FOR ADMINISTRATIVE USE ONLY

PROCEEDINGS
CUMBERLAND-SHENANDOAH FRUIT WORKERS CONFERENCE

63RD ANNUAL MEETING
HARPERS FERRY, WEST VIRGINIA

NOVEMBER 19-20, 1987

Felipe Aranz
Plant Pathology, NSCU
P.O. Box 7616
Raleigh, NC 27695

Helen Atthowe
Program Associate IPM-Fruit
Rutgers Cooperative Extention
Vineland, NJ 08360

Joseph G. Barrat
WVU Experimental Farm
P.O. Box 303
Kearneysville, WV 25430

Tara Baugher
W. VA University
P.O. Box 301
Kearneysville, WV 25430

Mark Brown
USDA-ARS
Route 2 Box 45
Kearneysville, WV 25430

Bill Butt
USDA-ARS Appal. Fruit. Res. Sta.
Route 2 Box 45
Kearneysville, WV 25430

Steve Carcatem
WVU Ext. Service
P.O. Box 1880
Romney WV 26757

Leonard Cobb
VPI & SU
2500 Valley Avenue
Winchester, VA 22601

Larry Crim
W. VA University
P.O. Box 301
Kearneysville, WV 25430

R. C. Diener
ASA Building
WVA University
Morgantown, WV 26506

C. R. Drake
Dept. Plant Path. & Weed Science
Virginia Tech
Blacksburg, VA 27068

Edward Durner
Rutgers Fruit Research
RD 2 Box 38
Cream Ridge, NJ 08514

Kendall C. Elliott
WV University
124 ASA
Morgantown, WV 26506

Mike Ellis
Dept. of Plant Pathology
OARDC
Wooster, OH 44691

Dr. Duke-Ervin A. Elsner
Blueberry/Cranberry Res. Ctr.
Rutgers University
Chatsworth, NJ 08019

Morris Engle
Plant and Soil
West Virginia University
Morgantown, WV 26506-6108

Chester L. Foy
Dept. of Plant Pathology
VPI & SU
Blacksburg, VA 24061

Jerry Frecon
Rutgers Cooperative Extension
N. Delsea Drive
Clayton, NJ 08312

R. C. Funt
Horticultural Dept. at Ohio State
2001 Fyffe Court
Columbus, OH 43210

D. M. Glenn
USDA-ARS
Kearneysville, WV 25430

Clyde S. Gorsuch
Department of Entomology
Clemson University
Clemson, SC 29634

Dr. Barbara Goulart
605 East McCormick Avenue
State College, PA 16801

George Greene
PSU Fruit Research Lab
P.O. Box 309
Biglerville, PA 17307

Robert H. Head
P.O. Box 400
Walhalla, SC 29691

Rick Heflebower
101 W. Antietam Street
Hagerstown, MD 21740

Elizabeth Herman
Rutgers Fruit Research
RD 2 Box 38
Cream Ridge, NJ 08514

K. D. Hickey
PSU Fruit Res. Lab
P.O. Box 309
Biglerville, PA 17307

Clint Hickman
535 Merideth Street
Morgantown, WV 26505

Henry W. Hogmire, Jr.
WVU Experiment Farm
P.O. Box 303
Kearneysville, WV 25430

Dr. J. Anthony Hopfinger
Rutgers Fruit Research Center
RD 2 Box 38
Cream Ridge, NJ 08514

R. L. Horsburgh
VPI & SU
2500 Valley Avenue
Winchester, VA 22601

Dan Horton
Extension Entomology Dept.
University of Georgia
Athens, GA 30602

L. A. Hull
PSU Fruit Res. Lab
P.O. Box 309
Biglerville, PA 17307

Francis Jacobs
USDA-HSF Fruit Lab
Rm. 105 Bldg. 6004
Beltsville, MD 20705

James W. Johnson
Dept. of Ent., 1-87 Ag. Bldg.
University of Missouri
Columbia, MO 65211

G. L. Jubb
UM-WMREC
Route 1 Box 49B
Keedysville, MD 21756

James Kolton
401 Brooke Hall
W. VA University
Morgantown, WV 26506

Steve Miller
USDA-ARS, Appal. Fruit Res. Sta.
Rt. 2 Box 45
Kearneysville, WV 25430

Mike Myers
WVU
Morgantown, NJ 26506

Carl Niedziela
Dept. of Horticulture
North Carolina State University
Raleigh, NC 27695

Richard Payne
Fruit Research Lab
Rm. 115 Bldg. 004
Beltsville, MD 20705

Doug Pfeiffer
Dept. Entomology
VPI & SU
Blacksburg, VA 24061

Dean Polk
Rutgers Fruit Research
RD 2 Box 38
Cream Ridge, NJ 08514

Ed Rajotte
106 Patterson Building
University Park, PA 16802

Tony Reiser
WVU
Morgantown, WV 26506

Donald L. Reteise
USDA-ARS
Kearneysville WV 25430

David Richie
Plant Pathology, NCSU
P.O. Box 7616
Raleigh, NC 27695

John D. Ridley
Department of Horticulture
Clemson University
Clemson, SC 29634-0375

H. A. Rollins, Jr.
VPI
Winchester Fruit Research Lab
Winchester, VA 22601

David Rosenberger
Hudson Valley Lab
Box 727
Highland, NY 12528

Jeffrey J. Schmitt
USDA-ARS
Appalachian Frt. Res. Station
Kearneysville, WV 25430

Jack Springer
Rutgers R & D Center
Bridgeton, NJ 08302

Van R. Starner
Rutgers Fruit R & D Center
RD 2 Box 38
Cream Ridge, NJ 08514

Paul W. Steiner
Botany Department
University of Maryland
College Park, MD 20742

John Stenett
USDA-ARS
Fort Detrick Bldg. 1301
Frederick, MD 21701

Dr. Fred C. Swift
Rutgers Fruit R & D Center
RD 2 Box 38
Cream Ridge, NJ 08514

James W. Travis
PSU
Dept. of Pathology
University Park, PA 16802

George Vass
USDA-ARS
Appalachian Fruit Research
Kearneysville, WV 25430

Joanne Whalen
Department of Entomology
University of Delaware
Newark, DE 19717-1303

Roger S. Young
WVA Experimental Farm
P.O. Box 303
Kearneysville, WV 25430

T. V. Zwet
USDA-ARS AFRS
Rt. 2 Box 45
Kearneysville, WV 25430

Claire Stuart
USDA-ARS
Rt. 2 Box 45
Kearneysville, WV 25430

F. Takeda
USDA-ARS
Kearneysville, WV 25430

L. D. Tukey ✓
Horticulture PSU
103 Tyson Building
University Park, PA 16802

Jim Walgenbach
Mtn. Hort. Crops Res. & Ext.
2016 Fanning Bridge Road
Fletcher, NC 28732

Duane Wydoski
USDA-ARS
Kearneysville, WV 25430

Eldon Zehr
Plant Pathology and Phys. Dept.
Clemson University
Clemson, SC 29634-0365

Ross E. Byers
Winchester Fruit Research Lab
2500 Valley Avenue
Winchester, VA 22601

Turner B. Sutton
Dept. of Plant Pathology
Box 7616 NCSU
Raleigh, NC 27695-7616

Mr. William Tietjen
Warren County Coop Ext.
Courthouse
Belvidere, NJ 07823

Thomas Tworkoski ✓
USDA-ARS
Fort Detrick Bldg. 1301
Frederick, MD 21701

Bill Walker
USDA-ARS Appal. Fruit Res. Sta.
Route 2 Box 45
Kearneysville, WV 25430

Keith S. Yoder
VA AG. Exp. Station
2500 Valley Avenue
Winchester, VA 22601

Richard Zimmerman
P.O. Box 6180
West Virginia University
Morgantown, WV 26506-6108

Richard Marini
Department of Horticulture
VPI & SU
Blacksburg, VA 24061

63RD ANNUAL MEETING
CUMBERLAND-SHENANDOAH FRUIT WORKERS CONFERENCE
Harpers Ferry, West Virginia
November 19-20, 1988

The 63rd Annual Meeting of the Cumberland-Shenandoah Fruit Workers Conference was called to order at 9:30 a.m. on November 19, 1987, by Chairman Edward Durner. The meeting was co-hosted by New Jersey and South Carolina. The hosts for future meetings are as follows:

1988 - Virginia
1989 - Maryland
1990 - North Carolina
1991 - USDA
1992 - Pennsylvania
1993 - West Virginia
1994 - New Jersey and South Carolina

The morning joint session was devoted to the topics of "Predictive Model for Improving Fire Blight Management Decisions" and the "Field Use of a Polycorder for Collecting and Manipulating Field Data".

Following lunch, entomology and plant pathology met in a joint session, while horticulture met separately. An evening meeting to discuss general situations by each group was made available at 8 p.m. after dinner.

All groups met separately on Friday morning until a 10:00 a.m. break. Following the submitted paper session, a joint wrap up session was held at 10:30 a.m. during which a brief report of significant events during the past year was given by a representative from each state as well as a wrap up session of each group.

The nominating committee presented the following slate for the 1988 meeting:

H. A. Rollins, Jr., VPI, Winchester, VA 22601, as general secretary.

R. L. Horsburgh, VPI & SU, 2500 Valley Avenue, Winchester, VA 22601, as entomology division coordinator.

Keith Yoder, VA Ag. Exp. Station, 2500 Valley Avenue, Winchester, VA 22601, as plant pathology division coordinator.

Ross E. Byers, Winchester Fruit Researach Lab, 2500 Valley Avenue, VA 22601, as horticulture division coordinator.

It was decided to hold the 1988 meeting at the Cliffside Inn, Harpers Ferry, West Virginia, on November 17-18, 1988. It was strongly advised that for the 1988 meeting that each attendant stay at the Cliffside Inn to ensure the availability of meeting rooms at no charge.

Respectfully submitted,

John Ridley

John Ridley

1987 CUMBERLAND-SHENANDOAH FRUIT WORKERS CONFERENCE

ENTOMOLOGY

Paper
No.

1. GORSUCH, CLYDE S. and R. E. McWHORTER. Seasonal distribution of the spotted tentiform leafminer, <u>Phyllonorycter</u> <u>blancardella</u> F., on apples in South Carolina.

2. GORSUCH, CLYDE S. and R. E. McWHORTER. Seasonal distribution of the grape root borer, <u>Vitacea polistiformes</u> (Harris) in South Carolina.

3. HOGMIRE, JR., HENRY W., LARRY CRIM and RICHARD ANNAN. Peach insecticide evaluation, 1987.

4. HORSBURGH, R. L. and LEONARD J. COBB. Apple insecticides evaluations, 1987.

5. HULL, LARRY A. Apple, dilute test of insecticides.

6. HULL, LARRY A. Apple, concentrate airblast insecticide test, 1987.

7. HULL, LARRY A. Apple, rosy apple aphid control, 1987.

8. JACOBS, S. B. Apple, evaluation of Fenoxycarb for Tabm control, 1987.

9. HULL, LARRY A. Apple, dilute test of acaricides, 1987.

10. HULL, LARRY A. Apple, integrated mite control with Savey, 1987.

11. HULL, LARRY A. Pear, seasonal pear psylla control experiment, 1987.

12. HULL, LARRY A. Pear mite control with Apollo, 1987.

13. HULL, LARRY A. Apple, effect of vydate on fruit thinning, 1987.

14. KNIGHT, ALAN L. and LARRY A. HULL. Tufted apple budmoth residue/Bioassay experiments.

15. PFEIFFER, D. G. and J. C. KILLIAN. Pheromone disruption of lesser peachtree borer, 1987.

16. PFEIFFER, DOUG G. and LEO F. PONTON. Apollo volume trial on mites.

17. PFEIFFER, DOUG G. and LEO F. PONTON. Apple, Savey trial - mite.

18. PFEIFFER, DOUG G. and LEON F. PONTON. DPX-EY059 trial/codling moth and other insect controls on apples.

19. PFEIFFER, DOUG. G. and J. C. KILLIAN. Grape root borer flight periods, 1987.

20. PFEIFFER, DOUG G. and RICHARD D. MARINI. Apple kelthane phytotoxicity trial, 1987.

21. PFEIFFER, DOUG G., J. C. KILLIAN, R. L. HORSBURGH and K. S. YODER. Pheromone disruption of codling moth.

22. POLK, DEAN and FRED C. SWIFT. False chinch bug as a late season peach pest.

23. STARNER, VAN R. and FRED C. SWIFT. Control of European red mites with _Typhlodromus_ _longipilus_ and two other phytoseiids.

24. SWIFt, FRED C., ELIZABETH J. HERMAN, and VAN STARNER. Effect of certain insecticides on dispersal of European red mite from apple trees.

25. SWIFT, FRED C. and ELIZABETH J. HERMAN. Diapause development and hatch of overwintering eggs of European red mite.

26. SWIFT, FRED C. and DEAN POLK. Evaluation of chlorpyrifos-oil-spreader combinations for control of European red mite.

27. SWIFT, FRED C. and ELIZABETH J. HERMAN. Diapause induction, development, and termination in field populations of _Amblyseius_ _fallacis_.

28. SWIFT, FRED C. and ELIZABETH J. HERMAN. Seasonal abundance and distribution of _Amblyseius_ _fallacis_ in an apple orchard.

29. WALGENBACH, JAMES F. Control of spotted tentiform leafminer in Western North Carolina.

Plant Pathology

30. BARRAT, J. G. Fire blight control trials, 1987.

31. BARRAT, J. G. Rubigan fungicide applications to apples, 1987.

32. BARRAT, J. G. Peach leaf curl, peach scab, brown rot, *Rhizopus* rot control trials with Bravo 720, 1987.

33. BARRAT, J. G. Peach leaf curl control with Bravo C/M, 1987.

34. CARSON, ANN; TONY WATSON, and R. W. MILLER. Observations and peach demonstration results, 1987.

35. DRAKE, C. R. Management of apple diseases in Virginia.

36. HICKEY, K. D., J. MAY, and G. McGLAUGHLIN. Control of apple scab and powdery mildew with sterol-inhibiting fungicides applied with an airblast sprayer, 1987.

37. HICKEY, K. D., J. MAY, and G. McGLAUGHLIN. Incidence of scab and powdery mildew on Rome Beauty apple treated with dilute fungicide sprays applied in post-infection application, 1987.

38. HICKEY, K. D., J. MAY, and G. McGLAUGHLIN. Evaluation of seasonal protective fungicide trial for control of apple scab and powdery mildew.

39. HICKEY, K. D., J. MAY, and G. McGLAUGHLIN. Comparison of wettable powder and flowable formulations of standard fungicides for control of apple scab.

40. HICKEY, K. D., J. MAY, and G. McGLAUGHLIN. Effect of sterol-inhibiting fungicide treatments in suppressing primary inoculum and preventing secondary spread of apple powdery mildew, 1987.

41. HICKEY, K. D., J. MAY, and G. McGLAUGHLIN. Incidence of scab on leaves of five apple cultivars treated with post-infection sprays of sterol-inhibiting fungicides, 1987.

42. HICKEY, K. D., J. MAY, and G. McGLAUGHLIN. Suppression of Conidia production of *Venturia inaequalis* on leaves of five apple cultivars with sterol-inhibiting fungicides, 1987.

43. HICKEY, K. D., J. MAY, and G. McGLAUGHLIN. Efficacy of fungicide treatments for control of peach brown rot and rusty spot, 1987.

44. HICKEY, K. D., J. MAY, and G. McGLAUGHLIN. Incidence of brown rot and leaf spot on tart cherry sprayed with seasonal dilute fungicide treatments, 1987.

45. HICKEY, K. D., J. MAY, and G. McGLAUGHLIN. Effect of seasonal fungicide treatments on control of brown rot blossom blight and fruit decay on Stanley Prune, 1987.

46. KOTCON, JAMES. Population dynamics of lesion and dagger nematodes in pecan orchards treated with fenamiphos.

47. RICHIE, DAVE F. and M. A. BENNETT. Peach scab control using Bravo 720.

48. SPRINGER, JOHN K. Disease control, 1987.

49. STEINER, PAUL W. and RICHARD HEFLEBOWER. Mary Blite: A predictive model for apple fire blight management.

50. SUTTON, T. B. and E. M. BROWN. Disease control on Golden Delicious, 1987.

51. SUTTON, T. B. and L. R. POPE. Sooty blotch and flyspeck control, 1987.

52. SUTTON, T. B. and E. M. BROWN. Disease control on Rome Beauty, 1987.

53. VAN der ZWET, T. and J. C. WALTER. Determination of incubation period and earliest blossom blight symptoms of Jonathan apple and Bartlett pear in the orchard following artificial inoculation with *Erwinia amylovora*.

54. YODER, K. S., A. E. COCHRAN II, J. R. WARREN, C. M. SCHMIDT, and M. A. VANN. Control of powdery mildew on Jonathan Apple by SI fungicides, 1987.

55. YODER, K. S., A. E. COCHRAN II, J. R. WARREN, C. M. SCHMIDT, and M. A. VANN. Evaluation of experimental fungicides on three apple cultivars, 1987.

56. YODER, K. S., A. E. COCHRAN II, J. R. WARREN, C. M. SCHMIDT, and M. A. VANN. Evaluation of mixtures of mildewcides on Jonathan Apples, 1987.

57. YODER, K. S., A. E. COCHRAN II, J. R. WARREN, C. M. SCHMIDT, and M. A. VANN. Evaluation of registered fungicides on Granny Smith and Red Delicious apples, 1987.

58. YODER, K. S., A. E. COCHRAN II, J. R. WARREN, C. M. SCHMIDT, and M. A. VANN. Evaluation of experimental postharvest dip treatments for control of Penicillium Blue Mold, 1986-87.

59. YODER, K. S., A. E. COCHRAN II, J. R. WARREN, C. M. SCHMIDT, and M. A. VANN. Evaluation of Terramycin for control of peach yellows, 1986-87.

60. YODER, K. S., A. E. COCHRAN II, J. R. WARREN, C. M. SCHMIDT, and M. A. VANN. Evaluation of experimental fungicides on peach and nectarine, 1987.

61. ZEHR, E. I., G. W. KIRBY, D. H. FOSTER. Fungicide sprays for controlling apple disease in 1987.

HORTICULTURE

62. BAUGHER, TARA A., K. C. ELLIOT, S. H. BLIZZARD, S. I. WALTER, T. A. KEISER. Mechanical bloom thinning of peach.

63. DIENER, R. G., K. C. ELLIOT, S. H. BLIZZARD, P. G. NESSELROAD, S. SINGHA, M. INGLE. A trunk impacator for harvesting apples from the Lincoln canopy.

64. DURNER, EDWARD., and THOMAS GIANFAGNA. Alar replacement update.

65. DURNER, EDWARD. Flower bud and wood hardiness of 'Red Haven' peach as affected on different rootstocks.

66. ELLIOTT, K. C., T. A. BAUGHER, and S. H. BLIZZARD. Under tree roller type shielded herbicide applicator.

67. FOY, C. L. and H. L. WITT. Evaluation of herbicides for control of Bermuda grass.

68. GOULART, BARBARA L. and JOHN F. GARDNER. Design and implementation of a microprocessor-driven overhead trickle system for evaporative cooling and chemical injection on strawberry.

69. GREENE, GEORGE M. Proposed standard procedures for electrical conductivity measurements of winter hardiness of decidious fruit crop shoots.

70. HICKMAN, C. E., R. K. ZIMMERMAN, T. A. BAUGHER, C. E. NIEDZIELA, S. I. WALTER. Preliminary observations of grape cultivar trial at WVU Experiment Farm.

71. KEISER, THOMAS A., and S. H. BLIZZARD. Summer pruning on the Lincoln canopy.

72. MYERS, MICHAEL A., S. SINGHA, and S. H. BLIZZARD. Irrigation requirement and leaf water potential of apple trees under high density management systems.

73. NIEDZIELA, JR. C. E. and C. E. HICKMAN. Strawberry (Fragaria x ananassa Duch.) nitrogen fertilization study.

74. TAKEDA, FUMIOMI, DONALD L. PETERSON, TADEUSZ KORNECKI, Jerry D. Franklin. Cultural modification of thornless blackberry for mechanized fruit harvest.

75. TWORKOSKI, T. J. and R. S. YOUNG. Effects of photoperiod on Virginia Creeper growth and senescence: implications for control.

76. VASS, GEORGE D. and WILLIAM V. WELKER, JR. Collecting and manipulating field data using a polycorder.

77. YOUNG, ROGER S. Glyphosate, Triclopyr, 2,4-D response on Virginia Creeper.

SEASONAL DISTRIBUTION OF THE SPOTTED TENTIFORM LEAFMINER, *Phyllonorycter blancardella* F., ON APPLES IN SOUTH CAROLINA

Clyde S. Gorsuch
R. E. McWhorter
Department of Entomology
Clemson University
Clemson, SC 29634-0365

Introduction: The spotted tentiform leafminer (STLM) has been a pest of apples in the Northeast and Midwest for a considerable length of time. It has been present in South Carolina since about 1982. Only in the last two or three years have they reached pest status. Due to the lack of information on the seasonal distribution and the number of generations in South Carolina, it is difficult to advise producers as to the optimal management strategies for the STLM.

Methods and Materials: STLM population monitoring was conducted using Pherocon IC wing traps baited with commercially available pheromone on rubber septa. Traps were monitored weekly beginning in June, 1986. Trap bottoms were replaced each week and pheromone dispensers each month.

Results and Discussion: Figure 1 shows the trap catch from one orchard in Oconee County over the 17 months since trapping was initiated in 1986. Male catches have continued since the first of October, 1987. Males were captured throughout the winter.

Figure 2 shows the trap catch from an Oconee County and a Pickens County, orchard from January to October, 1987. The Pickens County location was not sprayed after petal fall in 1986 due to complete crop loss from a late freeze. STLM populations were very low in 1986, maximum trap catch 160 between September 12 and 24, 1986. In 1987, the orchard was under a normal spray program and STLM populations increased significantly by late September.

The significance of male emergence throughout the winter is not known at this time. Temperatures through December were mild, however, more normal temperatures were experienced during January. The data indicate that there are at least four generations with potential for a significant flight in November.

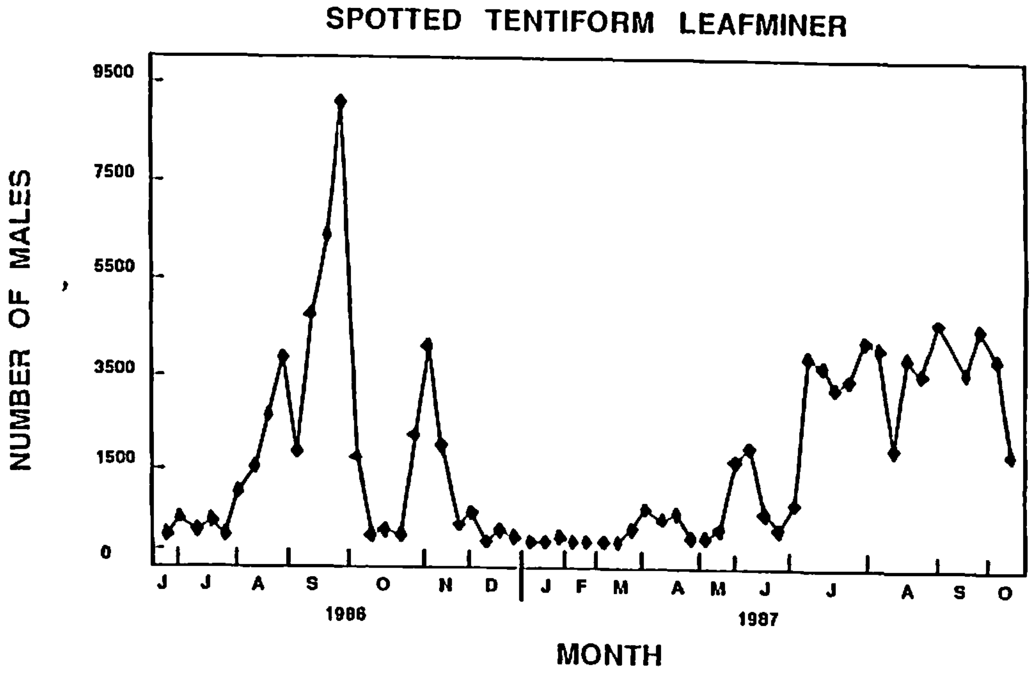


Figure 1. Seasonal distribution of the spotted tentiform leafminer based on pheromone trap catches. One Pherocon IC trap in an Oconee County, SC apple orchard. June 1986 to October 1987.

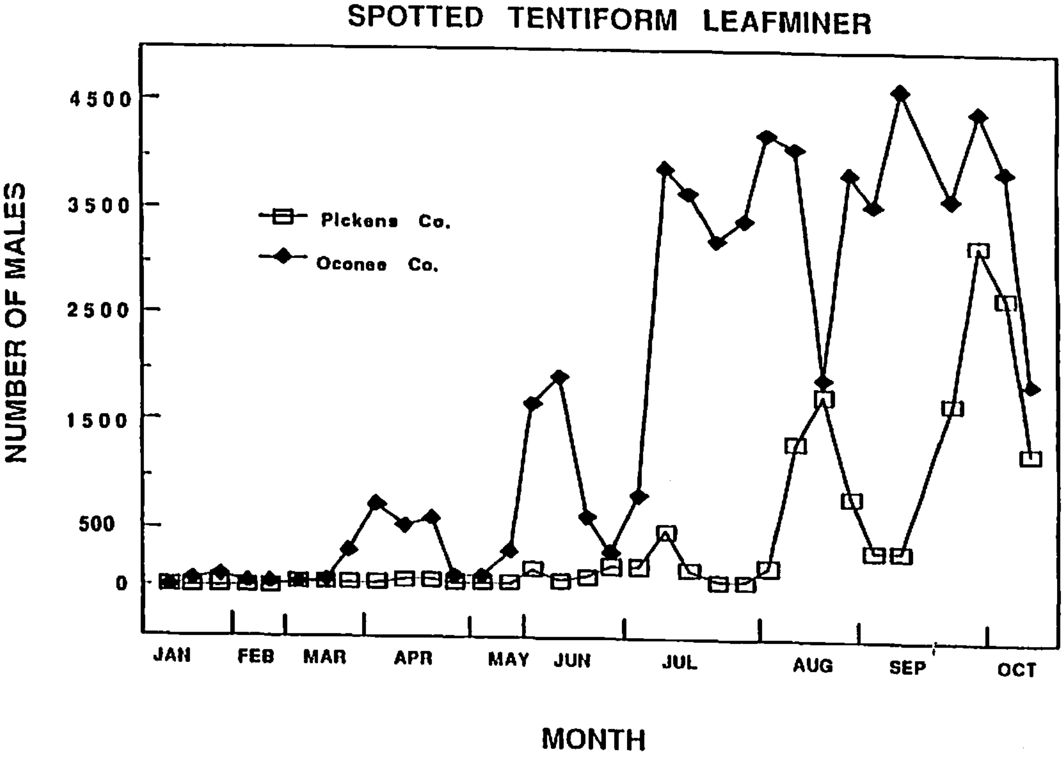


Figure 2. Seasonal distribution of the spotted tentiform leafminer based on pheromone trap catches. One Pherocon IC trap per orchard. January - October 1987.

Seasonal Distribution of the Grape Root Borer, *Vitacea polistiformes* (Harris) in South Carolina

Clyde S. Gorsuch
R. E. McWhorter
Department of Entomology
Clemson University
Clemson, SC 29634-0365

Two muscadine vineyards, one located in Leesville, Lexington County, SC and the other at the Simpson Agricultural Experiment Station, Pendleton, Anderson County, SC, were monitored for grape root borer activity during 1986 and 1987. Pherocon IC traps baited with a blend of (E,Z)-2,13 ODDA/(Z,Z)-3,13 ODDA (99:1) on rubber septa. Two traps per vineyard were used in 1986 and three traps per vineyard were used in 1987. Pheromone dispensers were replaced after about 60 days in the field. Pheromone dispensers were provided by Dr. J. Wendell Snow, Director, Southeastern Fruit and Tree Nut Research Laboratory, USDA, ARS, Byron, GA as part of a regional survey of grape root borer. Traps were placed in the vineyards in late June in 1986 and in late March in 1987. Traps were checked weekly with few exceptions. Trap bottoms were replaced and all the used bottoms returned to the laboratory for identification of all sessid males present. Specimens that we could not identify were forwarded to Dr. Snow. Counts were taken and recorded.

The results are shown in Figures 1 and 2. The flight period in both locations extended from early July to early October in 1986 and 1987. Male flight activity was more prolonged in 1986.

This information has raised serious questions regarding the current recomendations for grape root borer control. Lorsban 4E is the only material labeled at this time. It is labeled for a single application to the soil "just before the pest emerges from the soil." Do not "apply within 35 days before harvest." This restriction makes it difficult to apply when needed since some cultivars are harvested beginning in late July. Since much of the emergence takes place from mid-July through August, it is questionable if Lorsban will provide control.

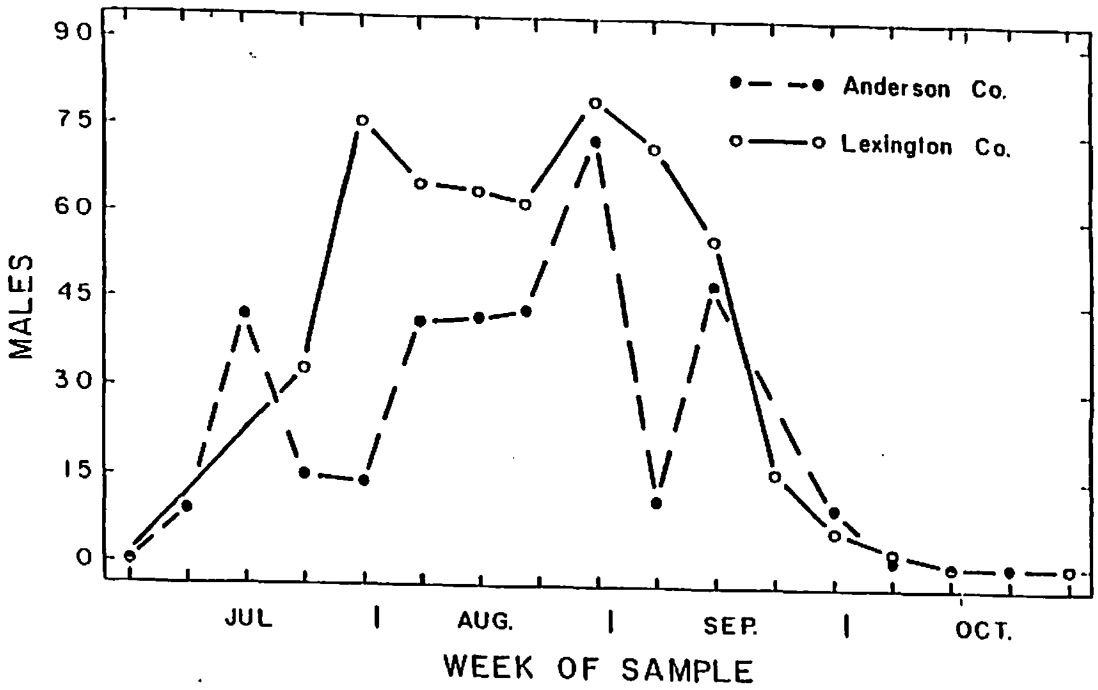


Figure 1. Total trap catch of grape root borer males in pheromone traps. Two Pherocon IC traps per vineyard. 1986.

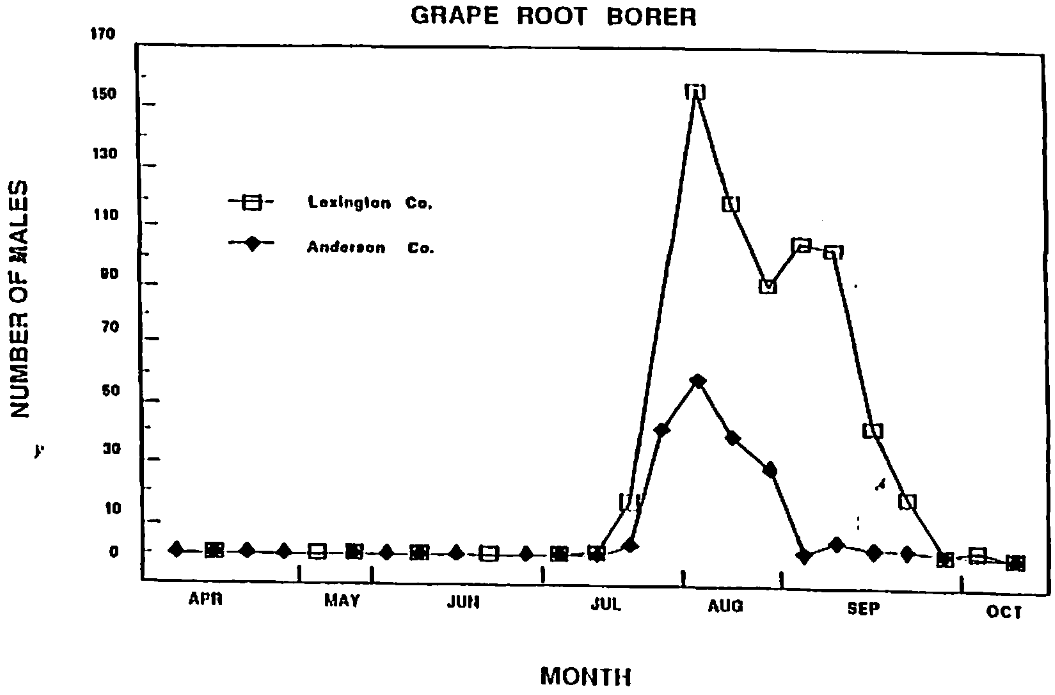


Figure 2. Total trap catch of grape root borer males in pheromone traps. Three Pherocon IC traps per vineyard. 1987.

NOT FOR PUBLICATION

Henry W. Hogmire, Jr.,
Larry Crim and
Richard Annan
WVU Experiment Farm
P. O. Box 303
Kearneysville, WV 25430
(304) 267-4712

PEACH: Prunus persicae, 'Blake'
European red mite (ERM): Panonychus ulmi (Koch)
Twospotted spider mite (TSSM): Tetranychus urticae Koch
Oriental fruit moth (OFM): Grapholitha molesta (Busck)
Catfacing insects: Tarnished plant bug, Lygus lineolaris (P. de B.)
Brown stink bug, Euschistus servus (Say)
Dusky stink bug, Euschistus tristigmus (Say)
Green stink bug, Acrosternum hilare (Say)

PEACH, INSECTICIDE EVALUATION, 1987: Insecticides were applied to an 18-tree plot (6 rows x 3 trees) with a Swanson DA500A airblast sprayer which traveled at 3.86 k/h and delivered 935 liters/ha. Dates of application were 22 Apr [petal fall (PF)], 6 May [shuck-split (SS)], 15 May [shuck-fall (SF)], 29 May [first cover (1C)], 11 Jun [second cover (2C)], 25 Jun [third cover (3C)], 8 Jul [fourth cover (4C)] and 23 Jul [fifth cover (5C)]. Sevin 50W was applied to all chemical treatment plots on 6 Aug. Fungicides, consisting of Captan or sulfur (one Asana treatment) plus Benlate (last two applications) were applied separately to all treatments on the same dates as insecticides.

Data were taken from four replications in the center of each plot. Treatment effect on ERM and TSSM was determined by sampling 25 leaves from the center of each tree on 3 Aug, removing mites with a mite-brushing machine and counting active stages with a binocular microscope. Control of OFM was evaluated on 4 Aug by counting the no. of damaged terminals per tree. Treatment effectiveness on catfacing insects was determined by examining 400 peaches (100/replication) for injury on 19 Aug.

Three applications (PF, SS, SF) of Asana resulted in a significantly higher population of both ERM and TSSM than three applications (PF, SS, SF) of Pounce or a single (PF) application of Asana. Three applications of Asana, followed by Guthion, provided more effective control of catfacing insects than a single Asana application, followed by Guthion. A monthly spray schedule of DPX-EY059 was ineffective in the control of catfacing insects and a little weak against OFM, with no difference between application rates. Pest pressure was light.

NOT FOR PUBLICATION

No.	Treatment and	rate/acre	(lb ai)	Time of Application	ERM/leaf[b]	TSSM/leaf[b]	OFM Damaged terminals/tree[b]	% Catfacing injury[b]
1.	Lannate 1.8L Guthion 50W	1184 ml 284 g	(0.56) + (0.31)	PF	.04 b	0 b	0 c	1.3 c
	Guthion 50W	568 g	(0.62)	SS, SF, 1C-5C				
2.	Asana 1.9EC	59 ml	(0.03)	PF	.04 b	.02 b	0.5 c	4.8 ab
	Guthion 50W	568 g	(0.62)	SS, SF, 1C-5C				
3.	Asana 1.9EC	59 ml	(0.03)	PF, SS, SF	.82 a	2.18 a	0 c	1.0 c
	Guthion 50W	568 g	(0.62)	1C-5C				
4.	Asana 1.9EC[a]	59 ml	(0.03)	PF, SS, SF	.56 a	1.08 a	0 c	0.8 c
	Guthion 50W	568 g	(0.62)	1C-5C				
5.	Pounce 3.2EC	148 ml	(.125)	PF, SS, SF	.08 b	.04 b	0 c	2.0 bc
	Guthion 50W	568 g	(0.62)	1C-5C				
6.	DPX-EY059 0.4EC	237 ml	(.025)	PF, SF, 2C, 4C	.06 b	0 b	0.8 bc	6.5 a
7.	DPX-EY059 0.4EC	474 ml	(0.05)	PF, SF, 2C, 4C	.06 b	0 b	1.5 b	7.3 a
8.	Check	Unsprayed			.06 b	.02 b	6.3 a	11.8 a

[a] Fungicide treatment consisted of Sulfur 95W rather than Captan 50W.

[b] Means in a given column followed by the same letter are not significantly different (DMRT, 0.05 level).

Data analyzed using a power transformation.

NOT FOR PUBLICATION

Henry W. Hogmire, Jr.,
Tara A. Baugher and
Larry Crim
WVU Experiment Farm
P. O. Box 303
Kearneysville, WV 25430
(304) 267-4712

APPLE: *Malus domestica* Borkh., 'Willow Twig'
Periodical cicada: *Magicicada septendecim* (L.)

APPLE, PERIODICAL CICADA CONTROL, 1987: Insecticides were applied to 5 single-tree plots of 2-yr-old trees in a randomized block design. Applications were made with a Century handgun sprayer operated at 200 psi and delivering approximately 3.8 liters of spray per tree. Dates of application were 1 Jun, 5 Jun, 9 Jun, 13 Jun and 17 Jun, with Asana also applied on an 8 day interval (1 Jun, 9 Jun and 17 Jun). Cicada knockdown was determined by counting the no. of immobilized cicadas on the ground beneath each tree in the early morning of 2 Jun following the evening application on 1 Jun. Damage to trees was evaluated on 20 Jul, by counting the no. of oviposition scars in a 40 cm section (previously marked with spray paint) on each of 3 branches per tree.

Vydate, Lannate and Asana were similar in providing excellent knockdown of cicadas, however, Asana was more effective in preventing oviposition injury. There was no significant difference between a 4 day (5 sprays) and an 8 day (3 sprays) interval for applications of Asana.

NOT FOR PUBLICATION

No.	Treatment and	rate/100 gal	(lb ai)	Cicada knockdown[c,d] (no. immobilized)	Oviposition scars/3 branches/tree[c]
1.	Vydate 2L[a]	474 ml	(0.25)	27.2 a	81.2 b
2.	Lannate 1.8L[a]	474 ml	(0.23)	22.0 a	85.4 ab
3.	Morestan 25WP[a]	454 g	(0.25)	5.6 b	91.2 ab
4.	Asana 1.9EC[a]	20 ml	(0.01)	26.6 a	30.2 c
5.	Asana 1.9EC[b]	20 ml	(0.01)	-	36.6 c
6.	Check	Unsprayed		0.4 c	121.2 a

[a] 4 day spray interval.

[b] 8 day spray interval.

[c] Means in a given column followed by the same letter are not significantly different (DMRT, 0.05 level).

[d] Data analyzed using a power transformation.

NOT FOR PUBLICATION

Henry W. Hogmire, Jr.,
Larry Crim and
Richard Annan
WVU Experiment Farm
Kearneysville, WV 25430
(304) 267-4712

APPLE: *Malus domestica* Borkh., 'Rome Beauty'
European red mite: *Panonychus ulmi* (Koch)

APPLE, THURINGIENSIN EVALUATION, 1987: Treatments were applied to 4 single-tree replications of 33-yr-old trees in a randomized block design. Applications were made with a Swanson DA500A airblast sprayer which traveled at 3.86 k/h and delivered 935 liters/ha. Other materials applied separately to all treatments were Bayleton, Benlate, Bordeaux mixture, Captan, Lannate, Manzate 200, Polyram, Sevin and Streptomycin. 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 active stages with a binocular microscope.

A pink application of two formulations of thuringiensin (ABG-6162A and ABG-6198A) provided mite control into early July. No significant rate effect was detected with ABG-6162A following a pink or summer application.

NOT FOR PUBLICATION

				Time of	European red mites/leaf[b]					
No.	Treatment and	rate/acre	(lb ai)	Application[a]	16 Jun	23 Jun	7 Jul	16 Jul	23 Jul	31 Jul
1.	ABG-6162A Carzol 92SP	2840 ml 340 g	(0.11) (0.69)	P, 8 Jul, 24 Jul 24 Jul	0.3 b	0.6 b	4.8 b	7.0 b	10.7 b	1.6 ab
2.	ABG-6162A Carzol 92SP	3788 ml 340 g	(0.14) (0.69)	P, 8 Jul, 24 Jul 24 Jul	0.4 b	0.7 b	4.5 b	12.2 b	7.6 b	1.5 ab
3.	ABG-6162A Carzol 92SP	5680 ml 340 g	(0.22) (0.69)	P, 8 Jul, 24 Jul 24 Jul	0 b	0.4 b	3.5 b	3.1 b	8.0 b	1.0 ab
4.	ABG-6162A	3788 ml 5680 ml	(0.14) (0.22)	P, PF, 8 Jul 24 Jul	0.1 b	0.2 b	1.8 b	2.2 b	4.3 b	1.1 ab
5.	ABG-6198A Carzol 92SP	1896 ml 340 g	(0.14) (0.69)	P, 8 Jul, 24 Jul 24 Jul	0.4 b	0.3 b	2.4 b	3.2 b	4.3 b	0.4 b
6.	Carzol 92SP	340 g	(0.69)	24 Jul	--	--	--	--	7.2 b	1.0 ab
7.	Check	Unsprayed			4.3 a	5.0 a	25.0 a	58.4 a	42.1 a	3.1 a

[a] P = pink (22 Apr), PF = petal fall (7 May).

[b] Means in a given column followed by the same letter are not significantly different (DMRT, 0.05 level). Data analyzed using a power transformation.

NOT FOR PUBLICATION

Henry W. Hogmire, Jr.,
Larry Crim and
Richard Annan
WVU Experiment Farm
P. O. Box 303
Kearneysville, WV 25430
(304) 267-4712

APPLE: *Malus domestica* Borkh., 'Rome Beauty'
European red mite: *Panonychus ulmi* (Koch)

APPLE, SUMMER MITE CONTROL WITH SAVEY AND APOLLO, 1987: Treatments were applied to 4 single-tree replications of 33-yr-old trees in a randomized block design. Applications were made with a Swanson DA500A airblast sprayer which traveled at 3.86 k/h and delivered 935 liters/ha. Date of application was 3 Jul for all treatments, with the Carzol treatment receiving a second application on 24 Jul. Other materials applied separately to all treatments were Bayleton, Benlate, Bordeaux mixture, Captan, Lannate, Manzate 200, Polyram, Sevin and Streptomycin. 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 active stages with a binocular microscope.

At 10 days after treatment, there was no significant difference in mite control between Savey and Apollo, or any difference due to application rate. The addition of Carzol to the low rate of Apollo provided the best mite reduction. At 20 and 25 days after treatment, the low rate of Apollo had a significantly higher mite population than the high rate, whereas no rate effect was detected with Savey.

NOT FOR PUBLICATION

No.	Treatment and rate/acre (lb ai)			European red mites/leaf[a]			
				2 Jul	13 Jul	23 Jul	28 Jul
1.	Savey 50WP	43 g	(0.05)	19.1 a	3.2 b	4.2 cd	0.8 b
2.	Savey 50WP	57 g	(0.06)	18.9 a	3.5 b	4.4 bcd	3.3 ab
3.	Savey 50WP	71 g	(0.08)	18.8 a	2.8 b	3.5 cd	2.1 ab
4.	Apollo 50SC	59 ml	(0.06)	12.9 a	6.4 b	10.0 b	7.1 a
5.	Apollo 50SC	89 ml	(0.09)	17.8 a	4.7 b	2.1 d	1.0 b
6.	Apollo 50SC Carzol 92SP	59 ml 340 g	(0.06) + (0.69)	16.4 a	0.8 c	2.2 d	1.0 b
7.	Carzol 92SP	340 g	(0.69)	11.2 a	3.2 b	7.2 bc	1.0 b
8.	Check	Unsprayed		25.9 a	35.5 a	42.1 a	4.1 ab

[a] Means in a given column followed by the same letter are not significantly different (DMRT, 0.05 level). Data analyzed using a power transformation.

NOT FOR PUBLICATION

Henry W. Hogmire, Jr.,
Larry Crim and
Richard Annan
WVU Experiment Farm
P. O. Box 303
Kearneysville, WV 25430
(304) 267-4712

APPLE: *Malus domestica* Borkh., 'Rome Beauty', 'Golden Delicious'
Rosy apple aphid (RAA): *Dysaphis plantaginea* (Passerini)
White apple leafhopper (WALH): *Typhlocyba pomaria* McAtee
European red mite (ERM): *Panonychus ulmi* (Koch)
Mite predator: *Stethorus punctum* (LeConte)
Codling moth (CM): *Cydia pomonella* (Linnaeus)
San Jose Scale (SJS): *Quadraspidiotus perniciosus* (Comstock)
Tufted apple budmoth (TABM): *Platynota idaeusalis* (Walker)

APPLE, INSECTICIDE EVALUATION, 1987: Insecticides were applied to 6 single-tree plots (3 'Rome Beauty', 3 'Golden Delicious') of 33-yr-old trees in a randomized block design. Applications were made with a Swanson DA500A airblast sprayer which traveled at 3.86 k/h and delivered 935 liters/ha. Dates of application were 9 Apr [delayed dormant (DD)], 14 Apr [tight cluster (TC)], 21 Apr [pre-pink (PP)], 7 May [petal fall (PF)], 26 May [first cover (1C)], 11 Jun [second cover (2C)], 25 Jun [third cover (3C)], 8 Jul [fourth cover (4C)], 23 Jul [fifth cover (5C)], 6 Aug [sixth cover (6C)], 20 Aug [seventh cover (7C)] and 3 Sep [eighth cover (8C)]. Other materials applied separately to all treatments were Bayleton, Benlate, Bordeaux mixture, Captan, Manzate 200, Polyram and Streptomycin. Control of RAA was determined by counting colonies on the periphery of each tree. WALH control was evaluated by counting nymphs found on 25 leaves selected from the periphery of each tree. Effect of treatments on ERM was determined by sampling 33 leaves from the periphery of each 'Rome Beauty' tree, removing mites with a mite-brushing machine and counting active stages with a binocular microscope. Treatment effect on *S. punctum* was determined by counting adults and larvae observed on the periphery of each 'Rome Beauty' tree during a 3-min period. Effect of treatments on fruit feeding insects was determined by scoring for injury 600 apples per treatment (100/replication) plus all fallen apples sampled on 28 Sep. Fruit picked from 'Golden Delicious' trees were rated for finish (0-5 worst).

The petal fall addition of Savey to the Danitol treatment resulted in a lower ERM population compared to Danitol applied alone. *S. punctum* was virtually nonexistent in the Danitol treatments. Lorsban provided excellent ERM suppression and SJS control but was a little weak in the control of CM and TABM. Although a ERM build-up occurred in the Asana + Lorsban treatment, a low level of *S. punctum* was also present. UC-84572 was weak in the control of CM and SJS, and appears to be toxic to *S. punctum* larvae. No difference in fruit finish was observed among treatments.

NOT FOR PUBLICATION

No.	Treatment and	rate/acre	(lb ai)	Time of Application	RAA colonies/tree[a]	WALH/25 leaves[a]	
					28 May	28 May	11 Aug
1.	Supracide 2E	1420 ml	(0.75)	DD	0 b	3.3 bc	3.7 ab
	Guthion 3F	947 ml	(0.75)	PF, 1C, 4C, 5C			
	Guthion 3F	947 ml	(0.75) +				
	Lannate 1.8L	710 ml	(0.34)	2C, 3C, 6C, 7C, 8C			
2.	Supracide 2E	1420 ml	(0.75)	TC	0 b	0.8 bc	1.0 b
	Guthion 50W	680 g	(0.75)	PF, 1C, 4C, 5C			
	Guthion 50W	680 g	(0.75) +				
	Lannate 1.8L	710 ml	(0.34)	2C, 3C, 6C, 7C, 8C			
3.	Lorsban 4E	1184 ml	(1.25)	TC	0 b	1.0 bc	1.2 b
	Lorsban 50W	908 g	(1.0)	PF, 1C, 4C, 5C			
	Lorsban 50W	680 g	(0.75) +				
	Lannate 1.8L	710 ml	(0.34)	2C, 3C, 6C, 7C, 8C			
4.	Asana 1.9EC	50 ml	(.025)	TC	0 b	2.3 ab	1.8 b
	Guthion 50W	680 g	(0.75)	PF, 1C, 4C, 5C			
	Asana 1.9EC	13 ml	(.006) +				
	Lorsban 50W	680 g	(0.75)	2C, 3C, 6C, 7C, 8C			
5.	Danitol 2.4EC	474 ml	(0.30)	PP, PF, 2C, 3C, 8C	1.5 ab	0.2 c	1.5 b
	Savey 50WP	113 g	(.125)	PF			
	Guthion 50W	680 g	(0.75)	1C, 4C, 5C			
	Lannate 1.8L	710 ml	(0.34) +				
	Penncap-M 2F	710 ml	(0.37)	6C, 7C			

					RAA colonies/tree[a]	WALH/25 leaves[a]	
No.	Treatment and	rate/acre	(lb ai)	Time of Application	28 May	28 May	11 Aug
6.	Danitol 2.4EC	474 ml	(0.30)	PP, PF, 2C, 3C, 7C, 8C	0.7 b	0.5 bc	0.8 b
	Guthion 50W	680 g	(0.75)	1C, 4C, 5C			
	Lannate 1.8L	710 ml	(0.34) +				
	Penncap-M 2F	710 ml	(0.37)	6C			
7.	Phosphamidon 8E	237 ml	(0.50) +		0 b	0.2 c	3.5 ab
	Thiodan 50W	680 g	(0.75) +				
	Superior oil 70°	3788 ml		PP			
	UC-84572 2F	188 ml	(0.10) +				
	PA-10	474 ml		PF-8C			
8.	Check	Unsprayed			3.2 a	6.7 a	7.2 a

[a] Means in a given column followed by the same letter are not significantly different (DMRT, 0.05 level). Data analyzed using a power transformation.

NOT FOR PUBLICATION

No.	Treatment and rate/acre		(lb ai)	Time of Application	ERM/leaf^a	S. punctum/3 min on 22 Jul^a	
					21 Jul	Adults	Larvae
1.	Supracide 2E	1420 ml	(0.75)	DD	14.7 bc	8.3 ab	9.3 ab
	Guthion 3F	947 ml	(0.75)	PF, 1C, 4C, 5C			
	Guthion 3F Lannate 1.8L	947 ml 710 ml	(0.75) + (0.34)	2C, 3C, 6C, 7C, 8C			
2.	Supracide 2E	1420 ml	(0.75)	TC	7.2 c	15.3 a	5.7 ab
	Guthion 50W	680 g	(0.75)	PF, 1C, 4C, 5C			
	Guthion 50W Lannate 1.8L	680 g 710 ml	(0.75) + (0.34)	2C, 3C, 6C, 7C, 8C			
3.	Lorsban 4E	1184 ml	(1.25)	TC	2.4 d	6.7 ab	2.3 bc
	Lorsban 50W	908 g	(1.0)	PF, 1C, 4C, 5C			
	Lorsban 50W Lannate 1.8L	680 g 710 ml	(0.75) + (0.34)	2C, 3C, 6C, 7C, 8C			
4.	Asana 1.9EC	50 ml	(.025)	TC	21.5 ab	12.7 a	4.7 ab
	Guthion 50W	680 g	(0.75)	PF, 1C, 4C, 5C			
	Asana 1.9EC Lorsban 50W	13 ml 680 g	(.006) + (0.75)	2C, 3C, 6C, 7C, 8C			
5.	Danitol 2.4EC Savey 50WP	474 ml 113 g	(0.30) (.125)	PP, PF, 2C, 3C, 8C PF	2.3 d	0.3 c	0 c
	Guthion 50W	680 g	(0.75)	1C, 4C, 5C			
	Lannate 1.8L Penncap-M 2F	710 ml 710 ml	(0.34) + (0.37)	6C, 7C			

				Time of	% Injury By:[a]				Finish
No.	Treatment and	rate/acre	(lb ai)	Application	CM	SJS	TABM	% CLEAN[a]	Rating[a]
1.	Supracide 2E	1420 ml	(0.75)	DD	7.3 cd	2.4 c	7.1 abc	85.1 ab	3.2 a
	Guthion 3F	947 ml	(0.75)	PF, 1C, 4C, 5C					
	Guthion 3F Lannate 1.8L	947 ml 710 ml	(0.75) + (0.34)	2C, 3C, 6C, 7C, 8C					
2.	Supracide 2E	1420 ml	(0.75)	TC	6.1 cd	2.3 c	2.7 c	90.2 ab	3.5 a
	Guthion 50W	680 g	(0.75)	PF, 1C, 4C, 5C					
	Guthion 50W Lannate 1.8L	680 g 710 ml	(0.75) + (0.34)	2C, 3C, 6C, 7C, 8C					
3.	Lorsban 4E	1184 ml	(1.25)	TC	11.2 bc	1.8 c	8.1 ab	80.2 ab	3.4 a
	Lorsban 50W	908 g	(1.0)	PF, 1C, 4C, 5C					
	Lorsban 50W Lannate 1.8L	680 g 710 ml	(0.75) + (0.34)	2C, 3C, 6C, 7C, 8C					
4.	Asana 1.9EC	50 ml	(.025)	TC	3.8 d	3.1 c	2.9 c	91.4 a	3.5 a
	Guthion 50W	680 g	(0.75)	PF, 1C, 4C, 5C					
	Asana 1.9EC Lorsban 50W	13 ml 680 g	(.006) + (0.75)	2C, 3C, 6C, 7C, 8C					
5.	Danitol 2.4EC Savey 50WP	474 ml 113 g	(0.30) (.125)	PP, PF, 2C, 3C, 8C PF	3.1 d	14.9 b	4.0 bc	80.9 ab	3.0 a
	Guthion 50W	680 g	(0.75)	1C, 4C, 5C					
	Lannate 1.8L Penncap-M 2F	710 ml 710 ml	(0.34) + (0.37)	6C, 7C					

No.	Treatment and	rate/acre	(lb ai)	Time of Application	ERM/leaf[a]	S. punctum/3 min on 22 Jul[a]	
					21 Jul	Adults	Larvae
6.	Danitol 2.4EC	474 ml	(0.30)	PP, PF, 2C, 3C, 7C, 8C	7.5 c	1.7 bc	0 c
	Guthion 50W	680 g	(0.75)	1C, 4C, 5C			
	Lannate 1.8L	710 ml	(0.34) +				
	Penncap-M 2F	710 ml	(0.37)	6C			
7.	Phosphamidon 8E	237 ml	(0.50) +		2.5 d	3.3 abc	0 c
	Thiodan 50W	680 g	(0.75) +				
	Superior oil 70°	3788 ml		PP			
	UC-84572 2F	188 ml	(0.10) +				
	PA-10	474 ml		PF-8C			
8.	Check	Unsprayed			38.9 a	15.0 a	25.3 a

[a] Means in a given column followed by the same letter are not significantly different (DMRT, 0.05 level). Data analyzed using a power transformation.

No.	Treatment and	rate/acre	(lb ai)	Time of Application	% Injury By:[a] CM	SJS	TABM	% CLEAN[a]	Finish Rating[a]
6.	Danitol 2.4EC	474 ml	(0.30)	PP, PF, 2C, 3C, 7C, 8C	5.3 cd	18.6 b	4.5 bc	74.5 b	3.1 a
	Guthion 50W	680 g	(0.75)	1C, 4C, 5C					
	Lannate 1.8L	710 ml	(0.34) +						
	Penncap-M 2F	710 ml	(0.37)	6C					
7.	Phosphamidon 8E	237 ml	(0.50) +		20.0 b	36.6 a	4.0 bc	48.1 c	3.8 a
	Thiodan 50W	680 g	(0.75) +						
	Superior Oil 70°	3788 ml		PP					
	UC-84572 2F	188 ml	(0.10) +						
	PA-10	474 ml		PF-8C					
8.	Check	Unsprayed			50.4 a	22.9 ab	13.5 a	31.5 d	3.4 a

---

[a] Means in a given column followed by the same letter are not significantly different (DMRT, 0.05 level). Data analyzed using a power transformation.

REPORT FOR THE 1987 CUMBERLAND-SHENANDOAH FRUIT WORKERS CONFERENCE

Virginia Polytechnic Institute and State University
Winchester Agricultural Experiment Station
Department of Entomology
Winchester, VA 22601

Robert L. Horsburgh[1] and Leonard J. Cobb[2]

The 1987 growing season was characterized by fluctuations in precipitation, a cool spring, and warmer than average temperatures during the summer. The July rainfall all came in the first two weeks, resulting in a very dry period until early September.

	Precipitation (inches)		Mean temperature (°F)	
	1987	74 yr. avg.	1987	66 yr. avg.
April	6.95	3.14	50.9	54.0
May	2.97	3.78	64.6	63.7
June	5.12	3.89	73.7	71.7
July	3.01	3.87	78.4	76.7
August	1.13	3.82	73.9	74.2
September	9.71	2.77	65.9	69.0

Rosy aphid populations were readily controlled in most orchards if applications were properly timed. European red mite populations increased slowly until late June. In many orchards in the northern Virginia area, insecticide applications for periodical cicada, Magicicada septendecim, reduced populations of beneficials and mites became quite numerous from late June throughout the season. The first generation of the leafroller complex was also held in check by these insecticide applications, but some orchards were damaged by the fall generation of tufted apple budmoth. No insecticides adequately managed the periodical cicada outbreak; consequently, there was significant damage to 2 and 3 year old wood in many trees.

Sources of materials used in these tests are:

Abbott Labs: ABG-6162
Chevron Chemical Company: Danitol
Ciba-Geigy, Agri. Division: Supracide
Dow Chemical USA: Lorsban 4E, Lorsban 50W, Plictran
E. I. duPont deNemours & Company: Asana, DPX-E4059, Lannate, Savey
FMC Corporation: Pounce, Brigade
Mobay Chemical Corporation: Guthion 50W, Guthion 3F
Rohm & Haas Company: Kelthane 4F (XF-86006 and XF-86038)
Union Carbide Corporation: Larvin
Uniroyal, Inc.: Omite 30W, Omite 6E

[1] Professor and Superintendent

[2] Agricultural Research Scientist

APPLE: Malus domestica Borkh
'Red Delicious' and 'York'
Rosy apple aphid;
Dysaphis plantaginea (Passerini)
White apple leafhopper;
Typhlocyba pomaria McAtee
European red mite;
Panonychus ulmi (Koch)
Codling moth;
Cydia pomonella (Linnaeus)
Redbanded leafroller;
Argyrotaenia velutinana (Walker)
Tufted apple budmoth;
Platynota idaeusalis (Walker)
Variegated leafroller;
Platynota flavedana Clemens
Plant bug; Lygus spp.

R. L. Horsburgh and L. J. Cobb
Department of Entomology
Winchester Agricultural Experiment Station
Virginia Polytechnic Institute and State University
2500 Valley Avenue
Winchester, VA 22601

APPLE, FULL SEASON INSECTICIDE EVALUATIONS, 1987: Experimental insecticide treatments were applied in a comparative test to Red Yorking and Redspur Delicious trees. A randomized block design was used and each treatment was replicated 4 times on each variety. Trees were sprayed to runoff using a Bean 35 gal/min hydraulic sprayer operating at 400 psi. European red mite populations were evaluated on Yorks throughout the season. Due to a shortage of fruit on the Yorks, post-bloom applications were included on Redspur Delicious. Mites and eggs were counted by randomly selecting 25 leaves/replicate, brushing onto glass plates with a modified Henderson-McBurnie brushing machine and counting all motile forms and viable eggs with a binocular microscope. Rosy apple aphid populations were evaluated on May 28 by counting all colonies found in 3 min/tree. Foliage was visually rated on a scale of 0-4 for white apple leafhopper damage on Sep 8.

All treatments provided good control of rosy aphids and were significantly better than the check. European red mite populations were below the action threshold of 3 mites per leaf on all treatments except the check through late Jun. During Jul mite populations increased rapidly and exceeded the action threshold on all treatments. By early Aug populations of ERM had declined on DPX-E4059, Guthion and the check but far exceeded economic thresholds on other treatments. All treatments prevented WALH damage except Guthion and the check as shown by the foliage rating on Sep 8. Fruit feeding insect populations were lower than expected based on last year's damage in this block of trees. This may be due to heavier spraying of the surrounding orchard blocks because of the cicada outbreak this year. Pre-mature fruit drop was a problem on the Pounce treatment due to foliage damage caused by European red mite. No fruit phytotoxicity was found as evidenced by the fruit finish ratings.

Materials and amounts/100 gal with dates of application	RAA colonies/ 3 min/tree (May 28)	WALH damage rating ** (Sep 8)
Asana 1.9E 0.5 fl oz (14.8 ml) on Apr 21* DPX-EY059 50 g/L 3.8 fl oz (112.4 ml) on May 18, Jun 22, Jul 16, Aug 20	0.25 b	.05
Pounce 25W 2.5 oz (70.9 gm) on Apr 21*, May 18; Brigade 10W 4.3 oz (121.9 gm) on Jun 11, Jun 30; Guthion 50W 8.0 oz (226.8 gm) on Jul 16, Aug 4, Aug 20	0.75 b	.00
Danitol 2.4E 4.0 fl oz (118.3 ml) on Apr 21*, Jun 11, Jun 30, Aug 4; same + Savey 50W 1.0 oz (28.4 gm) on May 18; Guthion 50W 8.0 oz (226.8 gm) on Jul 16, Aug 20	2.50 b	.00
Danitol 2.4E 5.33 fl oz (157.6 ml) on Apr 21*, Jun 11, Jun 30, Aug 4; same + Savey 50W 1.0 oz (28.4 gm) on May 18; Guthion 50W 8.0 oz (226.8 gm) on Jul 16, Aug 20	2.75 b	.00
Danitol 2.4E 5.33 fl oz (157.6 ml) on Apr 21*, May 18, Jun 11, Jun 30, Aug 4; Guthion 50W 8.0 oz (226.8 gm) on Jul 16, Aug 20	4.25 b	.00
Supracide 2E 1.0 pt (473.2 ml) on Apr 21*, Guthion 50W 8.0 oz (226.8 gm) on May 18, Jun 11, Jun 30, Jul 16, Aug 4, Aug 20	.00 b	2.50
Check	32.50 a	3.50

* Apr 21 - Treatments were applied to Yorks only. Red Delicious were sprayed with Supracide + oil on Apr 8.

**Visual rating of foliage damage rated on a scale of 0-4 with 4 showing the most feeding chlorosis.

Numbers in the same column followed by the same letter are not significantly different ($P < .05$), DMRT.

Analysis was done on untransformed RAA data.

Materials and amounts/100 gal with dates of application	Jun 8		Jun 22		Jul 23		Aug 3	
	mites/ leaf	eggs/ leaf	mites/ leaf	eggs/ leaf	mites/ leaf	eggs/ leaf	mites/ leaf	eggs/ leaf
Asana 1.9E 0.5 fl oz (14.8 ml) on Apr 21* DPX-EY059 50 g/L 3.8 fl oz (112.4 ml) on May 18, Jun 22, Jul 16, Aug 20	.00 b	.33 cd	.27 bc	.25 c	5.11 b	21.28 bc	1.43 c	3.01 d
Pounce 25W 2.5 oz (70.9 gm) on Apr 21*, May 18; Brigade 10W 4.3 oz (121.9 gm) on Jun 11, Jun 30; Guthion 50W 8.0 oz (226.8 gm) on Jul 16, Aug 4, Aug 20	.13 b	.62 bc	.90 b	2.05 b	9.14 b	9.27 c	47.47 a	170.50 a
Danitol 2.4E 4.0 fl oz (118.3 ml) on Apr 21*, Jun 11, Jun 30, Aug 4; same + Savey 50W 1.0 oz (28.4 gm) on May 18; Guthion 50W 8.0 oz (226.8 gm) on Jul 16, Aug 20	.00 b	.00 d	.00 c	.04 c	12.29 ab	27.81 abc	37.17 a	44.58 bc
Danitol 2.4E 5.33 fl oz (157.6 ml) on Apr 21*, Jun 11, Jun 30, Aug 4; same + Savey 50W 1.0 oz (28.4 gm) on May 18; Guthion 50W 8.0 oz (226.8 gm) on Jul 16, Aug 20	.00 b	.04 d	.04 c	.04 c	3.55 b	10.24 c	18.29 a	24.05 c
Danitol 2.4E 5.33 fl oz (157.6 ml) on Apr 21*, May 18, Jun 11, Jun 30, Aug 4; Guthion 50W 8.0 oz (226.8 gm) on Jul 16, Aug 20	.00 b	.04 d	.00 c	.04 c	8.90 b	19.04 c	32.31 a	71.11 ab
Supracide 2E 1.0 pt (473.2 ml) on Apr 21*, Guthion 50W 8.0 oz (226.8 gm) on May 18, Jun 11, Jun 30, Jul 16, Aug 4, Aug 20	.09 b	1.02 b	2.70 a	4.40 ab	40.90 a	74.32 a	1.83 bc	2.29 d
Check	.60 a	2.60 a	5.36 a	7.63 a	43.15 a	64.21 a	5.25 b	5.85 d

*Apr 21 - Treatments were applied to Yorks only. Red Delicious were sprayed with Supracide + oil on Apr 8.

Numbers in the same column followed by the same letter are not significantly different ($P < .05$), DMRT.

Data were transformed to $\log_{10}(X + .05)$ for analysis.

Materials and amounts/100 gal with dates of application	Percent fruit damaged by:						Mean no. drops/tree**
	CM	RBLR	TABM & VL	PB	Total	Finish	
Asana 1.9E 0.5 fl oz (14.8 ml) on Apr 21* DPX-EY059 50 g/L 3.8 fl oz (112.4 ml) on May 18, Jun 22, Jul 16, Aug 20	0	.25	.25	.75	1.25	2.46	24.25 b
Pounce 25W 2.5 oz (70.9 gm) on Apr 21*, May 18; Brigade 10W 4.3 oz (121.9 gm) on Jun 11, Jun 30; Guthion 50W 8.0 oz (226.8 gm) on Jul 16, Aug 4, Aug 20	0	.25	0	.75	1.00	2.24	136.75 a
Danitol 2.4E 4.0 fl oz (118.3 ml) on Apr 21*, Jun 11, Jun 30, Aug 4; same + Savey 50W 1.0 oz (28.4 gm) on May 18; Guthion 50W 8.0 oz (226.8 gm) on Jul 16, Aug 20	0	.25	0	.75	1.00	2.32	33.75 b
Danitol 2.4E 5.33 fl oz (157.6 ml) on Apr 21*, Jun 11, Jun 30, Aug 4; same + Savey 50W 1.0 oz (28.4 gm) on May 18; Guthion 50W 8.0 oz (226.8 gm) on Jul 16, Aug 20	0	0	0	.50	.50	2.55	52.50 b
Danitol 2.4E 5.33 fl oz (157.6 ml) on Apr 21*, May 18, Jun 11, Jun 30, Aug 4; Guthion 50W 8.0 oz (226.8 gm) on Jul 16, Aug 20	0	0	0	.25	.25	2.31	44.00 b
Supracide 2E 1.0 pt (473.2 ml) on Apr 21*, Guthion 50W 8.0 oz (226.8 gm) on May 18, Jun 11, Jun 30, Jul 16, Aug 4, Aug 20	0	0	0	1.00	1.00	2.43	15.75 b
Check	0	.50	1.25	1.25	3.00	2.38	21.25 b

* Apr 21 - Treatments were applied to Yorks only. Red Delicious were sprayed with Supracide + oil on Apr 8.

**Analysis was done on untransformed data.

Numbers in the same column followed by the same letter are not significantly different ($P < .05$), DMRT.

APPLE: _Malus domestica Borkh_
'Golden Delicious'
Rosy apple aphid;
Dysaphis plantaginea (Passerini)
European red mite; _Panonychus ulmi_ (Koch)
Codling moth; _Cydia pomonella_ (Linnaeus)
Redbanded leafroller;
Argyrotaenia velutinana (Walker)
Plum curculio;
Canotrachelus nenuphar (Herbst)
Plant bugs; _Lygus_ spp.
Tufted apple budmoth;
Platynota idaeusalis (Walker)
Variegated leafroller;
Platynota flavedana Clemens

R. L. Horsburgh and L. J. Cobb
Department of Entomology
Winchester Agricultural Experiment Station
Virginia Polytechnic Institute and State University
2500 Valley Avenue
Winchester, VA 22601

APPLE, FULL SEASON INSECTICIDE EVALUATIONS, 1987: Insecticide treatments were applied in a comparative test to mature Golden Delicious trees on Apr 21, May 13, May 27, Jun 16, Jul 6, Jul 27, and Aug 11. Treatments were applied with a Bean 35 gal/min hydraulic sprayer operating at 400 psi. Single tree treatments were used and replicated 4 times in a randomized block design. Trees were sprayed to runoff. All trees were sprayed with Lorsban 4E 2.5 pt/A on Apr 8, before the test began.

Control of rosy apple aphids was evaluated on Jun 9 in a 3 min/tree timed count. Although all trees had been previously treated with Lorsban 4E, the check trees still had significantly more aphid colonies than any treatment except Larvin. European red mites were evaluated on Jun 23. At that time Lorsban treatments had significantly fewer mites than all other treatments, indicating a possible suppressive effect. By early July, predators had reduced mite populations on all treatments and they remained low throughout the season. Insect damage was evaluated on Aug 24 by randomly selecting and checking 50 apples/replicate. Only codling moth and redbanded leafroller damage could be analyzed. Other damage is included on the chart and the total damage from all insects is shown. An unidentified Lepodopterous insect was responsible for some damage. This may have been European corn borer. Treatments were not significantly different from one another and all were significantly better than the check. No significant increase in insect damage occurred by Sep 28 when final harvest was completed. Average finish ratings were evaluated for each treatment by grading each apple in a 100 apple sample on a scale of 1 to 5 (1 being the best).

SEASONAL INSECTICIDE TRIAL - 1987

Materials and amounts/ 100 gal	Rosy aphid colonies/3 min/tree[1] Jun 9	Jun 23 mites/leaf[2]	Jun 23 eggs/leaf[2]
Lorsban 50W 5.28 oz (149.7 gm)	3.00 b	.13 b	.27 b
Lorsban 50W 10.56 oz (299.4 gm)	0.00 b	.23 b	.23 b
Lorsban 50W 5.28 oz (149.7 gm) + Lannate 1.8L 8.0 fl oz (236.6 ml)	0.00 b	.00 b	.22 b
Guthion 3F 10.7 fl oz (316.4 ml)	2.00 b	2.74 a	3.26 a
Guthion 50W 8.0 oz (226.8 gm)	0.00 b	1.95 a	3.78 a
Larvin 3.2F 8.0 fl oz (236.6 ml)	10.25 ab	1.65 a	3.10 a
Check	21.50 a	2.35 a	3.68 a

Numbers in the same column followed by the same letter are not significantly different ($P < .05$), DMRT.

[1] Analysis was done on untransformed data.

[2] Data were transformed to $\log_{10} (X + .05)$ for analysis.

SEASONAL INSECTICIDE TRIAL - 1987

	Percent fruit damaged by						
Materials and amounts/100 gal	CM[1]	RBLR[1]	PC[2]	PB[2]	TABM & VL[2]	Total[1,4]	Finish[1,3]
Lorsban 50W 5.28 oz (149.7 gm)	.50 b	.00 b	.00	1.00	.00	2.00 b	3.36 ab
Lorsban 50W 10.56 oz (299.4 gm)	.00 b	.00 b	.00	.50	.50	1.00 b	3.79 a
Lorsban 50W 5.28 oz (149.7 gm) + Lannate 1.8L 8.0 fl oz (236.6 ml)	.00 b	.50 b	.00	.00	.50	1.50 b	3.49 ab
Guthion 3F 10.7 fl oz (316.4 ml)	.00 b	.00 b	.00	.00	.50	1.50 b	3.31 bc
Guthion 50W 8.0 oz (226.8 gm)	.00 b	.00 b	.00	1.50	1.00	2.50 b	3.05 bc
Larvin 3.2F 8.0 fl oz (236.6 ml)	.00 b	.00 b	.00	1.00	.00	1.00 b	3.12 bc
Check	3.50 a	1.50 a	.50	1.50	1.00	9.50 a	2.87 c

Numbers in the same column followed by the same letter are not significantly different ($P < .05$), DMRT.

[1] Analysis was done on untransformed data.

[2] Populations were too low or variances too great for analysis.

[3] Fruit finish was rated on a scale of 1 to 5 (1 being the best) on Sep 28.

[4] Total percent damaged fruit includes some damage from an unidentified Lepodopterous larva, possibly European corn borer.

APPLE: Malus domestica Borkh
'Nittany'
European red mite;
Panonychus ulmi (Koch)

R. L. Horsburgh and L. J. Cobb
Department of Entomology
Winchester Agricultural Experiment Station
Virginia Polytechnic Institute and State University
2500 Valley Avenue
Winchester, VA 22601

APPLE, MITICIDE EVALUATIONS, 1987: Treatments were applied to 5 year old Nittany trees using single tree plots arranged in a randomized block design and replicated 5 times. Trees were sprayed to runoff using a Bean 35 gal/min hydraulic sprayer operating at 400 psi. Application dates varied from treatment to treatment. Refer to the table for application dates for each material. Mites and eggs were counted by randomly selecting 20 leaves/replicate, brushing onto glass plates with a modified Henderson-McBurnie brushing machine and counting all motile forms and viable eggs with a binocular microscope. Mite predators were kept out of these plots during the early season with sprays of Sevin and Asana.

ABG-6162A was applied at pink bud stage on 2 plots and at both pink and petal-fall on 3 plots. Other treatments were applied on Jun 18 when populations on the check were greater than 3 mites/leaf. Subsequent applications were made on each treatment at the same threshold until Aug 1 when miticide applications were discontinued. The number of applications and the total number of accumulated mite days for the season are important for each treatment. Populations on the check did not reach the action threshold until mid Jun and increased most rapidly during late Jul. All treatments were significantly better than the check and only ABG-6162A required more than 2 applications. Two early season applications of ABG-6162A did not perform better than a single application at corresponding rates and the 64.0 fl oz/100 gal rate was not significantly better than the 32.0 fl oz/100 rate. By Jul 30 early applications of ABG-6162A had broken down so that standard miticides were tank mixed with ABG-6162A to bring the populations under control. The role of ABG-6162A in these later applications is uncertain. Kelthane 4F, both 86006 and 86038, performed well as did Savey 50W. Plictran and Omite both performed well, but mite populations were rebounding in mid Aug.

Materials and amts/100 gal and dates of application	No. applications required	Accumulated mite days[1] Aug 17	Jun 17		Jun 29		Jul 8	
			Mites/leaf	Eggs/leaf	Mites/leaf	Eggs/leaf	Mites/leaf	Eggs/leaf
ABG-6162A 1.5% w/w 32.0 fl oz on Apr 27, Jul 10 followed by same + Plictran 50W 4.0 oz on Jul 30	3	630.8	.18 b	.09 b	.28 b	.61 cd	1.99 bc	5.18 bcd
ABG-6162A 1.5% w/w 40.0 fl oz on Apr 27, Jul 10 followed by same + Plictran 50W 4.0 oz on Jul 30	3	680.9	.07 b	.18 b	.67 b	.63 cd	2.71 bc	7.57 bcd
ABG-6162A 1.5% w/w 64.0 fl oz on Apr 27, Jul 10, Jul 30	3	630.1	.18 b	.07 b	.61 b	1.44 cd	5.11 b	14.43 b
ABG-6162A 1.5% w/w 32.0 fl oz on Apr 27, May 28, Jul 10 followed by ABG-6162A 1.5 w/w 64.0 fl oz + Plictran 50W 4.0 oz on Jul 30	4	440.7	.04 b	.09 b	.34 b	.66 cd	2.32 bc	4.43 bcd
ABG-6162A 1.5% w/w 40.0 fl oz on Apr 27, May 28, Jul 10 followed by ABG-6162A 1.5% w/w 64.0 fl oz + Kelthane 4F (86038) 8.0 fl oz on Jul 30	4	530.9	.04 b	.00 b	.62 b	.66 cd	1.84 bc	3.25 bcd
Savey 50WP 0.50 oz (14.2 gm) on Jun 18, Jul 22	2	207.4	--	--	.43 b	3.46 b	1.53 c	8.81 bc
Savey 50WP 0.67 oz (19.0 gm) on Jun 18, Jul 30	2	263.8	--	--	.72 b	3.22 b	.83 c	3.56 bcd
Savey 50WP 0.82 oz (23.2 gm) on Jun 18, Jul 22	2	198.0	--	--	.14 b	2.24 bc	1.46 c	3.93 bcd
Kelthane 4F (XF-86006) 16.0 fl oz on Jun 18	1	208.4	--	--	.09 b	.28 d	.98 c	1.46 d

Materials and amts/100 gal and dates of application	No. applications required	Accumulated mite days[1] Aug 17	Jun 17		Jun 29		Jul 8	
			Mites/leaf	Eggs/leaf	Mites/leaf	Eggs/leaf	Mites/leaf	Eggs/leaf
Kelthane 4F (XF-86038) 16.0 fl oz on Jun 18, Jul 22	2	215.4	--	--	.18 b	.41 d	1.57 c	2.48 cd
Plictran 50W 4.0 oz on Jun 18, Jul 22	2	342.2	--	--	.46 b	.07 d	1.47 c	6.23 bcd
Omite 6E 10.0 fl oz on Jun 18, Jul 22	2	416.5	--	--	.90 b	.07 d	2.04 bc	8.13 bc
Omite 30W 1.5 lb on Jun 18, Jul 22	2	461.1	--	--	.47 b	.31 d	1.23 c	8.07 bc
Check (unsprayed)	-	2387.3	4.64 a	2.62 a	7.95 a	16.60 a	27.11 a	70.13 a

[1] Mite days = $\frac{M_2 + M_1}{2} X(D_2 - D_1)$ where M_2 and M_1 are numbers of mites/leaf on two count days, D_2 and D_1.

Numbers in the same column followed by the same letter are not significantly different ($P < .05$), DMRT.

Data were transformed to $\log_{10} (X + .5)$ for analysis.

Materials and amts/100 gal and dates of application	Jul 20		Jul 30	
	Mites/leaf	Eggs/leaf	Mites/leaf	Eggs/leaf
ABG-6162A 1.5% w/w 32.0 fl oz on Apr 27, Jul 10 followed by same + Plictran 50W 4.0 oz on Jul 30	14.39 b	3.46 de	36.98 ab	44.69 ab
ABG-6162A 1.5% w/w 40.0 fl oz on Apr 27, Jul 10 followed by same + Plictran 50W 4.0 oz on Jul 30	16.56 b	3.38 de	33.93 ab	48.14 ab
ABG-6162A 1.5% w/w 64.0 fl oz on Apr 27, Jul 10, Jul 30	13.05 b	2.55 def	32.61 ab	39.95 ab
ABG-6162A 1.5% w/w 32.0 fl oz on Apr 27, May 28, Jul 10 followed by ABG-6162A 1.5 w/w 64.0 fl oz + Plictran 50W 4.0 oz on Jul 30	11.63 b	3.57 de	22.83 b	32.31 abc
ABG-6162A 1.5% w/w 40.0 fl oz on Apr 27, May 28, Jul 10 followed by ABG-6162A 1.5% w/w 64.0 fl oz + Kelthane 4F (86038) 8.0 fl oz on Jul 30	17.16 b	3.09 def	23.60 b	28.27 abc
Savey 50WP 0.50 oz (14.2 gm) on Jun 18, Jul 22	4.18 c	4.09 cde	1.94 d	16.88 abcd
Savey 50WP 0.67 oz (19.0 gm) on Jun 18, Jul 30	1.24 d	2.98 def	9.52 c	16.17 bcd
Savey 50WP 0.82 oz (23.2 gm) on Jun 18, Jul 22	4.15 c	2.80 def	1.54 d	11.80 cde
Kelthane 4F (XF-86006) 16.0 fl oz on Jun 18	1.23 d	1.01 f	2.32 d	8.07 def

Materials and amts/100 gal and dates of application	Jul 20		Jul 30	
	Mites/leaf	Eggs/leaf	Mites/leaf	Eggs/leaf
Kelthane 4F (XF-86038) 16.0 fl oz on Jun 18, Jul 22	3.74 c	1.83 ef	1.48 d	0.73 g
Plictran 50W 4.0 oz on Jun 18, Jul 22	10.75 b	6.71 bcd	1.85 d	3.21 f
Omite 6E 10.0 fl oz on Jun 18, Jul 22	14.74 b	11.58 b	2.93 d	3.39 f
Omite 30W 1.5 lb on Jun 18, Jul 22	14.60 b	9.91 bc	3.84 d	4.00 ef
Check (unsprayed)	64.96 a	37.52 a	55.35 a	52.71 a

Numbers in the same column followed by the same letter are not significantly different ($P < .05$), DMRT.

Data were transformed to $\log_{10}(X + .5)$ for analysis.

Materials and amts/100 gal and dates of application	Aug 7		Aug 17	
	Mites/leaf	Eggs/leaf	Mites/leaf	Eggs/leaf
ABG-6162A 1.5% w/w 32.0 fl oz on Apr 27, Jul 10 followed by same + Plictran 50W 4.0 oz on Jul 30	2.70 bcde	2.78 bcd	1.23 def	2.15 de
ABG-6162A 1.5% w/w 40.0 fl oz on Apr 27, Jul 10 followed by same + Plictran 50W 4.0 oz on Jul 30	1.68 cde	1.64 cd	0.86 ef	1.00 ef
ABG-6162A 1.5% w/w 64.0 fl oz on Apr 27, Jul 10, Jul 30	7.39 b	1.94 cd	2.11 cde	5.24 bc
ABG-6162A 1.5% w/w 32.0 fl oz on Apr 27, May 28, Jul 10 followed by ABG-6162A 1.5 w/w 64.0 fl oz + Plictran 50W 4.0 oz on Jul 30	1.70 cde	1.66 cd	0.22 f	0.53 f
ABG-6162A 1.5% w/w 40.0 fl oz on Apr 27, May 28, Jul 10 followed by ABG-6162A 1.5% w/w 64.0 fl oz + Kelthane 4F (86038) 8.0 fl oz on Jul 30	2.29 cde	0.94 d	0.52 f	1.89 de
Savey 50WP 0.50 oz (14.2 gm) on Jun 18, Jul 22	0.83 e	3.36 bcd	0.40 f	3.01 cd
Savey 50WP 0.67 oz (19.0 gm) on Jun 18, Jul 30	3.36 bcd	7.84 b	0.25 f	1.69 de
Savey 50WP 0.82 oz (23.2 gm) on Jun 18, Jul 22	0.94 de	3.30 bcd	0.73 ef	2.77 cd
Kelthane 4F (XF-86006) 16.0 fl oz on Jun 18	2.30 cde	4.86 bc	3.25 cd	8.15 b

Materials and amts/100 gal and dates of application	Aug 7		Aug 17	
	Mites/leaf	Eggs/leaf	Mites/leaf	Eggs/leaf
Kelthane 4F (XF-86038) 16.0 fl oz on Jun 18, Jul 22	1.01 de	2.77 bcd	0.34 f	0.91 ef
Plictran 50W 4.0 oz on Jun 18, Jul 22	1.20 de	3.79 bc	3.97 c	3.07 cd
Omite 6E 10.0 fl oz on Jun 18, Jul 22	1.50 cde	5.44 bc	4.66 bc	4.87 bc
Omite 30W 1.5 lb on Jun 18, Jul 22	4.29 bc	8.58 b	9.78 ab	7.86 b
Check (unsprayed)	41.77 a	49.39 a	15.64 a	21.43 a

Numbers in the same column followed by the same letter are not significantly different ($P < .05$), DMRT.

Data were transformed to $\log_{10} (X + .5)$ for analysis.

