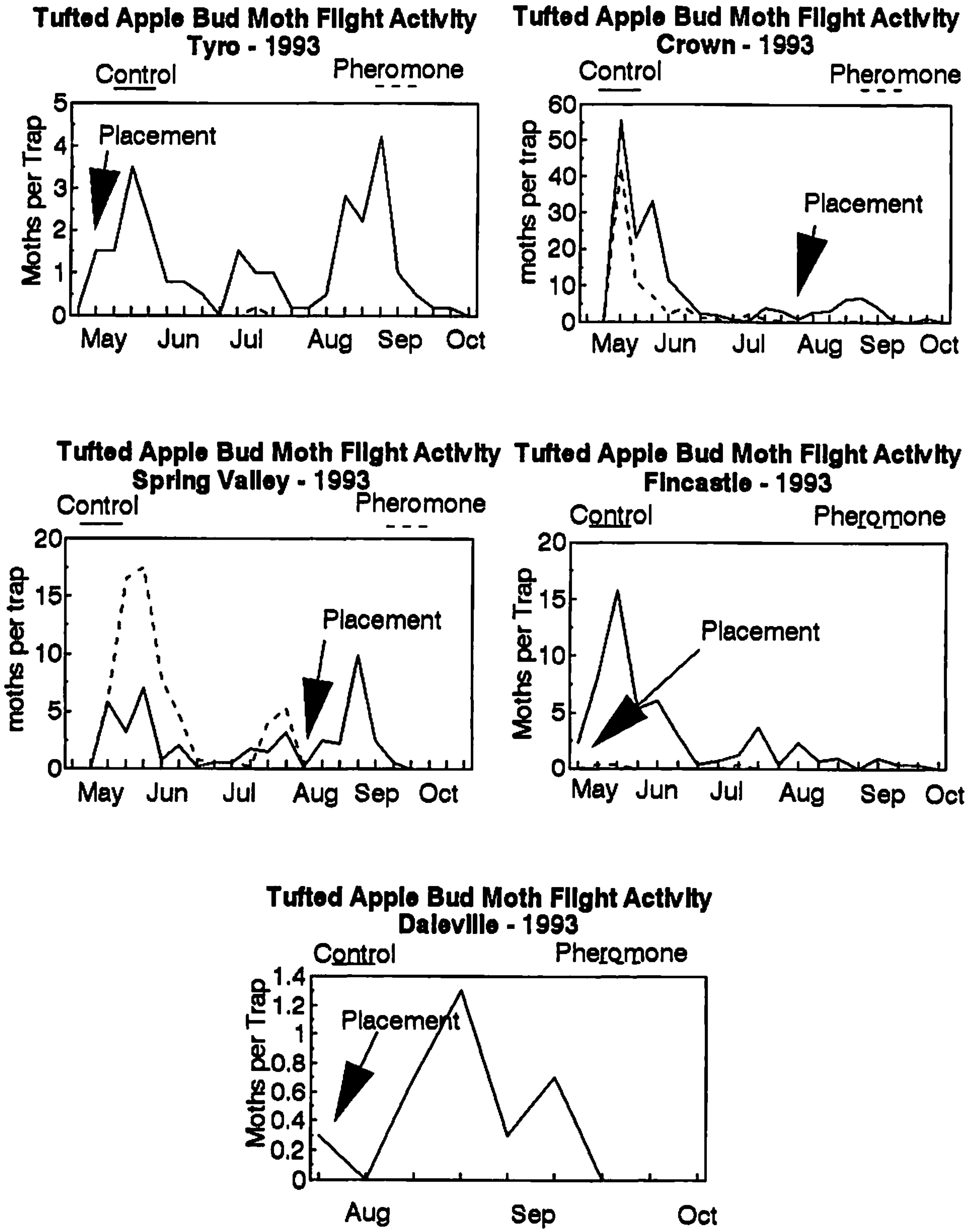
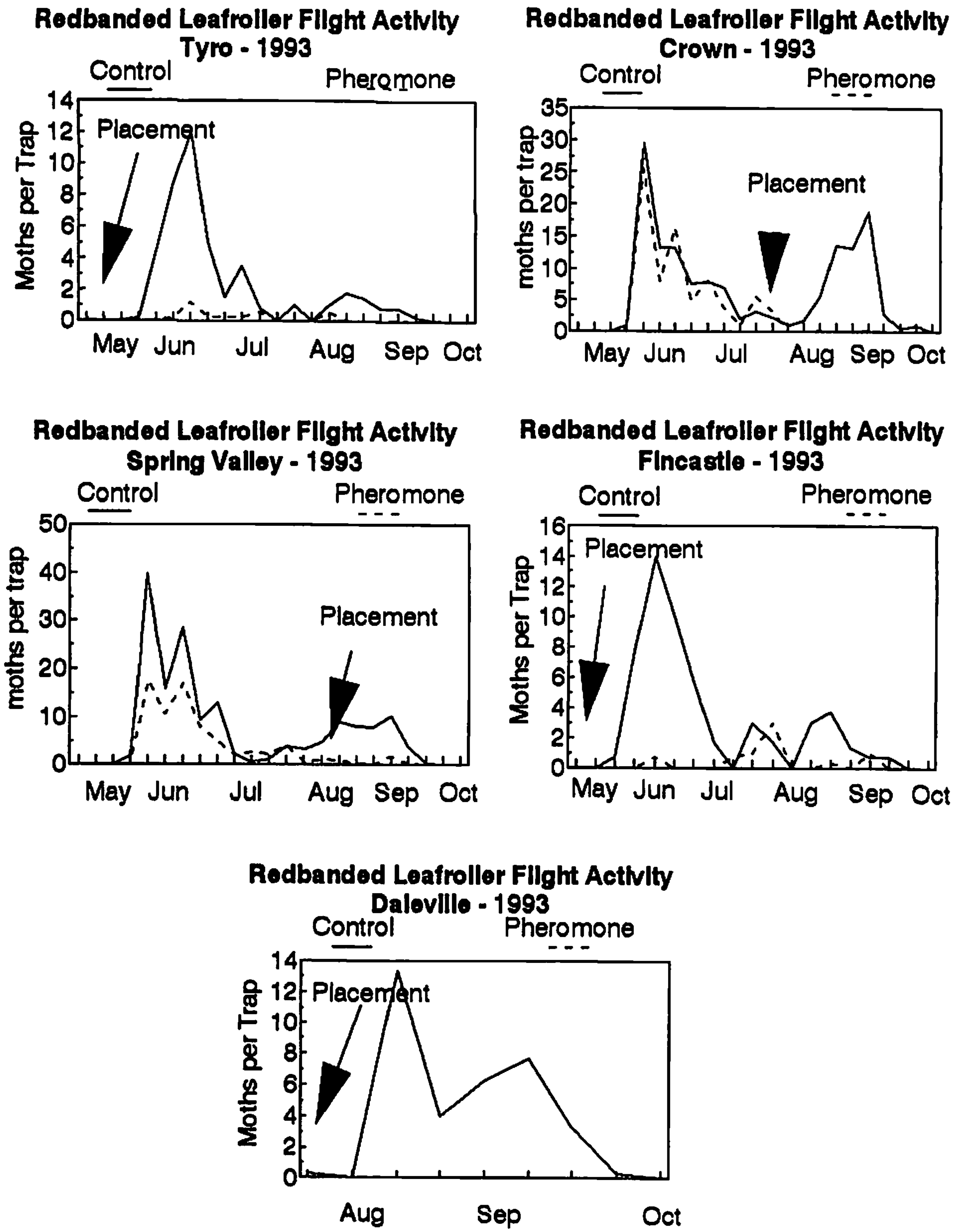

Variegated Leafroller Flight Activity
Tyro - 1993
Control
Pheromone
Moths per Trap
Placement
0
2
4
6
8
10
12
14
May
Jun
Jul
Aug
Sep
Oct
Variegated Leafroller Flight Activity
Crown - 1993
Control
Pheromone
moths per trap
Placement
0
2
4
6
8
10
12
14
16
May
Jun
Jul
Aug
Sep
Oct
Variegated Leafroller Flight Activity
Spring Valley - 1993
Control
Pheromone
moths per trap
Placement
0
2
4
6
8
10
12
14
May
Jun
Jul
Aug
Sep
Oct
Variegated Leafroller Flight Activity
Fincastle - 1993
Control
Pheromone
Moths per Trap
Placement
0
5
10
15
20
25
30
May
Jun
Jul
Aug
Sep
Oct
Variegated Leafroller Flight Activity
Daleville - 1993
Control
Pheromone
Moths per Trap
Placement
0
1
2
3
4
5
6
7
8
Aug
Sep
Oct

Fig. 2



Tufted Apple Bud Moth Flight Activity
Tyro - 1993
Control
Pheromone
Placement
Moths per Trap
0
1
2
3
4
5
May
Jun
Jul
Aug
Sep
Oct
Tufted Apple Bud Moth Flight Activity
Crown - 1993
Control
Pheromone
Placement
moths per trap
0
10
20
30
40
50
60
May
Jun
Jul
Aug
Sep
Oct
Tufted Apple Bud Moth Flight Activity
Spring Valley - 1993
Control
Pheromone
Placement
moths per trap
0
5
10
15
20
May
Jun
Jul
Aug
Sep
Oct
Tufted Apple Bud Moth Flight Activity
Fincastle - 1993
Control
Pheromone
Placement
Moths per Trap
0
5
10
15
20
May
Jun
Jul
Aug
Sep
Oct
Tufted Apple Bud Moth Flight Activity
Daleville - 1993
Control
Pheromone
Placement
Moths per Trap
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Aug
Sep
Oct

Fig. 3


Redbanded Leafroller Flight Activity
Tyro - 1993
Control
Pheromone
Placement
Moths per Trap
0
2
4
6
8
10
12
14
May
Jun
Jul
Aug
Sep
Oct
Redbanded Leafroller Flight Activity
Crown - 1993
Control
Pheromone
Placement
moths per trap
0
5
10
15
20
25
30
35
May
Jun
Jul
Aug
Sep
Oct
Redbanded Leafroller Flight Activity
Spring Valley - 1993
Control
Pheromone
Placement
moths per trap
0
10
20
30
40
50
May
Jun
Jul
Aug
Sep
Oct
Redbanded Leafroller Flight Activity
Fincastle - 1993
Control
Pheromone
Placement
Moths per Trap
0
2
4
6
8
10
12
14
16
May
Jun
Jul
Aug
Sep
Oct
Redbanded Leafroller Flight Activity
Daleville - 1993
Control
Pheromone
Placement
Moths per Trap
0
2
4
6
8
10
12
14
Aug
Sep
Oct

Small Plot Comparisons of Pheromone Blends for the Leafroller Species Complex: Scentry Regional Study - 1993

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Mary Washington College, Fredericksburg VA 22401

I. Introduction: The diversity of leafrollers affecting apple in the Mid-Atlantic region is greater than in many other areas (Weires & Riedl 1991). The most important leafroller species are variegated leafroller (VLR), *Platynota flavedana* (Clemens), tufted apple bud moth (TBM), *P. idaeusalis* Walker, redbanded leafroller (RBL), *Argyrotaenia velutinana* (Walker), and to a lesser extent, obliquebanded leafroller (OBL), *Choristoneura rosaceana* (Harris). Mating disruption can be an effective control for this complex (Pfeiffer et al. 1993), but may be cost-prohibitive unless a single set of dispensers can be made to disrupt the entire complex. Small plots are useful in comparing relative efficacy of blends in disrupting orientation of male moths (Pfeiffer et al. 1993), although insufficient to prevent injury. The following small plot study was performed in 1993 as part of a regional study comparing leafroller pheromone blends.

II. Materials and Methods: Two proposed generic blends were provided in spiral dispensers by Scentry, along with spirals containing the blend for VLR, the most important species in central Virginia, for use as a standard. Generic I was composed of *E*11-14:OH and *Z*11-14:Ac (50:50); Generic II was composed of these components plus *E*11-14:Ac (30:40:30). The overlap of these blends with those of the four main leafroller species in our region can be determined in Fig. 1.

The study was performed twice, the first starting on 10 May (covering the period of the first generation of VLR and TBM and second generation of RBL) and the second starting on 28 July (covering the period of the second VLR and TBM generations and third generation of RBL). Each of these studies included four replications, two each in orchards in Roseland and Tyro (Nelson Co.). The duration of the first trial was 11 weeks, that of the second trial was 12 weeks. Plots were 30 x 30 m, and were separated by 20 m buffers. Each replication (block) contained an untreated plot. One pheromone trap each for VLR, TBM, RBL and OBL (Traps by Scentry, lures by Trécé) was placed in the center of each plot and were monitored weekly. New plots were used and treatment positions re-randomized for the second trial. The relative positions of the pheromone traps for each species within a plot were determined randomly.

III. Results and Discussion: The performance of each pheromone blend within each species during the first trial is depicted in Fig. 2. Fig. 3 gives the same information arranged such that the behavior of each species is given within each blend. Trap captures of VLR in the first generation were generally low. Generic I appeared to reduce trap captures more than the other blends. All blends reduced captures of TBM. Both Generic I and II reduced captures of RBL; the VLR blend had little effect on that species, not surprising given the lack of overlap in the blends (Fig. 1).

In the second trial, VLR was the most numerous leafroller captured, typical of many orchards during the second generation. Generic II again had the lowest number of VLR moths captured. This was somewhat surprising since in that blend, a VLR component was reduced in favor on a non-component, relative to Generic I (Fig. 1). All blends reduced captures of TBM. Both generic blends reduced captures of RBL; as in the first trial, the VLR blend had no effect on RBL. In larger plots, VLR pheromone permeation failed to control RBL (Pfeiffer et al. 1993). Fig. 4 gives the data given in Fig. 3, but in the context of the four species' behavior within a blend.

The VLR blend, Generic II and, to a lesser extent, Generic I, appeared suitable for disruption of communication by both *Platynota* spp. Both generic blends were suitable for RBL, while the VLR blend was not suitable for that species. OBL was present at levels too low to yield meaningful results.

IV. References Cited:

Pfeiffer, D. G., W. Kaakeh, J. C. Killian, M. W. Lachance, and P. Kirsch. 1993. Mating disruption to control damage by leafrollers in Virginia apple orchards. Entomol. Exp. Applic. 67: 47-56.

Weires, R. & H. Riedl. 1991. North American species. p. 413-434. *In* L. P. S. van der Geest & H. H. Evenhuis (eds). World Crop Pests. vol. 5. Tortricid Pests: Their Biology, Natural Enemies and Control. Elsevier, N.Y.