Not for Publication

Larry A. Hull
Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

APPLE: Malus domestica Borkh, 'Golden Delicious', 'York Imperial'
European red mite (ERM): Panonychus ulmi (Koch)
Codling moth (CM): Cydia pomonella (Linnaeus)
Oriental fruit moth (OFM): Grapholitha molesta (Busck)
Redbanded leafroller (RBL): Argyrotaenia velutinana (Walker)
Tufted apple budmoth (TABM): Platynota idaeusalis (Walker)
Obliquebanded leafroller (OBL): Choristoneura rosaceana (Harris)
Spotted tentiform leafminer (STLM): Phyllonorycter blancardella (Fabr.)
White apple leafhopper (WALH): Typhlocyba pomaria McAtee
Apple aphid (AA): Aphis pomi DeGeer
Predatory mite (ZM): Zetzellia mali (Ewing)
Mite predator: Stethorus punctum (LeConte)

APPLE, DILUTE TEST OF INSECTICIDES, 1987: Experimental sprays were applied to run-off to single-tree plots in a randomized block design consisting of 2 replicates of Golden Delicious and 2 replicates of York Imperial. Treated single trees were separated by others not sprayed with insecticides. The trees were planted to a spacing of 6.1 X 10.7 m. Sprays were applied with a John Bean sprayer, 35 gpm pump, equipped with a spray mast carrying 7 spray guns arranged to wet the uniformly trimmed trees. Approximately 6.3 gal of spray were applied/replicate tree. Dates of application were: 21 May; 3 and 18 Jun; 1, 15, and 29 Jul; 12 and 26 Aug. For the DPX-42372 treatments, Guthion 50WP was substituted on 3 Jun (high rate only); 1 and 15 Jul; and 12 and 26 Aug. For the RH-7988 treatment, Guthion 50WP was substituted on 21 May; 1 and 15 Jul; and 12 and 16 Aug. General sprays of fungicides (Benlate, Manzate, Bayleton, Dithane M-45) were made ca one-two wk intervals throughout the experiment with a Friend Airmaster sprayer at 50 gpa. Effectiveness on the apple aphid was evaluated by counting the number of aphid-infested leaves/10 top terminals, and the number of aphids/most infested leaf. The effect of the sprays on the white apple leafhopper was evaluated by counting the number of nymphs/25 leaves/tree. Effectiveness of the test chemicals on the European red mite, two-spotted spider mite and predatory mites was evaluated by counting the mites several times during the season on samples of 25 leaves/tree, 100 leaves/treatment. The effect of sprays on the predator S. punctum was evaluated by 3-min counts of adults and larvae around the periphery of the test trees. Spotted tentiform leafminer was evaluated by a 5-min count of mines around the periphery of the test trees. Effectiveness of chemicals on fruit feeders was assessed by scoring for injury all drops after 1 Jul and two picked samples on 19 Aug and 15 Sep. Apple samples averaged 187 fruits/replicate and 748/treatment. Pest pressure was heavy throughout the season. Russet ratings are based on 30 Golden Delicious apples/ replicate, 60/treatment. Fruits were rated as 1 (no russeting), 2 (light russeting), 3 (moderate russeting), or 4 (severe russeting). Possible ranges were 30-60 (none to light), 60-90 (light to moderate), 90-120 (moderate to severe).

Although DPX-EY059 was slow in reducing WALH populations during the first brood, it provided excellent control of second brood. Supracide gave good initial knockdown of WALH as well as seasonal control. RH-7988 showed excellent activity against AA. Both DPX-42372 and DPX-EY059 demonstrated acaricidal activity against ERM. Low numbers of S. punctum larvae were found on the treatments of DPX-42372, DPX-EY059, UC-84572, and XRD-473, possibly indicating some toxic effects to this stage. The high rate of DPX-EY059 provided the best overall control of the lepidopterous complex. No phytotoxicity problems were observed.

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

Treatment	Rate/100 gal (lbs AI)	White apple leafhoppers/25 lvs[a]					STLM/5 min[a]
		18 May	26 May	29 May	11 Aug	18 Aug	17 Jul
DPX-42372 20WP +	14 g (0.00625)	19.8a	7.8bcd	4.3b-e	2.3a-d	5.0c-f	9.8d
Triton AG-98	237 ml						
DPX-42372 20WP +	43 g (0.01875)	20.0a	7.3bcd	4.3b-g	0.3ab	9.5e-h	0.8ab
Triton AG-98	237 ml						
DPX-42372 20WP +	113 g (0.05)	21.0a	3.8abc	1.3ab	0.5abc	6.0d-g	2.5bcd
Triton AG-98	237 ml						
DPX-42372 20WP +	284 g (0.125)	15.0a	1.5a	0.0a	0.0a	1.8abc	3.3bcd
Triton AG-98	237 ml						
DPX-EY059 50g/l	28 ml (0.003125)	21.0a	11.0cd	4.8b-g	0.0a	0.0a	0.0a
DPX-EY059 50g/l	56 ml (0.00625)	16.3a	13.0d	2.8a-e	0.0a	0.8ab	0.0a
DPX-EY059 50g/l	113 ml (0.0125)	25.5a	10.3cd	1.8abc	0.3ab	0.3a	0.8ab
DPX-EY059 50g/l	227 ml (0.025)	19.0a	9.5bcd	2.3a-d	0.0a	0.0a	0.0a
DPX-EY059 50g/l	454 ml (0.05)	16.8a	3.5abc	0.0a	0.0a	0.0a	1.0ab
UC-84572 2F +	47 ml (0.025)	15.3a	12.3d	7.3c-g	1.3a-d	4.0bcd	3.5bcd
Triton AG-98	237 ml						
XRD-473 50g/l	284 ml (0.03125)	17.8a	12.5d	7.0efg	2.3bcd	14.8h	0.0a

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

Treatment	Rate/100 gal (lbs AI)	White apple leafhoppers/25 lvs[a]					STLM/5 min[a]
		18 May	26 May	29 May	11 Aug	18 Aug	17 Jul
RH-7988 4E +	296 ml (0.3125)	15.3a	9.0cd	6.8d-g	0.0a	2.3a-d	1.3abc
60 Sec Oil	946 ml						
Supracide 40WP	425 g (0.375)	15.8a	2.5ab	4.8b-f	1.8a-d	0.8ab	2.0abc
Imidan 50WP	454 g (0.5)	17.0a	10.8cd	3.0a-e	5.5d	5.3c-f	1.3abc
Imidan 4F	473 ml (0.5)	11.3a	12.0d	6.8efg	2.3bcd	15.0gh	2.5bc
Guthion 3F	315 ml (0.25)	26.0a	15.8d	5.8c-g	3.8cd	11.0fgh	5.0cd
Guthion 35WP	162 g (0.125)	21.5a	14.3d	10.8g	3.8d	11.8fgh	4.3bcd
Guthion 50WP	113 g (0.125)	16.3a	14.0d	9.8fg	0.8bcd	10.0fgh	3.5bcd
Control	---	16.8a	14.0d	9.8fg	0.5bcd	5.8d-g	4.8bc

---

[a] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT). Data analyzed using a power transformation.

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

Treatment	Rate/100 gal	(lbs AI)	AA-inf lvs/term[a]				AA/most inf leaf/term[a]	
			2 Jun	8 Jun	16 Jun	23 Jun	2 Jun	8 Jun
DPX-42372 20WP +	14 g	(0.00625)	4.8a	7.6bcd	11.3bc	6.7c-f	111.0a-e	210.1d-g
Triton AG-98	237 ml							
DPX-42372 20WP +	43 g	(0.01875)	4.3a	5.2bcd	12.9bcd	5.8b-e	81.6abc	109.8b
Triton AG-98	237 ml							
DPX-42372 20WP +	113 g	(0.05)	4.8a	3.9abc	12.4bcd	6.5c-f	82.1a-d	126.2bc
Triton AG-98	237 ml							
DPX-42372 20WP +	284 g	(0.125)	4.5a	4.0ab	11.1b	4.1b	58.7a	144.7bcd
Triton AG-98	237 ml							
DPX-EY059 50g/l	28 ml	(0.003125)	4.8a	7.1bcd	11.7bcd	7.2c-f	86.3abc	219.9d-h
DPX-EY059 50g/l	56 ml	(0.00625)	4.7a	7.6bcd	13.7bcd	8.6ef	99.5a-d	206.3d-g
DPX-EY059 50g/l	113 ml	(0.0125)	5.7a	8.6d	11.9bcd	6.8c-f	186.2e	225.2e-h
DPX-EY059 50g/l	227 ml	(0.025)	5.2a	7.0bcd	15.0d	8.6f	150.1cde	260.9fgh
DPX-EY059 50g/l	454 ml	(0.05)	5.6a	6.9bcd	12.3bcd	7.4def	193.9e	290.8h
UC-84572 2F +	47 ml	(0.025)	5.7a	9.3d	13.9bcd	7.1c-f	138.8b-e	220.3d-h
Triton AG-98	237 ml							
XRD-473 50g/l	284 ml	(0.03125)	5.9a	10.4d	14.9d	7.4c-f	202.6e	269.4fgh

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

Treatment	Rate/100 gal (lbs AI)	AA-inf lvs/term[a]				AA/most inf leaf/term[a]	
		2 Jun	8 Jun	16 Jun	23 Jun	2 Jun	8 Jun
RH-7988 4E + 60 Sec Oil	296 ml (0.3125) 946 ml	5.3a	2.0a	5.9a	1.7a	125.6b-e	17.6a
Supracide 40WP	425 g (0.375)	4.6a	5.8bcd	12.8bcd	5.3bcd	68.5ab	154.7b-e
Imidan 50WP	454 g (0.5)	4.4a	9.2d	14.7cd	7.0c-f	124.3a-e	227.4e-h
Imidan 4F	473 ml (0.5)	5.3a	8.8d	13.8bcd	5.1bc	118.5a-e	281.0gh
Guthion 3F	315 ml (0.25)	5.7a	7.7bcd	12.4bcd	5.9b-e	156.0de	208.6d-g
Guthion 35WP	162 g (0.125)	4.2a	6.9bcd	13.6bcd	6.1b-e	92.8a-d	190.6c-f
Guthion 50WP	113 g (0.125)	5.2a	6.7bcd	14.2bcd	6.2c-f	137.7b-e	254.1fgh
Control	---	6.0a	7.9cd	12.6bcd	6.8c-f	195.3e	247.8fgh

[a] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT). Data analyzed using a power transformation.

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

	Rate/100 gal	ERM/leaf[a]	S. punctum/3 min[a]				
			Ad	Ad	Lar	Ad	Lar
Treatment	(lbs AI)	7 Jul	8 Jul	14 Jul	14 Jul	20 Jul	20 Jul
DPX-42372 20WP +	14 g (0.00625)	0.6a	0.0d	0.0e	0.5de	3.0c-f	0.0e
Triton AG-98	237 ml						
DPX-42372 20WP +	43 g (0.01875)	1.1ab	0.0d	0.3de	0.0e	1.0def	0.5de
Triton AG-98	237 ml						
DPX-42372 20WP +	113 g (0.05)	0.7a	0.3cd	0.3de	0.3e	1.0def	0.0e
Triton AG-98	237 ml						
DPX-42372 20WP +	284 g (0.125)	0.4a	0.0d	0.0e	0.0e	0.5f	0.3de
Triton AG-98	237 ml						
DPX-EY059 50g/l	28 ml (0.003125)	9.2b-f	1.3cd	1.3cde	1.3cde	2.8c-f	3.5bcd
DPX-EY059 50g/l	56 ml (0.00625)	3.3a-d	0.3cd	1.8b-e	0.3e	4.3c-f	2.8cde
DPX-EY059 50g/l	113 ml (0.0125)	4.9a-e	0.0d	1.3cde	0.0e	3.0c-f	0.0e
DPX-EY059 50g/l	227 ml (0.025)	4.5a-e	0.3cd	0.8de	0.0e	2.5c-f	0.3de
DPX-EY059 50g/l	454 ml (0.05)	1.2abc	0.0d	0.0e	0.0e	0.8ef	0.5de
UC-84572 2F +	47 ml (0.025)	7.9c-f	0.5cd	0.5de	0.0e	3.5c-f	0.3de
Triton AG-98	237 ml						
XRD-473 50g/l	284 ml (0.03125)	9.3d-g	1.5bcd	3.3b-e	0.3e	9.5b-e	1.5cde
RH-7988 4E +	296 ml (0.3125)	10.5def	1.5bcd	12.0a	1.0cde	17.0ab	8.5bc
60 Sec Oil	946 ml						

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

			S. punctum/3 min[a]				
Treatment	Rate/100 gal (lbs AI)	ERM/leaf[a] 7 Jul	Ad 8 Jul	Ad 14 Jul	Lar 14 Jul	Ad 20 Jul	Lar 20 Jul
Supracide 40WP	425 g (0.375)	27.3gh	7.3a	11.5a	7.5a	22.3a	31.5a
Imidan 50WP	454 g (0.5)	14.5e-h	2.5abc	7.3ab	3.3a-d	13.8ab	8.0bc
Imidan 4F	473 ml (0.5)	10.2d-g	1.3bcd	6.3abc	1.0cde	11.5ab	7.0bc
Guthion 3F	315 ml (0.25)	12.6d-h	2.5abc	5.5abc	5.0ab	13.3ab	16.0ab
Guthion 35WP	162 g (0.125)	15.8e-h	5.5ab	10.5a	5.0abc	19.8a	14.0ab
Guthion 50WP	113 g (0.125)	16.9fgh	2.3bcd	4.0bcd	2.5b-e	9.0bcd	6.3b-e
Control	---	28.6h	1.0cd	2.5b-e	2.0b-e	9.8abc	4.8bcd

[a] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT). Data analyzed using a power transformation.

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

	Rate/100 gal	ERM/leaf[a]	Z. mal/leaf[a]	S. punctum/3 min[a]	
				ad	lar
Treatment	(lbs AI)	28 Jul	28 Jul	28 Jul	28 Jul
DPX-42372 20WP + Triton AG-98	14 g (0.00625) 237 ml	7.6cde	0.0cde	14.0efg	2.8cd
DPX-42372 20WP + Triton AG-98	43 g (0.01875) 237 ml	4.6a-d	0.1a-d	7.0ghi	0.0d
DPX-42372 20WP + Triton AG-98	113 g (0.05) 237 ml	3.1abc	0.1abc	3.5ij	0.3d
DPX-42372 20WP + Triton AG-98	284 g (0.125) 237 ml	1.8a	0.0a	1.8j	0.0d
DPX-EY059 50g/l	28 ml (0.003125)	9.5c-f	0.1c-f	13.8e-h	3.5cd
DPX-EY059 50g/l	56 ml (0.00625)	7.2b-e	0.0b-e	16.8d-g	1.0d
DPX-EY059 50g/l	113 ml (0.0125)	5.1a-d	0.0a-d	10.3fgh	1.5d
DPX-EY059 50g/l	227 ml (0.025)	8.8b-e	0.1b-e	12.0e-h	0.0d
DPX-EY059 50g/l	454 ml (0.05)	2.4ab	0.0ab	6.5hij	0.8d
UC-84572 2F + Triton AG-98	47 ml (0.025) 237 ml	23.3ef	0.0ef	21.3b-e	1.0d
XRD-473 50g/l	284 ml (0.03125)	44.1f	0.2f	30.8bcd	2.3cd
RH-7988 4E + 60 Sec Oil	296 ml (0.3125) 946 ml	15.4def	0.1def	33.3bcd	9.0bcd

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

Treatment	Rate/100 gal (lbs AI)	ERM/leaf[a] 28 Jul	Z. mal/leaf[a] 28 Jul	S. punctum/3 min[a] ad 28 Jul	S. punctum/3 min[a] lar 28 Jul
Supracide 40WP	425 g (0.375)	9.6c-f	0.1c-f	54.0a	19.8ab
Imidan 50WP	454 g (0.5)	21.6ef	0.5ef	31.5bcd	24.8a
Imidan 4F	473 ml (0.5)	8.1c-f	0.3c-f	17.0c-f	6.5bcd
Guthion 3F	315 ml (0.25)	17.0ef	0.3ef	34.3ab	22.8a
Guthion 35WP	162 g (0.125)	22.2ef	0.9ef	30.5bc	7.5bcd
Guthion 50WP	113 g (0.125)	19.8ef	0.2ef	31.3bcd	16.0abc
Control	---	14.9ef	0.2ef	12.8e-h	8.0bcd

[a] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT). Data analyzed using a power transformation.

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

Treatment	Rate/100 gal (lbs AI)	ERM/leaf[a] 5 Aug	Z. mal/leaf[a] 5 Aug	S. punctum/3 min[a] ad 5 Aug	lar 5 Aug	ad 18 Aug
DPX-42372 20WP +	14 g (0.00625)	1.2abc	0.1a	3.3ef	3.0a-e	7.5c-f
Triton AG-98	237 ml					
DPX-42372 20WP +	43 g (0.01875)	0.5ab	0.0a	1.0f	0.3de	3.0fg
Triton AG-98	237 ml					
DPX-42372 20WP +	113 g (0.05)	0.6ab	0.0a	1.0f	0.0e	3.5ef
Triton AG-98	237 ml					
DPX-42372 20WP +	284 g (0.125)	0.2a	0.0a	0.3f	0.0e	0.5g
Triton AG-98	237 ml					
DPX-EY059 50g/l	28 ml (0.003125)	1.8bcd	0.1a	12.3bcd	0.8a-e	7.5c-f
DPX-EY059 50g/l	56 ml (0.00625)	1.7bcd	0.1a	12.5bcd	0.3de	12.8a-d
DPX-EY059 50g/l	113 ml (0.0125)	1.5bc	0.0a	8.5de	0.3de	11.5a-d
DPX-EY059 50g/l	227 ml (0.025)	4.3d	0.0a	14.5a-d	0.3de	18.8abc
DPX-EY059 50g/l	454 ml (0.05)	1.7bcd	0.0a	9.3de	0.5b-e	12.3a-d
UC-84572 2F +	47 ml (0.025)	10.0e	0.0a	28.0ab	1.0a-e	19.5ab
Triton AG-98	237 ml					
XRD-473 50g/l	284 ml (0.03125)	8.0e	0.0a	35.3a	0.5b-e	27.5a
RH-7988 4E +	296 ml (0.3125)	2.2cd	0.0a	10.5cd	3.5abc	14.3a-d
60 Sec Oil	946 ml					

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

				S. punctum/3 min[a]		
Treatment	Rate/100 gal (lbs AI)	ERM/leaf[a] 5 Aug	Z. mal/leaf[a] 5 Aug	ad 5 Aug	lar 5 Aug	ad 18 Aug
Supracide 40WP	425 g (0.375)	1.7bc	0.2a	24.0abc	3.5a-d	13.0a-d
Imidan 50WP	454 g (0.5)	2.8cd	0.4a	14.5a-d	3.8abc	9.8bcd
Imidan 4F	473 ml (0.5)	1.7bc	0.4a	13.5bcd	2.5a-e	13.8a-d
Guthion 3F	315 ml (0.25)	2.9cd	0.3a	18.3a-d	4.0abc	13.8a-d
Guthion 35WP	162 g (0.125)	1.7bcd	0.4a	20.5a-d	3.8ab	6.5c-f
Guthion 50WP	113 g (0.125)	1.8bcd	0.4a	16.3a-d	3.5a	8.0b-e
Control	---	1.6bc	0.2a	14.5bcd	1.3a-e	7.0def

[a] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT). Data analyzed using a power transformation.

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307
(717) 677-6116

		Injuries/100 apples[a]					
	Rate/100 gal	CM & OFM		Other		%	Russet
Treatment	(lbs AI)	Stings	Entries	leafrollers[b]	TABM	Clean[a]	rating
DPX-42372 20WP +	14 g (0.00625)	1.6a	37.3g	4.2c	13.4cde	50.6ef	58
Triton AG-98	237 ml						
DPX-42372 20WP +	43 g (0.01875)	1.6a	28.8efg	3.0abc	14.8cde	56.3ef	45
Triton AG-98	237 ml						
DPX-42372 20WP +	113 g (0.05)	1.4a	31.1fg	4.5c	15.2de	54.9ef	48
Triton AG-98	237 ml						
DPX-42372 20WP +	284 g (0.125)	1.9a	23.7def	4.5c	11.0b-e	62.4de	39
Triton AG-98	237 ml						
DPX-EY059 50g/l	28 ml (0.003125)	2.3a	35.8fg	0.2a	7.9abc	56.8ef	41
DPX-EY059 50g/l	56 ml (0.00625)	1.5a	28.8efg	1.8abc	8.9a-e	62.9de	45
DPX-EY059 50g/l	113 ml (0.0125)	1.2a	18.5cde	1.0abc	7.9a-d	73.5cd	40
DPX-EY059 50g/l	227 ml (0.025)	2.0a	15.6bcd	0.6ab	4.8ab	77.7abc	54
DPX-EY059 50g/l	454 ml (0.05)	1.8a	4.7a	0.2a	4.0a	89.8a	51
UC-84572 2F +	47 ml (0.025)	2.3a	27.8efg	0.5ab	10.5b-e	61.3def	58
Triton AG-98	237 ml						
XRD-473 50g/l	284 ml (0.03125)	2.1a	27.2efg	2.7bc	8.2a-d	63.5de	48
RH-7988 4E +	296 ml (0.3125)	2.5a	8.6ab	1.2abc	9.0a-e	79.5abc	46
60 Sec Oil	946 ml						

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307
(717) 677-6116

		Injuries/100 apples[a]					
		CM & OFM		Other			
Treatment	Rate/100 gal (lbs AI)	Stings	Entries	leafrollers[b]	TABM	% Clean[a]	Russet rating
Supracide 40WP	425 g (0.375)	0.9a	5.4a	1.7abc	5.2ab	88.0ab	54
Imidan 50WP	454 g (0.5)	0.9a	7.8ab	2.5abc	10.0b-e	79.7abc	44
Imidan 4F	473 ml (0.5)	0.7a	9.5abc	3.2bc	10.0b-e	79.2abc	42
Guthion 3F	315 ml (0.25)	1.4a	4.7a	1.8abc	4.8ab	88.8a	39
Guthion 35WP	162 g (0.125)	1.3a	10.1abc	3.2abc	9.1a-d	78.4abc	35
Guthion 50WP	113 g (0.125)	0.8a	13.3abc	2.8abc	11.4b-e	74.0bcd	38
Control	---	1.7a	39.9g	4.4bc	16.4e	45.4f	49

[a] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT).

[b] Other leafrollers include: obliquebanded leafroller and redbanded leafroller.

Not for publication

Larry A. Hull
Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

APPLE: Malus domestica Borkh, 'Golden Delicious', 'York Imperial'
European red mite (ERM): Panonychus ulmi (Koch)
Codling moth (CM): Cydia pomonella (Linnaeus)
Oriental fruit moth (OFM): Grapholitha molesta (Busck)
Redbanded leafroller (RBL): Argyrotaenia velutinana (Walker)
Tufted apple budmoth (TABM): Platynota idaeusalis (Walker)
Obliquebanded leafroller (OBL): Choristoneura rosaceana (Harris)
White apple leafhopper (WALH): Typhlocyba pomaria McAtee
Apple aphid (AA): Aphis pomi DeGeer
Mite predator: Stethorus punctum (LeConte)

APPLE, CONCENTRATE AIRBLAST INSECTICIDE TEST, 1987: Experimental sprays were applied to 3 tree plots in a randomized block design consisting of 3 replicates of York Imperial and 2 replicates of Golden Delicious. Experimental sprays were applied with a Friend Airmaster sprayer at 25 gpa/alternate side spray driven at 2 mph. Rates for treatments are listed as amt/A/both sides spray. Spray dates for the alternate side treatments were: 22 Apr, (Danitol treatments only, complete spray); 12,18, and 27 May; 5,12,19, and 26 Jun; 6,14,22, and 31 Jul; 10,17,24 Aug; and 2 Sep. Apollo 50SC was added to the Danitol treatments on 27 May; 6,14,22, and 31 Jul; and 24 and 31 Aug. Phosphamidon 8EC was added to the Larvin treatment on 19 and 26 Jun. Kelthane 4F (1.89 liters/A), Plictran 50WP (454 g/A), and Omite 30WP (2.27 kg/A) were added to all treatments except Danitol on 6 Jun and 14 Jul, respectively, as alternate side applications. General sprays of fungicides (Benlate, Dithane M-45) were made ca. one-two wk intervals throughout the experiment with a Myers Mity Mist sprayer at 50 gpa. Effectiveness on the apple aphid was evaluated by counting the number of aphid-infested leaves/10 terminals. The effect of the sprays on the white apple leafhopper was evaluated by counting the number of nymphs/25 leaves/tree. Effectiveness of the test chemicals on the European red mite was evaluated by counting the mites several times during the season on samples of 25 leaves/tree, 125 leaves/treatment. The effect of sprays on the predator S. punctum was evaluated by 3-min counts of adults and larvae around the periphery of the test trees. Effectiveness of chemicals on fruit feeders was assessed by scoring for injury all drops after 1 Jul and 2 pick samples on 21 Aug and 22 Sep. Apple samples averaged 140 fruits/replicate and 700/treatment. Pest pressure was heavy throughout the season. Russet ratings are based on 30 Golden Delicious apples/replicate, 60/treatment. Fruits were rated as 1 (no russeting), 2 (light russeting), 3 (moderate russeting), or 4 (severe russeting). Possible ranges were 30-60 (none to light), 60-90 (light to moderate), 90-120 (moderate to severe).

The synthetic pyrethroid Danitol, at both rates, and the combination of Lorsban plus Lannate provided good control of first brood WALH. Second brood populations were too low to determine any differences. These same three treatments also suppressed AA populations (18 Jun). The application of Apollo in combination with Danitol at petal-fall kept ERM under control until 10 Jul. S. punctum began increasing on all treatments in early Jul except the Danitol treatments in response to high ERM populations. S. punctum populations increased on the Danitol treatments in late Jul, 4 wk after Danitol sprays were stopped. However, when Danitol sprays were resumed on 10 Aug, S. punctum populations were reduced (14 Aug). All treatments provided excellent control of the lepidopterous complex. No phytotoxocity was observed.

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, Pa 17307-0309
(717) 677-6116

Treatment	Rate/acre (lbs AI)		White apple leafhoppers/25 lvs[a]					
			11 May	15 May	22 May	26 May	14 Aug	20 Aug
Danitol 2.4EC	473 ml	(0.3)	0.4ab	0.2a	0.4ab	0.0a	0.0a	0.0a
Apollo 50SC	118 ml	(0.125)						
(Penncap M 2FM)	1893 ml	(1.0)						
Danitol 2.4EC	631 ml	(0.4)	0.0a	0.0a	0.2ab	0.0a	0.0a	0.0a
Apollo 50SC	118 ml	(0.125)						
(Penncap M 2FM)	1893 ml	(1.0)						
Larvin 3.2F	710 ml	(0.6)	10.4bc	11.4bc	3.8c	5.4bc	0.2a	0.4a
Phosphamidon 8EC	237 ml	(0.5)						
Lorsban 50WP +	680 g	(0.75)	14.8c	5.2b	0.0a	1.0ab	0.6a	0.2a
Lannate 1.8L	473 ml	(0.225)						
Penncap M 3FM	1267 ml	(1.0)	13.8bc	8.0bc	2.2bc	5.0bc	0.2a	0.8a
Penncap M 2FM	1893 ml	(1.0)	20.4c	22.0c	9.6d	11.2c	2.0a	1.6a
Control	---		6.2bc	7.4b	9.0d	9.0c	1.4a	2.0a

[a] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT). Data analyzed using a power transformation.

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

Treatment	Rate/acre (lbs AI)	AA-inf lvs/term[a]			
		3 Jun	11 Jun	18 Jun	25 Jun
Danitol 2.4EC	473 ml (0.3)	3.5b	8.8b	8.7a	8.3a
Apollo 50SC	118 ml (0.125)				
(Penncap M 2FM)	1893 ml (1.0)				
Danitol 2.4EC	631 ml (0.4)	3.3ab	6.4a	6.2a	7.3a
Apollo 50SC	118 ml (0.125)				
(Penncap M 2FM)	1893 ml (1.0)				
Larvin 3.2F	710 ml (0.6)	4.4c	11.0c	12.3b	7.9a
Phosphamidon 8EC	237 ml (0.5)				
Lorsban 50WP +	680 g (0.75)	2.7a	7.3ab	9.0a	8.5a
Lannate 1.8L	473 ml (0.225)				
Penncap M 3FM	1267 ml (1.0)	4.0bc	11.6c	12.7b	7.4a
Penncap M 2FM	1893 ml (1.0)	3.9bc	11.2c	13.8b	7.9a
Control	---	3.9bc	12.4c	14.0b	7.8a

[a] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT).

Data analyzed using a power transformation.

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

Treatment	Rate/acre (lbs AI)	ERM/leaf[a]			S. punctum/3 min[a]					
					Ad	Lar	Ad	Lar	Ad	Lar
		18 Jun	25 Jun	10 Jul	18 Jun	18 Jun	25 Jun	25 Jun	10 Jul	10 Jul
Danitol 2.4EC	473 ml (0.3)	0.4a	0.8a	4.1a	0.2b	0.0a	0.0c	0.0c	0.2c	0.0d
Apollo 50SC	118 ml (0.125)									
(Penncap M 2FM)	1893 ml (1.0)									
Danitol 2.4EC	631 ml (0.4)	0.6a	1.5a	4.5a	0.0b	0.0a	0.0c	0.0c	0.4c	0.0d
Apollo 50SC	118 ml (0.125)									
(Penncap M 2FM)	1893 ml (1.0)									
Larvin 3.2F	710 ml (0.6)	40.8b	44.2b	30.0b	0.0b	0.0a	2.0bc	1.0bc	4.6ab	2.4cd
Phosphamidon 8EC	237 ml (0.5)									
Lorsban 50WP +	680 g (0.75)	25.8b	24.9b	26.1b	0.8b	1.4ab	1.2bc	1.0bc	12.0a	4.4bc
Lannate 1.8L	473 ml (0.225)									
Penncap M 3FM	1267 ml (1.0)	78.5bc	64.3b	27.4b	1.0b	1.8ab	2.6bc	6.4ab	3.4bc	3.2cd
Penncap M 2FM	1893 ml (1.0)	78.7bc	72.4b	40.6b	1.0b	4.2ab	3.8ab	7.2a	9.6ab	17.2a
Control	---	99.5d	80.8b	24.2b	8.2a	4.4b	10.6a	6.4ab	7.2ab	7.4ab

---

[a] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT). Data analyzed using a power transformation.

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

		Mites/leaf[a]		S. punctum/3 min[a]					
Treatment	Rate/acre (lbs AI)	ERM 17 Jul	ERM 24 Jul	ad 17 Jul	lar 17 Jul	ad 24 Jul	lar 24 Jul	ad 30 Jul	lar 30 Jul
Danitol 2.4EC	473 ml (0.3)	4.2a	22.3a	1.6c	0.4bc	65.8a	12.8a	55.2a	23.6a
Apollo 50SC	118 ml (0.125)								
(Penncap M 2FM)	1893 ml (1.0)								
Danitol 2.4EC	631 ml (0.4)	12.1ab	40.1a	3.8bc	0.0c	43.8ab	4.8a	40.4a	15.2ab
Apollo 50SC	118 ml (0.125)								
(Penncap M 2FM)	1893 ml (1.0)								
Larvin 3.2F	710 ml (0.6)	27.4bc	23.0a	13.0ab	6.2ab	10.6bc	8.8a	13.2b	10.6bc
Phosphamidon 8EC	237 ml (0.5)								
Lorsban 50WP +	680 g (0.75)	32.1c	31.7a	12.4a	7.2a	13.6bc	12.2a	10.8b	10.4bcd
Lannate 1.8L	473 ml (0.225)								
Penncap M 3FM	1267 ml (1.0)	20.7c	25.0a	5.8abc	4.2ab	8.6c	6.4a	10.0b	11.0bc
Penncap M 2FM	1893 ml (1.0)	23.7c	19.6a	15.4a	10.6a	16.0abc	7.0a	8.4b	4.6cd
Control	---	17.7bc	16.4a	6.4abc	6.0a	9.8bc	2.6a	5.2b	2.0d

[a] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT). Data analyzed using a power transformation.

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

			S. punctum/3 min[a]		
	Rate/acre	ERM/leaf[a]	ad	lar	ad
Treatment	(lbs AI)	7 Aug	7 Aug	7 Aug	14 Aug
Danitol 2.4EC	473 ml (0.3)	11.5a	12.0ab	15.6a	0.2a
Apollo 50SC	118 ml (0.125)				
(Penncap M 2FM)	1893 ml (1.0)				
Danitol 2.4EC	631 ml (0.4)	30.3b	20.0a	15.4a	0.8a
Apollo 50SC	118 ml (0.125)				
(Penncap M 2FM)	1893 ml (1.0)				
Larvin 3.2F	710 ml (0.6)	10.5a	5.6bc	3.6b	1.6a
Phosphamidon 8EC	237 ml (0.5)				
Lorsban 50WP +	680 g (0.75)	10.9a	6.2bc	2.2b	3.8a
Lannate 1.8L	473 ml (0.225)				
Penncap M 3FM	1267 ml (1.0)	7.2a	5.2bc	4.4ab	2.0a
Penncap M 2FM	1893 ml (1.0)	7.2a	5.0bc	0.8b	3.4a
Control	---	4.2a	2.6c	0.8b	1.4a

[a] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT). Data analyzed using a power transformation.

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

		Injuries/100 apples[a]					
	Rate/acre	CM & OFM		Other		%	Russet
Treatment	(lbs AI)	Stings	Entries	leafrollers[b]	TABM	Clean[a]	rating
Danitol 2.4EC	473 ml (0.3)	0.4a	1.3a	0.2a	0.9a	97.2a	38
Apollo 50SC	118 ml (0.125)						
(Penncap M 2FM)	1893 ml (1.0)						
Danitol 2.4EC	631 ml (0.4)	0.2a	1.3a	0.0a	0.6a	97.9a	39
Apollo 50SC	118 ml (0.125)						
(Penncap M 2FM)	1893 ml (1.0)						
Larvin 3.2F	710 ml (0.6)	0.2a	4.6a	0.1a	0.6a	94.8a	37
Phosphamidon 8EC	237 ml (0.5)						
Lorsban 50WP +	680 g (0.75)	0.7ab	3.2a	0.4a	1.1a	94.8a	45
Lannate 1.8L	473 ml (0.225)						
Penncap M 3FM	1267 ml (1.0)	0.2a	0.7a	0.0a	0.4a	98.7a	44
Penncap M 2FM	1893 ml (1.0)	0.8ab	0.9a	0.1a	1.0a	97.2a	48
Control	---	1.4b	25.3b	0.4a	4.7b	68.9b	41

[a] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT).

[b] Other leafrollers = redbanded leafroller plus obliquebanded leafrollers.

Not for Publication

Larry A. Hull
Fruit Research Laboratory
Biglerville, Pa 17307-0309
(717) 677-6116

APPLE: Malus domestica Borkh, 'Rome Beauty', 'York Imperial'
Rosy apple aphid (RAA): Dysaphis plantaginea (Passerini)

APPLE, ROSY APPLE APHID CONTROL, 1987: The experimental design was a randomized complete block, with 9 insecticide treatments and a control replicated 5 times. Plots consisted of 4 trees, one each of the cultivars York Imperial, Delicious, Golden Delicious, and Rome Beauty. Experimental sprays were applied with a Myers Mity Mist airblast sprayer calibrated to deliver 50 gpa. Spray dates corresponded to the following phenological stages (cv Golden Delicious): half-inch green - 9 Apr; early pink - 20 Apr; and pink - 22 Apr. A regular fungicide schedule (Benlate, Bayleton, Dithane M-45, Manzate 200) was maintained throughout the season. Post-bloom insecticides (Diazinon, Guthion, Lannate) were applied at 1- to 2-week intervals beginning in mid-Jun. Effectiveness of the sprays for rosy apple aphid was evaluated by counting the number of RAA colonies observed during a 10 min examination of the tree and total number of damaged apples/tree (cv Rome Beauty and York Imperial). Pest pressure was very heavy.

The formulation of Supracide 2E provided better control of RAA than the 40WP formulation. Ambush applied at half-inch green and RH-7988 plus oil applied at pink also gave excellent RAA control. No phytotoxicity was observed.

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

Treatment	Rate/acre (lbs AI)	Time of application[a]	RAA-inf clus/tree[b] 13 Jul	RAA-inj apples/tree[b] 1 Jul
Supracide 2E	1892 ml (1.0)	HG	0.4a	0.2a
Supracide 40WP	1134 g (1.0)	HG	31.2b	8.5b
Ambush 2E	189 ml (0.1)	HG	0.2a	0.2a
DPX-EY059 50 g/l	907 ml (0.1)	HG	46.1bc	19.6bc
DPX-42372 20WP	57 g (0.025)	EP	122.2c	85.5d
DPX-42372 20WP	170 g (0.075)	EP	60.4bc	49.0cd
DPX-42372 20WP	454 g (0.2)	EP	110.7bc	28.9bcd
DPX-42372 20WP	1134 g (0.5)	EP	56.3b	45.8bc
RH-7988 4E +	887 ml (0.9375)	P	0.2a	0.2a
60 Sec Oil	946 ml			
Control	---	--	136.5bc	47.3bcd

[a] HG = Half-inch green (9 Apr); EP = early pink (20 Apr); P = pink (22 Apr).

[b] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT).

Not for Publication

S. B. Jacobs, L. A. Hull, and
E. G. Rajotte
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

APPLE: *Malus domestica* Borkh, 'Golden Delicious', 'York Imperial'
Tufted apple budmoth (TABM: *Platynota idaeusalis* (Walker)
European red mite (ERM): *Panonychus ulmi* (Koch)
Mite predator: *Stethorus punctum* (LeConte)

APPLE, EVALUATION OF FENOXYCARB FOR TABM CONTROL, 1987: Experimental sprays were applied to 3-4 tree plots arranged in a randomized complete block design consisting of 6 replicates of alternating 'York Imperial' and 'Golden Delicious' trees. One 'York Imperial' and 'Golden Delicious' tree in the center of each plot was used for monitoring. All treatments were applied with a Friend Airmaster 393 airblast sprayer calibrated to deliver 50 gpa (complete spray), or 25 gpa/alternate side spray driven at 2.3 mph. The first four treatments were applied as complete sprays, whereas, the fifth, sixth and seventh treatments were applied as alternate side sprays. Dates of application were as follows: the first and second treatments (11 and 22 May; 20 and 29 Jul), the third and fourth treatments (1 and 15 Jun; 29 Jul; and 13 Aug), the fifth, sixth and seventh treatments (1,8,15, and 22 Jun; 29 Jul; 7,13, and 20 Aug). On 3 Jun an alternate side application of Lannate 1.8L (710 ml/acre) was applied to all plots to control the periodical cicada. Phosphamidon 8EC (237 ml/acre) was applied as alternate side applications to all treatments on 6,13, and 23 Jun and 10 Jul to control aphids. Vydate 2L (710 ml/acre) plus Carzol 92SP (227 g/acre) and Plictran 50WP (680 g/acre) were applied on 10 and 17 Jul, respectively, as alternate side sprays to control mites. During the experiment, general maintenance sprays of the fungicide Dithane M-45 as well as calcium chloride were applied to all treatments. The effect of the treatments on ERM was evaluated by counting the mites several times during the season on samples of 25 leaves/tree (cv York Imperial only), 150 leaves/treatment. The effect of sprays on the mite predator *S. punctum* was evaluated by 3-min counts of adults and larvae around the periphery of the test trees. Effectiveness of chemicals on the tufted apple budmoth was assessed by scoring for injury all the apples on the center Golden Delicious and York Imperial trees at harvest as well as all drops up to harvest. Pest pressure was moderate.

Fenoxycarb appears to affect the *S. punctum*/ERM complex by reducing the number of *S. punctum* larvae present. Numbers of adult *S. punctum* per treatment were not significantly different. No significant differences were observed among treatments for fruit injury.

Not for Publication

S. B. Jacobs, L. A. Hull, and
E. G. Rajotte
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

Treatment	Rate/acre (lbs AI)	Method of Application	ERM/leaf[1]		S. punctum/ 3 min[1]			
			24 Jun	2 Jul	Ad 1 Jul	Lar 1 Jul	Ad 8 Jul	Lar 8 Jul
Fenoxycarb 25WP	120 g (0.06614)	Complete	26.3a	71.0a	2.3a	0.8a	1.0a	0.8b
Fenoxycarb 25WP	240 g (0.1323)	Complete	19.9a	61.0a	2.3a	0.0a	2.3a	1.2b
Fenoxycarb 25WP	120 g (0.06614)	Complete	31.9a	41.2a	0.2a	0.2a	1.3a	0.0b
Fenoxycarb 25WP	240 g (0.1323)	Complete	77.2a	42.8a	1.3a	0.0a	1.2a	0.2b
Fenoxycarb 25WP	120 g (0.06614)	ARM	34.2a	179.9b	1.3a	0.2a	1.7a	0.5b
Fenoxycarb 25WP	240 g (0.5)	ARM	36.3a	61.1a	3.0a	0.0a	1.3a	0.5b
Guthion 50WP	454 g (0.5)	ARM	23.0a	32.0a	1.0a	0.2a	2.7a	0.5b
Control	—	—	51.3a	64.7a	2.0a	1.3a	2.7a	4.3a

[1] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT).

Not for Publication

S. B. Jacobs, L. A. Hull, and
E. G. Rajotte
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

Treatment	Rate/acre (lbs AI)	Method of Application	ERM/leaf[1]		S. punctum/ 3 min[1]			
			15 Jul	22 Jul	Ad 15 Jul	Lar 15 Jul	Ad 22 Jul	Lar 22 Jul
Fenoxycarb 25WP	120 g (0.06614)	Complete	26.7a	15.1a	0.7a	0.5b	0.7a	0.2b
Fenoxycarb 25WP	240 g (0.1323)	Complete	43.1a	29.3a	4.3a	1.7ab	0.3a	0.0b
Fenoxycarb 25WP	120 g (0.06614)	Complete	46.4a	28.8a	3.8a	0.8b	0.7a	0.0b
Fenoxycarb 25WP	240 g (0.1323)	Complete	42.4a	21.9a	2.7a	0.5b	1.7a	0.0b
Fenoxycarb 25WP	120 g (0.06614)	ARM	48.3a	33.3a	1.8a	0.2b	1.2a	0.0b
Fenoxycarb 25WP	240 g (0.5)	ARM	53.7a	36.7a	2.7a	0.5b	1.0a	0.5ab
Guthion 50WP	454 g (0.5)	ARM	30.5a	19.5a	2.0a	1.5ab	0.7a	1.3a
Control	—	—	38.8a	29.0a	4.2a	2.5a	1.0a	1.0ab

[1] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT).

Not for Publication

S. B. Jacobs, L. A. Hull
and E. G. Rajotte
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

Treatment	Rate/acre (lbs AI)	Method of Application	S. punctum/ 3 min[1]		ERM[1]	S. punctum/3 min[1]		
			Ad 29 Jul	Lar 29 Jul	12 Aug	Ad 12 Aug	Lar 12 Aug	Ad 19 Aug
Fenoxycarb 25WP	120 g (0.06614)	Complete	2.3a	1.3ab	3.4a	8.0a	1.5a	8.7a
Fenoxycarb 25WP	240 g (0.1323)	Complete	4.3a	0.7ab	3.1a	13.2a	0.2a	11.3a
Fenoxycarb 25WP	120 g (0.06614)	Complete	0.8a	0.2b	3.6a	10.2a	0.2a	7.7a
Fenoxycarb 25WP	240 g (0.1323)	Complete	0.8a	0.5ab	3.6a	11.0a	2.7a	10.5a
Fenoxycarb 25WP	120 g (0.06614)	ARM	2.2a	1.2ab	4.5a	7.7a	0.5a	6.3a
Fenoxycarb 25WP	240 g (0.5)	ARM	1.0a	0.3ab	3.3a	10.0a	2.7a	11.0a
Guthion 50WP	454 g (0.5)	ARM	1.7a	1.2ab	2.9a	8.0a	1.8a	10.0a
Control	—	—	0.8a	2.2a	3.1a	6.8a	0.8a	6.3a

[1] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT).

Not for Publication

S. B. Jacobs, L. A. Hull,
and E. G. Rajotte
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

Treatment	Rate/acre (lbs AI)	Method of Application	TABM Injuries/100 apples[1]		
			1st brood TABM	2nd brood TABM	Total TABM
Fenoxycarb 25WP	120 g (0.06614)	Complete	2.1a	2.7a	3.9a
Fenoxycarb 25WP	240 g (0.1323)	Complete	1.7a	2.9a	4.0a
Fenoxycarb 25WP	120 g (0.06614)	Complete	2.1a	3.8a	5.0a
Fenoxycarb 25WP	240 g (0.1323)	Complete	2.0a	2.2a	3.6a
Fenoxycarb 25WP	120 g (0.06614)	ARM	1.7a	3.6a	4.7a
Fenoxycarb 25WP	240 g (0.5)	ARM	2.2a	2.7a	4.0a
Guthion 50WP	454 g (0.5)	ARM	1.2a	1.9a	2.5a
Control	—	--	2.4a	3.7a	5.2a

[1] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT).

Not for Publication

Larry A. Hull
Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

APPLE: *Malus domestica* Borkh, 'Golden Delicious' 'Delicious'
European red mite (ERM): *Panonychus ulmi* (Koch)
Twospotted spider mite (TSSM): *Tetranychus urticae* Koch
Predatory mite (AF): *Amblyseius fallacis* (Garman)
Predatory mite (ZM): *Zetzellia mali* (Ewing)

APPLE, DILUTE TEST OF ACARICIDES, 1987: Plots consisted of single trees in a randomized block design with 2 replicates of Golden Delicious and 2 replicates of Delicious, both spur types. The trees were planted to a spacing of 6.1 X 10.7 m. Experimental sprays were applied to run-off with a handgun from a truck-mounted John Bean sprayer equipped with a 35 gpm pump. Approximately 5.0 gallons of spray were applied per replicate tree. Spray dates were as follows: 9 Apr (ECO-3187 treatments), 22 Apr (Morestan and all ABG treatments), 11 May (ABG-6162, 1081 ml/100 gal), 5 Jun (all treatments but Morestan and ABG), 16 Jun (all treatments but ECO-3187), 19 Jun (ECO-3187 treatments only), 30 Jun (all treatments but ECO-3187), 13 Jul (all treatments but ECO-3187 and Kelthane), 23 Jul (all treatments but ECO-3187). Morestan was applied only on 22 Apr, Savey substituted thereafter. On 13 Jul, the rate of Savey was increased from 20.3 g to 42.7 g/100 gal. On 23 Jul, Savey (42.7 g/100 gal) was added to the first two ABG-6162 treatments and Kelthane 4F (406 ml/100 gal was added to the last two ABG-6162 treatments. General sprays of fungicides (Benlate, Polyram, Manzate, Bayleton, Dithane M-45), insecticides (Lorsban, Phosphamidon, Guthion, Sevin, Pydrin), and calcium chloride were made at ca. one- to two-week intervals throughout the experiment with a Friend Airmaster sprayer at 50 gpa. Effectiveness of the materials on the mites was evaluated by making several counts on random samples of 25 leaves/tree, 100 leaves/treatment. Mite population pressure was heavy throughout the summer. Russet ratings are based on 30 Golden Delicious apples/replicate, 60/treatment. Fruits were rated as 1 (no russeting), 2 (light russeting), 3 (moderate russeting), or 4 (severe russeting). Possible ranges were 30-60 (none to light), 60-90 (light to moderate), 90-120 (moderate to severe).

The ECO-3187 treatments failed to provide control of ERM. Morestan and the ABG treatments provided excellent control of mites until mid-Jun. However, control of ERM during the summer with ABG was only fair. Despite 4 applications of Savey on the first treatment and 5 applications of Savey on the second treatment, mite populations continued to increase. Mite control with the 2 formulations of Kelthane was similar. Omite 6E provided better control of ERM (30 Jul) than the 30WP formulation. There was no difference in mite control between the 2 formulations of Plictran. The ECO-3187 caused russet rings on Golden Delicious.

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

Treatment	Rate/100 gal (lbs AI)	Mites/leaf-ERM^{a}								
		18 May	27 May	3 Jun	9 Jun	15 Jun	22 Jun	29 Jun	9 Jul	20 Jul
ECO-3187-12	10 gal (10%)	3.1a	19.6bcd	34.8de	30.1a	70.7a	74.8cde	79.7ef	--	--
ECO-3187-13	10 gal (10%)	0.6a	2.4a-d	14.4e	12.1a	46.5a	80.6e	111.5f	--	--
ECO-3187-15	10 gal (10%)	0.6a	1.5abc	16.3b-e	8.1a	56.4a	55.0cde	116.8f	--	--
Morestan 25WP	340 g (0.1875)									
Savey 50WP	28.4 g (0.03125)	--	0.0a	0.8a	0.5a	7.0a	10.0bcd	14.8a-d	38.7ef	76.3def
ABG-6162A	1081 ml (0.04114)	--	0.1a	1.0abc	1.0a	6.7a	19.6b-e	21.6bcd	28.3def	37.7c-f
ABG-6162A	1622 ml (0.06171)	--	0.1a	2.1a-e	1.1a	6.7a	8.3bcd	12.4a-d	6.6bcd	35.3c-f
ABG-6198A	541 ml (0.04114)	--	0.1a	1.4a-d	1.5a	8.1a	17.2b-e	18.4cde	18.3cde	53.4def
ABG-6162A	1081 ml (0.04114)	--	0.0a	1.3a-d	0.6a	7.1a	9.5bcd	20.9cde	23.6def	65.3def
ABG-6162A	811 ml (0.030857)	--	0.1a	1.1ab	0.8a	5.8a	12.0bcd	6.3abc	12.0b-e	36.3c-f
ABG-6162A	1622 ml (0.061714)									
Savey 50WP	20.3 g (0.02232)	0.1a	1.4abc	8.6a-e	5.4a	21.1a	26.0cde	34.8def	63.2fg	87.7ef
Savey 50WP	42.7 g (0.047)									
Kelthane 4F (XF-86006)	406 ml (0.42857)	--	--	5.3a-e	1.2a	4.4a	5.9abc	2.5ab	2.6ab	4.7ab
Kelthane 4F (XF-86038)	406 ml (0.42857)	--	--	25.1de	9.3a	28.8a	13.9abc	11.9a-d	4.1abc	13.0abc
Omite 30WP	680 g (0.45)	--	--	5.8cde	1.2a	9.4a	3.2ab	8.3a-d	15.4cde	31.0c-f
Omite 6E	284 ml (0.45)	--	--	7.3de	1.5a	22.5a	7.5abc	16.7bcd	16.0bcd	18.7bcd

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

Treatment	Rate/100 gal (lbs AI)	Mites/leaf-ERM[a] 18 May	27 May	3 Jun	9 Jun	15 Jun	22 Jun	29 Jun	9 Jul	20 Jul
Plictran 50WP	142 g (0.15625)	--	--	7.9b-e	2.5a	23.1a	16.2abc	21.6bcd	7.7bcd	25.8cde
Plictran 50WP	142 g (0.15625)	--	--	10.0de	2.2a	26.4a	19.1b-e	20.6a-d	20.4def	33.7c-f
Control	--	0.3a	1.9a-d	17.5cde	12.4a	39.5a	125.9de	128.2f	137.1g	124.3f

[a] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT). Data analyzed using a power transformation.

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

		Mites/leaf[a]					
Treatment	Rate/100 gal (lbs AI)	ERM 30 Jul	TSSM 30 Jul	ERM 13 Aug	TSSM 13 Aug	AF 13 Aug	Russet rating
ECO-3187-12	10 gal (10%)	---	---	---	---	---	70
ECO-3187-13	10 gal (10%)	---	---	---	---	---	60
ECO-3187-15	10 gal (10%)	---	---	---	---	---	65
Morestan 25WP	340 g (0.1875)	95.2def	0.1a	76.4d	0.1a	0.2ab	46
Savey 50WP	28.4 g (0.03125)						
ABG-6162A	1081 ml (0.04114)	15.7bc	0.0a	7.3bc	0.0a	0.0bc	50
ABG-6162A	1622 ml (0.06171)	24.6b-e	0.0a	11.7bc	0.1a	0.0bc	47
ABG-6198A	541 ml (0.04114)	31.6b-f	0.0a	15.8bcd	0.1a	0.1bc	45
ABG-6162A	1081 ml (0.04114)	42.7c-f	0.0a	18.7bcd	0.1a	0.0c	47
ABG-6162A	811 ml (0.030857)	22.4b-e	0.3a	6.1ab	1.7ab	0.0bc	44
ABG-6162A	1622 ml (0.061714)						
Savey 50WP	20.3 g (0.02232)	91.6ef	0.1a	48.7d	0.0a	0.3a	40
Savey 50WP	42.7 g (0.047)						
Kelthane 4F (XF-86006)	406 ml (0.42857)	26.9b-e	3.6a	17.3bc	14.3c	0.1bc	54
Kelthane 4F (XF-86038)	406 ml (0.42857)	35.0bcd	1.4a	28.0cd	2.4b	0.0bc	48

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

Treatment	Rate/100 gal (lbs AI)	Mites/leaf[a] ERM 30 Jul	TSSM 30 Jul	ERM 13 Aug	TSSM 13 Aug	AF 13 Aug	Russet rating
Omite 30WP	680 g (0.45)	32.4c-f	0.0a	24.1cd	0.3ab	0.1bc	54
Omite 6E	284 ml (0.45)	9.1ab	0.1a	20.3bcd	0.2ab	0.1bc	57
Plictran 50WP	142 g (0.15625)	24.2abc	0.0a	8.0abc	0.1a	0.0bc	44
Plictran 50WP	142 g (0.15625)	37.4c-f	0.0a	10.6bc	0.1a	0.0c	45
Control	--	114.3f	0.3a	13.9bc	0.2a	0.1bc	43

[a] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT). Data analyzed using a power transformation.

Not for Publication

Larry A. Hull
Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

APPLE: Malus domestica Borkh, 'Delicious'
European red mite (ERM): Panonychus ulmi (Koch)
Mite predator: Stethorus punctum (LeConte)

APPLE, INTEGRATED MITE CONTROL WITH SAVEY, 1987: Treatments were applied to small blocks of 4-tree plots in a completely randomized design consisting of 4 replicates/treatment. Each plot contained one each of the cultivars: Delicious, Golden Delicious, Stayman, and Rome Beauty. The sprays were applied as complete applications with a Myers Mity Mist sprayer calibrated at 50 gpa, driven at 2 mph. Spray dates were as follows: Savey 50WP (1 Jul); Plictran 50WP (1 Jul), Plictran 50WP plus Carzol 92SP (8 Jul), and Vydate 2L (17 Jul). A routine schedule of fungicides and insecticides (Dithane M-45, Benlate, Guthion, Lannate, Zolone, and calcium chloride) was maintained throughout the experiment. Effectiveness of the treatments on ERM was evaluated by counting the mites several times during the season on samples of 25 leaves/tree, 100 leaves/treatment (cv Delicious). The predator S. punctum was observed by making 3 min counts of adults and larvae around the periphery of the Delicious trees.

One application of Savey in conjunction with S. punctum prevented the mites from increasing beyond the threshold of 10 mites/leaf; whereas, three applications of materials that possess adulticidal activity were needed to bring the mites under control.

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

Treatment	Rate/acre (lb AI/A)		Applic date	ERM/leaf[a]					
				30 Jun	6 Jul	14 Jul	21 Jul	27 Jul	17 Aug
Savey 50WP	71 g	(0.078125)	1 Jul	10.2a	8.0a	1.0a	1.4a	10.0a	0.3a
Plictran 50WP	454 g	(0.5)	1 Jul	18.3a	41.0a	22.9b	17.9b	6.3a	0.9a
Plictran 50WP +	227 g	(0.25)							
Carzol 92SP	227 g	(0.46)	8 Jul						
Vydate 2L	946 ml	(0.5)	17 Jul						
Control	no acaricide		—	14.6a	36.5a	25.7b	40.5b	19.3a	0.4a

Treatment	Rate/acre (lb AI/A)		Applic date	S. punctum/3 min[a]					
				Ad 6 Jul	Lar 6 Jul	Ad 14 Jul	Lar 14 Jul	Ad 21 Jul	Lar 21 Jul
Savey 50WP	71 g	(0.078125)	1 Jul	0.0a	0.5a	0.3b	0.8a	1.0a	0.0b
Plictran 50WP	454 g	(0.5)	1 Jul	2.5a	0.8a	1.8ab	1.8a	3.3b	0.5b
Plictran 50WP +	227 g	(0.25)							
Carzol 92SP	227 g	(0.46)	8 Jul						
Vydate 2L	946 ml	(0.5)	17 Jul						
Control	no acaricide		—	1.3a	0.3a	6.3a	8.5a	15.3a	14.5a

---

[a] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT). Data analyzed using a power transformation.

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, Pa 17307-0309
(717) 677-6116

			S. punctum/3 min[a]				
		Applic	<u>Ad</u>	<u>Lar</u>	<u>Ad</u>	<u>Lar</u>	<u>Ad</u>
Treatment	Rate/acre (lb AI/A)	date	23 Jul	23 Jul	27 Jul	27 Jul	17 Aug
Savey 50WP	71 g (0.078125)	1 Jul	0.5b	0.3b	4.5a	2.5a	3.5a
Plictran 50WP	454 g (0.5)	1 Jul	4.0b	1.5b	5.5a	2.5a	5.5a
Plictran 50WP +	227 g (0.25)						
Carzol 92SP	227 g (0.46)	8 Jul					
Vydate 2L	946 ml (0.5)	17 Jul					
Control	no acaricide	---	16.3a	14.8a	17.0a	9.5a	4.3a

[a] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT). Data analyzed using a power transformation.

Not for Publication

Larry A. Hull
Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

PEAR: *Pyrus communis* L., 'Bartlett'
Pear psylla (PP): *Psylla pyricola* Foerster

PEAR, SEASONAL PEAR PSYLLA CONTROL EXPERIMENT, 1987: Experimental sprays were applied to replicated 4-5 tree plots consisting of the cultivar Bartlett (9 years old). Each treatment was replicated 5 times. Trees were planted to a spacing of 7.4 X 7.4 m. Treatments were applied with a handgun from a truck-mounted hydraulic sprayer at 375 psi. Dates of application were: bud-burst (BB), 3 Apr; white-bud (WB), 21 Apr; petal-fall (PF), 6 May; first cover (1C), 26 May; third cover (3C), 19 Jun; fourth cover (4C), 8 Jul; sixth cover (6C), 30 Jul. Approximately 1.75 gal of spray was applied per tree. Treatments were evaluated for pear psylla control by counts of eggs and nymphs at 1- to 2-wk intervals. Counts were made by sampling 10 mid-terminal or spur leaves from the middle tree in each replicate. Beginning on 1 Jun counts were made by sampling 5 mid-terminal and 5 distal leaves from each tree. Pear psylla pressure was moderate through the experiment.

Fenoxycarb, an insect growth regulator (IGR), provided outstanding control of PP on a seasonal program. Dimilin, another IGR, gave excellent early season control; however, by 12 Jun populations were not different from the control. The synthetic pyrethroids Asana, Danitol and Ambush also provided good early season control. No phytotoxicity was observed.

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

Treatment	Rate/100 gal (lbs AI)	Time of Application[a]	Pear psylla eggs/10 lvs[b]			
			12 May	21 May	1 Jun	12 Jun
Dimilin 25WP +	114 g (0.0625)	BB	20.4cd	11.4ab	134.0bc	337.2a
60 Sec Sup. Oil	7.57 l					
Dimilin 25WP	114 g (0.0625)	WB,PF,1C,3C,4C,6C				
Dimilin 25WP +	228 g (0.125)	BB	19.0d	17.8b	133.2bc	184.8a
60 Sec Sup. Oil	7.57 l					
Dimilin 25WP	228 g (0.125)	WB,PF,1C,3C,4C,6C				
Fenoxycarb 25WP +	120 g (0.6615)	BB	23.4d	9.6ab	61.2b	211.2a
60 Sec Sup. Oil	7.57 l					
Fenoxycarb 25WP	120 g (0.6615)	WB,PF,1C,3C,4C,6C				
Asana 1.9EC +	25 ml (0.0125)	BB	20.8bcd	14.2ab	69.2bc	235.2a
60 Sec Sup. Oil	7.57 l					
Fenoxycarb 25WP	60 g (0.03307)	WB,PF,1C,3C,4C,6C				
Asana 1.9EC +	25 ml (0.0125)	BB	19.4d	23.2b	82.4b	326.5a
60 Sec Sup. Oil	7.57 l					
Fenoxycarb 25WP	120 g (0.06615)	WB,PF,1C,3C,4C,6C				
Asana 1.9EC +	25 ml (0.0125)	BB	25.4bcd	8.8ab	59.0bc	159.4a
60 Sec Sup. Oil	7.57 l					
Asana 1.9EC	25 ml (0.0125)	WB				

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

Treatment	Rate/100 gal (lbs AI)	Time of Application[a]	Pear psylla eggs/10 lvs[b]			
			12 May	21 May	1 Jun	12 Jun
Danitol 2.4EC +	79 ml (0.05)	BB	11.0bcd	8.2ab	101.6bc	112.6a
60 Sec Sup. Oil	7.57 l					
Danitol	79 ml (0.05)	WB				
Ambush 2E +	190 ml (0.1)	BB	0.0a	5.0a	16.6a	92.2a
60 Sec Sup. Oil	7.57 l					
Ambush 2E	190 ml (0.1)	WB,PF,1C,3C,4C,6C				
Ambush 2E +	190 ml (0.1)	BB	1.2ab	3.6ab	41.4b	113.6a
60 Sec Sup. Oil	7.57 l					
Morestan 25WP	680 g (0.375)	WB				
Mitac 50WP	170 g (0.1875)	PF,1C,3C,4C,6C				
Morestan 25WP	680 g (0.375)	WB	3.8abc	10.8ab	202.2c	255.8a
Control	--	--	37.0d	62.2c	74.4bc	223.0a

[a] BB = bud burst (3 Apr); WB = white bud (21 Apr); PF = petal-fall (6 May); 1C = first cover (26 May); 3C = third cover (19 Jun); 4C = fourth cover (8 Jul); 6C = sixth cover (30 Jul).

[b] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT). Data analyzed using a power transformation.

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

Treatment	Rate/100 gal (lbs AI)		Time of Application[a]	Pear psylla nymphs/10 lvs[b]						
				12 May	21 May	1 Jun	12 Jun	23 Jun	6 Jul	17 Jul
Dimilin 25WP +	114 g	(0.0625)	BB	3.4c	3.4bc	10.8cd	46.0bc	25.0b	97.6d	39.2d
60 Sec Sup. Oil	7.57 l									
Dimilin 25WP	114 g	(0.0625)	WB,PF,1C,3C,4C, 6C							
Dimilin 25WP +	228 g	(0.125)	BB	3.0bc	3.4bc	1.2ab	16.0bc	13.4ab	39.2cd	17.4cd
60 Sec Sup. Oil	7.57 l									
Dimilin 25WP	228 g	(0.125)	WB,PF,1C,3C,4C,6C							
Fenoxycarb 25WP +	120 g	(0.6615)	BB	0.4ab	0.2a	1.4ab	0.6a	13.8ab	3.0a	1.6ab
60 Sec Sup. Oil	7.57 l									
Fenoxycarb 25WP	120 g	(0.6615)	WB,PF,1C,3C,4C,6C							
Asana 1.9EC +	25 ml	(0.0125)	BB	1.2abc	1.2abc	0.2a	0.8a	8.2a	8.8abc	17.0bc
60 Sec Sup. Oil	7.57 l									
Fenoxycarb 25WP	60 g	(0.03307)	WB,PF,1C,3C,4C,6C							
Asana 1.9EC +	25 ml	(0.0125)	BB	3.2abc	1.0abc	1.0a	0.6a	14.4ab	9.4ab	0.0a
60 Sec Sup. Oil	7.57 l									
Fenoxycarb 25WP	120 g	(0.06615)	WB,PF,1C,3C,4C,6C							
Asana 1.9EC +	25 ml	(0.0125)	BB	0.6ab	2.0abc	5.2bc	12.0bc	33.8b	---	---
60 Sec Sup. Oil	7.57 l									
Asana 1.9EC	25 ml	(0.0125)	WB							

Not for publication

Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

Treatment	Rate/100 gal (lbs AI)	Time of Application[a]	Pear psylla nymphs/10 lvs[b]						
			12 May	21 May	1 Jun	12 Jun	23 Jun	6 Jul	17 Jul
Danitol 2.4EC +	79 ml (0.05)	BB	0.6ab	2.8abc	4.4bc	10.6b	22.8b	---	---
60 Sec Sup. Oil	7.57 l								
Danitol	79 ml (0.05)	WB							
Ambush 2E +	190 ml (0.1)	BB	0.4ab	0.4a	0.2a	1.2a	23.4b	21.6ab	8.6bcd
60 Sec Sup. Oil	7.57 l								
Ambush 2E	190 ml (0.1)	WB,PF,1C,3C,4C,6C							
Ambush 2E +	190 ml (0.1)	BB	0.0a	1.0ab	0.4a	1.0a	16.4ab	15.0bcd	5.0bc
60 Sec Sup. Oil	7.57 l								
Morestan 25WP	680 g (0.375)	WB							
Mitac 50WP	170 g (0.1875)	PF,1C,3C,4C,6C							
Morestan 25WP	680 g (0.375)	WB	3.6abc	5.4c	11.6cd	16.4b	37.8b	---	---
Control	--	--	39.0d	25.8d	17.8d	33.4c	9.4ab	72.6d	33.8d

[a] BB = bud burst (3 Apr); WB = white bud (21 Apr); PF = petal-fall (6 May); 1C = first cover (26 May); 3C = third cover (19 Jun); 4C = fourth cover (8 Jul); 6C = sixth cover (30 Jul).

[b] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT). Data analyzed using a power transformation.

Not for Publication

Larry A. Hull
Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

PEAR: *Pyrus communis* L. 'Bartlett'
European red mite (ERM): *Panonychus ulmi* (Koch)

PEAR, MITE CONTROL WITH APOLLO, 1987: Experimental sprays were applied to single tree plots consisting of the cultivar Bartlett (9 years old). Each treatment was replicated 5 times. Trees were planted to a spacing of 7.4 X 7.4 m. Treatments were applied with a handgun from a truck-mounted hydraulic sprayer at 375 psi. Date of application was: 22 Jul. The effects of treatments on ERM was evaluated by counting the mites several times during the season on samples of 20 leaves/tree, 100 leaves/treatment. Pest pressure was light.

The combination of Apollo plus Carzol reduced the mite population faster than Apollo alone. All treatments of Apollo were different from the control after 17 days.

Treatment	Rate/100 gal	(lb AI)	ERM/100 lvs[a] 21 Jul	31 Jul	8 Aug
Apollo 50SC	26 ml	(0.028)	70a	22b	3a
Apollo 50SC	52 ml	(0.056)	93a	25b	1a
Apollo 50SC +	26 ml	(0.028)	134a	9a	2a
Carzol 92SP	110 g	(0.222)			
Control	--		88a	52b	34b

[a] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT).

Not for Publication

Larry A. Hull
Fruit Research Laboratory
Biglerville, PA 17307-0309
(717) 677-6116

APPLE: Malus domestica Borkh, 'Golden Delicious'

APPLE, EFFECT OF VYDATE ON FRUIT THINNING, 1987: A study was designed to examine grower complaints about the effect of Vydate applications on fruit set when applied at the pink and petal-fall stage on apple. Treatments were applied from a truck-mounted sprayer using a handgun operating at 375 psi. Each treatment was replicated 6 times on the cv Golden Delicious (4 yr old). Spray dates were: pink - 23 Apr, petal-fall - 13 May. The number of blossoms and circumference on one tagged limb/tree was measured on 22 Apr. After 'fruit drop' in Jun, the number of apples remaining on each tagged limb was determined on 15 Jun.

There was no effect of Vydate on fruit set when applied at pink, However, Vydate reduced the number of apples when applied at petal-fall.

Treatment	Rate/ 100 gals[a]	Time of Applic[a]	# blossoms /cm^2-limb[b] 23 Apr	# apples /cm^2-limb[b] 15 Jun	% fruit set[b] 15 Jun
Vydate 2L	473 ml	Pink	62.9a	1.62a	2.6a
Vydate 2L	473 ml	Petal-fall	58.5a	0.48b	1.0b
Control	---	---	93.4a	1.85a	2.5a

[a] Pink = 23 Apr, Petal Fall = 13 May

[b] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT).

** Not For Publication **

TUFTED APPLE BUDMOTH RESIDUE/BIOASSAY EXPERIMENTS
1987

Alan L. Knight & Larry A. Hull
The Pennsylvania State University
Fruit Research Laboratory
Biglerville, PA 17307

The tufted apple budmoth (TABM), *Platynota idaeusalis* (Walker) is the most serious direct pest of apples in Pennsylvania (Hull et al. 1983). A number of insecticides are registered for use against this pest with spray timing directed at the adults, eggs, and early larval instars (Anonymous 1986). Average fruit injury levels for TABM have increased during the last 15 years from 0.3% in 1973 (Colburn 1974) to 6% in 1985 (Meagher & Hull 1987) and 1986 (Knight & Hull 1987) with some orchards experiencing over 14% fruit injury in Adams County, Pennsylvania. Recent reports indicate that poor control of TABM in this region may be due to increased tolerance to the organophosphate (OP) insecticide, Guthion (Meagher & Hull 1986, Knight & Hull, unpubl. data).

Growers in Pennsylvania have responded to this decline in OP effectiveness with heavier use of the carbamate, Lannate mixed with an OP such as Guthion, Imidan, Lorsban, Penncap-M, or Zolone to control TABM. Unfortunately, serious problems from heavy use of Lannate can occur in maintaining biological control of the European red mite, *Panonychus ulmi* (Koch) with the coccinellid predator, *Stethorus punctum* (LeConte). In contrast, *S. punctum* is virtually unaffected by organophosphates.

Another factor which may be limiting control of TABM is that growers have stretched the intervals between alternate-row middle (ARM) sprays, thereby reducing the effective residue levels (Knight & Hull 1987). The use of ARM spraying has increased grower's flexibility in controlling pests, reduced their spray material costs, and promoted the development of integrated mite management (Asquith & Colburn 1971), and over 95% of apple growers in Pennsylvania use ARM sprays (Hull et al. 1983). However, growers have expanded their ARM spray intervals from the recommended 7 to over 10 days (Knight & Hull 1987). The effectiveness of the recommended pesticides under a stretched ARM spray schedule is not known.

Of the OP's registered for use on apple, Guthion has typically shown the greatest activity against the various stages of TABM (Travis et al. 1981). However, laboratory tests with Lorsban have demonstrated its high activity against TABM in leaf residue tests (Rock & Shaltout 1983, Knight & Hull, unpubl. data), and for other leafrollers in which Guthion resistance has been detected (Suckling 1983, Reissig et al.1986). Small field plot studies of Lorsban have not clearly demonstrated its effectiveness for controlling TABM (Hull 1986).

With the complex balance which exists between mite and TABM management on apples in Pennsylvania the effectiveness of the current control program is unclear at this time. Additional studies are needed to evaluate the seasonal effectiveness of insecticides for TABM. Specifically, research which can link seasonal residue coverage and activity with fruit injury levels would be valuable in recommending optimal chemical selection, spray rates and timing intervals.

In 1986/87, we conducted a series of bioassay/residue experiments to view the temporal dynamics of Guthion, Lannate, and Lorsban activity against TABM. Our experiments included the evaluation of a single ARM spray application, a 30-day ARM and complete spray program for second brood, and the decline in effectiveness of the last spray prior to harvest. We believe these types of studies provide a clearer assessment of the role of organophosphates and carbamates in apple IPM in Pennsylvania as well as those areas in the Cumberland-Shenandoah region where TABM is a problem.

Materials and Methods

Single Spray. The study was conducted in a block of 13-year-old apple trees arranged in four-tree plots ('Rome Beauty', 'Yorking', 'Golden Delicious', and 'Delicious') at the PSU Fruit Research Lab, Biglerville, PA. Four uniformly trimmed 'Golden Delicious' trees (12.5' x 13.5') each were sprayed on 12 August 1986 with Guthion 50WP and Lannate 1.8L and 11 August 1987 with Lorsban 50WP from only one side with a Myers Mity Mist PTO airblast sprayer calibrated to deliver 0.25 lbs AI Guthion/acre/side, 0.225 lbs AI Lannate/acre/side, and 0.5 lbs AI Lorsban/acre/side in 25 gal. water. Two control trees were selected which had not received any insecticides for > 45 days. Minimum and maximum temperatures and precipitation were recorded with standard meteorological equipment.

Two areas approximately 10 ft^2 each were designated on either side of each tree. A sample of 33 leaves within these areas was randomly selected and taken back to the lab on the following post-spray dates: -1, 0, 1, 3, 6, 10, and 15 days. A leaf punch (0.8 in. diameter) was used to collect two disks per leaf. On each date, fifty leaf disks per chemical/side/tree and controls were grouped and analysed for pesticide residue with gas chromatography. Residue data for Guthion and Lannate will be analysed by Dr. Ralph Mumma, Penn. State Univ. Pesticide Laboratory, and for Lorsban by Dow Chemical Company.

In addition, on each date, 4 samples of 5 first-instar TABM (<24 hrs-old) from both a laboratory colony and from field-collected egg masses were bioassayed with leaf disks from both sides of each tree. Two disks were placed with five larvae in 0.4 x 1.2 in. vials with cork stoppers. Mortality was assayed after storage at 68°F for 24 hrs.

Seasonal Program. In 1987, bioassays were conducted over a 6 week period during the 2nd brood of TABM to evaluate seasonal control programs achieved with 7 day ARM sprays of each chemical and 14 day complete sprays with Lorsban. ARM sprays were applied on 2, 11, 18, and 25 June; 4, 11, 18, and 25 August; and 1 September. Complete sprays of Lorsban were applied on 2 and 18 June; 4 and 18 August; and 1 September. These periods represent the adult, egg, and early larval stages, a time when TABM is most susceptible to insecticides (Travis et al. 1981). Spray rates were the same as for the single spray tests. The complete spray of Lorsban delivered 1 lb AI/acre in 50 gallons of water. Four randomized blocks each with 2 'Golden Delicious' and 'Yorking' trees were treated per chemical with an engine-driven Friend '393'.

Leaf residue bioassays and residue analysis were conducted on day 0 for both sides of a single 'Golden Delicious' (13' x 15.5') per block (S = sprayed side and N = non-sprayed side), only on the sprayed side (S) of each tree at 6 days postspray following 4 sprays during August (6 and 13 days postspray for complete Lorsban treatment), and on both sides of each tree on day 0 (1 September) followed by assays on 1, 3, 7, and 14 days postspray. Assays and collection of leaf samples were done similar to single spray tests, except only 24 leaves were collected per side for each tree (40 leaf disks for residue analysis and 8 leaf disks for bioassay). Residue analyses for the Lorsban complete treatment was always an average of both sides (24 leaves on each data).

In addition, fruit injury levels from full-season spray programs of Guthion, Lannate, Lorsban, Penncap-M, Lorsban plus Lannate, and Guthion plus Lannate were compared. Spray dates for combination treatments and Penncap-M were identical to the Guthion, Lorsban, and Lannate treatments. Penncap-M was applied at 0.38 lb AI/acre/side. All the fruit from the inner 'Golden Delicious' (average = 700 fruit/tree) and 'Yorking' (average = 979 fruit/tree) were evaluated for TABM injury. Injury was recorded according to broods. Fruit injury data were subjected to analysis of variance and treatment means were separated by the Duncan Multiple Range Test. Data were transformed with arcsin prior to analysis.

Results

Single Sprays. Control mortality of the laboratory population was high in tests conducted in both years averaging 30% in 1986 and 15% in 1987 (Fig. 1). This suggests that chemical drift during the experiment may have occurred or pesticide residue levels prior to the experiment were high. Earlier tests demonstrated that the laboratory population developed normally on washed apple leaves. Control mortality with field-collected larvae was generally < 5%.

Bioassays of laboratory larvae with the 3 insecticides demonstrated that at these rates control of susceptible larvae was similar (Fig. 1). On the sprayed side of each tree after 6 days mortality was approximately 80% for Guthion and Lannate and 60% for Lorsban. After 10 days, Guthion provided the best control (50% versus 25% for Lorsban and Lannate). For all chemicals control was poor on the unsprayed side of trees. Generally, within 3 days mortality levels were not different from the control.

Greater differences in effectiveness were seen between compounds in bioassays with field-collected larvae (Fig 2). With Guthion control was poor. On the sprayed side, mortality peaked at 50% on day 1 and fell to less than 20% within 6 days. On the opposite side of the tree, mortality levels did not differ from the control. With Lorsban control was excellent on both sides on day 0, but rapidly dropped off. After 24 hours control was 80% on the sprayed and 15% on the unsprayed side . By day 3, Lorsban was ineffective. Lannate was very effective for 3 days on the sprayed side of trees, but dropped off rapidly by day 10. Mortality levels on the unsprayed side of the tree were not different from the control.

In 1986, precipitation occurred at 3 periods during this study with the heaviest accumulation on days 5 and 8. Larval mortality from both chemicals tested dropped sharply during these periods suggesting that pesticide residues were washed off leaf surfaces. No substantial precipitation occurred during the Lorsban test in 1987.

Seasonal Studies. On days 0 and 28 when trees were sprayed within hours of the bioassay both Lannate and Lorsban gave 100% control on the treated side of the tree. On these dates, approximately 80 and 100%, respectively, of the larvae were killed from leaves collected from the unsprayed side as well. Guthion performed better than in 1986 with approximately 90 and 60% larval mortality on the sprayed and unsprayed sides, respectively, on days 0 and 28.

This may have occurred because of the larger sprayer used in these later tests. Evaluation and comparision of spray coverage and residue levels in these different tests will be possible when residue data are analysed.

In the bioassays conducted at 6 days postspray for the 4 sprays applied during August Lannate provided the best control (50-80%) followed by Guthion (30-50%) and Lorsban (10-25%) on the sprayed side of the tree. For all chemicals, levels of mortality increased during the season as residue levels on leaves presumedly increased. Control with Guthion persisted longer into September than either Lannate or Lorsban. Control from complete sprays of Lorsban was only marginally better than ARM applications during August. However, control was markedly better with the complete spray treatment after 3 days, but was not different after 7 days following the last spray on 1 September.

Precipitation was heavy after day 23 following the 4th ARM spray. The impact of rainfall in removing residues will be clearer when residue data becomes available, however, noticeable effects occurred in the bioassays. For example, larval mortality assayed at 6 days postspray declined between days 20 and 27 for Lannate during which approximately 1 in. of precipitation occurred (Fig. 3). The greatest effect, however, occurred after day 31 in which over 7 in. of precipitation occurred within 12 days. At 6 days postspray larval mortality in bioassays were lower for all chemicals compared to day 27 (Figs. 3 & 4). The greatest effect was seen with Lannate in which mortality was reduced by approximately 50% (Fig. 3).

Fruit injury for 'Golden Delicious' showed no significant differences among treatments for first brood, however, treatments with Lannate included and Lorsban alone (complete) had significantly lower injury than the control for second brood and for the entire season. With 'Yorking' several significant differences were found. For first brood all treatments except Guthion and Lannate alone differed from controls. However, for second brood, only treatments including Lannate were significantly different from controls and from Guthion alone. Differences among treatments for total injury levels were similar. The lowest fruit injury levels were with the Guthion-Lannate and Lorsban-Lannate combinations.

Discussion

Several studies have attempted to view the spray coverage within a tree from ARM spraying (Lewis and Hickey 1964, Travis 1981). These studies highlight that the size and speed of the sprayer used and the size and foliage density of the tree sprayed are but a few of the important factors affecting coverage. Their results, however, suggest that even under optimal spray practices coverage is variable between regions within a tree. Our results indicate that this variation in spray deposit has significant implications in insect pest management.

While the use of a 24 hr residue bioassay may underestimate the complete efficacy of a spray application under field conditions, we believe that these experiments do reveal the relative effectiveness of the insecticides tested. Our results are somewhat contradictory on whether the current ARM spray rate and intervals for these chemicals are effective in managing leafroller populations at low levels. For example, Fig. 1 demonstrates that control of even a susceptible TABM strain on the unsprayed portion of the tree is poor with any chemical beyond 1-2 days. Yet in the seasonal tests where trees were sprayed from both sides and residue levels accumulated over a 5 week period, larval mortality in the bioassays was much higher on the unsprayed side and after 7 days postspray averaged 81, 64, and 38% of the mortality levels in assays with leaves from the sprayed side of trees for Lannate, Guthion, and Lorsban, respectively (Figs. 3 & 4). Interpretation of these results will require analysis of the residue data.

The difficulty in controlling TABM with ARM sprays is further compounded by the development of OP resistance. Assays of first instars from orchards throughout Adams County, PA, have demonstrated a widespread, high level of resistance (approximately 18-fold) to Guthion and to a somewhat lesser extent other OPs (5 to 18-fold) (Knight & Hull, unpubl. data). Though the rate of Guthion used in our test was twice what growers typically apply (Hull et al. 1983), Fig. 2 suggests that the level of suppression of field TABM populations which can be achieved with Guthion is low and strongly indicates that alternative chemicals or management tactics are needed to control this pest. This is supported by the higher fruit injury levels which resulted with Guthion alone compared to the other compounds tested (Table 1).

Lorsban provided excellent control of TABM initially which was consistent with our laboratory assays (Knight & Hull, unpubl. data). However, in these field tests Lorsban quickly lost its effectiveness after 24 hrs. With 'Yorking' total fruit injury levels were high and did not differ from the controls (Table 1). The use of complete Lorsban sprays at 14 day intervals increased the effectiveness of TABM control only marginally even though more chemical was applied during second brood (3 complete vs 5 ARM sprays). A comparision of ARM with complete sprays for a chemical with a longer residual life, such as Guthion, may have shown a greater difference.

Lannate appeared to be the most effective chemical in controlling TABM. In addition, resistance to this compound has not been detected in bioassays (Knight & Hull, unpubl. data). However, persistence of this compound is shorter than Guthion (W. Bode, unpubl data), and maintaining close spray intervals may be a key to its successful use. The lowest fruit injury levels were obtained when Lannate was mixed with an organophosphate. The combination of a carbamate, at a rate low enough to allow predator survival, with an organophosphate has the additional advantage of allowing integrated mite control to develop and may be important in avoiding further increases in OP resistance levels.

Interpretation of these results suggest that the recommended ARM spray interval during the critical periods of maximum pest susceptibility, i.e. adults, eggs, and early larval instars, may need to be modified depending on which chemical (OP) is used and whether TABM pressure is high or if precipitation is heavy. Because Lorsban breaks down faster than Guthion or Penncap-M spray intervals may need to be shortened to 4-5 days compared to 5-7 days for these more persistent OPs. Also, if > 1 in. of precipitation accumulates after applying Lannate, another application may be required. In addition, matching the sprayer size and its capabilities with tree size is important in optimizing coverage. We recommend that if TABM has been a problem, growers should increase their amount of water to at least 100 gal per acre, especially during second brood, a period when tree canopy development is complete and the tree is laden with large fruit (Knight & Hull 1987).

References Cited

Anonymous, 1986. Tree fruit production guide. Penn State Univ. Coop. Ext. Serv. 80pp.

Asquith, D. & R. Colburn. 1971. Integrated pest management in Pennsylvania apple orchards. Bull. Entomol. Soc. Am. 17: 89-91.

Colburn, R. B. 1974. The 1973 Pennsylvania pilot apple pest management project. Pa. Fruit News 53(3): 16-22.

Hull, L. A., K. D. Hickey, and W. W. Kanour. 1983. Pesticide usage patterns and associated pest damage in commercial apple orchards of Pennsylvania. J. Econ. Entomol. 76: 577-583.

Hull, L. A. 1986. Apple, summer management of pests, 1985. Insecticide and Acaricide Tests 11: 58.

Knight, A. L. & L. A. Hull. 1987. Tufted apple budmoth control: past, present, and future. Pa. Fruit News 66(1): 10-14.

Lewis, F. D. and K. D.Hickey. 1964. Pesticide application from one side on decidious trees. Penn. Fruit News 43: 13-24.

Meagher, R. L. and L. A. Hull. 1986. Techniques to measure azinphosmethyl resistance in *Platynota idaeusalis* (Lepidoptera: Tortricidae). J. Econ. Entomol. 79: 1130-1133.

Meagher, R. L. and L. A. Hull. 1987. Predictive sampling and economic assessment of tufted apple budmoth damage at the field and processing markets. Pa. Fruit News 66(4):

Reissig, W. H., B. H. Stanley, and H. E. Hebding. 1986. Azinphosmethyl resistance and weight-related response of obliquebanded leafroller (Lepidoptera: Tortricidae) larvae to insecticides. J. Econ. Entomol. 79: 329-333.

Rock, G. C. and A. D. Shaltout. 1983. Toxicity of three synthetic pyrethroids and selected orchard insecticides to the tufted apple budmoth, *Platynota idaeusalis* (Lepidoptera: Tortricidae). J. Econ. Entomol. 76: 1384-1389.

Suckling, D. M. 1983. The responses of *Epiphyas postvittana* (Walker) and *Planotortrix excessana* (Walker) (Lepidoptera: Tortricidae) to insecticides. PhD dissertation. Lincoln College, University of Canterbury, New Zealand.

Travis, J. W. 1981. Factors affecting pesticide distribution in trees. PhD dissertation. N. C. State Univ., Raleigh, N.C.

Travis, J. W., D. Asquith, and P. D. Mowery. 1981. Bioassay study of commercial formulations of several insecticides on *Platynota idaeusalis*. J. Econ. Entomol. 74: 328-330.

Figure Captions

Figure 1. Bioassays of first instar TABM from a susceptible laboratory strain with leaf residues from trees treated with a single spray of Guthion (Fig. 1A), Lorsban (Fig. 1B) or Lannate (Fig. 1C) applied to one side (S = side sprayed, N = side not sprayed) of each tree. Rates for chemicals are listed as amt/A/complete spray.

Figure 2. Bioassays of field-collected first instar TABM with leaf residues from trees treated with a single spray of Guthion (Fig. 2A), Lorsban (Fig. 2B), or Lannate (Fig. 2C) applied to one side (S = side sprayed, N = side not sprayed) of each tree. Rates for chemicals are listed as amt/A/complete spray.

Figure 3. Bioassays of field-collected first instar TABM with leaf residues from trees treated with a series of Guthion (Fig. 3A) or Lannate (Fig. 3B) alternate-row middle sprays for second brood control. Leaves were collected from both the sprayed (S) and unsprayed (N) side of each tree. Rates for chemicals are listed as amt/A/complete spray.

Figure 4. Bioassays of field-collected first instar TABM with leaf residues from trees treated with a series of Lorsban alternate-row middle (Fig. 4a) or complete (Fig. 4b) sprays for second brood control. Leaves were collected from both the sprayed (S) and not sprayed (N) side of each tree. Rates for chemicals are listed as amt/A/complete spray.

** Not For Publication **

Alan L. Knight & Larry A. Hull
PSU Fruit Research Laboratory
Biglerville, PA 17307

Table 1. Tufted apple budmoth fruit injury records for 1987 bioassay/residue experiments, Arendtsville, PA.

		Cultivar[a]					
		'Golden Delicious'			'Yorking'		
		Brood			Brood		
Chemical (lbs AI/A)	Applic. Method[b]	1st	2nd	Total[c]	1st	2nd	Total[c]
Guthion 50WP (0.5)	ARM	0.39a	1.10ab	1.49ab	2.55ab	6.07a	7.57a
Lorsban 50WP (1.0)	ARM	0.54a	1.32ab	1.83ab	2.35bc	4.08abc	5.67ab
Lorsban 50WP (1.0)	Complete	0.46a	0.98ab	1.45b	1.84bc	4.84ab	5.94ab
Lannate 1.8L (0.45)	ARM	0.72a	0.61b	1.33b	2.35abc	2.63bcd	3.83bc
Guthion 50WP (0.5) + Lannate 1.8L (0.45)	ARM	0.42a	0.64b	0.97b	1.47c	1.98cd	2.69c
Lorsban 50WP (1.0) + Lannate 1.8L (0.45)	ARM	0.41a	0.68b	1.06b	1.43c	1.60d	2.33c
Penncap M2F (0.75)	ARM	0.51a	1.24ab	1.75ab	2.18bc	5.33ab	6.78ab
Control	-	1.17a	1.98a	3.12a	3.52a	5.81a	7.72a

[a] Column means followed by same letter(s) are significantly different (P = 0.05), DMRT. Data analysed with a power transformation.

[b] Alternate row-middle (ARM) spray applications were applied on 2,11,18, and 25 June; 4, 11, 18, and 25 August; and 1 September. Complete sprays were applied on 2 and 18 June; 4 and 18 August; and 1 September. Experimental sprays were applied with a Friend '393' airblast sprayer calibrated to deliver 25 gpa/alternate row middle (50 gpa complete) at 2 mph. Rates for chemicals are listed as amt/A/complete spray.

[c] Total injury is not the sum of 1st and 2nd brood injury because some apples had both.

Fig. 1A

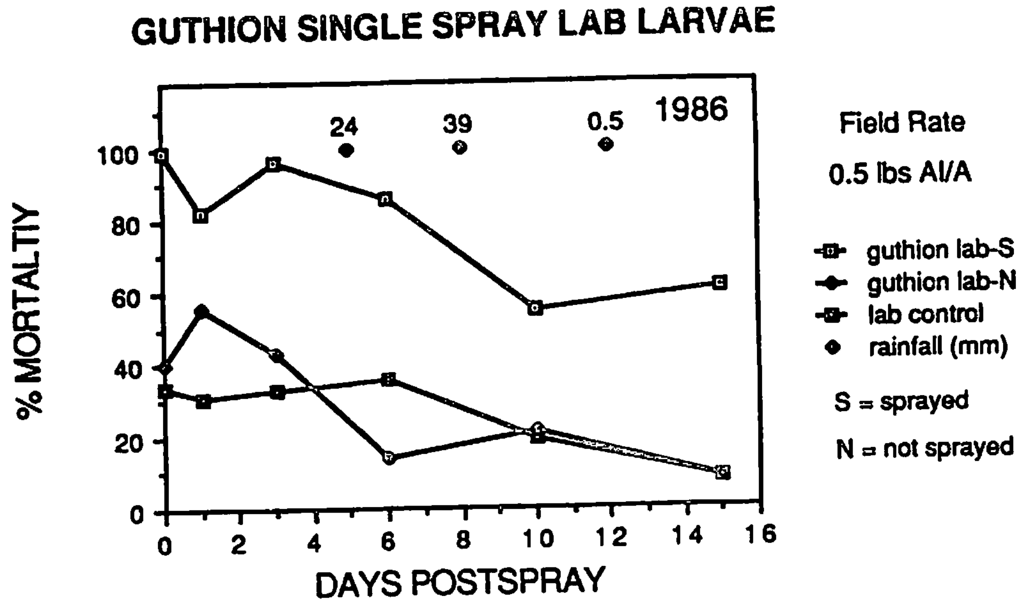


Fig. 1B

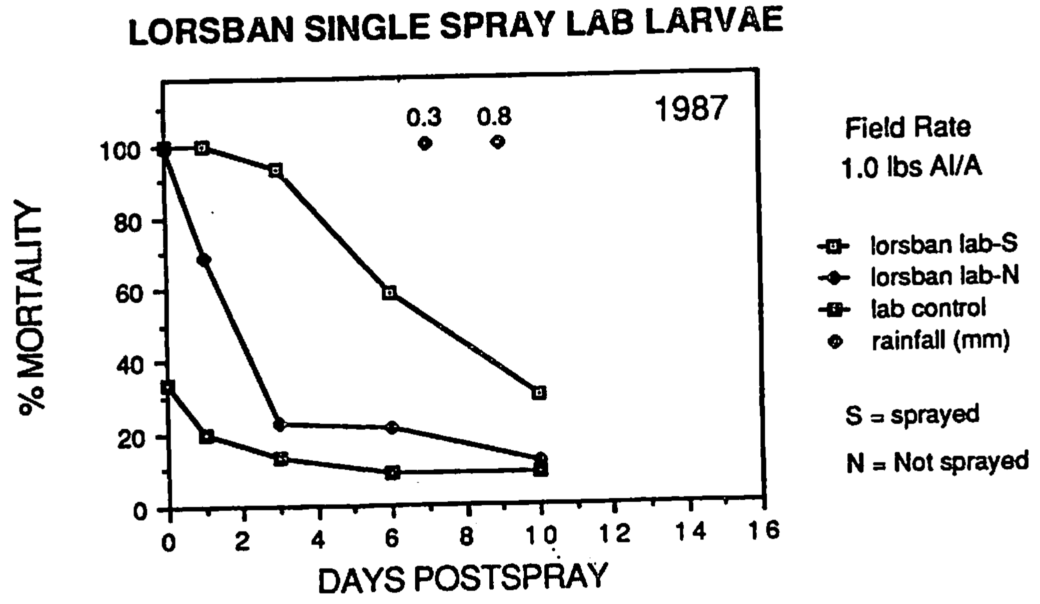


Fig. 1C

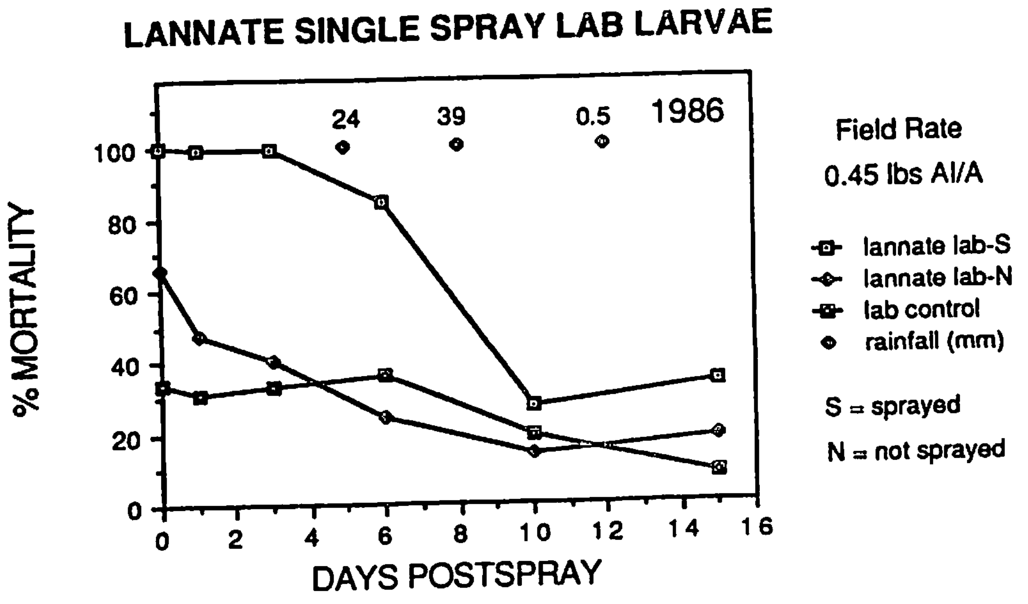
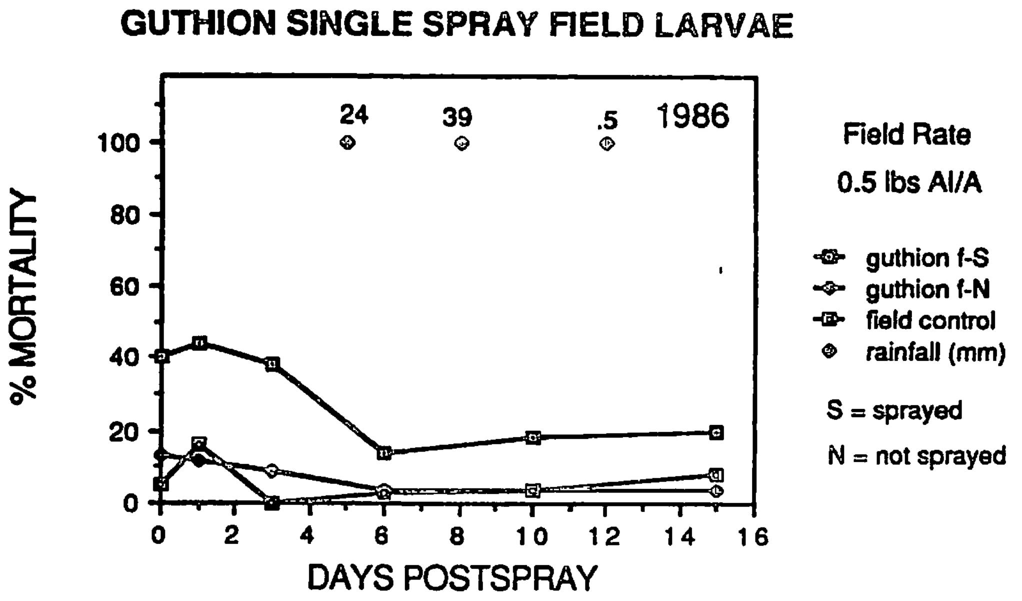
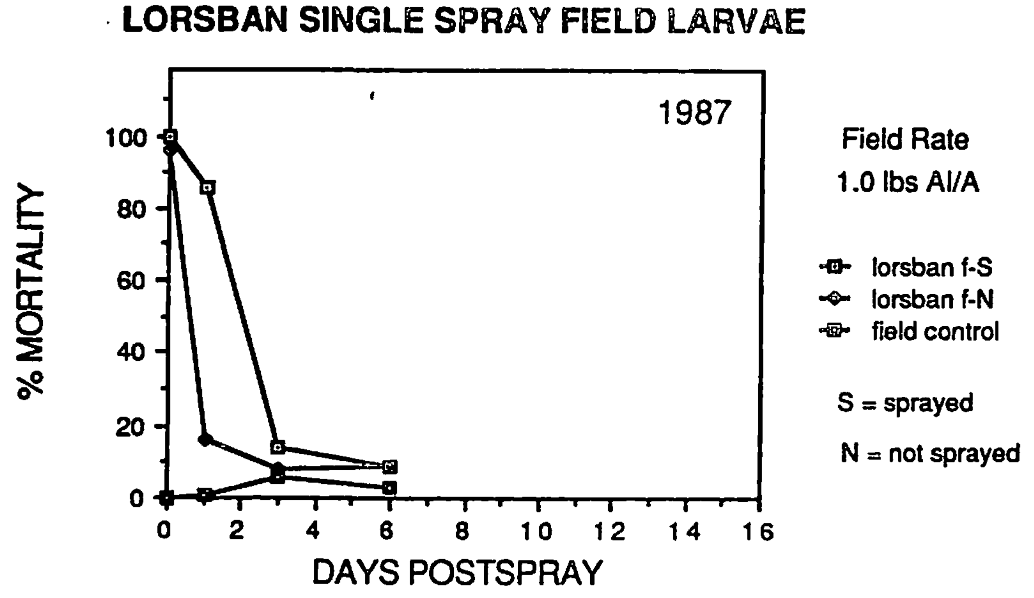


Fig. 2A



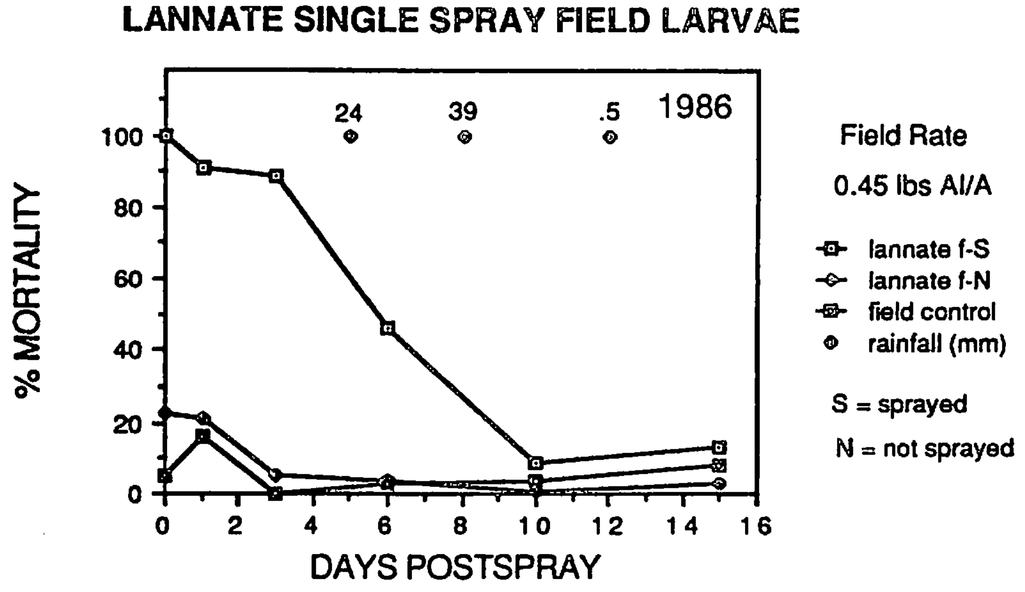
GUTHION SINGLE SPRAY FIELD LARVAE

Fig. 2B



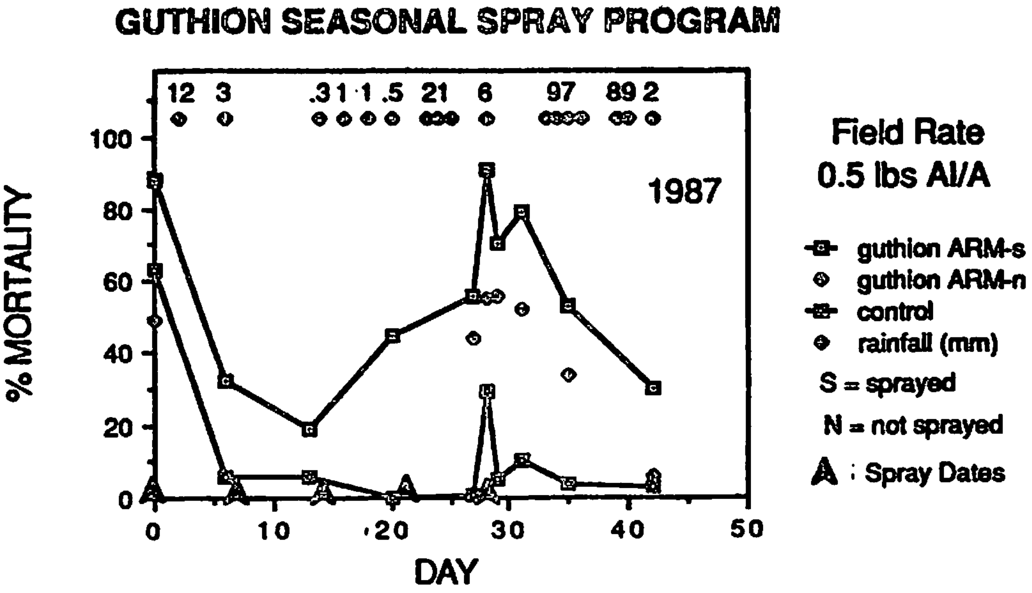
LORSBAN SINGLE SPRAY FIELD LARVAE

Fig. 2C



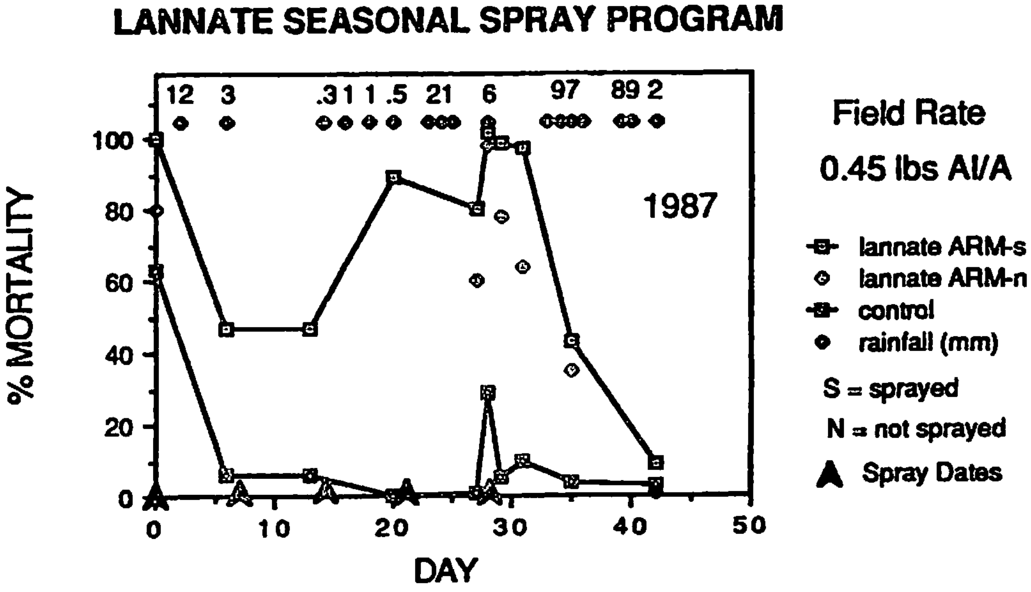
LANNATE SINGLE SPRAY FIELD LARVAE

Fig. 3A



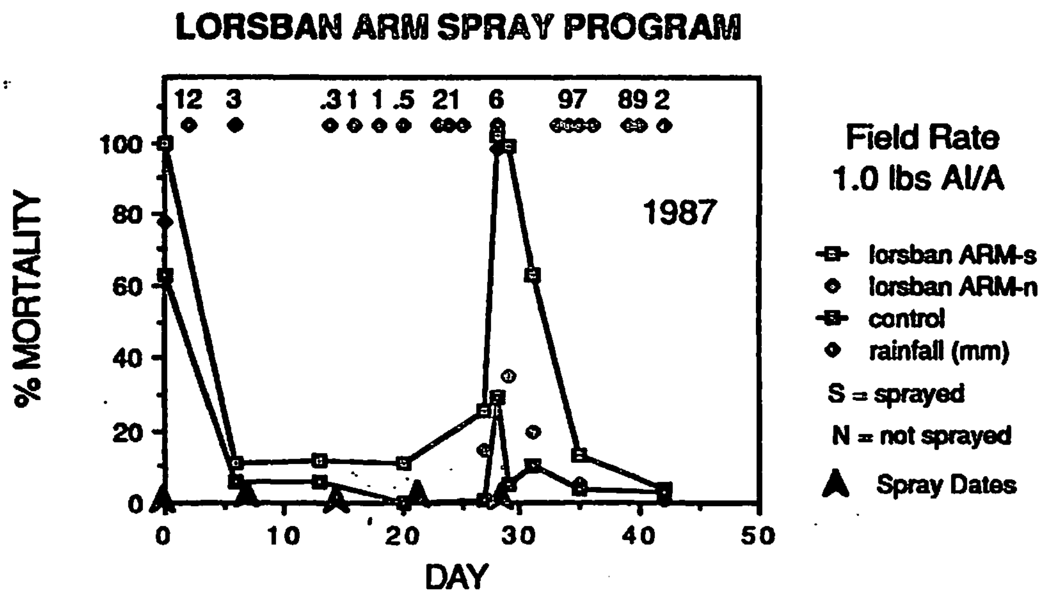
GUTHION SEASONAL SPRAY PROGRAM

Fig. 3B



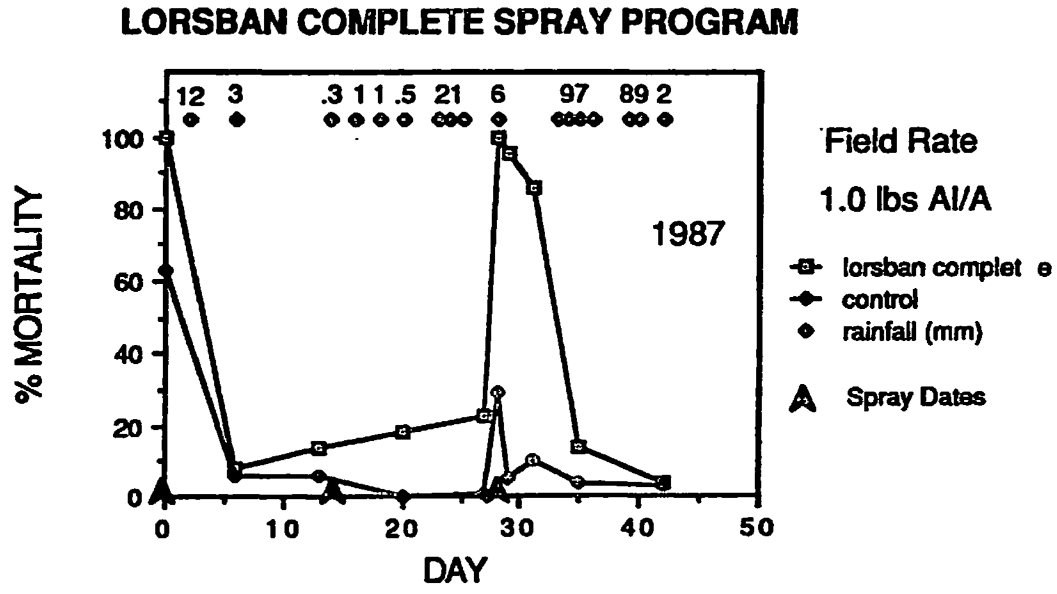
LANNATE SEASONAL SPRAY PROGRAM

Fig. 4A



LORSBAN ARM SPRAY PROGRAM

Fig. 4B



LORSBAN COMPLETE SPRAY PROGRAM

Pheromone Disruption of Lesser Peachtree Borer - 1987

D. G. Pfeiffer and J. C. Killian
Virginia Polytechnic Institute & State University
Blacksburg, VA 24061
Mary Washington College, Fredericksburg, VA 22401

Introduction: Several studies have examined the use of pheromone disruption of olfactory communication in peach borers (e.g. McLaughlin et al. 1976, Yonce and Gentry 1982). Some studies have examined disruption of attraction to conventional traps but did not examine damage. The present study, in which a new type of dispenser was used in a block large enough to minimize the effect of immigrating gravid females, was undertaken to determine not only the disruption of attraction of *Synanthedon pictipes* (Grote and Robinson) to conventional traps, but also the feasibility of this technique for preventing damage by this species in the Appalachian fruit-growing region.

Materials and Methods: The pheromone-treated area was a 4-ha 'Monroe' peach block at Batesville, Virginia. Pheromone dispensers for *S. pictipes* [20-cm polyethylene tubes containing 40 mg (E,Z)-3,13-octadecadien-1-ol acetate (ODDA)] were distributed in mid July 1986 (for flight of the second generation), and on 20 April 1987 (first generation) and on 17 July (second generation). Dispensers were placed at the rate of one per tree at a height of about one meter. No *S. pictipes* sprays were applied in 1986 or 1987.

The control area was a 4-ha block of 'Rio-Oso-Gem' peaches separated from the treated block by 0.2 km of apple orchard and woodland. The control treatment consisted of a program of conventional insecticide applications, parathion 0.85 kg ai/ha, every two weeks. A late summer handgun treatment of chlorpyrifos (18.0 g ai/100 liters) was applied for *S. pictipes* control.

As a means for determining disruption four *S. pictipes* pheromone traps were placed in each block on June 13 1986; trapping began on 13 April in 1987. Lures prepared at the Southeastern Fruit & Tree Nut Research Laboratory (USDA-ARS, Byron, GA) were suspended from trap tops. Each trap within a block was separated by at least 60 m. Numbers of captured *S. pictipes* were recorded weekly and the moths removed from the traps. Lures were replaced after six to eight weeks. Trap bottoms were replaced when they became excessively contaminated with insect parts, dust, etc. Traps were also maintained in two other commercial orchard blocks in Piney River, Virginia.

Hereafter the generations studied will be referred to in the order they were subjected to pheromone treatment: Generation 1 - the second 1986 generation; Generation 2 -

the first 1987 generation; Generation 3 - the second 1987 generation.

Damage was evaluated in 1987 by searching 100 trees per block (10 groups of 10 trees, the groups spread uniformly in the block) for pupal exuviae. Two counts were made to sample exuviae of each generation: 16 June and 3 August (reflecting disruption in Generation 1) and 17 September and 14 October (reflecting disruption of Generation 2). The same trees were sampled on each sampling date and exuviae were removed when counted. Numbers of exuviae per tree were summed for each generation.

Pheromone dispensers containing the pheromone of peachtree borer, _S. exitiosa_ [(Z,Z)-3,13-ODDA], were placed in a block at Jarman Gap at the rate of one per tree as part of a study of that species. Flight activity of _S. pictipes_ was monitored in this block; data are presented in Fig. 3.

Results and Discussion: Pheromone trap capture data are presented in Table 1 and Figs. 1-2. Fig. 1A represents the insecticide control block in 1986. Fig. 1B represents the pheromone block. Although the first generation was approximately of the same magnitude as in the control block, no second generation (Generation 1) males were captured (after pheromone dispensers were in place).

Figure 2A and 2B represent the two Piney River populations. Fig. 2C illustrates that both generations (Generations 2 and 3) were still active in the insecticide control block in 1987. There is no figure depicting populations in the pheromone-treated block in 1987; no males were caught all season. Thus, 100% disruption of attraction to pheromone traps was achieved over three generations.

Exuviae count data are presented in Table 1. Counts made during Generation 2 actually represent disruption of reproduction in Generation 1, etc. The pheromone treatment of Generation 1 resulted in a 96.7% reduction in exuviae sampled; after Generation 2 was treated, a 66.7% reduction in exuviae was observed. Infested trees in the pheromone block were usually near the edge of the orchard; these may have been due to immigration of gravid females.

In the block treated with (Z,Z)-3,13-ODDA, very few male _S. pictipes_ were captured after placement of pheromone dispensers (Fig. 3). Such disruptions of _S. pictipes_ after permeation by _S. exitiosa_ pheromone have been reported previously (Snow et al. 1985). Pupal counts will be made in 1988 in order to determine effects on damage. Benefits from disruption of communication in _S. pictipes_ by _S. exitiosa_ pheromone are two-fold: the (Z,Z) isomer is easier to produce (Tumlinson 1979), and potentially two species could be disrupted using one set of dispensers.

REFERENCES CITED

McLaughlin, J. R., R. E. Doolittle, C. R. Gentry, E. R. Mitchell, and J. H. Tumlinson. 1976. Response to pheromone traps and disruption of pheromone communication in the lesser peachtree borer and peachtree borer (Lepidoptera: Sesiidae). J. Chem. Ecol. 2: 73-81.

Snow, J. W., C. R. Gentry, and M. Novak. 1985. Behavior and control of the peachtree borer and lesser peachtree borer (Lepidoptera: Sesiidae) in peach orchards permeated with (Z,Z)-3,13-octadecadien-1-ol acetate. J. Econ. Entomol. 78: 190-196.

Tumlinson, J. H. 1979. The chemistry of Sisiidae pheromones. p. 1-10. In: J. W. Neal (ed.). Pheromones of the Sesiidae (formerly Aegeriidae). U.S. Dept. Agric. Sci. Educ. Admin. ARR-NE-6. 83 p.

Yonce, C. E., and C. R. Gentry. 1982. Disruption of mating of peachtree borer. p. 99-106. In: A. F. Kydonieus and M. Beroza (eds.). Insect Suppression with Controlled Release Pheromone Systems. Vol. II. 312 p.

Table 1. Pheromone trap and exuviae count data for three generations of lesser peachtree borer in Virginia. Control block treated with conventional chlorpyrifos program. EZ-ODDA block treated with (E,Z)-3,13-ODDA at outset of each generation. ZZ-ODDA block treated with (Z,Z)-3,13-ODDA at outset of Generation 3.[1]

	Generation				
	1 (Summer 1986)	2 (Spring 1987)		3 (Summer 1987)	
	Males /trap	Males /trap	Exuviae /10 trees	Males /trap	Exuviae /10 trees
Control	23.5(6.1)	67.5(5.9)	3.0(0.7)	52.8(2.4)	0.9(0.3)
EZ-ODDA	0.0(0.0)	0.0(0.0)	0.1(0.1)	0.0(0.0)	0.3(0.2)
ZZ-ODDA	--	568.0(118.6)	14.4(3.9)	2.2(1.1)	6.0(1.6)

[1] Numbers in parentheses represent standard errors of means.

Not for publication

Douglas G. Pfeiffer and
Leo F. Ponton
Dept. of Entomology
VPI&SU
Blacksburg, VA 24061
(703) 961-4183

APPLE: *Malus* x *domestica* 'Delicious'
European red mite (ERM): *Panonychus ulmi* (Koch)
Apple rust mite (ARM): *Aculus schlechtendali* (Nalepa)

APPLE, APOLLO VOLUME TRIAL, 1987: Apollo 50SC (clofentazine) was applied at the rate of 2.0 oz ai/A in four different volumes of water: 25, 50, 100, and 200 gal/A. Comparisons were made with an untreated control. The experimental block was at Steeles Tavern, VA. Applications were made using a truck-mounted Swanson sprayer on 5 June, when a preliminary count showed about 1 ERM per leaf. A twenty-leaf sample was collected from each of four trees in each plot on each sampling date. Mites were evaluated using a mite brushing machine. Subsamples from each glass disc were examined for ERM and ARM.

Population counts for ERM are given in Table 1 and Fig. 1. ERM pressure was low; the highest density in the control was 1.1 ERM per leaf. There were no consistent differences among the four treatments of Apollo; all caused motile ERM densities to fall to very low levels for the remainder of the season. ERM eggs (Table 1, Fig. 2) also fell to very low densities and remained there, but took longer to fall than the motile ERM densities. This is because of the propensity of eggs that fail to hatch to remain on leaves.

Data for ARM are given in Table 2 and Fig. 3. The population curves in Fig. 3 show the same general pattern of growth among treatments, although on any given sampling date there were significant differences among treatments. These differences showed no consistent pattern and may have been due to random variation.

Table 1. European red mites per leaf[1]

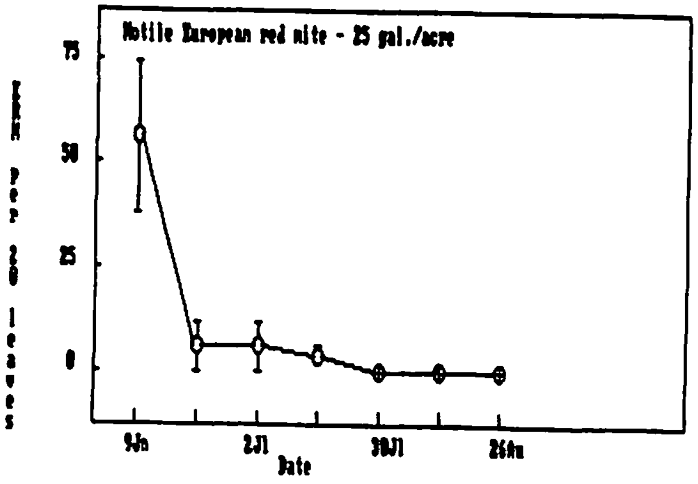
Treatment, g ai/A		Gal/A	9 June		22 June		2 July		15 July		30 July	
			motile	eggs	motile	eggs	motile	eggs	motile	eggs	motile	eggs
Apollo 50SC	56.7	25	2.9ab	13.7ab	0.3a	19.4a	0.3ab	7.4a	0.2a	0.8a	0.0a	0.0a
Apollo 50SC	56.7	50	1.9ab	16.6ab	0.0a	5.6ab	0.0a	1.2b	0.0a	0.4a	0.0a	0.0a
Apollo 50SC	56.7	100	7.7b	36.4b	0.2a	14.0ab	0.0a	6.0a	0.0a	0.4a	0.0a	0.1a
Apollo 50SC	56.7	200	2.5ab	18.6ab	0.2a	4.7ab	0.0a	3.0ab	0.0a	0.4a	0.0a	0.0a
Control			0.3a	4.1a	0.2a	1.5b	0.4b	5.5a	1.1b	5.2b	0.0a	0.2a

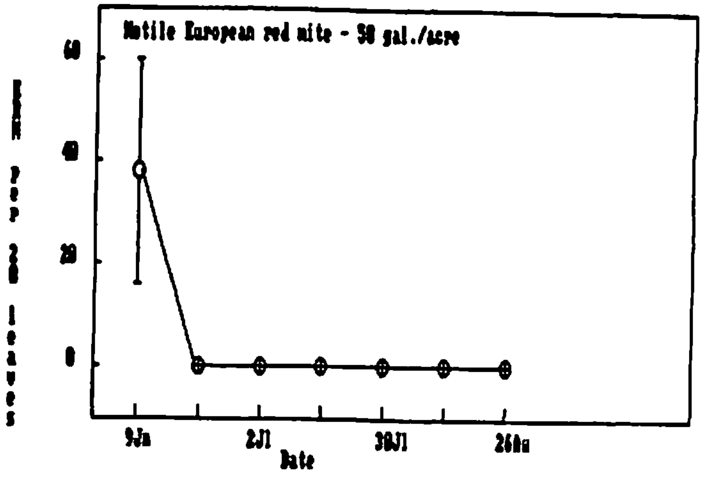
[1] Data transformed for analysis ($\sqrt{x + 0.5}$). Means in a column followed by the same letter are not significantly different (DMRT, alpha = 0.05).

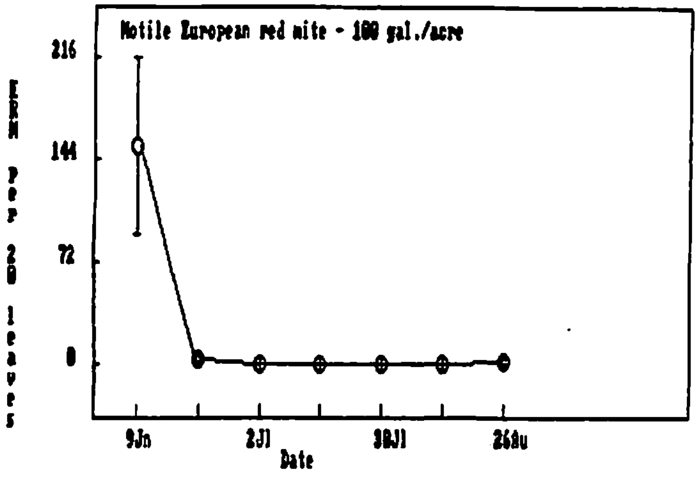
Table 2. Apple rust mites per leaf[1]

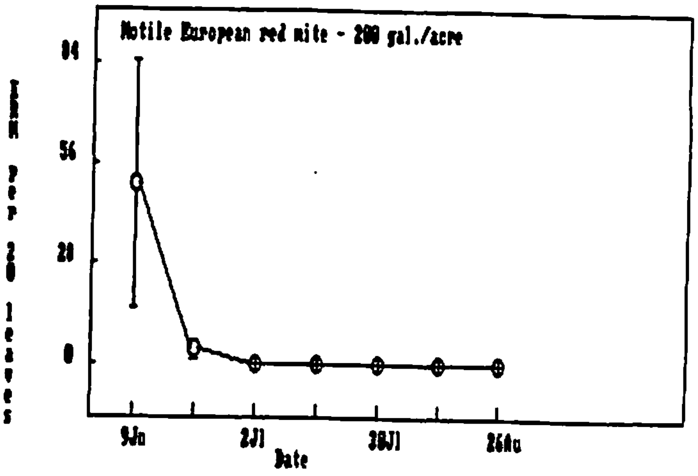
Treatment, g ai/A		Gal/A	9 June	22 June	2 July	15 July	30 July	11 Aug	26 Aug
Apollo 50SC	56.7	25	1.8a	5.2a	7.3a	9.6b	28.3a	46.3ab	47.0a
Apollo 50SC	56.7	50	5.0a	2.4a	3.4ab	4.2ab	6.4a	14.2a	31.9a
Apollo 50SC	56.7	100	1.0a	2.1a	3.4ab	3.2a	7.1b	23.3bc	11.7a
Apollo 50SC	56.7	200	1.2a	3.0a	2.2b	7.5ab	7.3b	35.0abc	17.3a
Control			1.0a	2.0a	5.9ab	23.8c	36.4a	67.0a	21.0a

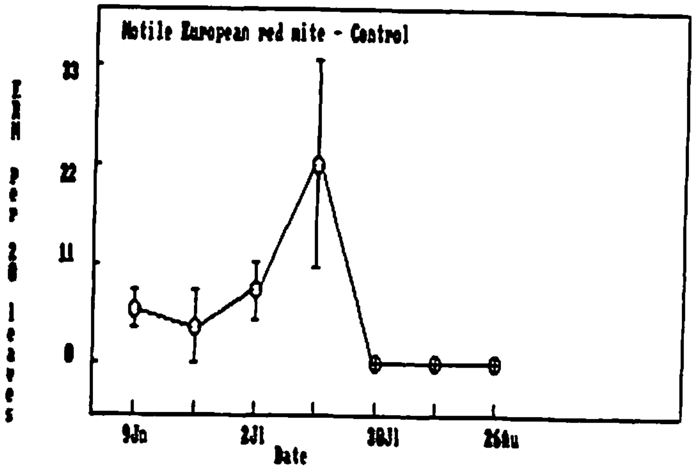
[1] Data transformed for analysis ($\sqrt{x + 0.5}$). Means in a column followed by the same letter are not significantly different (DMRT, alpha = 0.05).

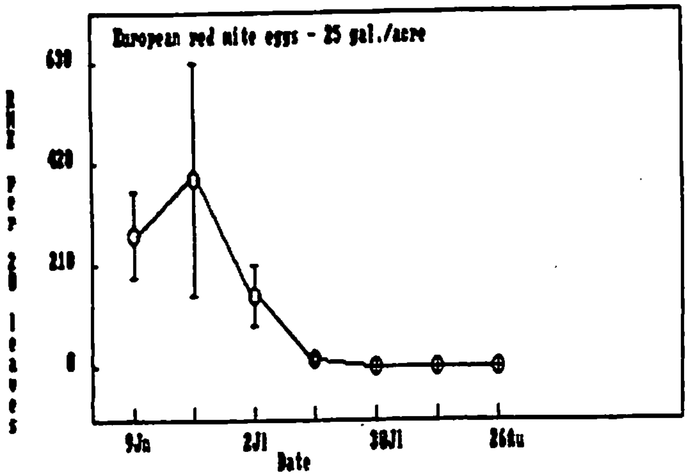

Motile European red mite - 25 gal./acre
75
50
25
0
ERM per 20 leaves
9Jn
2Jl
30Jl
26Au
Date

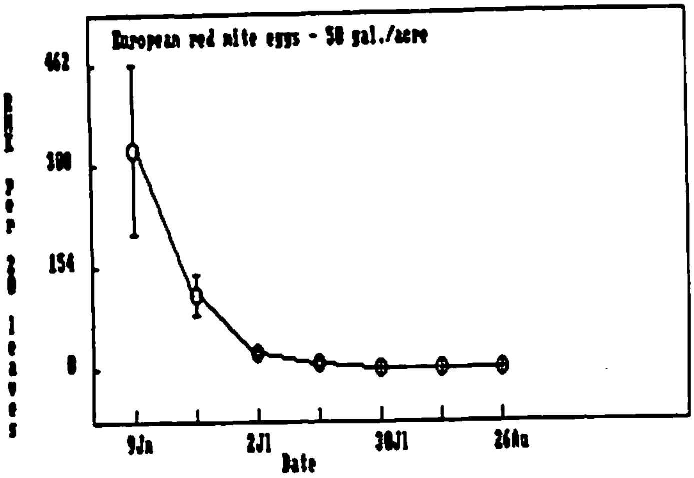

Motile European red mite - 50 gal./acre
60
40
20
0
ERM per 20 leaves
9Jn
2Jl
30Jl
26Au
Date

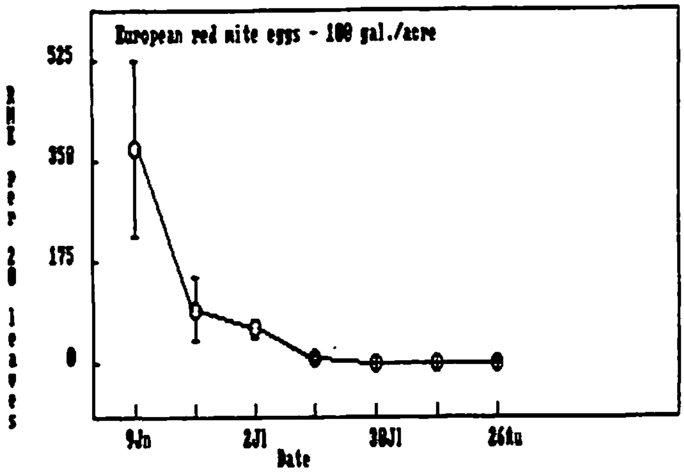

Motile European red mite - 100 gal./acre
216
144
72
0
ERM per 20 leaves
9Jn
2Jl
30Jl
26Au
Date

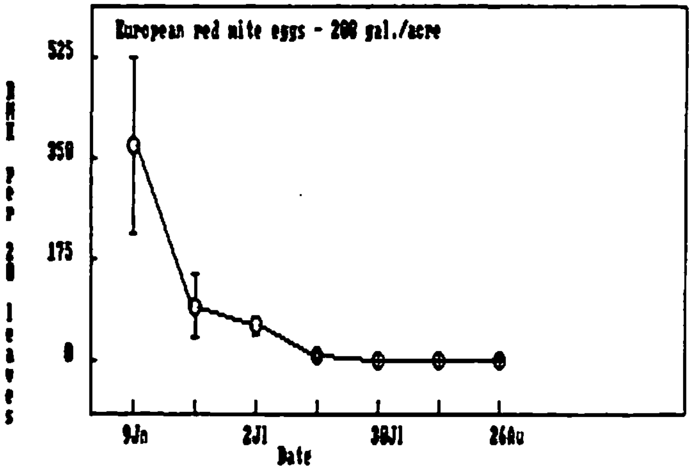

Motile European red mite - 200 gal./acre
84
56
28
0
ERM per 20 leaves
9Jn
2Jl
30Jl
26Au
Date

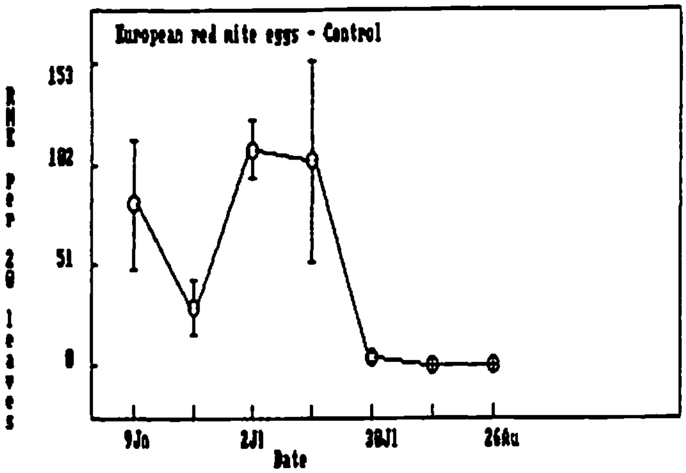

Motile European red mite - Control
33
22
11
0
ERM per 20 leaves
9Jn
2Jl
30Jl
26Au
Date

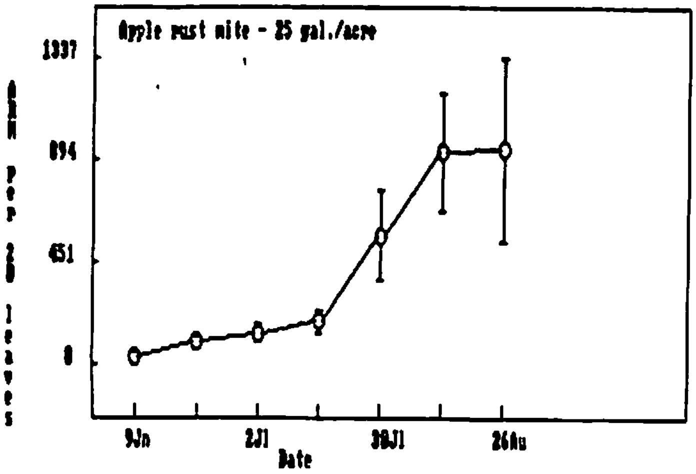

European red mite eggs - 25 gal./acre
ERM per 20 leaves
630
420
210
0
9Jn
2Jl
30Jl
26Au
Date

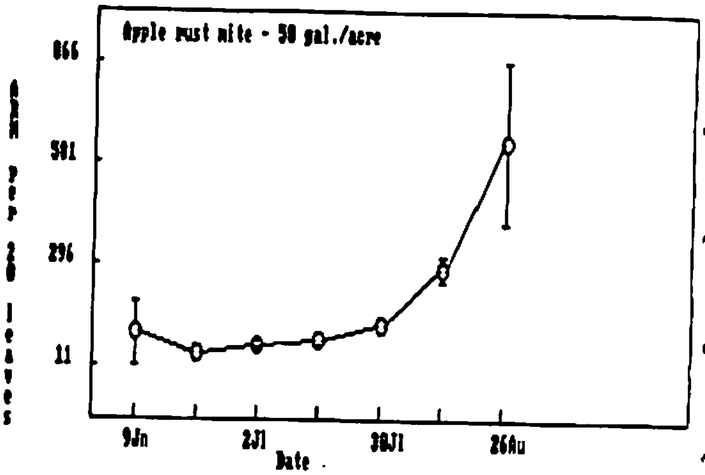

European red mite eggs - 50 gal./acre
ERM per 20 leaves
462
308
154
0
9Jn
2Jl
30Jl
26Au
Date

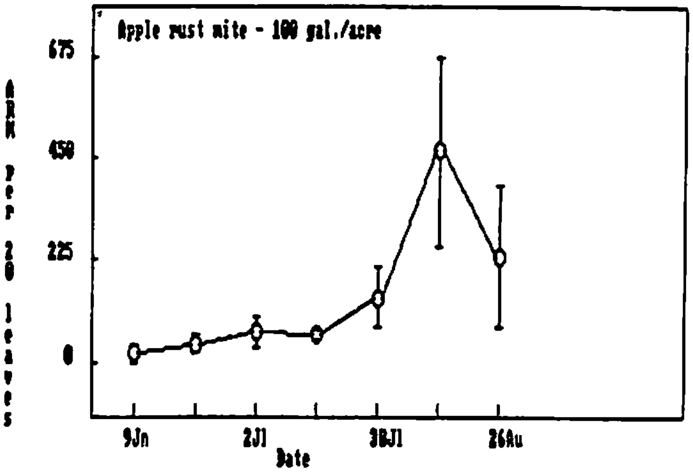

European red mite eggs - 100 gal./acre
ERM per 20 leaves
525
350
175
0
9Jn
2Jl
30Jl
26Au
Date

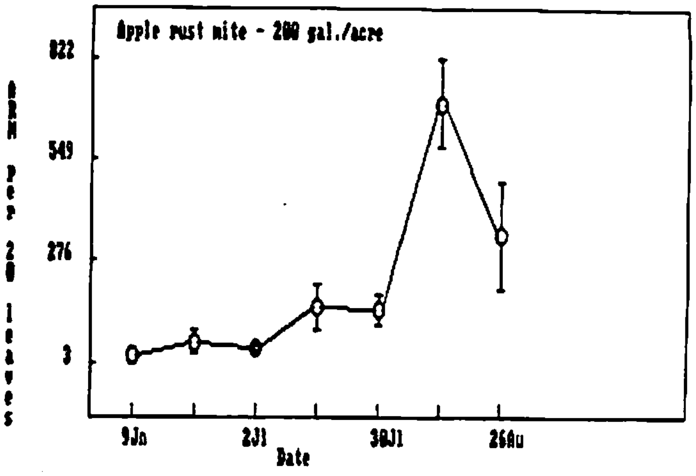

European red mite eggs - 200 gal./acre
ERM per 20 leaves
525
350
175
0
9Jn
2Jl
30Jl
26Au
Date

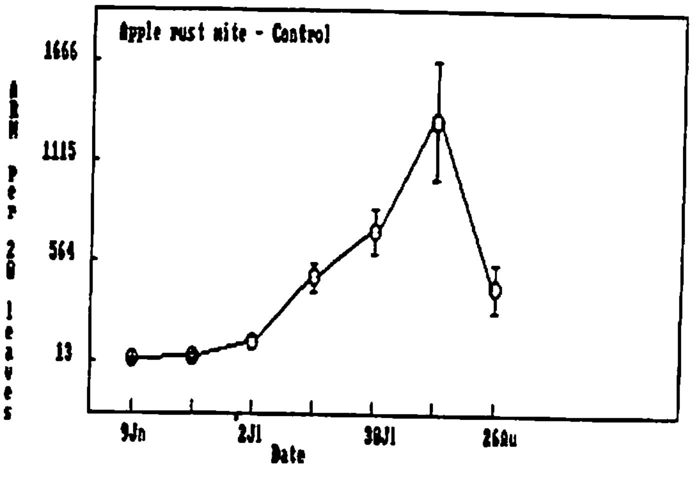

European red mite eggs - Control
ERM per 20 leaves
153
102
51
0
9Jn
2Jl
30Jl
26Au
Date


Apple rust mite - 25 gal./acre
1337
894
451
8
ARM per 20 leaves
9Jn
2Jl
30Jl
26Au
Date


Apple rust mite - 50 gal./acre
866
581
296
11
ARM per 20 leaves
9Jn
2Jl
30Jl
26Au
Date


Apple rust mite - 100 gal./acre
675
450
225
0
ARM per 20 leaves
9Jn
2Jl
30Jl
26Au
Date


Apple rust mite - 200 gal./acre
822
549
276
3
ARM per 20 leaves
9Jn
2Jl
30Jl
26Au
Date


Apple rust mite - Control
1666
1115
564
13
ARM per 20 leaves
9Jn
2Jl
30Jl
26Au
Date

Douglas G. Pfeiffer and
Leo F. Ponton
Department of Entomology
VPI&SU
Blacksburg, VA 24061
(703) 961-4183

APPLE: *Malus* x *domestica* 'Delicious'
European red mite (ERM): *Panonychus ulmi* (Koch)
Apple rust mite (ARM): *Aculus schlechtendali* (Nalepa)
Predatory mite (AF): *Amblyseius fallacis* (Garman)

APPLE, SAVEY TRIAL, 1987: Savey 50WP (hexythiazox) was applied at the rates of 1.00 and 1.25 oz ai/A, and was compared with Kelthane 4F (dicofol, 1.5 lb ai/A) and an untreated control. The experimental block was was at Steeles Tavern VA. Applications were made using a truck-mounted Swanson sprayer on 5 June. A single sample of twenty leaves was collected from each of four trees in each plot on each sampling date. Mites were evaluated using a mite-brushing machine. Subsamples of the glass disc were examined for ERM ane ARM after the whole disc was examined for AF.

Population data for motile forms of ERM are given in Table 1 and Fig. 1. Both rates of Savey allowed relatively high populations of ERM on the first sampling date (8 June, 3 days post-treatment). Kelthane, in contrast, had eliminated motile ERM on this date. Motile ERM densities fell to very low levels in the Savey plots after the first sampling date and remained there for the rest of the season [the higher rate of Savey showed a small increase on 24 August (Fig. 1), but this was a nonsignificant change]. Motile ERM densities in the Kelthane treatment increased on 1 July, but were variable and hence not significantly different from Savey treatments; all treatments gave control relative to the check.

Eggs of ERM showed an increase in Savey plots while motile forms were decreasing in abundance (Fig. 2); this was because of the accumulation of eggs that failed to hatch. ERM egg density started to increase in the Kelthane plot about two weeks later; this increase was related to the concurrent increase in motile ERM densities (Fig.1).

Both rates of Savey allowed survival of ARM (Fig. 3). In contrast, ARM densities in the Kelthane treatment remained very low until late July. Data for ARM are presented in Table 2.

The only sampling date on which there were significant differences in AF densities was 24 August, when the higher Savey rate had greater densities than Kelthane or control treatment (the low Savey rate was not different from any of these treatments). AF densities have historically been low in this orchard; densities are variable and difficult to interpret. It should be noted, however, that while AF was always absent from the Kelthane treatment, it was found in the control and in both Savey treatments (Fig. 4). These results may be attributable to the combination of Savey's low toxicity to both AF and ARM, an alternate food source, and Kelthane's greater toxicity for both species.

Table 1. European red mites per leaf*

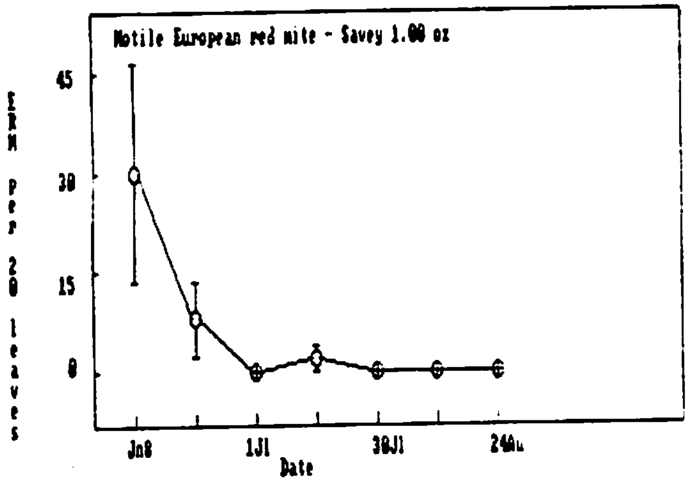
Treatment,	g ai/A	8 June		19 June		1 July		13 July		30 July		10 August	
		motile	eggs	motile	eggs	motile	eggs	motile	eggs	motile	eggs	motile	eggs
Savey 50W	28.4	1.5ab	9.8ab	0.4a	30.2a	0.0a	6.9a	0.1a	1.2a	0.0a	0.0a	0.0a	0.0a
Savey 50W	35.4	0.4ab	3.3a	0.0a	5.6b	0.0a	1.2a	0.0a	0.8a	0.0a	0.0a	0.0a	0.0a
Kelthane 4F	680.4	0.0a	1.1a	0.2a	1.4b	0.8a	7.2a	0.2a	6.1b	0.2a	0.3b	0.3a	0.2a
Control		2.9b	21.8b	3.3b	26.8a	4.6b	49.2b	3.4b	12.6c	0.2a	0.4b	0.0a	0.2a

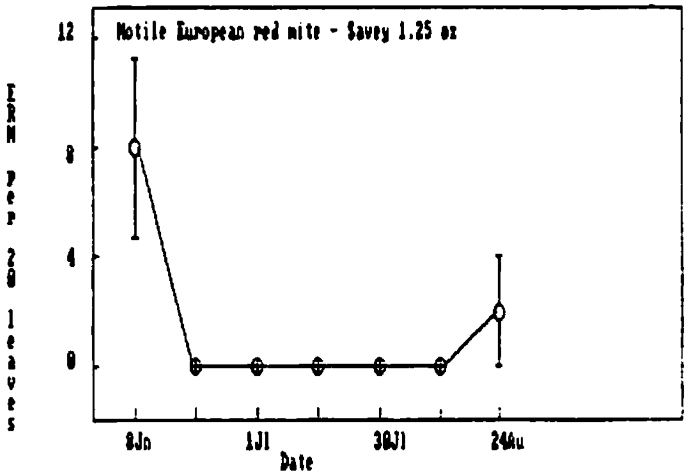
*Data transformed for analysis ($\sqrt{x + 0.5}$). Means in a column followed by the same letters are not significantly different (DMRT, alpha = 0.05).

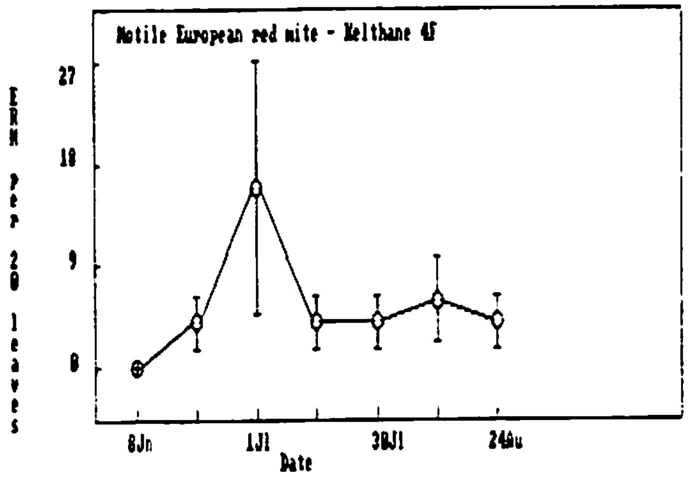
Table 2. Apple rust mites per leaf*

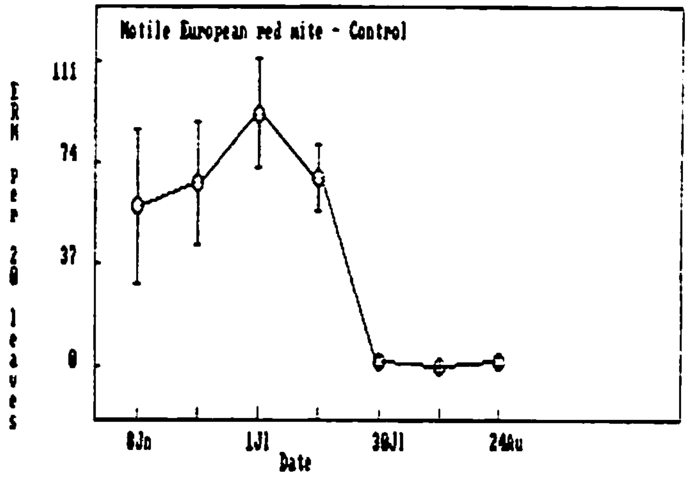
Treatment,	g ai/A	8 June	19 June	1 July	13 July	30 July	10 Aug
Savey 50W	28.4	6.0ab	26.9ab	18.2a	17.1b	47.3a	34.0a
Savey 50W	35.4	6.8b	34.0a	24.9a	13.2b	41.2a	24.9a
Kelthane 4F	680.4	0.0a	0.1b	0.5b	1.1a	6.0b	12.2a
Control		4.5ab	43.5a	20.2a	44.8c	54.1a	20.3a

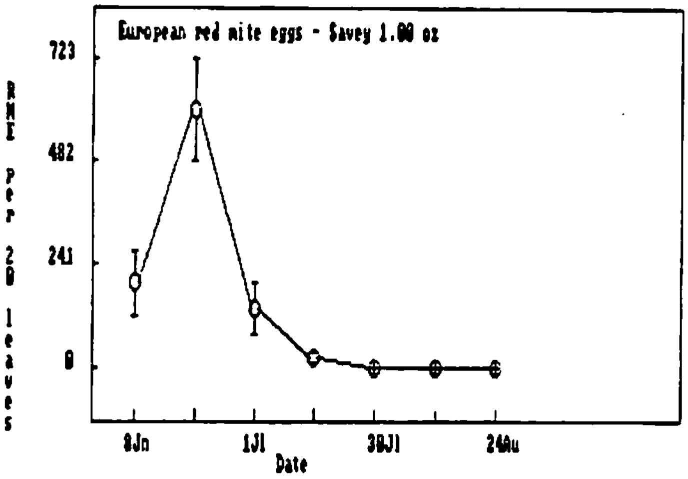
*Data transformed for analysis ($\sqrt{x + 0.5}$). Means in a column followed by the same letters are not significantly different (DMRT, alpha = 0.05).

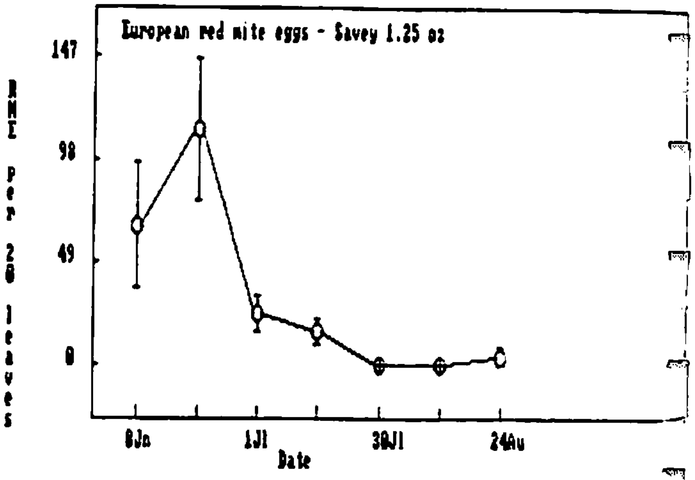

Motile European red mite - Savey 1.00 oz
ERM per 20 leaves
45
30
15
0
Jn8
1Jl
30Jl
24Au
Date

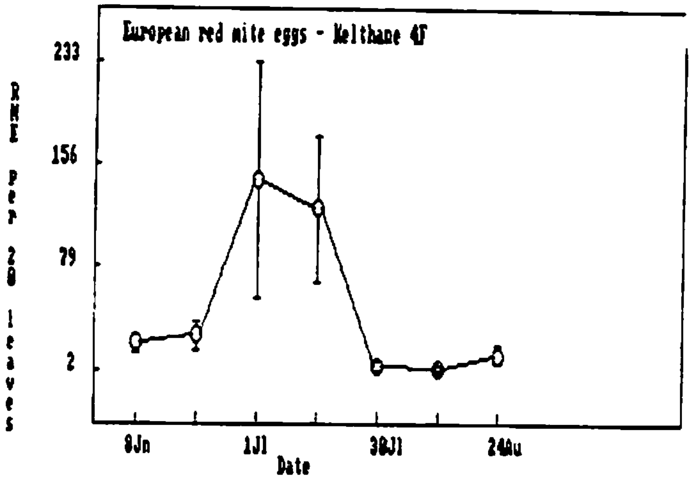

Motile European red mite - Savey 1.25 oz
ERM per 20 leaves
12
8
4
0
8Jn
1Jl
30Jl
24Au
Date

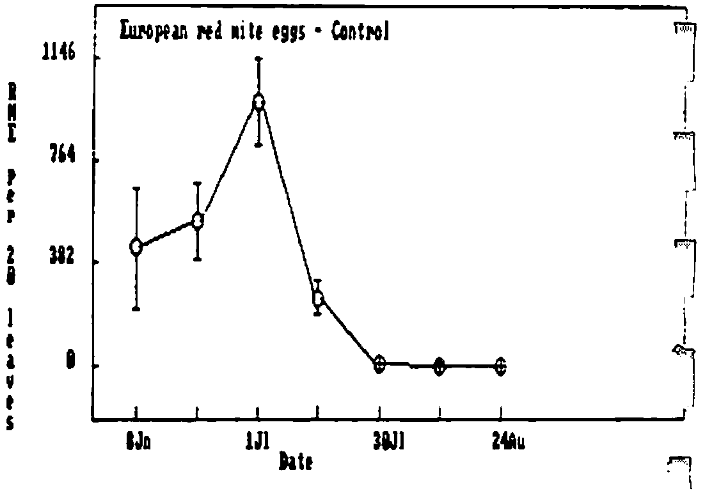

Motile European red mite - Kelthane 4F
ERM per 20 leaves
27
18
9
0
8Jn
1Jl
30Jl
24Au
Date

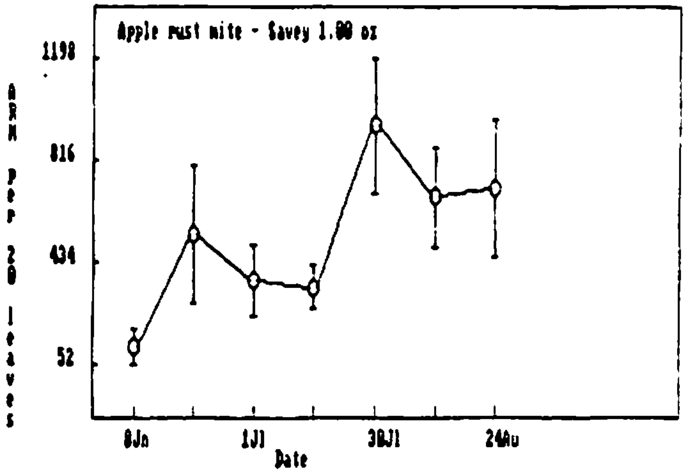

Motile European red mite - Control
ERM per 20 leaves
111
74
37
0
8Jn
1Jl
30Jl
24Au
Date

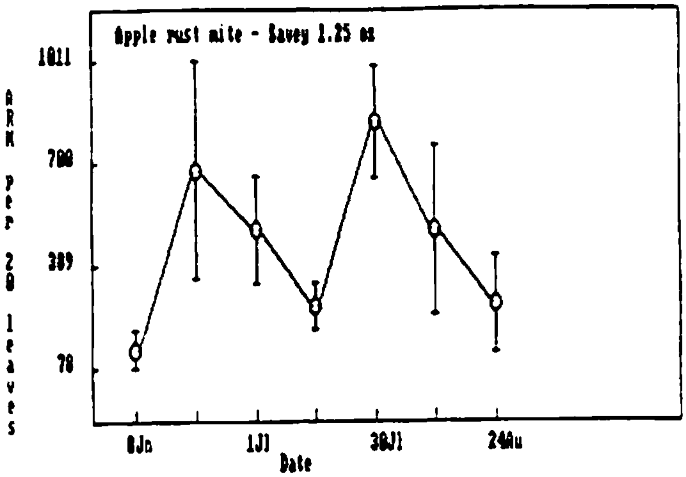

European red mite eggs - Savey 1.00 oz
723
482
241
0
RME per 20 leaves
8Jn
1Jl
30Jl
24Au
Date

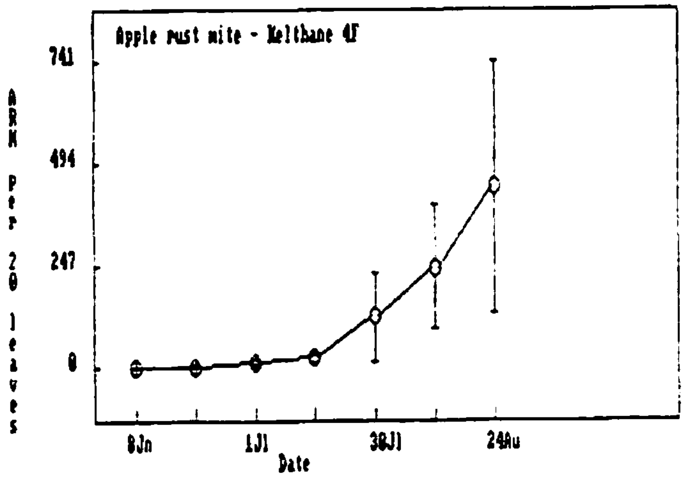

European red mite eggs - Savey 1.25 oz
147
98
49
0
RME per 20 leaves
8Jn
1Jl
30Jl
24Au
Date

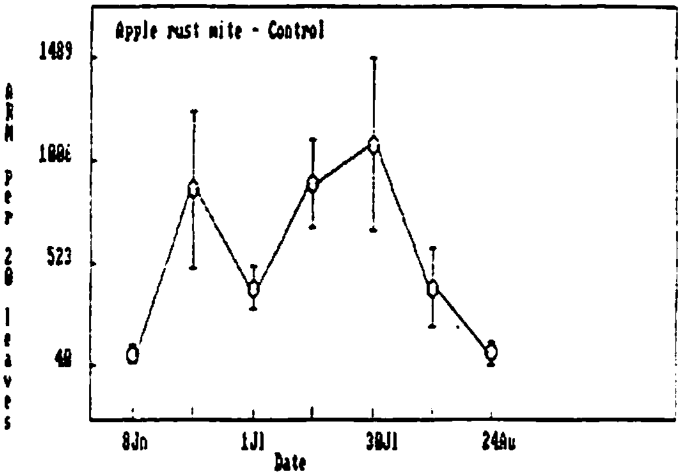

European red mite eggs - Kelthane 4F
233
156
79
2
RME per 20 leaves
8Jn
1Jl
30Jl
24Au
Date

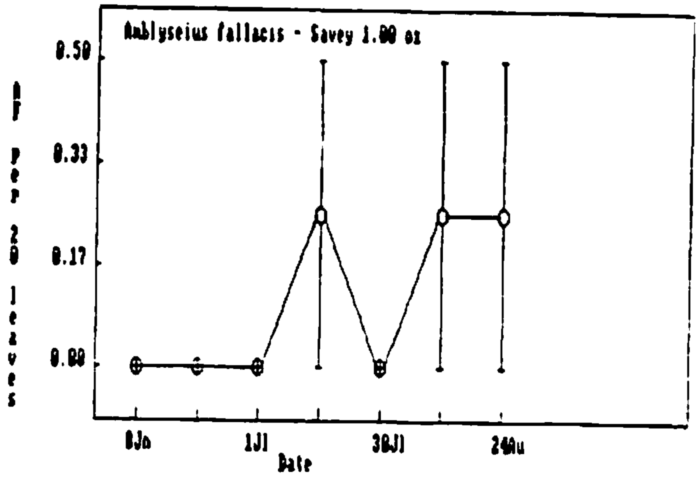

European red mite eggs - Control
1146
764
382
0
RME per 20 leaves
8Jn
1Jl
30Jl
24Au
Date

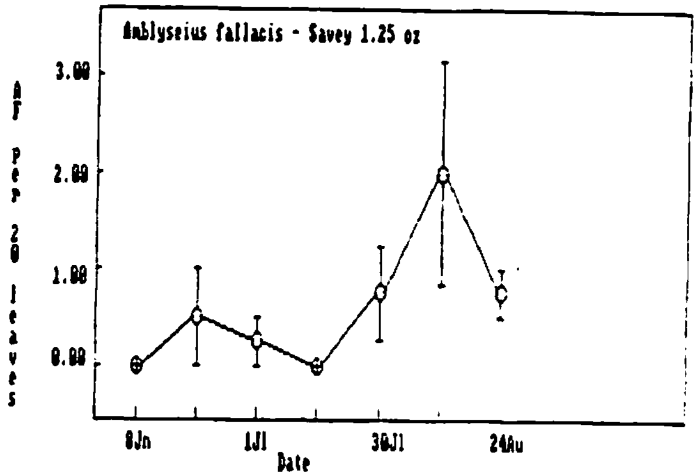

Apple rust mite - Savey 1.00 oz
ARM per 20 leaves
1198
816
434
52
8Jn
1Jl
30Jl
24Au
Date

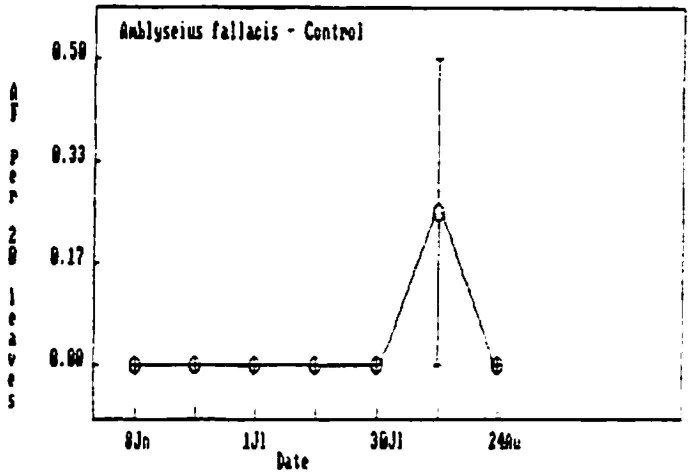

Apple rust mite - Savey 1.25 oz
ARM per 20 leaves
1011
700
389
78
8Jn
1Jl
30Jl
24Au
Date


Apple rust mite - Kelthane 4F
ARM per 20 leaves
741
494
247
0
8Jn
1Jl
30Jl
24Au
Date


Apple rust mite - Control
ARM per 20 leaves
1489
1006
523
40
8Jn
1Jl
30Jl
24Au
Date


Amblyseius fallacis - Savey 1.00 oz
AF per 20 leaves
0.50
0.33
0.17
0.00
8Jn
1Jl
30Jl
24Au
Date


Amblyseius fallacis - Savey 1.25 oz
AF per 20 leaves
3.00
2.00
1.00
0.00
8Jn
1Jl
30Jl
24Au
Date


Amblyseius fallacis - Control
AF per 20 leaves
0.50
0.33
0.17
0.00
8Jn
1Jl
30Jl
24Au
Date

Douglas G. Pfeiffer and
Leo F. Ponton
Department of Entomology
VPI&SU
Blacksburg, VA 24061
(703) 961-4183

APPLE: *Malus* x *domestica* 'Golden Delicious'
Codling moth (CM): *Cydia pomonella* (L.)
Leafrollers (LR): *Platynota flavedana* (Clemens),
P. idaeusalis (Walker)
Plum curculio (PC): *Conotrachelus nenuphar* (Herbst)
European red mite (ERM): *Panonychus ulmi* (Koch)
Apple rust mite (ARM): *Aculus schlechtendali* (Nalepa)

APPLE, DPX-EY059 TRIAL, 1987: DPX-EY059 was applied in an apple block at Steeles Tavern, VA, at three rates: 0.025, 0.050 and 0.100 lb ai/A. These were compared with an untreated control. Applications were made using a truck-mounted Swanson airblast sprayer calibrated for 200 gal/A. Treatments were applied to three adjacent rows. Samples were taken from the middle row, consisting of 'Golden Delicious'. The first spray date was 30 April (pink stage of bud development); three additional sprays were applied at 4-week intervals (28 May, 1 July, 30 July). Fifty fruit were collected from each of four trees in each treatment at harvest (24 September) and examined for direct insect damage. Mites were evaluated at approximately 2-week intervals using a mite-brushing machine. A 20-leaf sample was collected from each of four trees per treatment on each sampling date.

All three rates of DPX-EY059 gave effective control of CM (Table 1). There were no significant differences among treatments for either PC or LR.

Although the population curves for motile ERM showed the same general trends in all treatments (Fig. 1), ERM densities were significantly lower in the DPX-EY059 plots (Table 1). The three rates maintained ERM below an action threshold of 5 mites per leaf, which was exceeded in the control on two sampling dates. Red mite eggs were found in significantly lower densities in all DPX-EY059 plots on the first two sample dates (Table 2, Fig. 2). Densities increased in all treatments for one or two weeks thereafter until 2 July when the 0.025 and 0.050 lb rates had greater egg densities than the 0.100 lb rate or the control.

For the first part of the season (21 May through 15 July, except for 3 June) densities of ARM were lower in all DPX-EY059 plots relative to the control (Table 3). Thereafter, during a period of population decline in all plots (Fig. 3), there were significant differences with the lowest DPX-EY059 rate showing high ARM densities.

Table 1. Damaged Fruit Per 50 Fruit*

Treatment	lb ai/A	Codling Moth	Leafroller	Plum Curculio
DPX-EY059 50 g/L EC	0.025	0.8a	0.2a	0.2a
DPX-EY059 50 g/L EC	0.050	0.0a	0.2a	2.2a
DPX-EY059 50 g/L EC	0.100	0.0a	0.0a	2.5a
Control		5.5b	0.2a	1.2a

*Data transformed for analyses ($\sqrt{x + 0.5}$). Means in a column followed by the same letter are not significantly different (DMRT, alpha = 0.05).

Table 2. European red mites per leaf*

Treatment	lb ai/A	21 May		3 June		18 June	
		motile	eggs	motile	eggs	motile	eggs
DPX-EY059 50 g/L EC	0.025	0.3ab	9.0a	1.5a	4.7a	2.4a	30.6a
DPX-EY059 50 g/L EC	0.050	0.7b	24.6b	3.3b	15.2b	2.5a	59.2a
DPX-EY059 50 g/L EC	0.100	0.0a	11.6ab	1.3a	4.7a	1.3a	32.4a
Control		2.3c	87.2c	6.6c	29.5c	8.0b	56.0a

*Data transformed for analysis ($\sqrt{x + 0.5}$). Means in a column followed by the same letter are not significantly different (DMRT, alpha = 0.05).

Table 2. European red mites per leaf* (continued)

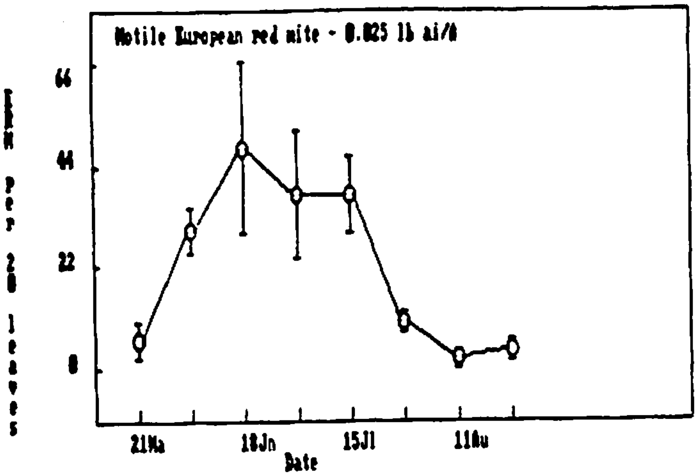
Treatment	lb ai/A	2 July		15 July		29 July	
		motile	eggs	motile	eggs	motile	eggs
DPX-EY059 50 g/L EC	0.025	1.9ab	40.7a	1.9a	2.8a	0.5a	1.5a
DPX-EY059 50 g/L EC	0.050	2.3b	41.3b	0.5ab	5.4ab	0.0b	0.6ab
DPX-EY059 50 g/L EC	0.100	0.4a	21.3b	0.3b	2.0b	0.0b	0.1b
Control		1.5ab	14.1b	0.6b	0.8b	0.0b	0.5ab

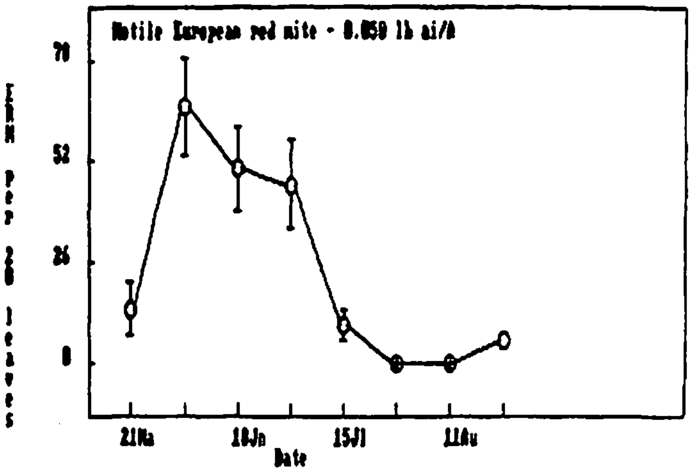
*Data transformed for analysis ($\sqrt{x + 0.5}$). Means in a column followed by the same letter are not significantly different (DMRT, alpha = 0.05).

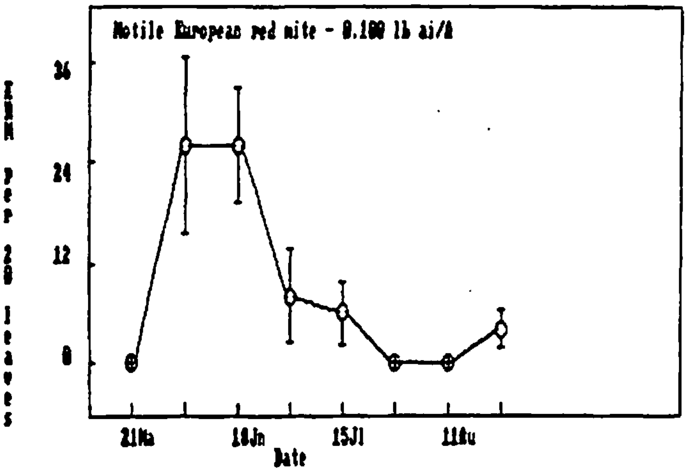
Table 3. Apple rust mites per leaf*

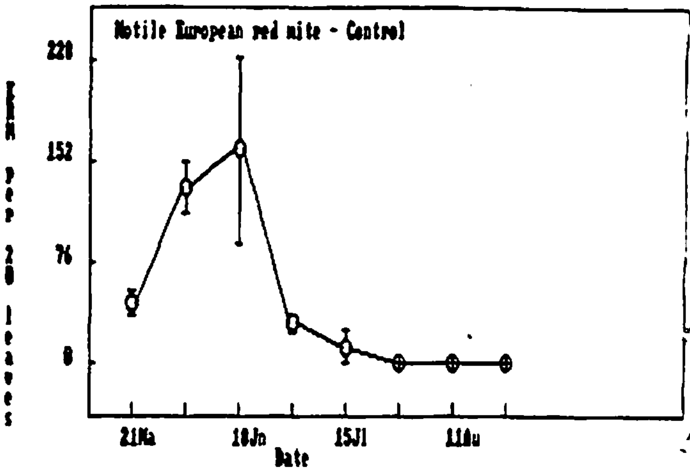
Treatment	lb ai/A	21 May	3 June	18 June	2 July	15 July	29 July	11 Aug	25 Aug
DPX-EY059 50 g/L EC	0.025	1.6a	2.3a	42.4b	32.6a	39.8b	50.6a	18.3a	10.4a
DPX-EY059 50 g/L EC	0.050	1.9a	3.0a	27.5ab	30.0a	39.4b	19.8b	2.3b	1.9b
DPX-EY059 50 g/L EC	0.100	1.6a	2.0a	13.9a	18.7a	14.0a	5.9c	2.1b	3.4b
Control		6.2b	4.9a	79.0c	72.4b	115.8c	19.7b	3.9b	7.8ab

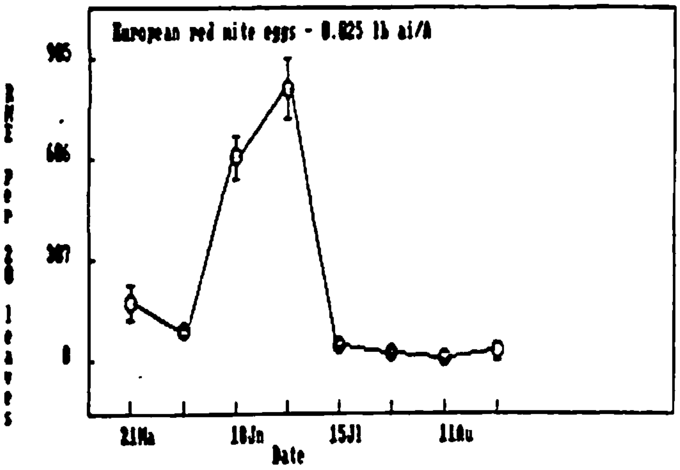
*Data transformed for analysis ($\sqrt{x + 0.5}$). Means in a column followed by the same letter are not significantly different (DMRT, alpha = 0.05).