Fig. 1

Sex Pheromone Compositions for Four Leafroller Species and Two Generic Blends - 1993

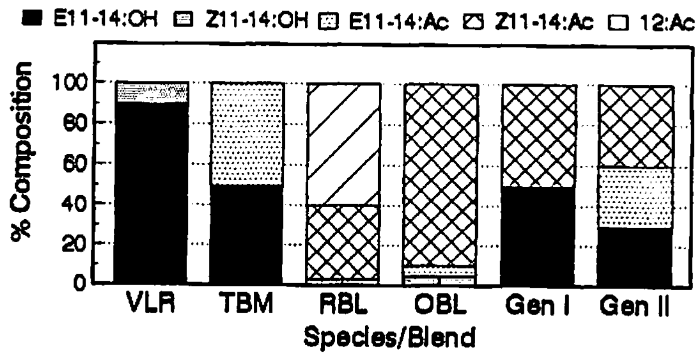


Fig. 2

Effect of Pheromone Environment on Trap Captures of Four Leafroller Species

Regional Study - Virginia 1993 (1st Placement)

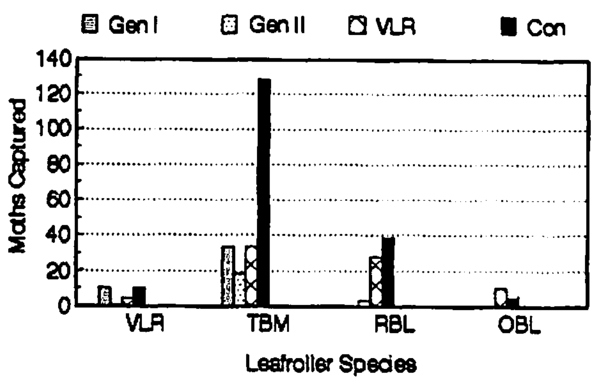


Fig. 3

Captures of Four Leafroller Species in Four Pheromone Environments

Regional Study - Virginia 1993 (1st Placement)

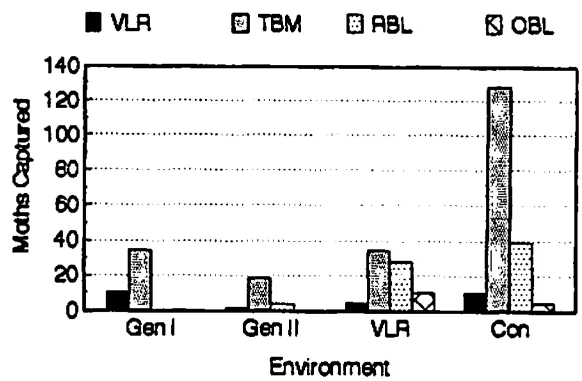


Fig. 4

Effect of Pheromone Environment on Trap Captures of Four Leafroller Species

Regional Study - Virginia 1993 (2nd Placement)

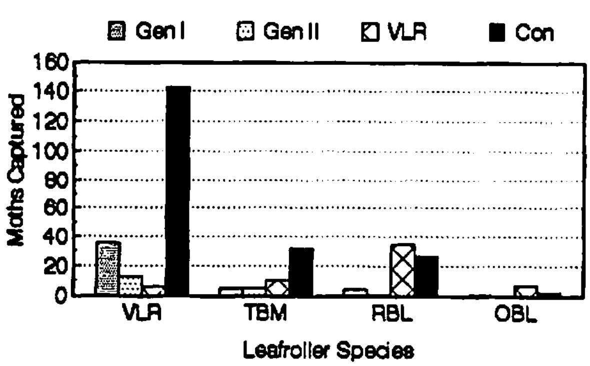
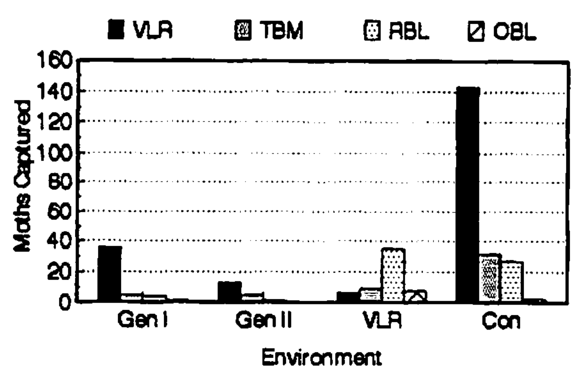


Fig. 5

Captures of Four Leafroller Species in Four Pheromone Environments

Regional Study - Virginia 1993 (2nd Placement)



Small Plot Comparisons of Pheromone Blends for the Leafroller Species Complex: Hercon Blend Study - 1993

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Virginia Polytechnic Institute and State University
Blacksburg, VA

Introduction: Several species in the leafroller complex possess the same chemical constituents in their pheromone. The chemicals are just at differing percentages. The Variegated leafroller (VLR) pheromone blend, for instance, contains 90% E11-14:OH. The tufted apple bud moth (TBM) contains 50% E11-14:OH. Red banded leafroller (RBL) pheromone blend consists of 37% Z11-14:Ac, while the oblique banded leafroller (OBL) pheromone blend consists of 90% Z11-14:Ac. In the preceding year, research was conducted on the effect one species pheromone blend had upon the other leafrollers. The data collected indicated that the other blends did disrupt other particular species (Gronning & Pfeiffer, 1992). Therefore this study was performed not only to support last years' results but determine whether a "generic" blend would disrupt as effectively as one species specific blend would.

Material and Methods: Seven small plot pheromone environments were used: VLR, TBM, RBL, OBL, Generic I, Generic II, and the control. Each environment was replicated four times, for a total of 28 individual small plots. A small plot consisted of a four tree by five tree area (approximately 214 m^2). Treatments were randomly allocated to plots and were separated by at least a two tree wide (7.3 m) zone. Five dispensers were placed upon each tree. Within each small plot four pheromone traps were placed: VLR, TBM, RBL, and OBL. Traps were recorded weekly.

Results and Discussion: Trap captures for VLR were greatly reduced in the VLR, TBM, Generic I, and Generic II. There was no significant difference between the VLR captures in the RBL, OBL, and control environments.

Trap captures for TBM were low in VLR, TBM, OBL, Generic I, and Generic II. They were all significantly different from the control except TBM captures in the RBL environment. It is important to note that TBM populations are low in central Virginia.

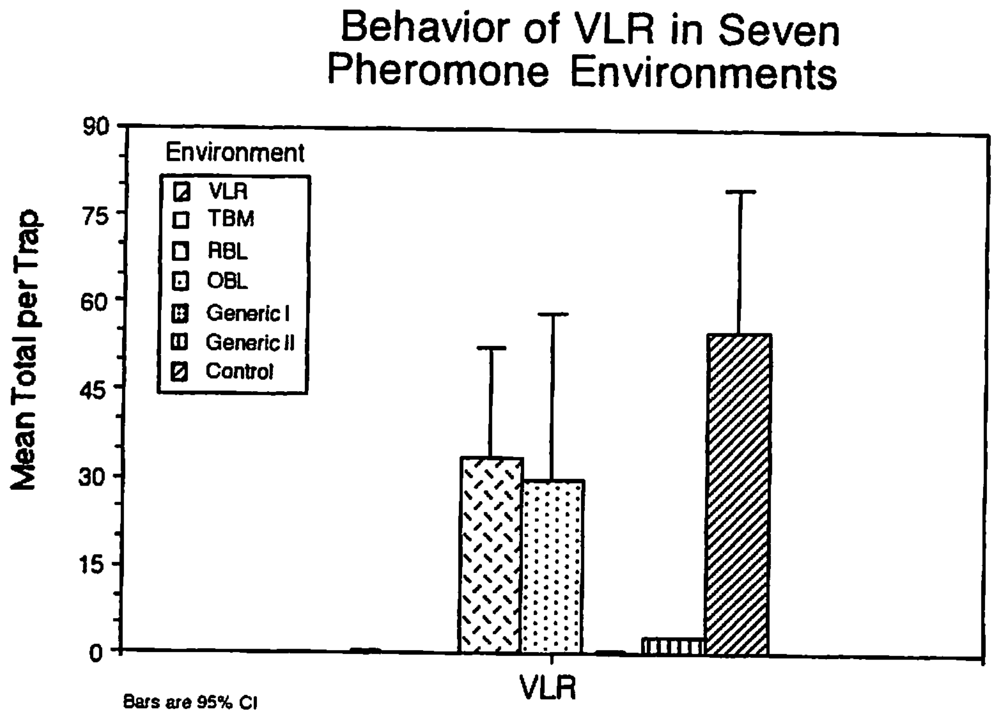
Trap captures for RBL were low for all environments except the control. However the control was not significantly different from any of the other environments.

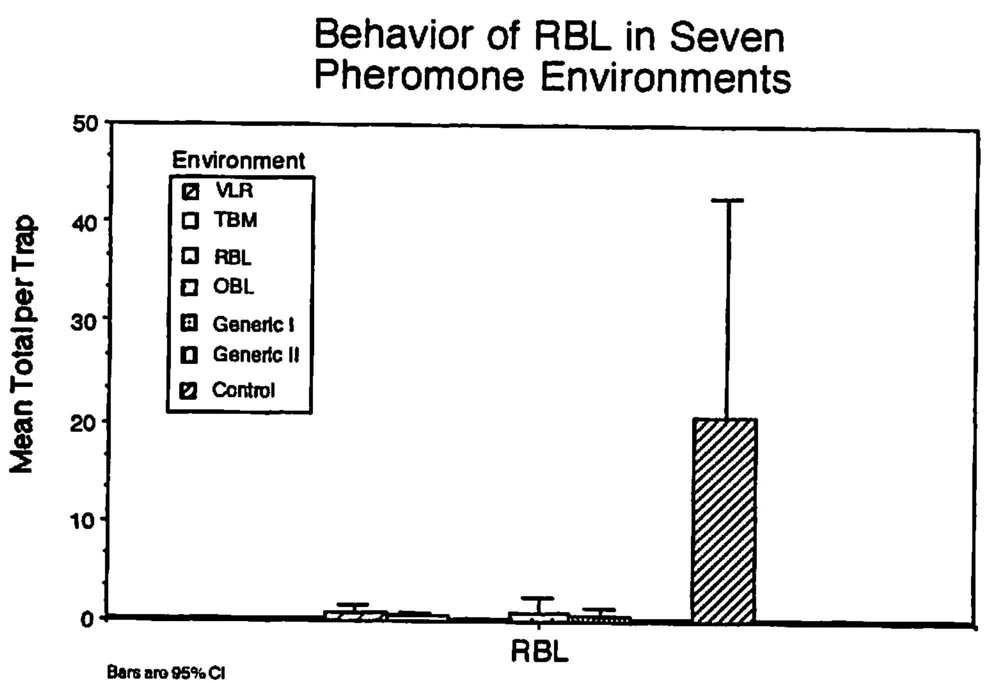
No OBL were captured in this experiment. OBL is not an important apple pest in Virginia to date.

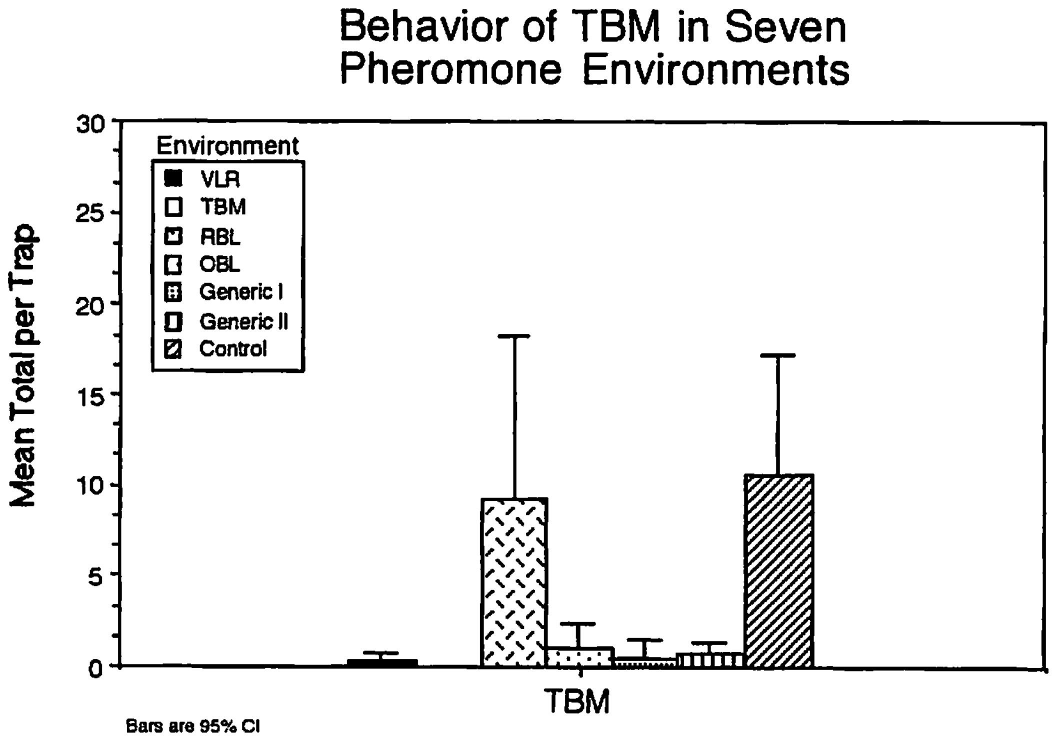
Confidence intervals were based on the mean total trap capture for each replicate. Trap capture of particular species varied greatly between replicates. Therefore determining significance might not be easy. In the RBL, for example, 94.4% of the trap capture, in the control, was in two traps. While definitely more moths were captured in the control, it does not show in the statistics.

References Cited:

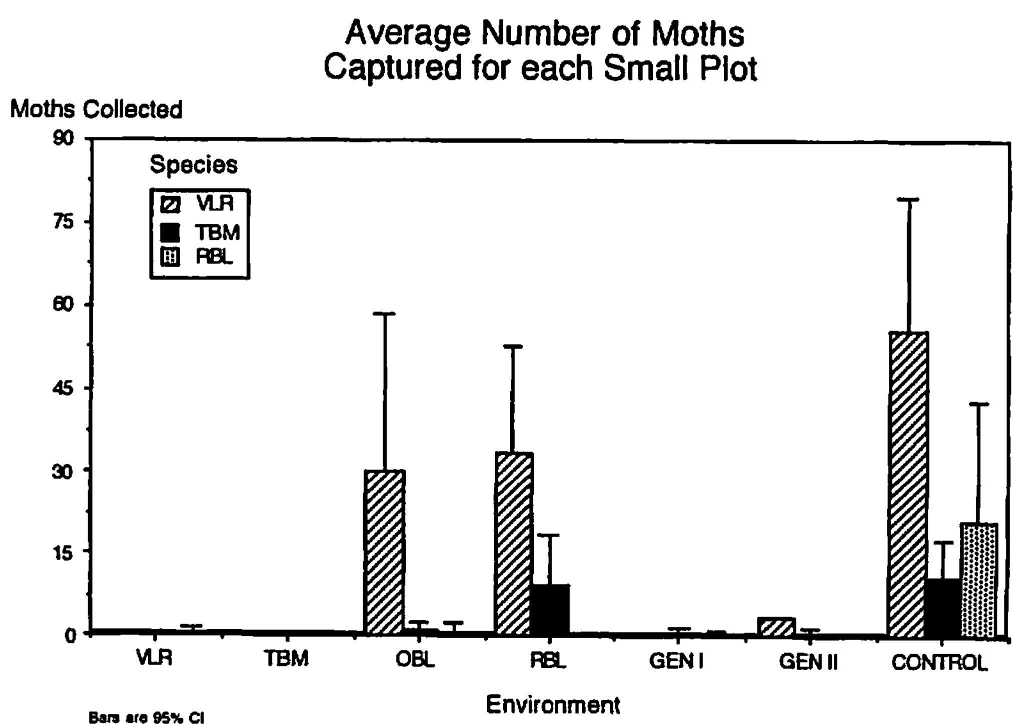
Gronning, E. K. & D. G. Pfeiffer. 1992. Effect of shading and dispenser design upon pheromone release rates. 68th Cumberland-Shenandoah Fruit Workers Conference Proceedings, Harper's Ferry WV. Nov. 19-20.


Behavior of VLR in Seven
Pheromone Environments
90
75
60
45
30
15
0
Mean Total per Trap
Environment
VLR
TBM
RBL
OBL
Generic I
Generic II
Control
VLR
Bars are 95% CI


Behavior of RBL in Seven
Pheromone Environments
50
40
30
20
10
0
Mean Total per Trap
Environment
VLR
TBM
RBL
OBL
Generic I
Generic II
Control
RBL
Bars are 95% CI



Behavior of TBM in Seven
Pheromone Environments
Mean Total per Trap
30
25
20
15
10
5
0
Environment
VLR
TBM
RBL
OBL
Generic I
Generic II
Control
TBM
Bars are 95% CI



Average Number of Moths
Captured for each Small Plot
Moths Collected
90
75
60
45
30
15
0
Species
VLR
TBM
RBL
VLR
TBM
OBL
RBL
GEN I
GEN II
CONTROL
Environment
Bars are 95% CI

NOT FOR CITATION

Title: Plum Curculio Trapping Trials In Southeastern Peaches

Authors: Russ Mizell, NFREC-Monticello, University of Florida, Route 4, Box 4092, Monticello, FL 32344 (904) 997-2596; Dan Horton, University of Georgia, Department of Entomology, Athens, GA 30602; Carroll Yonce, Louis Tedders & Jerry Payne, USDA Southeastern Tree Fruit and Nut Laboratory, Box 87, Byron, GA, 31008.

Abstract: Season-long comparisons of adult plum curculio captures were made in unsprayed middle Georgia and north Florida peach orchards. A slender masonite pyramid with a boll weevil trap mounted at the apex, "Tedders Trap" (Tedders and Wood 1993), was compared to the research standard of early morning limb jarring. Trap captures were comparable to jarring. The curculio trap's potential as a commercial IPM tool may be considerable.

Introduction: Plum curculio is a key pest of stone and pome fruit throughout eastern North America. Scientists have used a drop cloth with jarring of scaffold limbs which takes advantage of the weevil's thanototic behavior as a sampling and collection method. However, no practical and reliable commercial method of monitoring adult plum curculio was available.

Tedders and Wood (1993) reported on the use of a novel dark colored, pyramid trap as a practical and efficient method to monitor pecan weevil, _Curculio caryae_, in pecan orchards. The "Tedders Trap" is cheap to make, easy to use, statistically reliable and readily accepted by pecan growers. Following successes with pecan weevil monitoring, we decided to test the application of the Tedders Trap for monitoring of adult plum curculio in peach orchards.

Methods and Materials: The Tedders Trap is made out of eighth inch masonite and is four feet in height (Figs. 2 & 3). The top is cut such that a boll weevil plastic/screen collection trap (source is listed in references) with plastic channel inserts can be placed snugly on the top. The bottom is fastened to the ground with wire stakes. Traps colored a flat black or dark gray worked best for pecan weevil.

We evaluated three trap colors for plum curculio: white, light gray and dark gray. The traps were placed in the orchard within the rows between trees. One trap of each color was alternated in each trap line three times for a total of nine traps. Traps lines were placed within the rows nearest the edge of orchards where it was thought plum curculio might overwinter and other places in the orchard interior. Traps were checked at weekly or shorter intervals and limb jarring samples were also taken at the same time from surrounding trees.

Results and Discussion: The traps readily collected plum curculio in the field in numbers comparable to or higher than the limb jarring method. Plum curculio were caught in traps of all colors but significantly more were caught in the dark gray traps in most test locations. Plum curculio phenology indicated by trapping data reflected previous data on plum curculio emergence based on limb jarring and observations (Yonce, unpublished). Plum curculio were caught in the Tedders Trap at times when no plum curculio were detected by limb jarring (Fig. 1). The Tedders Trap has great potential for monitoring plum curculio and appears to have considerable use as an IPM tool.

References:

Source of Boll Weevil Trap: SEBWEF, Inc. 2119 East South Blvd. Montgomery, Al 36116. Phone: (205) 223-7532).

Tedders, W. L. & B. Wood. 1993. A new technique for monitoring pecan weevil emergence (Coleoptera: Curculionidae). J. Entomol. Sci. (In Press).

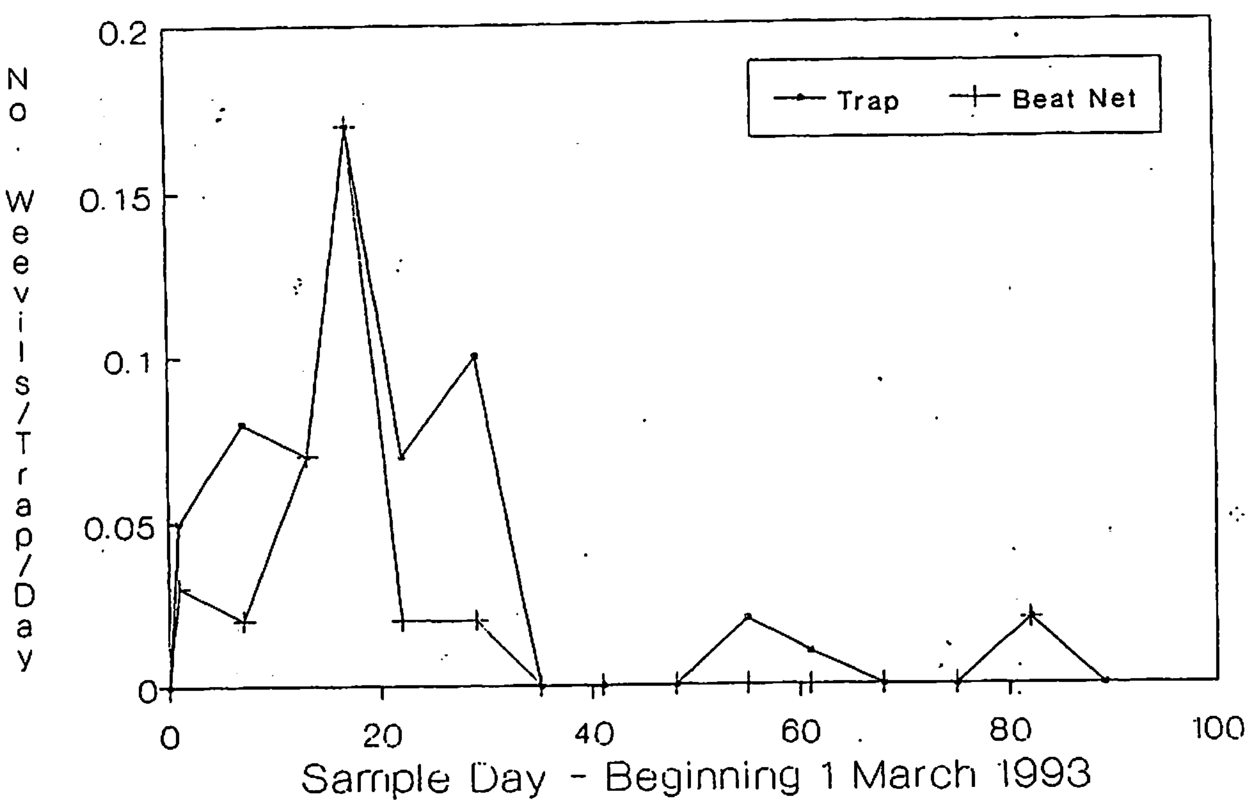


Figure 1: Mean number of plum curculio adults caught per Tedders trap per day in Florida.

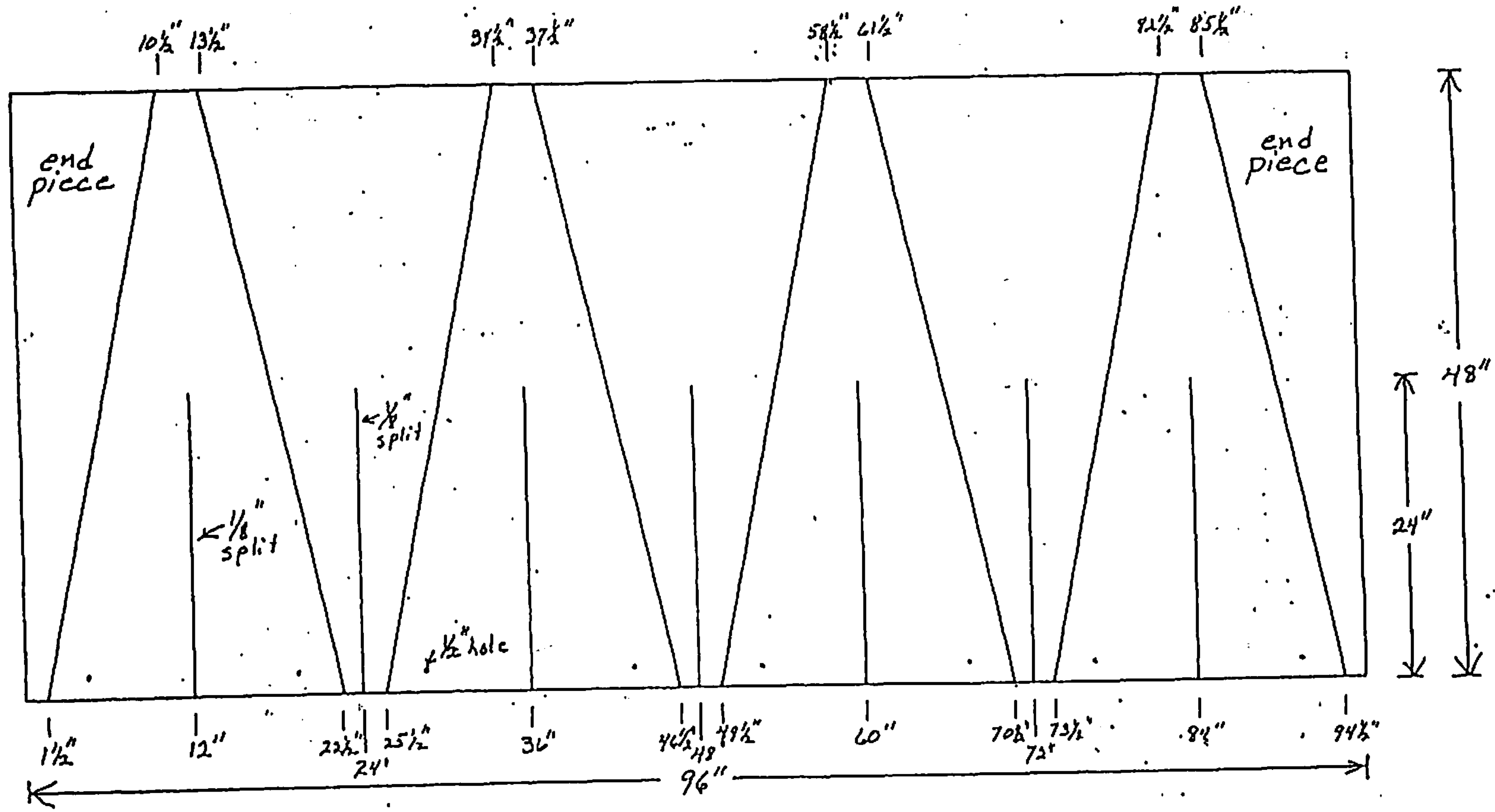


Figure 1: Plans for the Tedders Trap used to monitor plum curculio. The dimensions of the traps and saw cuts from a sheet of eight-inch tempered masonite. For correct measurement of cuts, measure from left to right along the two 96" sides as indicated. The two end pieces can be spliced together from the bottom or top side by glueing with a 3" x 24" strip of masonite and each sheet of masonite will yield 4 traps. Use stiff wire through a hole in the base corners or attach a block of wood to the base corners with a vertical hole to anchor trap to the ground.

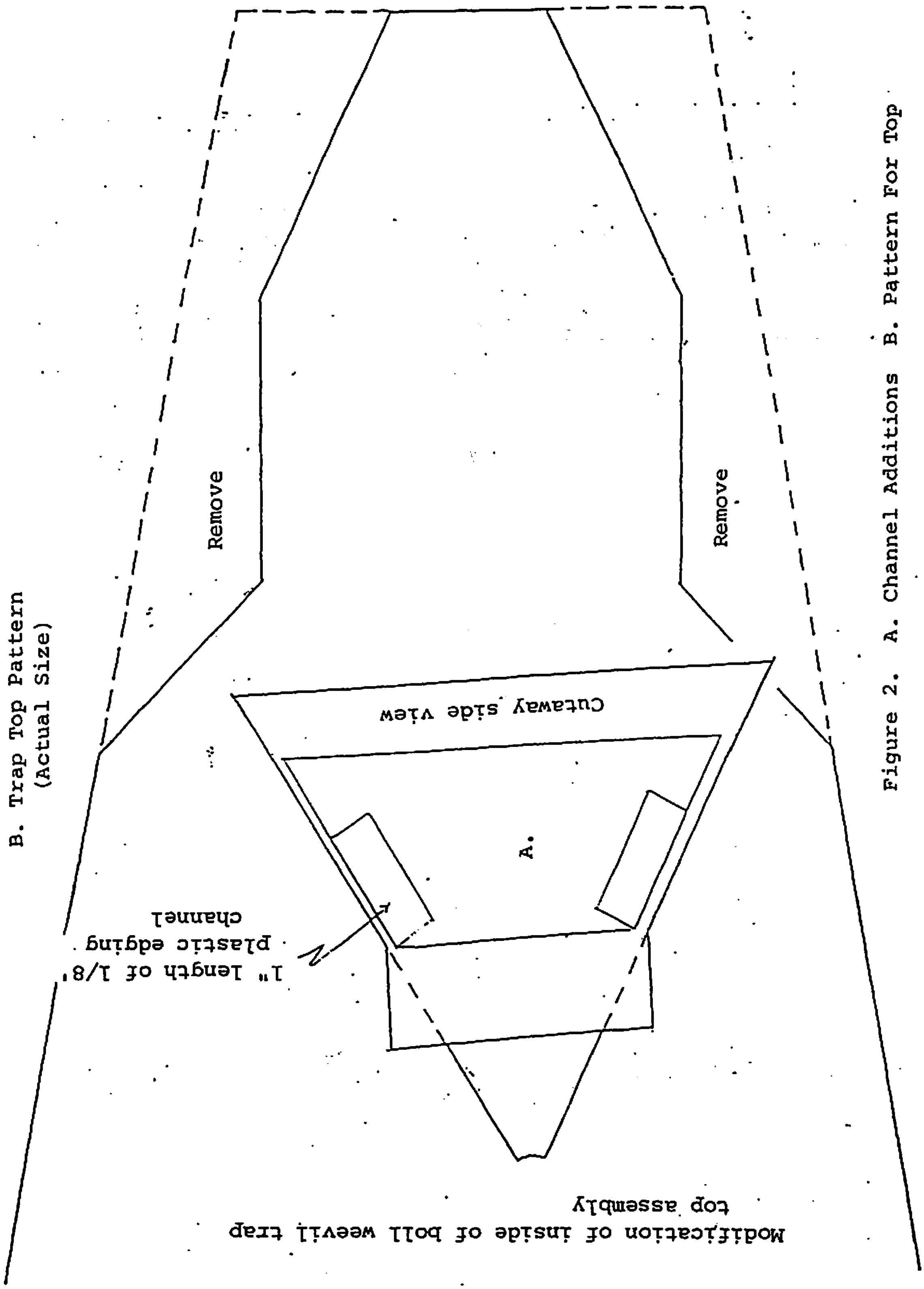


Figure 2. A. Channel Additions B. Pattern For Top

Title: Control of Western Flower Thrips on Nectarines at Harvest[1]

Authors: Carl M. Felland and Larry A. Hull
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Abstract:
Since at least 1991 western flower thrips (WFT), *Frankliniella occidentalis* (Pergande), has injured nectarine and peach during harvest in the mid-Atlantic region. WFT density on nectarines increased throughout the harvest period during an orchard trial in 1993. Highest infestation was in the lower third of the canopy suggesting that some adults moved up from white clover flowerheads. Carzol provided a longer period of protection from silvering injury than Lannate. A positive rate response for Carzol occurred between rates of 0.5 and 1.0 lb per acre.