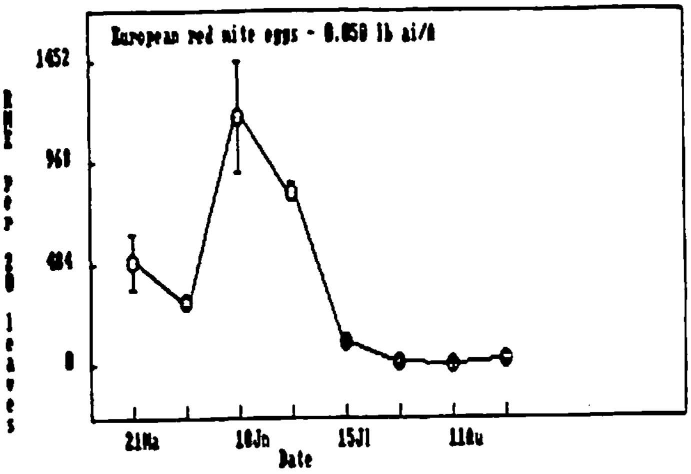

Motile European red mite - 0.025 lb ai/A
ERM per 20 leaves
66
44
22
0
21Ma
18Jn
15Jl
11Au
Date

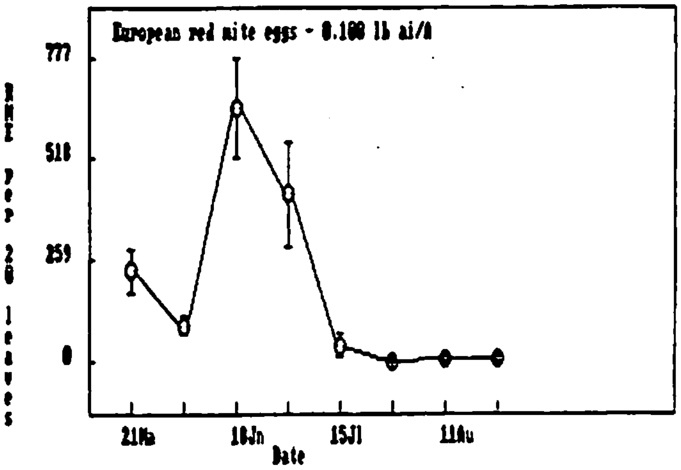

Motile European red mite - 0.050 lb ai/A
ERM per 20 leaves
78
52
26
0
21Ma
18Jn
15Jl
11Au
Date

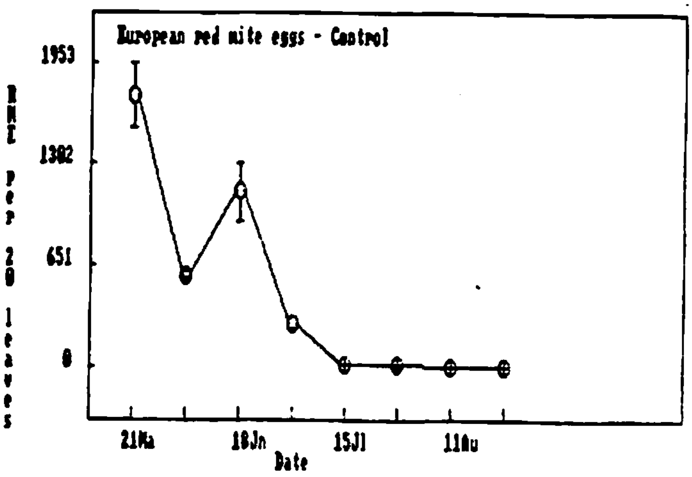

Motile European red mite - 0.100 lb ai/A
ERM per 20 leaves
36
24
12
0
21Ma
18Jn
15Jl
11Au
Date

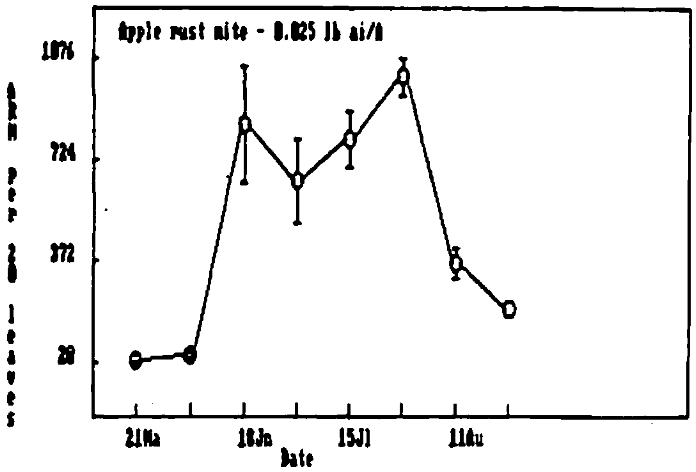

Motile European red mite - Control
ERM per 20 leaves
228
152
76
0
21Ma
18Jn
15Jl
11Au
Date

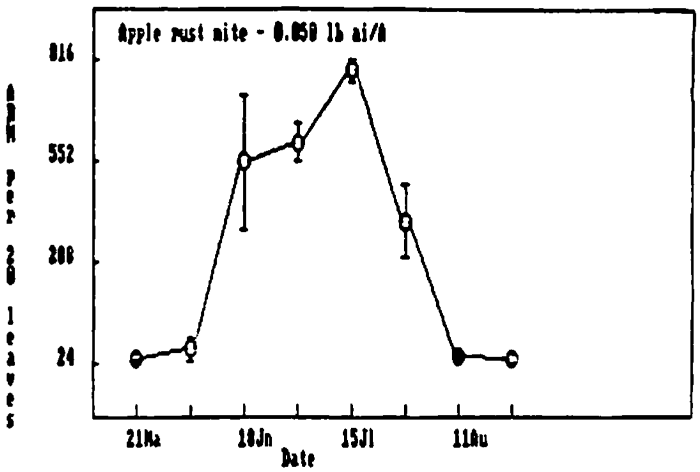

European red mite eggs - 0.025 lb ai/A
909
606
303
0
RME per 20 leaves
21Ma
18Jn
15Jl
11Au
Date

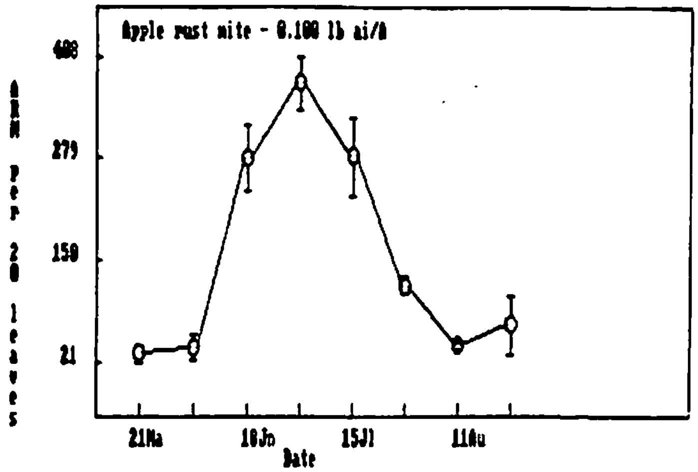

European red mite eggs - 0.050 lb ai/A
1452
968
484
0
RME per 20 leaves
21Ma
18Jn
15Jl
11Au
Date

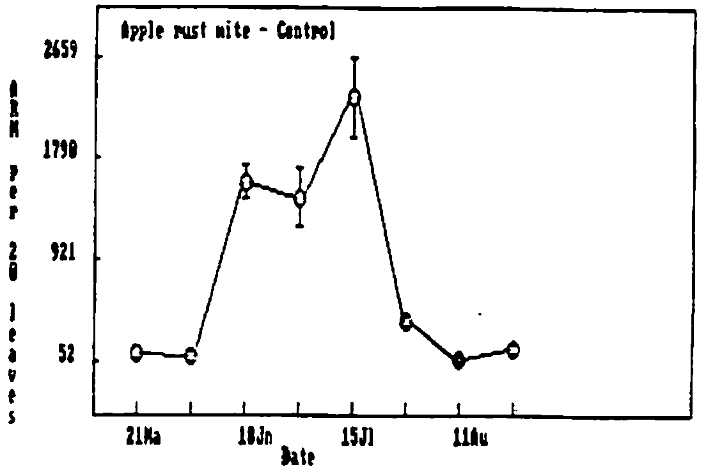

European red mite eggs - 0.100 lb ai/A
777
518
259
0
RME per 20 leaves
21Ma
18Jn
15Jl
11Au
Date


European red mite eggs - Control
1953
1302
651
0
RME per 20 leaves
21Ma
18Jn
15Jl
11Au
Date


Apple rust mite - 0.025 lb ai/A
1076
724
372
20
ARM per 20 leaves
21Ma
18Jn
15Jl
11Au
Date


Apple rust mite - 0.050 lb ai/A
816
552
288
24
ARM per 20 leaves
21Ma
18Jn
15Jl
11Au
Date


Apple rust mite - 0.100 lb ai/A
408
279
150
21
ARM per 20 leaves
21Ma
18Jn
15Jl
11Au
Date


Apple rust mite - Control
2659
1790
921
52
ARM per 20 leaves
21Ma
18Jn
15Jl
11Au
Date

Grape Root Borer Flight Periods - 1987

D. G. Pfeiffer and J. C. Killian
Virginia Polytechnic Institute & State University,
Blacksburg VA 24061, and
Mary Washington College, Fredericksburg VA 22401

The grape root borer (GRB) is a potentially serious pest of grapes in the southeastern United States. This species is more likely to be encountered in Virginia as vineyards in the state age. In 1986 a pheromone trapping program was initiated across the range of GRB using a mixture of (E,Z)-2,13-octadecadienyl acetate (99%) and (Z,Z)-3,13-ODDA (1%) (Snow et al. 1987).

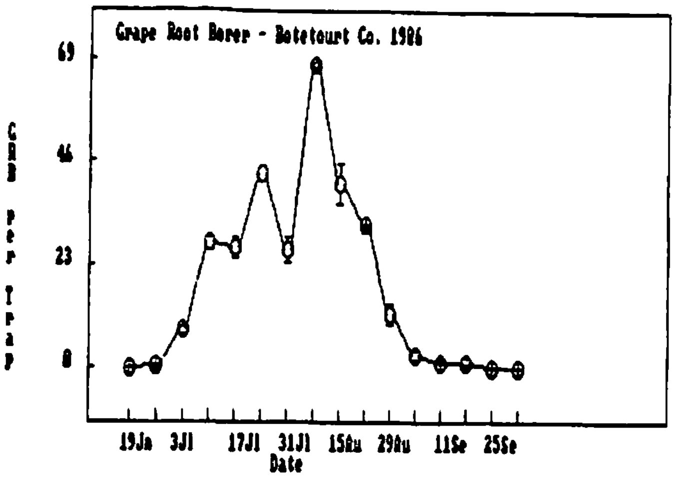
Seasonal flight data was obtained for the second year in 1987. Virginia vineyards were the same as those used in the 1986 survey, in Botetourt and Stafford Counties. Lures with GRB pheromone were obtained from the Southeastern Fruit & Tree Nut Research Laboratory (USDA-ARS, Byron, GA). Traps were put into vineyards on April 1. Traps were checked weekly until catches approached 30 males per trap, when twice weekly sampling was used; at higher levels traps become saturated and catch fewer moths (Pfeiffer and Killian 1986). As catchs dropped again to lower levels, weekly trap servicing resumed. Monitoring was ended at the end of GRB activity, i.e. when two consecutive weeks of no GRB catch occurred.

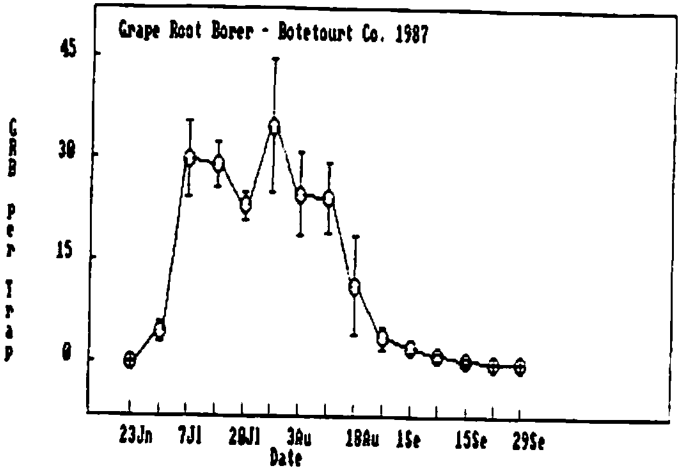
First male catch in Botetourt Co. occurred on 30 June, preceding that in Stafford Co. by eight days (compared to 14 days in 1986). Male flight peaked in late July (similar to 1986 results) and continued into early-mid September. Figures are included illustrating flight acivity in both vineyards in 1986 and 1987. Knowledge of phenology remains crucial to control measures taken against this species.

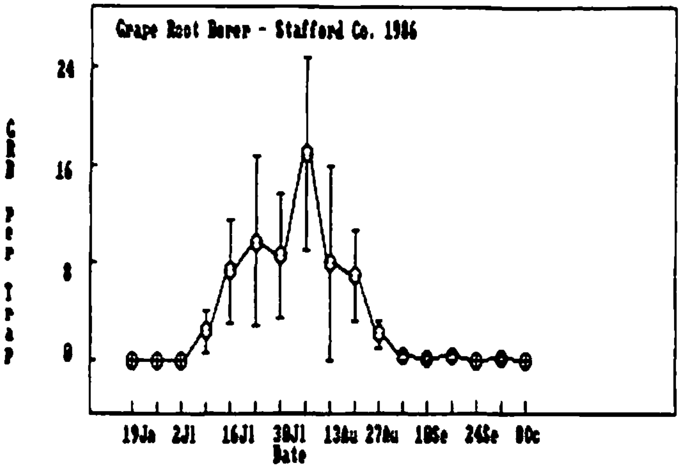
REFERENCES CITED

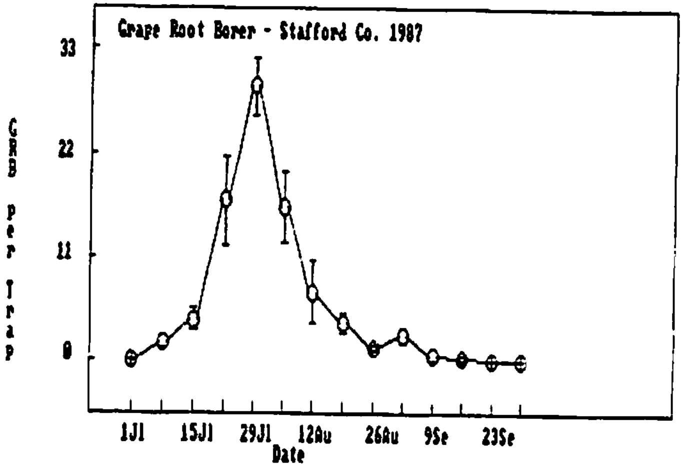
Pfeiffer, D. G., and J. C. Killian. 1986. Grape root borer flight activity in Virginia. Proc. 62nd Cumberland-Shenandoah Fruit Workers Conf., Harpers Ferry WV. Nov. 20-21.

Snow, J. W., M. Schwarz, and J. A. Klun. 1987. The attraction of the grape root borer, Vitacea politiformis (Harris) (Lepidoptera: Sesiidae) to (E,Z)-2,13 octadecadienyl acetate and the effects of related isomers on attraction. J. Entomol. Sci. 22: 371-374.


Grape Root Borer - Botetourt Co. 1986
69
46
23
0
GRB per Trap
19Jn
3Jl
17Jl
31Jl
15Au
29Au
11Se
25Se
Date


Grape Root Borer - Botetourt Co. 1987
45
30
15
0
GRB per Trap
23Jn
7Jl
20Jl
3Au
18Au
1Se
15Se
29Se
Date


Grape Root Borer - Stafford Co. 1986
24
16
8
0
GRB per Trap
19Jn
2Jl
16Jl
30Jl
13Au
27Au
10Se
24Se
8Oc
Date


Grape Root Borer - Stafford Co. 1987
33
22
11
0
GRB per Trap
1Jl
15Jl
29Jl
12Au
26Au
9Se
23Se
Date

Douglas G. Pfeiffer and
Richard P. Marini
Department of Entomology
VPI&SU
Blacksburg, VA 24061
(703) 961-4183

APPLE: Malus x domestica (Borkhausen)

APPLE, KELTHANE PHYTOTOXICITY TRIAL, 1987: Two preparations of Kelthane 4F (dicofol) were compared with Plictran 50W (cyhexatin) and an untreated control in a phytotoxicity trial utilizing six apple cultivars: 'Delicious', 'Golden Delicious', 'Stayman', 'Winesap', 'Rome', and 'York'. Kelthane 4F 86006 and Kelthane 4F 86038 were applied at the rate of 3 lb ai/A (3 qt form./A). Plictran 50 W was applied at the rate of 6.0 oz ai/A (12 oz form./A). Spray dates wered 13 May (petal fall) and 27 May. Sprays were applied in 100 gal/A using a truck-mounted Swanson airblast sprayer to sections of row consisting of five trees per cultivar. Fifty fruit and twenty shoots per tree were examined for signs of phytotoxicity. Sample dates were 18 May (5 days after first application), 1 June (golf ball-sized fruit), and harvest. Harvest sample dates varied with cultivar: 'Delicious' - 3 Sep, 'Golden Delicious' - 10 Sep, 'Stayman' - 9 Oct, 'Winesap' 16 Oct, 'York' - 20 Oct, and 'Rome' 21 Oct.

On the first sampling date no phytotoxicity was noted. On 1 June, no fruit damage was noted except for a heavy russet on all treatments on 'Golden Delicious' (including control); this russet was not further quantified at this time. An interveinal yellowing was seen on leaves. Significant differences among treatments were detected in some cultivars (Table 1). Both Kelthane 4F preparations showed leaf yellowing on 'Golden Delicious'. The 'Stayman' plot had more yellowing on trees treated with Kelthane 4F 86038 than with Kelthane 4F 86006 or the control (Plictran 50W was intermediate). Conversely, more yellowing was seen on Kelthane 4F 86006-treated 'Winesap' and 'Rome' trees than any other treatment. The interveinal yellowing was a transitory phenomenon; none was seen on the harvest sample dates.

Fruit harvest data are presented in Table 2. 'Golden Delicious' fruit were heavily russeted in all treatments (about 30% of each fruit's area covered, from 0-100%). Russeted fruit were counted to determine any treatment differences; no differences were detected. Color defects counted in other cultivars consisted of tiny brown flecking in the calyx area of the fruit. These flecks were difficult to see if fruits had developed red color in their lower portion (this was especially true in the 'Winesap' plot). A few significant differences were seen, although there were no consistent trends across cultivars. More 'Winesap' fruit had flecking on trees treated with Plictran 50W than with

Kelthane 4F 86038 or control (Kelthane 4F 86006 was intermediate). 'Rome' trees treated with Kelthane 4F 86006 had less flecking than control trees. Kelthane 4F 86038 and Plictran 50W were intermediate.

The brown flecking seen in five of the cultivars was inconspicuous, usually consisting of less than 1% of total fruit area. Flecking did not seem to be due only to Kelthane or Plictran sprays since it was common also in the control treatment (although often at lower levels). Other factors may be involved such as drying time of spray deposits or dew. The control used was an untreated control. For future studies on phytotoxocity and fruit finish, a water control should be used.

Table 1. Shoots with interveinal yellowing per 20 shoots (1 June)*

				Cultivar			
Treatment	ai/A	‘Delicious’	‘Golden Delicious’	‘Stayman’	‘Winesap’	‘York’	‘Rome’
Kelthane 4F 86006	3 lb	0.0a	8.2a	0.7a	2.0a	0.0a	8.0a
Kelthane 4F 86038	3 lb	0.0a	5.6a	1.0a	0.0b	0.0a	0.4b
Plictran 50W	12 oz	0.0a	0.0b	0.8ab	0.0b	0.0a	0.0b
Control		0.0a	0.0b	0.7a	0.0b	0.0a	0.0b

*Data transformed for analysis ($\sqrt{x + 0.5}$). Means in a column followed by the same letter are not significantly different (DMRT, alpha = 0.05).

Table 2. Discolored fruit per 50 fruit at harvest*

				Cultivar			
Treatment	ai/A	‘Delicious"	‘Golden Delicious’	‘Stayman’	‘Winesap’	‘York’	‘Rome’
Kelthane 4F 86006	3 lb	17.2a	49.6a	50.0a	8.8ab	1.2a	4.2a
Kelthane 4F 86038	3 lb	11.8a	50.0a	50.0a	6.6a	0.6a	7.0ab
Plictran 50W	12 oz	10.2a	49.4a	50.0a	12.0b	0.8a	7.8ab
Control		13.8a	49.8a	50.0a	6.4a	0.6a	11.2b

*Data transformed for analysis ($\sqrt{x + 0.5}$). Means in a column followed by the same letter are not significantly different (DMRT, alpha = 0.05).

Pheromone Disruption of Codling Moth - 1987

D. G. Pfeiffer[1], J. C. Killian[2],
R. L. Horsburgh[3] and K. S. Yoder[3]
[1]Virginia Polytechnic Institute & State University
Blacksburg, VA 24061
[2]Mary Washington College, Fredericksburg, VA 22401
[3]Winchester Fruit Research Laboratory, Winchester, VA 22601

Introduction: Codling moth, *Cydia pomonella* (L.), is one of the more important arthropod pests of apple worldwide. Sprays directed at this pest disrupt natural controls for a variety of other insects and mites. Control of this species by pheromone permeation has been attempted by earlier workers using a variety of dispensers (reviewed by Rothschild 1982).

This study was undertaken to determine efficacy of pheromone permeation as a control tactic of codling moth in Virginia.

Materials and Methods: The study site was a 7-acre block of apples (mixed cultivars) at the Winchester Fruit Research Laboratory. Dispensers containing (E,E)-8,10-dodecadien-1-ol were placed in trees at the rate of 100 per acre on 12 May 1987. This was five days after first male capture in a pheromone trap. Four commercially available pheromone traps were placed in this block, a commercial apple block, and an abandoned apple block, and were checked weekly. On 20 July, fruit damage was evaluated on 'Golden Delicious' trees by examining 20 fruit per tree from five trees in the periphery and five trees in the interior of the pheromone and commercial blocks. Five trees total from the abandoned block were sampled because of a lack of trees with sufficient fruit. Fruit were sliced open in an effort to distinguish between tunnels made by codling moth and those made by Oriental fruit moth [*Grapholitha molesta* (Busck)]. The criterion used was that if the tunnel proceeded to the core it was created by codling moth; if the tunnel wandered around the flesh of the fruit, it had been caused by Oriental fruit moth.

Results and Discussion: Fruit damage data are presented in Table 1. An unacceptable level of fruit damage occurred in the pheromone block; fruit in the commercial block were relatively clean. There are two possible reasons for the high level of damage in the pheromone block. One is that the pheromone dispensers did not provide sufficient disruption of olfactory communication. This is supported by the fact that male codling moths were detected in the pheromone traps in this block (males were apparently capable of finding point sources of pheromone). The codling moth population had been high in the previous season. If damage exceeds 10% of the fruit, pheromones alone will probably be insufficient for control in the following year (P. Kirsch, Biocontrol, Ltd., Davis CA, pers. comm.).

Another factor which complicates analysis is the possibility of Oriental fruit moth causing some of the damage attributed to codling moth. Oriental fruit moth damage to twigs was found in the pheromone block on 8 June. Only one tunnel was identified as having been caused by Oriental fruit moth. Only one larva was found in the fruit samples; it was Oriental fruit moth. Although Oriental fruit moth possibly created some of the damage, the presence of codling moths in the pheromone traps indicates that there was insufficient disruption of olfactory communication.

REFERENCE CITED

Rothschild, G. H. L. 1982. Suppression of mating in codling moths with synthetic sex pheromone and other compounds. p. 117-134. In: A. F. Kydonieus and M. Beroza (eds.). Insect Suppression with Controlled Release Pheromone Systems. Vol. II. CRC Press, Boca Raton, Florida. 312 p.

Table 1. Evaluation of fruit collected in three apple blocks at Winchester Va., based on 20 fruit from each of five trees.[1]

Treatment	Clean	Codling Moth	Oriental Fruit Moth	Stings
Pheromone				
Periphery	8.4(1.9)	4.0(1.1)	0.2(0.2)	7.4(1.2)
Interior	14.8(1.4)	1.8(0.8)	0.0(0.0)	3.4(1.1)
Commercial				
Periphery	19.8(0.2)	0.0(0.0)	0.0(0.0)	0.2(0.2)
Interior	19.8(0.2)	0.0(0.0)	0.0(0.0)	0.2(0.2)
Abandoned	14.8(0.8)	2.8(0.8)	0.0(0.0)	2.4(0.7)

[1] Numbers in parentheses represent standard errors of means.

THE FALSE CHINCH BUG AS A LATE SEASON PEACH PEST

NOT FOR PUBLICATION

Dean Polk
Fred C. Swift
Rutgers Fruit Research Center
RD #2, Box 38
Cream Ridge, NJ 08514

During the 1986 growing season, many New Jersey peach growers experienced high levels of catfacing injury. Injury seen in 1987 was at a much lower level. Tarnished plant bugs, green stink bugs, brown stink bugs, dusky stink bugs and false chinch bugs were all seen on peaches the past two seasons. The false chinch bug fed on peach only during the final week of August and early September.

The false chinch bug (Nysius niger Baker, fam. Lygaeidae) has been a common insect in New Jersey peach orchards during late August through September and October, but had not been previously observed feeding on fruit.

The North American species of N. niger has often been confused with the European species N. ericae and often synonymized with N. angustatus. An additional North American species, N. raphanus has also been called the "false chinch bug", Ashlock (1977 and pers. comm.).

During 1986 some late season varieties experienced up to 40% damage by this insect. Very little injury was present in 1987. The most heavily injured fruit were in blocks of Autumnglo, Sweet Sue and Rio-Oso-Gem. Since fruit feeding occurred during final swell and just prior to harvest, the traditional deformed catfacing appearance was not evident. Instead, injured fruit was characterized by having:

1) Several to many small "water soaked" feeding areas
2) Minute bleeding spots in a number of these areas
3) Shallow flesh injury to 1mm. deep.

These insects would often feed in groups of up to a dozen or more at the same time.

During this past season a small laboratory insecticide trial was initiated for this pest:

Materials and Methods

Insects were exposed to 2 rates each of azinphos-methyl, carbaryl and permethrin. The test consisted of 4 replicates and 7 treatments, arranged in a randomized complete block design. Replicates 1 and 2 were treated August 19, infested with false chinch bug August 19, and counted August 20. Replicates 3 and 4 were treated August 19, infested August 20, and counted August 21.

Treatments were applied in the following manner: Individual peaches were dipped in an insecticide mixture, allowed to dry, and then placed in 9 1/2 oz plastic cups, one peach per cup. False chinch bugs, which had been collected earlier and stored in paper bags in a cooler at circa 30°C, were poured into an aluminum foil-lined pan of ice. The chinch bugs, unable to move, were picked one by one out of the other insects and grass litter and set onto the peaches, 5-8 chinch bugs per cup. The cups were then covered with one layer of tissue paper, which was held on with a rubber band. The test was stored in an incubator set at 25°C and the number of live and dead chinch bugs were counted 24 hours later.

Data were transformed to arcsine $\sqrt{X}$ and subjected to an analysis of variance and comparison of means. In Fig. 1, means followed by the same letter are not significantly different at alpha=0.05, DMRT.

Results

FIGURE 1
Treatment and amount formulation/100 gal
% dead false chinch bugs

1. Sevin 50W 2 lb	89 a
2. Sevin 50W .5 lb	31 b
3. Guthion 50W .5 lb	27 b
4. Guthion 50W .13 lb	18 b
5. Ambush 25W .4 lb	100 a
6. Ambush 25W .1 lb	96 a
7. Control — —	14 b

References cited—

Ashlock, P. D. 1977. New records and name changes of North American Lygaeidae (Hemiptera:Heteroptera:Lygaeidae). Proc. Entomol. Soc. Wash. 79(4):575-582.

Ashlock, P. D. 1986. Personnal Communication, Department of Entomology, University of Kansas, Lawrence, Kansas.

Not for Citation

Control of European red mites with *Typhlodromus longipilus* and two other phytoseiids

Van R. Starner and Fred C. Swift
Rutgers Fruit Research and Development Center
Cream Ridge, NJ 08514

Abstract: In a walk-in growth room study *Typhlodromus longipilus* Nesbitt significantly reduced established populations of the European red mite, *Panonychus ulmi* (Koch), and disrupted the age-class structure of *P. ulmi* populations by "selectively" feeding on immature mites. *T. longipilus* survived and reproduced with *P. ulmi* as its sole food source.

Introduction: A significant aspect of pest control which is presently a severe problem in NJ apple orchards is control of the European red mite (ERM), *Panonychus ulmi*, the most important indirect pest of apples in the state. In recent years NJ growers have experienced increasing difficulties controlling ERM with conventional chemicals, due primarily to the buildup of mite resistance to most miticides. In addition, biological control of ERM with the phytoseiid mite *Amblyseius fallacis* and the coccinellid beetle *Stethorus punctum* has not been reliable.

For these reasons we began a research project to study the predatory ability of another phytoseiid mite, *Typhlodromus longipilus*, which has been found in numerous apple tree surveys of mite fauna in the eastern and midwestern U.S. (Specht 1959 and 1968, Horsburgh and Asquith 1968, Poe and Enns 1969, Zack 1969, Knisley and Swift 1972, Berkett and Forsythe 1980, Whalon and Croft 1986, Strickler et al. 1987). Using ERM as prey, we are studying *T. longipilus* in comparison with *A. fallacis* and *Typhlodromus occidentalis*, another phytoseiid mite which has been successfully exploited as a predator of pest mites on apples on the west coast (Hoyt 1969).

We designed the present experiment to examine predator/prey interactions on potted apple rootstocks in a walk-in growth room. The primary objectives of the study were to evaluate the effect of *T. longipilus* on established ERM populations, and to determine the reproductive capability of this phytoseiid with ERM as the sole food source.

Materials and Methods: The experiment was conducted in 1987 in a walk-in growth room constructed with a combination of florescent (400 watt cool white) and incandescent (60 watt) lights and an air conditioning unit (11,500 BTU) to provide temperature control. Lights were timed to provide a 14L:10D light cycle. During the study, hygrothermograph records showed that daily temperature ranged from 24-29°C and relative humidity from 50-60%.

Experimental units were one-yr-old EMLA-7 apple rootstocks (Oregon Rootsock, Inc., Woodburn, OR 97071) planted individually in Pro-Mix BX soil (Premier Brands, Inc., New Rochelle, NY 10801) in 15.2 cm plastic pots. On 7 July each of 120 plants of approximately equal size was trimmed to 12 leaves, sprayed for powdery mildew control with Bayleton 50W + Triton B-1956 (0.15 gr + 0.15 ml/l), and watered with 250 ml of a 20-10-20 fertilizer solution.

Two days later, 25 adult female ERM from a non-sprayed 'Red Delicious' tree in an experimental orchard at the research center were transferred to each plant with fine camel's hair brushes. Mites were released 2/leaf with the 25th mite released about mid-plant. Each plant stem was circled with tangletrap near the soil surface to prevent mite escape. Plants were placed in plastic-lined wooden trays (four plants/tray) and positioned so that leaves of adjacent plants did not touch or overlap. Throughout the study plants were watered as needed.

Trays were placed into six blocks (five trays/block) on two growth room benches (three blocks/bench). Four predator treatments and five sampling dates were randomly assigned to plants within trays and trays within blocks, respectively. Treatments consisted of no predators (control), T. longipilus, A. fallacis and T. occidentalis.

On 13 July five gravid female predators of each species were transferred to appropriately labelled plants with fine camel's hair brushes. Predators were randomly released onto leaves from the top to the bottom of the plants. Predatory mites were obtained from incubator-reared, petri-dish colonies with Tetranychus urticae as the food source, as described by Knisley and Swift (1971). T. longipilus colonies were initiated from mites found on strawberries in NJ, A. fallacis from apple trees at the fruit research center, and T. occidentalis from lab colonies at the Univ. of CA, Berkeley.

ERM and predatory mite populations were evaluated on each of five, weekly sampling dates (beginning 20 July) by examining each leaf of six plants/treatment under a stereo microscope and counting absolute numbers of all stages of prey and predator. As in a similar study by Collyer (1964), data on different dates were independent of all other dates. To study the age-class structure of ERM populations, we calculated percentages of mites in egg, immature, male and adult female stages. Data were analyzed on a mite/plant basis for each sample date using analysis of variance (GLM) and the Ryan-Einot-Gabriel-Welsh Multiple F Test for mean separation (SAS Institute, Inc., Cary, N.C.).

Results and Discussion: Data for the A. fallacis treatment were not included in the analysis since this predator did not prosper under these test conditions, and ERM populations were the same or higher than on control plants. In addition, several plants from other treatments were contaminated by T. urticae, another red tetranychid mite or tydeid predatory mites, and data for these plants were deleted from the analysis.

T. longipilus significantly reduced ERM populations compared to the control, except on the 10 August sample date (Table 1). On this sample date there was an unusually high number of ERM eggs on T. longipilus plants (853/plant) compared to control plants (445/plant). On every other date T. longipilus significantly reduced both egg and motile stages (immatures, males, adult females) of ERM. This peculiarity in the data can not be explained by low predator numbers since on this sample date the T. longipilus population was at its highest level during the study (Table 2). As indicated in Table 1, T. occidentalis significantly reduced ERM populations on each sample date.

Another indication of ERM control by these phytoseiids was the condition of the plants. By the fourth sample date, leaves on control plants were bronzing due to excessive mite feeding, while leaves on plants with Typhlodromus predators were still green and healthy.

ERM age-class structure data are presented in Figure 1 for the control treatment and both species of Typhlodromus. The fact that predators disrupted ERM age-class structure is clearly evident.

In the absence of predators (control), the data show a normal progression of ERM population development over time: from a good mixture of stages on sample date 1 to a preponderance of eggs a week later, to an increase in motile stages on sample dates 3 and 4, and finally a return to a large percentage of eggs on the last sample date. However this normal progression of development was disrupted by both predators, since on each sample date ERM populations, in the presence of phytoseiids, consisted largely of eggs and low percentages of motile stages.

These data indicate that by sample date 1 (11 days after plants were infested with adult female ERM) about 80% of the ERM population on plants of each treatment consisted of eggs and nymphs. But both predators altered the percentage of each ERM stage by "selectively" feeding on immature mites, and possibly "avoiding" eggs. The same trend is apparent throughout the test. On each sample date there was a statistically larger percentage of eggs and smaller percentage of nymphs on plants with either predator compared to plants with no predators. Treatments also differed statistically in the percentages of male and female ERM, but the trend was not as consistent as with eggs and nymphs.

The data presented in Table 2 show that both phytoseiid predators survived and reproduced with ERM as their sole food source. The study was initiated with five predators of a particular species per plant, so these data indicate substantial population growth for both species. Statistically there was no difference between T. longipilus and T. occidentalis population levels on any sample date.

Conclusions: In summary, the primary conclusions drawn from this study were three-fold. (1) T. longipilus significantly reduced established ERM populations. (2) T. longipilus disrupted the age-class structure of ERM populations by "selectively" feeding on immature mites. (3) T. longipilus survived and reproduced with ERM as its sole food source. These three conclusions can also be drawn for T. occidentalis.

REFERENCES CITED

Berkett, L. P. and H. Y. Forsythe, Jr. 1980. Predaceous mites (Acari) associated with apple foliage in Maine. Can. Entomol. 112:497-502.

Collyer, E. 1964. The effect of an alternate food supply on the relationship between two Typhlodromus species and Panonychus ulmi (Koch) (Acarina). Entomol. Exp. et Appl. 7:120-124.

Horsburgh, R. L. and D. Asquith. 1968. Initial survey of arthropod predators of the European red mite in south-central Pennsylvania. J. Econ. Entomol. 61:1752-1754.

Hoyt, S. C. 1969. Integrated chemical control of insects and biological control of mites on apple in Washington. J. Econ. Entomol. 62:74-86.

Knisley, C. B. and F. C. Swift. 1971. Biological studies of Amblyseius umbraticus (Acarina: Phytoseiidae). Ann. Entomol. Soc. Am. 64:813-822.

Knisley, C. B. and F. C. Swift. 1972. Qualitative study of mite fauna associated with apple foliage in New Jersey. J. Econ. Entomol. 65:445-448.

Poe, S. L. and W. R. Enns. 1969. Predaceous mites (Acarina: Phytoseiidae) associated with Missouri orchards. Trans. Missouri Acad. Sci. 3:69-82.

Specht, H. B. 1959. The effects of certain orchard chemical sprays on insects and mite populations and a survey of predaceous mites belonging to the genus Typhlodromus (Phytoseiidae) in New Jersey. Ph.D. Thesis, Rutgers University, New Brunswick, NJ. 163 pp.

Specht, H. B. 1968. Phytoseiidae (Acarina: Mesostigmata) in the New Jersey apple orchard environment with descriptions of spermathecae and 3 new species. Can. Entomol. 100:673-692.

Strickler, K., N. Cushing, M. Whalon and B. A. Croft. 1987. Mite (Acari) species composition in Michigan apple orchards. Environ. Entomol. 16:30-36.

Whalon, Mark E. and Brian A. Croft. 1986. Immigration and colonization of portable apple trees by arthropod pests and their natural enemies. Crop Protection 5:376-384.

Zack, R. E. 1969. Seven species and records of phytoseiid mites from Missouri (Acarina: Phytoseiidae). J. Kansas Entomol. Soc. 42:68-80.

Table 1. Mean number of ERM (all stages[1])/potted apple rootstock[2] on five dates of independent sampling.

Treatment	Sample date				
	Jul 20	Jul 27	Aug 3	Aug 10	Aug 17
Control	686.7a[3]	3281.2a	2002.7a	1228.5a	981.0a
T. longipilus	246.2b	482.6b	306.5b	1053.2a	372.5b
T. occidentalis	327.5b	759.5b	301.7b	360.2b	196.2b

[1] all stages = eggs + immatures + males + adult females
[2] plants/treatment = 6
[3] means within a column followed by the same letter are not significantly different (REGW; 5% level)

Table 2. Mean number of predators (all stages[1])/ERM-infested, potted apple rootstock[2] on five dates of independent sampling.

Treatment	Sample date				
	Jul 20	Jul 27	Aug 3	Aug 10	Aug 17
T. longipilus	17.8	17.6	15.8	28.0	26.3
T. occidentalis	23.2	17.0	21.2	21.8	17.8

[1] all stages = eggs + immatures + adults
[2] plants/treatment = 6

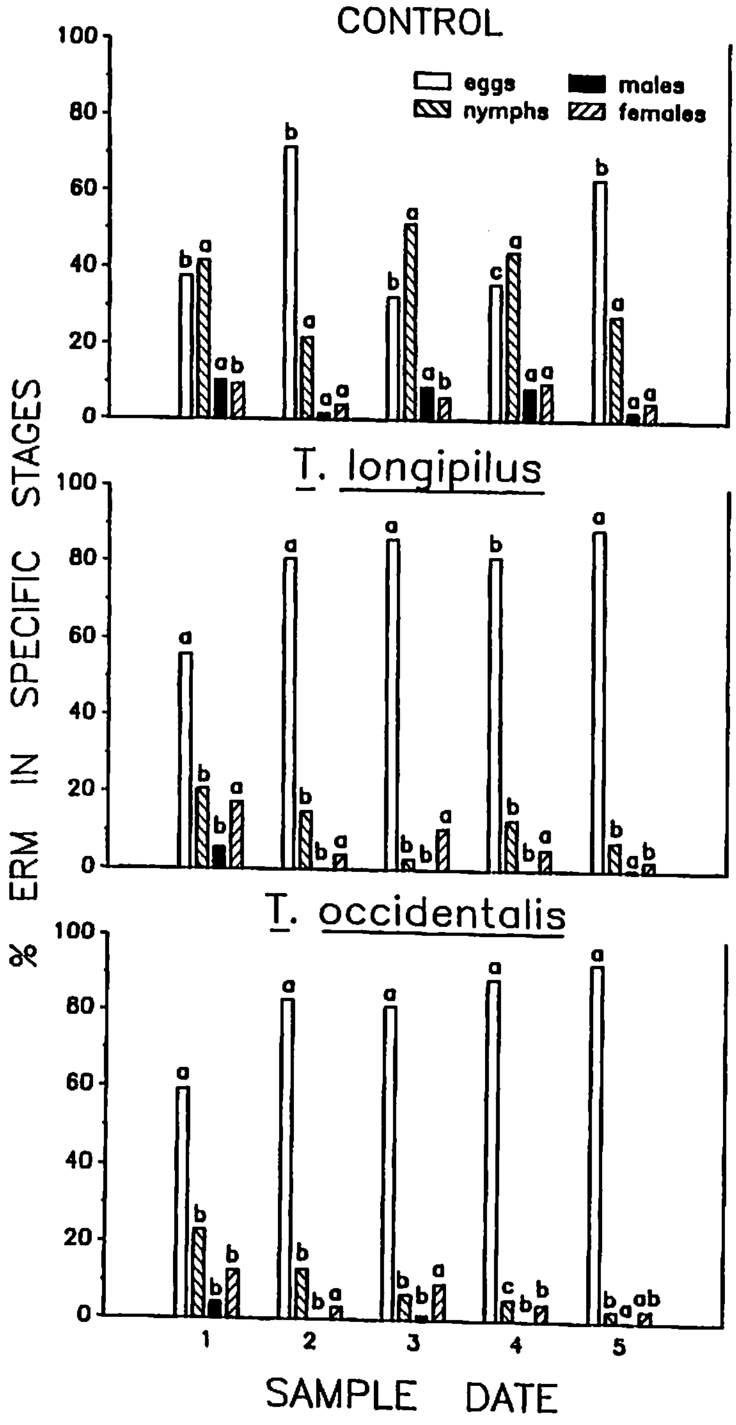


Figure 1. Comparison of age-class structure of ERM populations in the presence of 2 phytoseiid predators vs no predators. Before analysis, % data were transformed to arcsine (sqrt x). Specific age-class bars for each sample date, topped by the same letter, are not significantly different (REGW; 5% level).

Effect of Certain Insecticides on Dispersal of European Red Mite From Apple Trees

Fred C. Swift, Elizabeth J. Herman, and Van Starner
Rutgers Fruit Research & Development Center
Cream Ridge, NJ 08514

Introduction

Hall (1979, 1986), Ifner and Hall (1983) and Penman and Chapman (1983) have suggested that dispersal of mites from pyrethroid-treated foliage may be one of the factors involved in the outbreaks of phytophagous mites following pyrethroid treatments. The objective of this experiment was to determine whether European red mites were more prone to disperse from fenvalerate-treated foliage (Pydrin 2.4 EC) than from foliage treated with carbamate (methomyl-Lannate 1.8 L) or an organophosphate (dimethoate-Cygon 4E).

Materials and Methods

This test was arranged in a split-plot design with 6 replicates and 6 treatments. Treatments 1 and 2 were sprayed with a pyrethroid (Pydrin), treatments 3 and 4 with an organophosphate (Cygon), and treatments 5 and 6 with a carbamate (Lannate). Half of the trees, treatments 2, 4, and 6 were sprayed with a miticide whenever ERM populations built up to numbers that would bronze the leaves. Treatments were sprayed until runoff using a hydraulic sprayer equipped with a handgun and operated at 300 psi. Insecticides were applied at petalfall (May 7), and 1st through 5th cover (May 27, June 12, June 25, July 11, and August 25). Thiodan was added to all treatments on June 12 and July 11 to control an outbreak of rust mites interfering with the test. Miticides were applied at 1/2-inch green (April 4 - Oil, 2 gal/100), and 3 later dates (June 5, July 7, and August 25 - Plictran 5L, 95 ml/100). For disease control the orchard was sprayed with Captan and Polyram as needed.

Dispersal rates of ERM were measured with sets of 5 microscope slides covered with vaseline on one side, placed in the center of each tree (about 7 feet high) in a square wire cage tied to a wooden platform. The platform was not touching any foliage. In the cage, the slides were fastened to the walls facing north, east, south, and west, with the vaseline covered sides towards each other. The 5th slide was fastened, vaseline side up, to the floor in the center of the cage. Slides were changed once a week from June 10 to September 10, and all stages of ERM were counted with the aid of a stereomicroscope.

ERM were also measured on the leaves of the trees once a week from May 14 to September 10. Fifty leaves per tree were picked; one `old' leaf and one `new' leaf from 25 terminals per tree. Old and new leaves were kept separate from each other; ERM from the sets of 25 leaves were brushed onto glass plates covered with Triton B-1956, and all stages were counted using a stereomicroscope.

Mitedays were calculated using the following formula: Mitedays = MD1 + ((m1 + m2)/2 X Y), where MD1 = mitedays already accumulated, m1 = number of ERM/leaf on a given counting date, m2 = ERM/leaf on the next counting date after m1, and Y = number of days between m1 and m2.

Data were subjected to an analysis of variance, and LSD's were calculated for differences between subplot treatments for the same main plot treatment.

Results and Discussion

Only the data for the Lannate- and Pydrin-treated trees, without mite control, is shown since these data are the most relevant to the objective of the experiment. ERM populations built up significantly earlier in the Lannate-treated trees (Fig. 1) and reached their high point on June 19. One week later the ERM reached their maximum density on the Pydrin-treated trees (Fig. 1). Çumulative mite days for the two treatments closely paralleled each other (Fig. 2). However, dispersal from the Pydrin-treated trees was significantly greater on June 29, July 6, 13, 20 and 27, and August 3 and 10th (Fig. 3). Thus cumulative dispersal from the Pydrin trees greatly exceeded that from the Lannate-treated trees over the course of the summer (Fig. 4). From these data we conclude that the use of the pyrethroid, Pydrin, would tend to disperse ERM throughout an orchard but we do not know whether the net effect of this phenomenon would be to increase or decrease the total orchard population.

Literature Cited

Hall, F. R. 1979. Effects of synthetic pyrethroids on major insect and mite pests of apples. J. Econ. Entomol. 72: 441-446.

Hall. F. R. 1986. A summary of research on synthetic pyrethroids and mites in the apple orchard ecosystem. Ohio Agricultural Research and Development Center, Research Circ. 290: 49-51.

Iftner, D. C. anh F. R. Hall. 1983. Effects of fenvalerate and permethrin on Tetranychus urticae Koch (Acari: Tetranychidae) dispersal behavior. Environ. Entomol. 12: 1782-1786.

Penman, D. R. and R. B. Chapman. 1983. Fenvalerate induced distributional imbalances of two-spotted spider mite on bean plants. Entomol. Exp. Appl. 33: 71-78.

Figure 1

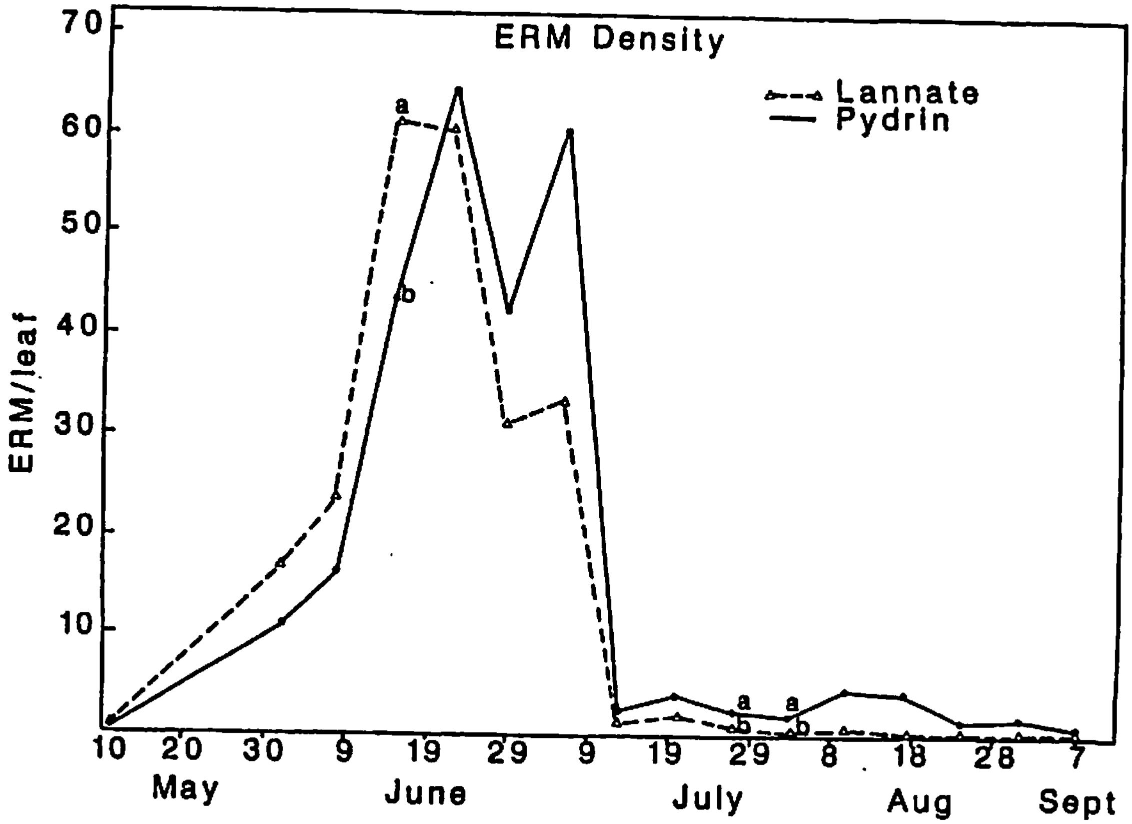


Figure 2

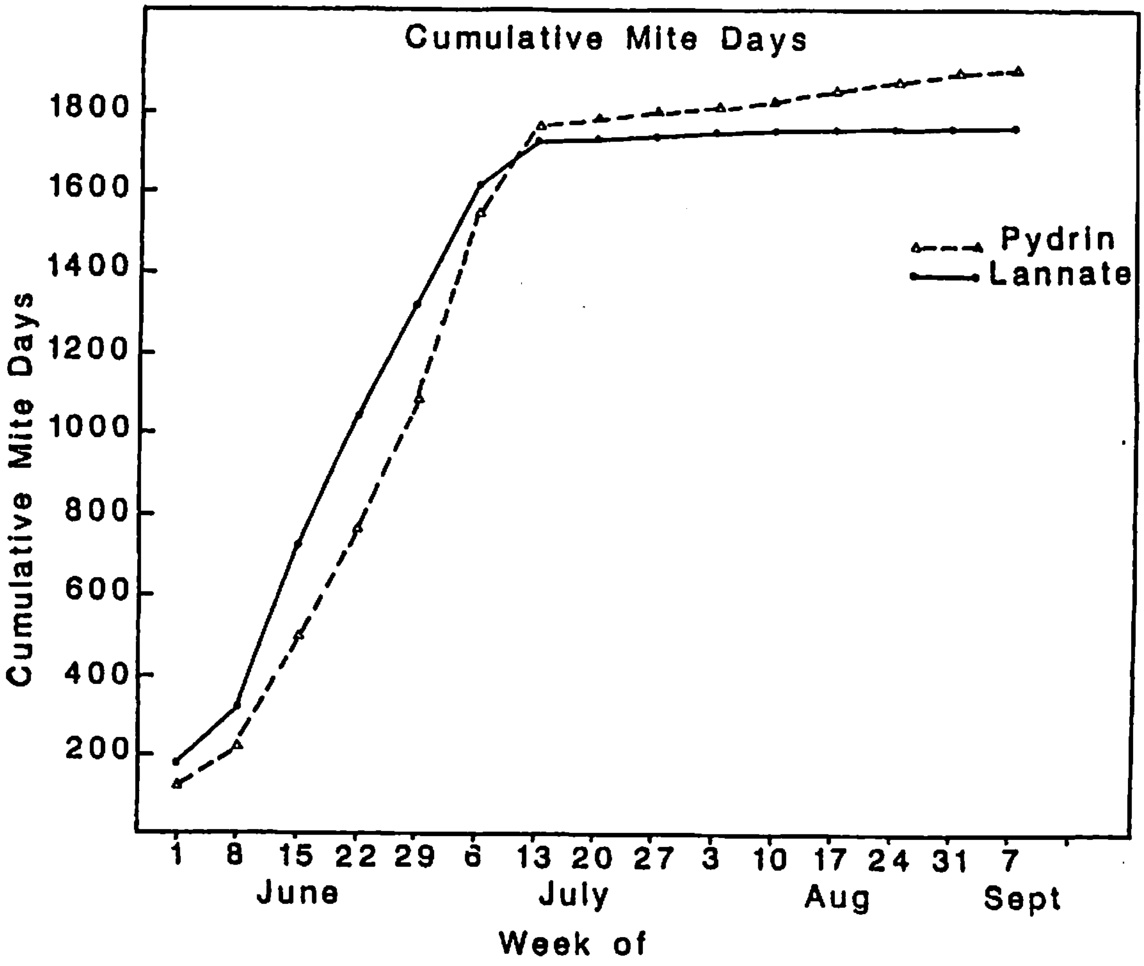


Figure 3

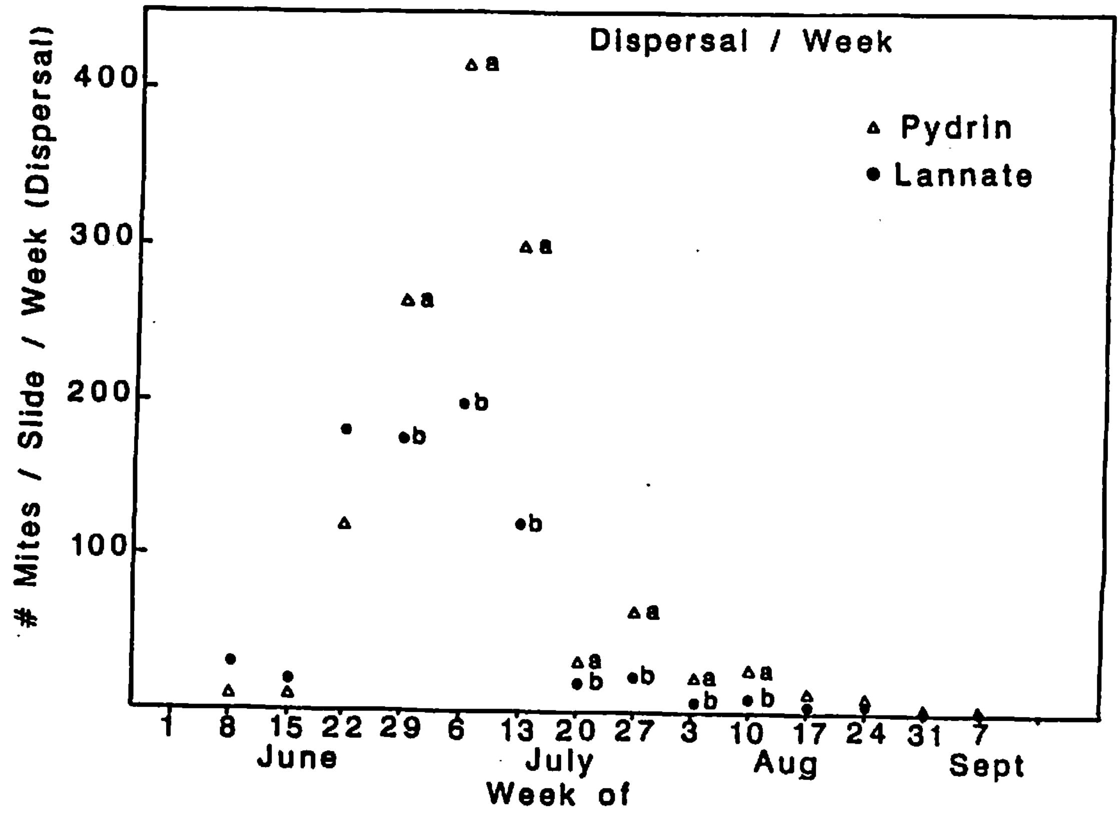
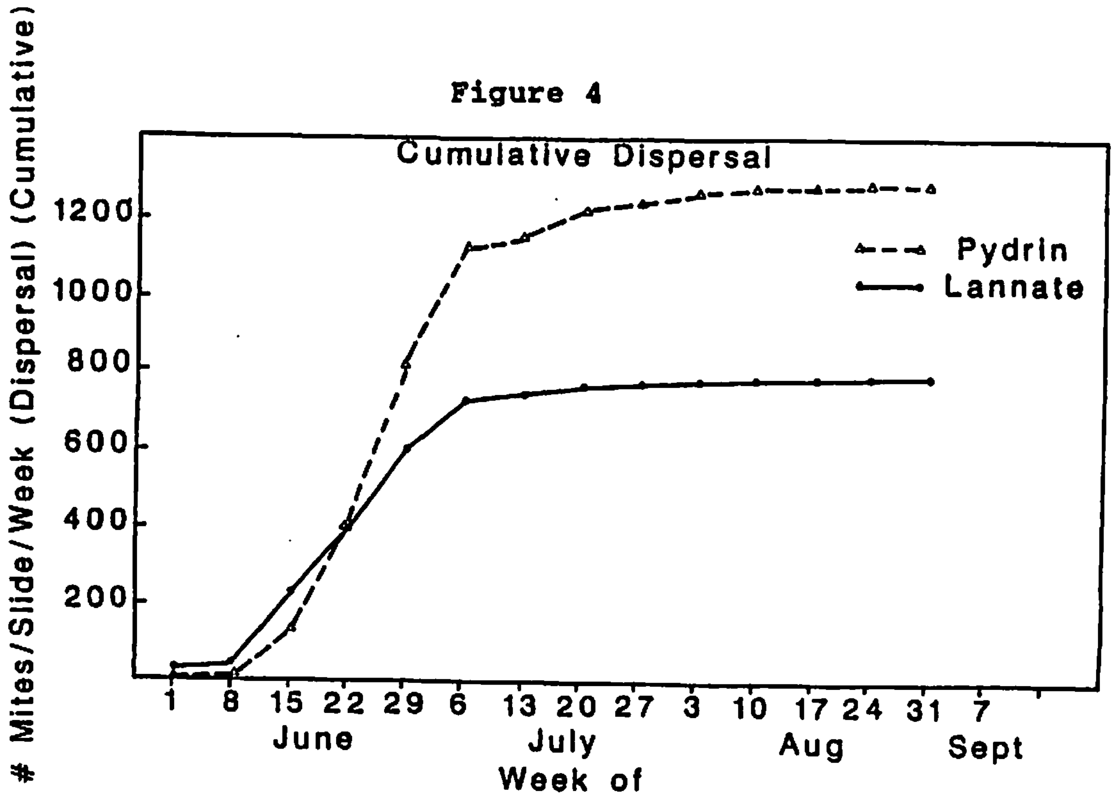


Figure 4



Diapause Development and Hatch of Overwintering Eggs of European Red Mite

Fred C. Swift and Elizabeth J. Herman
Rutgers Fruit Research & Development Center
Cream Ridge, NJ 08514

Introduction

Throughout its range the European red mite (ERM) overwinters in the egg stage on the bark of smaller branches of its hosts. Hatch occurs after host trees break dormancy in the spring. In New Jersey hatching commences at the 'pink' stage of apple tree development and continues through the bloom period.

We wished to have colonies of ERM available for acaricide resistance studies during the winter and early spring and needed to know when diapause development was completed. For overwintering eggs to hatch, morphogenesis must be preceeded by a period of chilling (Lees 1953). Also, hatching success is influenced by incubation temperatures following the chilling period (Cranham 1972). However, reports of both chilling requirements and incubation temperatures are conflicting (Cranham 1972, Tsugawa et al. 1966) indicating that ERM may have adapted to local conditions with respect to these characters. In this study we measured diapause development in field-collected overwintering eggs of ERM and also determined whether results with field-collected eggs could be duplicated by chilling overwintering eggs in a growth chamber programmed for long-term average field conditions of daily photo- and thermoperiods.

Materials and Methods

To obtain a uniform sample of ERM eggs throughout the winter, one mature 'Red Delicious' apple tree with a high population of overwintering ERM eggs was selected and approximately 1 inch long sections of fruiting spurs were cut. All buds were removed, and both ends of the twigs were dipped in hot parafin wax to prevent them from drying out. On Oct. 23, several hundred of these twigs were cut and placed in a closed container along with another container holding saturated NaCl; a saturated NaCl solution keeps the relative humidity at 75%, preventing excessive fungal growth. The twigs were placed in a growth chamber (Percival Manufacturing Co., Boone, Iowa) programmed to simulate the average weekly 24-hour temperature and photoperiod cycles at Cream Ridge, N.J., beginning Oct. 23, and continuing throughout the winter until natural ERM egg hatch occurred.

In addition, every week beginning on Oct. 27, 12 twigs were collected from the tree outside and put into 100 x 15 mm plastic petri dishes, two twigs per dish. Each dish held a wick saturated with NaCl , and petroleum jelly was spread on the bottom rim to form a sealed container when covered. Two dishes were placed in a Precision TM incubator set at 15° C, 14L::10D, two dishes in an incubator set at 15° C, 10L::14D, and two dishes in the Percival. At the same time, 12 twigs were removed from the Percival each week, put into petri dishes, and two dishes were placed into each of the above treatments.

Egg hatch was measured by counting the number of ERM larvae stuck in the petroleum jelly around the dish rims twice weekly, until no further hatch occurred. Outside and Percival temperatures were monitored with thermographs as well as Pro Temp 700 integrators (Pro El Co., Salt Lake City, Utah), which kept a running total of accumulated centigrade-hours.

Results and Discussion

At 15°C ERM hatch increased from <30% in November to ca 80% in February (Figs. 1 & 2) after which the % hatch remained the same (Growth Chamber) or declined somewhat (Eggs from Out-of-Doors). There was a significant interaction between month of sample and photoperiod; % hatch was higher in the shorter photoperiod from November to February and lower in the shorter photoperiod during March and April.

Eggs brought in from out-of-doors and placed in an incubator set at 25° C and long photoperiod (14::10 LD) failed to hatch until the February collections (Fig. 1). From February onward, % hatch for each succeeding collection increased until late April, when hatching commenced in the field.

Accompanying the increase in egg hatch was a decrease in the length of time from collection to 50% hatch (Figs 3 & 4). Eggs collected in November required ca 120 days to attain 50% hatch at 15° C. Eggs collected in February, when % hatch had reached a maximum, required ca 30 days to hatch. From February on, there was a gradual decrease in average length of time to egg hatch until hatching commenced in the field.

The pattern of egg hatch for eggs from out-of-doors and the growth chamber were very similar.

Although direct comparisons are difficult, the results of our study seem to differ from those reported by Cranham (1972) for ERM from southern England. At an incubation temperature of 21° C Cranham found that % hatch continued to increase for up to 200 days of chilling at 5°C. Also, the % hatch of field-collected eggs continued to increase at 21° C until hatching commenced in the field (May).

The purpose of this experiment was to determine when diapause development was complete in overwintering eggs of ERM so that mites could be obtained for acaricide resistance studies. Our results show that some eggs will hatch (ca 30%) when collected in November and incubated at 15°C, but approximately 4 months (until March) is required for 50% hatch. Raising the temperature of incubation does not speed the process since higher incubation temperatures reduce egg hatch. Possibly storing the eggs at 5° C during the chilling process would result in a somewhat earlier hatch; 5°C is the most effective chilling temperature according to Cranham (1972).

Literature Cited

Cranham, J. E. 1972. Influence of temperature on hatching of winter eggs of fruit-tree red spider mite, *Panonychus ulmi* (Koch). Ann. Appl. Biol. 70: 119-137.

Lees, A. D. 1953. Environmental factors controlling the evocation and termination of diapause in the fruit tree red spider mite, *Metatetranychus ulmi* Koch. Ann. Appl. Biol. 40: 449.

Tsugawa, C., Yamada, M., Shirasaki, S., and N. Oyama. 1966. Forecasting the outbreak of destructive insects in apple orchards. VII. Termination of diapause in hibernating eggs of *Panonychus ulmi* (Koch) in relation to temperature. Jap. J. Appl. Entomol. Zool. 10: 174.

Figure 1

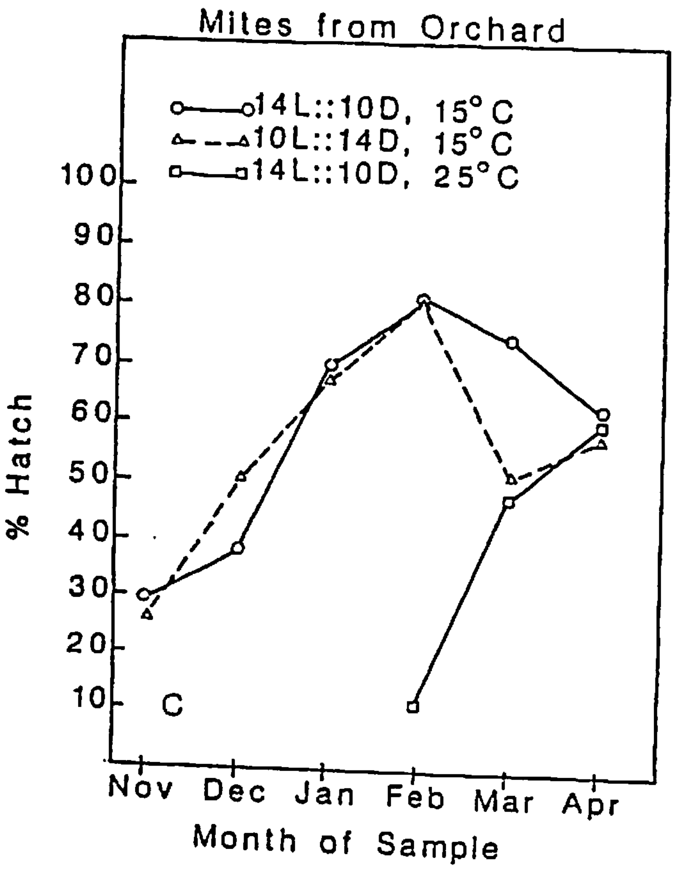


Figure 2

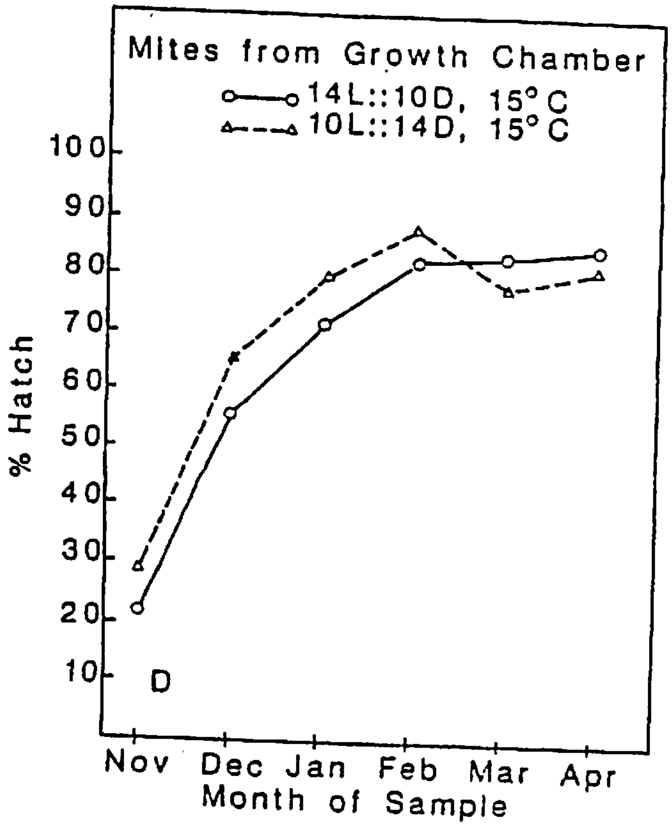


Figure 3

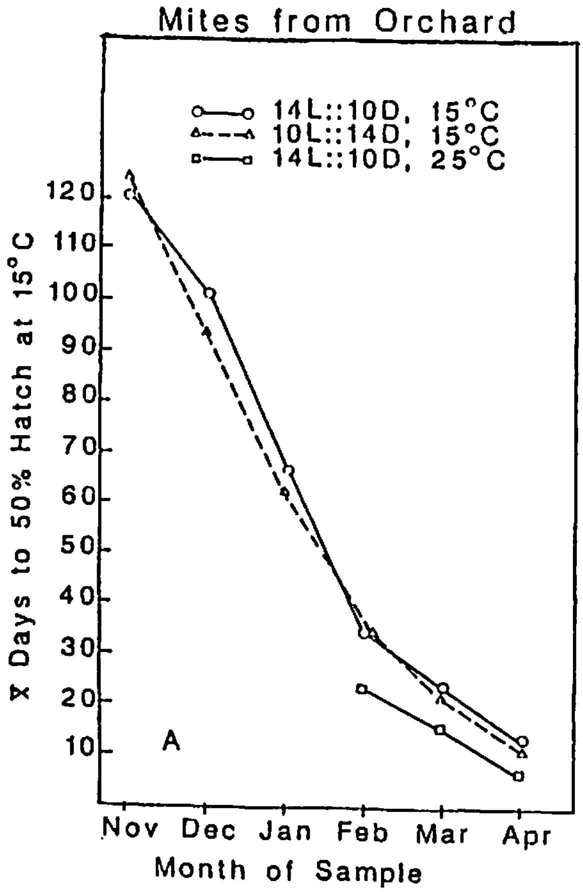
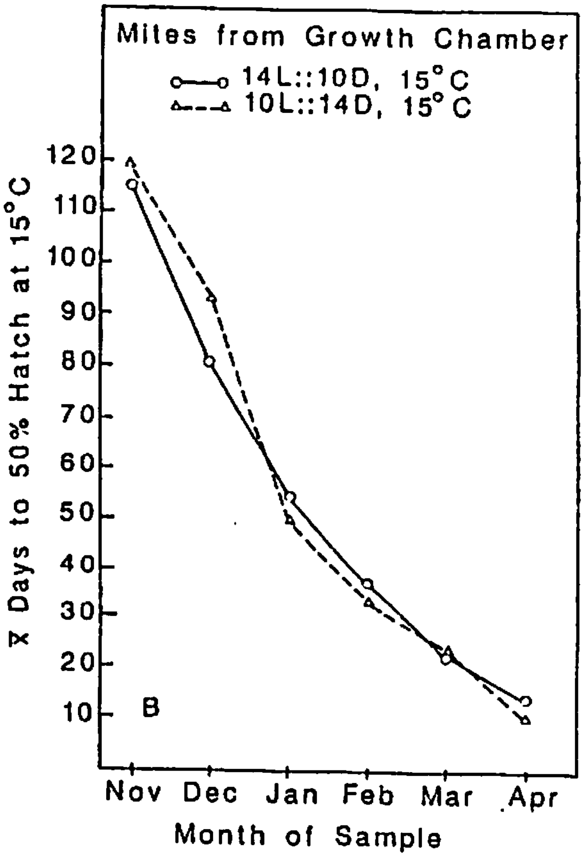


Figure 4



Evaluation on Chlorpyrifos - Oil - Spreader Combinations for Control of European Red Mite

Fred C. Swift and Dean Polk
Rutgers Fruit Research & Development Center
Cream Ridge, NJ 08514

Introduction

In New Jersey European red mite resistance to Plictran, Kelthane, Omite and other acaricides is widespread. Newer acaricides, notably Apollo and Savey, are very effective but are not registered in the United States for use on apples or peaches. Recently, Plictran was removed from the market. Thus, in the summer of 1987 we were faced with the prospect of not having any effective acaricides to use in many problem orchards. It became necessary to find a treatment that would, temporarily at least, provide some reduction in European red mite populations. Moreover, the compound had to 1) be labelled for use in apples and 2) not be toxic to *Stethorus punctum* or *Amblyseius fallacis*. Based on laboratory tests and previous field studies (Hogmire and Crim 1986, Hamilton et al. 1986) chlorpyrifos (Lorsban) seemed the most promising of all the pesticides labelled for use on apples.

Materials and Methods

In all, five tests were conducted during 1987. Except for Test IV the experiments were conducted in a 17-year-old block of Red and Golden Delicious varieties located at Cream Ridge, NJ. Treatments were applied with an FMC PT50 airblast sprayer operated at 300 psi and 1.5 MPH to deliver from 150-214 GPA. Spray dates are given in the tables. Single tree plots were replicated 2-4 times in a randomized complete block design. For disease control the entire orchard was sprayed with Polyram as needed. European red mites (ERM) were censused by counting all motile stages per leaf from a pooled sample of 15 leaves per tree. Test IV was carried out at Vincentown, NJ in a 4-year-old block of apples, variety 'Red Delicious' (Red Chief). Treatments were applied with a hydraulic sprayer equipped with a handgun and operated at 300 psi, delivering 0.45 gallons per tree (75 GPA). The spray date is given in the table. Single tree plots were replicated 3 times and arranged in a randomized complete block design. ERM were sampled by counting the number of motile mites on 10 leaves per tree.

In all tests data were transformed to either $\sqrt{x+1}$ or log (x+1) prior to analysis of variance and separation of means. In the tables, means followed by the same letter are not significantly different at alpha = 0.05, DMRT.

Lorsban or Lorsban-Oil-Spreader combinations were also used by 16 growers at some point during the 1987 season. Although in most cases the results were difficult to interpret because of the use of other compounds and the presence of *Stethorus*, a cross-section of the results are presented below.

Results and Discussion

The experimental results are given in Tables 1-5. In Test I Lorsban 50W was used at the rate of 2 lbs/100 gallons, 150 GPA. All Lorsban-Oil-Spreader combinations significantly reduced ERM populations. Safer soap plus oil, without Lorsban (Treatment 4) was ineffective. Two applications of Lorsban-Oil-Spreader (for example, Treatment 2), applied 9 days apart, provided excellent control. There was no evidence of spray injury.

In Test II Lorsban 50W at 3.0 lbs/A (1.4 lbs Lorsban 50W per 100 gallons; 214 GPA) reduced ERM populations by 95.6% (3 days post-spray). Addition of X-77 spreader further increased the effectiveness to 97.8%. Adding the oil resulted in a further increase in control to 98.9%. None of the treatments were toxic to *Amblyseius fallacis*. However, Lorsban was toxic to minute pirate bug, another predator. Lorsban did not reduce a small population of two-spotted spider mites.

In Test III % control ranged from 90.5 % (Treatment 1) to 98.1 % (Treatment 4). All treatments were very effective when compared to the control. There was no evidence of spray injury with any treatment.

In Test IV control with Lorsban, Lorsban-Oil-Spreader, and Plictran ranged from 95-98%. Omite was ineffective in this test but 48 hours may be too short a time to achieve a very high kill with Omite.

In Test V treatments of 4 oz/A of Apollo 50SC or Savey 50W, either alone or in combination with Lorsban-Oil-Spreader, were very effective. There was no evidence of phytotoxicity.

The results of grower usage of Lorsban-Oil-Spreader combinations is shown in Tables 6-12. In the tables S refers to a solid spray and A refers to alternate row middle applications. Results ranged from excellent (Power Block, Table 6) to complete failure (Table 12). In many cases the Lorsban-Oil-Spreader combination applied in an alternate row middle treatment program provided enough short-term control to prevent ERM populations from exploding before *Stethorus* became a factor (Table 6, Dutch Block; Tables 7 & 8). In two instances a single solid spray accomplished the same effect (Tables 9 & 10). On Farm K (Table 11) Lorsban was ineffective, probably because the concentration in the mix was too dilute. On Farm V (Table 12) a building population of mites on Red Delicious (Red Chief) could not be controlled with the Lorsban-Oil-Spreader combination or any other acaricide currently registered.

In summary, the Lorsban-Oil-Spreader combination was most effective when the Lorsban was mixed at the rate of ca 2 lbs Lorsban 50W/100 gallons spray mix and applied at a rate of 100-150 GPA. More dilute applications were less effective. We did not test more highly concentrated applications.

Literature Cited

Hogmire, Henry W., Jr. and Larry Crim. 1986. Apple, insecticide evaluation, 1985. Insecticide and Acaricide Tests: 1986: 27-29.

Hamilton, George C., Elizabeth Herman, and Fred C. Swift. 1986. Apple, all season insecticide test, 1985. Insecticide and Acaricide Tests: 1986: 20-24.

Table 1

Compound and Amount Formulation/Acre		ERM/leaf		
		June 19	June 26*	June 30
1 Lorsban 50W	3.0 lbs	7.5 ab	11.1 a-c	0.4 a
+ Bivert	1.5 pts			
+ Superior 60 Oil	4.5 pts			
2 Lorsban 50W	3.0 lbs	4.9 ab	6.8 ab	0.5 a
+ X-77	1.5 pts			
+ Superior 60 Oil	4.5 pts			
3 Lorsban 50W	3.0 lbs	10.4 ab	4.8 a	1.9 a
+ Bivert	1.1 pts			
+ Superior 60 Oil	4.5 pts			
4 Safer Soap	4.5 pts	35.5 bc	41.1 c	1.6 a
+ Superior 60 Oil	4.5 pts			
5 Lorsban 50W	3.0 lbs	4.2 a	16.0 a-c	1.1 a
+ Safer Soap	4.5 pts			
+ Superior 60 Oil	4.5 pts			
6 Untreated Control		56.6 c	38.4 bc	22.6 b

Spray Dates : 6/17/87

*2nd spray of:	
Lorsban 50W	4.4 lbs/A
X-77	1.1 pts/A
Superior 60 Oil	4.4 pts/A

-applied to Plots 1-5 on 6/26 following counts

Table 2

Treatment and Amount Formulation/A		ERM/leaf		
		Pre-treat June 19	Post-treat June 22	Counts June 25
1 Lorsban 50W	3.0 lbs	45.6	7.0 a	9.4
2 Lorsban 50W	3.0 lbs	38.8	3.4 a	5.3
+ X-77	1.5 pts			
3 Lorsban 50W	3.0 lbs	54.0	1.8 a	2.0
+ X-77	1.5 pts			
+ Superior 60 Oil	4.5 pts			
4 Untreated Control	—	57.6	157.8 b	34.0

Spray Date: 6/19/87

Table 3

Treatment and Amount Formulation/A		ERM/leaf Pre-treat June 25	ERM/leaf Post-treat June 29
1 Lorsban 50W	2.1 lbs	35.2	3.5 b
2 Lorsban 50W	2.1 lbs	28.8	2.3 ab
+ Superior 60 Oil	2.1 pts		
3 Lorsban 50W	2.1 lbs	36.4	1.7 ab
+ Superior 60 Oil	2.1 pts		
+ X-77	0.53 pt		
4 Lorsban 50W	4.2 lbs	28.8	0.7 a
+ Superior 60 Oil	2.1 pts		
+ X-77	0.53 pt		
5 Lorsban 50W	2.1 lbs	25.6	0.8 a
+ Vydate 2L	2.1 pt		
6 Lorsban 50W	2.1 lbs	23.6	1.4 a
+ Vydate 2L	2.1 pts		
+ X-77	0.53 pt		
+ Superior 60 Oil	2.1 pts		
7 Lorsban 50W	4.0 lbs	28.8	1.3 a
+ B-1956	0.53 pt		
+ Superior 60 Oil	2.1 pts		
8 Lorsban 50W	4.0 lbs	30.0	0.9 a
+ Triton AG 98	0.53 pt		
+ Superior 60 Oil	2.1 pts		
9 Untreated Control	—	24.4	37.0 c

Spray Date : 6/26/87

Table 4

Treatment and Amount Formulation/A		ERM/leaf Pre-treat June 23	ERM/leaf Post-treat June 25
1 Lorsban 50W	1.5 lbs	13.9	1.3 a
2 Lorsban 50W	1.5 lbs	13.5	0.6 a
+ X-77	0.37 pts		
+ Superior 60 Oil	1.13 pt		
3 Plictran 50W	0.75 lbs	17.8	1.4 a
4 Omite 30W	3.0 lbs	13.3	15.6 b
5 Untreated Control	—	26.7	28.7 b

Spray Date : 6/23/87

Table 5

Treatment and Amount	Formulation/A	ERM/leaf						
		July 15	July 29	Aug 6	Aug 17	Aug 25	Sept 9	Mite-days
1 Apollo 50SC	4.0 oz	0.9 ab	0.5 a	0.9 ab	0.6 a	0.3 a	0.6 a	34
2 Savey 50W	4.0 oz	1.7 bc	0.3 a	0.4 a	0.6 a	0.4 a	0.7 a	35
3 Savey 50W	0.5 oz	0.3 a	0.5 a	1.0 ab	2.4 b	3.5 c	6.6 c	130
+ Vydate 2L	1.5 pts							
+ Lorsban 50W	1.5 lbs							
+ AG 98	0.75 pts							
+ Superior 60 Oil	3.0 pts							
4 Apollo 50SC	4.0 oz	0.2 a	0.1 a	0.4 a	0.8 a	0.7 ab	0.3 a	24
+ Lorsban 50W	3.0 lbs							
+ AG 98	0.75 pts							
+ Superior 60 Oil	3.0 qts							
5 Savey 50SC	4.0 oz	0.6 ab	0.4 a	0.3 a	0.4 a	0.5 a	0.5 a	25
+ Lorsban 50W	3.0 lbs							
+ AG 98	0.75 pts							
+ Superior 60 Oil	3.0 qts							
6 Lorsban 50W	3.0 lb	0.5 ab	0.7 a	2.9 b	1.6 ab	2.4 bc	3.2 b	106
+ AG 98	0.75 pts							
+ Superior 60 Oil	3.0 qts							
7 Untreated Control		2.5 c	2.9 b	5.0 c	11.0 b	10.4 d	7.6 c	378

Spray Date : 7/10/87

Table 6

CHLORPYRIFOS & MITE CONTROL IN NJ APPLE ORCHARDS 1987 FARM Q

BLK	DATE	6/19	6/26	7/1	7/3	7/9	7/10 7/13	7/17	7/21	7/24	7/29	7/31	8/7	8/8	8/14	8/21
FOWER	Mites/L	14.8	40	35	*	7.4	*	.4	*	1.3	*	<1	<1		<1	<1
	S. punctum/3 min	—	<1	?		?		19		25		10	—		—	—
Dutch	Mites/L	<1	2	2.1		4.5	*	1.1	*	17	*	1	50	*	20	4
	S. punctum/3 min	—	—	—		—		?		11		17	39		100	92

Treatments:
7/03 Lorsban 2 lb/A, Oil 1 qt/A, X-77 1/4 pt/A; 100 gal/A; S
7/10 Lorsban 2 lb/A, Oil 1 qt/A, X-77 1/4 pt/A; 100 gal/A; A
7/13 Lorsban 2 lb/A, Oil 1 qt/A, X-77 1/4 pt/A; 100 gal/A; A
7/21 Lorsban 2 lb/A, Oil 1 qt/A, X-77 1/4 pt/A; 100 gal/A; A
7/29 Lorsban 2 lb/A, Oil 1 qt/A, X-77 1/4 pt/A; 100 gal/A; A
8/08 Lorsban 2 lb/A, Oil 1 qt/A, X-77 1/4 pt/A; 100 gal/A; S

Table 7

CHLORPYRIFOS & MITE CONTROL IN NJ APPLE ORCHARDS 1987 FARM P

BLK	DATE	6/22	6/29	7/4	7/6	7/13	7/15	7/20	7/23	7/27	7/29	8/3	8/10
Grove	Mites/L	<1	2.1			13	*	16	*	6.2	*	2.5	1
	S. punctum/3 min	—	—			<1		<1		19		23	11
House	Mites/L	<1	16	*	6	25.1	*	22.1	*	2	*	1.8	<1
	S. punctum/3 min	—	—		—	<1		36		12		16	3

Treatments:
7/4 and
7/6 Lorsban 2 lb/A, Oil 1 qt/A, X-77 1/2 pt/A; 167 gal/A; A
7/15 Lorsban 3 lb/A, Oil 1 qt/A, X-77 3/4 pt/A; 167 gal/A; A
7/23 Lorsban 2 lb/A, Oil 1 qt/A, X-77 1 pt/A; 167 gal/A; A
7/29 Lorsban 1 1/2 lb/A, Oil 1 1/3 pt/A, X-77 1 pt/A; 167/A; A

Table 8

CHLORPYRIFOS & MITE CONTROL IN NJ APPLE ORCHARDS 1987 FARM D

BLK	DATE	6/17	6/22	6/24	6/25	7/1	7/8	7/13	7/15	7/20	7/22	7/24	7/29	8/5	8/13
#14	Mites/L	<1		1.9	*	1.5	5.9	*	3	*	17.3	*	7.8	18.6	<1
	S. punctum/3 min	<1				<1	<1		<1		8		14	94	3
#25	Mites/L	<1	*	<1		1.1	5.2	*	4.6	*	13.7	*	6.6	1.8	<1
	S. punctum/3 min	—		—		—	—		1		2.9		14	67	—

Treatments:
6/22 Lorsban 2 1/2 lb/A, Oil 1qt/A, X-77 1/2 pt/A, Kelthane 4lb/A; 250gal/A;A
6/25 Kelthane 4 1/4 lb/A, X-77 1/2 pt/A; 167 gal/A; S
7/13 Lorsban 2 1/2 lb/A, Oil 1 qt/A, X-77 1/4 pt/A; 167 gal/A; A
7/20 Lorsban 2 1/2 lb/A, Oil 1 qt/A, X-77 1/4 pt/A; 167 gal/A; A
7/24 Lorsban 2 1/2 lb/A, Oil 1 qt/A, X-77 1/4 pt/A; 167 gal/A; A

Table 9

CHLORPYRIFOS & MITE CONTROL IN NJ APPLE ORCHARDS 1987 FARM S

BLK		6/22	6/29	7/6	7/13	7/15	7/20	7/21	8/3	8/10
Chestnut	Mites/L	<1	3.5	<1	9.4	*	11.3	34.2	24	<1
	S. punctum/3 min	—	<1	<1	9		8	73	215	91

Treatment:
7/15 Lorsban 3 lb/A, Oil 1 1/4 qt/A; 250 gal/A; S

Table 10

CHLORPYRIFOS & MITE CONTROL IN NJ APPLE ORCHARDS 1987 FARM 0

BLK		6/11	6/18	6/25	7/3	7/9	7/16	7/21	7/23	7/25	7/30	8/6	8/13	8/20	8/25
RC-3	Mites/L	<1	8	2	1.5	9.2	14.3	*	31.6	*	3.6	16.3	1.2	1.2	1.1
	S. punctum/3 min	—	—	—	—	<1	<1		5		15	33	3	7	2

Treatments:
7/21 Plictran 1 lb/A, Oil 1 qt/A; 100 gal/A; A
7/25 Lorsban 2 lb/A, Oil 1 qt/A, Induce 5 oz/A; 100 gal/A; S

Table 11

CHLORPYRIFOS & MITE CONTROL IN NJ APPLE ORCHARDS 1987 FARM K

BLK		6/29	7/6	7/6	7/13	7/20	7/26	7/27	8/3	8/10	8/16	8/17
#8	Mites/L	<1	<1	*	1	6.1	*	20	60	100		65
	S. punctum/3 min	—	—		—	—		—	29	25		20
#9	Mites/L	<1	<1	*	1	4	*	9	20.5	25		2
	S. punctum/3 min	—	—		—	2		25	85	200		54
#5	Mites/L	<1	<1		1	<1	*	4.3	12	50	*	1
	S. punctum/3 min	—	—	—	—	—		—	—	2		—

Treatments:
7/06 Lorsban 2 1/2 lb/A, Oil 1 1/4 qt/A; 250 gal/A; S
7/26 Lorsban 2 1/2 lb/A, Oil 1 1/4 qt/A, X-77 10 oz/A; 250 gal/A; S
8/16 Lorsban 3 lb/A, Oil 1 1/4 qt/A; 250 gal/A; S

Table 12

CHLORPYRIFOS & MITE CONTROL IN NJ APPLE ORCHARDS 1987 FARM V

BLK		6/12	6/19	6/23	6/26	6/26	7/6	7/7	7/9	7/17	7/18	7/24	7/27	7/31	8/7
RC	Mites/L	<1	10	*	18.7	*	38.9	*	18.3	107.8	*	*	3.7	2.1	<1
	S. punctum/3 min	—	—		<1		<1	<1	<1	10			92	12	4

Treatments:
6/23 Lorsban 2 lb/A, Oil 1 pt/A, X-77 1/2 pt/A; 100 gal/A; S
6/26 Lorsban 2 lb/A, Oil 1 1/5 pt/A, X-77 1/2 pt/A; 100 gal/A; S
7/06 Lorsban 2 lb/A, Oil 1 1/5 pt/A, X-77 1/2 pt/A; 100 gal/A; A
7/18 Lorsban 2 lb/A, Oil 1 1/5 pt/A, X-77 1/2 pt/A; 100 gal/A; A
7/23 Lorsban 2 lb/A, Oil 1 1/5 pt/A, X-77 1/2 pt/A; 100 gal/A; A

Diapause Induction, Development, and Termination in Field Populations of *Amblyseius fallacis*

Fred C. Swift and Elizabeth J. Herman
Rutgers Fruit Research & Development Center
Cream Ridge NJ 08514

Introduction

The phytoseiid mite, *Amblyseius fallacis*, Garman can be an important predator of European red mite (ERM) in Michigan and the mid-Atlantic and northeastern states. However, although the predator is present in many orchards in New Jersey, it seldom develops populations sufficient to control ERM. It can be a factor in maintaining populations of ERM at low levels after populations have crashed for other reasons.