Introduction:
Silvering injury by western flower thrips (WFT), *Frankliniella occidentalis* (Pergande), to nectarines and peaches has occurred at harvest in the mid-Atlantic region since 1991 (Felland & Kleiner 1991). This injury is characterized by removal of cell pigment by adults and larvae feeding on the surface of the ripening fruit. In 1991 about 50% of the mid-season nectarines in Adams County, Pa. were injured, with about 10% being downgraded on account of this injury at the Rice Fruit Co. (Aspers, Pa.). This high incidence of silvering is thought to be attributed to high temperatures and severe drought conditions which caused other weed hosts to be less attractive and favored WFT development and survival. In addition, Sevin was used during the preharvest and harvest period, but does not control WFT. Previously in the mid-Atlantic region WFT had been recorded only in and around greenhouses.

WFT overwintering was confirmed in Adams County in 1992 (Felland et al. 1993b). Control options were expanded as Pennsylvania obtained a 24C label for the use of Lannate on nectarines to control WFT. Silvering injury was widespread in Adams and Franklin Counties but at a much lower level than in 1991. Population dynamics of thrips were monitored throughout the 1992 season in nectarine orchards in Adams, Franklin, and Lycoming Counties in Pennsylvania and Burlington County in New Jersey (Felland et al. 1993a). WFT was locally abundant only in Adams County, was uncommon in southern Franklin County and was rare in Burlington County. No WFT were recovered in Lycoming County in northern Pennsylvania. In 1992 and 1993 white clover flowerheads were sampled during the summer to determine extent of WFT infestation in the mid-Atlantic region (Felland et al. in press). WFT was present in most samples and was locally abundant in New Jersey, northern Virginia, eastern West Virginia and southcentral Pennsylvania.

Although Lannate provided relatively high control in a laboratory bioassay, results in an orchard trial were not excellent (Felland et al. 1992). In 1993 we conducted an orchard trial including Lannate and three application timings of Carzol. We examined the timing of infestation by WFT, location of infestation in the nectarine canopy, and period of control provided by Lannate and two rates of Carzol.

Materials and Methods:
This experiment was conducted in a half acre commercial nectarine block in Biglerville, Pa. Adult WFT populations were monitored throughout the season in water traps and in white clover flowerheads in an adjoining nectarine block (Felland et al. in press). Density of flowerheads was recorded so that WFT density in the sod row middles could be calculated.

Experimental sprays were applied on three dates to contiguous single-tree plots. Ten treatments were assigned to 50 replicate trees using a completely random design. The replicate trees were surrounded by an untreated buffer consisting of two single rows and single trees at both ends of the five rows containing the replicate trees. The trees were 9 years old and planted to a spacing of 20 x 30 ft. All treatments were applied dilute to run-off with a handgun from a pull-type hydraulic sprayer at 400 psi. Approximately 2.2 gallons of spray were applied per replicate tree (ca. 400 GPA). The entire block was sprayed routinely through third cover and received a complete application of Sevin XLR (1.5 qt per A), captan 50% WP (1.5 lb per A), and Topsin-M 85% WDE (0.5 lb per A) on 21 July for fourth cover. Sevin was added in an

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[1]We acknowledge support from the PDA Peach and Nectarine Research Program and from Nor-AM. We thank Hollabaugh Bros. (Biglerville, Pa.) for allowing us to work in their orchards.

attempt to increase the density of WFT. A pre-harvest treatment of Ronilan 50% WP (1.0 lb per A) was applied to the entire block on 27 July.

The harvest evaluation was made on 2 August (1.1 bu per tree). Preliminary and final harvests were made on 28 July (0.6 bu per tree) and 9 August (0.2 bu per tree), respectively. Grower harvests for 'Early Scarlet' outside the experiment block was included in harvest totals. Fruit for evaluation were taken from throughout the canopy, while avoiding the area of tree overlap. The number of fruit examined per replicate tree was 5, 30, 30, and 17 on 23 and 28 July and 2 and 9 August, respectively. Each fruit was evaluated for amount of silvering (cm^2) and number of adults and larvae (primarily second stage) of WFT. Calculation of WFT*days was begun 23 July. On this date a total of 9 WFT (7 larvae on one fruit and 2 adults) and 6 lightly silvered fruit were found in the sample of 250 nectarines. Moderate silvering injury that results in downgrading of nectarines in packout was ranked as greater than 1 cm^2 per fruit. Thrips identification was 100% WFT (n=22) in a sample of adult females removed from fruit on 27 July.

On 2 August adult WFT density was determined in each of six quadrants in the tree canopy for untreated trees. These included lower, middle, and upper regions of the inner and outer canopy. During the experiment TSSM were observed on some fruit causing silvering similar to that of WFT. For the 9 August sample silvering was analyzed as both light and moderate levels of that caused by WFT and possibly by TSSM.

<u>Results and Discussion</u>:

Density of WFT adults in the sod row middles increased during June and July. Capture in water traps followed the same general pattern but was delayed two or three weeks (Fig. 1). This build up in the orchard corresponded to the first ripening fruit of 'Early Scarlet' on 23 July.

WFT infestation and injury increased throughout harvest (Table 1). Larvae comprised 36.8, 26.1, and 23.8% of the total on 28 July, 2 and 9 August, respectively. No treatment effect was observed 28 July. On 2 August WFT*days were reduced by all treatments, although the level of control was somewhat lower for Carzol at the 0.5 lb rate applied 7 day PHI and for Lannate. Percent silvering was relatively high, but moderate silvering was largely prevented in all treatments. Apparently some increased injury occurred between the 3 and 2 day PHI Carzol treatments. On August 9 control remained excellent for the Carzol treatments at the 1.0 lb rate and the 0.5 lb rate applied 2, 3 and 2 and 7 days PHI. Moderate injury was largely explained by WFT*days (Fig. 2). Based on extrapolating from the data the dates that moderate silvering injury began occurring after the treatments, the number of days of fruit protection was 3, 7 to 8, and 11 for Lannate, 0.5 lb Carzol and 1.0 lb Carzol, respectively (Fig. 3).

WFT adult density per fruit was highest in the outer region of the lower third of the canopy (Table 2). This quadrant was closest to the sod row middles. Apparently some of the fruit infestation comes from WFT moving up from weeds. Injury apparently caused by twospotted spider mite (TSSM), *Tetranychus urticae* Koch, comprised only 0.6% and 4.1% of the light and moderate silvering, respectively, on 9 August. Treatment effects were not significant for either light or moderate TSSM silvering.

<u>Conclusion</u>:

WFT has been a local pest in the mid-Atlantic region for at least three years. In this study WFT density built up in a nectarine orchard and initially infested fruit in the lower third of the canopy. Carzol provided longer residual control than Lannate. Nor-Am is proceeding toward reducing the PHI interval for this product so that Carzol can be used to prevent silvering injury.

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Table 1. Effect of various treatments on density of western flower thrips (WFT) and silvering injury on nectarine, Adams Co., Pa., 1993

Trmt.	Amt Form/A	Days before main harvest*	Applic. date	Cum WFT Days (Ad & La)/fruit			% silvered			% of fruit with mod inj**		
				28 Jul	2 Aug	9 Aug	28 Jul	2 Aug	9 Aug	28 Jul	2 Aug	9 Aug
Carzol 92SP	0.5 lb	7	26 Jul.....	0.72a	1.30d	5.56def	2.7a	31.3a-d	79.0dc	0.00a	1.38a	21.45b
Carzol 92SP	1.0 lb	7	26 Jul.....	0.03a	0.33ab	3.83cde	4.7a	24.7a	65.4bcd	0.00a	0.00a	7.45a
Carzol 92SP	0.5 lb	3	30 Jul.....	0.13a	0.34ab	2.14abc	6.7a	29.1abc	56.5abc	0.00a	0.67a	1.82a
Carzol 92SP	1.0 lb	3	30 Jul.....	0.08a	0.13ab	0.65a	4.7a	36.0a-d	47.7ab	0.00a	1.33a	0.00a
Lannate 1.8L	1.0 qt	3	30 Jul.....	0.20a	1.42cd	6.84ef	7.3a	46.7de	87.7e	0.00a	0.67a	26.29b
Carzol 92SP	0.5 lb	2	31 Jul.....	0.33a	0.57bc	2.63bcd	12.0a	44.7de	73.5cde	0.00a	2.67ab	8.14a
Carzol 92SP	1.0 lb	2	31 Jul.....	0.15a	0.30ab	0.78a	8.0a	42.0cd	65.7cd	0.00a	2.67ab	3.33a
Carzol 92SP	0.5 lb	2,7	26,31 Jul..	0.23a	0.30ab	2.38abc	6.0a	36.0bcd	65.6bcd	0.01a	0.67a	3.00a
Carzol 92SP	1.0 lb	2,7	26,31 Jul..	0.00a	0.05a	1.42ab	2.7a	24.7ab	44.2a	0.00a	0.00a	0.00a
Control	Untreated			0.43a	2.29c	7.79f	12.7a	54.7e	91.2e	0.00a	5.33b	30.47b

Means followed by the same letter(s) are not significantly different based on transformed means (Fisher's Protected LSD, P<0.05).

* Harvest on 2 Aug, preliminary harvest and final harvest on 28 Jul and 9 Aug, respectively.

** Moderate injury is silvering of greater than 1.0 cm^2 per fruit.

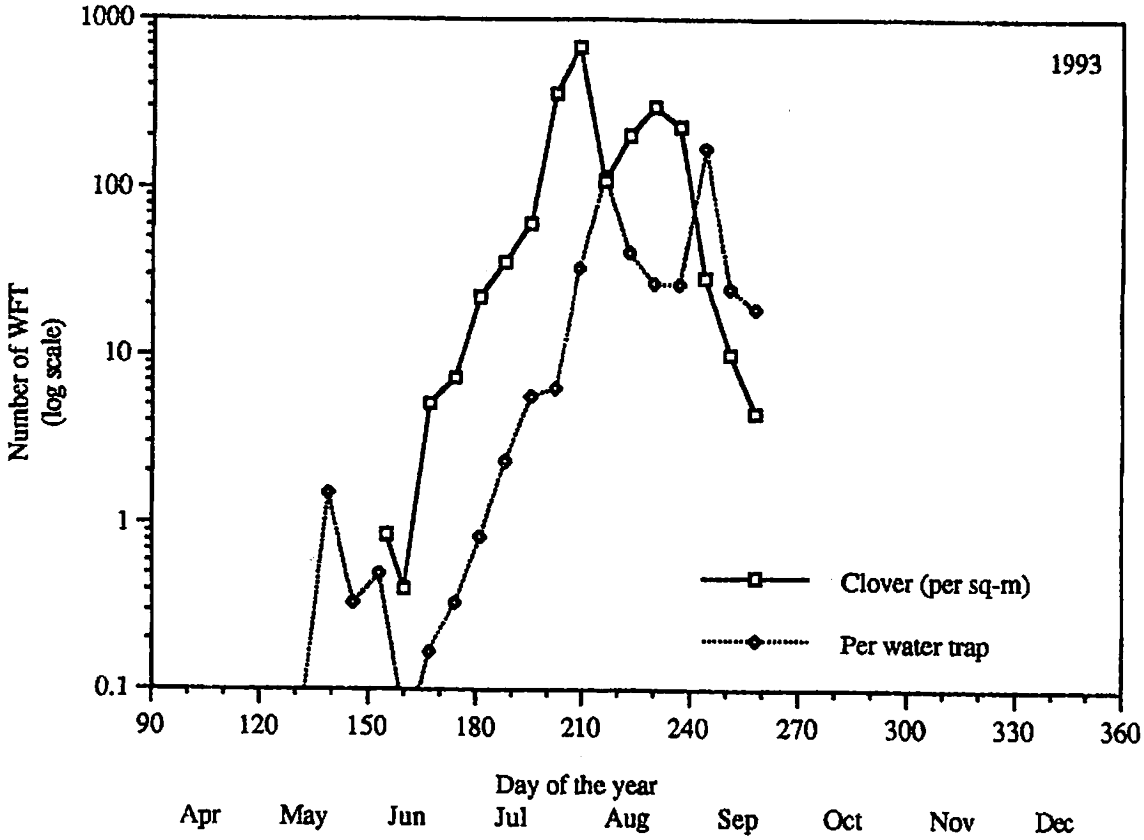

Fig 1. Seasonal density of western flower thrips (WFT) in white clover flowerheads and water traps in a nectarine orchard in Adams County, Pennsylvania, 1993.

Table 2. Effect of location in the canopy on number of adult western flower thrips (WFT) in untreated nectarine trees, 2 August, 1993.

Zone of tree		Count	Mean		Std. Error
Upper	Inner	5	0.280	a	0.233
Upper	Outer	5	0.280	a	0.174
Middle	Inner	5	0.240	a	0.098
Middle	Outer	5	0.440	a	0.147
Lower	Inner	5	0.880	ab	0.361
Lower	Outer	5	1.320	b	0.326

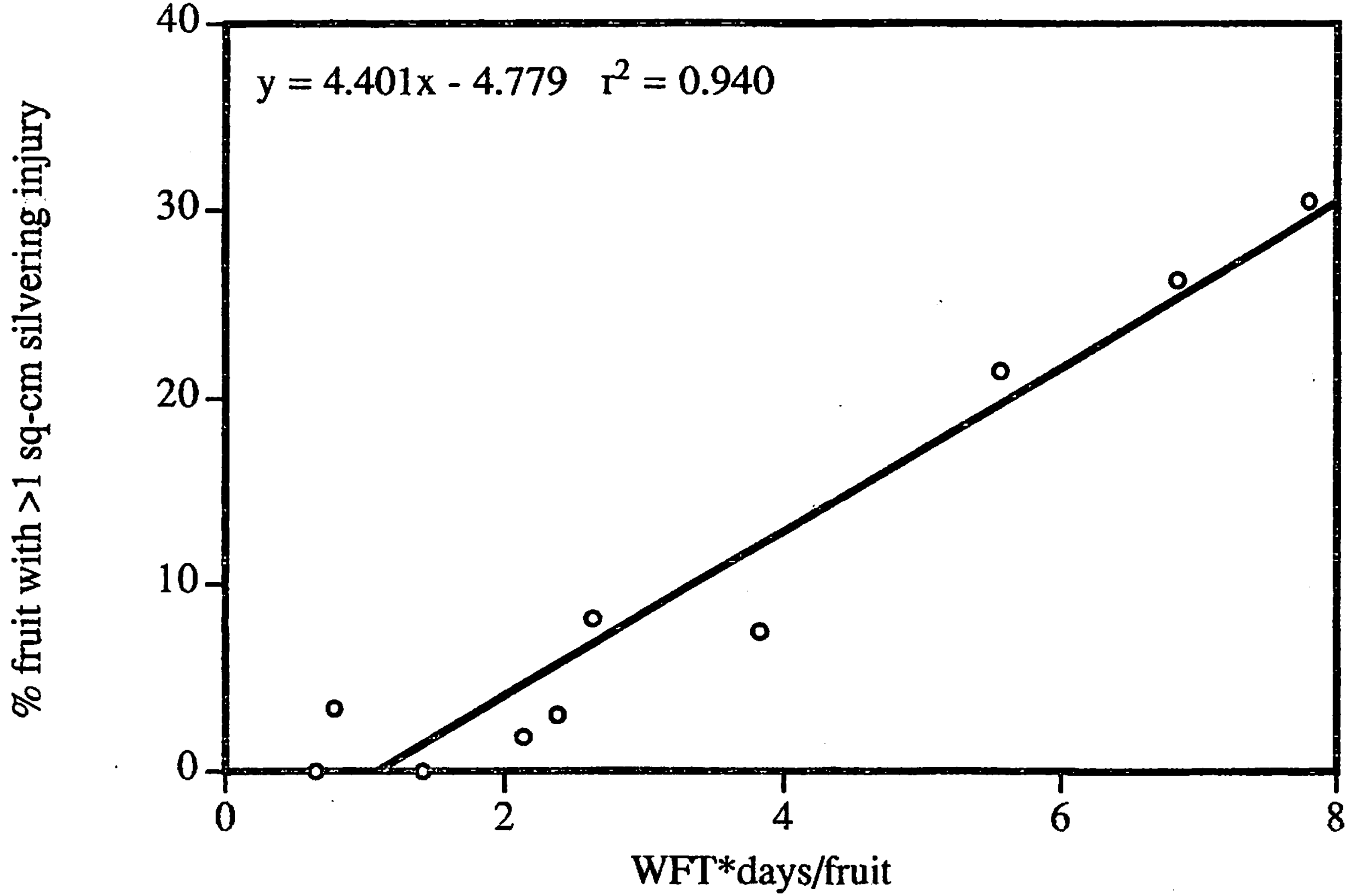

Fig. 2. Relationship of WFT*days and silvering injury Biglerville, PA, 9 August 93.

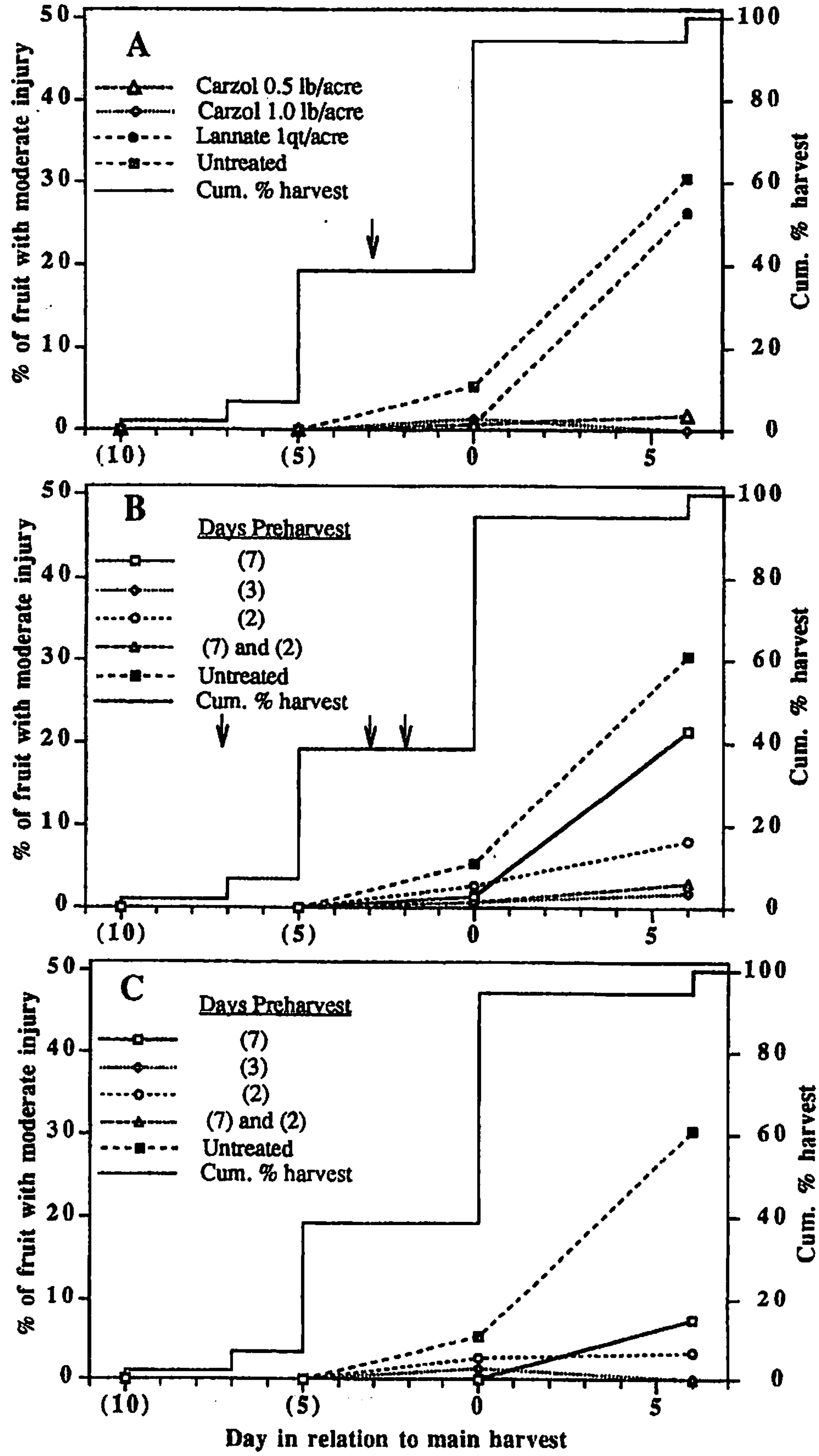

Fig. 3. Control of WFT silvering in relation to cumulative harvest for (A) three treatments applied 3 days before the main harvest and Carzol applied at four timings at (B) 0.5 lb per acre or (C) 1.0 lb per acre

TEMPORAL DISTRIBUTION OF THRIPS IN A FRUIT-BEARING ORCHARD

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Introduction

Thrips are phytophagous, mycophagous, or predatory insects that inhabit numerous plants in a wide range of habitats. The flower thrips, *Frankliniella tritici* (Fitch), is native and causes injury to a number of plant species. Recent attention has been focused on Western flower thrips, *F. occidentalis* (Pergande), because of silvering damage that it had caused on nectarines and peaches in Adams County, PA (Felland and Kliener 1991). *Leptothrips mali* (Fitch) is a common predator in Virginia apple orchards (Parella et al. 1982).

Materials and Methods

A study was conducted to determine the abundance and temporal distribution of arthropod species in different orchards in 1991. Arthropods were collected by beating branches with a rubber hose knocking specimens into a large plastic funnel (1/2 m^2 collecting area) with a ball jar containing alcohol attached to the bottom. Four orchards were sampled: an 8-yr-old unmanaged block (A) of apple trees; an 8-yr-old block (C) of apple trees that was mowed and pruned but unsprayed; a 3-yr-old mixed block (D) of apples, peaches, and cherry trees; and a 13-yr-old block (M) of apple trees under commercial management as a control. Sampling was conducted in Blocks A, C, and D for 24 consecutive hours on one day in each of May, June, July, and August. Two apple trees each from Blocks A, C, and D and 2 peach trees from Block D were sampled each hour. One cherry tree from Block D was sampled every other hour. Ten trees each were sampled in Block M at 0100, 1300, and 2000 hrs within 4 days of the day the other samples were obtained.

Results

Thrips were collected on 76% of the trees sampled. Eighteen species and 17 genera representing 4 families were collected. The most abundant adult phytophagous species were *F. tritici* and soybean thrips, *Neohydatothrips variabilis* (Beach), on 22 and 9% of the trees, respectively. The most abundant adult predatory species was *L. mali* (8%). Two other predatory species were collected. One specimen of *Aelothrips melaleucus* Haliday was collected on a peach tree in June. Five *Scolothrips pallidus* (Beach) were collected in July and August: three on unsprayed apple trees, one on a sprayed apple tree, and one on a peach tree.

The majority of thrips (79%) were collected in the months of May and June. *F. tritici*, *N. variabilis*, *L. mali*, immature *Frankliniella* spp., immature *Neohydatothrips* spp., immature Phlaeothripidae, and immature Thripidae comprised 95% of the thrips species collected. Interestingly, *N.*

variabilis maintained a consistent population throughout the sampling period with 48% of the population collected in July and August. Eighty-seven percent of F. tritici occurred in May and June. Immature Frankliniella spp. and Neohydatothrips spp. were collected in 6 and 5% of the samples, respectfully.

Only three other adult Phlaeothripidae, other than L. mali, composing 2% of all thrips species were collected. Therefore, the majority of the 13% of Phlaeothripidae probably were L. mali.

Significantly more immature Frankliniella spp., Phlaeothripidae, and Thripidae occurred in unsprayed apple trees versus sprayed apple trees based on chi-square test, suggesting potential susceptibility of immatures to commercial sprays (Table 1). However, more adult F. tritici occurred on sprayed apple trees than expected. Adult mobility may be an important factor in this occurrence. No host preferences were detected for species between 8-year-old unmanaged blocks and blocks that were mowed, pruned but unsprayed.

In the 3-year-old mixed block, adult F. tritici preferred peach trees to apple trees and apple trees to cherry trees (Table 2). Immature Neohydatothrips spp. in the same block preferred apple trees to peach trees and peach trees to cherry trees.

Circular statistics indicated a peak abundance at 2:00 a.m. (± 4.5 hr) for adult L. mali and 6:00 PM (± 4 hr) for immature Thripidae. L. mali may avoid the warmth of the afternoon seeking a cooler environment (ex. grass, weeds).

Information is lacking regarding the effect of F. tritici and N. variabilis on apple. As important is the role phytophagous thrips play as a food resource in the orchard. Both F. tritici and N. variabilis have been observed on the young expanding terminals of apple trees (personal observation). Crab spiders who commonly wait to ambush their prey may be an influential predator. Another common predator on growing terminals is the minute pirate bug, Orius insidiosus Say, which also will have some influence on the abundance of these species.

Correlation information between predacious thrips and mites needs to be determined. All three predator species collected have been documented to feed on mites - L. mali, European red mite, Panonychus ulmi (Koch)(Parella et al. 1980); A. melaleucus and S. pallidus, twospotted spider mite, Tetranychus urticae Koch)(Stannard 1968, Ananthakrishnan 1993).

In summary, the most abundant phytophagous species collected were F. tritici and N. variabilis with F. tritici preferring peach trees and immature Neohydatothrips spp. preferring apple trees in a 3-year-old mixed cultivar block. Abundance of F. tritici was greater than expected on sprayed apple trees. L. mali was the most abundant predatory species in the study and was more commonly collected on trees at 2:00 AM. More information is needed regarding the effects of thrips on fruit trees and their role in the orchard ecosystem as both predator and prey.

Table 1. Number of sprayed and unsprayed apple trees possessing thrips collected in May, June, July and August of 1991.

	Unsprayed	Sprayed	
Neohydatothrips variabilis (Beach)	42	12	n.s.
Immature *Neohydatothrips* spp.	35	3	n.s.
Frankliniella tritici (Fitch)	73	63	***
Immature *Frankliniella* spp.	32	2	*
Immature Thripidae	28	1	**
Leptothrips mali (Fitch)	38	12	n.s.
Immature Phlaeothripidae	82	0	***

* significantly different $P < .10$
** significantly different $P < .05$
*** significantly different $P < .001$

Table 2. Number of 3-year-old apple, peach, and cherry trees possessing thrips in May, June, July, and August of 1991.

	Apple	Peach	Cherry	
Neohydatothrips variabilis (Beach)	10	15	6	n.s.
Immature *Neohydatothrips* spp.	13	5	1	*
Frankliniella tritici (Fitch)	20	34	4	*
Immature *Frankliniella* spp.	10	14	2	n.s.
Immature Thripidae	11	12	2	n.s.
Leptothrips mali (Fitch)	10	11	3	n.s.
Immature Phlaeothripidae	20	15	7	n.s.

* significantly different $P < .10$

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The Cost of Tree Fruit IPM Programs in New Jersey

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Rutgers Fruit Research and Development Center
283 Rt. 539
Cream Ridge, NJ 08514

Introduction and Background:

The Rutgers Cooperative Extension (RCE) Fruit integrated pest management program (IPM) have been running since 1980. During the initial years we concentrated on delivering a scouting and recommendation program for apples in southern counties where production has and still is primarily wholesale based. In 1984 the program was taken into northern counties where fruit production is geared to the retail market. The program was expanded to include stone fruits (peaches and nectarines) in 1987, blueberries in 1989, and pears and grapes in 1993. The current programs consist of delivery (scouting, sampling, and recommendations), sustainable apple and peach extension and research projects, pesticide efficacy testing, new IPM program development in pears, grapes and blueberries, and publication of newsletters and development of other extension educational materials and programs.

In the early days of NJ IPM programming, state and federal budgets heavily subsidized grower delivery. Participation fees were established to offset the cost for seasonal scouting and scout travel. Later these fees were increased to include single use field supplies and laboratory fees. Fees are structured as per acre charges which are the same for all growers of a given commodity. Minimum charges were established in 1988 to allow for the small acreage grower. New Jersey fruit production in southern counties is over larger farms, usually over 100 acres each, while northern county farms are small, usually under 20 acres. While minimum charges offset most of the scouting costs incurred for the small farm, charges for larger farms still "subsidize" some of the difference.

Current Changes:

IPM programs by definition are multidisciplinary and are enhanced by input from other extension and research workers. Unfortunately with shrinking budgets, total Experiment Station/Extension staffing has decreased while IPM programming efforts have expanded. In order to retain total program integrity and streamline the delivery portion of the program, we have encouraged independent scouting (with Extension backup), and more grower involvement with scout supervision and program administration. In 1993 one scout who had previously been employed by RCE independently contracted for six growers in northern counties with 139 acres of fruit. As a part time scout he billed these growers $2,240, considerably less than it would have cost if RCE continued to employ him. In another development, a grower cooperative took over the employment of their own field scout. Six growers had over 700 acres scouted. Since each farm was larger than the average grower in the RCE program, the cooperative spent less per acre than the average RCE IPM participant.