We are attempting to identify factors that limit the effectiveness of *A. fallacis* as a predator. One such factor would be the fate of predator populations during the winter, since this determines the size of predator populations available to recolonize the apple trees the following growing season. The objectives of this study were to determine when the predator enters diapause in the fall, the course of diapause development in the fall and winter, the effect of photoperiod on diapause development, and the time of diapause termination. Follow-up studies will be concerned with the relationship of food availability to the size of populations going into diapause, food availability and the size of spring populations, and the relationship of diapause development and cold-hardiness.

Materials and Methods

The time of diapause induction was determined by finding apple trees that had high populations of *A. fallacis*, sampling the foliage from these trees, and counting the number of predators in each stage of development. Since *A. fallacis* overwinters as fertilized females, the criteria for diapause induction was a change in population structure from all stages being present on the foliage to a population consisting entirely of adults, primarily females. To assure that changes in population structure were due to the onset of diapause rather than the predators simply running out of food, laboratory-reared 2-spotted spider mites were released into the trees in the region from which the foliage samples were being picked.

Diapause induction was also measured by collecting predators from the foliage weekly, confining them in rearing dishes, and placing the dishes in a growth chamber (Percival Manufacturing Company, Boone, Iowa) programmed for outdoor temperatures and photoperiods. The temperature cycles were the average weekly 24-hour cycles for the weeks of October 10, 17, 24, and 31 (See Fig.

1). Diapause induction was considered complete when females no longer laid eggs and also took on the appearance of diapausing females.

Diapause development during fall and winter was measured by collecting overwintering females from the orchard ground cover, confining the predators in petri dish rearing chambers, and holding the mites at 15^{O}C under one of two photoregimes, either 10::14 or 14::10 LD. Predators were collected at approximately weekly intervals. In addition, a large collection of predators was made from October 20-23, confined to culture dishes (10 predators/dish), and held in the growth chamber (See temperature and photoregime, Fig. 1) through the fall and winter months. Four dishes were removed from the growth chamber each week; two dishes were placed in each of the two photoregimes (10::14 or 14::10) mentioned above. Length of time to first oviposition of each mite was used as the measure of diapause development. Diapause development was considered complete when two criteria had been fulfilled: 1) the length of time from collection to first oviposition was 6-9 days, which is the minimum preoviposition time at 15^{O}C for predators that have not been foraging in the field, and 2) the predators no longer responded to photoperiod, that is, when the length of time to first oviposition was the same in both diapausing-maintaining (10::14 LD) and diapause-averting (14::10 LD) photoregimes. Subsequently, the preoviposition period shortened still further to 1-4 days, indicating that the predators had commenced feeding in the field and that ovogenesis was underway by the time they were brought into the laboratory.

Results and Discussion

Oviposition had ceased in the field by the end of October (Fig. 2) indicating that diapause induction was complete. In the growth chamber no oviposition occurred after October 27. Adding civil twilight onto each end of the day, the daylength was 12::12 LD by mid-October (Fig. 2), which is very near the critical photoperiod for diapause induction in A. fallacis (Rock et al, 1971). Moreover, Swift (1987) has shown that adult female predators exposed to 12::12 photoregimes will gradually cease ovipositing and go into diapause. Thus, laboratory and field results are in close agreement on this point.

The rate of diapause development was greatly influenced by photoperiod (Fig. 3), with development being much more rapid in the longer photoperiod. Diapause development was completed in some mites by mid-January (See January 19 results in Fig. 4), in that by this time some mites were no longer influenced by photoperiod and began ovipositing within 6-9 days in the short photoperiod. From that point on there was a gradual increase in the number of mites in which diapause had been completed. However, some mites remained sensitive to photoperiod through mid-March (Fig. 4). All mites in the long photoperiod were ovipositing in 9 days or less by the last week in February (Fig. 5).

During the last week in March the length of time to first oviposition decreased to 1-4 days, indicating that the predators had already fed by the time they were collected and ovogenesis had begun.

Results for mites brought in from the field and mites from the growth chamber paralleled each other (Fig. 3), indicating that future studies, i.e. cold-hardiness, could be done with mites from the growth chamber. This would facilitate such studies; collecting mites from their overwintering habitat in mid-winter is very time-consuming.

We conclude that 1) photoperiod is important in maintaining diapause in *A. fallacis*, 2) populations vary greatly among individuals with respect to diapause intensity, 3) since the predators are still reproducing well into October, size of the diapausing population must be strongly affected by the availability of food during September and October, and 4) since ovogenesis begins by the end of March, predators must be strongly food-limited during early spring; ground cover growth, which could support reproducing populations of alternative food such as 2-spotted spider mites, is only beginning at this time.

Literature Cited

Rock, G. 1971. Diapause in the phytoseiid mite *Neoseiulus* (T.) *fallacis*. J. Insect Physiol. 17: 1651-1659.

Swift, F. C. 1987. Diapause induction in *Amblyseius fallacis* (Acari: Phytoseiidae). Environ. Entomol. 16: 72-76.

Figure 1

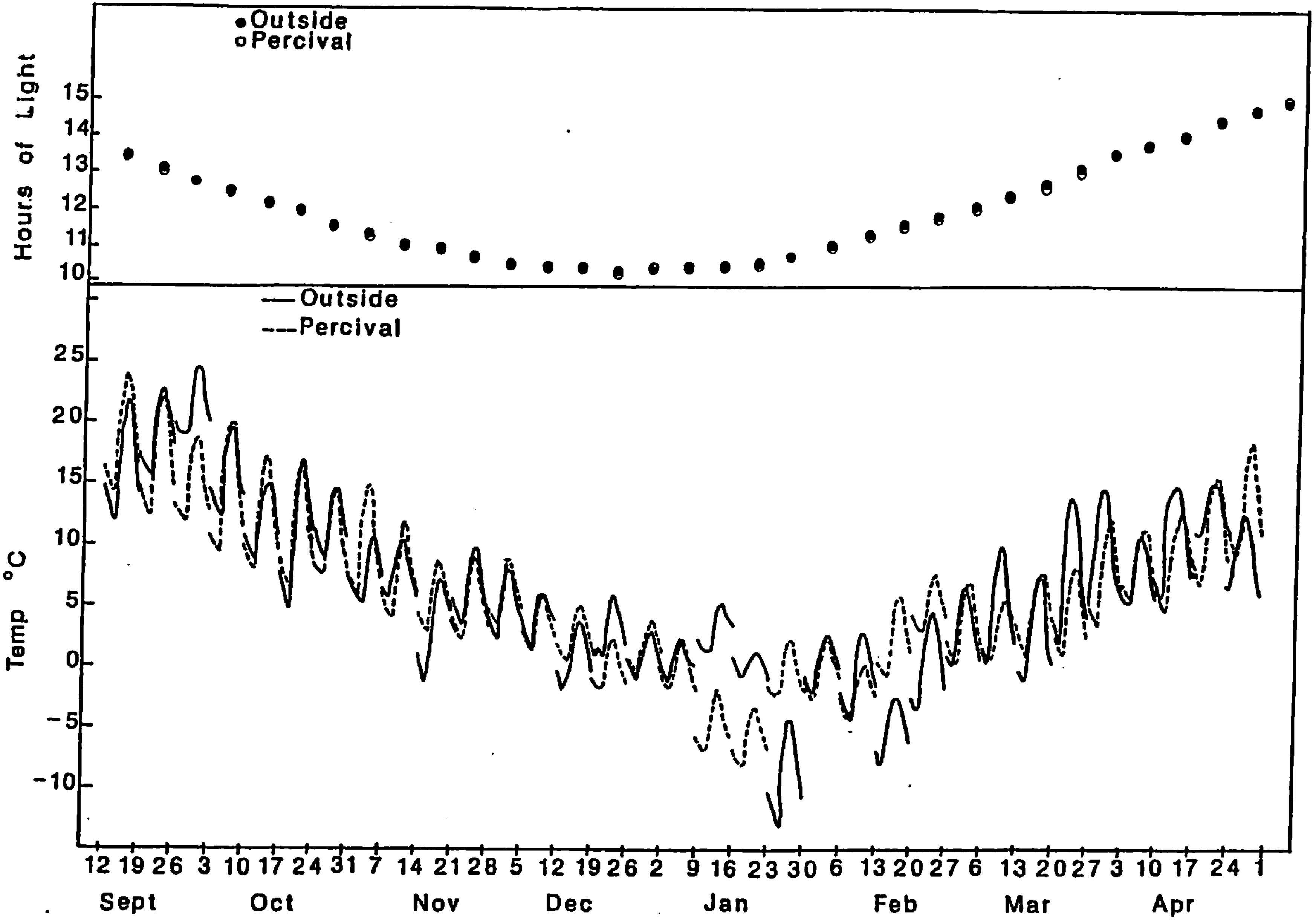

●Outside
○Percival
Hours of Light
15
14
13
12
11
10
—Outside
---Percival
Temp °C
25
20
15
10
5
0
-5
-10
12 19 26 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 6 13 20 27 6 13 20 27 3 10 17 24 1
Sept
Oct
Nov
Dec
Jan
Feb
Mar
Apr

Figure 2

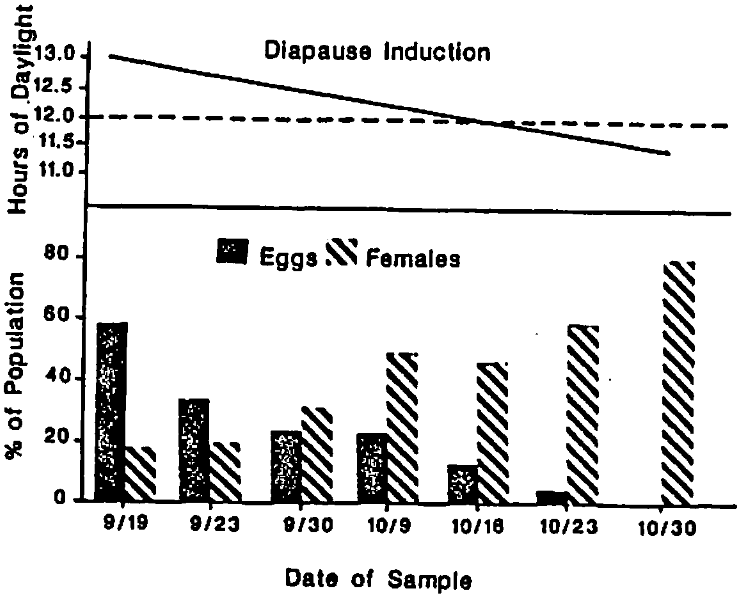


Figure 3

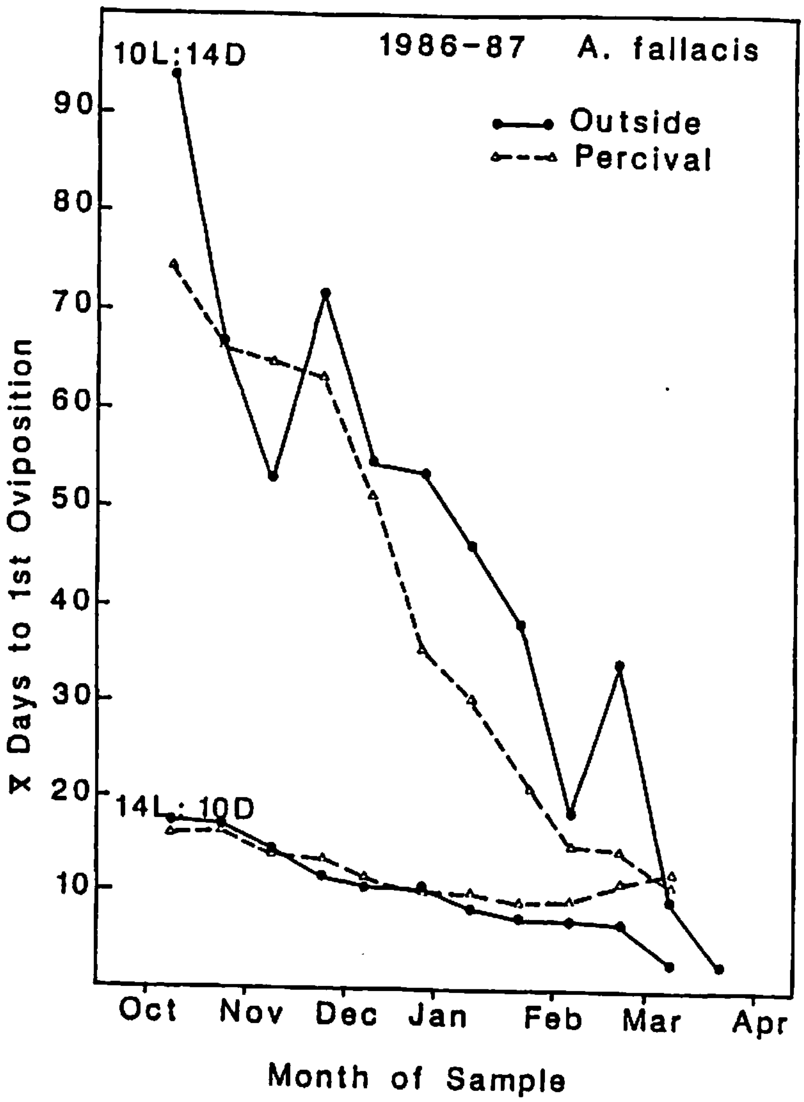


Figure 4

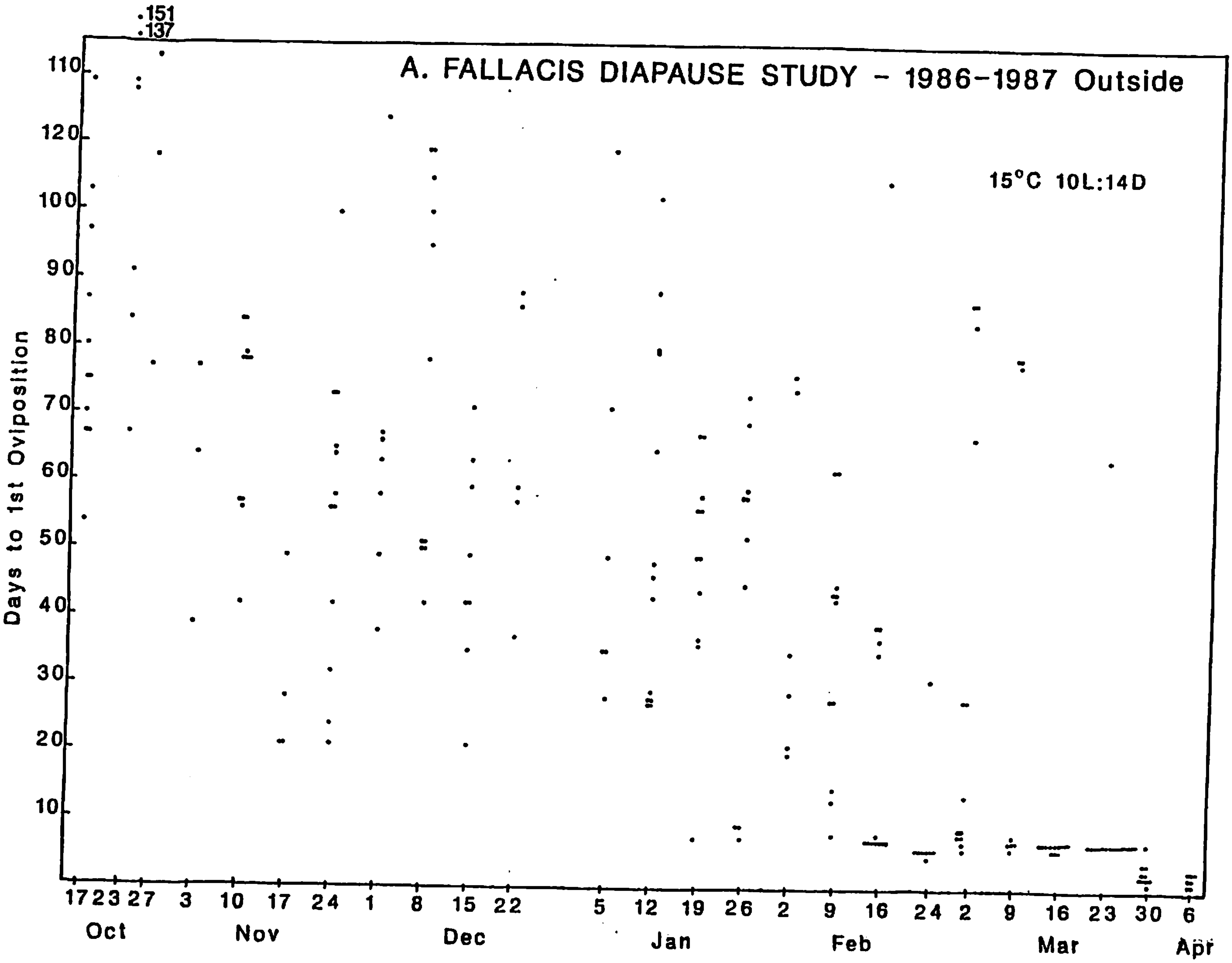
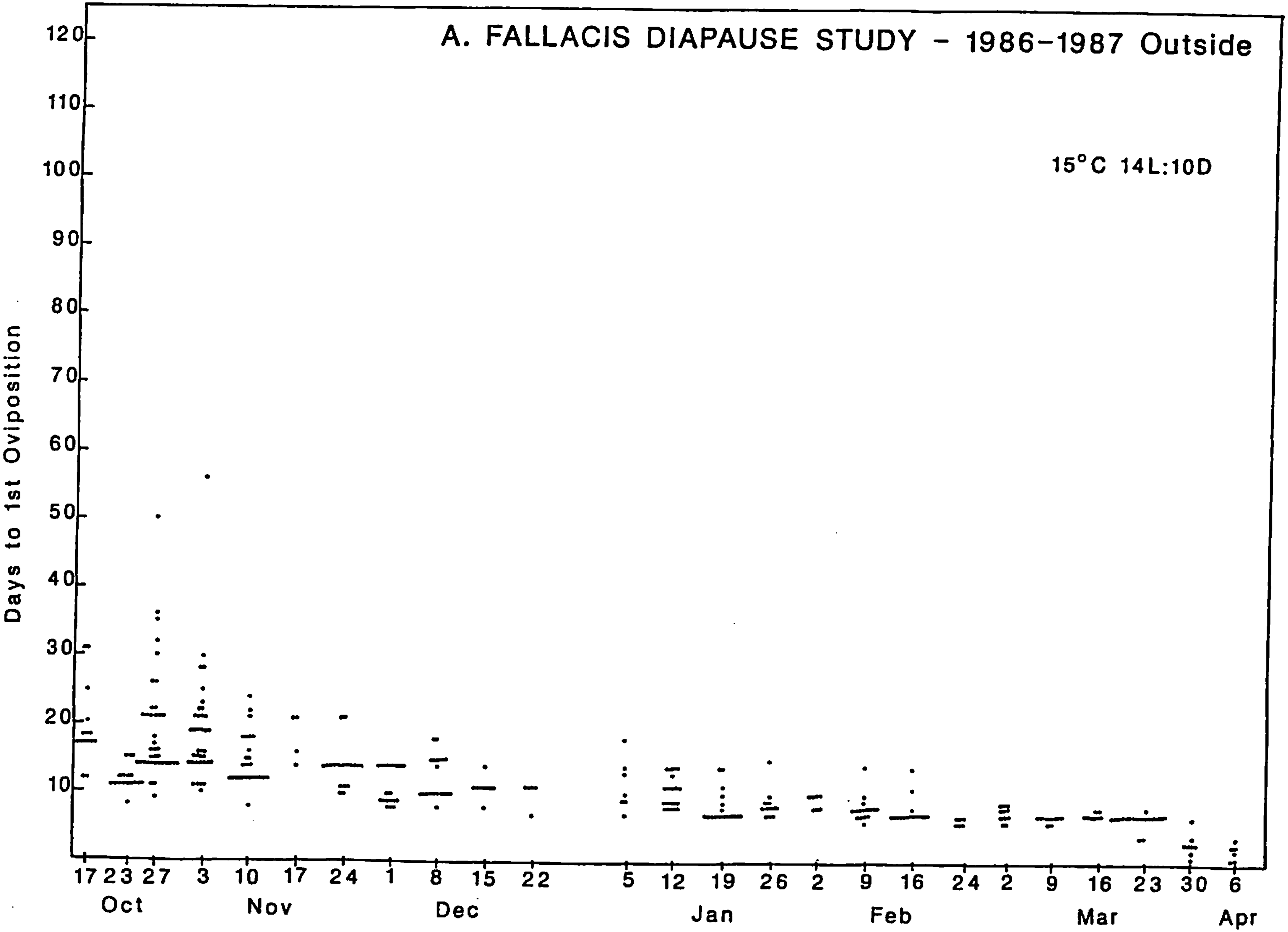

A. FALLACIS DIAPAUSE STUDY - 1986-1987 Outside
15°C 10L:14D
Days to 1st Oviposition
110
120
100
90
80
70
60
50
40
30
20
10
.151
.137
17 23 27 3 10 17 24 1 8 15 22 5 12 19 26 2 9 16 24 2 9 16 23 30 6
Oct
Nov
Dec
Jan
Feb
Mar
Apr

Figure 5


A. FALLACIS DIAPAUSE STUDY - 1986-1987 Outside
15°C 14L:10D
Days to 1st Oviposition
120
110
100
90
80
70
60
50
40
30
20
10
17
23
27
3
10
17
24
1
8
15
22
5
12
19
26
2
9
16
24
2
9
16
23
30
6
Oct
Nov
Dec
Jan
Feb
Mar
Apr

Seasonal Abundance and Distribution of *Amblyseius fallacis* in an Apple Orchard

Fred C. Swift and Elizabeth J. Herman
Rutgers Fruit Research & Development Center
Cream Ridge, NJ 08514

Introduction

As part of a study of factors that limit the effectiveness of *Amblyseius fallacis* as a predator of European red mite (ERM), the seasonal abundance and distribution of both predator and prey were determined in an experimental orchard at Cream Ridge. The orchard was managed to provide `optimum' conditions for the predator; that is, for two years weed control was restricted to mowing row middles, and a minimum spray schedule of selective pesticides was employed. ERM densities were manipulated to compare the effect of early-, mid-, and late-season buildup of prey populations on abundance and distribution of *A. fallacis*.

Materials and Methods

The basic design of this test was a randomized complete block consisting of 4 replicates (2 Yellow Delicious and 2 Red Delicious) and 3 treatments (12 trees per treatment, within each replicate). Within each replicate, 1/2 of the trees were spur-type and 1/2 were not (see fig. 1).

To manulipate ERM populations, treatments 1-3 were sprayed with an FMC PT50 airblast sprayer as follows: Treatment 1) for early season ERM buildup - no miticide was used; treatment 2) for mid season ERM buildup - Plictran was sprayed at petal fall (May 14); and treatment 3) for late season ERM buildup - Plictran was sprayed at petal fall and 1st cover (June 2). To keep other insects from interfering with the test, all treatments received Thiodan at tight cluster (April 20), Imidan at petal fall, and Guthion on July 10. For disease control the entire orchard was sprayed with Polyram as needed.

A. fallacis populations were monitored in the ground cover as well as in the trees throughout the season. The ground cover, consisting mainly of clover and grasses, was sampled from May through October in the following manner: Trees were selected about once a week, and from underneath each tree 50 clover stems were cut, put into Berlese funnels under 100 watt incandescent lights, and `heated' for several days. As the clover dried up, all insects and mites moved down and fell into jars containing 70% alcohol fastened to the bottom of the funnels. Later these jars were removed, the phytoseiids were counted, and a sample of them were mounted onto microscope slides in Berlese fluid for species identification. In the trees, *A. fallacis* were counted whenever leaves were sampled for ERM counts.

ERM populations were monitored in the trees from early June through the end of July (6 sampling dates). Twenty-four trees were selected; 6 trees/replicate, 2 trees/treatment within each replicate, one spur-type and one non spur-type tree within each treatment. From each tree 3 sets of 15 leaves were picked from the lower branches; one set from the trunk-area, one set from 1/2 way out the branches, and one set from around the periphery of the tree. Each leaf set was brushed onto a glass plate covered with Triton B-1956, and motile ERM as well as A. fallacis eggs and motiles were counted with the aid of a stereomicroscope.

Other ERM predators, Stethorus punctum, minute piratebug, and green lacewing were also monitored on all trees. On July 1 and July 17 a 3 minute count was made for S. punctum on all trees in the test. Three minute counts were also made on selected trees in late July, early, and late August. Minute pirate bug and green lacewing larvae were monitored with a 6 minute count on all trees on July 7, and by counting 100 leaves/tree on selected trees in late July, early, and late August.

The distribution of ERM and A. fallacis in a single tree, with or without suckers, was studied on selected trees from late July through October (5 sampling dates). Each tree was divided into 12 sections (4 levels X 3 zones); trees with suckers also had 3 levels for the suckers (see Fig. 2). On a given sampling date, 15 leaves per section were picked, each leaf was examined with the aid of a stereomicroscope, and motile ERM, A. fallacis eggs, and motile A. fallacis were counted. In September and October, Zetzellia mali, another mite predator that had built up to significant numbers, was counted. In order to find out exactly how many mites were living in each section of the tree, the number of leaves per section had to be determined. A mature apple tree, similar to the trees used in the distribution study, was divided into its sections, all leaves were collected from each section, and with the help of a leaf area meter and a metric scale, the number of leaves and area of leaf surface was calculated for each section.

Results and Discussion

ERM populations peaked in late June in treatment 1 (Fig. 3), early July in treatment 2 (Fig. 4) and early August in treatment 3 (Fig. 5). Maximum densities were 50 mites per leaf in treatment 1, 30 mites per leaf in treatment 2 and 12 mites per leaf in treatment 3. Predators, especially S. punctum, probably were responsible for preventing ERM populations from reaching higher levels (See predator census, Figs. 3-5).

A. fallacis populations remained stable in the ground cover during early- to mid-season (Fig. 3), or declined during mid-season (Figs. 4, 5) but then increased in the ground cover of all treatments during July - September. A. fallacis invaded the trees in July and August, but populations remained low. The major factors limiting the effectiveness of A. fallacis seemed to be 1) the slowness of the predator to disperse into the trees from the ground cover despite increasing populations of ERM in the trees, and 2) the rapid numerical response of S. punctum to increasing ERM populations which put limits on the time that ERM were available to A. fallacis. Possibly S. punctum and the other predators, minute piratebugs and lacewing larvae, were also feeding on A. fallacis.

Intra-tree distribution of A. fallacis and ERM for one of the trees in treatment 2 is shown in Figs. 6-9. This tree had the highest population of A. fallacis of any of the trees in the experiment. On a per leaf basis A. fallacis was most numerous on the sucker growth around the trunk and in the lower central portions of the tree. There were fewer predators per leaf in the periphery and tops of the tree (Fig. 6). However, when the total number of leaves in the various sampling sections were considered, there were actually more predators in the periphery than on the suckers or in the center (Fig. 7). In other words the predators are "diluted" by the great abundance of foliage in the periphery and top of the tree. We conclude that A. fallacis populations build up first on the suckers and lower central portion of the tree and gradually disperse outward and upward. However, the functional and numerical response of the predators is much too low relative to the amount of foliage and numbers of ERM in the periphery and tops of the tree.

Late in the season, after the ERM population had crashed, some A. fallacis continued to be present in the tree. However, the stigmaeid mite, Zetzellia mali, was generally distributed throughout the tree at this time (Figs. 8, 9) and reduced the ERM density to very low levels.

Figure 1

YDS = Yellow Delicious, spur-type
YD = Yellow Delicious, non spur-type
RDS = Red Delicious, spur-type
RD = Red Delicious, non spur-type

YDS	REP D YDS	Trt 3 YD	YD	RDS	REP B RDS	Trt 3 RD	RD
YDS	YDS	YD	YD	RDS	RDS	RD	RD
YDS	YDS	YD	YD	RDS	RDS	RD	RD
YDS	YDS	Trt 1 YD	YD	RDS	RDS	Trt 2 RD	RD
YDS	YDS	YD	YD	RDS	RDS	RD	RD
YDS	YDS	YD	YD	RDS	RDS	RD	RD
YDS	YDS	Trt 2 YD	YD	RDS	RDS	Trt 1 RD	RD
YDS	YDS	YD	YD	RDS	RDS	RD	RD
YDS	YDS	YD	YD	RDS	RDS	RD	RD
YDS	REP C YDS	Trt 2 YD	YD	RDS	REP A RDS	Trt 1 RD	RD
YDS	YDS	YD	YD	RDS	RDS	RD	RD
YDS	YDS	YD	YD	RDS	RDS	RD	RD
YDS	YDS	Trt 3 YD	YD	RDS	RDS	Trt 2 RD	RD
YDS	YDS	YD	YD	RDS	RDS	RD	RD
YDS	YDS	YD	YD	RDS	RDS	RD	RD
YDS	YDS	Trt 1 YD	YD	RDS	RDS	Trt 3 RD	RD
YDS	YDS	YD	YD	RDS	RDS	RD	RD
YDS	YDS	YD	YD	RDS	RDS	RD	RD

Figure 2

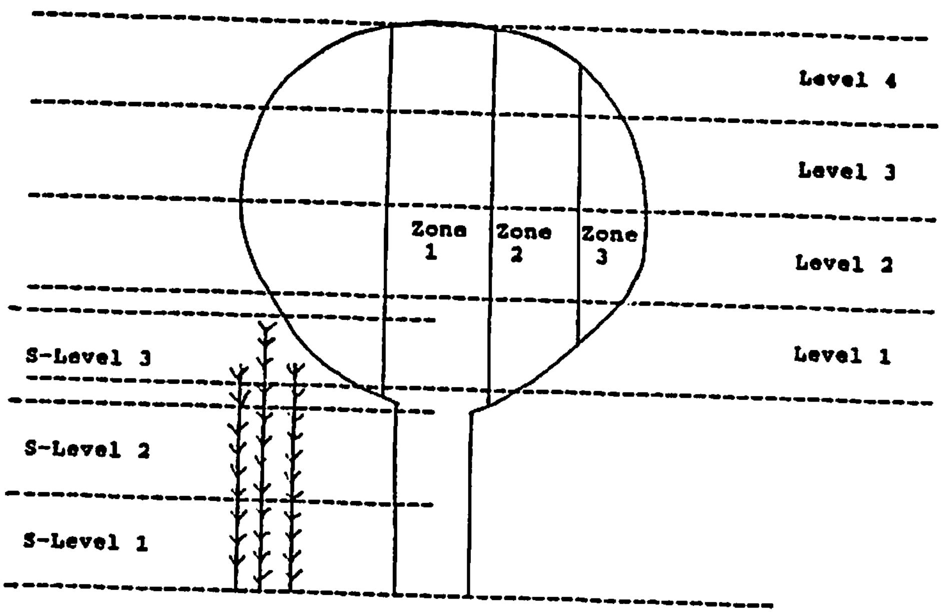


Figure 3

Census - July 1

S.punctum	9.3 /3 min/tree
Minute pirate bug	1.1 /3 min/tree
Lacewing larvae	0.4 /3 min/tree
A. fallacis	1.25 /100 leaves

Census - July 16

S.punctum	4.6 /3 min/tree
Minute pirate bug	0.04 /3 min/tree
Lacewing larvae	0.08 /3 min/tree
A. fallacis	0.75 /100 leaves

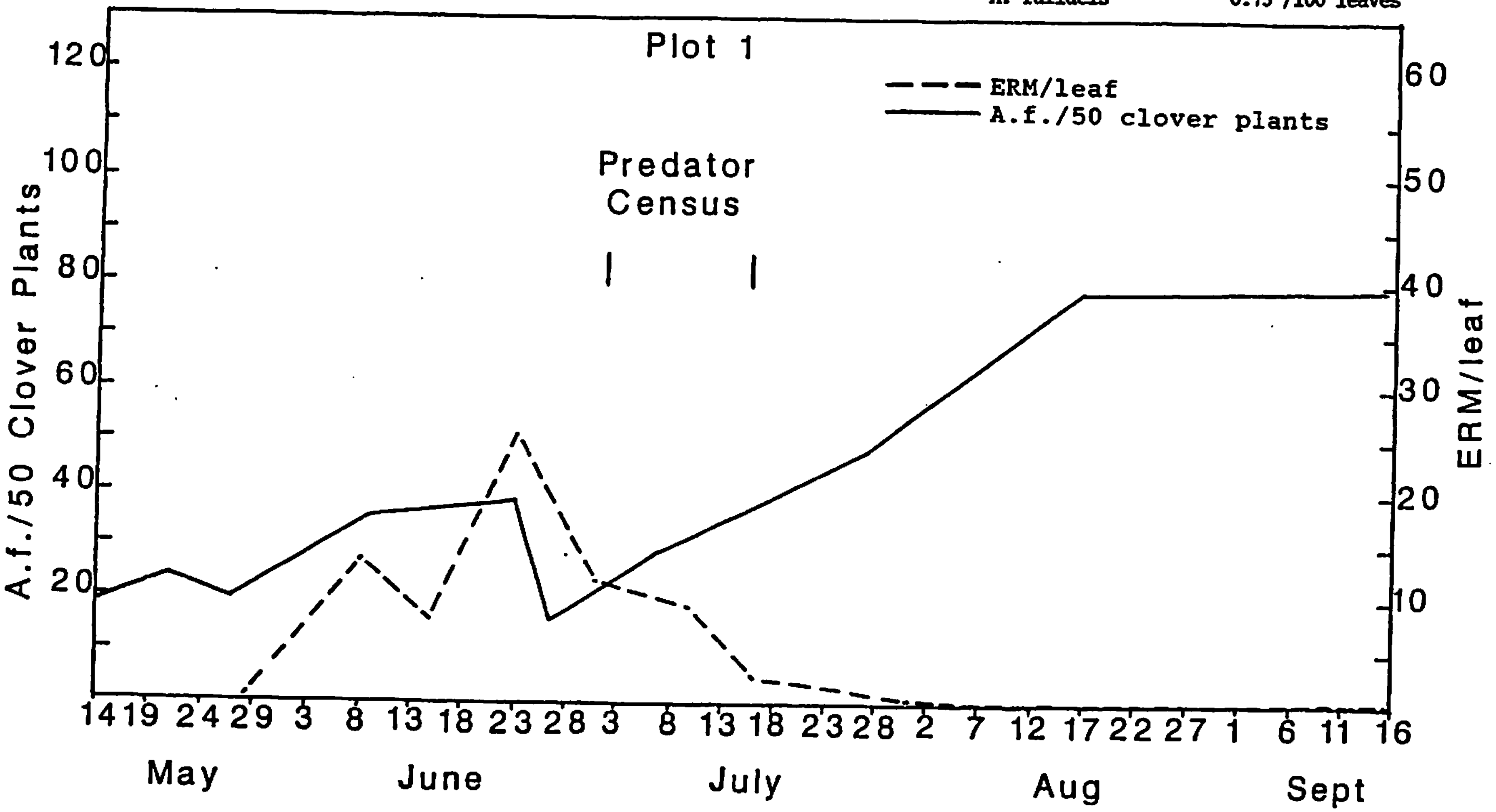


Figure 4

Census - July 1

S.punctum	5.5 /3 min/tree
Minute pirate bug	1.2 /3 min/tree
Lacewing larvae	0.6 /3 min/tree
A. fallacis	1.16 /100 leaves

Census - July 16

S.punctum	11.7 /3 min/tree
Minute pirate bug	0.2 /3 min/tree
Lacewing larvae	0.02 /3 min/tree
A. fallacis	0.0 /100 leaves

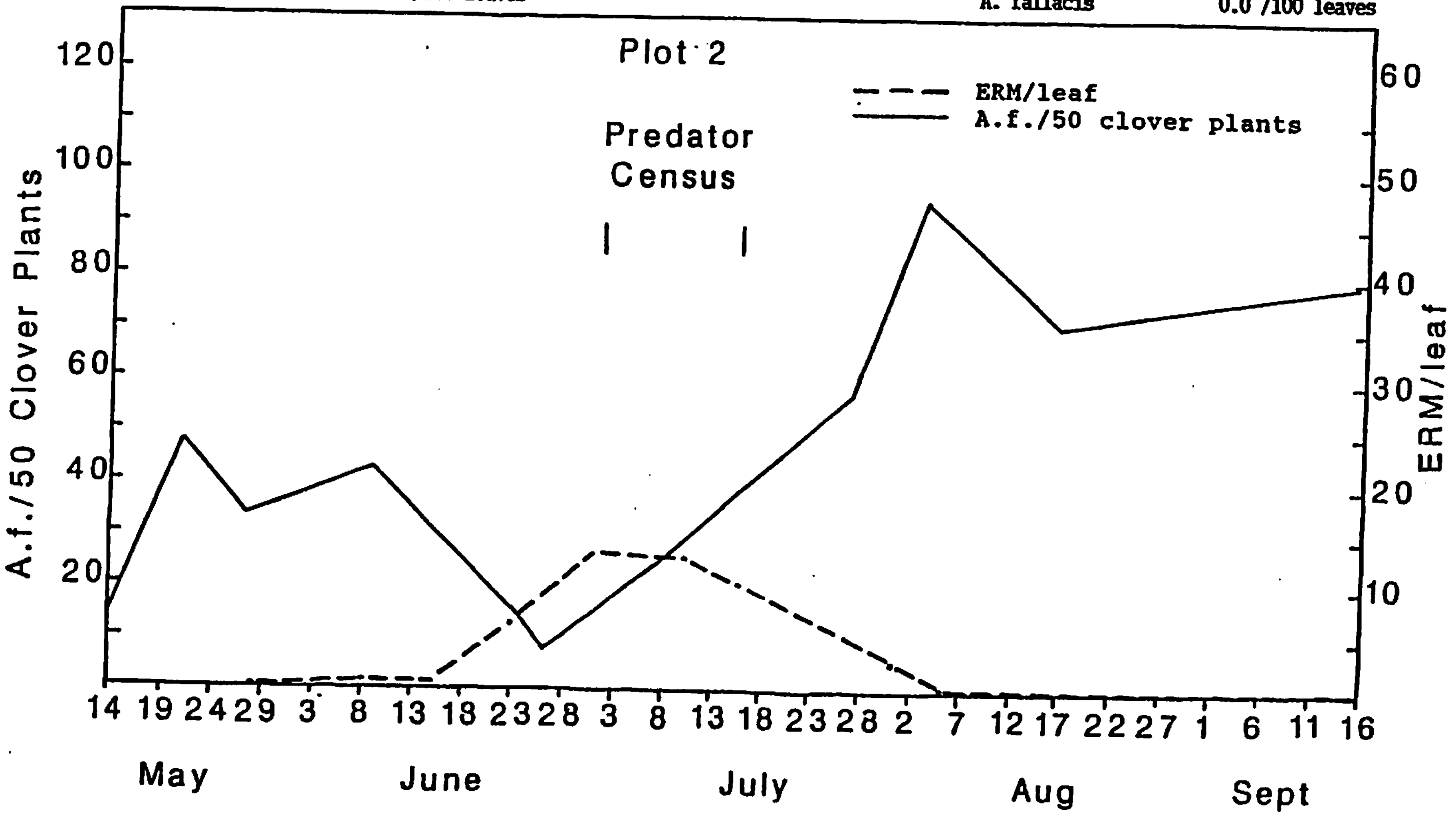


Figure 5

Census - July 1

S.punctum	0.9 /3 min/tree
Minute pirate bug	0.1 /3 min/tree
Lacewing larvae	0.3 /3 min/tree
A. fallacis	0.0 /100 leaves

Census - July 16

S.punctum	1.5 /3 min/tree
Minute pirate bug	0.06 /3 min/tree
Lacewing larvae	0.02 /3 min/tree
A. fallacis	0.0 /100 leaves

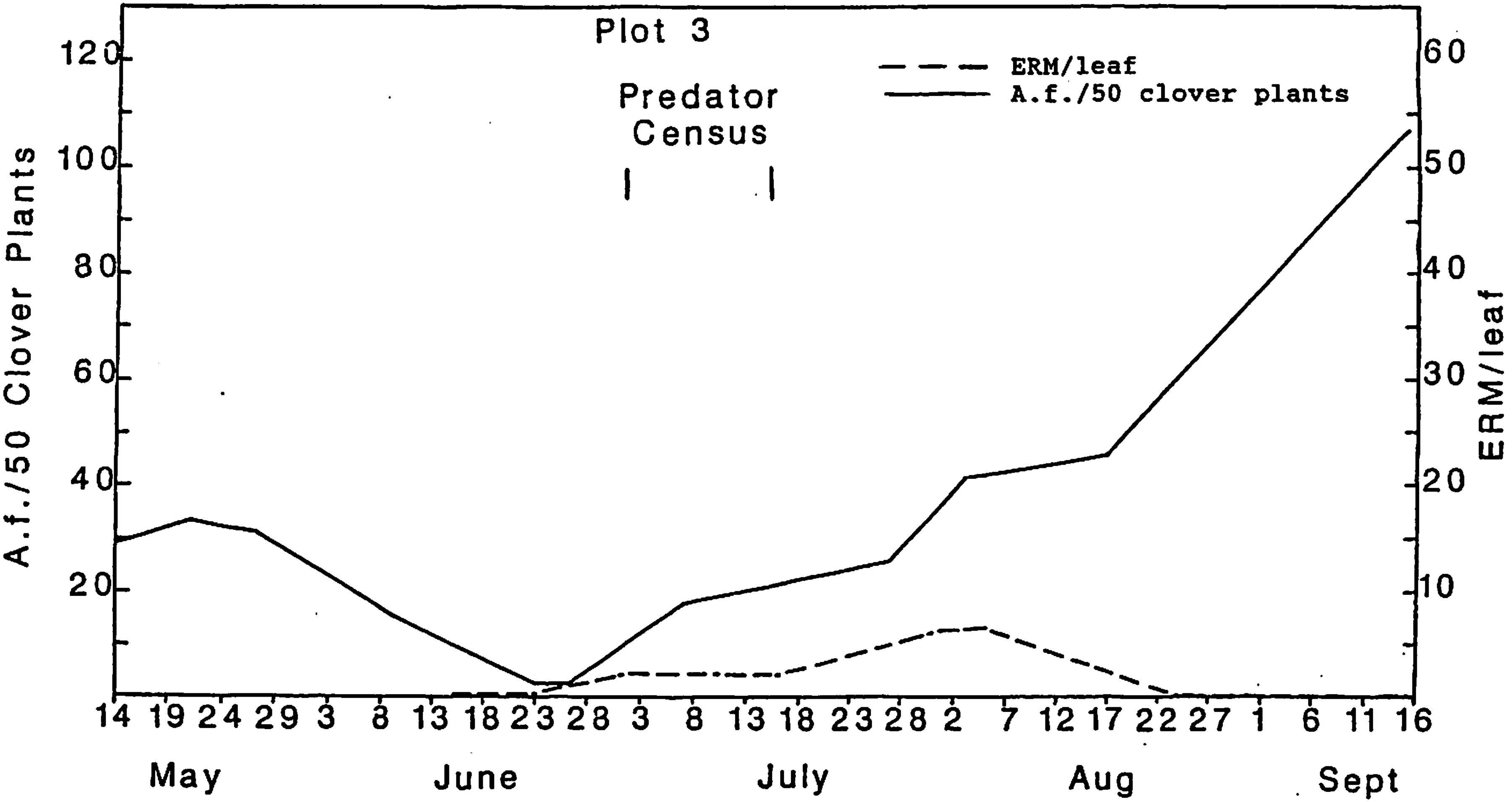


Figure 6

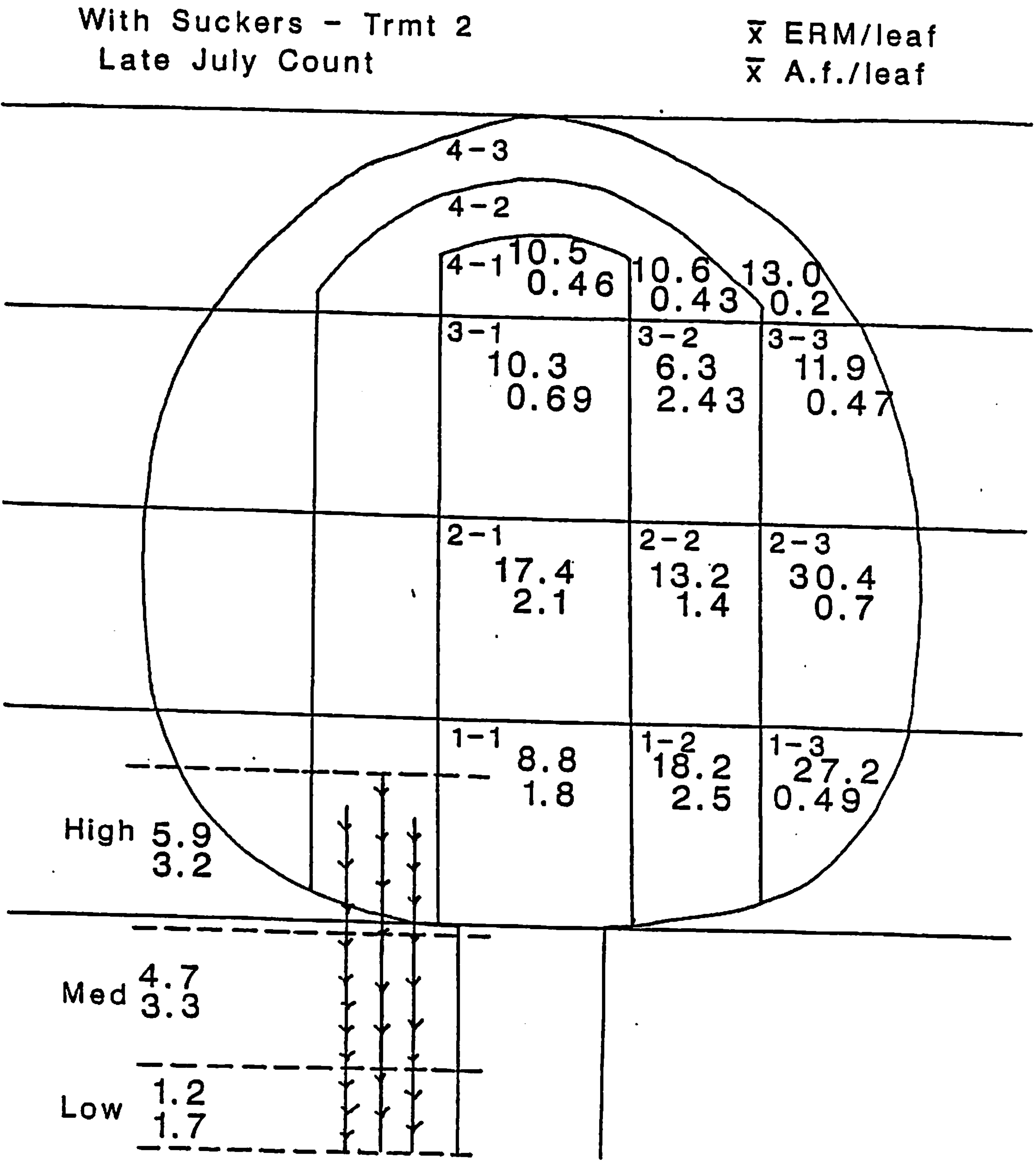

With Suckers - Trmt 2
Late July Count
x̄ ERM/leaf
x̄ A.f./leaf
4-3
4-2
4-1
10.5
0.46
10.6
0.43
13.0
0.2
3-1
10.3
0.69
3-2
6.3
2.43
3-3
11.9
0.47
2-1
17.4
2.1
2-2
13.2
1.4
2-3
30.4
0.7
1-1
8.8
1.8
1-2
18.2
2.5
1-3
27.2
0.49
High 5.9
3.2
Med 4.7
3.3
Low 1.2
1.7

Figure 7

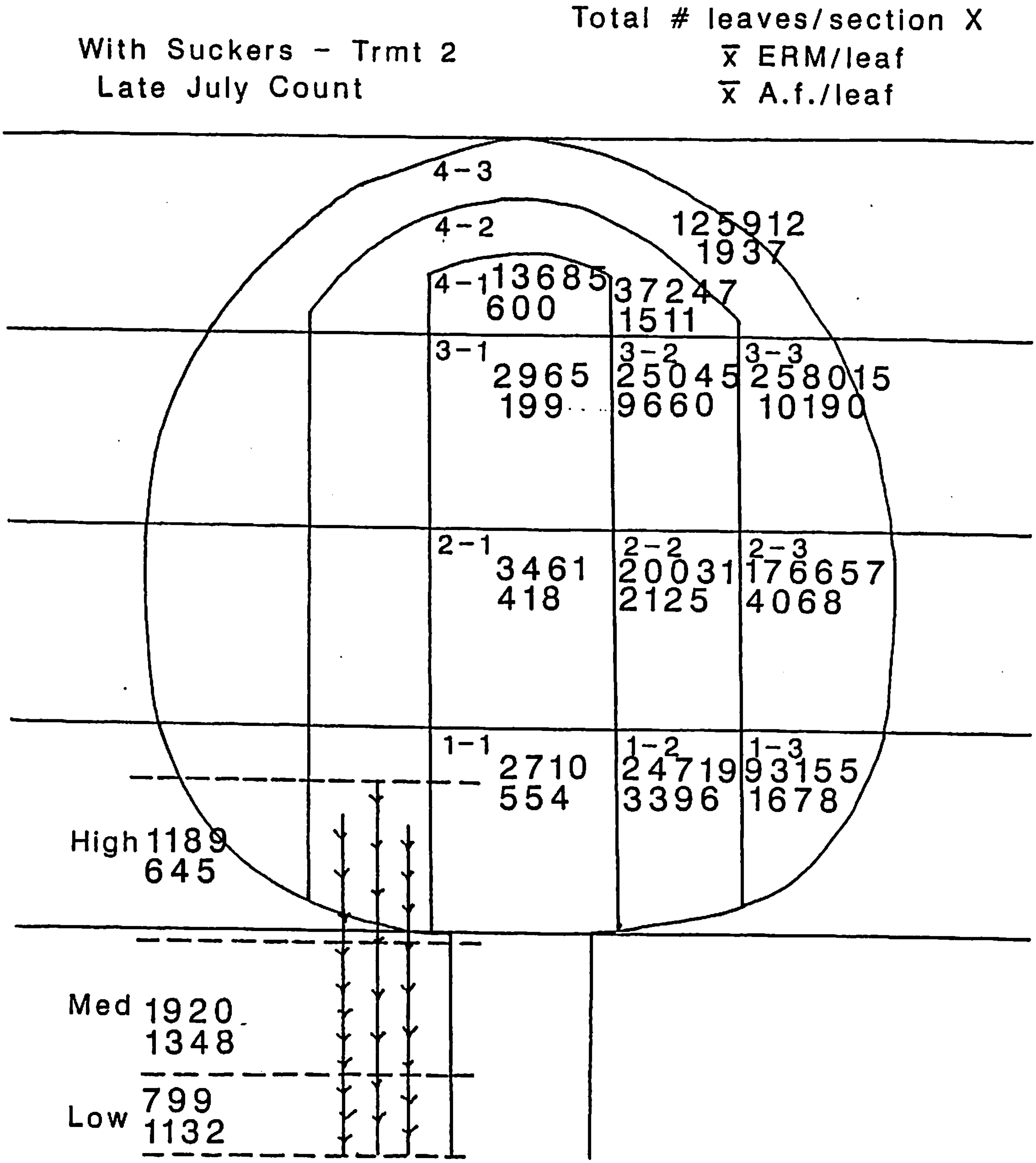

With Suckers - Trmt 2
Late July Count
Total # leaves/section X
$\bar{x}$ ERM/leaf
$\bar{x}$ A.f./leaf
4-3
4-2
125912
1937
4-1
13685
600
37247
1511
3-1
2965
199
3-2
25045
9660
3-3
258015
10190
2-1
3461
418
2-2
20031
2125
2-3
176657
4068
1-1
2710
554
1-2
24719
3396
1-3
93155
1678
High 1189
645
Med 1920
1348
Low 799
1132

Figure 8

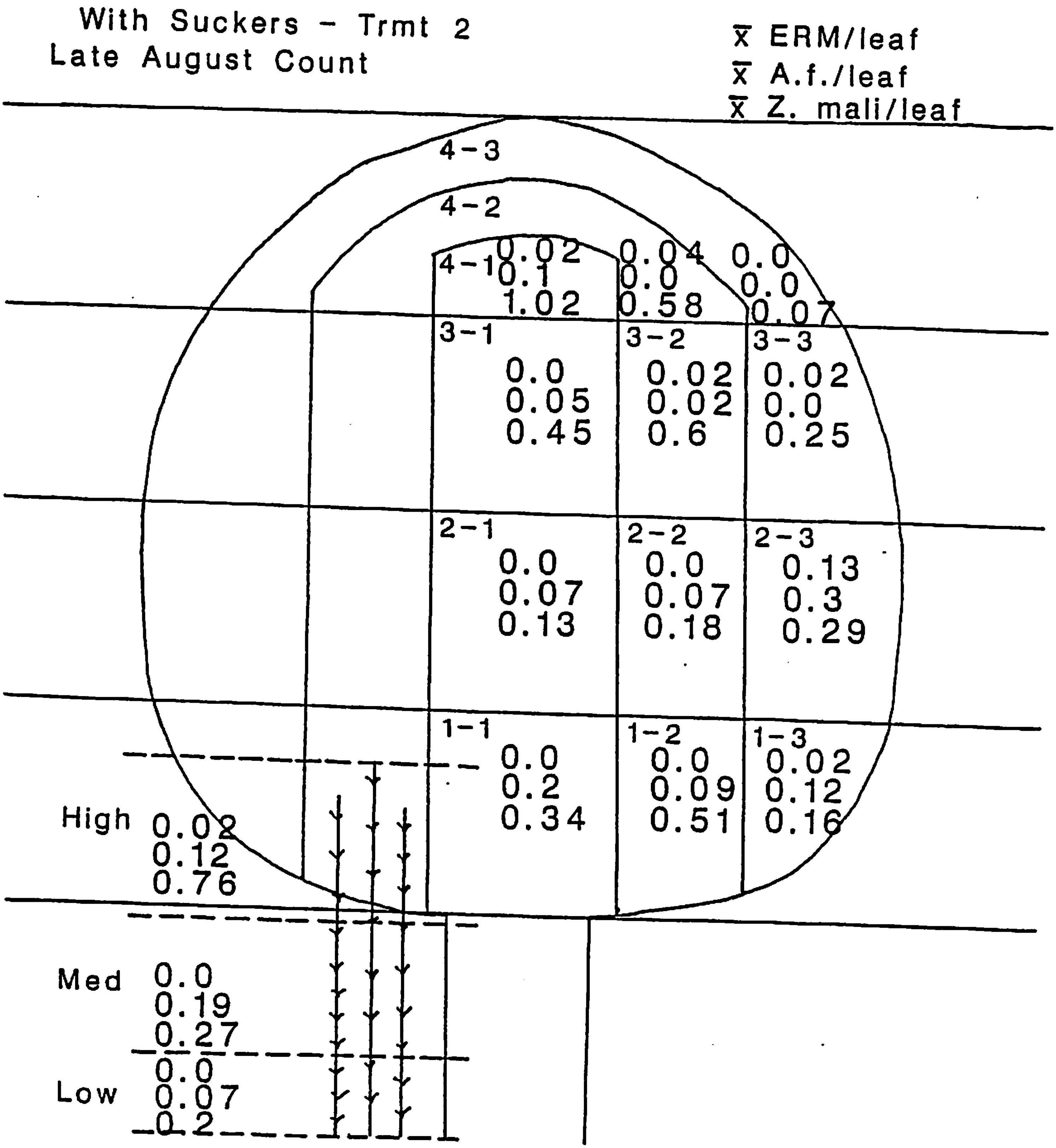
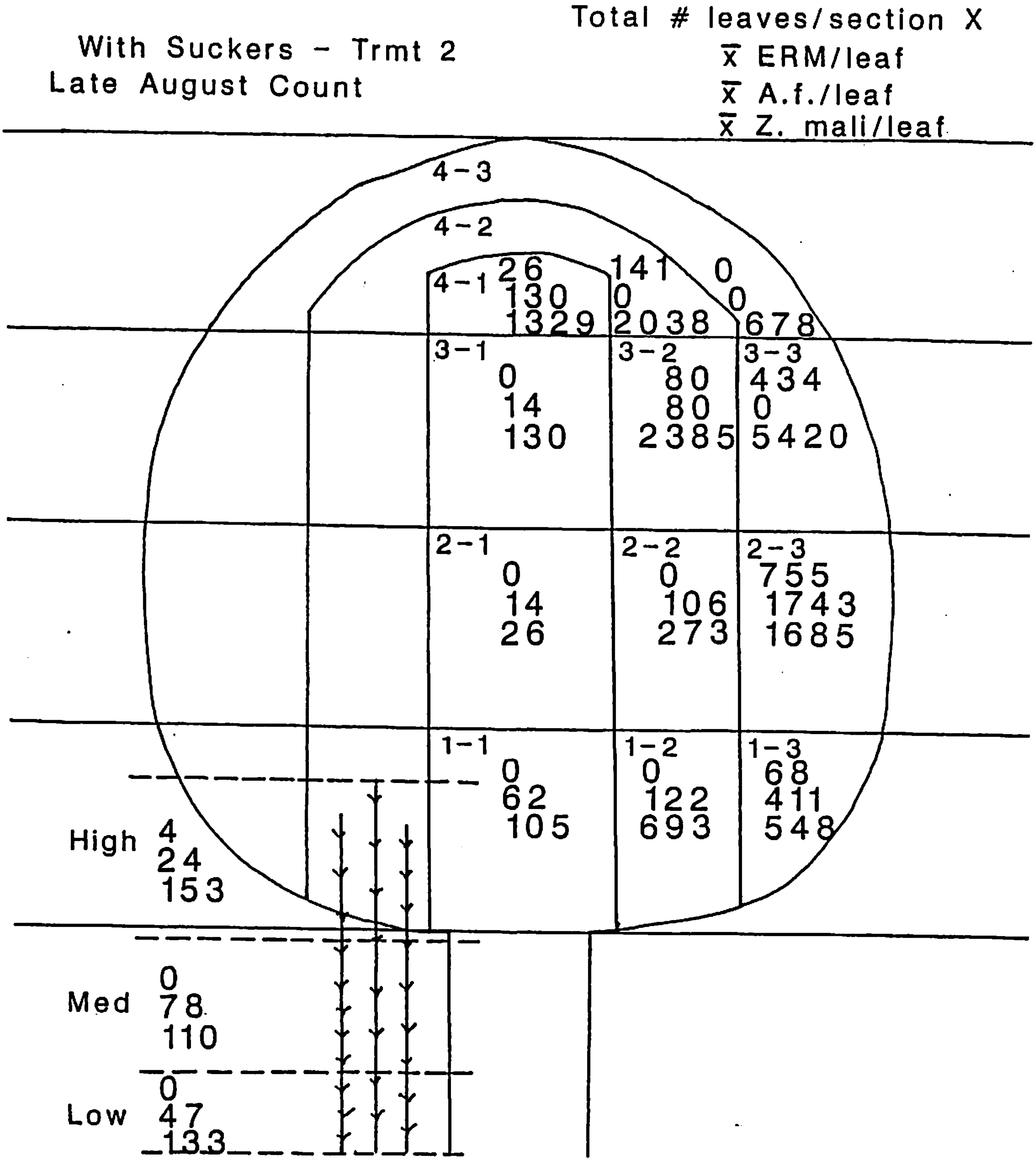

With Suckers - Trmt 2
Late August Count
x̄ ERM/leaf
x̄ A.f./leaf
x̄ Z. mali/leaf
4-3
4-2
4-1
0.02
0.1
1.02
0.04
0.0
0.58
0.0
0.0
0.07
3-1
0.0
0.05
0.45
3-2
0.02
0.02
0.6
3-3
0.02
0.0
0.25
2-1
0.0
0.07
0.13
2-2
0.0
0.07
0.18
2-3
0.13
0.3
0.29
1-1
0.0
0.2
0.34
1-2
0.0
0.09
0.51
1-3
0.02
0.12
0.16
High
0.02
0.12
0.76
Med
0.0
0.19
0.27
Low
0.0
0.07
0.2

Figure 9


With Suckers - Trmt 2
Late August Count
Total # leaves/section X
$\bar{x}$ ERM/leaf
$\bar{x}$ A.f./leaf
$\bar{x}$ Z. mali/leaf
4-3
4-2
4-1
26
130
1329
141
0
2038
0
0
678
3-1
0
14
130
3-2
80
80
2385
3-3
434
0
5420
2-1
0
14
26
2-2
0
106
273
2-3
755
1743
1685
1-1
0
62
105
1-2
0
122
693
1-3
68
411
548
High
4
24
153
Med
0
78
110
Low
0
47
133

Not for Citation

Control of the Spotted Tentiform Leafminer in Western North Carolina

James F. Walgenbach
North Carolina State University
Mtn. Hort. Crops Res. & Ext. Ctr.
Fletcher, NC 28732

The spotted tentiform leafminer (STLM) is a relatively new pest of apples in North Carolina. Infestations were first observed in Henderson Co. in 1984, and by 1986 infestations were reported from all apple production areas. The frequency of orchards requiring insecticide applications directed specifically at the STLM increased dramatically in 1987, and it is apparent that this pest is well established in North Carolina. The establishment of the STLM as a major pest in New York (Weires et al. 1982) and southern Ontario (Pree et al. 1980) has been associated with populations resistant to organophosphate insecticides, primarily azinphosmethyl. Alternative insecticides included a number of synthetic pyrethroids, the carbamates oxamyl and methomyl, and the organochlorine material endosulfan.

To develop a better understanding of the STLM in North Carolina, field studies were initiated in 1987 to determine the life cycle of this insect under NC conditions, the effectiveness of currently available insecticides for adult and larval control, and the occurrence of natural control agents. Reported here are preliminary findings from these studies.

Materials and Methods

Insecticides were evaluated for adult control in two commercial orchards that were heavily infested with STLM during the 1986 growing season. In both orchards, treatments consisted of a single tank of material applied at pink, which approximately corresponded to peak adult catches in pheromone traps. In the first orchard (Wilkes Co.) applications were made on April 14, and materials included two rates of permethrin 3.2E (0.1 and 0.05 lb AI/A), formetanate 92S (1 lb AI/A), endosulfan 3E (2 lb AI/A), and chlorpyrifos 50WP (1 lb AI/A). In the second orchard (Haywood Co.) applications were made on April 22, and again included two rates of permethrin 3.2E (0.1 and 0.05 lb AI/A), oxamyl 2E (1 lb/A), and chlorpyrifos 50WP (1 lb AI/A). Materials were evaluated by counting the number of larval mines (first and second generations) on 10 clusters/tree from each of six trees per treatment.

A wide range of insecticides were evaluated as larvicides in laboratory bioassays, which utilized field collected leaves containing mines of third or fourth generation larvae. Experiment 1 was conducted

---

Acknowledgements. The author thanks C. Palmer and C. Curtis for their technical assistance, and to the Growers of Haywood, Henderson and Wilkes Co. for their cooperation.

with leaves (fourth generation larvae) collected on September 15, from an orchard treated with permethrin (0.1 lb AI/A) on April 14 (pink). Experiment 2 used leaves (thirdgeneration larvae) collected on July 31, from an orchard with no previous history of STLM, and treated with azinphosmethyl and chlorpyrifos throughout the season. Leaves were dipped in solutions containing formulated materials in 1 gal water plus 5 ml of spreader sticker (Security brand). Control leaves were dipped in solutions of water plus spreader sticker. Leaves were submersed in solutions for 5 seconds, air dried for 30 minutes, and placed on moist filter paper in 15 cm diam petri dishes. Petri dishes were sealed with parafilm to maintain a moist environment and to isolate each leaf. Each treatment consisted of three replications of 10 leaves (30 leaves total). Larval mortality was assessed at 72 h post treatment by opening active mines on all leaves and recording the stage of larval development (sap feeder or tissue feeder) and whether larvae were dead or alive.

To obtain preliminary information on the natural enemy complex and extent of parasitization of the STLM in NC, three orchards with known STLM infestations were sampled at various times during the season. All tissue feeder mines were opened and the agent responsible for mortality was determined, if possible. Samples of each parasite type were saved for identification by the Insect Identification and Beneficial Insect Introduction Institute (USDA-ARS, Beltsville, MD).

Results and Discussion

The occurrence of four distinct broods of sap feeders (mid May, late June, early August and early September), coupled with four adult flight periods indicate that the STLM completed four generations in North Carolina in 1987. Peak adult flight periods are clearly distinguished in pheromone trap catches from Polk Co. (Fig. 1). This is in contrast to only three generations in New York (Weires et al. 1982), the midwest (Dutcher & Howitt 1978, Ridgway & Mahr 1985) and southern Ontario (Pree et al. 1980). Pheromone trap catches at the Mountain Horticultural Crops Research Station (Fletcher, NC) did not distinguish adult flight periods as clearly (Fig. 2), but trap counts do illustrate that adult activity began in late March (green tip) and continued into October. Although few in number, adults have continued to be captured during November.

The timing of insecticide applications during pink at the Wilkes and Haywood locations coincided with peak adult activity. First generation larval populations were present in extremely low numbers at both locations, so low that meaningful data could not be collected. However, second generation larvae were present in large numbers, and the pink application of all materials significantly reduced second brood larval populations below those in the untreated control (Table 1). Although an untreated control was not included at the Haywood location, it appears that the Haywood population was more resistant to azinphosmethyl than the Wilkes population. Formetanate, endosulfan, oxamyl and both rates of permethrin appear to be effective early season (prebloom) materials for STLM control in North Carolina.

The organophosphate insecticides chlorpyrifos and azinphosmethyl were both ineffective against field collected STLM larvae (Table 2). Oxamyl, methomyl, endosulfan and permethrin were all highly toxic to sap feeding larvae in experiment 1. Formetanate was less effective and did not significantly differ from chlorpyrifos. Similar results were obtained when testing materials against tissue feeding larvae (experiment 2), except that permethrin was less effective and did not differ significantly from control mortality. Oxamyl, methomyl and endosulfan were also the most toxic materials against tissue feeders.

The response of NC STLM populations to various insecticides is similar to that of organophosphate resistant populations in New York (Weires et al. 1982) and southern Ontario (Pree et al. 1980). The failure of both chlorpyrifos and azinphosmethyl against larvae in our studies suggests that the appearance of the STLM in North Carolina is also associated with resistance to organophosphate insecticides. However, in a trial evaluating anzinphosmethyl and chlorpyrifos as cover sprays, azinphosmethyl provided excellent control of second generation larvae while chlorpyrifos did not (table 3). These results, coupled with the fact that chlorpyrifos exhibited significant control of leafminers when applied at pink at the Wilkes Co. location (Table 1), indicate that STLM populations within NC vary in their level of resistance to different organophosphate insecticides.

The two most commonly encountered STLM parasites were a braconid, preliminarily identified as _Pholetesor ornigis_ (Weed), and the eulophid _Sympiesis marylandensis_ Girault (identified by M.E. Schauff, Systematic Entomology Laboratory, USDA). These species have been previously been reported to be the most important STLM parasites throughout North America (Pottinger & LeRoux 1971, Dutcher & Howitt 1978, Weires et al. 1980, Van Driesche & Taub 1983, Ridgway & Mahr 1985). In our studies the braconid was the predominant parasite of first generation tissue feeders in the Henderson and Haywood Co. orchards, whereas _S. marylandensis_ was the predominate parasite of third and fourth generation larvae in two different Henderson Co. orchards (Table 4). This is in contrast to the situation in the northern US and Canada, where _P. ornigis_ was most important during first and third STLM generations and _S. marylandensis_ was highest on second generation STLM, and very low on third generation (Ridgway & Mahr 1985). The reason for this reversed trend in NC is not clear, but possibilities include different environmental conditions or differential toxicity of orchard insecticides to parasites. Different _P. ornigis_ populations have been shown to differ in their response to permethrin, fenvalerate, and methomyl (Trimble & Pree 1987).

Conclusion

Similar to other areas of North America, the sudden appearance of the STLM as a major pest of apples in North Carolina appears to be associated with populations resistant to organophosphate insecticides. However, resistance to one organophosphate insecticide does not necessarily confer cross resistance to similar materials. Control of this insect may be obtained with a prebloom application of formetanate, oxamyl, endosulfan, or a pyrethroid. Insecticides to be used against larvae after bloom include oxamyl, methomyl or endosulfan. The use of pyrethroids after bloom is discouraged due to the reduced effectiveness of these materials against tissue feeder larvae and their disruptive effect on integrated mite control programs. Parasites determined to be effective natural control agents in the northern ranges of STLM distribution appear to be well established in NC. Determination of parasite flight periods and insecticide toxicity to parasites will aid in developing an integrated approach to control of the STLM in NC.

Literature Cited

Dutcher, J.D, and A.J. Howitt. 1978. Bionomics and control of *Lithocolletis blancardella* in Michigan. J. Econ. Entomol. 71: 736-38.

Pottinger, R.P. and E.J. LeRoux. 1971. The biology and dynamics of *Lithocolletis blancardella* (Lepidoptera: Gracillariidae) on apple in Quebec. Entomol. Soc. Can. Mem. 77: 1-437.

Pree, D.J., E.A.C. Hagley, and C.M. Simpson. 1980. Resistance of the spotted tentiform leafminer, *Phyllonorycter blancardella* (Lepidoptera: Gracillariidae), to organophosphorous insecticides in southern Ontario. Can. Ent. 112: 469-474.

Ridgway, N.M., and D.L. Mahr. 1985. Natural enemies of the spotted tentiform leafminer, *Phyllonorycter blancardella* (Lepidoptera: Gracillariidae), in sprayed and unsprayed apple orchards in Wisconsin. Environ. Entomol. 14: 459-463.

Trimble, R.M. and D.J. Pree. 1987. Relative toxicity of six inseticides to male and female *Pholetesor ornigis* (Weed) (Hymenoptera: Braconidae), a parasite of the spotted tentiform leafminer, *Phyllonorycter blancardella* (Fabr.) (Lepidoptera: Gracillariidae). Can. Ent. 119: 153-157.

Van Driesche, R., and G. Taub. 1983. Impact of parasitoids on *Phyllonorycter* leafminers infesting apple in Massachusetts, U.S.A. Prot. Ecol. 5: 303-317.

Weires, R.W., D.R. Davis, J.R. Leeper, and W.H. Reissig. 1980. Distribution and parasitism of gracillariid leafminers on apple in the North East. Ann. Entomol. Soc. Am. 73: 541-546.

Weires, R.W., J.R. Leeper, W.H. Reissig, and S.E. Lienk. 1982. Toxicity of several insecticides to the spotted tentiform leafminer (Lepidoptera: Gracillariidae) and its parasite, *Apanteles ornigis*. J. Econ. Entomol. 75: 680-684.

Table 1. Second generation STLM tissue feeder mines resulting from various insecticides applied at pink stage of development on April 14 (Wilkes Co.) and April 22 (Haywood Co.).

Material	Rate (lb AI/A)	Mines/10 leaves*	
		Wilkes (Jul 9)	Haywood (Aug 7)
permethrin 3.2EC	0.1	0.7 a	1.0 a
permethrin 3.2EC	0.05	1.0 a	2.8 a
formetanate 92S	1.0	1.1 a	-
oxamyl 2EC	1.0	-	1.8 a
endosulfan 3EC	2.0	1.3 ab	-
chlorpyrifos 50WP	1.0	2.1 b	13.6 b
control	-	13.6 c	-

* Numbers in the same column followed by the same letter are not significantly different by Tukey's HSD (P<0.05).

Table 2. STLM larval mortality resulting from dipping infested leaves into various concentrations.

Material	Rate (lb AI/100 gal)	% Mortality*	
		Exp. 1 (sap feeders)	Exp. 2 (tissue feeders)
chlorpyrifos 50WP	0.5	26 ab	31 b
azinphosmethl 35WP	1.0	-	9 a
oxamyl 2E	0.25	91 c	85 bc
methomyl 1.8L	0.45	82 c	92 c
formetanate 92S	0.25	42 b	28 a
endosulfan 3E	0.5	86 c	78 bc
permethrin 3.2E	0.025	92 c	48 abc
Control	-	14 a	21 a

* Numbers in the same column followed by the same letter are not significantly different by Tukey's HSD (P<0.05).

Table 3. First and second generation spotted tentiform leafminer populations on apples treated with various inseciticides. Applications made on April 18, May 4, May 19, June 5 and July 17, 1987. Henderson Co., North Carolina.

		Mines/leaf*	
Material	Rate (lb AI/A)	First Gen. (May 28)	Second Gen. (July 23)
chlorpyrifos 50WP	0.5	0.2 b	2.7 b
chlorpyrifos 50WP	1.0	0.7 c	3.6 c
chlorpyrifos 50WP	1.5	0.4 b	2.0 b
chlorpyrifos 50WP +	0.5	0.0 a	0.4 a
methomyl 1.8L	0.34		
azinphosmethyl 35WP	1.5	0.0 a	0.6 a

* Numbers in the same column followed by the same letter are not significanty different by Tukey's HSD (P<0.05).

Table 4. Parasitization of the STLM in western North Carolina. 1987.

			% Mines parasitized*	
Location	Generation	Number of Mines	Pholetesor ornigis	Sympiesis marylandensis
Henderson 1	Second	2,075	13.1	-
Henderson 1	Third	161	2.3	43.7
Haywood 1	Second	376	24.8	11.8
Henderson 2	Fourth	200	0.5	67.5

* Pholetesor ornigis (Weed) (Hymenoptera: Braconidae) identifiec by P.M. Marsh (Systematic Entomology Laboratory, USDA). Sympiesis marylandensis (Girault) (Hymenoptera: Eulophidae) identified by M.E. Schauff (Systematic Entomoloyg Laboratory, USDA).

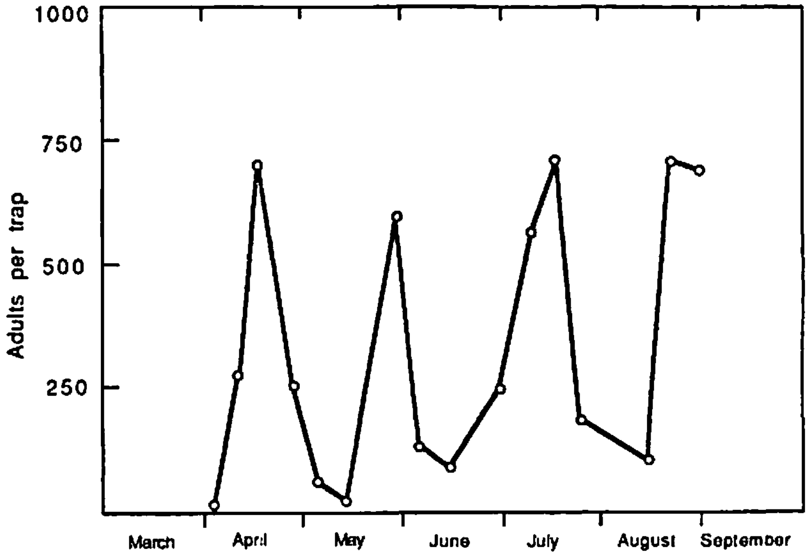


Figure 1. Pheromone trap catches of the spotted tentiform leafminer in a sprayed orchard. Polk, Co., NC. 1987.

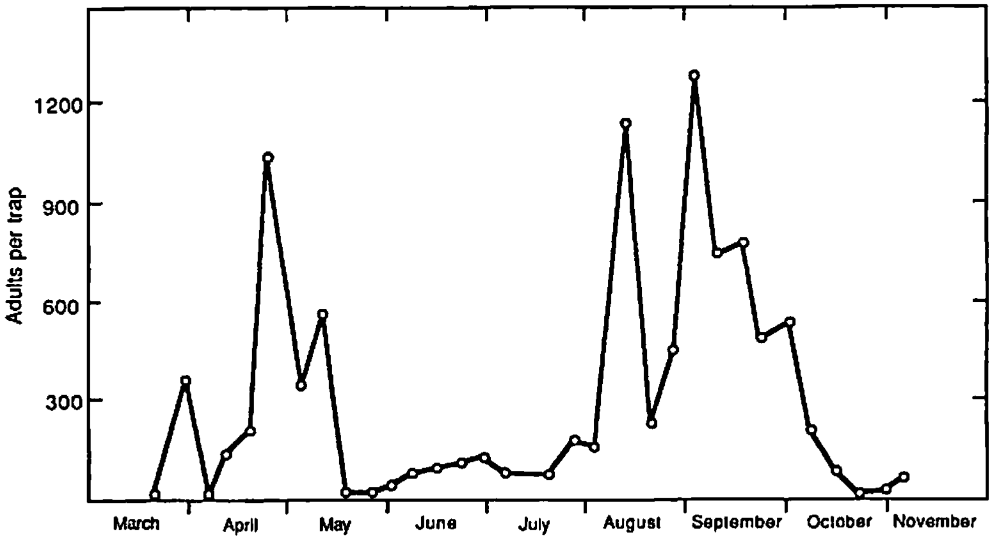


Figure 1. Pheromone trap catches of the spotted tentiform leafminer in a sprayed orchard at the Mountain Horticultural Crops Research Station, Fletcher, NC. 1987.

FIRE BLIGHT CONTROL TRIALS - 1987

J. G. Barrat, WVU Experiment Farm Kearneysville, WV 25430
T. van der Zwet, Appalachian Fruit Research Station, Kearneysville, WV

BLOCK X

Chemical materials for the control of fire blight were applied to 7-year old Golden Delicious/MM106 and Rome Beauty/MM106 apple trees. The trees were set 16 x 24 feet in six alternate variety rows with 33 trees per row. The spray materials were applied to three replicates of 4 trees each using a Swanson DA-23 3-point hitch airblast sprayer at 100 psi and delivering 250 gallons per acre while traveling at 1.17 mph. The sprays were applied at pink (4/23), full bloom (5/1) and petal fall (5/11). The trees were inoculated on 5/1 just prior to the chemical spray with Erwinia amylovora at 10^8 bacterial cells per ml. Generally, weather conditions were cool and not favorable for fire blight development. Fire blight strikes per tree were recorded on 6/8 and 6/18 and combined per trial in Table 1. DC 5772 2% caused severe injury to the foliage in the pink spray and was not repeated. Standard spray materials were applied to control fungus diseases and insects. Fruit finish ratings (0-5, 5 = heavy) were made on September 3rd.

Table 1. Fire blight strikes per trial.

GOLDEN DELICIOUS

	JUNE 8		JUNE 18		Fruit Finish Rating
Chemical	No. trees affected	No. strikes per trial	No. trees affected	No. strikes per trial	(0-5)
S0208 60 ppm	1	2	3	6	1.58
S0208 100 ppm	2	3	3	4	1.32
S0208 300 ppm	1	1	1	1	1.99
Strep 60 ppm	2	3	2	2	1.51
Strep 100 ppm	0	0	2	2	1.12
COCS 4 oz/100 gal	1	1	0	0	2.73
DC 5772 2%	1	1	1	1	3.16
Check	5	11	5	15	1.50

ROME BEAUTY

	JUNE 8		JUNE 18		Fruit Finish Rating
Chemical	No. trees affected	No. strikes per trial	No. trees affected	No. strikes per trial	(0-5)
S0208 60 ppm	3	3	3	20	1.70
S0208 100 ppm	2	4	5	8	1.46
S0208 300 ppm	1	1	6	9	1.50
Strep 60 ppm	5	15	6	57	1.40
Strep 100 ppm	2	2	2	6	1.48
COCS 4 oz/100 gal	1	1	5	14	1.85
DC 5772 2%	4	4	6	13	3.23
Check	5	13	8	34	1.15

FUNGUS DISEASE CONTROL ON GOLDEN DELICIOUS AND ROME BEAUTY APPLES WITH NUSTAR-MANCOZEB FUNGICIDES - 1987

J. G. Barrat, WVU Experiment Farm, Kearneysville, WV 25430

Nustar fungicide (I. E. du Pont de Nemours & Co.) plus manzate 200 were applied to 6 rows of 7-year old Golden Delicious and Rome Beauty apple trees in Block X for general fungus disease control. Fire blight materials were also applied to this block and the fungus control data were taken from 3 randomized check replicates of 4 trees each for each variety. Twelve trees in a seventh row of Golden Delicious served as three 4-tree/insecticide only replicates. Trees were set 16 x 24 feet with 33 trees per row. Nustar was applied at the rate of 0.6 oz ai (3.0 oz product) per acre in combination with mancozeb 80W (Manzate 200) at the rate of 2.0 lb per acre. The sprays were applied with a Swanson DA-23 3-point hitch airblast sprayer delivering 250 gallons of spray mixture per acre at 100 psi while traveling at 1.17 mph. The dates of Nustar-Manzate 200 applications were on a 10-14 day schedule: 4/9, 4/20, 5/5, 5/19, 6/1 (second cover) followed by benomyl 50W (Benlate) at 3.0 oz product per acre plus Manzate 200 at 21.5 oz per acre on a 10-14 day schedule on 6/15, 6/25, 7/8, 7/22, 8/5 and 8/19.

Foliar apple scab, cedar rust, powdery mildew and frog-eye leafspot data were taken on June 30. Fruit disease and finish data were taken on August 31. The data were taken from 200 leaves and 50 fruit per replicate, counting the number of infections and converting to percent infection per treatment (Table 1). Fruit finish was rated on a 0 to 5 basis with 5 heavy russeting. Powdery mildew infections in all treated plots were mild. Golden Delicious check trees were sprayed with insecticides only. No Rome Beauty check trees were available.

Table 1. Percent disease infection on leaves and fruit and rating of fruit finish.

	FOLIAGE (6/30)			
Variety	Apple scab	Cedar rust	Powdery mildew	Frog-eye leafspot
Rome Beauty	1.16	0.0	46.10	3.16
Golden Delicious	1.83	0.0	35.16	6.00
Golden Del. (Check)	18.00	15.16	45.66	22.00

	FRUIT (8/31)					
Variety	Apple scab	Cedar rust	Sooty blotch	Fly speck	Black rot	Fruit finish rating (0-5)
Rome Beauty	7.3	0.0	0.0	0.0	4.0	1.33
Golden Delicious	0.0	0.0	0.0	0.0	9.3	1.50
Golden Del. (Check)	43.0	0.0	5.0	2.5	2.0	1.91

RUBIGAN FUNGICIDE APPLICATIONS TO APPLES - 1987

J. G. Barrat, WVU Experiment Farm, Kearneysville, WV 25430

The combination of Rubigan 12.5EC (Elanco) at the rate of 6.0 oz/acre plus metiram 80W (Polyram) at 3.0 lb/acre was applied to Spur Red Delicious/M9, Golden Delicious/M9 and Red York/M9 apples and compared with benomyl 50W (Benlate) at 12 oz/acre plus Polyram at 3.0 lb/acre, both at 100 gallons per acre. No check trees were available for this trial. The Rubigan-Polyram sprayed trees were grown on a 3-wire trellis system set 6 x 12 feet while the Benlate-Polyram sprayed trees were on a Dutch spindlebush system set 3 x 9 feet. The trees were maintained at about 6 to 8 feet in height. The spray materials were applied with a Bean G 257CP airblast sprayer delivering 100 gallons per acre while traveling at 2.5 mph. The fungicidal applications were maintained on about a 2-week schedule from pre-pink (4/20) to the 2nd cover spray (5/26) and followed by Dikar 76.7W at 5 lb/acre from the 3rd cover (6/22) to the 5th cover (7/21) and then with mancozeb (Dithane M-45) for the 7th and 8th cover sprays. Standard insecticides included: Cygon 400, Thiodan 50W, Carzol 92SP, Guthion 50W, Lannate 1.8L, Penncap-M 2F, Vydate 2L and Sevin 50W. Spray dates were: 4/2, 4/20, 4/27, 5/12, 5/26, 6/11, 6/22, 7/6, 7/20, 8/3 and 8/17.

Foliar disease data were taken on 7/28 by collecting 50 leaves from each of 5 replicates per trial and recording disease incidence (Table 1). Fruit disease counts were made on 9/4 from 50 fruits per trial (Table 2).

Table 1. Disease infection per 250 leaves per trial.

	FOLIAGE			
Rubigan-Polyram	Apple scab	Cedar rust	Powdery mildew	Frog-eye leafspot
Spur Red Delicious/M9	16	0	7	7
Red York/M9	11	9	15	24
Golden Delicious/M9	4	3	14	12
Benlate-Polyram				
Spur Red Delicious/M9	61	0	14	25
Golden Delicious/M9	22	26	17	28

Table 2. Disease infection and fruit finish per 50 fruit per trial.

	FRUIT					
Rubigan-Polyram	Apple scab	Cedar rust	Sooty blotch	Fly speck	Black rot	Fruit Finish Rating (0-5)
Spur Red Delicious/M9	0	0	0	0	0	1.5
Red York/M9	0	0	1	0	2	2.0
Golden Delicious/M9	0	0	0	0	2	2.3
Benlate-Polyram						
Spur Red Delicious/M9	1	0	0	0	2	0.5
Golden Delicious/M9	0	0	0	0	1	2.9

TD-2246 FUNGICIDE (PENNWALT) TRIALS ON GOLDEN DELICIOUS APPLES-1987

J. G. Barrat, WVU Experiment Farm, Kearneysville, WV 25430

TD-2246 fungicide (thiophanate-methyl 70W (Topsin-M) combined with mancozeb 80W (Penncozeb) (Pennwalt) (4.5 lb ai (67.9%)/acre) was applied to sixteen 7-year old Golden Delicious/MM106 apple trees set 16 feet apart in a row and comprising four 4-tree replicates. The material was applied with a Swanson DA-23 3-point hitch airblast sprayer delivering 250 gallons of material per acre at 100 psi while traveling at 1.17 mph. The spray dates were: 4/7, 4/14, 4/20, 4/29, 5/6, 5/13, 5/21, 6/1, 6/15, 6/25, 7/8, 7/22, 8/5 and 8/19. Foliar disease data were taken on June 30, and fruit disease data and finish were taken on August 25. Disease data were taken from 200 random leaves and 50 fruit per replicate; counting the number of infections and converting to percent infection for each treatment Table 1). Fruit finish was rated on a 0 to 5 basis with 5 heavy russeting. All powdery mildew infections in the TD-2246 plots were mild. Check trees consisted of three 4-tree replicates in a single row. Disease and finish counts were made in the same manner and received insecticide sprays only.

Table 1. Percent foliar and fruit infections and rating of fruit finish on Golden Delicious/MM 106 apple trees.

	FOLIAGE (6/30)			
	Apple scab	Cedar rust	Powdery mildew	Frog-eye leafspot
TD-2246	1.5	0.25	15.0	3.125
Check	18.8	15.16	45.6	22.0

	FRUIT (8/25)						
	Apple scab	Cedar rust	Black rot	Sooty blotch	Fly speck	Other	Fruit finish rating (0-5)
TD-2246	0	0	3.5	0	0	4.5	1.11
Check	43.0	0	2.0	5.0	2.5	2.0	1.91

PEACH LEAF CURL, PEACH SCAB, BROWN ROT AND *RHIZOPUS* ROT CONTROL TRIALS WITH BRAVO 720 - 1987

J. G. Barrat, WVU Experiment Farm, Kearneysville, WV 25430

Bravo 720 (Fermenta) fungicide was applied to M. A. Blake peaches at various concentrations and timing schedules (Table 1).

SCHEDULE #1. Bravo 720 at 3.125 pints/acre changing to captan 50W at 4.0 lb acre plus wettable sulfur 95W at 12 lb/acre.

SCHEDULE #2. Bravo 720 at 4.0 pints/acre changing to captan 50W plus wettable sulfur 95W.

SCHEDULE #3. Bravo 720 at 4.0 pints/acre at petal fall and 8 pints/acre at shuck-split and changing to captan 50W plus wettable sulfur 95W.

SCHEDULE #4. Captan 50W at 4.0 lb/acre plus wettable sulfur 95W at 12 lb/acre.

SCHEDULE #5. Insecticide sprays only.

Table 1. Bravo 720 and captan-sulfur applications and timing schedules.

Timing	Schedule #1	Schedule #2	Schedule #3	Schedule #4	Schedule #5
Dormant 3/23	Bravo 720	0	0	capt-sulf	0
Pink 4/9	+	0	0	+	0
Full Bloom 4/20	+	0	0	+	0
Petal Fall 4/29	+	Bravo 720	Bravo 720	+	0
Shuck-Split 5/5	+	+	+	+	0
Shuck-Fall 5/13	+	0	0	+	0
1st Cover 5/27	capt-sulf	capt-sulf	0	+	0
2nd Cover 6/10	+	+	Capt-sulf	+	0
3rd Cover 6/24	+	+	+	+	0
4th Cover 7/8	+	+	+	+	0
5th Cover 7/22	+	+	+	+	0
6th Cover 8/5	+	+	+	+	0
7th Cover 8/19	+	+	+	+	0

The test materials were applied to 7-year old trees set 20 x 20 feet with a Swanson DA-23 3-point hitch airblast sprayer delivering 250 gallons per acre at 100 psi while traveling at 1.17 mph. Ferbam 75W (Carbamate) at 5.0 lb/acre had been applied to all plots in the fall of 1986 for peach leaf curl control. The incidence of peach leaf curl was recorded on 5/21 (Table 2). Peach scab infections were first noted on the Blake variety on 7/14, and the data for scab infection taken at harvest on 8/20 (Table 2).

Table 2. Peach leaf curl infected leaves per trial 5/21 and percent fruit infected with peach scab 8/20.

	Peach leaf curl	Percent peach scab
Schedule #1	0	0
Schedule #2	0	0
Schedule #3	0	0.66
Schedule #4	0	1.3
Schedule #5	0	58.0

At harvest maturity, 150 peaches from each trial were collected at random, placed on cardboard filler trays, peach scab incidence recorded, and the development of brown rot and Rhizopus rot recorded after 4, 8 and 12 days (Table 3).

Table 3. Percent Brown rot and Rhizopus rot infections after 4, 8 and 12 days.

	FOURTH DAY		EIGHTH DAY		TWELFTH DAY	
	Brown rot	Rhizopus rot	Brown rot	Rhizopus rot	Brown rot	Rhizopus rot
Schedule #1	0.6	2.6	0.6	6.6	2.4	14.6
Schedule #2	0.0	4.6	2.0	6.0	5.3	18.6
Schedule #3	1.3	1.3	5.3	2.6	6.0	14.0
Schedule #4	0.6	2.0	2.6	6.0	5.3	15.3
Schedule #5	2.0	1.3	12.0	6.0	18.0	20.6

PEACH LEAF CURL CONTROL WITH BRAVO C/M - 1987

J. G. Barrat
WVU Experiment Farm
Kearneysville, WV 25430

Bravo 720, Bravo C/M, ferbam and no spray were applied to Redskin/Siberian C peach trees for peach leaf curl control. The trees were 7-year old and set 20 x 20 feet in two separate mini-blocks of 36 trees each. There were 3 randomized replicates of 3 trees each in each trial. Previously, these trees had been sprayed in the fall of 1986 with ferbam at 5 lb/acre. A single spray was applied to each trial on March 23 in the late dormant with a Swanson DA-23 3-point hitch airblast sprayer at 100 psi delivering 250 gal/acre while traveling at 1.17 mph. Standard pesticides were used in the early part of the season for disease and insect control. The trees were examined for symptoms of peach leaf curl on May 11 and recorded per trial.

Table 1. Incidence of peach leaf curl infected leaves per trial.

			REDSKIN		REDHAVEN
Bravo 720	3.125 pints/acre		-		0
Bravo C/M	10 lb/acre		0		0
Ferbam 76W	(fall & Spring) 5 lb/acre		33		-
Ferbam 76W	(fall only) 5 lb/acre	(1)	38	(1)	44
		(2)	0	(2)	6

Peach (*Prunus persica*)
Brown rot; *Monlinia fructicola*
Leaf curl; *Taphrina deformans*
Anthracnose; *Glomerella cingulata*
Oak root rot; *Armellaria* spp.
Ring nematode; *Criconemella xenoplax*
Scab; *Cladosporium carpophilum*
Mr. Wiskers; *Rhizopus* &
Gilbertella spp.
Sour rot; *Monilia implicata* &
Geotrichum candidum
Crown rot; *Phytophthora cinnamoni*
Gummosis; *Botryosphaeria dothidea*

Ann Carson, Area Fruit Agent
Tony Watson, Area Fruit Agent
R. W. Miller, Professor
Clemson University Cooperative
Extension Service
Clemson, SC 29634-0344

OBSERVATIONS AND PEACH DEMONSTRATION RESULTS, 1987: Many farmers did not spray peaches in 1986 due to early fruit loss. Even though many orchards were unsprayed in 1986, curl and plum pockets were a minor problem in 1987. The low disease incidence is attributed to the lack of cool wet weather at bud swell and the increased use of leaf curl control chemicals. The use of copper compounds is increasing: growers and sales reps hope this may give some bacterial spot suppression as well as leaf curl control. Ferbam is increasingly more difficult to find. Some distributors are pushing Ziram.

A late freeze on April 1 significantly reduced the crop in the Piedmont (60%) and the Ridge (40%). Damaged flowers were infected with the brown rot fungus shortly after the freeze. Dry weather and use of fungicides limited infections and only moderate number of cankers with just a few blighted terminals were observed in the Piedmont and Ridge. Blossom blight virtually did not occur in coastal production areas. There is resistance to use of expensive fungicides in bloom unless a problem is observed.

In the Piedmont over 40% of the orchards changed hands with many blocks being totally abandoned. Several blocks that changed hands that had not received any dormant, bloom, petal fall or shuck off sprays that had a crop after the freeze began being sprayed at 2nd cover. Dry weather favored these growers as these blocks escaped with very little scab infection. Totally abandoned blocks were heavily infected with brown rot.

In the Ridge area blocks with documented scab fungus resistance to benomyl or thiophanate methyl dating as far back as the mid seventies are still having problems with resistance. Growers with these problems have in many cases persisted in using benomyl or thiophanate methyl.

Individual blocks initiated second swell under relatively dry conditions in the Ridge and Piedmont. In June and July brown rotted fruit were observed immediately. These observations suggested to observers that quiescent infections had occurred. Ongoing demonstrations in these blocks with Funginex and Ronilan indicated that these compounds could contain the brown rot if applied at full rates at close intervals.

Discoloration resulted in significant losses. The state wide impact was estimated at 243,500 bushels representing an out-of-pocket loss to growers of $1,339,250. This amount includes any money growers may have received as salvage. Captan generically was attributed as a major factor in the discoloration problem. Warnings will be included in subsequent spray schedules about use of captan close to harvest when fruit are predisposed by continuous wet weather.

In July and August a malady best described as red spots similar to those associated with white peach scale was observed throughout the state. There was an association of levels of ozone in excess of 100 g/cubic meter for as much as 20-22 hours per day.

The pH of captan is 9 or 10 when first mixed up in the tank and the half life of soluble captan is quite short at this pH. This created some excitement till it was understood that the solubility limit is 1 - 2 ppm.

Anthracnose was a moderate problem in the Piedmont and a slight to moderate problem in the Ridge. The use of captan is a major component of the spray program.

Widespread adoption of using chlorine in the hydro-cooler has almost eliminated problems with sour rot.

In the Piedmont problems were encountered with control of bacterial spot in a few blocks where Mycoshield was used on a regular basis. Evaluation of bacterial spot isolates at 100 ppm did not indicate tolerance.

Gummosis has been confirmed in three additional cases in the state this year. The disease does not appear to be spreading rapidly as most growers are on a program of rogueing.

In 1987 there was a continued decrease in acreage such that there are about 1,350,000 trees in the Piedmont. The total percent dead trees was up slightly from 3.2 to 4.0 %. Of these, 25% died of peach tree short life (PTSL), 60% oak root rot (ORR) and 15% crown rot. Tree population remained the same in the Ridge. In The Ridge area the percent dead declined to 2.5% with 85% PTSL, 11% ORR and 1.5% crown rot. In the Coastal Plains acreage continues to grow to an estimated 600,000 trees. The percent dead trees remains about the same at 2.1%. Peach tree short life, ORR, and crown rot are still the major diseases at 26, 50 and 7% respectively.

In summary 109,100 trees died in 1987. Peach tree short life accounted for 52,901 of the dead trees and 43,375 were lost to ORR. An estimated loss to the growers from tree death was $8,132,500 in the 1987 season. This is down from 137,950 trees in the 1986 season with an estimated value in excess of 10 million dollars. This brings the total tree loss since 1980 to 101,555,315 dollars.

1987 DEMONSTRATION RESULTS "RIDGE AREA OF SOUTH CAROLINA" Bravo 720 was evaluated for persistence in scab control using the variety 'Durbin' nectarine. Treatments included Bravo at the low labeled rate of 3 1/8 pints per acre applied at 50 % shuck off. Subsequently fungicides for scab control were started at 10, 17, 24, and 32 day intervals following shuck off. A control which received no fungicides was also included. The following chart represents the means for the various treatments.

Shuck off	50.62 %	(no additional fungicides)
10 days after shuck off	91.43 %	(standard schedule)
17 days " " "	83.48 %	
24 days " " "	61.49 %	
32 days " " "	35.91 %	
check	17.77 %	(no fungicides)

Statistical analysis showed no differences between the 10 and 17 day treatments. These data suggest that Bravo at shuck off is very efficacious for scab control having residual activity beyond the normal 7-10 day period. It is felt that although there is no significant difference the level of disease at the 17 day treatment is not acceptable.

Ronilan and Rovral were evaluated using two types of spreader stickers. In all cases there was no differences between the control achieved by either compound when used with spreader stickers. No advantages to using spreader stickers in these cases were noted.

Ronilan WP and Ronilan FL were compared for Brown Rot control. Very small, if any, differences were seen between the two formulations. Ronilan and Rovral demonstrations showed little differences between the two compounds when peaches were harvested and placed at room temperature in apple trays and observed for rot after 7 days. Plots of Ronilan and Rovral received 2 pre-harvest sprays.

A Bacterial Spot disease prediction model was evaluated for its ability to reduce the number of sprays necessary for spot control. The model uses doubling times based on temperature during periods of leaf or fruit wetness. Leaf wetness was measured in two ways. A modified hydrothermograph after Hardy which uses the contraction or expansion of a cotton string when wet or dry. Alternatively leaf wetness was determined by a computer model developed by Dale Linvill. For both models a bactericide was applied when the number of doublings of the bacteria reached 21. After three seasons of using the hydrothermograph an estimated 3 sprays per season were saved over 7 day or recommended program. First impressions of the computer model was that it is a reasonable approximation of the hydrothermograph. More evaluation is needed.

Thirty orchards were sampled for resistance to the benomyl or thiophanate methyl fungicides. Of these only three were found to be sensitive to benomyl. In those cases where sensitive strains were found growers had not used benomyl for at least two seasons. In these cases considerable savings were realized.

Nemacur plots were continued on the Ridge using a 10 lb. rate vs. a 20 lb. rate on a broadcast basis. After the ring nematode populations were reduced to threshold levels the low rate performed as well as the high rate. There was a somewhat higher tree mortality until populations were reduced. It must be noted that the 10 lb. plots for what ever reason started with a much higher initial population accounting for the increased tree loss.

FUNGICIDE DEMONSTRATION RESULTS-PIEDMONT REGION OF S.C. Processing peaches in the Babygold series are known to be susceptible to fruit brown rot and were used to compare the efficacy of Rovral 50W at 1.5 pounds/acre and at 2 pounds/acre in controlling brown rot at harvest. A sticker was used in both treatments. Three days after harvest 200 fruit per treatment were evaluated. The low rate of Rovral did not adequately control brown rot in Babygold-5 (34% decay vs 3% decay at the 2 pound rate. These results suggest that if disease pressure is great enough to warrant the use of Rovral,the 2 pound rate is advisable.

In tests comparing Rovral and Ronilan at the 2 pound rate to control pre-harvest brown rot, little difference was noted on fruit held at 68 degrees F for 5 days. However, after 9 to 12 days Ronilan continued to be fungicidal whereas Rovral's strength had waned. By contrast if fruit were held in cold storage between 34 and 38 degrees F no differences were noted. These results suggest that if fruit is to be sold locally at roadside markets or farmers' markets or trucked in open containers to regional markets on unrefrigerated trucks pre-harvest sprays should be considered differently from those blocks where fruit is to be hydrocooled shipped under refrigeration and sold in cool produce sections.

Twenty fruit were plated for brown rot resistance to Benlate fungicide during the summer from varieties ripening from June through August. Of the 20 samples 14 tested positive for Benlate resistance.

APPLE (*Malus sylvestris* 'Delicious', 'Golden
Delicious', 'Rome', 'Stayman')
Sooty blotch; *Gloeodes pomigena*
Fly speck; *Microthyriella rubi*
Fruit rots; *Physalospora obtusa*, *Glomerella cingulate* and *Botryosphaeria dothidea*
Apple scab; *Venturia inaequalis*
Rust: *Gymnosporangium juniperi-virginianae*
Golden Delicious leaf blotch; stress

C. R. Drake
Department of Plant Pathology, Physiology and Weed Science
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

MANAGEMENT OF APPLE DISEASES AT BLACKSBURG, VIRGINIA DURING 1987: Seventeen fungicides and fungicide combinations were evaluated for disease control in a closely managed orchard of 22-year old semi-dwarf apple trees. Three tree plots replicated four times for each treatment, as well as the unsprayed check trees, were used for the investigation. Treatments were applied Apr 10, 20, 27; May 4, 11, 18, 25; Jun 8, 22; Jul 6, 20; and Aug 3, 18. The fungicides were applied dilute (1x) with a John Bean conventional high-pressure sprayer delivering 450 psi equipped with a spray mast containing four guns. The insecticides were applied with an AgTech Model 3002 low volume sprayer delivering 50 gal/A. Azinphosmethyl 50W (Guthion) 1.5 lb/A concentrate was used as the standard insecticidal program. Phosphamidon 8E 12.0 oz/A concentrate was used in the pink and petal fall stage of bud development for aphid control. Carbaryl 50W (Sevin) 6.5 lb/A concentrate was used Jul 6, 20 and Aug 5 for Japanese beetle control. Savey 50W 3.0 oz/A dilute was used Jun 1 for mite control. Data were recorded May 12 through 15, Jun 16 through 19, Jul 21 through 24 and Aug 28 through Sep 28.

Climatological conditions were variable with many extremes, but excellent for high quality fruit production for growers with irrigation equipment and a source of water. The temperature never dropped below freezing after the mid-tight cluster stage of bud development; thus, all fruit buds developed normal healthy fruit. The temperature, however, soared to all time highs during Jul and Aug. Similarly record precipitation occurred during Apr and Sep (7.75" Apr and 6.43" Sep) with only light showers in between. Minor scab developed as the result of two infection periods during Apr, but primarily within treatments with marginal concentrations of test chemicals (Tables 1, 2, 3, 4). Cedar apple and quince rust inoculum were attached to post around the perimeter of the orchard, but only minor rust developed because of the lack of moisture. Sooty blotch, flyspeck and rots were greatly reduced as the result of the hot dry weather during Jul and Aug. Minor sooty blotch and flyspeck developed in treatments where sterol inhibiting fungicides were the only protectants used late in the season. Golden Delicious leaf blotch varied extensively from treatment to treatment and also from tree to tree within a treatment. As a whole, all test pesticides provided an excellent fruit finish with a high percentage of US Extra Fancy packout fruit.

Table 1. Golden Delicious

Fungicide and rate/100 gal[1]	% fruit, leaves or terminals affected with:										% fruit[5] area russetted
	scab[2]			rust[2]			sooty[3]	fly[3]	GDLB[4]		
	terminals	leaves	fruit	fruit	leaves	rots[3]	blotch	speck	affected	defoliated	
Nustar 20DF 4.0 oz + Manzate 80W 2.0 lb through 2nd cover, then DPX-7331-356 50DF 3.5 lb/A	0	0	0	0	0	0	1	0	28.8	18.8	6
Rally 60DF 0.5 oz through PF, then + Dithane M-45 12.0 oz ai through 2nd cover, then drop out Rally	0	0	0	0	1	0	2	1	20.8	5.9	7
RH0611 62.25W 15.0 oz ai	0	0	0	0	0	0	1	0	25.8	12.3	8
Dithane M-45 80W 2.0 lb	0	0	0	0	0	0	0	0	23.5	6.1	7
Polyram 80W 12.0 oz + Benlate 50W 2.0 oz	2	1	1	0	0	0	2	2	9.6	5.4	8
Polyram 80W 12.0 oz + Benlate 50W 2.0 oz/100 gal through PF, then Polyram 80W 6.0 lb/A.	1	2	0	0	0	0	0	0	9.2	2.8	6
Manzate 200 80W 12.0 oz + Benlate 50W 2.0 oz	3	2	5	0	0	1	1	0	19.1	11.0	7
Penncozeb 80W 2.0 lb ai	0	0	1	0	0	2	0	0	8.3	2.4	6
Penncozeb 4F 2.0 lb ai	0	0	0	0	0	0	0	1	12.9	6.7	7
Penncozeb 80W 1.6 lb ai	0	1	1	0	0	2	0	0	8.5	3.8	6
Penncozeb 4F 1.6 lb ai	1	0	0	0	1	0	3	1	37.8	29.7	8
Topsin-M/Maneb zn (TD 2246) 67.9W 1.125 lb ai	0	0	1	0	0	0	0	0	32.3	17.2	8
Topsin-M/Maneb zn (TD 2246) 67.9W 2.250 lb ai	0	1	0	0	0	0	1	1	18.7	5.8	7
Rubigan 1EC 6.0 oz/A	0	0	0	0	0	2	5	5	16.9	7.9	8
Rubigan 1EC 6.0 oz + Polyram 80W 3.0 lb/A	0	0	0	0	0	4	2	2	1.9	0.0	7
Folicur 1.2EC 3.6 oz ai/A	0	0	0	0	0	0	2	1	17.9	6.7	8
Folicur 45DF 3.6 oz ai/A	0	0	0	0	0	1	3	1	12.4	4.5	7
Control (no fungicide)	50	50	15	2	10	7	97	94	49.0	26.5	11

---

[1] All rates are /100 gal except where designated /acre (/A).

[2] Scab and cedar apple rust data were recorded on 100 fruit/treatment/replicate, primary leaf scab infection on leaves of 10 shoots/tree/treatment/replicate and terminal scab by examining the last 8 initiated leaves of 30 terminals/treatment/replicate.

[3] Rots included black (*Physalospora obtusa*), bitter (*Glomerella cingulata*) and white (*Botryosphaeria dothidea*); rot, sooty blotch and fly speck infections were determined by counting 100 fruit from each treatment and replicate.

[4] Golden Delicious leaf blotch (GDLB) percentage of leaves affected and defoliated were determined by counting the leaves on current shoot growth of 36 shoots for each treatment.

[5] Fruit russet was determined by counting 100 fruit/treatment/replicate.

Table 2. Delicious

Fungicide and rate/100 gal[1]	% fruit, leaves or terminals affected with: scab[2] terminals	scab[2] leaves	scab[2] fruit	rust[2] fruit	rots[3]	sooty[3] blotch	fly[3] speck	% fruit[4] area russetted
Nustar 20DF 4.0 oz + Manzate 80W 2.0 lb through 2nd cover, then DPX-7331-356 50DF 3.5 lb/A	0	0	0	0	0	0	0	6
Rally 60DF 0.5 oz through PF, then + Dithane M-45 12.0 oz ai through 2nd cover, then drop out Rally	0	0	0	0	0	0	0	6
RH0611 62.25W 15.0 oz ai	0	0	0	0	2	0	0	4
Dithane M-45 80W 2.0 lb	0	0	1	0	0	0	0	6
Polyram 80W 12.0 oz + Benlate 50W 2.0 oz ...	2	1	1	0	0	0	0	6
Polyram 80W 12.0 oz + Benlate 50W 2.0 oz/100 gal through PF, then Polyram 80W 6.0 lb/A.	1	1	1	0	0	0	0	5
Manzate 200 80W 12.0 oz + Benlate 50W 2.0 oz	3	2	5	0	0	0	0	6
Penncozeb 80W 2.0 lb ai	0	0	1	0	0	0	0	6
Penncozeb 4F 2.0 lb ai	1	0	2	0	0	4	1	5
Penncozeb 80W 1.6 lb ai	1	1	2	0	0	0	0	5
Penncozeb 4F 1.6 lb ai	2	2	1	0	0	3	3	5
Topsin-M/Maneb zn (TD 2246) 67.9W 1.125 lb ai	5	2	5	0	0	0	3	5
Topsin-M/Maneb zn (TD 2246) 67.9W 2.250 lb ai	0	0	0	0	0	2	3	6
Rubigan 1EC 6.0 oz/A	0	0	0	0	0	7	2	5
Rubigan 1EC 6.0 oz + Polyram 80W 3.0 lb/A ..	0	0	0	0	0	0	0	4
Folicur 1.2EC 3.6 oz ai/A	0	0	1	0	0	6	2	6
Folicur 45DF 3.6 oz ai/A	0	0	1	0	0	5	3	6
Control (no fungicide)	100	50	52	7	8	94	94	10

---

[1] All rates are /100 gal except where designated /acre (/A).

[2] Scab and cedar apple rust data were recorded on 100 fruit/treatment/replicate, primary leaf scab infection on leaves of 10 shoots/tree/treatment/replicate and terminal scab by examining the last 8 initiated leaves of 30 terminals/treatment/replicate.

[3] Rots included black (*Physalospora obtusa*), bitter (*Glomerella cingulata*) and white (*Botryosphaeria dothidea*) and white (*Botryosphaeria dothidea*); rot, sooty blotch and fly speck infections were determined by counting 100 fruit from each treatment and replicate.

[4] Fruit russet was determined by counting 100 fruit/treatment/replicate.

Table 3. Rome

Fungicide and rate/100 gal[1]	% fruit, leaves or terminals affected with:								% fruit[4] area russetted
	scab[2]			rust[2]					
	terminals	leaves	fruit	fruit	leaves	rots[3]	sooty[3] blotch	fly[3] speck	
Nustar 20DF 4.0 oz + Manzate 80W 2.0 lb through 2nd cover, then DPX-7331-356 50DF 3.5 lb/A	0	0	0	0	0	0	0	0	5
Rally 60DF 0.5 oz through PF, then + Dithane M-45 12.0 oz ai through 2nd cover, then drop out Rally	0	0	0	0	0	0	0	0	5
RH0611 62.25W 15.0 oz ai	0	1	1	0	0	0	0	0	4
Dithane M-45 80W 2.0 lb	1	0	5	1	1	0	0	0	4
Polyram 80W 12.0 oz + Benlate 50W 2.0 oz	5	3	1	1	1	0	1	1	4
Polyram 80W 12.0 oz + Benlate 50W 2.0 oz/100 gal through PF, then Polyram 80W 6.0 lb/A.	1	2	1	5	1	0	0	0	4
Manzate 200 80W 12.0 oz + Benlate 50W 2.0 oz	2	2	2	3	2	0	0	2	4
Penncozeb 80W 2.0 lb ai	1	1	3	1	1	0	0	0	5
Penncozeb 4F 2.0 lb ai	0	0	1	1	0	0	0	0	4
Penncozeb 80W 1.6 lb ai	1	1	4	1	0	0	0	0	4
Penncozeb 4F 1.6 lb ai	4	1	4	1	0	0	0	0	5
Topsin-M/Maneb zn (TD 2246) 67.9W 1.125 lb ai	3	3	5	2	0	0	0	0	4
Topsin-M/Maneb zn (TD 2246) 67.9W 2.250 lb ai	1	1	0	1	0	0	0	0	5
Rubigan 1EC 6.0 oz/A	0	0	0	0	0	1	17	5	5
Rubigan 1EC 6.0 oz + Polyram 80W 3.0 lb/A	0	0	2	0	0	3	0	0	4
Folicur 1.2EC 3.6 oz ai/A	0	0	0	0	0	0	4	1	4
Folicur 45DF 3.6 oz ai/A	0	0	0	0	0	1	3	5	4
Control (no fungicide)	50	60	45	14	16	5	84	82	7

---

[1] All rates are /100 gal except where designated /acre (/A).

[2] Scab and cedar apple rust data were recorded on 100 fruit/treatment/replicate, primary leaf scab infection on leaves of 10 shoots/tree/treatment/replicate and terminal scab by examining the last 8 initiated leaves of 30 terminals/treatment/replicate.

[3] Rots included black (*Physalospora obtusa*), bitter (*Glomerella cingulata*) and white (*Botryosphaeria dothidea*) and white (*Botryosphaeria dothidea*); rot, sooty blotch and fly speck infections were determined by counting 100 fruit from each treatment and replicate.

[4] Fruit russet was determined by counting 100 fruit/treatment/replicate.

Table 4. Stayman

Fungicide and rate/100 gal[1]	% fruit, leaves or terminals affected with: scab[2] terminals	scab[2] leaves	scab[2] fruit	rust[2] fruit	rust[2] leaves	rots[3]	sooty[3] blotch	fly[3] speck	% fruit[4] area russeted
Nustar 20DF 4.0 oz + Manzate 80W 2.0 lb through 2nd cover, then DPX-7331-356 50DF 3.5 lb/A	0	0	2	0	0	0	3	1	4
Rally 60DF 0.5 oz through PF, then + Dithane M-45 12.0 oz ai through 2nd cover, then drop out Rally	0	0	0	0	0	0	1	1	5
RH0611 62.25W 15.0 oz ai	1	3	1	1	0	1	0	0	4
Dithane M-45 80W 2.0 lb	1	0	0	0	0	2	0	1	4
Polyram 80W 12.0 oz + Benlate 50W 2.0 oz	1	3	1	0	0	1	3	2	4
Polyram 80W 12.0 oz + Benlate 50W 2.0 oz/100 gal through PF, then Polyram 80W 6.0 lb/A.	0	0	1	0	0	0	0	0	4
Manzate 200 80W 12.0 oz + Benlate 50W 2.0 oz	3	1	0	2	0	0	0	0	4
Penncozeb 80W 2.0 lb ai	0	1	1	0	0	0	1	0	4
Penncozeb 4F 2.0 lb ai	0	1	2	1	0	0	0	1	5
Penncozeb 80W 1.6 lb ai	1	1	2	0	0	0	0	0	5
Penncozeb 4F 1.6 lb ai	5	5	3	0	0	0	3	1	5
Topsin-M/Maneb zn (TD 2246) 67.9W 1.125 lb ai	5	5	2	0	0	0	0	0	5
Topsin-M/Maneb zn (TD 2246) 67.9W 2.250 lb ai	1	1	0	1	0	1	0	1	5
Rubigan 1EC 6.0 oz/A	0	0	1	0	0	2	1	1	5
Rubigan 1EC 6.0 oz + Polyram 80W 3.0 lb/A	0	1	0	0	0	0	0	0	4
Folicur 1.2EC 3.6 oz ai/A	0	0	0	0	0	1	1	4	5
Folicur 45DF 3.6 oz ai/A	0	0	0	0	0	3	4	3	5
Control (no fungicide)	38	49	17	8	5	8	67	59	9

---

[1] All rates are /100 gal except where designated /acre (/A).

[2] Scab and cedar apple rust data were recorded on 100 fruit/treatment/replicate, primary leaf scab infection on leaves of 10 shoots/tree/treatment/replicate and terminal scab by examining the last 8 initiated leaves of 30 terminals/treatment/replicate.

[3] Rots included black (*Physalospora obtusa*), bitter (*Glomerella cingulata*) and white (*Botryosphaeria dothidea*) and white (*Botryosphaeria dothidea*); rot, sooty blotch and fly speck infections were determined by counting 100 fruit from each treatment and replicate.

[4] Fruit russet was determined by counting 100 fruit/treatment/replicate.

PEACH (<u>Prunus persica</u> 'Redhaven')
Brown rot; <u>Monilinia fructicola</u>
Rhizopus rot; <u>Rhizopus</u> sp.
Scab; <u>Cladosporium carpophilum</u>

C. R. Drake
Department of Plant Pathology, Physiology and Weed Science
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

MANAGEMENT OF PEACH DISEASES AT BLACKSBURG, VIRGINIA DURING 1987: Various fungicides and fungicide combinations were evaluated for their effectiveness for control of scab, brown and Rhizopus rot. Eight-year-old well managed Redhaven trees were used for the study. Two tree plots replicated four times for each treatment as well as the untreated trees were used for the study. Fungicides were applied with a John Bean Conventional high pressure sprayer delivering 450 psi equipped with a single nozzle gun or a spray mast equipped with four guns. Treatments were applied Apr 9 (pink), 17 (full bloom), 23 (petal fall), 29 (shuck-split), May 7 (shuck-fall), cover sprays May 21, Jun 4, 18, and Jul 2, 16, 30. Insecticides were applied with an AgTech 3002 model low volume sprayer delivering 50 gal/A. Azinphosmethyl 50W (Guthion) 1.2 lb/A was used as the standard insecticidal program. For Japanese beetle control, carbaryl 50W (Sevin), 6.5 lb/A low volume was applied Jul 21, 24, 28 as the fruit approached maturity.

The 1987 growing season was characterized as hot and usually dry weather conditions even though 7.75" of precipitation occurred during Apr. Drip irrigation (pulse system) was initiated at the pit hardening stage of fruit development and continued for 8 wk. Thus, highly unfavorable conditions for infections and disease development existed through May, Jun, Jul and Aug. All test chemicals mixed well and no phytotoxicity occurred with any combinations, although some of the Bravo 720 combinations were complex with double concentrations for some application dates. All test fungicides provided similar control of brown rot at harvest and when held at room temperature for 5-days. Although Rhizopus rot was present when mature harvested fruit was held at room temperature it was greatly reduced. The relative-humidity was so low that there was only minor activity of either of the rot fungi. The foliage on trees treated with Ziram seemed to be denser and/or thicker than foliage on trees of all other treatments. This phenomenon is not clearly understood; thus, further research is needed.

	% Peach fruit affected with:				Fruit color and eye appeal[3]
	brown rot		rhizopus rot	scab	
Fungicide and rate per 100 gal[1]	at harvest	after 5 days[2]	after 5 days	at harvest	
Bravo 720 3.125 pt/A to shuck-split, then captan 50W 2.0 lb rest of season ..	0	1	1	0	3
Bravo 720 4.0 pt/A at petal-fall and shuck-split only, then captan 50W 2.0 lb rest of season	1	4	2	0	3
Bravo 720 4.0 pt/A at PF, then 8.0 pt/A at shuck-split, then wait 5 wk, then start captan 50W 2.0 lb rest of season .	2	7	1	0	3
Bravo 720 4.0 pt/A dormant through petal-fall, then 8.0 pt/A at shuck-split, then captan 50W 2.0 lb rest of season ..	0	1	1	0	3
Bravo 720 4.0 pt/A dormant through shuck-split, then 8.0 pt/A at shuck-fall, then wait 6 wk, then start captan 50W 2.0 lb rest of season	1	2	2	0	3
Ziram 4F 6.0 pt/A	2	4	1	0	5
Ziram 4F 4.0 pt/A	1	8	4	0	5
Topsin-M 70W 4.0 oz + captan 50W 1.0 lb ..	0	1	1	0	3
Folicur 1.2EC 3.6 oz ai/A.................	0	1	1	0	4
Folicur 45DF 3.6 oz ai/A	1	2	1	3[4]	4
Control (no fungicide)	6	14	7	17	8

---

[1] All rates are per 100 gallons except where designated per acre (/A).

[2] One hundred fruit from each replicate of each treatment were held at room temperature (70-80°F) for 5 da to determine residual effectiveness of the fungicide.

[3] Color and eye appeal of fruit was based on and index number of 1-10 with 1 rating the best.

[4] Scab only on one tree of the treatment, it was used for a control, 1986.

NECTARINE (Prunus persica var. nectaria 'Red Gold')
Brown rot; Monilinia fructicola
Rhizopsu rot; Rhizopus sp.
Scab; Cladosproium carpophilum

C. R. Drake
Department of Plant Pathology, Physiology and Weed Science
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

MANAGEMENT OF NECTARINE DISEASES AT BLACKSBURG, VIRGINIA DURING 1987: Various fungicides and fungicide combinations were evaluated for scab, brown and Rhizopus rot control on 8-year-old trees. Three tree plots replicated four times for each treatment as well as the untreated trees were used for the investigation. Fungicides were applied with a John Bean conventional high pressure sprayer delivering 450 psi equipped with a single nozzle gun or a spray mast equipped with four guns. Insecticides were applied with an AgTech model 3002 low volume sprayer delivering 50 gal/A. Azinphosmethyl 50W (Guthion) 1.2 lb/A was used as the standard insecticidal program. Treatments were applied Apr 8 (pink), 15 (full bloom), 22 (petal fall), 30 (shuck-split), May 8 (shuck-fall), cover sprays May 22, Jun 5, 19, Jul 3, 17, 31, Aug 11, and 18, respectively. For Japanese beetle control, carbaryl 50W (Sevin) 6.5 lb/A low volume was applied at 3-da-intervals beginning 9 days before harvest.

Climatological conditions were excellent for high quality nectarine fruit production, but highly unfavorable for infection and development of brown and Rhizopus rot. Although record rainfall occurred during Apr that facilitated peach leaf curl and scab infections only light showers followed during the next four months; thus, reducing the incidence of brown and Rhizopus rot development. Peach leaf curl was severe on foliage and fruit of trees that had been used as unsprayed check trees during 1986 and 1987. But 1987 check trees that had a full season fungicide treatment during 1986 had only 16 percent of the foliage and no fruit affected with leaf curl. Similar results were recorded for peach scab (see data table); thus, it seems that the researcher may have to rotate or alternate the experimental trees and use them for pesticide testing every 2nd year so as to facilitate a source of inoculum for infection and disease development. In general all the test chemicals seemed to have a good residual carry-over for suppression of brown and Rhizopus rot infections at room temperature. All treatments provided excellent high quality fruit with attractive eye appeal. The color of the fruit treated with Ziram was less intense than fruit treated with captan or a combination with captan.

	% nectarine fruit affected with:[2]				
	brown rot		rhizopus rot	scab	Fruit color and eye
Fungicide and rate per 100 gal[1]	at harvest	after 5 days[3]	after 5 days	at harvest	appeal[4]
Bravo 720 3.125 pt/A to shuck-split, then captan 50W 2.0 lb rest of season ..	2	15	0	0	3
Bravo 720 4.0 pt/A at petal-fall and shuck-split only, then captan 50W 2.0 lb rest of season	1	3	2	0	3
Bravo 720 4.0 pt/A at PF, then 8.0 pt/A at shuck-split, then wait 5 wk, then start captan 50W 2.0 lb rest of season .	1	0	0	0	3
Bravo 720 4.0 pt/A dormant through petal-fall, then 8.0 pt/A at shuck-split, then captan 50W 2.0 lb rest of season ..	3	13	7	0	3
Bravo 720 4.0 pt/A dormant through shuck-split, then 8.0 pt/A at shuck-fall, then wait 6 wk, then start captan 50W 2.0 lb rest of season	3	5	5	0	3
Ziram 4F 6.0 pt/A	1	1	1	1	6
Ziram 4F 4.0 pt/A	2	1	1	0	6
Topsin-M 70W 4.0 oz + captan 50W 1.0 lb ..	2	3	3	1	3
Folicur 1.2EC 3.6 oz ai/A.................	2	3	3	1	4
Folicur 45DF 3.6 oz ai/A	1	3	5	1	4
Control (no fungicide)	12	15	15	100[5]	9

---

[1] All rates are per 100 gallons except where designated per acre (/A).
[2] Two hundred fruit from each treatment were examined for disease count.
[3] One hundred fruit from each treatment were held at room temperature (70-80°) for 5 day to determine residual effectiveness of the fungicide.
[4] Fruit were rated 1-10 for color and eye appeal at harvest with 1 being the most attractive.
[5] The same trees were used for unsprayed checks 1986 and 87.

PEACH (Prunus persica 'Redhaven')

C. R. Drake
Department of Plant Pathology, Physiology and
Weed Science
Virginia Polytechnic Institute and State
University
Blacksburg, Virginia 24061

EFFECT OF VAPOR GARD ON COLOR, SIZE AND MARKET QUALITY OF PEACH FRUIT AT BLACKSBURG, VIRGINIA DURING 1987: Vapor Gard, an antitranspirant, was applied to 50 8-year-old Redhaven peach trees 17-days before harvest. Vapor Guard was applied at the rate of 1.0 gal/50 gal of water/A with a John Bean conventional high pressure sprayer delivering 450 psi equipped with a single nozzle gun. Another 50 trees were not treated with Vapor Gard to provide comparison fruit. Fruit were harvested from 10 treated and 10 untreated trees at maturity as follows: 1) All the fruit on 5 trees of each category were harvested when the fruit on the outside of the trees were mature, and 2) Only mature fruit on 5 trees, from each category, were harvested at any one time. All harvested fruit were evaluated for size and color immediately after they were removed from the trees.

Vapor Gard treated fruit matured three to eight days (particularly inside the trees) earlier than non-treated fruit. In fact, there was a reversal of percent of mature fruit harvested at any-one harvest date when only mature fruit were harvest. For example, in Vapor Gard treated trees 53.5% of the total fruit on the trees were harvested during the first harvest date versus (51% of the fruit were harvested the last picking date with no Vapor Gard. Thus, Vapor Gard could be used as a management tool to extend or lengthen the harvest season for growers with large acreages of a single variety (treat part of the acreage with Vapor Gard and leave the rest untreated). Vapor Gard also could be used to lengthen the season with certain varieties to supply road side stands and/or pick-your-own marketing systems. Fruit color was attractive with good eye appeal. Color of treated fruit was brighter, more uniform and more complete around the circumference of the fruit than with untreated fruit. In most cases, there were no 2.0 inch peaches in the treated area, but there were a high percentage in the untreated area. In general, growers would save money and profit through the use of Vapor Gard as follows: 1) Eliminate at least one harvest date, 2) Reduce the number of 2.0 peaches (during 1986 the price of peaches increased $4.50/box when the size range was increased from 2 to 2 1/4), 3) Higher percentage of the fruit in the more attractive size ranges (2 1/4 - 2 3/4), and 4) The treated fruit were more attractive with a better color eye appeal and definitely more competitive at the market place. One, however, can not distinguish all the assets that Vapor Gard initiates in fruit at a mirror glance. It requires close measurements of many fruit, good close observations and well designed planning for Vapor Gard to produce its best results.

Treatment	Harvest dates	% of peaches in different size ranges when treated with Vapor Gard versus no Vapor Gard: Fruit size in inches 2.0	2 1/4	2 3/8	2 1/2	2 5/8	2 3/4	2 7/8	3.0	% of total fruit harvested at any one time	Mean fruit diameter (inches)
		all fruit on trees harvested at the same time[1]									
Vapor Gard[3]	7/30	7.9	13.9	13.5	18.8	16.9	13.9	6.4	8.3	--	2.5
No Vapor Gard	7/30	31.9	21.6	13.6	11.4	11.4	9.5	0.2	0.0	--	2.4
		only mature fruit were harvested at any one time[2]									
Vapor Gard	7/30	0.0	1.2	1.7	35.4	22.0	26.7[4]	4.0	8.7	53.5	
	8/3	0.0	10.4	10.4	29.0	19.7	20.9	5.8	3.4	26.8	
	8/6	0.0	25.4	23.7	42.3	1.6	6.7	0.0	0.0	18.3	2.6
No Vapor Gard	7/30	1.2	1.2	2.5	28.7	18.7	20.0	12.5	15.0	17.0	
	8/3	5.5	8.3	5.5	12.5	47.2	15.2	1.3	4.1	15.0	
	8/6	14.0	41.0	15.3	23.0	6.4	0.0	0.0	0.0	17.0	
	8/11	21.3	23.3	18.4	15.6	11.0	8.2	0.8	1.2	51.0	2.4

---

[1] Fruit were harvested when most were mature on the outside of trees.
[2] Only mature fruit were harvested at anyone date; thus, better quality fruit.
[3] One gallon of Vapor Gard was applied per acre 17 days before harvest.
[4] Underscoring is to highlight the size ranges where most fruit were harvested.

APPLE (Malus domestica 'Rome Beauty')
Apple scab; Venturia inaequalis
Powdery mildew; Podosphaera leucotricha

K. D. Hickey, J. May and
G. McGlaughlin
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309

CONTROL OF APPLE SCAB AND POWDERY MILDEW WITH STEROL-INHIBITING FUNGICIDES APPLIED WITH AN AIRBLAST SPRAYER, 1987: The fungicide treatments were evaluated in an experimental orchard with heavy inoculum and under highly favorable conditions for disease development. There were ten primary apple scab infections periods between 31 Mar and 13 Jun, 5 being severe infections, and conditions were moderately favorable for development of powdery mildew. Trees used in the experiment were planted 9.1 X 10.7 m and were well pruned to a height of 4.5 - 5 m. Each treatment plot consisted of 2 trees arranged in a randomized complete block design with an untreated border row between parallel plots. The fungicide treatments were applied as concentrate sprays at 50 gal/A (467 L/ha) with a commerical orchard airblast sprayer (Metters 36 in fan) operated at 2.5 mph (4.0 km/hr) at a manifold pressure of 1380 kPa (200 psi). Spray treatments were applied at 10-da intervals between the open-cluster phenological stage and the second cover spray. The first application was made 100 hr after the first apple scab infection period had occurred. Applications of mancozeb or captan were applied at 14-da intervals in the third through seventh cover sprays. Complete sprays were applied on the following dates and phenological stages - 20 Apr (open-cluster), 1 May (full-bloom), 11 May (petal-fall), 22 May (first cover), 28 May (second cover), third through the seventh cover sprays were applied on 11 and 24 Jun; 8 and 22 Jul; and 4 Aug. Temperatures during the time of applications were always above 15.5° C except at full-bloom (7.2° C). Commercially used insecticides were applied separately as needed to maintain control of insects and mites in the orchard. Scab and mildew incidence was recorded by observing all leaves on 10 terminal shoots/tree (2 tree plots) on each of the 4 replicates on 7 Jul. The youngest unfolded leaf on each terminal observed was marked on 3 dates forming four time zones on each terminal as follows: leaves 1-6, 8 Apr - 5 May; leaves 7-9, 6 May - 22 May; leaves 10-12, 23 May - 3 Jun; leaves 13-17, 4 Jun - 25 Jun. The percent disease incidence during these specific periods was calculated along with a total incidence for the entire season. Disease incidence on fruit at harvest was determined on 12 Oct and measurements of fruit length and width were made on 100 fruits/replicate. Scab severity on fruit was determined by counting the total number of lesions on 5 most severely infected fruits. The data obtained were subjected to an analysis of variance using appropriate transformations and the significance between treatment means was determined by the Duncan's Multiple Range Test ($P = 0.05$).

Because apple scab infection occurred at approximately 7-10 da intervals during the early part of the season, apple scab incidence was moderately high during each of the specific periods observed as well as for the entire season. Mildew incidence was moderate in severity. Most of the treatments provided very good control of scab and acceptable control of mildew considering the disease pressure in this orchard. The combination of Procure plus Kolospray sulfur did not provide the expected level of scab control and was no more effective against mildew than the Procure plus Dithane M-45 combination. There was no significant difference between the 4 and 6 fl oz rate/A of Rubigan 1EC used in combination with Polyram but the level of scab control was significantly lower than with other treatments except the Procure plus Kolospray treatment. Outstanding control of scab was provided by the Nustar and Ro 15-1297 treatments. There was no difference between the 3 oz and 4 oz/A rate of Nustar for scab or mildew control. Captec 4F or Captan 50W used in combination with Ro 15-1297 appeared to provide equally combatible mixtures and performed similarly. There was no evidence of phytotoxicity to leaves or fruit or treatment effect on fruit length or width among the treatments.

Not for Publication

Percent Scab and Powdery Mildew Infection on 'Rome Beauty' Treated with Fungicides Applied with a Metters Airblast Sprayer at 10-14 Day Intervals in 1987.

		Percent scab						
		Terminal Leaf position						% P. mildew
Fungicide and Amt g ai/ha (Form/A)	Timing	1 - 6	7 - 9	10 - 12	13 - 17	1 - 17	Fruit	on leaves
1. Procure 50W 315 (9.0 oz) + Dithane M-45 80W 2689 (3.0 lb) Dithane M-45 80W 3583 (4.0 lb)	0C-2C 3C-7C	1.0b[1]	0.7d	0.5d	3.5c	1.5d	0.5de	9.6d
2. Procure 50W 315 (9.0 oz) + Kolospray 81 W 2723 (3.0 lb) Dithane M-45 80W 3583 (4.0 lb)	0C-2C 3C-7C	3.7b	15.1b	27.4b	21.8b	14.3b	9.0b	11.3cd
3. Rubigan 1EC 35 (4.0 fl oz) + Polyram 80W 2689 (3.0 lb) Polyram 80W 3585 (4.0 lb)	0C-2C 3C-7C	1.7b	3.5cd	5.3d	5.0c	3.9d	5.0b	21.2b
4. Rubigan 1EC 52.5 (6.0 fl oz) + Polyram 80W 2689 (3.0 lb) Polyram 80W 3585 (4.0 lb)	0C-2C 3C-7C	3.5b	2.9cd	5.3d	3.4c	3.8d	4.3bcd	19.4b
5. Ro 15-1297 4E 87.5 (2.5 fl oz) Captec 4F 2630 (72 fl oz)	0C-2C 3C-7C	3.5b	7.4c	12.8c	8.8c	7.7c	2.5cde	16.6bc
6. Ro 15-1297 4E 87.5 (2.5 fl oz) + Captan 50W 1680 (3.0 lb) Captec 4F 2630 (72 fl oz)	0C-2C 3C-7C	0.5b	1.8cd	2.6d	3.9c	2.3d	2.5cde	12.4cd
7. Nustar 20DF 42 (3.0 oz) + Manzate 200 80W 2689 (3.0 lb) Manzate 200 80W 3585 (4.0 lb)	0C-2C 3C-7C	0.7b	1.5cd	5.6d	3.1c	2.2d	0.3e	15.3bcd
8. Nustar 20DF 56 (4.0 oz) + Manzate 200 80W 2689 (3.0 lb) Manzate 200 80W 3585 (4.0 lb)	0C-2C 3C-7C	0.9b	0.4d	2.5d	3.6c	1.8d	0.8de	17.5bc
9. Untreated		52.0a	88.1a	80.6a	64.2a	66.6a	76.3a	39.7a

[1] Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT).

APPLE (*Malus domestica* 'Rome Beauty')
Apple scab; *Venturia inaequalis*
Powdery mildew; *Podosphaera leucotricha*

K. D. Hickey, J. May and
G. McGlaughlin
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309

INCIDENCE OF SCAB AND POWDERY MILDEW ON ROME BEAUTY APPLE TREATED WITH DILUTE FUNGICIDE SPRAYS APPLIED IN POST-INFECTION APPLICATIONS, 1987: Treatments were evaluated for control of scab when applied in four post-infection applications during the primary apple scab infection period. The experimental orchard contained a high level of natural inoculum for both the scab and powdery mildew pathogens and highly favorable disease conditions occurred during the active leaf development stages. Each treatment plot consisted of a single tree arranged in a randomized complete block design with 4 replicates. The trees were well pruned to a height of 4.5 - 5.0 m and were in a block planted at a distance of 9.1 X 10.7 m. Treatments were applied as dilute sprays to the point of run-off with a high pressure sprayer operated at 2,758 kPa (400 psi) equipped with a 5 nozzle boom which delivered 7.2 L/tree (850 L/ha). The spray mixture was applied to 2 sides of the tree from the bottom up to 3.5 m leaving a 1.0 to 1.5 m horizontal band at the top of the tree which received no direct spray and allowed scab and mildew to infect most leaves and fruit in that area of the tree. The first four applications were applied as post-infection sprays on the following dates, phenological stages, and hr after the scab infection period occurred: 20 Apr (open-cluster, 100 hr); 28 Apr (king-bloom, 118 hr); 7 May (petal-fall, 117 hr); 21 May (first cover, 70 hr). The treatments were applied for the remainder of the season as protective sprays at approx. 14-da intervals as follows: 2nd-7th cover sprays on 3 and 18 Jun, 7, 15, and 29 Jul, and 13 Aug. Commerically used insecticides were applied separately as needed to control insects and diseases in the orchard. In order to determine scab incidence during specific growth periods the youngest unfolded leaf on each of 10 terminals/tree was marked on 3 dates when scab infections occurred forming 4 time zones on each terminal as follows: leaves 1-5, 10 Apr -7 May (infections 1,2,and 3); leaves 6-10, 8-21 May (infection 4); leaves 11-14, 22 May-3 Jun (infections 5,6, and 7); leaves 15-20, 4 Jun-18 Jun (infections 8 and 9). According to the Mills Scab Infection Severity chart, infections 1-4, and 7 were high infections while the other infection periods were considered low. The percent scab incidence on susceptible leaves during these specific periods was calculated along with a total incidence for the entire season. Mildew incidence was recorded for the entire season and the percent fruit infected with scab recorded on 8 Oct at harvest on 100 fruit/tree. Fruit size in length and diameter was also determined on the 100 fruit sample. The data obtained were subjected to an analysis of variance using appropriate transformations and the significance between means was determined by the Duncan's Multiple Range Test (P = 0.05).

Incidence of scab was severe on the nontreated check with terminal leaf infection ranging from 75-94% for each of the four specific periods observed. Scab infection on fruit was at 90% by harvest time. The below expected level of scab control obtained by many of the treatments may be attributed to the high severity level of scab, high rainfall during the early season, and relatively long intervals between post-infection sprays. The intervals between the sprays applied at the open-cluster, bloom, petal-fall, first cover, and second cover were 8,9,14,13, and 15 da, respectively. Treatments providing exceptionally good control of scab on both leaves and fruit were FBC 39865 75 mg ai/L and C 2338 applied at 155 mg ai/L. The performance of Spotless 25 W plus Manzate 200 was not improved by the addition of X-77 spreader for scab control on leaves but there was a significant improvement on fruit. The combination performed much better than Spotless used alone. Better scab control was obtained with Folicur 1.2E than with the 45DF formulation. The combination of Rubigan plus Polyram provided only about 75% control. All treatments control powdery mildew at a level acceptable in commercial orchards but none provided exceptional control under the moderate disease pressure in this orchard. No phytotoxicity to leaves was observed or any effect on fruit size produced by these treatments.

Not for Publication

Percent Scab and Powdery Mildew Infection on 'Rome Beauty' when Dilute Fungicide Sprays were Applied as Post-Infection Applications for Scab Control in 1987.

	Percent Scab						
	Leaf position[1]						
Fungicide and Amt mg ai/L (Form/100 Gal)	1 - 5	6 - 10	11 - 14	15 - 20	1 - 20	Fruit	% P. mildew leaves
1. Folicur 45 DF 67 (2.0 oz)	5.4bc[2]	29.2cd	53.8bc	31.5b	29.0bcd	36.5bc	14.5cd
2. Folicur 1.2E 67 (6.0 oz)	4.1bc	8.7ef	22.7d	7.7c	9.9e	20.5cde	18.1bcd
3. Spotless 25W (CC-14030) 20 (1.1 oz) + Manzate 200 80W 960 (1.0 lb)	6.0bc	23.4de	39.8cd	9.8bc	17.8cde	25.3bcd	22.0bcd
4. Spotless 25W (CC-14030) 20 (1.1 oz) + Manzate 200 80W 960 (1.0 lb) + X-77 Spreader (8.0 fl oz)	10.4bc	20.9de	32.3cd	14.4bc	18.4cde	11.5ef	21.7bcd
5. Spotless 25W (CC-14030) 20 (1.1 oz)	5.5bc	43.1bc	72.4ab	23.5bc	33.2bc	39.5b	12.3d
6. Spotless 25W (CC-14030) 20 (1.1 oz) + CC-15883 (8.0 fl oz)	18.3b	55.4b	53.8bc	23.7bc	38.0b	39.8b	23.5bc
7. FBC 39865 25W 37 (2.0 oz)	8.5bc	18.5de	41.0cd	22.7bc	21.1cde	18.0de	15.3cd
8. FBC 39865 25W 75 (4.0 oz)	0.5c	13.6def	31.5cd	8.7c	12.1e	9.0f	14.9cd
9. C-2338 10E 74 (1.0 fl oz)	6.7bc	19.8de	54.3bc	17.1bc	22.2b-e	26.3bcd	19.1bcd
10. C-2338 10E 113 (15.0 fl oz)	0.0c	18.9de	33.9cd	11.2c	16.2de	19.5de	28.8b
11. C-2338 10E 155 (20.0 fl. oz)	0.0c	6.0ef	32.9cd	7.8c	9.6e	9.5f	20.2bcd
12. Rubigan 1E 18.7 (2.0 fl oz) + Polyram 80W 960 (1.0 lb)	11.3bc	41.2bc	49.3bcd	21.3bc	30.8bcd	24.3bcd	23.8bc
13. Untreated	74.6a	91.8a	93.6a	78.0a	82.2a	90.3a	40.7a

---

[1] The youngest unfolded leaf on each terminal observed was marked on three dates when scab infections occurred forming four time zones on each terminal as follows: leaves 1-5, 10 Apr - 7 May (3 P.I. sprays); leaves 6-10, 8-21 May (1 P.I. spray); leaves 11-14 22 May - 3 Jun (1 P.I. and Prot. Spray); leaves 15-20, 4 Jun - 18 Jun (1 P.I. spray).

[2] Numbers followed by the same letter(s) within columns do not differ significantly, DMRT (*P* = 0.05).

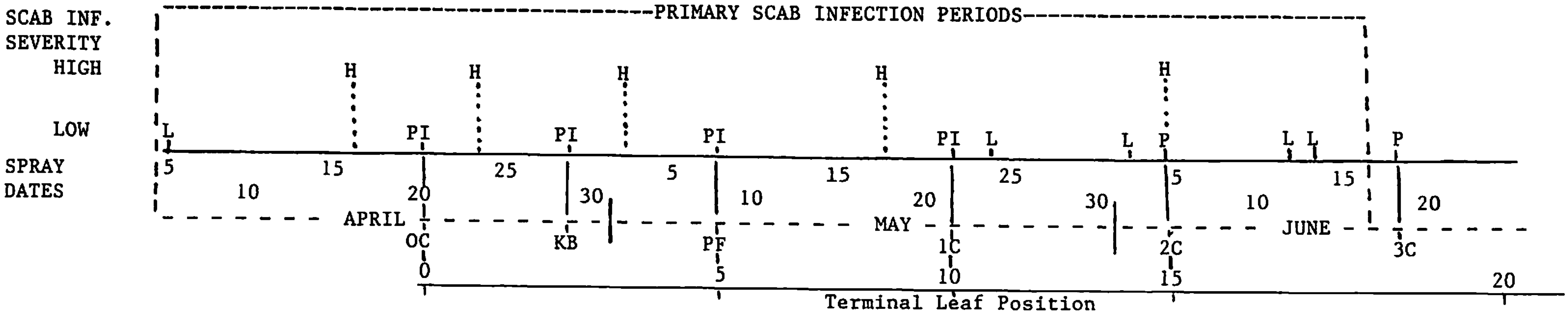
APPLE (*Malus domestica* 'Rome Beauty', 'Golden Delicious', 'Delicious')
Apple scab; *Venturia inaequalis*
Powdery mildew; *Podosphaera leucotricha*

K. D. Hickey, J. May and
G. McGlaughlin
PSU Fruit Research Laboratory
Biglerville, PA 17307

EVALUATION OF SEASONAL PROTECTIVE FUNGICIDE TREATMENTS FOR CONTROL OF APPLE SCAB AND POWDERY MILDEW, 1987: The efficacy of six sterol-inhibiting (EBI) fungicides combined with manzoceb or metiram (Polyram) was compared with two formulations of thiophanate methyl (TD-2239 or Topsin M) used in combination with mancozeb (Pencozeb) in an experimental orchard on 3 apple cultivars. The treatments were arranged in a randomized complete block design with four single tree (grafted to each of the 3 cultivars) replicates. The trees were planted at 9.1 X 10.7 m and well-pruned to a height of 4.5-5.0 m. High levels of natural inoculum of both the apple scab and mildew pathogens were present in the orchard. The dilute fungicide sprays were thoroughly applied to the point of run-off using 7.2 L/tree (850 L/ha). Sprays were applied with a high pressure sprayer operated at 2,758 kPa (400 psi) equipped with a 5 nozzle boom. Sprays were thoroughly applied to the lower portion of the trees up to 3.5 m high leaving a 1-1.5 m horizontal band at the top of the tree which did not receive direct sprays. This unsprayed portion of the tree at the top allowed scab and mildew to become established very early in the season. All treatments except the 2 Nustar treatments were applied at the green-tip, pink, bloom, and petal-fall phenological stages at 11,9,and 7-da intervals, respectively. Intervals between the 1st and 7th cover sprays were approximately 14 da. The Nustar treatments were applied at 14-da intervals from green-tip through 3rd cover followed by DPX-7331 at 21-da intervals in the 4th through 7th cover sprays. Apple scab incidence was determined on cluster leaves on 27 May by observing all leaves on 10 blossoming clusters/single tree replicate. The incidence of scab and mildew on terminal leaves was determined by observing on 17 and 20 Jul (Rome) and 21-22 Jul (Delicious) all leaves on 10 terminals/single tree replicate. The youngest unfolded leaf on each terminal observed was marked on 5 Jun (2nd cover) forming 2 time zones on each terminal as follows: leaves 1-15, 10 Apr-5 Jun; and leaves 16-19, 6 -25 Jun. Scab incidence on fruit and fruit size measurements at harvest were recorded by observing 100 fruits/cultivar on 6 and 7 Oct. Scab severity on fruit was determined by observing all lesions on the 5 most severely infected fruits/tree. Fruit finish on Golden Delicious was determined by the Horsfall-Barratt rating scale with units transformed to percent surface affected with russet. The data obtained were subjected to an analysis of variance using an appropriate transformation and the significance between means was determined by the Duncan's Multiple Range Test (P = 0.05).

Highly favorable conditions for scab development occurred with 9 apple scab infection periods resulting in over 90% leaf infection and 100% fruit infection on nontreated checks. Mildew incidence was moderate to low in this test. Cluster leaves had 72% scab infection on nontreated checks. All treatments allowed some cluster leaf infection except Nova (RH 3866) 75 ml ai/L. Better scab control on leaves 1-15 which developed during the green-tip through 2nd cover period was obtained with the sterol-inhibitors used during this period than with mancozeb or metiram applied in the 3rd-7th cover (data not shown). Although all fungicide treatments provided highly significant control of apple scab, the disease level was somewhat higher than expected. Scab lesions on cluster leaves was showing by early bloom at a time highly favorable for secondary spread. Relatively poor performance by the sterol-inhibitor fungicides may have been affected by the timing of sprays which occurred between major infections. For example, a heavy scab infection period occurred 5 da after the first application was applied and 6 da before the second application was applied. The second and third applications, however, preceded heavy infection periods by only 1 da. Only moderate mildew control was obtained with most treatments. RH-0611, however, provided excellent control of mildew. Measurements of Delicious and Rome Beauty fruit showed no differences among treatments. No significant difference among most of the treatments on fruit finish was observed. Some treatments provided exceptionally smooth finish on Golden Delicious.

Figure 1. 1987 PRIMARY APPLE SCAB INFECTIONS AND AIRBLAST SPRAY APPLICATIONS TIMED 70-118 HOURS POST-INFECTION IN 'ROME BEAUTY' BLOCK.



Primary Apple Scab Infections

	Date	Severity Level
1.	31 Mar - 5 Apr	Low
2.	16 Apr	High
3.	23 Apr	High
4.	2 May	High
5.	18 May	High
6.	23 May	Low
7.	1 Jun	Low
8.	3 Jun	High
9.	12 Jun	Low
10.	13 Jun	Low

Spray Applications, Number Hours Post-Infection and Temperature

	Date	Phen. Stage	# Hrs. P.I.	Temp. °F	Terminal Leaf Position
1.	20 Apr	open-cluster	100	66	1 - 5
2.	28 Apr	king-bloom	118	41	
3.	7 May	petal-fall	117	52	
4.	21 May	1st cover	70	68	6 - 10
5.	3 Jun	2nd cover	P	70	11 - 14
6.	18 Jun	3rd cover	P	55	15 - 20
7.	7 Jul	4th cover	P	71	No new leaves
8.	15 Jul	5th cover	P	74	
9.	29 Jul	6th cover	P	68	
10.	13 Aug	7th cover	P	72	

Not for Publication

Percent Scab and Powdery Mildew Infection on Leaves Treated with Dilute Fungicide Sprays in a Protective Schedule in 1987.

		Percent scab					
		Cluster lvs	Terminal leaves		Fruit		% P. mildew
Fungicide and Amt mg ai/L (Form/100 Gal)	Timing	Del	Del	Rome	Del	Rome	Rome
1. Nova (RH 3866) 60 DF 37 (0.83 oz)	GT-B						
Nova (RH 3866) 60 DF 37 (0.83 oz) +							
Dithane M-45 80W 899 (15.0 oz)	PF-2C						
Dithane M-45 80W 1438 (24.0 oz)	3C-7C	17.1bcd[1]	28.1bc	50.7bc	73.5b	42.0b	16.4c
2. Nova (RH 3866) 60 DF 75 (1.67 oz) +							
Dithane M-45 80W 1438 (24.0 oz)	GT-2C						
Dithane M-45 80W 1438 (24.0 oz)	3C-7C	0.0d	16.6c	38.9cd	23.5f	10.5d	17.7c
3. RH-0611 62.25W 1123 (24.0 oz)	GT-7C	1.4cd	16.2c	24.6d	29.8ef	18.0cd	6.5d
4. Procure 50W 112 (3.0 oz) +							
Polyram 80W 959 (1.0 lb)	GT-2C						
Polyram 80W 1438 (24 oz	3C-7C	9.8bcd	19.3c	54.7bc	53.3cd	33.5bc	17.5c
5. Rubigan 1EC 28 (3.0 fl oz) +							
Polyram 80W 959 (1.0 lb)	GT-2C						
Polyram 80W 1438 (24 oz)	3C-7C	19.4bcd	40.4b	67.1b	59.0bcd	43.0b	32.1ab
6. FBC 39865 25W 37 (2 oz)	GT-2C						
Dithane M-45 80W 1438 (24.0 oz)	3C-7C	25.8b	28.1bc	36.8cd	52.8cd	31.8bc	20.5bc
7. Nustar 20 DF 15 (1.0 oz) +							
Manzate 200 80W 959 (1.0 lb)	GT-3C*						
DPX-7331-165 50DF 700 (18.7 oz)	4C-7C**	26.5b	30.8bc	33.5cd	66.0bc	32.3bc	22.7abc
8. Nustar 20DF 20 (1.33 oz) +							
Manzate 200 80W 959 (1.0 lb)	GT-3C*						
DPX-7331-165 50DF 700 (18.7 oz)	4C-7C**	24.5b	39.4b	36.3cd	64.0bc	30.3bc	21.9abc
9. Ro 15-1297 4E 75 (2.0 fl oz) +							
Dithane M-45 80W 959 (1.0 lb)	GT-7C	15.5bcd	29.0bc	35.8cd	31.3ef	16.0cd	15.9c
10. TD-2239 85 WDG 89 (1.4 oz) +							
Penncozeb 80W 959 (1.0 lb)	GT-7C	20.8cd	29.0bc	53.0bc	34.5ef	31.3bc	33.8ab

Not for Publication

Percent Scab and Powdery Mildew Infection on Leaves Treated with Dilute Fungicide Sprays in a Protective Schedule in 1987.

		Percent scab					
		Cluster lvs	Terminal leaves		Fruit		% P. mildew
Fungicide and Amt mg ai/L (Form/100 Gal)	Timing	Del	Del	Rome	Del	Rome	Rome
11. TD-2239 85 WDG 178 (2.8 oz) + Penncozeb 80W 959 (1.0 lb)	GT-7C	28.2b	29.7bc	50.8bc	31.8ef	24.3bcd	23.2abc
12. Topsin M-45 4.5F 105 (2.5 fl oz) + Penncozeb 80W 959 (1.0 lb) + Bayleton 50W 37 (0.5 oz)	GT-7C P + 2C only	23.3b	27.5bc	48.8bc	43.3de	23.5bcd	27.0abc
13. Untreated	----	72.1a	92.3a	91.2a	100.0a	100.0a	35.9a

[1] Numbers followed by the same letter(s) within columns do not differ significantly, DMRT (P = 0.05)

* Applications made at 14-day intervals.

** Applications made at 21-day intervals.

Apple (*Malus domestica* 'Rome Beauty',
'Golden Delicious', Delicious')
Scab; *Venturia inaequalis*
Powdery mildew; *Podosphaera leucotricha*

K. D. Hickey, J. May and
G. McGlaughlin
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309

COMPARISON OF WETTABLE POWDER AND FLOWABLE FORMULATIONS OF STANDARD FUNGICIDES FOR CONTROL OF APPLE SCAB, 1987: Dilute sprays of wettable powder and flowable formulations of captan, maneb, mancozeb, and benomyl were evaluated in a block of 12 year old semi-dwarf trees planted 9 x 10.7 m in groups of 3 trees in each tree site (1 of each cultivar). The trees were well pruned at a height of 3 m. Treatments were arranged in a randomized complete block design with 5 replicates. All fungicides except the Rubigan + Manzate 200 were applied as protective sprays on the following dates and phenological stages: 11 Apr (1/2"-green), 20 Apr (open-cluster), 23 Apr (pink), 28 Apr (king-bloom), 2 May (full-bloom), 8 May (petal-fall), 1st through 7th cover sprays on 14, 21, 28 May, 12, 25 June, 8, 23 July, and 5 Aug, respectively. The Rubigan + mancozeb treatment was applied in post-infection applications as follows: 20 Apr, 100 hr; 28 Apr, 118 hr; 8 May, 141 hr; and 21 May, 70 hr. Manzate 200 was substituted in this treatment for the remainder of the season in a protective schedule at approximately 14-day intervals. Scab incidence on terminal leaves was determined by observing on 21 Jul (Rome) and 22 July (Delicious) all leaves on 5 terminals per single tree replicate. Scab incidence on fruit and fruit size measurements at harvest were recorded by observing 100 fruits/tree on 28 Sep (G. Del., Del.) and 7 Oct (Rome Beauty). Fruit finish on G. Del. was determined by the Horsfall-Barratt rating scale with units transformed to percent surface affected with russet. The data obtained were subjected to an analysis of variance using appropriate transformations and significance between means was determined by the Duncan's Multiple Range Test (P = 0.05).

Incidence of scab was severe due to frequent rains resulting in 9 primary apple scab infection periods. All of the protective treatments provided outstanding control of apple scab on both leaves and fruit. The flowable formulations of captan (Captec 4F) and maneb (Manex 4F) provided control of scab equal to the wettable powder formulations without producing any significant effect on fruit finish. Scab control with the post-infection applications of Rubigan + Manzate 200 was significantly lower than with the protective sprays. The Benlate + Manzate 200 standard treatment provided control equal to the other protective sprays. There was no treatment effect on finish of G. Del. or on fruit size on Del. or Rome Beauty. No phytotoxicity to leaves was observed in any of the treatments.

Not for Publication K. D. Hickey/PSU/Plant Pathology

Percent Scab on Terminal Leaves and Fruit Treated with Fungicides Applied Dilute in a Seasonal Protective Program in 1987.

Fungicide and Amt ai/L (Form/100 Gal)	Percent Apple Scab				
	Terminal lvs[1]		Fruit[2]		
	'Rome'	'Del'	'Rome'	'Del'	'G. Del'
1. Captan 50W 1200 (2.0 lb)	6.7c[3]	2.4bc	3.0c	3.4c	0.8c
2. Captec 4F 1200 (32.0 fl oz)	4.1c	2.3bc	1.0c	3.4c	0.4c
3. Captec 4F 900 (24.0 fl oz)	6.1c	2.5bc	1.6c	3.0c	0.6c
4. Manex 4F 1688 (45.0 fl oz)	4.2c	4.2bc	2.4c	3.2c	0.2c
5. Manzate 200 80W 1918 (2.0 lb)	3.5c	3.1bc	1.6c	3.4c	0.2c
6. Benlate 50DF 300 (4.0 g) + Manzate 200 80W 959 (1.0 lb)	3.6c	3.2bc	2.0c	1.4c	0.0c
7. Rubigan 1E 38 (4.0 fl oz)* Manzate 200 80W 959 (1.0 lb)	20.3b	9.2b	10.0b	22.0b	5.0b
8. Untreated	78.6a	60.6a	80.0a	80.2a	51.0a

---

* Rubigan used only in post infection sprays 70-141 hr PI from OC - 1st C (21 May). Manzate 200 used in standard schedule in 2nd - 7th C. sprays.

[1] Percent terminal leaves infected was determined by observing on 21 Jul ('Rome') and 22 Jul ('Delicious') all leaves on the terminals or on each section of 5 terminals/single-tree replicate (4 reps).

[2] Based on observation of 100 fruits/replicate (4 reps) at harvest on 1 Oct 1987.

[3] Numbers followed by the same letter(s) within columns do not differ significantly, DMRT ($P = 0.05$).

APPLE (*Malus domestica* 'Rome Beauty")
Powdery mildew; *Podosphaera leucotricha*

K. D. Hickey, J. May
and G. McGlaughlin
PSU Fruit Res. Laboratory
Biglerville, PA 17307-0309

EFFECT OF STEROL-INHIBITING FUNGICIDE TREATMENTS IN SUPPRESSING PRIMARY INOCULUM AND PREVENTING SECONDARY SPREAD OF APPLE POWDERY MILDEW, 1987: Treatments were evaluated in a mature block of standard Rome Beauty trees planted 9.1 X 10.7 m and well pruned to a height of 4.5 m. Primary inoculum (overwintering infected terminals) was very high from heavy infection in previous years and environmental conditions for secondary mildew development was favorable. The experimental plots consisted of two trees and were arranged in a randomized complete block design with 4 replicates. Treatments were applied as dilute sprays to the point of run-off with a high pressure handgun sprayer operated at 2,758 kPa (400 psi) which delivered 11 L/tree (1,262 L/ha). Dilute sprays were applied on the following dates and phenological stages: 11 Apr (green-tip), 21 Apr (open-cluster), 28 Apr (pink), 6 May (bloom), 12 May (petal-fall), 1st - 8th cover sprays were applied on 21 May, 2, 16, and 30 Jun, 7 and 20 Jul, 3 and 18 Aug, respectively. Specific rates of Nova applied at various phenological stages are indicated in the table. Treatment effect on growth and sporulation of the mildew fungus on overwintering infected terminals was measured on 10 primary infected terminals on each of the paired trees/replicate. These primary infected terminals were marked as soon as visible during the early blossom period, exised on 20 Jun, leaf area determined with a Li-Cor, LI 3000 portable area meter, oven-dried and weight determined. The percent of terminal leaves infected with secondary mildew was determined on 29 Jun by observing all leaves produced through 2 Jun (2nd cover) and on those produced after 2nd cover on 10 terminals/tree. The data obtained were subjected to an analysis of variance using an appropriate transformation and the significance between means was determined by the Duncan's Multiple Range Test ($P = 0.05$).

Incidence of primary mildew was very high with a mean 112 primary infections/tree. Nova 60DF was highly suppressive of fungus growth and sporulation as evidence by the low number of visibly detectable primary infections/tree on 12 May (petal-fall). Nova applications were discontinued on 2 Jun and observations for primary infections/tree were made again on 19 Jun. The number of primaries observed on this date ranged from 58-70/trees indicating a resumption of growth within two weeks of the discontinuation of the treatment. Primary infected terminals on all treated trees produced significantly more growth as reflected by dry weight and leaf area than the untreated check. There were significantly less visible infected terminals on the treatments receiving Nova or RH-0611 than on trees treated with Bayleton. All treatments significantly reduced the amount of secondary mildew produced on leaves 1-9 (those produced from green-tip through 2nd cover). Although all treatments provided outstanding control of mildew on the youngest 5 leaves on the terminal (leaves 10-15), infection on some leaves was evident. The strong suppression of the mildew pathogen on primary infected terminals and subsequent control of secondary mildew on new leaves with Nova and RH-0611 was clearly evident in this experiment. Equally evident was the return of growth and sporulation on treated trees after the treatments were discontinued.

Not for Publication

Number and Characteristics of Primary Powdery Mildew Infected Terminals and Percent of 'Rome Beauty' Leaves Infected with Secondary Mildew after Seasonal Fungicide Treatments in 1987.

		# primary inf terminals/tree		Terminal wt & size		Sec mildew % terminal leaves inf^{1}	
Fungicide and Amt mg ai/L (Form/100 Gal)	Applic Timing	12 May	19 Jun	Dry wt gm	Leaf area cm^{2}	1-9	10-15
1. Nova 60DF (RH 3866) 75 (1.67 oz) Nova 60DF (RH 3866) 37 (0.83 oz) Dithane M-45 80W 899 (15.0 oz) Dithane M-45 80W 1438 (24.0 oz)	1/2"-G, 0C, P B, PF, 1C, 2C PF, 1C, 2C 3C - 7C	4.3a^{2}	57.6a	2.31bc	201.6bcd	1.0bc	12.2b
2. Nova 60DF (RH 3866) 37 (0.83 oz) Nova 60DF (RH 3866) 75 (1.67 oz) Nova 60DF (RH 3866) 37 (0.83 oz) + Dithane M-45 80W 899 (15.0 oz) Dithane M-45 80W 1438 (24.0 oz)	1/2"-G, 0C P, B PF, 1C, 2C 3C - 7C	7.4a	70.4a	2.20bc	198.0bc	0.7bc	6.6b
3. Nova 60DF (RH 3866) 37 (0.83 oz) Nova 60DF (RH 3866) 75 (1.67 oz) Nova 60DF (RH 3866) 37 (0.83 oz) + Dithane M-45 80W 899 (15.0 oz) Dithane M-45 80W 1438 (24.0 oz)	1/2"-G, 0C P, B, PF, 1C 2C PF, 1C, 2C 3C - 7C	7.3a	53.5a	2.88c	238.9d	0.3c	6.9b
4. Nova 60DF (RH 3866) 37 (0.83 oz) Dithane M-45 80W 899 (15.0 oz) Dithane M-45 80W 1438 (24.0 oz)	1/2"-G,0C,P,B,PF,1C,2C PF, 1C, 2C 3C - 7C	11.1a	69.5a	2.33bc	192.5bc	1.4bc	12.3b
5. RH 0611 62.25W 1123 (24.0 oz)	1/2"-G - 7C	15.4a	64.5a	2.67bc	212.4cd	2.5bc	4.1b
6. Dithane M-45 1917 (32.0 oz) Bayleton 50W 75 (2.0 oz) Dithane M-45 80W 1438 (24.0 oz)	1/2"-G,0C,P,B,PF,1C,2C P, B, PF, 1C 3C - 7C	42.1b	72.4a	2.24b	173.3b	4.0b	4.1b
7. Untreated	--	112.3b	112.3b	1.35a	80.5a	20.2a	91.0a

---

[1] The percent of terminal leaves infected with secondary mildew was determined on 29 Jun by observing all leaves produced through 2 Jun (2nd cover) and on those produced after 2nd cover on 10 terminal/tree (2-tree plots, 4 reps).

[2] Means followed by the same letter(s) within columns do not differ significantly, DMRT ($P = 0.05$).

APPLE (*Malus domestica* 'Rome Beauty', 'Golden Delicious',
'Delicious' 'Stayman', 'Cortland')
Apple scab; *Venturia inaequalis*

K. D. Hickey, J. May and
G. McGlaughlin
PSU Fruit Res. Laboratory
Biglerville, PA 17307

INCIDENCE OF SCAB ON LEAVES OF FIVE APPLE CULTIVARS TREATED WITH POST-INFECTION SPRAYS OF STEROL-INHIBITING FUNGICIDES, 1987: The effect of 1, 2, or 3 applications of 4 highly effective sterol-inhibiting fungicides on the incidence of scab on leaves of 5 commonly grown cultivars was determined in an experimental planting on the PSU Fruit Research farm, Biglerville, PA. The experimental plots consisted of 2 complete sets of 3-yr old trees planted on M-26 rootstocks. Each group of trees consisted of 1 tree each of five cultivars planted 3 m apart and supported by a single wire trellis and a bamboo pole at each tree. Treatments were applied as dilute sprays to the point of run-off with a high pressure sprayer operated at 2,758 kPa (400 psi) and equipped with a 5- nozzle boom which delivered 3.3 L/tree (1,775 L/ha). The spray mixture was applied to 2 sides of the trees resulting in complete wetting of all leaves. The treatments were first applied to both sets of trees on 21 May, 70 hr after a heavy scab infection period. A second application followed 8 da later to one set of trees while the second set was not sprayed. The youngest unfolded leaf on each of 5 vegetative terminals/tree was marked on 20 May on all trees. A third application was made on 6 Jun (66 hr after a heavy scab infection), and was applied to both sets of trees. The youngest unfolded leaf during this infection period was also marked. Scab incidence during these separate scab infection periods was determined by observing on 29-30 Jun the five contigious leaves below each of the markers. The data obtained were subjected to an analysis of variance using appropriate transformations and the significance between means was determined by the Duncan's Multiple Range Test (P = 0.05).

By marking the youngest unfolded leaf and recording scab incidence on 5 leaves below the marker, incidence of scab for each of the infection periods and the effect of 1, 2, or 3 fungicide applications was possible. Scab incidence on all untreated trees was very high. All fungicide treatments provided significant reduction in scab incidence when applied in a single post-infection application, but were more effective when applied in 2 or 3 applications. Differences in scab incidence among the cultivars was apparent but not great. In general, Nustar and Nova provided significantly better control of scab than Rubigan or Spotless.