Program Costs, Grower Contributions, and Extension Share:

The following data is derived from the last two years of the delivery (scouting and sampling) portion of the tree fruit program only. Actual costs are presented for all insect traps, supplies, laboratory fees, scouting labor and mileage, and permanent staff. Costs are offset by participation fees. The participation fee (income side) is presented as a function of the number of farms, the farm size, acreage scouted, and total acreage managed by IPM participants. Fringe benefits are calculated at 7.96% for hourly field scouts and 29% for faculty and staff. On some larger farms only a portion of the total acreage is scouted, but recommendations are used on the entire farm, creating a program impact is seen over more acreage than what is scouted. Therefore per acre program costs to RCE are calculated based on actual acres scouted and the number of acres managed by participating growers. This was conservatively estimated at an additional 3,000 acres each year.

Program Costs - Traps, Supplies, Laboratory Fees								
Year	Traps	Supplies	Soil Fert. Sam.	Soil Fert. Cost	Nematode Sam.	Nematode Cost	Leaf Tissue Sam.	Leaf Tissue Cost
1992	$5,417	$920	199	$995	199	$1,990	231	$3,234
1993	$3,921	$706	301	$1,505	301	$3,010	293	$4,102

Program Costs - Scouting and Staff							
Year	No. Scouted Hr.	Scouting $ w/o Fringe	Scouting $ w/ Fringe	Scout Mi. $	Total Scouting $	Staff $ w/o Fringe	Staff $ w/ Fringe
1992	3,813	$30,772	$33,221	$9,778	$42,999	$76,719	$98,967
1993	2,934	$23,594	$25,472	$7,544	$33,016	$81,305	$104,883

Program Acreage and Total Cost per Participating Acre			
Year	Total Costs	Total Acres	Total Costs/Acre
1992	$154,522	3,021	$51.15
1993	$151,143	3,814	$39.63

Participation Fees and Acreage - 1992 ($9-Peach, $14-Apple, $200 minimum for each crop)							
Crop	No. of Acres	No. of Farms	Smallest Farm	Largest Farm	Average Acreage	Fee	Per Acre Income
Peach	1,973	48	3	180	41.1	$21,017	
Apple	1,048	53	1	111	19.8	$15,940	
Total	3,021					$36,957	$12.23

Participation Fees and Acreage - 1993 $10, $12-Peach, $14-Apple, $15-Pear, $300 minimum combined)							
Item	No. of Acres	No. of Farms	Smallest Farm	Largest Farm	Average Acreage	Fee	Per Acre Income
Peach	2,838	49	4	300	57.9	$21,688	
Apple	948	52	.5	76	18.2	$7,812	
Pear	28	3	3	20	9.3	$420	
Other (Coop)						$6,939	
Lab						$189.55	
Min. Charges						$9300	
Total	3,814					$46,348.55	$12.15

University/Extension Costs/Acre			
Year	Scouted Acreage	Managed Acreage (+3,000)	Calculation
1992	$38.92	6,021 A = $13.43	(Total Costs/Total Acres) - Fees
1993	$27.48	6,814 A = $10.03	

BIOLOGICAL CONTROL OF PEAR PSYLLA - 1993

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I. Introduction. Pear psylla is a major pest of pear that is not reliably controlled with chemical insecticides because it rapidly develops resistance. My research involves the development of biological agents as alternatives to controlling pear psylla with chemicals. Although no fungal pathogens of pear psylla have ever been reported, we identified isolates of Beauveria bassiana, Paecilomyces fumosoroseus, and Verticillium lecanii that yielded nearly 100% nymphal mortality in laboratory tests. In another laboratory study, we determined that a sugar-ester (SE) extracted from Nicotiana gossei, which had been previously shown to be effective for whitefly control, was also effective against pear psylla nymphs. The sugar-ester applied at 0.1% yielded 100% nymphal mortality. My objective was to determine if these biological agents could control pear psylla under field conditions.

II. Materials and Methods. Two fungal pathogen studies were conducted. The spring 1993 study was conducted on 2-yr old pear trees approximately 6 ft. tall. One isolate each of B. bassiana, P. fumosoroseus, and V. lecanii were cultured on SDAY medium in petri dishes. Conidia were harvested from the dishes by adding 10 ml of sterile water and scraping the colonies with a spatula. Spore concentrations were determined by haemocytometer and the final test solutions were adjusted to 6.6 x 10^6 spores/ml for each isolate. The spore solutions were formulated in 1% Sunoil or 1% Sunoil plus UV protectant (Blankoflor). Other studies have shown that vegetable or petroleum oils aid as spore stickers or UV protectors. The solutions were applied to runoff (84 ml/tree) with a Sigma aerosol sprayer. Control treatments of water, 1% oil, and 1% oil plus 0.5% UV protectant were also included to determine their contribution to psylla mortality. The experimental design consisted of 9 treatments applied with a completely randomized design with 4 replications. Sampling consisted of removing two terminals/tree and recording the number of live and dead pear psylla to determine percent control 1, 3, 5, and 7 days after treatment.

The fall study consisted of the same fungal isolates, plus an additional B. bassiana and P. fumosoroseus isolate, formulated in 0.1% Sunoil, 0.1% additive (new formulation test), and water only. The amount of Sunoil in the formulation was reduced from 1.0 to 0.1% because of some phytotoxicity problems that were encountered in the spring study. The spore concentrations were standardized at 2.5 x 10^8 spores/ml for each isolate. Control treatments included water, 0.1% Sunoil, and 0.1% additive. Potted trees 2 ft tall artificially infested with 2nd-3rd instar nymphs were sprayed in the evening with 5 ml of each treatment using a Sigma aerosol sprayer. Afterward, the trees were placed in the field. The experimental design was completely randomized with 5 replications. Sampling consisted of removing 2-3 leaves/tree and recording the number of live and dead pear psylla to determine percent control 1, 3, 5, and 7 days after treatment.

SE studies were conducted in the spring and fall. SE treatments in the spring consisted of 0.05% and 0.01% concentrations plus an Asana XL O.66 EC treatment (3.0 oz./A). The controls were used from the spring fungal pathogen study which was conducted at this time on the same orchard. Data collection was conducted in the same manner as the spring pathogen study. The SE study in the fall consisted of 0.05% SE, 0.1% SE, and a water control applied to potted trees and data collection was the same as previously mentioned for the fall pathogen study.

Results and Discussion. In the spring fungal pathogen study, formulation significantly affected the performance of the isolates. Fungal isolates formulated in 1% oil yielded psylla mortalities that ranged from 25-48% at 3 days after application. The 1% oil plus 0.5% UV protectant only had a significant effect on B. bassiana where it appeared to accelerated spore germination. Spores of this isolate formulated in oil resulted in 40% nymphal mortality 3 days after application, but when it was formulated in oil plus UV protectant, it yielded 40% mortality 1 day after application. However, the UV protectant had no significant affect on V. lecanii, and had a negative effect on P. fumosoroseus. In spore survival studies, we found that fungal spores were killed within 5 hours after exposure to sunlight. Therefore, we will not pursue UV protectants because they realistically serve no function if spores are applied in the evening. Psylla mortalities appeared to be attributed to the infection process that occurred the first night after treatment application, thus, no UV protectant is needed. V. lecanii and P. fumosoroseus gave the highest psylla mortalities of 48% and 40%, respectively. Psylla mortalities in the controls were 5.0%, 10%, and 20% for the water, 1% oil, and 1% oil plus 0.5% UV protectant, respectively.

In the fall pathogen study, formulation also affected pathogen performance. In general, the formulation with the additive caused psylla mortalities to peak 2 days faster than the 0.1% oil or water formulations. Fungal isolates formulated in 0.1% oil did not cause significantly different psylla mortalities than those formulated in water. The 0.1% oil formulation caused psylla mortalities that ranged from 15-52% at day 5. B. bassiana caused 52% mortality when formulated with the additive or 0.1% oil which was significantly higher than any other pathogen-formulation combination. Over an extended period of time (7 days) B. bassiana formulated with water gave the highest mortality of 70%. The additive shows promise as an important component in a fungal formulation, however, much research is needed to determine the proper concentrations of oil and other additives. From these fungal studies it is obvious that certain isolates can obtain ≥50% control, yet, more field trials are needed to determine which isolates provide the best control under a variety of field conditions.

The spring SE study resulted in excellent control of pear psylla. The 0.1% SE resulted in 90% mortality while the 0.05% concentration provided 86% nymphal mortality 1 day after treatment. SE applied at 0.1% resulted in better control than Asana XL which caused 79% nymphal mortality 1 day after treatment. The fall study had similar results; 0.1% SE caused 84% mortality and 0.05% SE caused 62% nymphal mortality 1 day after application. Based on these results, SE would be a good alternative to chemical insecticides. Other studies have shown that the SE activity is limited to soft bodied insects, therefore, it may be quite selective and leave many natural insect enemies unharmed. Further research is planned to determine the selectivity of this compound.

The effect of these biological agents on pear psylla adults has not been determined, but will be the focus of future studies. These biological agents show great promise as alternatives to chemical control of pear psylla. The level of acceptable pear psylla control yielded by a particular biological control agent hinges on it's selectivity. Pear growers on the west coast considered 50% control acceptable if natural insect enemies of pear pests are spared. The place of these biological agents in an IPM program for pear will depend on their degree of selectivity.

NOT FOR PUBLICATION

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APPLE: *Malus domestica* Borkh. 'Rome'
Rose leafhopper; *Edwardsiana rosae* (L.)

ROSE LEAFHOPPER CONTROL, 1993: This experiment was conducted in 3 mini-blocks, each 1/3 acre, of 15-yr-old trees on MM 111, which measured 14.6 ft. in height and 13.4 ft. in width and were planted at a spacing of 20 x 20 ft. The experimental design consisted of six single-tree replications per treatment, with two replications per mini-block in a randomized block design. Each replicate was surrounded by one unsprayed tree on each side. Insecticides were applied on 30 Jun with a Swanson DA500A airblast sprayer, which traveled at 2.4 mph and delivered a volume of 100 gal/acre. Other materials applied separately to all treatments during the time of this experiment were Captan and Topsin-M. Rose leafhopper control was evaluated by counting nymphs on the underside of 25 randomly selected leaves per tree.

Asana and Endosulfan provided the most effective control at each date after treatment, resulting in the lowest accumulation of leafhopper-days. Carzol and Ryania also had a low accumulation of leafhopper-days which were not significantly different from Asana and Endosulfan. Similar control was provided by Lannate, Dimethoate and Sevin XLR PLUS, with no significant difference in accumulated leafhopper-days. Dimethoate was slower acting than Lannate and Sevin XLR PLUS, with significantly more leafhoppers three days post-treatment. Lannate was evaluated at a reduced rate typically used in combination with phosphate insecticides for leafroller control. Of the two botanical insecticides, Pyrellin was less effective than Ryania and not significantly different from the untreated.

No.	Treatment	Rate/acre	lb AI	Rose leafhopper/25 leaves 30 Jun	3 Jul	7 Jul	10 Jul	14 Jul	Accumulated leafhopper-days 30 Jun to 14 Jul
1.	Asana XL 0.66 EC	178 ml	0.03	42.2 b	1.7 d	0.7 e	0.3 d	0 e	49.2 d
2.	Carzol 92 SP	454 g	0.92	65.3 ab	1.2 d	1.5 e	2.0 c	1.8 d	81.4 cd
3.	Endosulfan 50 W	1360 g	1.50	51.5 ab	1.0 d	0 e	0 d	0 e	54.0 d
4.	Ryania	3632 g	0.009	55.5 ab	2.0 d	4.8 d	2.7 c	0.3 e	82.3 cd
5.	Lannate 1.8 L	710 ml	0.34	54.2 ab	9.0 c	13.2 bc	11.7 b	13.3 b	172.0 b
6.	Dimethoate 4 EC	710 ml	0.75	47.3 ab	26.2 b	17.0 b	10.5 b	7.8 bc	205.7 b
7.	Pyrellin 0.11 EC	474 ml	0.01	65.3 ab	44.7 ab	60.3 a	30.2 a	27.5 a	488.4 a
8.	Sevin XLR plus 4 SC	474 ml	0.50	72.8 a	10.8 c	9.0 cd	7.2 b	4.8 c	154.5 bc
9.	Untreated	--------	------	51.3 ab	56.3 a	65.7 a	31.8 a	22.3 a	513.4 a

Means in a given column followed by the same letter are not significantly different (P = 0.05; Fisher's LSD).

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APPLE: *Malus domestica* Borkh. 'Delicious'
European red mite; *Panonychus ulmi* (Koch)

ACARICIDE EVALUATION, 1993: This experiment was conducted in a one third acre block of 8-yr-old 'Redchief' trees on M26, which measured 13.5 ft. in height and 9 ft. in width and were planted at a spacing of 10 x 15 ft. The experimental design consisted of 4 single-tree plots in a randomized block design, with each replicate surrounded by at least one unsprayed tree on each side. Acaricides were applied with an FMC Economist airblast sprayer, which traveled at 2.2 mph and delivered a spray volume of 100 gal/acre. Dates of application were 24 Jun, 14 and 29 Jul. Other materials applied separately to all treatments during the experiment were Captan, Guthion, Penncap-M and Topsin-M. European red mite control was evaluated by sampling 25 leaves from the periphery of each tree, removing mites with a mite-brushing machine, and counting motile stages with a binocular microscope.

Kelthane and Omite treatments provided the most effective mite control, which was significantly better than TD 2336. There was no significant difference in mite control between a 30 W and 6 EC formulation of Omite, which were compared at their lowest label rate.

No.	Treatment	Rate/acre	lb AI	European red mites/leaf				
				23 Jun	29 Jun	6 Jul	13 Jul	21 Jul
1.	Omite 30 W	2270 g	1.50	1.8 ab	0.9 bc	3.0 b	1.4 b	0.9 c
2.	Omite 6 EC	710 ml	1.13	1.3 b	1.4 abc	3.6 b	1.5 b	1.7 c
3.	Kelthane 50 W Latron AG-44M	1588 g 474 ml	1.75+	3.4 a	0.7 c	3.5 b	1.3 b	1.8 c
4.	Vendex 50 W	510 g	0.56	2.2 ab	1.6 abc	5.4 ab	2.4 b	2.1 c
5.	TD 2336 50 W	510 g	0.56	2.5 ab	2.1 ab	3.6 b	1.5 b	5.6 b
6.	Untreated	——	----	2.1 ab	2.3 a	7.4 a	6.4 a	18.8 a

Means in a given column followed by the same letter are not significantly different (P = 0.05; Fisher's LSD).

No.	Treatment	Rate/acre	lb AI	European red mites/leaf		Accumulated mite-days
				27 Jul	5 Aug	23 Jun - 5 Aug
1.	Omite 30 W	2270 g	1.50	4.4 b	7.1 bc	114.1 c
2.	Omite 6 EC	710 ml	1.13	4.6 b	3.8 bc	119.5 c
3.	Kelthane 50 W Latron AG-44M	1588 g 474 ml	1.75+	3.9 b	3.1 c	105.3 c
4.	Vendex 50 W	510 g	0.56	4.9 b	12.8 ab	182.4 bc
5.	TD 2336 50 W	510 g	0.56	8.0 b	30.9 a	295.9 b
6.	Untreated	-----	----	26.6 a	43.2 a	646.8 a

Means in a given column followed by the same letter are not significantly different (P = 0.05; Fisher's LSD).