Not for Publication

Incidence of Apple Scab on Leaves of Five Apple Cultivars Treated with Post-infection Sprays of Sterol-inhibiting Fungicides in 1987.

	Percent Leaves Infected[2]		
	Number of Applications		
Fungicide and Amt mg ai/L (Form/100 Gal)[1]	1	2	3
'Delicious'			
Nustar 20DF 30 (2.0 oz)	50.7c[3]	15.5c	7.0c
Nova (RH 3866) 60DF 67 (1.5 oz)	40.1c	15.2c	7.3c
Rubigan 1EC 28 (3.0 fl oz)	81.6b	52.8b	41.7b
Spotless 25W 36 (2.0 oz)	85.8ab	26.4c	18.1c
Untreated	91.7a	90.0a	67.6a
'Stayman'			
Nustar 20DF 30 (2.0 oz)	30.3c	19.5c	5.7c
Nova (RH 3866) 60DF 67 (1.5 oz)	11.0d	18.5c	7.0c
Rubigan 1EC 28 (3.0 fl oz)	75.4b	50.5b	25.9b
Spotless 25W 36 (2.0 oz)	62.0b	46.0b	17.2b
Untreated	90.6a	98.7a	72.7a
'Rome Beauty'			
Nustar 20DF 30 (2.0 oz)	22.0c	29.0bc	9.6c
Nova (RH 3866) 60DF 67 (1.5 oz)	29.0c	23.0c	9.4c
Rubigan 1EC 28 (3.0 fl oz)	63.4b	42.0bc	24.3bc
Spotless 25W 36 (2.0 oz)	62.6b	56.1b	32.2b
Untreated	96.0a	91.6a	69.6a
'Golden Delicious'			
Nustar 20DF 30 (2.0 oz)	20.0b	26.0b	9.3c
Nova (RH 3866) 60DF 67 (1.5 oz)	18.2b	26.1b	10.7c
Rubigan 1EC 28 (3.0 fl oz)	27.0b	39.0b	17.5bc
Spotless 25W 36 (2.0 oz)	33.0b	49.1b	25.5b
Untreated	70.8a	81.0a	50.3a
'Cortland'			
Nustar 20DF 30 (2.0 oz)	8.8d	17.2b	6.5bc
Nova (RH 3866) 60DF 67 (1.5 oz)	13.8cd	11.4b	5.5c
Rubigan 1EC 28 (3.0 fl oz)	40.0bc	31.0b	18.1b
Spotless 25W 36 (2.0 oz)	43.0b	33.3b	13.5bc
Untreated	82.0a	93.8a	73.8a

---

[1] Applied dilute as post-infection sprays on 21 May (70 hrs P.I.), 29 May (Protectant), and on 6 Jun (66 hrs P.I.).

[2] Percent leaves infected was determined by observing on 29-30 Jun all leaves on the terminals or on each section of 5 terminals per single-tree replicate (4 reps).

[3] Means followed by the same letter(s) within columns do not differ significantly, DMRT (P = 0.05).

APPLE (*Malus domestica* 'Rome Beauty', 'Golden Delicious', 'Delicious'
'Stayman', 'Cortland')
Apple scab; *Venturia inaequalis*

K. D. Hickey, J. May and
G. McGlaughlin
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309

SUPPRESSION OF CONIDIA PRODUCTION OF *VENTURIA INAEQUALIS* ON LEAVES OF FIVE APPLE CULTIVARS WITH STEROL-INHIBITING FUNGICIDES, 1987: Three to six applications of sterol-inhibiting fungicides were applied to establish apple scab lesions to measure the effect on conidia production. The experiment was conducted in a 3-yr old semi-dwarf orchard that received no fungicide treatment before the test fungicides were first applied on 21 May. The experimental plots consisted of two complete sets of trees, each set consisting of 1 tree each of the five cultivars grown on M-26 rootstock planted 3 m apart and supported by a single wire trellis and a bamboo pole at each tree. Scab lesions were present on a high percentage of the terminal leaves present (8-10 leaves) at the time of first application. A tape marker was placed around the petiole of the youngest unfolded leaf on each of 10 vegetative terminals/tree. Dilute fungicide sprays were applied to the point of run-off using the fungicide suspensions at 3.3 L/tree (1,775/ha). Sprays were applied with a high pressure sprayer operated at 2,758 kPa (400 psi) and equipped with a 5-nozzle boom. Six applications were made at 8-15 da intervals on the following dates: 21, 29 May, 11, 22 Jun, 2 and 17 Jul. The effect of fungicide treatment on conidial production was measured by hemacytometer count of spores collected from 10 lesions (7 m diam from 10 leaves one from each of the 10 terminals) on each single tree replicate. Leaves collected contained lesions which were present at the time of the first spray application on 21 May. Observations were made on 15 Jun (after 3 applications), 25 Jun (after 4 applications), and 27 Jul (after 6 applications). The intervals between the 3 observation dates and the first spray were 25, 35, and 67 da, respectively. The intervals between the observation dates and the last application were 4, 3 and 10 da, respectively. Conidial counts were expressed as thousands of spores/cm^2 of lesion area. The data obtained were subjected to an analysis of variance using an appropriate transformation and the significance between means was determined by the Duncan's Multiple Range Test ($P = 0.05$).

Conidia production was high on untreated lesions on the 15 and 25 Jun observation dates, but was very low on the 3rd observation date on 27 Jul. Although the mean number of conidia on the treated trees was appreciably less than the untreated check, these differences were often not statistically significant. This may have been due to high variation in spore production among lesions. The fungicides appeared to provide equal suppression among the cultivars. Four applications were more effective than three. Lesion activity appeared to be too low to adequately measure the effect of six applications. Observations of treated lesions made in early September showed a return of sporulation. No conidial counts were made at this time. These data suggest that the sterol-inhibiting fungicides are highly suppressive of conidial production after the use of 3 applications, that 4 applications are more effective but that treated lesions may resume sporulation after discontinuation of applications.

Not for Publication

Suppression of Spore Production on Apple Scab Lesions on Leaves Treated with Sterol-Inhibitor Fungicides Applied in Three, Four, and Six Dilute Sprays in 1987.

Fungicide and Amt mg ai/L (Form/100 Gal)	# conidia/cm^2 (Ths) After 3,4, or 6 Applic		
	3 sprays	4 sprays	6 sprays
'Delicious'			
Spotless 25W 18 (1.0 oz)	21.0ab[1]	17.9b	5.2a
Rubigan 1EC 19 (2.0 oz)	56.6ab	23.4b	4.4a
Nova (RH 3866) 60DF 45 (1.0 oz)	21.8ab	14.3b	5.5a
Nustar 20DF 15 (1.0 oz)	27.5ab	19.4b	5.2a
Untreated	75.1a	70.9a	9.4a
'Rome Beauty'			
Spotless 25W 18 (1.0 oz)	22.6ab	9.4a	6.2b
Rubigan 1EC 19 (2.0 oz)	42.6ab	4.2a	7.8b
Nova (RH 3866) 60DF 45 (1.0 oz)	7.3ab	2.3a	2.3b
Nustar 20DF 15 (1.0 oz)	17.4ab	7.5a	2.3b
Untreated	63.9a	13.0a	19.2a
'Golden Delicious'			
Spotless 25W 18 (1.0 oz)	44.7ab	7.1a	1.0a
Rubigan 1EC 19 (2.0 oz)	19.2ab	6.8a	1.8a
Nova (RH 3866) 60DF 45 (1.0 oz)	39.0ab	6.4a	1.6a
Nustar 20DF 15 (1.0 oz)	20.8ab	10.1a	0.6a
Untreated	60.0a	9.9a	1.1a
'Stayman'			
Spotless 25W 18 (1.0 oz)	34.3b	8.3ab	1.8a
Rubigan 1EC 19 (2.0 oz)	39.0b	12.5ab	3.7a
Nova (RH 3866) 60DF 45 (1.0 oz)	21.8b	9.1ab	1.8a
Nustar 20DF 15 (1.0 oz)	21.0b	4.0ab	1.8a
Untreated	78.4a	20.2a	1.9a
'Cortland'			
Spotless 25W 18 (1.0 oz)	25.1b	9.1ab	1.7b
Rubigan 1EC 19 (2.0 oz)	14.6bc	3.4ab	1.2b
Nova (RH 3866) 60DF 45 (1.0 oz)	4.7bc	1.8ab	0.4b
Nustar 20DF 15 (1.0 oz)	8.1bc	4.7ab	0.5b
Untreated	43.9a	22.1a	5.1a

---

[1] Numbers followed by the same letter(s) within columns do not differ significantly, DMRT ($P = 0.05$).

PEACH (*Prunus persica* 'Redhaven', 'Rio Oso Gem')
Brown rot; *Monilinia fructicola*
Rusty spot; *Podosphaera leucotricha*

K. D. Hickey, J. May,
and G. McGlaughlin
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309

EFFICACY OF FUNGICIDE TREATMENTS FOR CONTROL OF PEACH BROWN ROT AND RUSTY SPOT, 1987: The fungicide treatments were evaluated in a mature block of 8-yr old Redhaven and Rio Oso Gem trees planted in pairs 3.5 m apart and in rows 9 m wide. Treatment plots consisted of 1 set of paired trees and were arranged in a randomized block design with 4 replicates. The fungicides were applied as dilute sprays with a high pressure sprayer to the point of run-off at 5 L/tree (988 L/ha). The sprayer was equipped with a 5 nozzle boom and was operated at 2,758 kPa (400 psi). The trees were pruned to a height of 2 m and were thoroughly sprayed on the following dates and phenological stages: Redhaven - 15 Apr (pink), 23 Apr (full-bloom), 2 May (petal-fall), 27 Jul (10-da before harvest), and 7 Aug (da of harvest); Rio Oso Gem - 15 Apr (pink), 23 Apr (full-bloom), 2 May (petal-fall), 9 May (shuck-split), 18 May (shuck-fall), 26 May (1st cover), 11 Jun (2nd cover), 21 Aug (10 da before harvest), and 4 Sep (da of harvest). The blossom blight test was conducted on Triogem blossoms collected during bloom and dipped in a suspension of each of the fungicide treatments. The blossoms were dipped for 30 sec, allowed to dry, inoculated with conidia of *Monilinia fructicola* (83,000 spores/cc), placed in water agar petri dish chambers and incubated at 24° C for 5-6 da. Severity of colonization of blossoms was based on a rating from 0 (no infection) to 5 (complete colonization). Incidence of brown rot on fruit was determined by observing 20 fruits/replicate collected 1 hr after final spray on 7 Aug (Redhaven) and on 18 Sep (Rio Oso Gem). Fruits were inoculated with a conidial suspension (125,000 spores/cc) and incubated for 5-11 da at 19°-31° C and 90-100% RH under polyethylene tarp before observations were made. Incidence of rusty spot on Rio Oso Gem fruit was determined by observing 100 fruits/replicate and severity was determined by counting the number of lesions/100 fruit. The data obtained were subjected to analysis of variance using appropriate tranformations and the significance among treatment means was determined by the Duncan's Multiple Range Test (P = 0.05).

Incidence of brown rot blossom blight was very high on most treatments. Ronilan and the Benlate plus Captan combination were highly effective. There were significant differences in severity of blossom colonization among several of the experimental fungicides. The higher rates of FC-0858 and RH -7592 significantly reduced colonization of the blossom. These treatments were also effective in reducing the incidence of brown rot decay on fruit. The C-2338 was ineffective against brown rot. Orbit provided control about the same as that obtained with Ronilan which was at a level somewhat below that expected. Because of the severity of test conditions in this experiment, fungicides showing some activity in this test are likely to provide much better control under commercial field conditions. Most of the fungicide treatments were ineffective against rusty spot. Procure and RH-7592 produced significantly better control than the check providing about 50% control. None of the treatments produced any phototoxicity to leaves or fruit.

Not for Publication

K. D. Hickey/PSU/Plant Pathology

Incidence of Brown Rot and Rusty Spot on Peach Sprayed with Dilute Fungicide Treatments in 1987.

Fungicide and Amt mg ai/L (Form/100 gal)	Percent Brown Rot						Rusty Spot	
	Blossom Blight		Fruit				Fruit	
	'Triogem'		'RedHaven'		'Rio Oso Gem'		'Rio Oso Gem'	
	% Inf	Sev	5 da	11 da	3 da	7 da	% Inf.	Lesions/fruit
1. Orbit 3.6E 22.5 (0.7 fl oz)	75.0ab[2]	0.85fg	5.0ab	17.5b	8.8abc	45.0bc	78.8bc	3.7bcd
2. Ronilan 50W 600 (1.0 lb)	55.0c	0.65gh	5.0ab	26.3ab	10.0abc	42.5bcd	83.4ab	4.8ab
3. Ronilan 50W 600 (1.0 lb) + X-77 Spreader (16.0 fl oz)	10.0d	0.10i	2.5ab	21.3ab	12.5abc	31.3cd	84.3ab	5.1ab
4. Ronilan 50W 300 (0.5 lb) + X-77 Spreader (16.0 fl oz)	25.0d	0.25hi	3.8ab	21.3ab	10.0abc	50.0abc	77.8abc	3.8bcde
5. SC-0858 50W 240 (6.4 oz)	100.0a	2.05cd	0.0b	12.5b	21.3ab	43.8bcd	84.1ab	6.0a
6. SC-0858 50W 480 (12.8 oz)	100.0a	1.20ef	0.0b	5.0b	6.3bc	30.0cd	89.2a	5.1ab
7. Procure 50W 300 (0.5 lb)	100.0a	1.45e	11.3a	27.5ab	13.8abc	51.3abc	65.0de	3.6bcd
8. C-2338 10E 155 (20.0 fl oz)	95.0ab	2.75b	5.0ab	17.5b	13.8abc	60.0ab	74.0bcd	4.6abc
9. C-2338 10E 113 (15.0 fl oz)	95.0ab	2.40bc	0.0b	22.5ab	11.3abc	63.8ab	76.0bcd	3.7bcd
10. RH 7592 2F 48 (2.6 fl oz)[1]	95.0a	1.95d	0.0b	8.8b	6.3c	27.5cd	47.3f	2.4d
11. RH 7592 2F 96 (5.1 fl oz)	80.0ab	1.25ef	3.8ab	21.3ab	2.5c	20.0d	58.8ef	3.1cd
12. Benlate 50DF 300 (0.5 lb) + Captan 50W 600 (1.0 lb)	10.0d	0.15i	3.8ab	12.5b	22.5ab	65.0ab	70.3cde	3.6bcd
13. Untreated	100.0ab	4.85a	12.5a	43.8a	25.0a	75.0a	84.0ab	5.7a

---

[1] Used RH 3866 (NOVA) 60 DF 3.3 oz/100 gal on 'Rio-Oso-Gem' in 5 sprays from petal-fall through 2nd cover.

[2] Numbers followed by the same letter(s) do not differ significantly, DMRT, (P = 0.05).

[3] Inoculated with conidia (125,000/cc) of *Monilinia fructicola*.

CHERRY (RED TART) (Prunus ceraus 'Montmorency')
Brown rot; Monilinia fructicola
Cherry leaf spot; Coccomyces hiemalis

K. D. Hickey, J. May,
and G. McGlaughlin
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309

INCIDENCE OF BROWN ROT AND LEAF SPOT ON TART CHERRY SPRAYED WITH SEASONAL DILUTE FUNGICIDE TREATMENTS, 1987: Seasonal fungicide treatments were evaluated in a block of 8-yr old trees planted 9 x 9 m and pruned to a height of 3.5 m. Treatments were arranged in a randomized complete block design with 5 single tree replicates. The fungicides were applied in dilute sprays with a high pressure sprayer equipped with a 5 nozzle boom which was operated at 2,758 kPa (400 psi). Trees were sprayed to the point of run-off using 6 L/tree (740 L/ha). No spray was directed toward the top 1 1/2 m of the trees to allow for disease development in each tree. Applications were made on the following dates and phenological bud stages: 21 Apr (full-bloom), 5 May (petal-fall), 11 May (shuck-fall), 23 May (1st cover), 8 Jun (2nd cover), 22 Jun (10 da before harvest), 2 Jul (da of harvest), and 22 Jul (post-harvest). Incidence of brown rot infection on fruit was determined on a 100 fruit sample taken at random on the lower portion of each replicated tree. The fruit sample was placed in trays, sprayed with a conidial suspension (120,000 spores/cc) and incubated at 27°-31° C and 90-100% RH under polyethylene tarp for 4 da. The number of fruit/km sample collected from each tree was determined. The percent soluble solids in fruit juice taken from a 50 fruit sample/tree was determined with a Chemtrix hand refractometer. The incidence of cherry leaf spot on leaves was determined by observing all leaves on each of 10 terminal shoots/tree on 24 Jul, 13 Aug, and 31 Aug. The data obtained were subjected to an analysis of variance using appropriate transformations and significance between means was determined using Duncan's Multiple Range Test ($P = 0.05$).

Incidence of brown rot on fruit was 73% on nontreated checks. RH-7592 and Procure produced significantly better control than other treatments. Leaf spot incidence was 79% on 24 Jul and 92% on 31 Aug on the untreated checks. There was significantly less disease on 31 Aug on trees treated with RH-7592 and Ro 15-1297. C-2338 also provided very good control of leaf spot and was superior to that obtained with Procure or Rubigan. There was no significant difference among treatments in fruit size or soluble solids of fruit. No phytotoxicity to leaves was observed on any of the treated trees.

Not for Publication

Fruit Quality and Incidence of Fruit Rot and Leaf Spot on Tart Cherry Sprayed with Dilute Fungicide Treatments in 1987.

Fruit and Amt mg ai/L	(Form/100 gal)	# fruit/ Kilogram	% Soluble Solids[1]	% Brown Rot[2]	% Leaf spot[3]		
					24 Jul	13 Aug	31 Aug
1. RH-7592 2F 48	(2.6 fl oz)	228a[4]	14.9ab	8.6c	2.8e	7.8de	15.5de
2. RH-7592 2F 96	(5.0 fl oz)	193cd	15.1a	5.4c	2.2e	4.6e	10.2e
3. Rubigan 1E 19	(2.0 fl oz)	200bcd	14.2abc	42.6b	9.6cd	15.8bc	23.9cd
4. Rubigan 1E 37	(4.0 fl oz)	201bcd	14.0bc	36.8b	19.5b	25.1b	36.9bc
5. Procure 50W 150	(4.0 oz)	191d	14.6abc	19.8bc	16.8bc	25.4b	39.8b
6. C-2338 10E 155	(20 fl oz)	193cd	13.7c	40.8b	8.3d	12.1cd	22.0d
7. Ro 15-1297 4E 75	(2.0 fl oz)	205bc	14.2abc	45.8b	1.8e	6.9de	16.2de
8. Untreated		210b	14.6abc	72.8a	78.5a	85.0a	92.1a

---

[1] Determined at harvest on 2 Jul with a Chemtrix hand refractometer.

[2] Incidence of brown rot fruit decay was determined by observing 100 fruits per replicate (5 reps) collected one hour after the harvest spray (0 da pre-harvest) on 2 Jul. Fruit were inoculated with conidia of *Monilinia fructicola* (120,000 spores/ml) and incubated at 27° - 31° C (81-88° F) and 90-100% RH under polyethylene tarp for 4 days.

[3] Observations made on all leaves on 10 terminals per replicate (5 reps) on 24 Jul, 13 Aug, and 31 Aug, 1987.

[4] Numbers followed by the same letter(s) within columns do not differ significantly, (DMRT, (*P* = 0.05).

Plum (<u>Prunus</u> <u>domestica</u> 'Stanley')
Brown rot; <u>Monilinia</u> <u>fructicola</u>

K. D. Hickey, J. May and
G. McGlaughlin
PSU Fruit Research Laboratory
Biglerville, PA 17307-0309

EFFECT OF SEASONAL FUNGICIDE TREATMENTS ON CONTROL OF BROWN ROT BLOSSOM BLIGHT AND FRUIT DECAY ON STANLEY PRUNE, 1987: Seasonal fungicide treatments were evaluated in an 8 yr old block of trees planted 9 x 9 m and pruned to a height of 3.5 m. The experimental plot design consisted of single trees in a randomized complete block design with 3 replicates. The treatments were applied as dilute sprays to the point of run-off with a high pressure sprayer operated at 2758 kPa (400 psi) equipped with a 5-nozzle boom which delivered 5.0 L/tree (988 L/ha). Each of the applications was thoroughly applied on the following dates and phenological bud stages: 21 Apr (full-bloom), 2 May (petal-fall), 9 May (shuck-fall), first through seventh covers on 22 May; 6, 19 June; 3, 17, 31 July; 14 Aug.; respectively, and on 28 Aug. (7 da before harvest); and 4 Sept. (day of harvest). Insecticides were used as necessary and were applied separately with a conventional airblast sprayer. The brown rot blossom blight data were based on observations made on 20 blossoms/treatment which were dipped in a suspension of each of the fungicides for 30 seconds, allowed to dry, inoculated with conidia of <u>Monilinia</u> <u>fructicola</u> (117,000 spores/cc) placed in water agar petri dish chambers and incubated at 24° C for 5-6 da. Severity ratings were from 0 (no infection) to 5 (complete colonization). Brown rot on fruit was based on observations of 20 uninoculated fruit/replicate harvested at 1 hr and 7 da after the last spray application. Fruits were placed in trays and incubated at 24-26° C and 90-100% RH under polyethylene tarp for 5, 7, and 12 da. The data obtained were statistically analyzed using the appropriate transformations, analysis of variance, and the Duncan's Multiple Range Test for mean separation (P = 0.05).

The petri dish moist chambers provided highly favorable conditions for blossom blight development and all blossoms sprayed with Captan or Dithane M-45 were almost completely colonized after 5-6 days. The Nova and RH 7592 treatments provided very good protection of the blossoms and prevented extensive colonization. These treatments were all significantly different from the untreated check or the Captan standard. Brown rot development on fruit was light during the first 7 da on fruit samples taken the day of last application. Nova provided outstanding control of brown rot even after 12 da of incubation. Observations on fruit collected 7 da after the last spray showed that both Nova and RH 7592 still provided significant control of brown rot. No phytotoxicity to leaves or fruit was observed in this experiment.

Not for Publication

K. D. Hickey/PSU/Plant Pathology

Efficacy of Fungicide Treatments for Control of Brown Rot on 'Stanley' Prunes in 1987.

	Percent Brown Rot					
			Fruit[3] Days after last spray			
	Blossom Blight[1]		0		7	
Fungicide and Amt mg ai/L (Form/100 gal)	% Inf.	Sev.	7 da	12 da	5 da	7 da
1. RH 7592 0.5E 20 (4.25 fl oz)	23.3b[2]	0.28c	5.3bcd	28.0bcd	19.3cde	35.3bc
2. RH 7592 0.5E 40 (8.5 fl oz)	35.0b	0.42c	0.7cd	27.3bcd	16.7cde	32.7bc
3. RH 7592 0.5E 80 (17 fl oz)	23.3b	0.28c	2.0bcd	19.3bcd	11.3de	24.0c
4. Nova (RH 3866) 40W 75 (2.5 oz)	13.3b	0.23c	0.0d	2.7d	6.7e	18.7c
5. Nova (RH 3866) 40W 150 (5.0 oz)	28.3b	0.67c	0.0d	10.0cd	15.3de	25.3c
6. Dithane M-45 80W 1917 (2.0 lb)	96.7a	3.82ab	8.0ab	56.0ab	49.3ab	67.3a
7. Dithane M-45 80W 3835 (4.0 lb)	100.0a	3.28b	17.3a	71.3a	57.3a	78.0a
8. Captan 50W 1200 (2.0 lb)	100.0a	3.23b	8.7abc	54.0ab	30.7bcd	66.0a
9. Untreated	100.0a	4.07a	9.3ab	42.7abc	37.3abc	61.3ab

---

[1] Data are based on 3 replicated tests where observations were made of 20 blossoms/treatments which were dipped in a suspension of each fungicide for 30 seconds, allowed to dry, inoculated with conidia of <u>Monilinia fructicola</u> (117,000 spores/cc, Rep 1 and 292,000 spores/cc, Reps 2 and 3) placed in water-agar petri dish chambers and incubated at 24° C (75° F) for 5-6 days. Severity ratings were from 0 (no infection) to 5 (complete colonization).

2 Means followed by the same letter(s) are not significantly different (P = 0.05, DMRT).

3 Based on observation of 20 uninoculated fruit/replicate (4 reps) harvested at 0 and 7 da after last spray application (harvest) and observed at 5 to 12 da after incubation at 24-26° C.

POPULATION DYNAMICS OF LESION AND DAGGER NEMATODES IN PEACH ORCHARDS TREATED WITH FENAMIPHOS

James Kotcon
Div. of Plant and Soil Sciences
West Virginia University
Morgantown, WV 26506

Two nematicide trials are being conducted in newly established peach orchards in Jefferson and Berkeley counties in West Virginia. The objectives of these studies are to evaluate the efficacy of fenamiphos (Nemacur 3E) applied as a broadcast spray or through drip irrigation and to compare rates and timing of applications to achieve optimum nematode control. Plant growth, tree mortality, and movement of the nematicide through soil are also being evaluated, but only preliminary results are available at this time.

MATERIALS AND METHODS:

The Jefferson County site, Location 1, had been in peaches for the last 18 years. The previous orchard was removed in fall 1986 and peach trees were planted in April, 1987. Trickle irrigation was installed with two, 2-gal/hr emmitters located approximately 3 feet from each side of the tree. Fenamiphos (Nemacur 3E) was applied June 5 in four treatments; 18 lb. a.i. per treated acre applied as a broadcast spray, 18 lb. a.i. per treated acre applied via the drip irrigation system, 9 lb. a.i. per treated acre applied through the drip irrigation system in both spring and fall, and an untreated control. Drip applications were applied with a GEWA fertilizer proportioner using a 1-hour application period followed by a 1-hour irrigation with water to incorporate the fenamiphos. Rates in drip applications were calculated assuming each emitter wetted a four foot diameter circle. Separate irrigation lines were used for each drip application treatment to prevent contamination of untreated plots. Five replicate eight-tree plots for each treatment were arranged in a randomized block design.

Soil suction lysimeters were installed in two replicate plots of each treatment to monitor movement of fenamiphos through the soil profile. Lysimeters were installed at 6, 12, and 36 inch depths within the wetted zone from drip emitters. Another set of lysimeters was installed outside the wetted zone at the same depths. Samples of soil water were collected from each lysimeter on May 20, June 15, July 10, Aug. 7, Sept. 4, Oct. 13, and Nov. 4 and were analyzed for fenamiphos concentrations by the Mass Spectrometry Center, Dept. of Biochemistry, West Virginia Univ.

Nematode population densities were determined from soil samples collected from the root zone of trees in each plot on June 4, July 15, and Sept. 25. Nematodes were extracted from 100 cm^3 soil using the centrifugal flotation method and all plant parasitic nematodes were counted. Representative specimens of important genera were identified to species. Tree diameters and tree mortality were assessed on Sept. 25.

Location 2 is in Berkeley County and was rotated with corn for two years prior to planting peach trees in April, 1987. Nemacur 3E was applied as a broadcast spray on April 25 and was incorporated with a shallow discing. Four treatments, 18 lb. a.i. per acre applied in spring, 18 lb. applied in fall, 9 lb. applied in both spring and fall, and an untreated control, were applied to plots of eight trees each. Five replicates per treatment were arranged in a randomized complete block design. Soil samples were collected from the root zone of trees in each plot on April 24, June 4, and Sept. 25. Plant parasitic nematodes were extracted from 100 cm^3 samples by the centrifugal flotation method. Representative specimens of plant parasitic nematode genera were identified to species. Trunk diameter and tree mortality were assessed Sept. 25.

RESULTS:

Mixed populations of the dagger nematodes *Xiphinema americanum* and *X. rivesi* were found at both locations 1 and 2. Mixed populations of the root lesion nematodes *Pratylenchus penetrans* and *P. crenatus* were found at location 1 while *P. crenatus* and *P. neglectus* were found at location 2. Root Knot nematodes, *Meloidogyne hapla*, Spiral nematodes, *Helicotylenchus* spp., Pin nematodes, *Paratylenchus* spp., and Ring nematodes, *Criconemella* spp., were also found in some plots at both locations. The predaceous nematode, *Mylonchulus* spp., was also observed in many plots.

Mean tree diameters were 2.5 and 2.6 cm at Location 1 and 2, respectively, and did not differ among treatments. Tree mortality was less than 3 % at either location. Fenamiphos was not detected in water samples from lysimeters deeper than 12 inches in water samples analysed through July 10.

Population densities of dagger and root lesion nematodes in these orchards did not differ significantly among treatments in pre-treatment samples, nor in samples collected approximately 6 weeks after treatment (Table 1). However, by Sept. 25 population densities of both dagger and root lesion nematodes were lower in fenamiphos-treated plots ($P < 0.05$) than in untreated plots at Location 2 (Table 1). Since these samples were collected before the fall application, the treatments compared the effect of 0, 9, or 18 lb. a.i. per acre on nematode population densities. Differences between the 9 and 18 lb. rates were not statistically significant. Population densities of predaceous nematodes in treated plots were significantly lower than in untreated plots and were significantly lower in the plots treated with 18 lb. a.i. than in plots treated with 9 lb. a.i. per acre ($P < 0.05$).

Nematode population densities also did not differ significantly among treatments at location 1, either pretreatment June 4, or at 6 weeks after application, July 16 (data not shown). Population densities on July 16 were significantly lower in soil wetted by drip irrigation than in dry soil (data not shown). This trend was also observed Sept. 25, however, there was an interaction between treatment and irrigation for both root lesion nematode ($P < 0.01$) and dagger nematode ($P < 0.10$). Population densities of both dagger and root lesion nematodes were lower in wetted areas than in dry areas of untreated plots (Table 2). When fenamiphos was broadcast, population densities were significantly reduced in both wetted and dry areas compared to untreated plots; however they tended to be slightly greater in the wetted than in the dry areas. When fenamiphos was applied through drip irrigation at 18 lb. a.i., nematode population densities in wetted areas were significantly lower than in broadcast treatments, but population densities in dry areas did not differ significantly from untreated plots. When fenamiphos was applied through drip irrigation at 9 lb. a.i., population densities in wetted areas were intermediate between those in the 18 lb. drip and the 18 lb. broadcast applications.

The population density of predaceous nematodes in wetted areas was reduced by all fenamiphos applications, but, in dry areas, densities in the 18 lb. drip treatments were significantly greater than those in untreated or broadcast treatments. Relatively low population densities of predaceous nematodes makes interpretation of this result difficult.

DISCUSSION:

Population densities of dagger nematodes changed very little over the season in untreated plots at both locations. Population densities of root lesion nematodes in untreated plots increased significantly at location 1, but declined at location 2. The two locations were infested with different species of root lesion nematode which may account for the diffences in population trends observed.

Fenamiphos reduced nematode population densities in treated soil at both locations. Control ranged from 60 to 88 %. Whether this is adequate to provide an economic return on the cost of application will depend on the duration of the population reduction, the susceptibility of the orchard to nematode diseases, and the value of the crop produced.

Fenamiphos moves systemically within the plant and may provide some control of plant parasitic nematodes in areas of the root zone that did not receive direct applications of the nematicide. These first season results from applications through drip irrigation demonstrated a slight trend toward lower nematode population densities in non-wetted areas of soil; however densities were not statistically different from untreated plots. Therefore, translocation does not seem to provide sufficient control in dry areas to produce observable differences within the first season after application. Since drip application greatly reduces the cost and amount of nematicide applied, the lower nematode control may still result in acceptable economic returns or enhanced environmental safety. Additional studies are underway to determine if multiple year applications, or split spring and fall applications will provide improved nematode control throughout the root zone and will result in a measurable increase in tree growth, yield, or longevity.

Table 1. Nematode population densities at location 2 in 1987

	Pratylenchus			Xiphinema			Mononchids		
TRMT	4/24	6/4	9/25	4/24	6/4	9/25	4/24	6/4	9/25
UNTREATED	46	25	20 a	25	20	23 a	6.5	7.8	5.2 a@
18 LB-SPRING*	27	19	6 b	20	21	6 b	2.5	6.0	1.2 c
9LB-SPR & FALL	52	37	8 b	21	12	5 b	6.4	3.3	2.1 b
18 LB-FALL•	33	20	25 a	18	27	21 a	5.4	5.8	8.7 a
LSD (0.05)	NS	NS	10	NS	NS	8	NS	NS	3.3

@ MEANS SEPARATED BASED ON LOG(X +1) TRANSFORMATION
* SPRING APPLICATION APRIL 25
# FALL APPLICATION OCT. 12

Table 2. Nematode population density at location 1 on Sept. 25, 1987

	Pratylenchus		Xiphinema		Mononchids	
TRMT	WETTED	DRY	WETTED	DRY	WETTED	DRY
UNTREATED	32 a	39 a	15 a*	31 a	3.3 a	1.6 b@
18 LB-BROADCAST	10 b	8 b	9 b	7 b	1.6 b	1.5 b
18 LB-DRIP	4 c*	28 a	3 c*	18 ab	1.6 b	3.0 a
9 LB-DRIP SP & FALL#	8 bc*	35 a	5 bc*	20 a	1.8 b	2.1 ab
LSD (0.05)	5	13	6	12	1.4	1.4

* SIGNIF. DIFF. FROM DRY (P < 0.05)
@ MEANS SEPARATED BASED ON LOG(X +1) TRANSFORMATION
# SPRING APPLICATION JUNE 5, FALL APPLICATION SEPT. 26

PEACH (*Prunus persica* 'Emery')
Scab; *Cladosporium carpophilum*
Brown rot; *Monilinia fructicola*

D.F. Ritchie and M.H. Bennett, Dept.
of Plant Pathology, N.C. State
University, Raleigh, NC 27695-7616

EVALUATION OF DIFFERENT RATES AND APPLICATIONS OF BRAVO 720 FOR CONTROL OF SCAB, 1987: The test was conducted at the Sandhills Research Station, Jackson Springs. Fungicides were applied to 5-yr-old trees using a Swanson DA 500 airblast sprayer traveling 2 mph at a pressure of 150 psi. Rates were based on the use of 150 gal water/A as dilute. Each treatment consisted of four, six-tree replications in a randomized complete block design. Treatments were applied 12 Feb (about 2 wk before bud swell at late dormancy; d), 24 Mar (pink-25% bloom; p), 2 Apr (75%-full bloom; fb), 8 Apr (petal fall; pf), 21 Apr (shuck split/shuck fall; ss/sf), 30 Apr (1 wk after ss/sf; 1c), 12 and 26 May, 9 and 23 Jun, 14 Jul (cover sprays; 2c-6c). Also, three preharvest sprays (3ph) at weekly intervals (28 Jul, 4 Aug, 11 Aug) were applied for brown rot control; however, because of very dry weather conditions during this period no brown rot developed. On 12 Aug, 70 fruit per replication were harvested and evaluated for percent fruit having scab with each fruit rated for severity of infection based on number of lesions. The insecticide Guthion 50W was applied every 2 to 3 wk starting at shuck split.

All treatments significantly controlled scab relative to the check. The Benlate + Captan bloom spray followed by six, 2-wk interval cover sprays of Captan provided significantly less scab control than any of the Bravo 720 treatments. There were no significant differences among the three Bravo 720 treatments although the treatment in which the first three cover sprays (1c-3c) were omitted had slightly fewer clean fruit than where the full schedule of cover sprays was used. Under the conditions of this experiment, satisfactory scab control was achieved through the use of chlorothalonil (Bravo 720 6F and GX-095C 4.14F) applied in a large dose at ss/sf with the first cover spray not being applied until 6 wk later at fourth cover (4c). No leaf curl, blossom blight, bacterial spot (*Xanthomonas campestris* pv. *pruni*) or phytotoxicity were observed.

	% fruit with the following number of scab lesions/fruit at harvest				
Treatment and rate/A [a.i.]	0	1 - 5	6 - 10	11 - 25	> 25
Check (insecticides only)	16	31	17	16	21
Benlate 50W 12 oz [6.0 oz] + Captan 50W 4.0 lb [2.0 lb] (b,3ph) Captan 50W 4.0 lb [2.0 lb] (1c-6c)	78	15	5	1	1
Bravo 720 6F 3.25 pt [2.44 lb] (d, p, fb, pf, ss/sf); Captan 50W 4.0 lb [2.0 lb] (1c-6c); SDS 65311 50W 1.0 lb [0.5 lb] (3ph)	95	4	0	1	0
Bravo 720 6F 4.0 pt [3.0 lb] (pf, ss/sf); Captan 50W 4.0 lb [2.0 lb] (1c-6c); SDS 65311 50W 2.0 lb [1.0 lb] (3ph)	91	7	1	1	0
Bravo 720 6F 4.0 pt [3.0 lb] (pf), 8 pt [6.0 lb] (ss/sf); Captan 50W 4.0 lb [2.0 lb] (4c-6c); Rovral 50W 2.0 lb [1.0 lb] (3ph)	90	8	0	1	1
GX-095C 4.14F 5.8 pt [3.0 lb] (pf), 11.6 pt [6.0 lb] (ss/sf); Captec 4L 2 qt [2.0 lb] (4c-6c, 3ph).	86	9	2	1	1
Bravo C/M* 10 lb (d); Sulfobrite 90W 12 lb [10.8] (fb, ss/sf, 1c-6c); Funginex 1.6EC 2 pt [0.4 lb] (3ph)	87	11	1	1	0
L.S.D. (p = 0.05)	11	9	4	2	5

* 27.0% chlorothalonil, 48.3% copper oxychloride, 5.4% maneb

NECTARINE (*Prunus persica* var. *nectarina* 'Carolina Red')
Scab; *Cladosporium carpophilum*

D.F. Ritchie and M.H. Bennett,
Dept. of Plant Pathology, N.C.
State University, Raleigh, NC
27695-7616

EVALUATION OF SELECTED FUNGICIDES FOR CONTROL OF PEACH SCAB WHEN APPLIED AS A SINGLE APPLICATION AT SHUCK FALL, 1987: The test was conducted at the Sandhills Research Station, Jackson Springs. Fungicides were applied to 7-yr-old trees using a Swanson DA 500 airblast sprayer traveling 2 mph at a pressure of 150 psi. Rates were based on the use of 150 gal water/A as dilute. Each treatment consisted of six, two-tree replications in a randomized complete block design. Treatments were applied on 23 Apr when approximately 90% of the fruit were in shuck-split stage with approximately 25% of the shucks fallen. No other fungicide applications were made. Fruit were evaluated by randomly examining 25 fruit per replication weekly from the time scab was first observed (9 Jun) until harvest. The insecticide Guthion 50W was applied at 2 to 3-wk intervals starting at shuck split.

The two chlorothalonil fungicides, Bravo 720 6F and GX-095C 4.14F, gave excellent scab control. The other fungicides gave better control than the check but still would not be considered as providing adequate scab control without the use of subsequent cover sprays. Based on rainfall, temperature, growth stage and considering an incubation period of 4 to 6 wk, infections probably occurred on 24-26 Apr, 14 and 20 May, and possibly 29 May. Infections occurring after this period would not have had time to produce symptoms by the last evaluation date. If the first infection occurred during the 24-26 Apr period, 1-3 days after the fungicides were applied, this would suggest that chlorothalonil provided 7-8 wk of scab control. It is not known whether chlorothalonil provides scab control by a protective action or is eradicative by affecting the overwintering twig lesions.

Treatment and rate/A [a.i.]	Fruit with scab (%)		
	9 Jun	15 Jun	23 Jun
Check (insecticides only)	41	84	90
Bravo 720 6F 8.0 pt [6.0 lb]	0	0	4
GX-095C 4.14F 11.6 pt [6.0 lb]	0	0	1
Ziram F-4 12 pt [6.0 lb]	8	28	47
Captec 4L 4 pt [2.0 lb]	7	31	37
L.S.D. (P = 0.05)	8	11	15

PEACH (*Prunus persica* 'Winblo')
Brown rot; *Monilinia fructicola*
Scab; *Cladosporium carpophilum*

D.F. Ritchie and M.H. Bennett,
Dept. of Plant Pathology, N.C.
State University, Raleigh, NC
27695-7616

EVALUATION OF ROVRAL, RONILAN, CAPTEC AND OTHER SELECTED FUNGICIDES FOR CONTROL OF BROWN ROT AND SCAB, 1987: The test was conducted at the Sandhills Research Station, Jackson Springs. Fungicides were applied to 8-yr-old trees using a Swanson DA 500 airblast sprayer traveling 2 mph at a pressure of 150 psi. Rates were based on the use of 150 gal water/A as dilute. Each treatment consisted of four, four-tree replications in a randomized complete block design. Fungicides were applied 24 Mar (pink-25% bloom, p); 21 Apr (shuck split/shuck fall, ss/sf); 30 Apr, 12 and 26 May, 9 and 23 Jun (cover sprays, 1c-5c); 2 and 9 Jul (preharvest sprays, 2ph). Five days after the second preharvest spray, 25 fruit per replication were picked and evaluated for scab. A sample of 18 fruit (field inoculum) from each replication was also placed in trays in 3/4 bu boxes and stored at 65-70 F for 1 wk. Another sample consisting of six fruit (inoculated) per replication was treated similarly except the fruit were misted with a conidial suspension of *M. fructicola* just prior to placing in storage. Conditions for scab development were moderate while those for brown rot were light during the 2 wk prior to harvest.

All treatments provided better scab control than did the check. Sprays with wettable sulfur (Sulfobrite 90W) gave poorer scab control than the captan formulations (either Captan 50W or Captec 4L); for some treatments this was statistically significant. Where Captan 50W was started in ss/sf sprays, scab control was not different from Captan 50W treatments that started 1 wk later at 1c. Most treatments gave good control of brown rot. A major exception was the 1.5 qt rate of Captec 4L which was not significantly better than the check. Captan 50W, Captec 4L and Ronilan 50W did not give as good brown rot control when fruit were inoculated. The flowable formulation of Rovral seemed to be as good or better than the wettable powder formulation of Rovral.

Treatment and rate/A [a.i.]	% scab 14 Jul	% brown rot after 7 days storage	
		Field inoculum	Inoculated
Check (insecticides only)	74	14	25
Benlate 50W 12 oz [6 oz] + Captan 50W 4.0 lb [2.0 lb] (p, 2ph); Captan 50W 4.0 lb [2.0 lb] (1c-5c)	2	0	4
Funginex 1.6EC 2 pt [0.4 lb] (b, 2ph]; Sulfobrite 90W 12 lb [10.8 lb] (ss/sf, 1c-3c); Captan 50W 4.0 lb [2.0 lb] (4c-5c)	13	3	2
Captan 50W 4.0 lb [2.0 lb] (ss/sf, 1c-5c, 2ph)	3	4	8
Captec 4L 1.5 qt [1.5 lb] (ss/sf, 1c-5c, 2ph)	0	10	25
Captec 4L 2.0 qt [2.0 lb] (ss/sf, 1c-5c, 2ph)	3	4	17
Ronilan 50W 1.5 lb [0.75 lb] (p, 2ph); Sulfobrite 90W 12 lb [10.8 lb] (1c-3c); Captan 50W 4.0 lb [2.0 lb] (4c-5c)	24	4	17
Rovral 50W 1.5 lb [0.75 lb] (p, 2ph); Sulfobrite 90W 12 lb [10.8 lb] (1c-3c); Captan 50W 4.0 lb [2.0 lb] (4c-5c)	13	3	0
Rovral 4F 1 pt [0.5 lb] (p, 2ph); Captan 50W 4.0 lb [2.0 lb] (1c-5c)	2	0	2
Rovral 4F 1.5 pt [0.75 lb] (p, 2ph); Captan 50W 4.0 lb [2.0 lb] (1c-5c)	0	4	2
Rovral 4F 2.0 pt [1.0 lb] (p, 2ph); Captan 50W 4.0 lb [2.0 lb] (1c-5c).	1	3	0
L.S.D. (P = 0.05)	12	6	14

PEACH (<u>Prunus persica</u> 'Clayton' 'Winblo')
Brown rot; <u>Monilinia fructicola</u>
Scab; <u>Cladosporium carpophilum</u>

D.F. Ritchie and M.H. Bennett,
Dept. of Plant Pathology, N.C.
State University, Raleigh, NC
27695-7616

EVALUATION OF RH-7592, RH-3866 AND OTHER SELECTED FUNGICIDES FOR BROWN ROT AND SCAB CONTROL, 1987: The test was conducted at the Sandhills Research Station, Jackson Springs. Fungicides were applied to 7-yr-old trees using a handgun with a pressure of 150 psi. Rates were based on the use of 200 gal water/A as dilute. Each treatment consisted of five, single-tree replications for the scab control test on Winblo. Fungicides were applied to Winblo on 24 Mar (pink-25% bloom; p), 2 Apr (75%-full bloom; fb); 8 Apr (petal fall; pf); 23 Apr (shuck split/shuck fall; ss/sf); 5 and 19 May, 2 and 16 Jun (cover sprays; 1c-4c); 30 Jun and 7 Jul (preharvest sprays; 2ph). Because the crop was very light on Winblo, the brown rot test was done using Clayton. Treatments consisted of four, single-tree replications in a randomized complete block. Treatments were applied as for Winblo except no bloom sprays were used but three cover sprays of Captan 50W 4.0 lb/A were applied to all the trees with an airblast sprayer. Preharvest sprays were applied 30 Jun and 7 Jul with a handgun. Two days after the first preharvest spray 18 fruit from each replication of Clayton were picked, placed in trays in 3/4 bu boxes and stored at 65-70 F for 7 days. The percentage of brown rot fruit on the trees was evaluated 2 days after the second preharvest spray. Brown rot and scab pressure were moderate during the susceptible periods of these two cultivars.

No blossom blight, phytotoxicity or plant growth regulator effects were observed. All treatments gave better scab control than the check; however, RH-3866 at both rates gave unacceptable scab control under the conditions of this test. RH-7592 gave very good scab control, particulary at the two higher rates, considering that most sterol-inhibiting fungicides give very poor control of peach scab. The greater rates of RH-7592 and RH-3866 gave good brown rot control. Although not statistically significant, there was the trend toward increased control of brown rot and scab as the rates increased. Dithane M-45 and Manex 4F gave excellent scab control. These products were not evaluated for brown rot control.

Treatment and rate/A [a.i.]	% scab cv. Winblo 9 Jul	% brown rot on cv. Clayton	
		After 1st preharvest spray and 7 days storage	Tree ripe fruit 2 days after 2nd preharvest spray
Check (insecticides only)	58	40	14
Benlate 50W 12 oz [6.0 oz] + Captan 50W 4.0 lb [2.0 lb] (p,2ph); Captan 50W 4.0 lb [2.0 lb] (1c-4c).	1	13	1
Funginex 1.6EC 2 pt [0.4 lb] (fb,2ph); Captan 50W 4.0 lb [2.0 lb] (1c-4c). . . .	3	13	1
RH-7592 2F 3.2 fl oz [0.05 lb] *full season	6	10	1
RH-7592 2F 6.4 fl oz [0.10 lb] full season	1	6	1
RH-7592 2F 12.8 fl oz [0.20 lb] full season	0	4	0
RH-3866 60DF 5.1 oz [0.19 lb] full season	22	8	0
RH-3866 60DF 10.2 oz [0.38 lb] full season	16	3	0
Dithane M-45 80W 6.0 lb [4.8 lb] full season	1	---	---
Dithane M-45 80W 12 lb [9.6 lb] full season	0	---	---
Manex 4F 3.0 qt [3.0 lb] (p,fb,ss/sf, 1c-4c)	0	---	---
L.S.D. (P = 0.05)	11	12	5

* Full season includes p, fb, pf, ss/sf, 1c-4c, and 2ph sprays.

John K. Springer
Extension Specialist in Plant Pathology
Rutgers University, R.D. #5, Box 232, Bridgeton, NJ 08302

APPLE PHYTOPHTHORA ROOT ROT - 1987

J.K. Springer & J.R. Phillips

Apple trees, cv. MM-106 which were planted and treated with fungicides in 1986, were retreated with the same chemicals in 1987. The trees "leafed-out" about 3 weeks later than normal because of the severe cold temperatures the trees were exposed to during the winter of 1986-87. Plots were single trees and treatments were replicated 10 times in a complete block design. Treatments 1 and 2 were applied dilute using a back-pack mistblower. Treatment 3 was applied with a watering can using 1 pt of solution/3 ft circle around the base of the tree. Treatments 1 and 2 were applied on 5/18, 7/23 and 10/7. Treatment 3 was applied on 4/13, 7/23 and 10/7. No collar rot has been observed and the test will be continued in 1988. Treatment and rates are provided below.

1. Aliette 80WP-2.5 lb/A
2. Aliette 80WP-5.0 lb/A
3. Ridomil 2E-3 ml/10.2 sq ft

PEACH BACTERIAL SPOT - 1987

J.K. Springer & J.L. Frecon

Four-year-old peach trees, cv 'Parade,' growing in a commercial orchard in Richwood, NJ were used in this test. Plots were individual trees and treatments were replicated 3 times in a complete block design. Treatments were applied with a back-pack mistblower and were applied at 4X (0.5 gal/tree). Imidan 50 WP (14 gm/gal) was applied to control trees and mixed with the fungicides and applied to all trees. Treatments were applied on 5/8 (SS), 5/18, 5/28, 6/11, 6/25, 7/7, 7/17 and 7/28. Plots were evaluated on 8/17. The plots were visited on 9/8 and disease levels had not changed and no evaluation was performed. No fruit infection was observed on 8/17 or 9/8. Evaluation of the foliage was assessed on a scale of 0-100, with 100 representing severe infection. Leaf fall was absent from the plot area. Thus, bacterial leaf spot levels were very light. The results are presented below. The data were analyzed at both the 5% and 1% level, using Duncan's New Multiple Range Test. All fungicides tested provided significant control of the low level of bacterial leaf spot present. Dodine 4F at 15 fl oz/100 gal was similar to Cyprex 65WP at 0.5 lb/100 gal. Dodine 4F at 10 fl oz and at 7.5 fl oz were less effective than the higher rate of Dodine 4F and Cyprex 65WP.

	Percent Leaf Infection	
Treatment & rate/100 gal	5% Level	1% Level
Cyprex 65WP-0.5 lb	0.67a	0.67a
Dodine 4F-15 fl oz	0.67a	0.67a
Dodine 4F-10 fl oz	0.83b	0.83ab
Dodine 4F-7.5 fl oz	1.67b	1.67b
Control (Imidan only)	5.33c	5.33c

PEACH FRUIT ROT CONTROL - 1987

J.K. Springer & J.R. Phillips

Six-year old Cresthaven trees at the Rutgers Research & Development Center-Cream Ridge were sprayed with Sulfur 95WP (6 lb) and Carzol 92SP (0.25 lb)/100 gallon on April 13. The weather turned cold and the trees developed very slowly until the differential fungicide treatments were started on 4/20 (70% bloom). Additional sprays were applied on 5/1, 5/14, 5/24, 6/5, 6/15, 6/30, 7/13, 7/29 and 8/12. Sprays were applied with a handgun at 250 psi using approximately 1.5 gallons/tree initially and increasing to 2.5 gallons/tree during later cover sprays. Captan 50WP (2 lb/100 gal) was applied to trees in Treatments 1-7 on those dates when designated fungicides were not applied. Insecticide sprays were applied separately throughout the season to the entire plot area. Plots were single trees and treatments were replicated 3 times in a complete block design. Fruit were harvested on 8/25, 8/31 and 9/4. The fruit were placed in field boxes and the boxes placed in cold storage until they could be transported to the Rutgers Research & Development Center-Bridgeton. The fruit were then placed in common storage until they matured sufficiently for evaluation. Harvest 1 was evaluated on 8/31, Harvest 2 on 9/4 and Harvest 3 on 9/14 and 9/16. The fruit from Harvest 1 were at the proper stage of maturity for good fruit rot evaluation, while those from Harvest 2 were a little immature. Fruit from Harvest 3 were a little over-mature on the dates that they were evaluated. Treatments, rates and application schedule were as follows:

PEACH FRUIT ROT CONTROL - 1987 (continued)

No.	Material	Rate/100 gal	Application Schedule
1.	Orbit 3.6EC	20 ml	Bl,PF, 2 Pre-Harvest
2.	Ronilan 50WP	1 lb	Bl,PF, 2 Pre-Harvest
3.	Ronilan 50WP + X-77 spreader	1 lb + 1pt	Bl,PF, 2 Pre-Harvest
4.	Ronilan 50WP + X-77 spreader	0.75 lb + 1pt	Bl,PF, 2 Pre-Harvest
5.	Ronilan 50WP + X-77 spreader	0.50 lb + 1pt	Bl,PF, 2 Pre-Harvest
6.	Ronilan DF	1 lb	Bl,PF, 2 Pre-Harvest
7.	Sulfur plus Ronilan 50WP	6 lb plus 1 lb	B,PF plus 2 Pre-Harvest
8.	Captex 4L	950 ml	Full Season
9.	Captex 4L	710 ml	Full Season
10.	Manex 4L	1520 ml	Full Season
11.	Control		

---

* Treatments 1-7 sprayed with Captan 50WP (2 lb/100 gal) on dates not specified.

Disease pressure was very high because of frequent rains after the fruit began their final swell. Several periods of very heavy rainfall occurred, and a low level of fruit splitting resulted. A low level of split-pits was present in Harvest 1. The number of fruit/tree varied from harvest to harvest. Differences in fruit number were attributed to tree vigor and thinning practices rather than fungicidal treatments. The percent healthy fruit was consistently lower for the control than for any fungicide treated fruit. The highest rate of Ronilan generally provided the highest level of healthy fruit. Brown rot levels were very high in this test. Blossom blight was present at very low levels in the test area, and it was present in other sites at the Research Center in very high levels. Weather conditions were very favorable for brown infection on mid- and late-seasoned varieties. A trace of blossom blight was found in one replicate of Treatment 8 and one replicate of Treatment 9. About 1% blossom blight was found in all replicates of the control treatment. This suggests that the infections occurred during late bloom, since all treatments received a sulfur treatment in early bloom when less than 0.5% of the flowers had just opened. All fungicide treatments provided significant control of this phase of the disease. Fruit from control plots consistently contained higher levels of brown rot fruit infections than in any of the fungicide treated plots. The lower rate of Captex 4L was too low to provide acceptable brown rot control. Brown rot levels were generally higher in larger fruit than smaller fruit. Thus, trees with a lighter crop had higher disease levels in general. Treatments 2, 3, 4 and 6 were generally quite similar in performance, as were Treatments 8 and 10. Orbit 3.6EC would have performed better had a slightly higher rate been used. Significant differences in Rhizopus rot and sour rot were recorded for some harvests. However, the differences were not felt to be the result of treatment differences, but rather to the size and maturity of the fruit in any given replicate.

TABLE 1. Peach blossom blight-1987.

No.	% Blossom Blight	No.	% Blossom Blight
1.	0.0a	7.	0.0a
2.	0.0a	8.	0.3a
3.	0.0a	9.	0.3a
4.	0.0a	10.	0.0a
5.	0.0a	11.	1.1b
6.	0.0a		

TABLE 2. Fruit rot levels in fruit from Harvest 1.

		Percent			
No.	Total No.	Healthy	Brown rot	Rhizopus rot	Sour rot
1.	80b	86c	3.7a	9abc	1ns
2.	48ab	97c	0.3a	2a	0
3.	53ab	95c	0.7a	2a	2
4.	38ab	92c	0.0a	5abc	4
5.	15a	91c	0.0a	9abc	0
6.	59ab	86c	8.3ab	4ab	2
7.	83b	87c	2.0a	10ab	1
8.	29a	76bc	4.7a	10abc	3
9.	41ab	56b	20.7c	21c	1
10.	56ab	79c	13.3bc	5abc	3
11.	46ab	35a	45.0d	20bc	0

PEACH FRUIT ROT CONTROL - 1987 (continued)

TABLE 3. Fruit rot levels in fruit from Harvest 2.

No.	Total No.	Percent			
		Healthy	Brown rot	Rhizopus rot	Sour rot
1.	148ab	93a	1.8b	4ab	1ns
2.	74a	97a	0.8ab	1a	1
3.	80ab	98a	1.6ab	0a	1
4.	107a	99a	0.0a	1a	0
5.	96ab	99a	0.3ab	1a	0
6.	177b	94a	1.2ab	4ab	1
7.	136ab	94a	0.9ab	3ab	2
8.	73a	97a	2.0b	1a	1
9.	111ab	93a	0.5ab	3ab	2
10.	115ab	96a	1.0ab	2a	0
11.	140ab	82b	8.0c	9b	2

TABLE 4. Fruit rot levels in fruit from Harvest 3.

No.	Total No.	Percent			
		Healthy	Brown rot	Rhizopus rot	Sour rot
1.	92a	26ab	42.8abc	31ns	0.3a
2.	284b	47bc	30.9ab	22	0.3a
3.	163ab	44bc	29.5ab	26	0.7ab
4.	143ab	56c	19.5a	25	0.0a
5.	155ab	33abc	49.7bc	17	0.5ab
6.	87a	48bc	23.3a	27	1.9ab
7.	107a	22ab	42.2abc	33	3.3b
8.	93a	37bc	36.3ab	27	0.0a
9.	191ab	22ab	56.8cd	21	0.1a
10.	152ab	38bc	30.5ab	31	0.5ab
11.	115a	9a	72.7d	19	0.0a

TABLE 5. Combined data from all three harvests.

No.	Total No.	Percent			
		Healthy	Brown rot	Rhizopus rot	Sour rot
1.	330ab	69bcd	16.1b	15ns	0.8ns
2.	407b	81dc	10.7ab	8	0.3
3.	296ab	79cde	10.6ab	9	1.3
4.	289ab	82e	6.5a	10	1.2
5.	266ab	74cde	16.7b	9	0.3
6.	323ab	76cde	11.0ab	12	1.7
7.	326ab	67bc	15.0b	16	2.0
8.	195a	70cde	14.3b	13	1.3
9.	343ab	57b	26.0c	15	1.1
10.	323ab	71cde	14.9b	13	1.1
11.	300ab	42a	41.9d	16	0.6

PEACH FUMIGATION TEST - 1987

J.K. Springer & J.L. Frecon

This test was established in 1983 with the variety Rio-Oso-Gem. The trees were treated with nematicides during the spring of 1983, 1984, and 1985. Results for these years were presented in this publication for the years 1983, 1984 and 1985, respectively. Plots were 2 adjacent trees in the row and treatments were replicated 4 times in a complete block design. On 11/11/86, 18 months after the last nematicide treatment, nematode samples were collected to determine the long-term effect of soil fumigation on nematode populations. The results are presented below. Lesion nematode population levels were significantly higher in the control than in the fumigated plots. The ring nematode and

PEACH FUMIGATION TEST - 1987 (continued)

other nematode data were not significantly different. Thus, some long-term benefit from soil fumigation was evident in this site.

	Number of Nematodes/250 ml soil					
	Lesion		Ring		Other	
Treatment & rate/A	1985	1986	1985	1986	1985	1986
Telone II-15 gal	1.3a	44.4a	0.0ns	8.1ns	0.0ns	10.6ns
Control	32.5b	87.5b	5.0	56.9	0.0	10.0

PEACH NEMATICIDE TEST - 1987

J.K. Springer & J.L. Frecon

This test was established in 1983 using the variety Rio-Oso-Gem. The test trees were treated with nematicides during the spring of 1983, 1984, and 1985. Results for these years were presented in this publication for the years 1983, 1984, and 1985, respectively. Plots were single trees and treatments were replicated 4 times in a complete block design. On 11/11/86, 18 months after the last nematicide treatment, nematode samples were collected to determine the long term effect of soil fumigation on nematode populations. The results are presented below. Nematode population levels of lesion, ring, dagger and other nematodes did not differ significantly between nematicidal and control treatments. Nemacur 3SC maintained a low population of lesion nematode for two growing seasons.

	Number of Nematodes/250 ml soil							
	Lesion		Ring		Dagger		Other	
Materials & gal/A	1985	1986	1985	1986	1985	1986	1985	1986
Furadan 4F-1.5	16.3ab	116.3b	0	38.8ns	0	0.0a	0	53.8ns
Advantage 4EC-1.5	15.0ab	80.0ab	0	90.0	0	5.0ab	0	36.3
Nemacur 3SC-3.3	1.3a	16.3a	0	1.3	0	11.3b	0	1.3
Vydate L-3.0	3.8a	66.3ab	0	63.8	0	0.0a	0	0.0
Furadan 15G-40lb	21.3ab	51.3ab	0	95.0	0	3.8ab	0	0.0
Mocap 6EC-4.0	13.8ab	77.5ab	0	23.8	0	1.3ab	0	0.0
Mocap 6EC-9.5	5.0a	78.8ab	0	23.8	0	0.0a	0	0.0
Control	33.8b	52.5ab	0	20.0	0	6.3ab	0	3.8

PEACH PHYTOPHTHORA ROOT ROT-2 YEAR OLD TREES - 1987

J.K. Springer & J.R. Phillips

The second leaf Jerseyglo trees at the Rutgers Research & Development Center-Bridgeton, which were planted and treated with fungicides in 1986, were to be treated with the same chemicals in 1987. Plots were single trees and treatments were replicated 4 times in a complete block design. Treatments and rates were as follows:

1. Ridomil 2E-1 gal
2. Ridomil 2E-2 gal
3. Ridomil 2E-3 gal
4. Ridomil 2E-4 gal
5. Aliette 80WP-2.5 lb
6. Aliette 80WP-5.0 lb
7. Control

All flower and leaf buds were killed during the winter of 1986-87. Most of the trees died, but a few produced foliage from adventitious leaf buds in the woody tissue. Trees were neither treated nor evaluated and the test was abandoned.

PEACH PHYTOPHTHORA ROOT ROT-3 YEAR OLD TREES - 1987

J.K. Springer & J.R. Phillips

The third leaf Jerseyglo trees at the Rutgers Research & Development Center-Bridgeton, which were planted in 1985 and treated with fungicides in 1985 and 1986, were to be treated with the same chemicals in 1987. Plots were single trees and treatments were replicated 8 times in a complete block design. Treatments and rates were as follows:

1. Aliette 80WP-2.5 lb
2. Aliette 80WP-5.0 lb
3. Ridomil 2E-12 ml/64 sq ft
4. Control

All flower and leaf buds were killed during the winter of 1986-87. Most of the trees died, but a few produced foliage from adventitious leaf buds in the woody tissue. Tree were neither treated nor evaluated and the test was abandoned.

PEACH PHYTOPHTHORA ROT-CREAM RIDGE - 1987

J.K. Springer & J.R. Phillips

Seven-year-old Cresthaven peach trees, which were treated in 1986, were retreated in 1987 with the same chemicals and rates. Plots were single trees and treatments were replicated 5 times in a complete block design. Treatments were as follows:

1. Aliette 80WP-2.5 lb/A
2. Aliette 80WP-5.0 lb/A
3. Ridomil 2E-12 ml/100 sq ft

Treatments 1 and 2 were applied dilute with a hand gun at 250 psi. Treatment 3 was applied in 1 qt of solution using a compressed air sprayer. Treatments 1 and 2 were applied on 5/14 and 7/30. Treatment 3 was applied on 4/15 and 7/30. A boron foliar spray test was inadvertently superimposed on the plot area. Trees were harvested in a manner which prevented securing yield data from this test.

PEACH POST HARVEST TREATMENT STUDY - 1987

J.K. Springer, J.A. Hopfinger and G.C. Hamilton

Peach fruit, cv 'Parade,' which had been picked the previous day and were placed in cold storage, were placed in field boxes which had previously been treated with calcium hypochlorite. The boxes were transported to the Rutgers Research & Development Center-Bridgeton on 9/16. The field boxes containing the fruit were dipped for 5 minutes in a dump tank containing water or a water-fungicide mixture on 9/16. Plots were individual field boxes and treatments were replicated 3 times. Treatments were as follows:

No.	Material	Rate
1.	Agclor (Ca Hypochlorite)	125 ppm
2.	Benlate 50W + Botran 75W	0.5+0.33 lb/100
3.	Water Control	-

Immediately after dipping the fruit, 12 fruit from each field box were placed in plastic trays so the fruit did not contact one another. Two trays of each replicate were processed in this manner for Test 1 and Test 2, respectively. Plots were individual trays and treatments were replicated 3 times in a complete block design. The remaining fruit were transported to the Rutgers Research & Development Center-Cream Ridge after dipping and the boxes were placed in cold storage for use in Test 3 and Test 4.

Fruit in Test 1 were inoculated on 9/16 about 3 hours after the fruit were dipped. The spore suspension used was collected by washing spores from the surface of sporulating peach fruit lesions. Immediately after spraying the spore suspension on the fruit, the trays were covered with a black, plastic film until the following morning. Fruit were evaluated for brown rot infections on 9/21, 9/22, 9/23 and 9/25. Rotted fruit were removed from the trays after each evaluation date. Cumulative total brown data from Test 1 are presented in Table 1.

Fruit in Test 2 were inoculated in a similar manner on 9/18, two days after dipping fruit. Plots were handled exactly as in Test 1, including evaluation dates. Cumulative total brown rot data from Test 2 are presented in Table 2. Twelve fruit from each field box were removed from cold storage after 9 days of storage and placed in black plastic bags on 9/25. The bags were placed on a laboratory bench until 9/29, when they where transported to the Rutgers Research & Development Center-Bridgeton. The fruit were removed from the bags and placed in plastic trays on 9/30 and the trays placed on a greenhouse bench. The fruit were evaluated for rot on 10/5 and the results are presented in Table 3. The field boxes of fruit were removed from cold storage on 10/3, after 17 days of storage. The boxes were left in the packing shed until 10/8, when they were evaluated for rot. The data secured from this test is presented in Table 4.

Brown rot incidence was very high in tests where fruit was inoculated with spores of the fungus. Agclor and the control were similar whether fruit were inoculated 3 hours or 2 days after dipping. The Benlate-Botran treatment provided excellent control in both tests. Brown rot incidence was similar for the control and Agclor treatments with fruit stored either 9 or 17 days. Rhizopus rot levels were considerably higher in fruit stored 9 days than for fruit stored 17 days. This apparently resulted from greater bruising when the soft fruit were transported from Cream Ridge to Bridgeton. The control had more Rhizopus rot than either chemical treatment. Agclor provided a moderate level of control, while Benlate-Botran provided excellent control. The value of reducing inoculum was particularly evident with the use of Agclor in Test 3. The deleterious effects of rough handling were obviously overcome by reducing the inoculum of Rhizopus, resulting in some control of this disease. However, even though Agclor is a very good sanitizing agent, a residual type of treatment is needed prior to storage or before shipment for effective fruit rot control.

PEACH POST HARVEST TREATMENT STUDY - 1987 (continued)

TABLE 1. Brown rot incidence of fruit inoculated 3 hrs after dipping.

Treatment & rate	Total No.	Number Infected			
		9/21	9/22	9/23	9/25
Control	12	0.7ns	1.0ab	3.0a	9.7a
Agclor-125ppm	12	0.3	2.7a	3.3a	10.3a
Benlate-Botran (0.5+0.33 lb/100 gal)	12	0.0	0.0b	0.0b	0.0b

TABLE 2. Brown rot incidence of fruit inoculated 2 days after dipping.

Treatment & rate	Total No.	Number Infected			
		9/21	9/22	9/23	9/25
Control	12	0.7ns	1.7a	2.0a	9.0a
Agclor-125ppm	12	0.3	0.7ab	1.0ab	7.7a
Benlate-Botran (0.5+0.33 lb/100 gal)	12	0.0	0.0b	0.0b	1.7b

TABLE 3. Natural brown rot incidence of fruit after 9 days cold storage.

Treatment & rate	Total No.	Infected Fruit							
		Healthy		Brown Rot		Rhizopus Rot		Sour Rot	
		No.	%	No.	%	No.	%	No.	%
Control	12	7.0a	58.3	1.3ns	10.5	3.7a	30.8	0.0ns	0.0
Agclor-125ppm	12	9.3ab	75.5	1.7	14.2	1.0b	8.3	0.0	0.0
Benlate-Botran (0.5+0.33 lb/100 gal)	12	11.4b	94.2	0.0	0.0	0.3c	2.5	0.3	2.5

TABLE 4. Natural brown rot incidence of fruit stored for 17 days.

Treatment & rate	Total No.	Percent Infected			
		Healthy	Brown Rot	Rhizopus Rot	Sour Rot
Control	93ns	83a	16a	1ns	0.7ns
Agclor-125ppm	93	84a	14a	2	0.4
Benlate-Botran (0.5+0.33 lb/100 gal)	83	99b	0b	0	1.2

NECTARINES - FRUIT EVALUATION FOR DEFECTS OF SUNGLO AND REDGOLD - 1987 J.L. Frecon & J.K. Springer

A survey of fruit defects in the nectarine cultivars Sunglo and Redgold was conducted at two grower locations in New Jersey in 1987. Data for Sunglo nectarine were collected on 8/19 and data for Redgold nectarine were collected on 8/27. Fruit were examined from the dump bin in the packing line (Dump bin), from bulk bins in the orchard which contained recently harvested fruit (Field bins), from fruit harvested in the orchard by the authors (Orchard), or fruit from cold storage which had been previously partially graded (Graded bins). The individual defects were characterized as cultural defects, insect-induced defects and disease-induced defects. Plot size was 100 randomly selected fruit and treatments were replicated 4 times. The data were subjected to ANOVA and the treatment means were compared at the 5% level, using Duncan's New Multiple Range Test. The data secured are presented in Table 1A, 1B, and 1C for the cultivar Sunglo and Table 2A, 2B, and 2C for the cultivar Redgold.

NECTARINES - FRUIT EVALUATION FOR DEFECTS OF SUNGLO AND REDGOLD - 1987 (continued)

The major cultural defect was fruit russet with both varieties. Although most of the russet was of minor extent, up to 1.5% of the Sunglo and 4.7% of the Redgold fruit were felt to be nonmarketable. Since appearance is highly critical for successful marketing, research efforts are needed to determine practices which will reduce russet levels of fruit in New Jersey. Mechanical injury was the second most commonly encountered fruit defect, with losses as high as 5.3% with the cultivar Sunglo. There was no difference in mechanical injury of Sunglo fruit between fruit remaining in the orchard and fruit entering the packing line. There was a significant difference between fruit of the Redgold cultivar which had been partially graded and fruit which had not yet been graded. Growth cracks were more troublesome in Sunglo fruit than in Redgold fruit. Fruit produced at Grower 1 location were subjected to several heavy rains after the fruit began their final swell. During most years, growth cracks are not this prevalent. A sunken depression associated with the lenticels was observed on some fruit of the cultivar Redgold. This injury is felt to be the result of heat-induced injury of fruit from trees which are stressed by drought. The injury only occurred in the location where rainfall was deficient.

Japanese beetles caused the highest level of insect-induced fruit defects. This is a very common problem on both nectarines and peaches. Excellent control measures are available to our growers, but orchards must be scouted regularly to determine when treatments are needed. Aphid injury (small swellings on the fruit) was observed only on Sunglo fruit. This injury is felt to be caused by feeding of the green peach aphid during the early part of the growing season. Fruit in this category are probably marketable, but they suffer somewhat in appearance from noninjured fruit. Thrip (a slight scaring of the fruit skin), oriental fruit moth, and plum curculio feeding injury were generally quite light. A feeding injury symptom which could not be attributed to the above listed insects was designated as leafroller injury. Leafrollers are not normally a problem on peaches and nectarines, but they are occasionally observed on the fruit. Fruit injury to all insects was as high as 6.9%, an amount too high for successful production.

Bacterial leaf spot was the principal disease-induced defect. The disease was much more prevalent on Redgold fruit produced by Grower 1. Fruit which are infected late in the season, within 30 days of harvest, exhibit symptoms consisting of small yellow spots on the skin. Since the skin is not "broken," the fruit are marketed as No. 1 fruit. The high level of bacterial spot at Grower 1 was related to the age of the block, 3-year-old. As 2-year-old trees last year, they did not receive a regular spray program. Thus, these trees contained a high number of spring cankers to initiate new infections during the early part of the season. Brown rot was the second most prevalent disease-induced fruit defect observed. At both locations and with both cultivars, the level of fruit infection was higher in fruit in the orchard than in fruit harvested by professional pickers. Obviously, pickers are instructed to discard visually diseased fruit. However, the level of brown rot infected fruit is too high for satisfactory commercial production. Rhizopus rot and sour rot are post-harvest diseases. The fruit examined was not sufficiently mature for symptom expression of these diseases. Thus, disease levels were very low.

TABLE 1A. Cultural defects of Sunglo nectarines-1987.

Location	Defect Free	Russet		Growth Cracks	Mech. Injury	Lenticel Injury
		Market.	Rejects			
Grower 1-Dump bin	65.5ns	18.3a	0.8ns	2.0ns	5.3ns	0.0ns
Grower 1-Orchard	71.3	8.8b	1.5	3.8	4.0	0.0

TABLE 1B. Insect-induced defects of Sunglo nectarines-1987.

Location	Japanese Beetles	Aphids	Leaf-roller	Thrips	Oriental F.M.	Plum Curculio
Grower 1-Dump bin	2.3ns	1.3ns	0.0ns	0.3ns	0.0ns	0.0ns
Grower 1-Orchard	3.8	0.3	1.5	0.0	1.3	0.0

TABLE 1C. Disease-induced defects of Sunglo nectarines-1987.

Location	Bacterial Spot		Brown Rot	Rhizopus Rot	Sour Rot
	Market.	Rejects			
Grower 1-Dump bin	0.0ns	0.3ns	0.0a	0.3ns	0.7ns
Grower 1-Orchard	1.0	0.0	6.3b	0.0	0.0

NECTARINES - FRUIT EVALUATION FOR DEFECTS OF SUNGLO AND REDGOLD - 1987 (continued)

TABLE 2A. Cultural defects of Redgold nectarines-1987.

Location	Defect Free	Russet		Growth Cracks	Mech. Injury	Lentical Injury
		Market.	Rejects			
Grower 2-Graded bins	67.5a	19.8ns	4.7a	0.5ns	1.3a	1.7ns
Grower 2-Orchard	59.8b	25.5	1.5b	0.0	3.0b	0.7
Grower 1-Field bins	42.5c	16.0	0.7b	1.3	2.7b	0.0

TABLE 2B. Insect-induced defects of Redgold nectarines-1987.

Location	Japanese Beetles	Aphids	Leaf-roller	Thrips	Oriental F.M.	Plum Curculio
Grower 2-Graded bins	1.0ns	0.0ns	0.0ns	1.3ns	0.5ns	0.0ns
Grower 2-Orchard	1.0	0.0	0.3	0.0	0.0	0.7
Grower 1-Field bins	0.5	0.0	0.3	0.0	0.3	0.0

TABLE 2C. Disease-induced defects of Redgold nectarines-1987

Location	Bacterial Spot		Brown Rot	Rhizopus Rot	Sour Rot
	Market.	Rejects			
Grower 2-Graded bins	0.0a	0.3a	0.0a	0.0ns	0.0ns
Grower 2-Orchard	0.7a	0.7a	4.8b	0.0	0.3
Grower 1-Field bins	5.3b	30.8b	0.3a	0.0	0.0

MARY BLITE: A PREDICTIVE MODEL FOR APPLE FIRE BLIGHT MANAGEMENT

Paul W. Steiner, Associate Professor, Botany Department. The University of Maryland, and **Richard Heflebower**, Washington County Agent, Maryland Cooperatiave Extension System

INTRODUCTION

Fire blight is one of the most destructive and sporadic diseases affecting apples and pears worldwide. Because of this, fruitgrowers have had to adopt expensive ($100 to $150 per acre per year), preventative control programs that are used routinely each year. Such programs generally prevent serious losses, but they seldom achieve complete control and sometimes fail when conditions for infection are highly favorable. Without reliable methods for predicting fire blight epidemics, the same full-scale programs are often followed in years when conditions are marginal or unfavorable for disease development. Thus, while not ineffective, our current recommendations for control lack the precision necessary for consistent performance and the flexibility needed to be cost-effective.

The forecasting system outlined here has been tentatively named MARY BLITE. It is designed for use as a practical aid to disease management, allowing growers to predict the onset of conditions supporting fire blight epidemics and to make timely decisions on whether and what treatments are needed. The system is still under development and the reliability of decisions made using it has yet to be validated in field tests. Nevertheless, we are optimistic in the light of the accuracy of MARY BLITE when applied to data from past epidemics or when used to monitor on-going events. This accuracy extends to the generation of positive and negative forecasts of specific events that were verified by symptom development (or lack thereof) at predicted times and to the satisfactory technical explanations it offers. These aspects provide a basis for developing an expert system for teaching disease management and for an area-wide blight alert/warning communication system for fruitgrowers.

MARY BLITE - - THE MARYLAND FIRE BLIGHT MANAGEMENT MODEL

Apple fire blight epidemics can be separated into three distinct phases: blossom blight (BB), canker blight (CB) and shoot blight (SB). Each phase arises from a different source of inoculum and develops in response to different parameters. In a given orchard or season, these phases may develop alone, in combination but separated by time, or together and overlapping. Trauma blight, a fourth, incidental phase associated with hail and frost injury must also be considered. Sound disease management of fire blight requires a clear understanding of each phase, its potential for development, and the timing an nature of treatment measures likely to be effective.

BLOSSOM BLIGHT SUBMODEL

For MARY BLITE, blossom blight refers exclusively to fire blight that is initiated by direct infections of open blossoms and is independent from the systemic invasion of flower spurs by bacteria from nearby blossom and canker infections. The primary source of inoculum for BB is epiphytic (6), possibly as low populations of the pathogen overwintering among bud tissues (1). Blossom blight develops in response to four basic conditions, all of which must develop in sequence and persist long enough for infections to occur and for an epidemic to be supported. These conditions are:

1. **Blossoms must be open with stigmas exposed.** Blossom susceptibility to infection is limited to the period between flower opening and petal fall (3). Once flowers open, the exposed stigma surfaces are rapidly and selectively colonized by the pathogen (6). The pathogen may be present on some stigmas when flowers open, but pollinating insects most likely disseminate the bacteria quickly to large numbers of flowers throughout the orchard soon after they open. This does not constitute inoculation, per se, but provides the "seed" population needed to begin the development of an inoculum potential.

2. **Development of an inoculum potential.** For pear blossoms, Zoller and Sisevich (7) note that a minimum of 110 degree hours (DH) >65°F must accumulate before E. amylovora bacteria can be routinely detected and an epidemic supported. In that system, DH>65°F were accumulated from the start of the season and reduced to zero in response to exposure to either 32°F or three consecutive days with temperatures <65°F. The same basic parameters seem relevant to apple BB epidemics but, with MARY BLITE, monitoring is delayed until the full pink stage and reduces the cumulative total DH>65°F by one-third, two-thirds and then to zero for one, two and three consecutive days' time, respectively, where temperatures do not exceed 65°F. No adjustment is made for days where the maximum temperature equals 65°F.

Actual DH accumulations are difficult and laborious without special recording instruments. However, a reasonably accurate estimate of the inoculum potential can be made easily using a simple minimum-maximum thermometer and assuming a daily time-temperature distribution of 6 hrs each at the minimum and maximum temperatures and 12 hrs at the daily average temperature. Thus,

$$\text{Daily DH}>65^{\circ}\text{F} = 6\text{hr}({}^{\circ}\text{F}_{\text{min}}-65) + 6\text{hr}({}^{\circ}\text{F}_{\text{max}}-65) + 12\text{hr}({}^{\circ}\text{F}_{\text{ave}}65).$$

3. **Inoculation.** Although high pathogen populations may accumulate on flower stigmas, infections do not occur unless rain or heavy dew completes inoculation into the hypanthium (= base of flower cup) (6). Since E. amylovora cells are multiflagellate and capable of directed movement in water (2), the minimum wetting requirement here is for a continuous water film between the stigma surface and the base of the flower. Generally, the amount of rainfall appears less important than the fact that some wetting occurs. One exception to this generalization

is when, occasionally, concentrated bacterial ooze becomes available on canker surfaces during bloom (once in 4yrs of this MD study). Here, a splashing rain could have a major effect in increasing the efficiency of inoculation, placing high populations of the pathogen directly into many blossom infection courts in a short time.

4. **Daily mean temperature >65 F.** In each of the epidemics thus far studied, the daily mean temperature must be equal to or >65^{o}F for at least two days for infections to occur. Our data base so far is too small to make a more definitive statement on whether this time period should begin with a wetting event or simply include one for infections to occur.

CANKER BLIGHT SUBMODEL

Canker blight refers to the activation and subsequent progress of infections centered in overwintering cankers and is independent from current season cankers initiated through blossom or shoot infections. The beginning of overwintering canker activity (OCA) is a key decision point in the MARY BLITE model. If it occurs early, additional inoculum may be available for blossom infections and, whenever it occurs, the potential for shoot blight increases, changing the focus of control efforts.

Early evidence marking the onset of OCA occurs at canker margins several days to a week before bacterial ooze develops on the surface and up to two weeks before canker blight symptoms appear. The first indication of OCA can be found by regularly monitoring canker margins using a double-cut procedure. The first cut is shallow and, when OCA begins, reveals a narrow (1-2mm) water-soaked zone in the green bark adjacent to the necrotic canker tissue. A second, deeper cut in the same location exposing the canker margin at the inner bark level shows a similarly narrow but diffuse brownish zone. With both cuts, if OCA has not yet begun, the margin appears sharp and clear.

The onset of OCA occurs regularly every year with the accumulation of 136 + 6 degree days (DD)>55^{o}F from green tip, irrespective of whether the season in general is early or late, wet or dry, cool or warm. On this basis, MARY BLITE uses a minimum threshold for predicting OCA of 130DD>55^{o}F accumulated from green tip. The accuracy of this prediction threshold seems, in large part, due to the use of the <u>daily mean temperature</u> as the base for DD calculations rather than the daily high temperature used in most conventional DD applications, and reflects both the positive and negative effects of warm and cool temperatures, respectively, on bacterial populations and symptom development.

PREDICTING BLOSSOM AND CANKER BLIGHT SYMPTOM APPEARANCE

By continuing to monitor the accumulation of DD>55^{o}F from green tip beyond the time of OCA, early symptoms of BB can be anticipated at 185 ± 10 DD, followed shortly by symptoms associated with CB at 219 ± 2 DD.

SHOOT BLIGHT SUBMODEL

Shoot blight refers to direct infections of vegetative apple shoots (terminals, water sprouts, root suckers) independent of any direct association with nearby canker or blossom infections. Detailed guidelines on the factors controlling shoot blight development have yet to be defined for the MARY BLITE system, but several observations, thus far, seem consistent. SB symptoms appear after those of BB or CB develop in the area (not necessarily within the same orchard). SB occurs frequently and is most severe on young, non-bearing trees which generally receive no streptomycin treatments and few insecticide sprays on a regular basis. Finally, SB in Maryland is usually more severe where foliar injury by white apple leafhoppers (WALH) is also evident. At present, we assume the bacteria are readily available for dissemination by sapfeeding insects shortly after OCA begins and, certainly, after BB or CB symptoms appear. Further investigations to develop more definitive guidelines on SB inoculum potentials and insect vector activity are planned.

TRAUMA BLIGHT

Occasionally, a fourth phase of fire blight develops, taking precedence over the requirements for all other phases. The exacerbation of fire blight following the injuries caused by early summer hail storms is well known in most apple production areas. Hail normally occurs after warm temperatures have incited OCA and much inoculum is available for the immediate inoculation and colonization of many foliar and bark injuries; epiphytic populations of the pathogen at this time are also normally high. Evidence from Ohio in 1987 (personal communication, M.A. Ellis, O.A.R.D.C., Wooster, OH) and South Carolina in 1986 (personal communication, E. Zehr, Clemson University) suggest that temperatures of <25°F at or near the time of OCA or when epiphytic inoculum potentials are high may result in a higher than expected incidence of fire blight. Following a freeze sufficient to cause ice formation within cherry leaves, Pseudomonas syringae pv. syringae bacteria in moisture on leaf surfaces are apparently drawn into the intercellular spaces within 30 minutes of thawing (5). A similar mechanism may be operative with apple tissues and Erwinia amylovora bacteria.

USING MARY BLITE

The basis for decision-making with MARY BLITE lies in the routine monitoring of daily temperatures (minimum, maximum, average), rainfall and dew observations. Data is recorded daily from green tip and a cumulative DD>55°F value is calculated. During the bloom period (full pink to petal fall), the daily DH>65°F is calculated and added to a cumulative total which is reduced, as described, for frosts or days with no temperature >65°F. Progress of the epidemic is followed using a graph format where the conditions supporting fire blight development are plotted relative to a common threshold line representing a daily mean temperature of 65°F, 130 accumulated DD>55°F from green tip and 110 accumulated DH>65°F from full pink. Fire blight risk is assessed daily on the basis of whether all three critical thresholds have been exceeded and whether a wetting event has or is expected to occur. Potential risks can be forecast using local weather forecasts and the slope of these plotted lines to anticipate their intercept with the threshold line in either a positive or negative direction.

The fire blight model defined as MARY BLITE suggests a number of critical research questions to be addressed as well as some ways in which the timing of currently recommended treatments might be made more cost-effective.

1. Will fixed copper applications at tight cluster be more effective than conventional dormant sprays in reducing epiphytic populations of the pathogen on exposed bud tissues prior to bloom?