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APPLE: *Malus domestica* Borkh. 'Golden Delicious'
Spirea aphid (SA); *Aphis spiraecola* Patch
Rose leafhopper (RLH); *Edwardsiana rosae* (L.)
European red mite (ERM); *Panonychus ulmi* (Koch)
Spotted tentiform leafminer (STLM); *Phyllonorycter blancardella* (F.)
Codling moth (CM); *Cydia pomonella* (L.)
Oriental fruit moth (OFM); *Grapholitha molesta* (Busck)
Tufted apple bud moth (TABM); *Platynota idaeusalis* (Walker)
Redbanded leafroller (RBLR); *Argyrotaenia velutinana* (Walker)

SEVIN XLR PLUS BLOCK TREATMENT, 1993: A treatment which included Sevin XLR PLUS and a standard treatment was each applied to a 1/3 acre block (6 rows x 6 trees/row) of 13-yr-old trees on M7A, which measured 17 ft. in height and 13.5 ft. in width and were planted at a spacing of 20 x 20 ft. Insecticides were applied with a Swanson DA500A airblast sprayer, which traveled at 2.4 mph and delivered a spray volume of 100 gal/acre. Dates of application were 27 May (first cover [1C]), 14 Jun (second cover [2C]), 29 Jun (third cover [3C]), 15 Jul (fourth cover [4C]), 30 Jul (fifth cover [5C]), 12 Aug (sixth cover [6C]), 26 Aug (seventh cover [7C]), and 8 Sep (eighth cover [8C]). Other materials applied separately to both treatments and an untreated block during this experiment were Captan and Topsin-M. Data were taken from 4 single-tree replications in the center 2 rows of each block. Control of SA was evaluated by counting aphids on the most infested leaf on each of 10 terminals from the periphery of each tree. Effect of treatments against RLH was determined by counting nymphs on 25 leaves selected from the tree periphery. European red mite control was evaluated by sampling 25 leaves from the periphery of each tree, removing mites with a mite-brushing machine, and counting motile stages with a binocular microscope. Treatment effect against STLM was determined by counting mines observed on the periphery of trees during a 5 min period. Control of fruit-feeding insects was determined by scoring for injury 400 picked apples/treatment (100/replication) plus up to 400 drop apples/treatment (up to 100/replication) sampled on 23 Sep. Picked fruit were rated for finish as 0 (no russet), 1 (enlarged and raised lenticels), 2 (1-10% russeted surface), 3 (11-25% russeted surface), 4(26-50% russeted surface), or 5 (>50% russeted surface).

There was no significant difference between spray treatments in SA and RLH populations, or in injury from fruit-feeding insects. The Sevin treatment resulted in a significantly higher population of ERM, but a lower incidence of STLM, compared to the standard treatment. There was no significant difference among treatments in fruit finish.

No.	Treatment	Rate/acre	lb AI	Time of application	SA/most inf leaf/term		RLH/25 leaves
					10 Jun	21 Jun	7 Jul
1.	Guthion 3 F	947 ml	0.75	1C,4C,5C	96.9 a	51.9 b	1.3 b
	Penncap-M 2 F	710 ml	0.37+				
	Lannate 1.8 L	710 ml	0.34	2C,3C,6C-8C			
2.	Sevin XLR PLUS 4 SC	947 ml	1.00	1C,6C	89.5 a	34.6 b	0.5 b
	Sevin XLR PLUS 4 SC	474 ml	0.50+				
	Lannate 1.8 L	710 ml	0.34	2C			
	Penncap-M 2 F	710 ml	0.37+				
	Lannate 1.8 L	710 ml	0.34	3C,7C,8C			
	Guthion 3 F	947 ml	0.75	4C,5C			
3.	Untreated	------	----		126.7 a	130.7 a	30.8 a

Means in a given column followed by the same letter are not significantly different (P = 0.05; Fisher's LSD).

No.	Treatment	Rate/acre	lb AI	Time of application	ERM/leaf	STLM/5 min
					29 Jul	18 Aug
1.	Guthion 3 F	947 ml	0.75	1C,4C,5C	0.2 b	4.8 a
	Penncap-M 2 F	710 ml	0.37+			
	Lannate 1.8 L	710 ml	0.34	2C,3C,6C-8C		
2.	Sevin XLR PLUS 4 SC	947 ml	1.00	1C,6C	2.1 a	2.5 b
	Sevin XLR PLUS 4 SC	474 ml	0.50+			
	Lannate 1.8 L	710 ml	0.34	2C		
	Penncap-M 2 F	710 ml	0.37+			
	Lannate 1.8 L	710 ml	0.34	3C,7C,8C		
	Guthion 3 F	947 ml	0.75	4C,5C		
3.	Untreated	------	----		0.1 b	5.5 a

Means in a given column followed by the same letter are not significantly different (P = 0.05; Fisher's LSD).

No.	Treatment	Rate/acre	lb AI	Time of application	% CM and OFM Injury: Pick sample	% CM and OFM Injury: Drop sample	% CM and OFM Injury: Total sample	% TABM and RBLR Injury: Pick sample	% TABM and RBLR Injury: Drop sample	% TABM and RBLR Injury: Total sample
1.	Guthion 3 F	947 ml	0.75	1C,4C,5C	0 b	1.6 b	0.3 b	1.3 ab	0 b	1.2 b
	Penncap-M 2 F	710 ml	0.37+							
	Lannate 1.8 L	710 ml	0.34	2C,3C,6C-8C						
2.	Sevin XLR PLUS 4 SC	947 ml	1.00	1C,6C	0.3 b	8.3 b	0.5 b	0.8 b	0 b	0.8 b
	Sevin XLR PLUS 4 SC	474 ml	0.50+							
	Lannate 1.8 L	710 ml	0.34	2C						
	Penncap-M 2 F	710 ml	0.37+							
	Lannate 1.8 L	710 ml	0.34	3C,7C,8C						
	Guthion 3 F	947 ml	0.75	4C,5C						
3.	Untreated	------	----		6.3 a	13.3 a	8.2 a	5.5 a	3.4 a	5.3 a

Means in a given column followed by the same letter are not significantly different (P = 0.05; Fisher's LSD).

No.	Treatment	Rate/acre	lb AI	Time of application	% Clean Fruit: Pick sample	% Clean Fruit: Drop sample	% Clean Fruit: Total sample	Fruit finish rating
1.	Guthion 3 F	947 ml	0.75	1C,4C,5C	98.8 a	98.5 a	98.6 a	3.67 a
	Penncap-M 2 F	710 ml	0.37+					
	Lannate 1.8 L	710 ml	0.34	2C,3C,6C-8C				
2.	Sevin XLR PLUS 4 SC	947 ml	1.00	1C,6C	99.0 a	91.5 ab	98.8 a	3.46 a
	Sevin XLR PLUS 4 SC	474 ml	0.50+					
	Lannate 1.8 L	710 ml	0.34	2C				
	Penncap-M 2 F	710 ml	0.37+					
	Lannate 1.8 L	710 ml	0.34	3C,7C,8C				
	Guthion 3 F	947 ml	0.75	4C,5C				
3.	Untreated	------	----		88.3 b	83.4 b	86.6 b	3.53 a

Means in a given column followed by the same letter are not significantly different (P = 0.05; Fisher's LSD).

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Spirea aphid (SA); *Aphis spiraecola* Patch
Spotted tentiform leafminer (STLM); *Phyllonorycter blancardella* (F.)
Rose leafhopper (RLH); *Edwardsiana rosae* (L.)
White apple leafhopper (WALH); *Typhlocyba pomaria* McAtee
European red mite; *Panonychus ulmi* (Koch)
Codling moth (CM); *Cydia pomonella* (L.)
Oriental fruit moth (OFM); *Grapholitha molesta* (Busck)
Tufted apple bud moth (TABM); *Platynota idaeusalis* (Walker)
Redbanded leafroller (RBLR); *Argyrotaenia velutinana* (Walker)

INSECTICIDE EVALUATION, 1993: This experiment was conducted in a 5.4 acre block of 39-yr-old trees, which measured 16.5 ft. in height and 23 ft. in width and were planted at a spacing of 20 x 40 ft. The experimental design for the first 7 treatments and the check consisted of 6 single-tree plots (3 'Rome Beauty', 3 'Golden Delicious') in a randomized block design. The experimental design for treatments of S-71639 and Fenoxycarb consisted of 3 replications of 9-tree plots (3 rows x 3 trees/row) in a randomized block design, with insect data taken from the center tree ('Rome Beauty') in each plot. Insecticides were applied with a Swanson DA500A airblast sprayer which traveled at 2.4 mph. A spray volume of 300 gal/acre was used in the delayed dormant application of oil in the first treatment, with all other treatments applied at the rate of 100 gal/acre. Dates of application were 14 Apr (delayed dormant [DD]), 24 Apr (prepink [PP]), 14 May (petal fall [PF]), 27 May (first cover [1C]), 14 Jun (second cover [2C]), 29 Jun (third cover [3C]), 15 Jul (fourth cover [4C]), 30 Jul (fifth cover [5C]), 12 Aug (sixth cover [6C]), 26 Aug (seventh cover [7C]), and 8 Sep (eighth cover [8C]). Other materials applied separately to all treatments were Bayleton, Captan, Dodine, Kocide, NAA, Nova, Streptomycin, Topsin-M, and Ziram. Control of SA was evaluated by counting aphids on the most infested leaf on each of 10 terminals from the periphery of each tree. Treatment effect against STLM was determined by counting mines observed on the periphery of trees during a 5 min period. Effect of treatments against RLH and WALH was determined by counting nymphs on 25 leaves selected from the tree periphery. European red mite control was evaluated by sampling 25 leaves from the periphery of each tree, removing mites with a mite-brushing machine, and counting motile stages with a binocular microscope. For the first 7 treatments and the check, control of fruit-feeding insects was determined by scoring for injury 600 picked apples/treatment (100/replication) plus up to 600 drop apples/treatment (up to 100/replication) sampled on 22 Sep. For S-71639 and Fenoxycarb treatments, 300 picked apples/treatment (up to 100/replication) plus up to 300 drop apples/treatment (up to

100/replication) were sampled on 22 Sep and scored for injury by fruit-feeding insects. Fruit picked (100/tree) from 3 replications of 'Golden Delicious' trees were rated for finish as 0 (no russet), 1 (enlarged and raised lenticels), 2 (1-10% russeted surface), 3 (11-25% russeted surface), 4 (26-50% russeted surface), or 5 (>50% russeted surface).

NTN 33893, TD-2321 and Danitol provided very effective control of SA. The 10 WP formulation of Danitol was significantly better than the 2.4 EC formulation in SA control. Excellent control of STLM occurred with NTN 33893, Danitol, Fenoxycarb and the high rate of S-71639. All treatments provided excellent control of RLH and WALH, except for S-71639 and Fenoxycarb which had higher populations than in untreated plots. All treatments provided excellent control of all fruit-feeding insects, except for TD-2321, S-71639 and Fenoxycarb. TD-2321 was very effective against TABM and RBLR, but weak against CM and OFM. S-71639 and Fenoxycarb provided poor control of all fruit-feeding insects. This may have been due, at least in part, to the reduced spray program of only 4 applications with these materials, resulting in insufficient residue to provide adequate fruit protection throughout the prolonged egg-hatching period. There was no significant difference among treatments in fruit finish on 'Golden Delicious'.

No.	Treatment	Rate/acre	lb AI	Time of application	SA/most inf leaf/term		STLM/5 min	
					1 Jun	22 Jun	22 Jun	18 Aug
1.	Sun 6 E Oil	22.7 l		DD	33.6 a	74.1 bcd	3.2 ab	11.0 bc
	Endosulfan 50 W	1360 g	1.50	PP				
	Imidan 70 W	652 g	1.01+					
	Lannate 1.8 L	474 ml	0.23	PF				
	Imidan 70 W	973 g	1.50	1C,4C,5C				
	Imidan 70 W	487 g	0.75+					
	Lannate 1.8 L	710 ml	0.34	2C,3C,6C-8C				
2.	NTN 33893 240 FS	189 ml	0.10	PP	1.2 e	44.8 de	0.3 d	3.3 cde
	NTN 33893 240 FS	189 ml	0.10+					
	Guthion 3 F	888 ml	0.70	PF,1C				
	Guthion 3 F	444 ml	0.35+					
	Lannate 1.8 L	710 ml	0.34	2C,3C,6C-8C				
	Guthion 3 F	888 ml	0.70	4C,5C				
3.	TD-2321 40 W	1022 g	0.90	DD-8C	2.9 de	50.1 cd	4.7 ab	5.7 cd
4.	Danitol 2.4 EC	474 ml	0.30	DD,2C,8C	13.5 abc	50.0 cd	2.0 bc	2.0 de
	Orthene 75 SP	454 g	0.75	PF,1C				
	Penncap-M 2 F	1420 ml	0.74	3C-7C				
5.	Danitol 10 WP	1360 g	0.30	DD,2C,8C	16.1 abc	27.5 e	3.7 ab	3.8 cde
	Orthene 75 SP	454 g	0.75	PF,1C				
	Penncap-M 2 F	1420 ml	0.74	3C-7C				
6.	Orthene 75 SP	454 g	0.75	PP,PF,1C	10.8 bcd	108.2 ab	4.3 ab	25.0 a
	Penncap-M 2 F	1420 ml	0.74	2C-8C				

No.	Treatment	Rate/acre	lb AI	Time of application	SA/most inf leaf/term		STLM/5 min	
					1 Jun	22 Jun	22 Jun	18 Aug
7.	Orthene 75 SP Penncap-M 2 F	605 g 1420 ml	1.00 0.74	PP,PF,1C 2C-8C	9.4 cd	86.4 abc	5.8 a	8.2 bc
8.	S-71639 0.83 EC	201 ml	0.04	PF,2C,4C,6C	19.3 abc	142.7 a	2.3 ab	5.0 cde
9.	S-71639 0.83 EC	301 ml	0.07	PF,2C,4C,6C	10.7 bcd	119.7 ab	0.7 cd	1.0 e
10.	Fenoxycarb 25 WP	170 g	0.09	PF,2C,4C,6C	15.5 abc	131.5 a	3.0 ab	2.3 de
11.	Untreated	-----	----		25.8 ab	118.8 ab	8.0 a	15.5 ab

Means in a given column followed by the same letter are not significantly different (P = 0.05; DMRT).

No.	Treatment	Rate/acre	lb AI	Time of application	RLH/25 leaves 6 Jul	RLH & WALH /25 leaves 18 Aug	ERM/leaf 13 Jul
1.	Sun 6 E Oil	22.7 l		DD	1.0 c	0.2 e	0.7 bcd
	Endosulfan 50 W	1360 g	1.50	PP			
	Imidan 70 W	652 g	1.01+				
	Lannate 1.8 L	474 ml	0.23	PF			
	Imidan 70 W	973 g	1.50	1C,4C,5C			
	Imidan 70 W	487 g	0.75+				
	Lannate 1.8 L	710 ml	0.34	2C,3C,6C-8C			
2.	NTN 33893 240 FS	189 ml	0.10	PP	0.0 c	0.0 e	2.0 ab
	NTN 33893 240 FS	189 ml	0.10+				
	Guthion 3 F	888 ml	0.70	PF,1C			
	Guthion 3 F	444 ml	0.35+				
	Lannate 1.8 L	710 ml	0.34	2C,3C,6C-8C			
	Guthion 3 F	888 ml	0.70	4C,5C			
3.	TD-2321 40 W	1022 g	0.90	DD-8C	0.0 c	0.0 e	1.6 abc
4.	Danitol 2.4 EC	474 ml	0.30	DD,2C,8C	0.2 c	0.0 e	0.1 d
	Orthene 75 SP	454 g	0.75	PF,1C			
	Penncap-M 2 F	1420 ml	0.74	3C-7C			
5.	Danitol 10 WP	1360 g	0.30	DD,2C,8C	0.0 c	0.3 de	0.3 cd
	Orthene 75 SP	454 g	0.75	PF,1C			
	Penncap-M 2 F	1420 ml	0.74	3C-7C			
6.	Orthene 75 SP	454 g	0.75	PP,PF,1C	0.0 c	0.2 e	1.6 abc
	Penncap-M 2 F	1420 ml	0.74	2C-8C			

No.	Treatment	Rate/acre	lb AI	Time of application	RLH/25 leaves	RLH & WALH /25 leaves	ERM/leaf
					6 Jul	18 Aug	13 Jul
7.	Orthene 75 SP Penncap-M 2 F	605 g 1420 ml	1.00 0.74	PP,PF,1C 2C-8C	0.2 c	0.8 cde	2.4 a
8.	S-71639 0.83 EC	201 ml	0.04	PF,2C,4C,6C	15.7 a	7.0 ab	0.6 bcd
9.	S-71639 0.83 EC	301 ml	0.07	PF,2C,4C,6C	22.0 a	2.7 bcd	0.4 bcd
10.	Fenoxycarb 25 WP	170 g	0.09	PF,2C,4C,6C	25.0 a	7.0 a	0.4 bcd
11.	Untreated	-----	----		7.8 b	3.7 abc	0.2 cd

Means in a given column followed by the same letter are not significantly different (P = 0.05; DMRT).

No.	Treatment	Rate/acre	lb AI	Time of application	% CM and OFM Stings			% CM and OFM Entries		
					Pick sample	Drop sample	Total sample	Pick sample	Drop sample	Total sample
1.	Sun 6 E Oil	22.7 l		DD	0 d	0 c	0 b	0.8 de	15.5 cd	3.8 c
	Endosulfan 50 W	1360 g	1.50	PP						
	Imidan 70 W	652 g	1.01+							
	Lannate 1.8 L	474 ml	0.23	PF						
	Imidan 70 W	973 g	1.50	1C,4C,5C						
	Imidan 70 W	487 g	0.75+							
	Lannate 1.8 L	710 ml	0.34	2C,3C,6C-8C						
2.	NTN 33893 240 FS	189 ml	0.10	PP	0 d	0 c	0 b	0 e	11.1 cd	2.7 cd
	TN 33893 240 FS	189 ml	0.10+							
	Guthion 3 F	888 ml	0.70	PF,1C						
	Guthion 3 F	444 ml	0.35+							
	Lannate 1.8 L	710 ml	0.34	2C,3C,6C-8C						
	Guthion 3 F	888 ml	0.70	4C,5C						
3.	TD-2321 40 W	1022 g	0.90	DD-8C	0.5 cd	0 c	0.3 b	0.2 e	26.9 bc	12.2 b
4.	Danitol 2.4 EC	474 ml	0.30	DD,2C,8C	0 d	0.5 bc	0.1 b	0.2 e	18.3 cd	3.4 cd
	Orthene 75 SP	454 g	0.75	PF,1C						
	Penncap-M 2 F	1420 ml	0.74	3C-7C						
5.	Danitol 10 WP	1360 g	0.30	DD,2C,8C	0 d	0 c	0 b	0 e	4.3 d	0.9 d
	Orthene 75 SP	454 g	0.75	PF,1C						
	Penncap-M 2 F	1420 ml	0.74	3C-7C						
6.	Orthene 75 SP	454 g	0.75	PP,PF,1C	0.2 cd	0 c	0.1 b	0 e	11.2 cd	1.6 cd
	Penncap-M 2 F	1420 ml	0.74	2C-8C						

No.	Treatment	Rate/acre	lb AI	Time of application	% CM and OFM Stings			% CM and OFM Entries		
					Pick sample	Drop sample	Total sample	Pick sample	Drop sample	Total sample
7.	Orthene 75 SP Penncap-M 2 F	605 g 1420 ml	1.00 0.74	PP,PF,1C 2C-8C	0 d	0 c	0 b	0.2 e	4.2 d	1.1 cd
8.	S-71639 .83 EC	201 ml	0.04	PF,2C,4C,6C	3.0 ab	4.0 b	3.5 a	1.7 cd	44.7 b	23.2 ab
9.	S-71639 .83 EC	301 ml	0.07	PF,2C,4C,6C	2.7 bc	5.7 a	4.1 a	4.3 bc	37.0 b	17.4 b
10.	Fenoxycarb 25 WP	170 g	0.09	PF,2C,4C,6C	3.3 ab	1.8 bc	2.8 a	5.0 b	27.6 bc	11.7 b
11.	Untreated	-----	----		4.3 a	2.0 b	3.2 a	16.7 a	76.3 a	46.2 a

Means in a given column followed by the same letter are not significantly different (P = 0.05; DMRT).

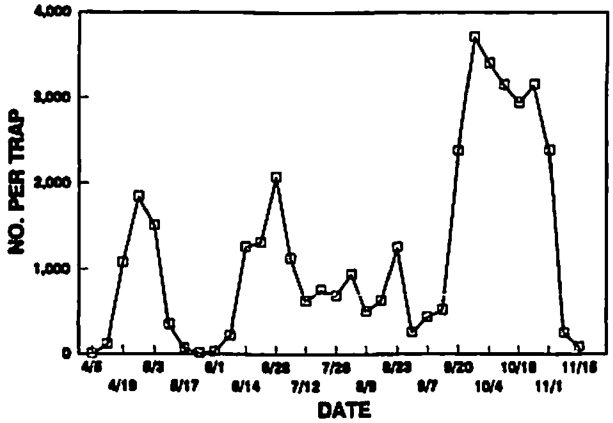
No.	Treatment	Rate/acre	lb AI	Time of application	% TABM and RBLR Injury			% Clean Fruit			Fruit finish rating
					Pick sample	Drop sample	Total sample	Pick sample	Drop sample	Total sample	
1.	Sun 6 E Oil	22.7 l		DD	3.5 b	4.8 bc	4.2 b	95.7 a	79.8 ab	91.9 ab	2.62 a
	Endosulfan 50 W	1360 g	1.50	PP							
	Imidan 70 W	652 g	1.01+								
	Lannate 1.8 L	474 ml	0.23	PF							
	Imidan 70 W	973 g	1.50	1C,4C,5C							
	Imidan 70 W	487 g	0.75+								
	Lannate 1.8 L	710 ml	0.34	2C,3C,6C-8C							
2.	NTN 33893 240 FS	189 ml	0.10	PP	1.0 bcd	3.5 bc	1.6 bcd	99.0 a	84.4 ab	95.7 a	2.73 a
	TN 33893 240 FS	189 ml	0.10+								
	Guthion 3 F	888 ml	0.70	PF,1C							
	Guthion 3 F	444 ml	0.35+								
	Lannate 1.8 L	710 ml	0.34	2C,3C,6C-8C							
	Guthion 3 F	888 ml	0.70	4C,5C							
3.	TD-2321 40 W	1022 g	0.90	DD-8C	2.8 bc	1.6 c	2.0 bc	96.5 a	71.6 bcd	85.6 b	3.31 a
4.	Danitol 2.4 EC	474 ml	0.30	DD,2C,8C	0.5 bcd	5.4 bc	1.3 bcd	99.3 a	75.8 abc	95.2 a	2.33 a
	Orthene 75 SP	454 g	0.75	PF,1C							
	Penncap-M 2 F	1420 ml	0.74	3C-7C							
5.	Danitol 10 WP	1360 g	0.30	DD,2C,8C	0.5 bcd	0.7 c	0.7 cd	99.5 a	95.0 a	98.5 a	2.36 a
	Orthene 75 SP	454 g	0.75	PF,1C							
	Penncap-M 2 F	1420 ml	0.74	3C-7C							
6.	Orthene 75 SP	454 g	0.75	PP,PF,1C	0 d	1.3 c	0.2 d	99.8 a	87.3 ab	98.0 a	2.78 a
	Penncap-M 2 F	1420 ml	0.74	2C-8C							

No.	Treatment	Rate/acre	lb AI	Time of application	% TABM and RBLR Injury: Pick sample	Drop sample	Total sample	% Clean Fruit: Pick sample	Drop sample	Total sample	Fruit finish rating
7.	Orthene 75 SP Penncap-M 2 F	605 g 1420 ml	1.00 0.74	PP,PF,1C 2C-8C	0.3 cd	3.2 bc	0.7 cd	99.5 a	92.6 a	98.2 a	2.63 a
8.	S-71639 .83 EC	201 ml	0.04	PF,2C,4C,6C	11.7 a	9.3 ab	10.5 a	83.7 b	42.0 e	64.5 d	2.83 a
9.	S-71639 .83 EC	301 ml	0.07	PF,2C,4C,6C	15.7 a	3.3 bc	10.6 a	77.3 c	54.0 de	67.8 cd	2.42 a
10.	Fenoxycarb 25 WP	170 g	0.09	PF,2C,4C,6C	11.7 a	12.5 a	11.9 a	80.3 bc	58.8 cde	74.0 c	2.37 a
11.	Untreated	-----	----		18.5 a	6.8 abc	12.7 a	62.7 d	18.8 f	41.0 e	2.29 a

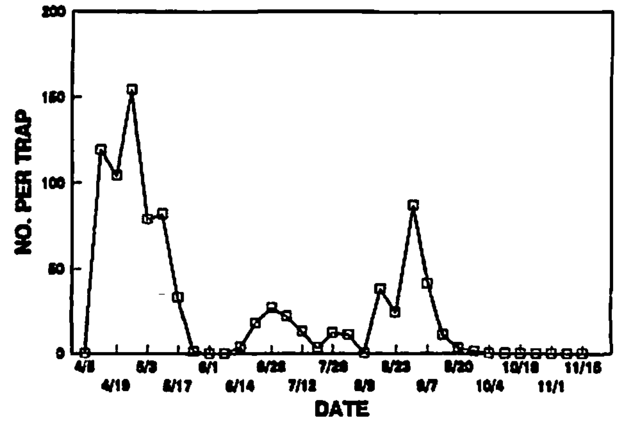
Means in a given column followed by the same letter are not significantly different (P = 0.05; DMRT).

PHEROMONE TRAPPING-1993
WVU EXPERIMENT FARM

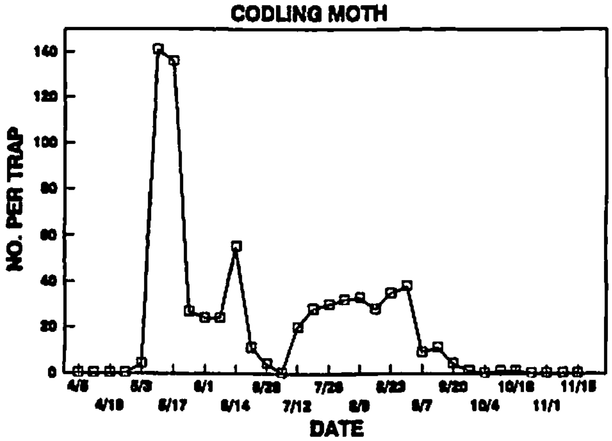
SPOTTED TENTIFORM LEAFMINER



REDBANDED LEAFROLLER



CODLING MOTH



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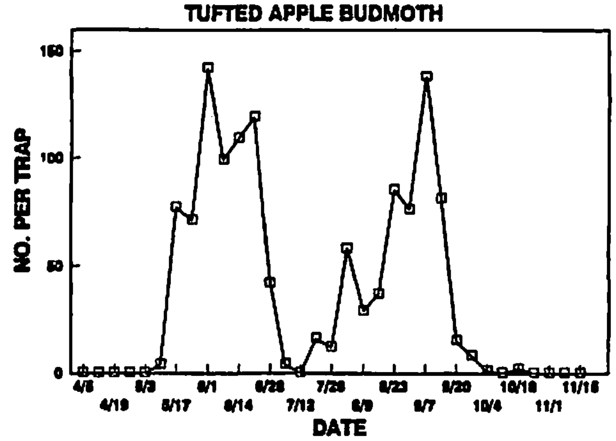

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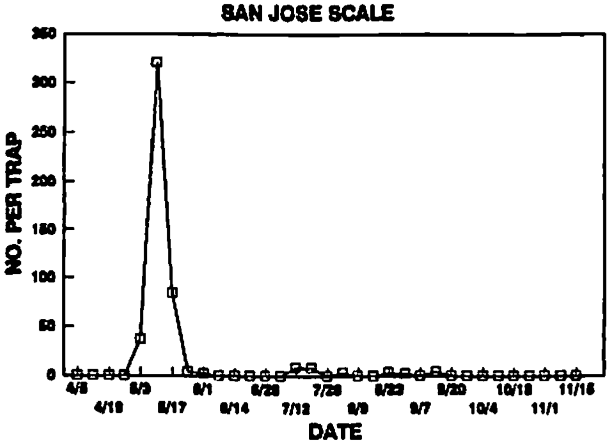
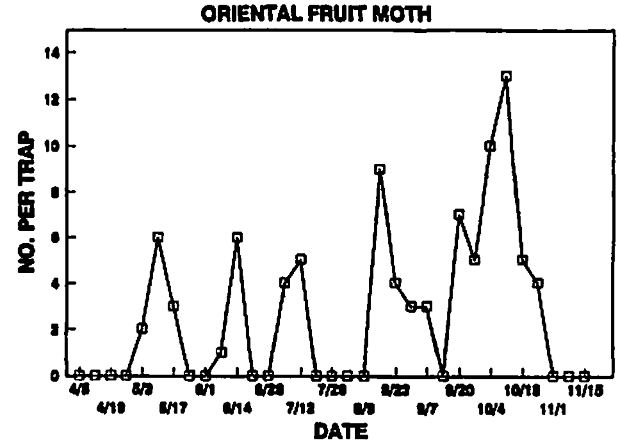
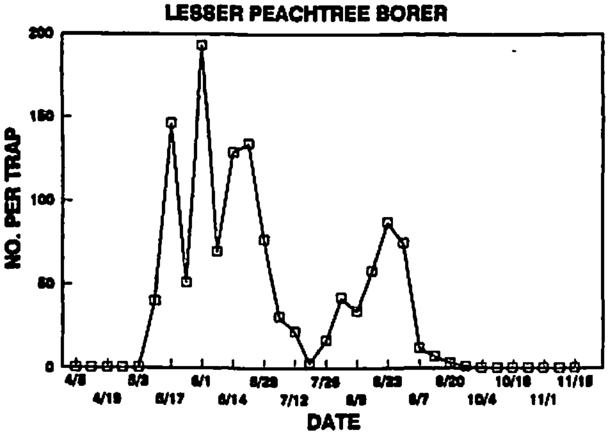


ORIENTAL FRUIT MOTH



LESSER PEACHTREE BORER



PEACHTREE BORER