2. The timing of streptomycin bloom sprays is best based on daily mean temperature and DH>65°F and not delayed until wetting since the incidence of light rains and dew is difficult to predict accurately. Applications should probably be made within 24-48 hours of threshold attainment. Where temperatures and inoculum potential remain above threshold, sprays should be repeated at 4-5 day intervals depending on the rate of flower development, the amount of bloom remaining, and local rain forecasts. Where cool temperatures cause these factors to drop below threshold, further sprays during bloom can be delayed safely.

3. Regardless of how or when streptomycin is applied, a spreader-activator adjuvant should be included to increase uptake of the antibiotic. This may be especially important in slowing the later development of shoot blight. The use of alternate row middle applications is specifically discouraged since thorough coverage of all open blossoms is important.

4. When OCA is anticipated during bloom, streptomycin spray intervals should not exceed 4 days for the remainder of the bloom period, irrespective of other MARY BLITE indicators. Should a fixed copper application during bloom be recommended when OCA develops early?

5. On bearing trees, where streptomycin is applied during bloom and OCA develops after petal fall, insecticide treatments for vectors may need to be timed with the OCA date. Where streptomycin is not used during bloom, none is available in shoots (4) to inhibit bacterial growth following vector inoculation. Thus, on non-bearing trees and bearing trees not treated with streptomycin in bloom, the antibiotic should be tank-mixed with the insecticide and applied at OCA (130DD>55°F) and, again, just before symptoms of blossom (185DD>55°F) or canker blight (219 D>55°F) are anticipated.

6. While hail is seldom forcast well enough in advance to allow any sort of prophylactic treatment, severe frost periods usually are. If the mechanism of bacterial entry into cherry leaves following a freeze applies to apples, will a pre-frost antibiotic spray be effective in preventing major loss?

REFERENCES

1. BALDWIN, C.H., JR. & R.N. GOODMAN (1963). Prevalence of *Erwinia amylovora* in apple buds as detected by phage typing. Phytopathology 53:1299-1303.

2. BAYOT, R.G. & S.M. RIES (1986). Role of motility in apple blossom infection by *Erwinia amylovora* and studies of fire blight control with attractant and repellant compounds. Phytopathology 76:441-445.

3. PAULIN, J.P. (1985). Susceptibility to *Erwinia amylovora* of flower buds of pear trees under natural conditions. Proc. 6th International Cong. on Plant Pathogenic Bacteria, June 2-7, 1985. In Plant Pathogenic Bacteria, 1987 (eds. E.L. Civerolo, et al.) Martinus Nijhoff Publishers, Inc. pp 623-627.

4. SHAFFER, W.H. & R.N. GOODMAN (1969). Effectiveness of an extended Agri-mycin 17 spray schedule against fire blight. Plant Disease Reporter 53:669-672.

5. SÜLE, S. & E. SEEMÜLLER (1987). The role of ice formation in the infection of sour cherry leaves by *Pseudomonas syringae* pv. syringae. Phytopathology 77:173-177.

6. THOMSON, S.V. (1986). The role of the stigma in fire blight infections. Phytopathology 76:476-482.

7. ZOLLER, B.G. & J. SISEVICH (1976). Effect of temperature on blossom poopulations of *Erwinia amylovora* in Bartlett pear orchards in California during 1972-1976. Proc. American Phytopathological Society 3:322.

Cumberland-Shenandoah Fruit Workers Conference
Harper's Ferry, West Virginia
November 1987

Apple (*Malus* x *domestica* 'Golden Delicious')
Powdery mildew; *Podosphaera leucotricha*
Brooks spot; *Mycosphaerella pomi*
Sooty blotch; *Gloeodes pomigena*
Flyspeck; *Zygophiala jamaicensis*
Black rot; *Physalospora obtusa*
White rot; *Botryosphaeria dothidea*
Bitter rot; *Glomerella cingulata*

T. B. Sutton and E. M.
Brown, Department of
Plant Pathology, NC
State Univ., Raleigh,
NC 27695-7616

DISEASE CONTROL ON GOLDEN DELICIOUS, 1987. Treatments were applied to two five-tree replications of 9-yr-old Golden Delicious with an airblast sprayer at 150 psi and 206 gpa at the Mountain Horticultural Crops Research Station, Fletcher. The second and fourth trees within each replicate were used for data collection. Treatments were applied on 9 (green tip, gt), 16, and 23 (pink,p) Apr, 6, 13 (1st cover, 1C), and 28 May, 10 and 24 Jun, 8 and 22 Jul, and 6 and 20 Aug. Rubigan, Nustar, and HWG 1608 treatments were not applied on 16 Apr. The incidence of powdery mildew was determined on 9 Jun by examining the leaves on 10 terminals selected at random on each replicate. Sooty blotch, flyspeck, and Brooks spot incidences were determined from a random sample of 25 fruit/replicate at harvest on 8 Sep. Rot data were taken from a sample of 25 symptomless fruit/replicate picked at harvest and stored at room temperature (65-75 F) for 2 wk. Fruit with atypical or questionable symptoms were isolated in PDA to identify the pathogen involved.

HWG 1608 treatments and the Nustar treatment provided excellent powdery mildew control. Control of powdery mildew with both formulations of Rubigan was equally good; however, the level of control was reduced when captan 50W was added to Rubigan. HWG 1608 was weak on Brooks spot; the Nustar treatment provided excellent sooty blotch and flyspeck control. The EC formulation of Rubigan was more effective than the AS formulation against Brooks spot. HWG 1608 was ineffective against sooty blotch and flyspeck. The Nustar treatment provided excellent control; 100% of the fruit would have packed out allowing 5% or less severity. Good control was also achieved in the treatment with Dithane M45 in the cover sprays. There was no difference in bitter rot control between treatments. HWG 1608 demonstrated some activity against black rot and white rot. Generally, there was considerable variation in rot incidence among replications in all treatments and there were no distinct differences between materials or application rates. No PGR effects were noted by any materials.

Treatment and Rate/100 gal	% leaves infected with powdery mildew	% fruit affected					Sooty blotch and flyspeck severity*
		Brooks spot	Sooty blotch	Flyspeck	Black rot	White rot	
Nustar 20DF 2 oz + Manzate 200 80W 1.5 lb through 1C; Benlate 50W 2.0 oz + Manzate 200 1.5 lb	2.4 a**	0 ab	4.0 a	1.0 a	2.0 a	4.0 ab	0.3 a
Cyprex 65W 8 oz through pf; Dithane M45 80W 2 lb	-	8 ab	55.0 b	18.0 b	13.0 c	10.0 c	3.3 ab
Rubigan 1EC 3 oz + Captan 50W 1.5 lb through 1C; Captan 50W 2 lb	10.5 cd	11 ab	91.0 c	88.0 c	2.0 a	2.0 ab	5.8 ab
Rubigan 1EC 3 oz through 1C; Captan 50W 2 lb	3.3 ab	13 abc	94.0 c	97.0 d	10.0 bc	0.0 a	5.8 ab
Rubigan 1AS 3 oz through 1C; Captan 50W 2 lb	3.3 ab	34 d	100.0 c	100.0 d	2.0 a	4.0 ab	9.5 b
Dodine 4F 10 fl oz through pf; Captan 50W 2 lb	-	5 ab	94.0 c	95.0 cd	14.0 c	2.0 ab	3.3 ab
Dodine 4F 15 fl oz through pf; Captan 50W 2 lb	-	11 ab	96.0 c	97.0 d	7.0 abc	2.0 ab	8.0 ab
Cyprex 65W 11.5 oz through pf; Captan 50W 2 lb	13.5 d	14 abc	96.0 c	98.0 d	8.0 abc	4.0 ab	5.8 ab
Dodine 4F 30 fl oz through pf; Captan 50W 2 lb	-	3 a	99.0 c	98.0 d	3.0 ab	7.0 bc	10.5 b
HWG 1608 1.2 EC 6 oz	7.1 bc	27 cd	99.0 c	99.0 d	2.0 a	2.0 ab	29.3 c
HWG 1608 45 DF 2 oz	3.5 ab	17 bc	100.0 c	100.0 d	1.0 a	0.0 a	25.5 c
Control (insecticide only)	32.9 e	95 e	100.0 c	100.0 d	7.0 c	1.0 ab	59.3 d

*% of fruit surface area covered.

**Means within the same column followed by the same letter are not significantly different at P=0.05 as determined by the Waller-Duncan k-ratio t-test.

Apple (Malus x domestica 'Golden Delicious')
Sooty blotch; Gloeodes pomigena
Flyspeck; Zygophiala jamaicensis

T. B. Sutton and L. R. Pope, Dept. of Plant Pathology, NC State Univ., Raleigh, NC 27695-7616

SOOTY BLOTCH AND FLYSPECK CONTROL, 1987. Treatments were applied dilute at 200 gpa and 180 psi with an airblast sprayer to two five-tree replicates of 7-yr-old trees at the Central Crops Research Station, Clayton, NC. Data were collected from the second and fourth trees within each replicate. Fungicides were applied on 28 Apr (1st cover), 13 and 26 May, 9 and 23 Jun, 7 and 16 Jul, and 14 and 18 Aug. At harvest on 16 Sep, 25 fruit were chosen at random from each tree and scored for sooty blotch and flyspeck incidence and the percent surface area covered by both pathogens (severity) was estimated on each fruit.

Jun and Jul were dry and sooty blotch and flyspeck did not develop in the plots until mid-Aug. At harvest, the incidence of both diseases was greater than 90% in the control; however, the severity was relatively low. All treatments which included Dithane M-45 80W effectively controlled sooty blotch and flyspeck. The addition of 2 or 4 oz of Benlate 50W to the captan 50W treatments throughout the season improved control over captan 50W alone. Addition of Benlate 50W in the last two sprays only did not improve control over captan 50W alone.

Treatment and Rate/100 gal	% fruit infected		% surface covered
	Sooty blotch	Flyspeck	
Dithane M-45 80W 2.0 lb + Benlate 50W 2.0 oz	0 a*	0 a	0 a
Benlate 50W 4.0 oz	0 a	0 a	0 a
Dithane M-45 80W 1.5 lb + Benlate 50W 2.0 oz	0 a	0 a	0 a
Dithane M-45 80W 1.5 lb	0 a	0 a	0 a
Dithane M-45 80W 2.0 lb; last 2 sprays ADD Benlate 50W 4.0 oz	0 a	0 a	0 a
Dithane M-45 80W 2.0 lb; last 2 sprays ADD Benlate 50W 2.0 oz	0 a	0 a	0 a
Dithane M-45 80W 2.0 lb + Benlate 50W 4.0 oz	0 a	0 a	0 a
Captan 50W 1.5 lb + Benlate 50W 2 oz	0 a	0 a	0 a
Dithane M-45 80W 1.5 lb + Benlate 50W 4.0 oz	0 a	0 a	0 a
Dithane M-45 80W 2.0 lb	0 a	0 a	0 a
Captan 50W 1.5 lb + Benlate 50W 4 oz	0 a	0 a	0 a
Captan 50W 2.0 lb + Benlate 50W 4 oz	0 a	0 a	0 a
Captan 50W 2.0 lb + Benlate 50W 2 oz	0 a	0.2 a	0.2 a
Ro 15-1297 4E 1.0 oz + Dithane M-45 80W 1.0 lb	0 a	0 a	0 a
Captan 50W 2.0 lb; last 2 sprays ADD Benlate 50W 4.0 oz	2 a	14 bc	1.2 bc
Captan 50W 2.0 lb	6 a	10 b	1.7 c
Captan 50W 2.0 lb; last 2 sprays ADD Benlate 50W 2.0 oz	6 a	17 c	1.4 b
Captan 50W 1.5 lb	14 b	26 d	1.6 bc
Captan 50W 1.0 lb	20 b	30 d	1.4 bc
Control (insecticide only)	91 c	95 e	6.35 d

*Means in the same column followed by the same letter are not significantly different at P=0.05 as determined by the Waller-Duncan k-ratio t-test.

Apple (*Malus* x *domestica* 'Rome Beauty')
Powdery mildew; *Podosphaera leucotricha*
Brooks spot; *Mycosphaerella pomi*
Sooty blotch; *Gloeodes pomigena*
Flyspeck; *Zygophiala jamaicensis*
Black rot; *Physalospora obtusa*
White rot; *Botryosphaeria dothidea*

T. B. Sutton and E. M.
Brown, Department of Plant
Pathology, NC State Univ.,
Raleigh, NC 27695-7616

DISEASE CONTROL ON ROME BEAUTY, 1987. Fungicides were applied to blocks of four to six trees in a 25-yr-old block of Rome Beauty at the Mountain Hortricultural Crops Research Station, Fletcher, with an airblast sprayer at 150 psi and 257 gpa. Data were collected from three trees (replicates) within each block chosen at random. Treatments were applied on 9 (green tip, gt), 16, and 23 Apr, 6 (petal fall, pf), 13 (1st cover, 1C), and 28 May, 10 and 24 Jun, 8 and 22 Jul, 6 and 20 Aug, and 3 and 17 Sep. Powdery mildew and frogeye leafspot incidences were determined on 9 Jul by recording the percent leaves infected on each of 10 terminals selected at random on each replicate. Sooty blotch, flyspeck, and Brooks spot incidence was determined from a subsample of 25 fruit selected at random from 100 fruit picked at random from each tree at harvest on 6 Oct. The percent surface area affected with sooty blotch and flyspeck on each fruit was visually estimated. The percent fruit infected with black rot and white rot was determined from count of the number of infected fruit and total fruit per replicate at harvest. In addition, 100 symptomless fruit per replicate were picked at harvest and stored at room temperature (60-70 F) for 2 wk and examined for rot.

All treatments provided excellent powdery mildew control. Treatments with Rally 60DF or RH 0611 61.25W generally provided better frogeye leafspot control than those with Ro 15-1297 4E. All treatments provided approximately 90% control of Brooks fruit spot. The incidence of sooty blotch and flyspeck was high in all treatments. Control was best in the Ro 15-1297 4E 1 oz + Manzate 200 80W 1.0 lb early-season treatment. The severity of sooty blotch and flyspeck was also less in this treatment; 100% of the fruit would have packed out allowing 5% or less of the surface area affected. Ro 15-297 4E at 2.0 oz used alone exhibited good activity against sooty blotch and flyspeck; 89% of the fruit would have packed out using the criterion above. RH 0611 62.25W treatments generally provided better sooty blotch and flyspeck control than those with Rally 60DF. Black rot and white rot developed extensively in some plots. Although some treatments provided better control than others, there was no consistent relationship to material or application rate. There was no significant difference in the amount of white rot or black rot among treatments after fruit were stored for 2 wk. The amount of rot ranged from 33% to 12.3% among treatments. Poor control of black rot and white rot may be related to the use of mancozeb as a mixing partner as it has little activity against white rot or black rot.

Treatment and Rate/100 gal	% leaves infected with		% fruit affected				Sooty blotch and flyspeck severity*
	Powdery mildew	Frogeye leafspot	Brooks spot	Black rot/ White rot	Sooty blotch	Flyspeck	
Rally 60DF 1.66 oz GT and TC; Rally 60DF 0.83 oz P through 2C; Dithane M-45 80W 15 oz PF through harvest	0.0 a**	2.3 a	9.3 bc	30.6 cd	80.0 bcd	34.7 c	6.7 b
Rally 60 DF 0.83 oz GT-2C; ADD 1 qt oil at GT and TC. Dithane M-45 80W 15 oz PF to harvest	0.0 a	2.5 a	7.0 bc	13.8 abc	86.7 cde	28.0 abc	7.0 b
Ro 15-1297 4E 2.0 oz	0.0 a	6.6 ab	10.7 bc	26.2 bcd	92.0 cde	18.7 abc	3.3 ab
Rally 60 DF 0.83 through 2C; at PF and 1C Dithane M-45 80W 15 oz to harvest	0.2 a	5.6 ab	8.0 bc	3.9 a	77.3 bcd	22.7 bc	6.3 ab
Ro 15-1297 4E 1.0 oz + Manzate 200 80W 1.0 lb through 1C; Manzate 200 80W 2.0 lb	0.2 a	7.6 ab	1.3 c	12.3 ab	24.0 a	1.3 a	1.3 a
RH 0611 62.25W 1.5 lb GT through harvest; at GT and TC add 1 qt. oil	0.2 a	1.8 a	21.3 b	5.6 a	77.3 bcd	26.7 bc	4.3 ab
Ro 15-1297 4E 1.0 oz through 1C; Ro 15-1297 4E 1.0 oz + Manzate 200 80W 1.0 lb	0.2 a	18.9 bc	8.0 bc	19.5 abcd	96.0 de	12.0 ab	8.0 b
Ro 15-1297 4E 1.0 oz through 1C; Manzate 200 80W 2.0 lb	0.2 a	11.1 bc	8.0 bc	32.5 d	66.7 b	16.0 ab	4.7 ab
RH 0611 62.25W 1.5 lb GT through harvest	1.9 a	1.8 a	8.0 bc	19.2 abcd	76.0 bc	24.0 bc	3.0 ab
Control (insecticide only)	18.1 b	6.4 ab	72.0 c	21.8 abcd	100.0 e	100.0 d	70.3 c

*% surface area covered.

**Means within each column followed by the same letter are not significantly different at P=0.05 as determined by the Waller-Duncan k-ratio t-test.

DETERMINATION OF INCUBATION PERIOD AND EARLIEST BLOSSOM BLIGHT SYMPTOMS ON JONATHAN APPLE AND BARTLETT PEAR IN THE ORCHARD FOLLOWING ARTIFICIAL INOCULATION WITH ERWINIA AMYLOVORA

T. van der Zwet and J. C. Walter

United States Department of Agriculture

Agriculture Research Service

Appalachian Fruit Research Station

Kearneysville, WV 25430

During the past 50 years, numerous researchers have studied the blossom blight phase of fire blight, but specific, fundamental information on the incubation period and earliest signs of blossom infection is still lacking (4). Rosen (3) made the first detailed observations of the penetration and invasion of Erwinia amylovora in apple and pear blossom tissues. He showed conclusively how the bacteria can be traced through several layers of cells below the nectarthode chamber soon after artificial inoculation of blossoms.

Regarding the number of bacteria needed to obtain infection, Powell (2) reported from Illinois that terminal shoot injections on Jonathan with 2×10^2 bacterial cells/ml did not result in blight infection, whereas with 2×10^4 cells/ml, 40% of shoots developed blight in 7-10 days and 2×10^6 cells/ml resulted in 100% infection in 4-5 days. In England, Billing (1) determined that 10^9 cells of E. amylovora are required to obtain blossom infection and that 30 doublings of the bacterium (generation time equals 90 min) are needed for one cell to reach this concentration. With a maximum of 12.5 doublings/day, about 2-3 days are required to achieve the theoretical time for completion of an incubation period.

Degree hours above 65°F (18.3°C) were calculated according to the system developed by Zoller (6). This empirical system is based on blossom monitoring experiences of epiphytic populations of E. amylovora and field observations of locations of new infections. Thus, the bacteria initially colonize flowers in warm weather, but decline during intervening cool periods below 65°F.

Our research was conducted to obtain the most accurate determination of the incubation period in apple and pear blossoms following inoculation with 3 concentrations of the pathogen and based on earliest detection of blossom blight symptoms. Secondly, these records were analyzed under existing weather conditions during bloom 1987 and were compared against recordings of degree hours and potential doubling of the bacterium.

MATERIALS AND METHODS

The experiments were carried out in a 2 acre (1 ha) block of fruit trees at the Appalachian Fruit Research Station (AFRS) in alternate rows of 'Jonathan' apple and 'Bartlett' pear. Other pear and apple cultivars were used in addition. Blossoms were inoculated by atomizing whole clusters with a suspension of E. amylovora (10^8 cfu/ml) or by placing 50 ul of 10^2cfu/ml (low dose), 10^5cfu/ml (medium dose) or 10^8cfu/ml (high dose) of 3 different isolates with a micro pipet dispenser inside 200 individually tagged blossoms. Blossoms were inoculated several times during the blooming season in order to compare inoculation periods with meterological data recorded in this block. Weather data were collected with a Pestcaster TM recorder and a hygrothermograph back-up.

RESULTS AND OBSERVATIONS

Significantly more pear and apple blossoms blighted following artificial inoculation with 10^8 than with 10^5 or 10^2 cfu/ml (Table 1). This was true with each isolate of E. amylovora as well as the combination of all 3 isolates. With one exception, this was also reflected in the number of blighted blossom clusters, counted about 10 days after initial symptoms were observed. Of special interest was the observation of some blighted blossoms in pear where only buffer was applied to the blossoms, presumably due to the presence of epiphytic bacteria. More blossom blight developed in 'Bartlett' than in 'Jonathan'. This cannot be due to the difference in flower structure (open vs closed nectary) since bacteria were placed inside the blossoms.

In the early experiment, the incubation period was 10 days for both 'Bartlett'pear and 'Jonathan' apple (Table 2). When blossoms were inoculated one week later (May 7), these periods were reduced to 5 and 8 days, respectively. Earliest symptoms detected were ooze droplets visible at the base of the flower. Comparison of weather data indicated a minimum of 181 degree hours required for 'Bartlett' pear and 875 degree hours for 'Jonathan' apple. Temperature appeared a more significant factor for blight development than rainfall, which confirmed our observations made in the spring of 1985 (5).

LITERATURE CITED

1. Billing, E. 1980. Fire blight in Kent, England, in relation to weather (1955-1976). Ann. Appl. Biol. 95:341-364.
2. Powell, D. 1965. Factors influencing the severity of fire blight infections on apple and pear. Mich. State Hort. Soc. Ann. Mtg. 94:1-7.
3. Rosen, H. R. 1937. Mode of penetration and of progressive invasion of fire blight bacteria into apple and pear blossoms. Ark. Agric. Expt. Sta. Bul. 331, 68 pp., illus.
4. van der Zwet, T. and H. L. Keil. 1979. Fire blight - a bacterial disease of rosaceous plants. U.S. Dept. Agric. Handbk. 510, 200 pp., illus.
5. van der Zwet, T., P. Steiner, J. G. Barrat, K. D. Hickey, and K. S. Yoder. 1987. Development of a blossom blight prediction system for the Appalachian fruit growing region. Acta Hortic. 222: in press.
6. Zoller, B. G. and J. Sisevich 1979. Blossom populations of Erwinia amylovora in pear orchards vs accumulated degree hours over 18.3°C (65°F), 1972-1976. Phytopathology 69:1050 (Abstr.)

"van der Zwet--3"

Table 1. Severity of blossom blight on Bartlett pear and Jonathan apple following artificial inoculation with three isolates of *Erwinia amylovora*. (Spring 1987)

E. amylovora isolate dosage	% blighted blossoms[1] Bartlett (May 4)	% blighted blossoms[1] Jonathan (May 12)	Number of blighted blossom clusters[2] Bartlett (May 15)	Number of blighted blossom clusters[2] Jonathan (May 20)
Isolate 259				
10^2 cfu/ml	0.0	12.5	3 (14)	3
10^5 cfu/ml	49.5	20.0	31	21
10^8 cfu/ml	74.0	61.5	36	33
Isolate 260				
10^2 cfu/ml	26.0	2.5	17	0 (6)
10^5 cfu/ml	51.5	18.0	25	9
10^8 cfu/ml	79.0	46.5	39	6
Isolate 1112				
10^2 cfu/ml	16.5	5.0	6	7
10^5 cfu/ml	59.5	30.0	33	29
10^8 cfu/ml	87.5	79.5	40	40
All 3 isolates				
10^2 cfu/ml	14.5	1.5	13	8 (25)
10^5 cuf/ml	31.0	18.5	19	18
10^8 cfu/ml	95.5	55.0	39	31
Controls				
Buffer only	3.0	0.0	2	0
Natural infection	1.0	2.0	1	3

[1] Based on inoculation (pear, April 24 and apple, May 1) of 200 blossoms (5 blooms/10 blossom clusters in each of 4 repications) with 50 ml of bacterial suspension in a micropipet.

[2] Based on examination of 40 blossom clusters with infections advanced into the woody tissue, showing necrosis in nearest leaves; figures in parenthesis indicate number of blighted blossoms.

Table 2. Detection of earliest blossom blight symptoms in pear and apple in relation to meteorological recordings (spring 1987)

Cultivar	Bloom stage	Inoculation			First Symptom		Degree		Temperature (°F)			Moisture	
		Date	Method	Inoculum	Date	Incubation days	blight severity	Min.	max.	°(hrs) 65°	rainfall (in)	hrs 80%RH
1. Pai Li	full bloom	4/15	micropipet	50 ul; 10^8	4/28	13	severe	36	80	323	2.09	184
2. Seckel	full bloom	4/21	micropipet	50 ul; 10^8	5/01	10	severe	34	80	359	.28	86
3. Bartlett	full bloom	4/24	micropipet	50 ul; 10^8	5/04	10	severe	34	80	181	1.45	80
4. Sparlett	petal fall	5/01	spray	10^8	5/10	9	moderate	38	90	630	1.20	72
5. Bartlett	some petal fall	5/01	micropipet	50 ul; 10^8	5/09	8	very severe	38	80	392	1.20	68
6. Bartlett	petal fall	5/01	spray	10^8	5/09	8	light					
7. Jonathan	full bloom	5/01	micropipet	50 ul; 10^8	5/11	10	severe	38	90	873	1.20	76
8. Jonathan	full bloom	5/01	spray	10^8	5/11	10	severe					
9. Jonathan	full bloom	5/01	spray	10^8	5/11	10	severe					
10. Granny Smith	full bloom	5/01	spray	10^8	5/11	10	light					
11. Law Spur	full bloom	5/01	spray	10^8	5/11	10	moderate					
12. Red Chief	full bloom	5/01	spray	10^8	5/15	14	very light	38	90	1105	1.20	92
13. Jonathan	some petal fall	5/05	spray	10^8	5/12	7	severe	40	90	800	.04	32
14. Rome Beauty	full bloom	5/05	spray	10^8	5/14	9	moderate	40	90	974	.04	32
15. *P. betulafolia*	full bloom	5/05	spray	10^8	5/18	13	very light	40	90	1463	.04	60
16. Bartlett	late petal fall	5/07	micropipet	50 ul; 10^8	5/12	5	severe	44	90	1625	.04	29
17. Jonathan	some petal fall	5/07	micropipet	50 ul; 10^8	5/15	8	severe	44	90	1081	.04	44
18. Bartlett			natural		5/10		light					
19. Jonathan			natural		5/15		light					
20. Jonnee			natural				none (5/27)					
21. Rome Beauty			natural				none (5/27)					
22. York			natural				none (5/27)					

"van der Zwet--4"

APPLE (*Malus domestica*
'Jonathan')
Powdery mildew;
Podosphaera leucotricha
Fruit finish
Jonathan spot

K. S. Yoder, A. E. Cochran II,
J. R. Warren, C. M. Schmidt,
M. A. Vann
Virginia Agricultural Exp. Station
V. P. I. and State University
2500 Valley Avenue
Winchester, VA 22601

CONTROL OF POWDERY MILDEW ON JONATHAN APPLE BY SI FUNGICIDES, 1987: Eleven treatments were applied at selected intervals to compare their residual effectiveness on powdery mildew in a heavily infected 20-yr-old block of trees 5-6 m high planted on a 9 X 9 m spacing. The test was conducted in a randomized block design with four single-tree replicates, each surrounded by border trees. Treatments were applied from both sides of the tree row on each application date with a Swanson Model DA-400 airblast sprayer (100 gal/A). Dates for treatments of the indicated approximate designated application intervals were as follows: 10-day 1/2-in green to 2nd cover treatments: 9 Apr (1/2-in green), 21 Apr (pink), 1 May (bloom), 11 and 22 May, 5 Jun (or 11 Jun for Rubigan and Bayleton treatments). 2-wk 1/2-in green-2nd cover treatments: 9 Apr, 23 Apr (bloom); 6 May (petal fall), 22 May and 5 Jun. All treatments 3rd-7th covers: 19 Jun, 7 and 22 Jul and 10 Aug. Insecticides applied separately with the same equipment included Supracide, Spray Oil 7E, Guthion 50W, Lannate L, Kelthane 4F, and Plictran. Foliar mildew ratings were conducted 9 Jun. Fruit were harvested 4 Sep and evaluated after 9 wk storage at 2C.

Under relatively heavy mildew pressure all treatments gave significant ($p = 0.05$) control of mildew on leaves and fruit. Rally and Bayleton applied at 10-day intervals gave outstanding control on foliage. Control by Rubigan was adequate. Mildew control by Nustar was rather inconsistent and generally weaker than by other treatments. Many treatments provided somewhat poorer control of mildew on fruit than on foliage, probably due in part to the difficulty in controlling mildew which overwintered in fruit buds. After presumed mildew russet was excluded, fruit finish was generally acceptable, but a significant increase in opalescence and russet was noted with one Rubigan treatment, and one Bayleton treatment gave a significant increase in "non-mildew" russet compared to untreated fruit. With such a high incidence of mildew russet on untreated fruit, some of the russet attributed to Rubigan, Bayleton and other treatments actually may have been partially controlled mildew russet. Although Jonathan spot is considered to be a physiological disease, all treatments gave a significant reduction in its incidence, possibly because of reduced tree stress during a growing season with erratic precipitation patterns.

Table 1. Control of powdery mildew by sterol-inhibiting fungicides on Jonathan apple

Treatment, rate/A[1], and approximate application schedule	Mildew incidence (%)[2]			Fruit finish[3]		spot,
	leaves	leaf area	fruit	opalescence	russet	% fruit
Untreated	56.7 c	19.5 c	70 c	1.2 a	1.0 a	68 b
Nustar 20DF 3.0 oz + Manzate 200 80W 2.0 lb (10 day, ½"G-2nd C then 2 wk, 3rd-7th C)	18.8 ab	3.3 ab	27 ab	1.3 a	1.2 ab	27 a
Nustar 20DF 3.0 oz + Manzate 200 80W 2.0 lb (2 wk, ½"G-7th C).	13.8 a	2.7 ab	20 ab	1.6 a	1.2 ab	28 a
Nustar 20DF 4.0 oz + Manzate 200 80W 2.0 lb (2 wk, ½"G-7th C).	18.0 ab	4.5 ab	35 b	1.7 a	1.4 abc	25 a
Nustar 20DF 4.0 oz + Manzate 200 80W 2.0 lb (10 day, ½"G-2nd C then 2 wk, 3rd-7th C)	32.4 b	6.9 b	33 b	1.1 a	1.1 a	25 a
Rally 60DF 3.33 oz + spray oil 7E 4.0 qt (10 day, ½"G & pink) Rally 60DF 3.33 oz + spray oil 7E 4.0 qt + Dithane M-45 80W 3.75 lb (10 day, bloom-2nd C) Rally 60DF 3.33 oz + Dithane M-45 80W 3.75 lb (2 wk, 3rd-7th C)	9.1 a	1.8 a	26 ab	1.9 ab	1.3 ab	15 a
Rally 60DF 3.33 oz (10 day, ½"G-petal fall) Rally 60DF 3.33 oz + Dithane M-45 80W 3.75 lb (10 day, 1st & 2nd C then 2 wk, 3rd-7th C)	2.1 a	0.4 a	9 a	1.4 a	1.1 a	14 a
Rally 60DF 6.67 oz (10 day, ½"G & pink) Rally 60DF 3.33 oz (10 day, bloom) Rally 60DF 3.33 oz + Dithane M-45 80W 3.75 lb (10 day, petal fall-2nd C then 2 wk, 3rd-7th C)	2.3 a	0.6 a	23 ab	1.3 a	1.1 a	22 a
Rubigan 1E 6.0 fl oz + Polyram 80W 3.0 lb (10 day, ½"G-2nd C then 20 day to 3rd C) Dikar 76.7W 6.5 lb (2 wk, 4th-7th C)	11.2 a	3.0 ab	26 ab	2.6 b	1.8 c	27 a
Rubigan 1E 9.0 fl oz + Polyram 80W 3.0 lb (10 day, ½"G-2nd C then 20 day to 3rd C) Dikar 76.7W 6.5 lb (2 wk, 4th-7th C)	11.2 a	2.3 ab	20 ab	1.1 a	1.2 ab	27 a
Bayleton 50W 4.0 oz (10 day, ½"G-petal fall) Bayleton 50W 4.0 oz + Dithane M-45 80W 3.75 lb (10 day, 1st & 2nd C then 20 day to 3rd C) Dikar 76.7W 6.5 lb (2 wk, 4th-7th C)	7.7 a	1.8 a	30 ab	1.9 a	1.6 bc	21 a
Bayleton 50W 4.0 oz (2 wk, ½"G-petal fall) Bayleton 50W 4.0 oz + Dithane M-45 80W 3.75 lb (2 wk, 1st & 2nd C) Dikar 76.7W 6.5 lb (2 wk, 4th-7th C)	10.6 a	2.0 ab	33 b	1.5 a	1.3 ab	24 a

Mean separation by Duncan's Multiple Range Test ($p = 0.05$).

[1] Formulated material per acre. Applied at 100 gal/A from both sides of the treated row on each application date with a Swanson Model DA-400 airblast sprayer.

[2] Averages of 10 terminal shoots or 25 fruit from each of four single-tree replicates.

[3] Fruit finish excluding presumed mildew russet. Rated on a scale of 0-5 (0 = perfect finish; 5 = severe opalescence or russet).

APPLE (*Malus domestica*
'Red Delicious',
'Golden Delicious',
'Rome Beauty')
Scab; *Venturia inaequalis*
Powdery mildew;
Podosphaera leucotricha
Fruit effects

K. S. Yoder, A. E. Cochran II,
J. R. Warren, C. M. Schmidt,
M. A. Vann
Virginia Agricultural Exp. Station
V. P. I. and State University
2500 Valley Avenue
Winchester, VA 22601

EVALUATION OF EXPERIMENTAL FUNGICIDES ON THREE APPLE CULTIVARS, 1987: Sixteen fungicide treatments were evaluated for disease control, fruit finish, and growth regulator effects on a 15-yr-old block of semi-dwarf trees planted in groups with one tree of each cultivar per group. The test was conducted in a randomized block design with four replicate groups per treatment. Treatments were applied as dilute sprays to the runoff point with a single nozzle handgun at 500 psi as follows: 10 Apr (1/2-in green Rome, tight cluster Red Delicious); 21 Apr (Rome open cluster, R. Delicious pink); 1 May (bloom); first through sixth covers, respectively: 18 May, 5 and 19 Jun, 7 and 23 Jul and 7 Aug. Insecticides, applied separately with an airblast sprayer, included Supracide, Lannate L, Guthion 50W, Kelthane 4F, Plictran and Spray Oil 7E.

Primary scab inoculum was light, but frequent early infection periods promoted disease buildup on untreated leaves and fruit. Under these conditions all treatments gave good scab control. All treatments had less than 5% scab compared to 57% on untreated Rome fruit. Mildew overwintered quite heavily in the test block, resulting in a strong comparative test. FBC 39865 gave good mildew control at all rates tested. SC-0858 appeared weak for mildew control on foliage, but all treatments gave significant control of mildew on fruit compared to untreated fruit. Fruit finish by the treatments was generally acceptable, but Benlate + Polyram caused a significant increase in opalescence on Rome Beauty. There was no significant increase in opalescence on Red Delicious or russetting on any cultivar by any treatment. RH-0611 + oil significantly ($p = 0.05$) reduced russetting on Rome Beauty and Golden Delicious. The following parameters were recorded on Golden Delicious as indicators of possible growth regulator effects: fruit length diameter, length/diameter ratio, core length, weight, seed count. Of these parameters, the only significant effect ($p = 0.05$) compared to untreated fruit was a reduction in core length (3.7 cm to 3.3 cm) by CGA 453 23.7 ml. This was not evident at the higher rate nor was it expressed in fruit length or length/diameter ratio.

Table 2. Evaluation of experimental fungicides on three apple cultivars.

Treatment, rate per 100 gal and schedule[1]	% leaves with scab		Mildew incidence, Rome			Finish ratings[2]			
			leaves		%	opalescence	russet		
	R.Del.	Rome	% infected	% area	fruit	Rome	R.Del.	Rome	G.Del.
No fungicide	29.8 b	30.9 b	56.4 c	48.1 b	28 d	1.8 abc	1.7 b-e	1.6 b	2.4 bc
FBC 39865 25W 2.0 oz (½"G-6th C)	2.7 a	2.7 a	7.2 a	2.5 a	0 a	1.1 a	1.4 a-d	1.1 ab	2.7 c
FBC 39865 25W 4.0 oz (½"G-6th C)	0.9 a	0.3 a	3.7 a	1.1 a	1 ab	1.2 ab	1.6 b-e	0.8 a	2.4 bc
FBC 39865 25W 8.0 oz (½"G-6th C)	0.0 a	1.4 a	5.9 a	1.8 a	5 ab	1.5 abc	1.4 a-d	0.8 a	2.3 abc
CGA 453 3.5E 23.7 ml (½"G-6th C)	0.4 a	2.5 a	8.4 a	2.1 a	2 ab	1.5 abc	1.3 abc	1.2 ab	2.5 bc
CGA 453 3.5E 35.5 ml (½"G-6th C)	0.4 a	0.3 a	24.1 ab	9.8 a	5 ab	1.5 abc	0.9 ab	1.3 ab	2.1 ab
Spotless 25W (CC-14030) 22.7 g + Polyram 80W 1.0 lb (½"G-3rd C) Polyram 80W 2.0 lb (4th-6th C)	0.9 a	1.1 a	13.5 ab	3.9 a	11 bc	2.1 cd	2.4 e	1.3 ab	2.1 abc
Spotless 25W (CC-14030) 22.7 g + Polyram 80W 1.0 lb + X-77 8.0 fl oz (½"G-3rd C) Polyram 80W 2.0 lb (4th-6th C)	0.6 a	0.9 a	19.6 ab	10.0 a	3 ab	1.7 abc	2.0 cde	1.0 ab	2.4 bc
Spotless 25W (CC-14030) 22.7 g + CC-15883 8.0 fl oz (½"G-3rd C) Polyram 80W 2.0 lb (4th-6th C)	0.4 a	3.6 a	13.4 ab	3.1 a	7 abc	1.9 bcd	1.6 b-e	1.3 ab	2.2 abc
Spotless 25W (CC-15949) 22.7 g (½"G-3rd C) Polyram 80W 2.0 lb (4th-6th C)	2.7 a	0.4 a	5.9 a	1.8 a	2 ab	1.5 abc	1.9 cde	0.9 a	2.5 bc
Benlate 50W 2.0 oz + Polyram 80W 1.0 lb (½"G-6th C)	0.5 a	1.0 a	20.3 ab	12.7 a	5 ab	2.7 d	1.9 cde	1.6 b	2.6 bc
SC-0858 50W 4.0 oz (½"G-6th C)	0.9 a	1.3 a	18.9 ab	11.0 a	1 ab	1.6 abc	1.4 a-d	1.1 ab	2.2 abc
SC-0858 50W 8.0 oz (½"G-6th C)	0.8 a	0.8 a	32.6 b	12.9 a	9 abc	2.0 bcd	1.6 a-d	1.3 ab	2.1 ab
Rubigan 1E 3.0 fl oz (½"G-3rd C) Polyram 80W 2.0 lb (4th-6th C)	0.5 a	2.7 a	8.7 a	2.5 a	1 ab	1.9 bcd	1.9 cde	1.1 ab	2.3 bc
Rubigan 1E 3.0 fl oz + Polyram 80W 1.0 lb (½"G-3rd C) Polyram 80W 2.0 lb (4th-6th C)	0.6 a	0.4 a	7.1 a	2.4 a	4 ab	2.2 cd	0.9 a	1.5 ab	2.5 bc
RH-0611 62.25W 24.1 oz (½"G-6th C)	0.3 a	1.1 a	18.0 ab	7.8 a	2 ab	1.6 abc	2.1 de	1.1 ab	2.5 bc
RH-0611 62.25W 24.1 oz + spray oil 7E 1.0 qt (½"G-6th C)	1.3 a	0.4 a	7.5 a	1.6 a	11 bc	1.7 abc	1.5 a-d	1.1 a	1.8 a

Mean separation by Duncan's Multiple Range Test ($p = 0.05$).

Averages of ten terminal shoots 13 Jul or harvest counts of 25 fruits from each of four replications.

[1] Formulated material per 100 gal dilute. Applied by handgun to runoff at 500 psi. G = green tip; C = cover spray.

[2] Rated on a scale of 0-5 (0 = perfect finish; 5 = severe russet or opalescence, excluding presumed mildew russet.

APPLE (*Malus domestica* 'Jonathan')
Powdery mildew;
Podosphaera leucotricha
Fruit effects

K. S. Yoder, A. E. Cochran II,
J. R. Warren, C. M. Schmidt,
M. A. Vann
Virginia Agricultural Exp. Station
V. P. I. and State University
2500 Valley Avenue
Winchester, VA 22601

EVALUATION OF MIXTURES OF MILDEWCIDES ON JONATHAN APPLE, 1987: Four treatments with combined mildewcides and six other treatments were compared for mildew control and fruit finish effects in a 20-yr-old block of trees 5-6 m high planted on a 9 X 9 m spacing. The test was conducted in a randomized block design with four single-tree replicates, each surrounded by border trees. Treatments were applied from both sides of the row on each application date with a Swanson Model DA-400 airblast sprayer (100 gal/A). Treatment dates through 4th cover were as follows: 14 Apr (open cluster), 22 Apr (bloom), 1 May (bloom-petal fall), 12 and 27 May, 11 and 25 Jun. All treatments were covered with Dikar 76.7W 6.5 lb per acre as the 5th and 6th covers 13 and 28 Jul. Insecticides applied separately with the same equipment included Supracide, Spray Oil 7E, Guthion 50W, Lannate L, Kelthane 4F and Plictran. Fruit were harvested 4 Sep and evaluated after 9 wk storage at 2 C.

Under relatively heavy mildew pressure all treatments gave acceptable commercial control on foliage, with the combination of Rubigan + Dikar being particularly outstanding. Mildew incidence on fruit was high considering the level of control on foliage, probably due in part to the difficulty in controlling mildew which overwintered in fruit buds. Benlate + oil was the least effective treatment for control of mildew on fruit. Excluding presumed mildew russet,fruit finish was generally good. Dikar gave a significant improvement in "non-mildew" russetting. There was no evidence of incompatability by any of the combination treatments in this test. Although Jonathan spot is considered to be a physiological disease, all treatments gave a significant reduction in its incidence, possibly because of reduced tree stress during a growing season with erratic precipitation patterns.

Table 3. Powdery mildew control by fungicide mixtures on Jonathan apple

Treatment through 4th cover and rate/A[1]	Mildew incidence (%)[2]			Finish ratings[3]		Jonathan spot (%)
	leaves	leaf area	fruit	russet	opalescence	
Untreated	69.2 b	37.8 b	83 c	1.3 b	1.2 a	65 b
Bayleton 50W 2.0 oz + Kolodust Xtra 53% 3.0 lb	7.7 a	1.4 a	35 a	1.4 b	1.2 a	30 a
Bayleton 50W 2.0 oz + Benlate 50W 5.0 oz + spray oil 7E 2.0 qt	11.0 a	2.9 a	26 a	1.0 ab	1.2 a	25 a
Bayleton 50W 2.0 oz + Dikar 76.7W 3.25 lb	6.2 a	1.0 a	29 a	1.2 ab	1.6 a	16 a
Bayleton 50W 4.0 oz	3.3 a	1.0 a	31 a	1.4 b	1.4 a	26 a
Kolodust Xtra 53% 6.0 lb	11.8 a	2.3 a	39 ab	1.2 ab	1.5 a	34 a
Benlate 50W 10.0 oz + spray oil 7E 2.0 qt	5.0 a	1.2 a	53 b	1.4 b	1.5 a	25 a
Dikar 76.7W 6.5 lb	13.0 a	2.6 a	30 a	0.8 a	1.1 a	27 a
Rubigan 1E 6.0 fl oz (OC-2nd C) Bayleton 50W 4.0 oz (3rd & 4th C)	4.7 a	1.0 a	38 ab	1.3 b	1.6 a	27 a
Rubigan 1E 9.0 fl oz (OC-2nd C) Bayleton 50W 4.0 oz (3rd & 4th C)	4.0 a	1.1 a	39 ab	1.3 b	1.6 a	34 a
Rubigan 1E 4.0 fl oz + Dikar 76.7W 3.25 lb (OC-2nd C) Bayleton 50W 4.0 oz (3rd & 4th C)	1.8 a	0.4 a	39 ab	1.4 b	1.5 a	30 a

Mean separation by Duncan's Multiple Range Test ($p = 0.05$).

[1] Formulated material per acre. Applied at 100 gal/A from both sides of the treated row on each application date with a Swanson Model DA-400 airblast sprayer. OC = open cluster; C = cover spray.

[2] Averages of 10 terminal shoots from each of four single-tree replicates.

[3] Fruit finish excluding presumed mildew russet. Rated on a scale of 0-5 (0 = perfect finish; 5 = severe opalescence or russet).

APPLE (*Malus domestica*
'Granny Smith',
'Redchief Red Delicious')
Scab; *Venturia inaequalis*
Fruit effects

K. S. Yoder, A. E. Cochran II,
J. R. Warren, C. M. Schmidt,
M. A. Vann
Virginia Agricultural Exp. Station
V. P. I. and State University
2500 Valley Avenue
Winchester, VA 22601

EVALUATION OF REGISTERED FUNGICIDES ON GRANNY SMITH AND RED DELICIOUS APPLES, 1987: Rubigan applied at equivalent rates in 50 and 300 gal of water per acre was compared to other registered fungicides for disease control and fruit effects on six-yr-old trees 3-4 m high planted on a 5 X 9 m spacing. The test was conducted in a randomized block design with four single-tree replicates, each surrounded by border trees. Treatments were applied from both sides of the tree row on each application date with a Swanson Model DA-400 airblast sprayer calibrated to deliver the indicated gallonage as follows: 10 Apr (tight cluster); 21 Apr (bloom); 29 Apr (bloom); 6 May (Granny Smith, bloom; Red Delicious 90% petal fall); 14 May (petal fall); 22 May (1st cover). The test block was in a commercial orchard and the grower treated the entire test block with fungicides and insecticides after 15 Jun. Insecticides applied separately with the same equipment during the test application period included Lannate L, Guthion 50W and Kelthane 4F. Foliar counts were conducted 1 Jul. Fruit were rated after 7 wk storage at 2 C for Red Delicious and 4 wk storage for Granny Smith.

Moderate primary scab inoculum and frequent early season infection periods combined to give a relatively strong fungicide test. No difference was evident in level of control or side effects on fruit by applying Rubigan in differing amounts of water per acre. The 8 oz/A rate of dodine in combination with Bayleton was weak for scab control under these test conditions. Benlate + Manzate gave good scab control. The only significant ($p = 0.05$) side effect observed was a slight increase in length/diameter ratio of Red Delicious by Bayleton + dodine, apparently related to a significant increase in fruit diameter rather than a reduction in length. Other possible fruit effects which were evaluated but no significant differences detected included fruit russet on Red Delicious and opalescence and weight of both cultivars.

Table 4. Evaluation of registered fungicides on Granny Smith and Red Delicious apples

Treatment, rate, gal/A and timing*	Scab incidence (%)				Red Delicious fruit		
	Red Delicious		Granny Smith		Dimensions (cm)		length/ diam ratio
	leaves	fruit	leaves	fruit	length	diam	
Untreated	47 b	81 b	47 c	95 b	6.4 a	7.0 b	0.93 a
Rubigan 1E 6.0 fl oz, 300 gpa (TC-1st C)	4 a	0 a	8 ab	31 a	6.8 a	7.2 ab	0.94 a
Rubigan 1E 6.0 fl oz, 50 gpa (TC-1st C)	4 a	0 a	3 a	19 a	6.4 a	7.0 ab	0.92 ab
Bayleton 50W 4.0 oz + Dodine 65W 8.0 oz, 50 gpa (TC-1st C)	7 a	9 a	15 b	38 a	6.6 a	7.4 a	0.89 b
Benlate 50W 12.0 oz + Manzate 200 80W 4.0 lb + spray oil 7E 1.0 gal, 50 gpa (TC-bloom & 1st C) Benlate 50W 8.0 oz + Manzate 200 80W 6.5 lb + spray oil 7E 1.0 gal, 50 gpa (petal fall)	1 a	0 a	2 a	4 a	6.7 a	7.2 ab	0.93 a

Mean separation by Duncan's Multiple Range Test ($p = 0.05$). Averages of ten terminal shoots or 15-25 fruit from each of four replicate trees.

*Formulated material per acre. Applied from both sides of the tree on each application date with Swanson Model DA-400 airblast sprayer. TC = tight cluster; C = cover spray.

APPLE *Malus domestica*
'Golden Delicious'
Blue mold; *Penicillium expansum*

K. S. Yoder, C. M. Schmidt,
A. E. Cochran II, J. R. Warren
Virginia Agricultural Exp. Station
V. P. I. and State University
2500 Valley Avenue
Winchester, VA 22601

EVALUATION OF EXPERIMENTAL POSTHARVEST DIP TREATMENTS FOR CONTROL OF PENICILLIUM BLUE MOLD, 1986-87: Fruit which had been stored in a commercial storage at 2 C for 11 weeks were selected for uniform firmness and maturity and randomized into four 20-fruit replicates for each treatment. Following wounding to a depth of 7 mm in three locations on one side of the fruit with a 7 mm dowel rod, fruit were dipped 20 sec. in an inoculum suspension containing 6.5 X 10^4 benomyl-sensitive conidia/ml, dipped in a fungicide suspension 30 sec., unless indicated otherwise, placed on fiber trays, boxed by treatment and stored at 1 C. Fruit were evaluated for blue mold after 52 days storage at 1 C.

Blue mold incidence was high as indicated by 100% infection on fruit treated with captan or several experimental treatments. Although the fruit were inoculated only with benomyl-sensitive conidia, isolates from fruit treated with Benlate averaged 77% resistant to 5 ppm benomyl, indicating much surface contamination of fruit used in the experiment by benomyl-resistant strains. Under these conditions, Benlate + captan gave significantly better control than Benlate or captan used separately at twice the rate in the mixture. CGA 449 showed good evidence of control at the 4 oz rate, but reduced control at lower rates. A rate effect was also noted with Nustar. Rovral and Tilt were the only other experimental fungicides which gave promising results at the rates tested.

Table 5. Evaluation of experimental postharvest dip treatments for control of Penicillium blue mold on Golden Delicious apples, 1986-87

Treatment and rate/100 gal	Active ingredient (mg/L)	Blue mold % fruit infected 2 Feb 87
Benlate 50W 4.0 oz + Captan 50W 1.0 lb	150 + 600	44 ab
Benlate 50W 8.0 oz	300	75 c
Captan 50W 2.0 lb	1200	100 e
Nustar 20DF 37.0 g	16	40 ab
Nustar 20DF 18.5 g	8	91 d
RH 7592 0.5E 8.0 fl oz	38	99 de
RH 7592 0.5E 4.0 fl oz	19	99 de
Tilt 3.6E 20.0 ml	23	49 b
CGA 449 50W 4.0 oz	150	23 a
CGA 449 50W 2.0 oz	75	44 ab
CGA 449 50W 1.0 oz	38	94 d
CGA 449 50W 0.5 oz	19	99 de
Rovral 50W 8.0 oz	300	38 ab
SC 0858 96.2W 1200 ppm (3.1% denatured alcohol)	1200	71 c
SC 0858 96.2W 600 ppm (1.55% denatured alcohol)	600	94 de
SC 0858 96.2W 300 ppm (0.78% denatured alcohol)	300	100 e
FBC 39865 25W 4.0 oz	75	100 e
FBC 39865 25W 2.0 oz	38	99 de
SAN 619 10G 50.0 g	11	100 e
SAN 619 10G 25.0 g	5	100 e
Fungaflor 50EC 12.8 fl oz	479	98 de
Deccozil-289 28.8 fl oz	479	98 de
Denatured alcohol 95%	3.3%	99 de
Wounded, not inoculated, untreated	---	73 c
Wounded, not inoculated, dipped in water only	---	38 ab

Averages of four replications of 20 fruit.

Mean separation by Duncan's Multiple Range Test ($p = 0.05$).

PEACH (*Prunus persica* 'Madison')
Yellows; mycoplasma

K. S. Yoder, A. E. Cochran II,
J. R. Warren, C. M. Schmidt,
M. A. Vann
Virginia Agricultural Exp. Station
V. P. I. and State University
2500 Valley Avenue
Winchester, VA 22601

EVALUATION OF TERRAMYCIN FOR CONTROL OF PEACH YELLOWS, 1986-87: Terramycin Tree Injection Formula was evaluated for chemotherapy of yellows in a 6 yr-old block of trees near Gore, VA. Yellows symptoms suddenly appeared in the block in mid-summer 1986, apparently through insect transmission as a result of a reduced insecticide program during the light crop year of 1985. Treatments were assigned to uniformly symptomatic trees in a seven-replicate randomized block design. Trees were injected on mild sunny days (highs 19 and 26C) while still in full foliage 7 and 8 Oct 86. Four 6.3 mm diameter holes were drilled 3.2 cm into the trunk 10-13 cm below the lowest scaffold limb. Holes were drilled slanted slightly downward and each hole was kept filled with deionized water until the tapered plastic nipple or pipette was inserted and the solution introduced to prevent an air-lock which would have restricted uptake. Two injection methods were used: pipette infusion method -- 6.68 oz (189.4 g) of Terramycin Tree Injection Formula was dissolved into 1 gal (3.79 L) water. Ten ml of the solution was injected with each of four 10-ml pipettes per tree. The sealing of the pipette in the hole was enhanced by wrapping several layers of Parafilm M around the tapered tip before inserting it into the hole. dilute infusion method -- 1 qt (0.95 L) of a solution containing 6.68 oz/7.5 gal (6.7 g/L) of water was poured into a plastic jug which was attached to rubber tubing which branched into tapered plastic connectors inserted into each of four holes. When uptake was complete by either method, the connector or pipette was removed, the hole was plugged with a short dowel rod and pruning paint was sprayed over the wound. On a second four-replicate set of treated and untreated trees, affected branches were marked Oct 86 for removal May 87. These were removed 22 May 87 if symptoms were evident on new growth on the marked branches. If new symptoms were not evident at that time, the marked branches were not removed.

Observations Jun 87 indicated a good response to the treatment with only 13% of the treated trees symptomatic compared to 93% of the untreated trees. By 17 Aug some of the treated trees had begun to show some mild symptoms, much less severe than untreated trees. The treatments dramatically increased marketable yield because much of the untreated fruit dropped prematurely. There was no significant difference in mass of individual fruits. Cankered areas surrounding treatment wounds 2 Oct 87 were not found to be significant ($p = 0.05$).

Table 1. Evaluation of Terramycin Tree Injection Formula for chemotherapy of peach yellows

Infusion treatment method	Spring removal of symptomatic branches	Trees with yellows symptoms on: 30 Jun 87 shoots	17 Aug 87 shoots	17 Aug 87 fruit	Trees with marketable fruit	Marketable yield per tree (kg)	Mean canker area (cm^2)/injection wound 2 Oct 87
1. None	no	6/7	7/7	7/7	1/7	1.5 b	--
2. None	yes	7/7	7/7	7/7	4/7	6.1 b	--
3. Pipette	no	1/6	4/7	5/7	7/7	16.8 a	208 a
4. Pipette	yes	1/7	3/7	5/7	7/7	14.3 a	131 a
5. Dilute	no	1/4	1/5	2/5	5/5	13.7 a	91 a
6. Dilute	yes	0/6	0/7	1/7	7/7	15.6 a	156 a

Mean separation by Duncan's Multiple Range Test ($p = 0.05$).

PEACH (*Prunus persica*
'Redhaven', 'Loring')
NECTARINE (*Prunus persica* var.
nectarine 'Redgold')
Brown rot; *Monilinia fructicola*
Scab; *Cladosporium carpophilum*
Leaf curl; *Taphrina deformans*

K. S. Yoder, A. E. Cochran II,
J. R. Warren, C. M. Schmidt,
M. A. Vann
Virginia Agricultural Exp. Station
V. P. I. and State University
2500 Valley Avenue
Winchester, VA 22601

EVALUATION OF EXPERIMENTAL FUNGICIDES ON PEACH AND NECTARINE, 1987: Experimental fungicides were evaluated for disease control and phytotoxicity on 8-yr-old trees at the VPI and SU Research Farm near Winchester, VA. Dilute treatments were applied with a single nozzle handgun at 35 kg/cm^2 (500 psi) in a randomized block design with four single-tree replications (Redhaven) or three (Loring and Redgold) as follows. All cultivars: 26 Mar (BS - bud swell), 2 Apr (P - pink), 20 Apr (Bl - bloom), 27 Apr (PF - petal fall), 5 May (SS - shuck split), 22 May and 11 Jun (1st and 2nd covers); Redhaven: 29 Jun (3rd cover or 5 wk pre-harvest, pre-H); 14 and 28 Jul (3 wk and 1 wk pre-H); 4 Aug (1 day pre-H as indicated). Loring and Redgold: 29 Jun (3rd cover), 14 Jul (4th cover or 5 wk pre-H), 28 Jul and 18 Aug (3 wk and 1 wk pre-H). After harvest one set of 20 uniformly ripe fruit/replication was inoculated by atomizing a suspension containing 5.0-6.5 X 10^4 *M. fructicola* conidia/ml over the uninjured fruit surface. Another set of fruit was misted with water only. Both sets of fruit were enclosed in plastic bags on packing trays during the incubation period at 21C. Redhaven fruit were harvested, rated for scab and inoculated 5 Aug. Redgold and Loring fruit were harvested, rated for scab and inoculated 24 Aug.

Frequent wetting periods occurred through June, but, the pre-harvest season, particularly for Loring and Redgold, was relatively dry. Hail 13 Jun damaged some fruit and increased pre-harvest brown rot pressure on Redhaven, resulting in a stronger test. Over all RH 7592 was the most effective treatment for brown rot control, with rate effects apparent on Redhaven. The Folicur 1.2E was also quite effective on brown rot. Good control of scab was provided by full season applications of RH 7592, Folicur 1.2E, Dithane M-45 4 lb rate and bud swell to shuck split applications of Bravo or Olé followed by captan. Rally was weak on scab control. Bud swell applications of Bravo and Olé gave good control of leaf curl under moderate disease pressure (52% of the untreated shoots with infection). Folicur 1.2E first applied at bloom also showed evidence of leaf curl control on Redgold nectarine.

Table 1. Evaluation of experimental fungicides on Redhaven peach

Treatment and rate/ 100 gal	Timing*	Brown rot, % fruit after indicated days incubation**						% fruit infected with scab
		non-inoculated			inoculated			
		3	5	7	3	5	7	
0. Untreated	--	4 a	36 c	74 d	20 cd	74 d	94 e	68 d
1. Bravo 720 25 fl oz Captan 50W 2 lb SDS 65311 50W 8 oz	BS-SS 1st-3rd C 3 wk,1 wk, 1 day Pre-H	0 a	4 a	10 ab	9 abc	31 abc	66 b-e	0 a
2. Bravo 720 2 pt Captan 50W 2 lb SDS 65311 50W 8 oz	PF & SS 1st-3rd C 3 wk,1 wk, 1 day Pre-H	0 a	3 a	19 ab	9 abc	43 a-d	80 b-e	3 a
3. Bravo 720 2 pt Bravo 720 4 pt Captan 50W 2 lb SDS 65311 50W 8 oz	PF SS 2nd & 3rd C 3 wk,1 wk, 1 day Pre-H	0 a	9 a	38 abc	6 abc	33 abc	64 b-e	0.2 a
4. Olé 40.4%F 35.8 fl oz Captec 4L 1 qt Rovral 50W 1 lb	BS-SS 1st & 2nd C 5 wk,3 wk, 1 wk Pre-H	0 a	6 a	21 abc	10 abc	64 bcd	84 b-e	0 a
5. RH 7592 2F 1.0 fl oz RH 7592 2F 1.6 fl oz	P Bl-1 wk Pre-H	0 a	8 a	29 abc	5 abc	30 abc	68 b-e	0 a
6. RH 7592 2F 2.0 fl oz RH 7592 2F 3.2 fl oz	P Bl-1 wk Pre-H	0 a	11 a	21 ab	0 a	40 bcd	68 b-e	2 a
7. RH 7592 2F 4.0 fl oz RH 7592 2F 6.4 fl oz	P Bl-1 wk Pre-H	0 a	0 a	5 a	0 a	3 a	10 a	0 a
8. Rally 60DF 1.67 oz Rally 60DF 2.5 oz	P Bl-1 wk Pre-H	0 a	8 a	30 abc	0 a	35 abc	60 bcd	21 b
9. Rally 60DF 3.33 oz Rally 60DF 5.0 oz	P Bl-1 wk Pre-H	0 a	1 a	15 ab	0 a	15 ab	43 abc	32 c
10. Dithane M-45 80W 2 lb Dithane M-45 80W 3 lb	P Bl-1 wk Pre-H	1 a	8 a	15 ab	16 a-d	54 bcd	83 b-e	2 a
11. Dithane M-45 80W 4 lb Dithane M-45 80W 6 lb	P Bl-1 wk Pre-H	13 a	31 bc	51 cd	29 d	63 cd	91 de	0 a
12. Folicur 1.2E 8 fl oz	P-1 wk Pre-H	0 a	0 a	5 a	0 ab	18 ab	41 ab	5 a
13. Folicur 45DF 2.7 oz	P-1 wk Pre-H	1 a	15 ab	35 abc	13 abc	43 bcd	73 cde	0 a
14. Funginex 1.6E 12 fl oz Captan 50W 2 lb	P-SS, 5,3,1 wk Pre-H 1st-2nd C	0 a	15 ab	41 bc	18 bcd	53 bcd	81 de	0 a
15. Carbamate 76W 2.25 lb Rovral 50W 1 lb Captan 50W 2 lb	BS P-SS,5,3 & 1 wk Pre-H 1st & 2nd C	0 a	10 a	41 abc	10 abc	51 bcd	74 b-e	4 a

Averages of four replications. Mean separation by Duncan's Multiple Range Test ($p = 0.05$).

* Formulated material per 100 gal dilute. Applied to the runoff point with a single nozzle handgun at 500 psi as indicated: Mar 26 (BS-bud swell), Apr 2 (P-pink), Apr 20 (Bl-bloom), Apr 27 (PF-petal fall), May 5 (SS-shuck split), May 22, Jun 11 (1st & 2nd covers), Jun 29 (3rd cover or 5 wk pre-harvest), Jul 14 and Jul 28 (3 wk and 1 wk pre-harvest), Aug 4 (1 day pre-harvest).

**Duplicate samples of 20 apparently uninfected fruit/replication harvested and placed on fiber trays Aug 5. Inoculated fruit misted with suspension containing 6.5×10^4 *Monilinia fructicola* conidia per ml. Non-inoculated fruit misted with sterile de-ionized water. All fruit incubated at 70°F on trays in plastic bags.

Table 2. Evaluation of experimental fungicides on Loring peach and Redgold nectarine

Treatment and rate/ 100 gal*	Timing	% fruit with brown rot after indicated days' incubation								% fruit infected with scab	
		Loring peach				Redgold nectarine					
		non-inoculated		inoculated		non-inoculated		inoculated			
		5	7	5	7	5	8	5	8	Loring	Redgold
0. Untreated	--	6 a	16 b	14 de	19 f	3 b	13 b	9 bc	19 c	28 b	54 c
1. Bravo 720 25 fl oz Captan 50W 2 lb SDS 65311 50W 8 oz	BS-SS 1st-4th C 3 wk, 1 wk Pre-H	3 a	8 ab	15 e	19 f	1 a	4 a	9 c	18 c	0 a	1 a
2. Bravo 720 2 pt Captan 50W 2 lb SDS 65311 50W 8 oz	PF & SS 1st-4th C 3 wk, 1 wk Pre-H	2 a	9 ab	9 bcd	19 f	1 a	3 a	5 abc	15 c	11 ab	2 a
3. Bravo 720 2 pt Bravo 720 4 pt Captan 50W 2 lb SDS 65311 50W 8 oz	PF SS 2nd-4th C 3 wk, 1 wk Pre-H	5 a	12 ab	15 e	20 f	1 a	5 a	2 a	16 c	18 ab	29 abc
4. Olé 40.4%F 35.8 fl oz Captec 4L 1 qt Rovral 50W 1 lb	BS-SS 1st-4th C 5 wk, 3 wk, 1 wk Pre-H	1 a	4 a	7 abc	16 def	1 a	2 a	2 a	8 ab	1 a	0 a
5. RH 7592 2F 1.0 fl oz RH 7592 2F 1.6 fl oz	P Bl-1 wk Pre-H	3 a	11 ab	6 ab	15 def	1 a	4 a	1 a	9 b	0 a	2 a
6. RH 7592 2F 2.0 fl oz RH 7592 2F 3.2 fl oz	P Bl-1 wk Pre-H	4 a	12 ab	7 ab	17 ef	1 a	2 a	1 a	5 ab	5 a	3 a
7. RH 7592 2F 4.0 fl oz RH 7592 2F 6.4 fl oz	P Bl-1 wk Pre-H	3 a	10 ab	2 a	9 ab	0 a	3 a	1 a	3 a	1 a	3 a
8. Rally 60DF 1.67 oz Rally 60DF 2.5 oz	P Bl-1 wk Pre-H	2 a	10 ab	3 a	13 b-e	1 a	4 a	1 a	7 ab	6 ab	49 bc
9. Rally 60DF 3.33 oz Rally 60DF 5.0 oz	P Bl-1 wk Pre-H	1 a	6 ab	6 ab	16 ef	1 a	4 a	2 a	8 ab	23 ab	53 bc
10. Dithane M-45 80W 2 lb Dithane M-45 80W 3 lb	P Bl-1 wk Pre-H	3 a	11 ab	13 de	19 f	1 a	2 a	8 bc	18 c	7 ab	5 a
11. Dithane M-45 80W 4 lb Dithane M-45 80W 6 lb	P Bl-1 wk Pre-H	5 a	13 ab	12 cde	19 f	1 a	4 a	3 ab	15 c	0 a	0 a
12. Folicur 1.2E 8 fl oz	P-1 wk Pre-H	2 a	8 ab	2 a	11 abc	1 a	0 a	1 a	3 ab	0 a	3 a
13. Folicur 45DF 2.7 oz	P-1 wk Pre-H	1 a	2 a	1 a	7 a	1 a	5 a	1 a	4 ab	12 ab	0 a
14. Funginex 1.6E 12 fl oz Captan 50W 2 lb	P-SS,5,3,1 wk Pre-H 1st-3rd C	1 a	6 ab	4 ab	12 bcd	0 a	3 a	5 abc	15 c	11 ab	49 bc
15. Carbamate 76W 2.25 lb Rovral 50W 1 lb Captan 50W 2 lb	BS P-SS, 5,3 & 1 wk Pre-H 1st-3rd C	3 a	9 ab	4 ab	14 cde	0 a	1 a	1 a	7 ab	10 ab	16 ab

Averages of four replications. Mean separation by Duncan's Multiple Range Test (p = 0.05).

Fungicide Sprays for Controlling Apple Disease in 1987

E. I. Zehr, G. W. Kirby, and D. H. Foster
Department of Plant Pathology and Physiology
Clemson University
Clemson, SC

Eleven-yr-old apple trees on MM106 rootstock at the Clemson University Experiment Station were sprayed in season-long treatments for apple disease control. Sprays were applied to runoff, using a single-nozzle handgun (ca. 6 liters per tree), at 250 psi. Each treatment was replicated four times, one tree per replicate, in a randomized complete block design. Spray dates were 26 Mar (green tip), 6 Apr (tight cluster), 16 Apr (full bloom), and 24 Apr, 6 and 19 May, 2, 15, and 30 Jun, and 13 and 31 Jul. Insecticides, applied separately by airblast sprayer, were Penncap M, 1.0 qts/100 gallons, on 10 Apr and 1 Jun; Imidan 50W, 1.0 lb/100 gallons on 24 Apr, 1, 8 and 22 May, 15 and 30 Jun; and Sevin 80W 1.0 lb/100 gallons on 1 and 8 May. Agrimyrin was applied for fire blight on 15 and 24 Apr. Data for scab and cedar-apple rust on cluster leaves were collected from 100 leaves per tree on 9 Jun; scab on terminal leaves from 10 shoots at random per tree on 12 Aug; and data on fruit diseases on 25 Aug from 100 fruit per tree. Russet on Golden Delicious was estimated from 25 fruit at random per tree.

Rainfall for the season was moderate, but dry weather prevailed from green tip to petal fall, from mid-May to mid-June, and throughout the month of July. V. inaequalis inoculum was light in early season; and primary scab was light in the plots. However, late-season scab and summer diseases became severe on control trees. The best broad-spectrum control was in the captan and RH-0611 plots, however RH-0611 was superior to captan for scab control, but inferior for sooty blotch. Except when combined with myclobutanil in RH-0611, mancozeb did not control white rot or Brooks' spot. Captec was equivalent to wettable captan, except that the 1-pt rate may have been too low for optimum scab control.

Table 1. Apple scab control and percent fruit surface russeted on Golden Delicious.

Treatment and rate per 100 gallons	scab (% infection)						
	Cluster leaves		terminal leaves		Fruit		
	Delicious	G. Del.	Delicious	G. Del.	Delicious	G. Del.	Russet[1]
RH-0611 62.25W 2.0 lb.	0.0	0.0	2.2	0.8	1.5	1.5	12
Nustar 40EC 2.0 oz.	0.0	0.0	17.5	2.8	0.8	0.8	14
Rubigan 1EC 3.0 oz; Dithane M-45 1.5 lb after 2nd cover.	--	0.0	--	3.2	--	0.0	9
Rally 60DF 1.67 oz; Dithane M-45 1.5 lb after 2nd cover . .	0.0	0.0	11.0	1.8	2.5	0.8	15
Captan 50W 2.0 lb	0.0	0.0	15.0	4.0	0.2	0.5	8
Captec 4F 1.33 pt	--	0.0	--	2.5	--	1.5	11
Captec 4F 1.0 pt.	--	0.0	--	7.2	--	1.0	7
Control (no fungicide).	21.0	16.2	76.0	92.8	21.0	6.0	11
L.S.D. 0.05	--	--	12.7	4.7	2.5	2.1	3.9

[1] % fruit surface russetted based on estimations from 25 fruit per replicate.

Table 2. Control of frogeye leafspot, and summer diseases[1].

	% leaves infected		% fruit infected				
Treatment and rate per 100 gallons	Cedar-apple rust	Frogeye	Bitter rot	white rot	flyspeck	sooty blotch	Brooks spot
RH-0611 62.25W 2.0 lb.	0.0	1.2	0.5	3.2	0.0	24.8	2.0
Nustar 40EC 2.0 oz.	0.0	0.2	4.8	16.5	0.2	15.5	7.5
Rubigan 1EC 3.0 oz; Dithane M-45 1.5 lb after 2nd cover.	0.2	1.2	1.2	15.8	0.8	11.8	11.8
Rally 60DF 1.67 oz; Dithane M-45 1.5 lb after 2nd cover . .	0.0	6.2	0.5	6.5	0.2	21.8	5.5
Captan 50W 2.0 lb	0.0	3.0	2.2	2.8	0.2	0.2	2.8
Captec 4F 1.33 pt	2.0	2.0	1.5	3.2	0.5	0.0	3.0
Captec 4F 1.0 pt.	2.8	3.2	0.8	2.5	0.5	0.2	2.2
Control (no fungicide).	37.0	4.5	11.0	12.0	39.2	100.0	20.2
L.S.D. 0.05	3.6	2.5	3.6	N.S.	6.1	10.8	10.7

---

[1] Data from Delicious cv. for frogeye leafspot and Golden Delicious cv. for other diseases.

Not for Citation

MECHANICAL BLOOM THINNING OF PEACH

T. A. Baugher, K. C. Elliott, S. H. Blizzard,
S. I. Walter, T. A. Keiser

West Virginia University Morgantown,WV

Abstract. A bloom thinning mechanism utilizing suspended flexible strands of rubber belting or rope, moved through trees on a frame mounted on a forklift, was tested on 'Early Loring' peach [*Prunus persica* (L.) Batch]. The study was designed to evaluate thinning response based on shoot and flower positions, time of treatment, and machine parameters. Maximum thinning occurred in the upper two thirds of the tree canopy. Shoot orientation and flower position did not affect bloom removal. Thinning at full bloom and passing through a tree at least four times provided greatest bloom removal. Tractor speed did not significantly influence thinning. The most effective treatments removed 45 to 59% of the blossoms, reduced number of fruit from 18 to 10-11·cm^{-2} limb cross-sectional area (CSA), reduced hand thinning 4 to 8 minutes, and increased fruit diameter 2%.

Thinning peaches by hand is a labor intensive and an expensive cultural practice in the peach industry. Research on chemical and mechanical means of fruit removal began as early as the 1950's (7), but due to variable and unsatisfactory responses neither method has been widely accepted commercially.

The mechanisms of peach fruit abscission are not fully understood, but considerable progress has been made in the last 10 years (2,3,4,9,11). Gaps in this knowledge have resulted in numerous failures in the testing of thinning chemicals, e.g. inconsistent responses, phytotoxity. Recent research on bloom thinning with desiccating chemicals (2,3) and on fruit thinning with photosynthetic inhibitors (4) show promise; however, commercial usage of these new compounds is questionable.

Available mechanical peach thinners shake the trunk or scaffold branches when fruit are 2 to 3 cm in diameter. Thinning success depends on the shaker type and training system (1,6). In general, more fruit are removed from the tree tops than from lower portions, and larger fruit are removed easier than smaller fruit (5). Slow adoption of mechanical fruit thinning has been attributed to the undesirable removal of largest fruit, damage to trees by the shaker, and grower unwillingness to raise tree height to improve access to the trunk.

Benefits of satisfactory thinning by either chemicals or machines include reduced labor costs and an increased opportunity to complete the thinning process early enough for maximum influence on fruit size. Greatest benefit is on heavy setting, early maturing cultivars (7). Recent bloom thinning work reinforces the importance of early thinning for maximum fruit size (2). Another effect from early thinning is increased flower bud formation for the following season.

Hand thinning during bloom is becoming a more common practice in peach orchards (8,10). Growers partially thin at bloom for the beneficial effects on fruit size and complete the process after danger of frost has past. During the pink to full bloom stage, blooms are easily removed by hand or by using various types of brushes. The major drawback, as with hand thinning fruits, is the labor requirement. A few growers have mechanized bloom thinning by dragging ropes or some other flexible material through the trees. Two of these grower designs and modifications thereof were evaluated in this study. The objectives were to evaluate mechanisms for bud removal, shoot and tree positions were optimum removal occurred, reduction in hand thinning time, and influence on ultimate fruit size.

Materials and Methods

Plot Design. The mechanical thinner designs were tested in a block of 'Early Loring' peaches planted in 1981 at an orchard in Martinsburg, West Virginia. Trees in the block were of uniform vigor and had received similar annual fertilizer, pesticide, pruning and hand thinning treatments. Tree training was open center (standard) with four main scaffolds. Trees were 2.3 m high and 3.6 m wide, and the bearing surface extended 1.2 m above the trunk. Tree spacing was 5.4 m X 7.2 m. Fourteen thinning treatments were applied to six replications of randomized complete blocks.

Mechanical Thinner Design. The bloom removal scheme consisted of moving a series of suspended hanging flexible strands of rope or rubber through the peach tree. As a strand moved through the tree, its surface contacted blossoms and physically separated them from shoots. The texture of the strand surface, the weight and flexibility of the strand, the blossom position on a shoot, the limb height in a tree, and the shoot orientation to the direction of the strand movement were factors thought to affect flower removal.

Grower designed thinning concepts that were tested included a rope removal system developed by Brad Johnson, Inman, South Carolina and a rubber belting system built by Charles and Ronald Lewis, Martinsburg, West Virginia (unpublished). The Johnson thinner uses heavy hemp or manila rope cut into 3.6 m lengths and doubled over a supporting frame. The ropes are secured to the frame at equal intervals, and the ends are tightly wired and taped to prevent unravelling. The Lewis thinner uses rubber belting cut in continuous 2.5 cm wide strips. The length is 1.5 m, and three half-moon notches are cut on each side of the lower 0.3 m of each strip with a 1.3 cm diameter hole punch. The belting is attached to a frame with a crank mechanism driven by a hydraulic motor, which moves the thinning strands up and down as they are dragged through the tree. Both units are mounted on a forklift for maneuvering through the orchard.

The test unit evaluated in this study (Fig. 1) had a frame on which both belting and ropes were mounted. The frame was 3 m wide with 2.5 cm hemp rope, spaced 2.5 cm apart, and continuous strands of rubber belting. The unit was attached to a conventional front mounted bulk bin forklift on a 53 kW farm tractor. The fork rotator hydraulic circuit was used to operate the hydraulic rotation motor.

Treatments. The two removal systems were tested simultaneously and separately (by tying up the strands not in use). Tests were conducted with and without oscillation, at 3 stages of development (pink, full bloom, post-bloom), with various numbers of passes over the trees (two, four, and eight), and at two speeds (1.6 and 3.2 $km{\cdot}h^{-1}$). All possible factorial combinations of the above could not be included in the experiment, so 13 mechanical thinning treatments (see Table 2) and one hand fruit thinning treatment were selected for evaluation. Mechanical treatments performed only partial thinning; therefore, follow-up hand thinning was also conducted.

Pretest. Since percent thinning could be determined immediately following use of the mechanical thinner, a pretest was conducted to determine where in the tree and on a shoot maximum thinning occurred. Shoots were tagged in each half of six trees at the pink stage of bloom in the following canopy positions: lower 0.5 m, mid 0.5 m, and upper 0.5 m. Each limb unit contained three to six shoots having a total of 50 to 75 blossoms, and within this unit, one vertical and one horizontal shoot were tagged. Blossoms were counted immediately before and after two passes through the trees with the thinner, and information was recorded on total number of blossoms, number of blossoms on vertical shoot, number of blossoms on horizontal shoot and position of each bloom (top, side, bottom).

Main Test. Information from the pretest was used to develop the best procedure for collecting data from the main test to evaluate the 13 mechanical thinning treatments. Two limbs, containing a total of 30 to 60 flowers, were tagged in the mid 0.5 m section of each tree canopy. Again, blossoms were counted immediately before and after each thinning treatment (pink - April 10, full bloom - April 15, post-bloom - May 14). Limb diameter was measured with a vernier caliper, and the cross-sectional area was calculated.

Blossoms in each treatment were counted a second time following the physiological June drop. Treatments were compared on the basis of percentage flower removal and number of fruit·cm^{-2} limb CSA.

Follow-up hand thinning was conducted by the orchardist on June 8, and the time required to hand thin each tree was recorded. Percentage crop load per tree (before hand thinning) was also estimated on this date. Two days before the second picking, July 29, 10 fruit of equal maturity were sampled from all sides of each tree at a height of 1.5 to 2.0 m in the outer 1 m periphery. Diameter of each fruit was measured with a vernier caliper.

Results and Discussion

Maximum thinning was observed in the top and middle portions of the tree canopy (Table 1). Flower removal was greatest at full bloom and with four to eight passes (Table 2). Responses to thinning were generally greater at full bloom, with oscillation, and with at least four passes (Table 2).

Limb and Flower Position. The pretest determined that maximum mechanical thinning occurred on limbs in the top and middle portions of the tree. Thinning on lower limbs was 10 to 15% less. To avoid over-thinning, it will be important to base thinning strategies on results observed in the top two thirds of the open center trained tree. A modified training system may allow contact with more blossoms throughout the canopy, and plans are underway to evaluate alternative tree designs.

The orientation of shoots and flowers had no apparent effect on flower removal. Percentage flower removal was equal on vertical and horizontal shoots and on flowers on the top and underside of shoots. Providing the thinning strand contacted a portion of the flower, it was separated from the shoot. For example, although only the tip of underside blossoms was exposed, removal occurred. Shoot rigidity was a more important factor affecting flower removal. Excessively long slender shoots often hung down too far for optimum contact with the thinning strand. This problem may be corrected by changing pruning practices and will be studied further.

Texture of Thinning Strand. Rope and belting treatments were not significantly different. A rough surface to brush across the flower was important, but the notches on the belting and the threads on the hemp rope were equally effective. Weight is another property of the thinning strand that may be important, and a future test unit will be built with a larger diameter rope. It should be noted here that Johnson (unpublished) had previously observed that synthetic rope was less effective than hemp or manila and that optimum diameter was at least 3.2 cm.

that hand thinning time can be significantly reduced and that much greater increases in fruit size can be obtained. It is interesting to note that the best treatments in the current study had an average of 9 to 11 fruit·cm^{-2} CSA following physiological drop, and the grower hand thinned to 4 fruit·cm^{-2} CSA. Most of the treatments were providing less than half the total thinning which was considered necessary by the grower.

Commercial Potential. Before the peach mechanical bloom thinning concept is ready for commercial adoption, improved effects on fruit size and hand thinning requirements must be demonstrated. Our initial experience with a mechanical bloom thinner indicates a number of advantages over other methods, however, including predictability (regardless of weather conditions), low cost, simplified timing, immediately apparent response, avoidance of chemicals and the associated regulations, and the ease and flexibility a grower has of building a unit (tailored to a specific orchard) in the farm shop. Additionally, there is no danger of phytotoxicity and there are no calibration problems.

Literature Cited

1. Barden, D. 1971. Peach thinning by trunk shaking is fast and inexpensive. Fruit Grower 34 (1):33.
2. Byers, R.E. and C.G. Lyons, Jr. 1984. Flower thinning of peach with desiccating chemicals. HortScience 19:545-546.
3. Byers, R.E. and C.G. Lyons, Jr. 1985. Peach flower thinning and possible sites of action of desiccating chemicals. J. Amer. Soc. Hort. Sci. 110:662-667.
4. Byers, R.E., C.G. Lyons, Jr., and K.S. Yoder. 1985. Peach and apple thinning by shading and photosynthetic inhibition. J. Hort. Sci. 60:465-472.
5. Beutel, J., J. Yeager, W. Anderson, L. Brown, F. Perry, G. Post, D. Rough and N. Ross. 1969. Mechanical and chemical cling peach thinning. Cling Peach Quart. 6(1):20-21.
6. Costa, G. and M. Grandi. 1978. Experiments on the chemical and mechanical fruit thinning of some cultivars of freestone and clingstone peach trees. Rivista Della Ortoflorofruitticoltura Italiana 62 (2):155-176.
7. Havis, A.L. 1962. Effect of time of fruit thinning of 'Redhaven' peach. Proc. Amer. Soc. Hort. Sci. 80:172-176.
8. Myers, S.C. 1986. Effect of thinning time on the subsequent development of fruit, shoots, and flower buds of peach. HortScience 21:128. (Abstract)
9. Schneider, G.W. 1977. Studies on the mechanism of fruit abscission in apple and peach. J. Amer. Soc. Hort. Sci. 102:179-181.

Time of Thinning. Full bloom was the optimum time for mechanically removing peach blossoms. Flower removal was 15% less at the pink stage and 40% less 30 days after bloom. Based on this and previous work on manual blossom thinning (8,10), mechanical thinning in a commercial orchard could begin as the first blossoms open and should be completed within two to three days after full bloom. This will give the fruit grower a wider, effective thinning period than he has with most chemical thinners.

Tractor Speed. Thinning at 3.2 km•h^{-1} had a tendency to remove more flowers than thinning at 1.6 km•h^{-1} , but the difference was not statistically significant. Crop load, hand thinning time and fruit diameter were not evaluated because, due to the nature of the treatments, the sampling unit was a tree row rather than an individual tree, and an adjoining block had to be utilized.

Oscillation. Oscillating belting plus ropes was not one of the most effective treatments based on measurements made the day of thinning, but following June drop the percentage of remaining flowers was equal to the best treatments. The reason is unclear, and a closer examination of flowers will be needed to determine if partial detachment was occurring. As the thinning strands moved up and down, they also swung back and forth and brushed against more limbs. Average number of oscillations as the strands passed through a tree was three.

Number of Passes Through a Tree. Another factor which can be manipulated to improve thinning response is number of passes through a tree. A major advantage of mechanical blossom thinning is that results are immediately apparent, and if a greater thinning response is desired, the operator can simply drive the thinner through the orchard again. Preliminary tests with our thinning unit quickly indicated that an insufficient number of blossoms were removed with just one trip through a tree; therefore, the minimum treatment was two passes through a tree. Future studies will focus on modifying the mechanical thinner to decrease number of trips through the orchard. Most fruit growers would probably like to have the option of conducting total thinning with two trips through the orchard or doing only partial bloom thinning with one trip.

Four passes through a tree were better than two passes in the majority of the evaluations which were conducted. Eight passes most consistently gave the highest thinning responses. This treatment along with the oscillating treatment increased the average fruit size to 5.7 cm. Increases in fruit size were not as pronounced as in previously reported bloom studies (2,7). This was possibly a result of periodical cicada damage early in the season and dry weather prior to harvest. By simulating the effect of increased numbers of passes through a tree, it is anticipated

10. Weinberger, J.H. 1941. Studies on time of peach thinning from blossoming to maturity. Proc. Amer. Soc. Hort. Sci. 38:137-140.

11. Zucconi, F. 1978. Peach fruit abscission: the mode of action of thinning agents. Acta Horticulturae 80:245-255.

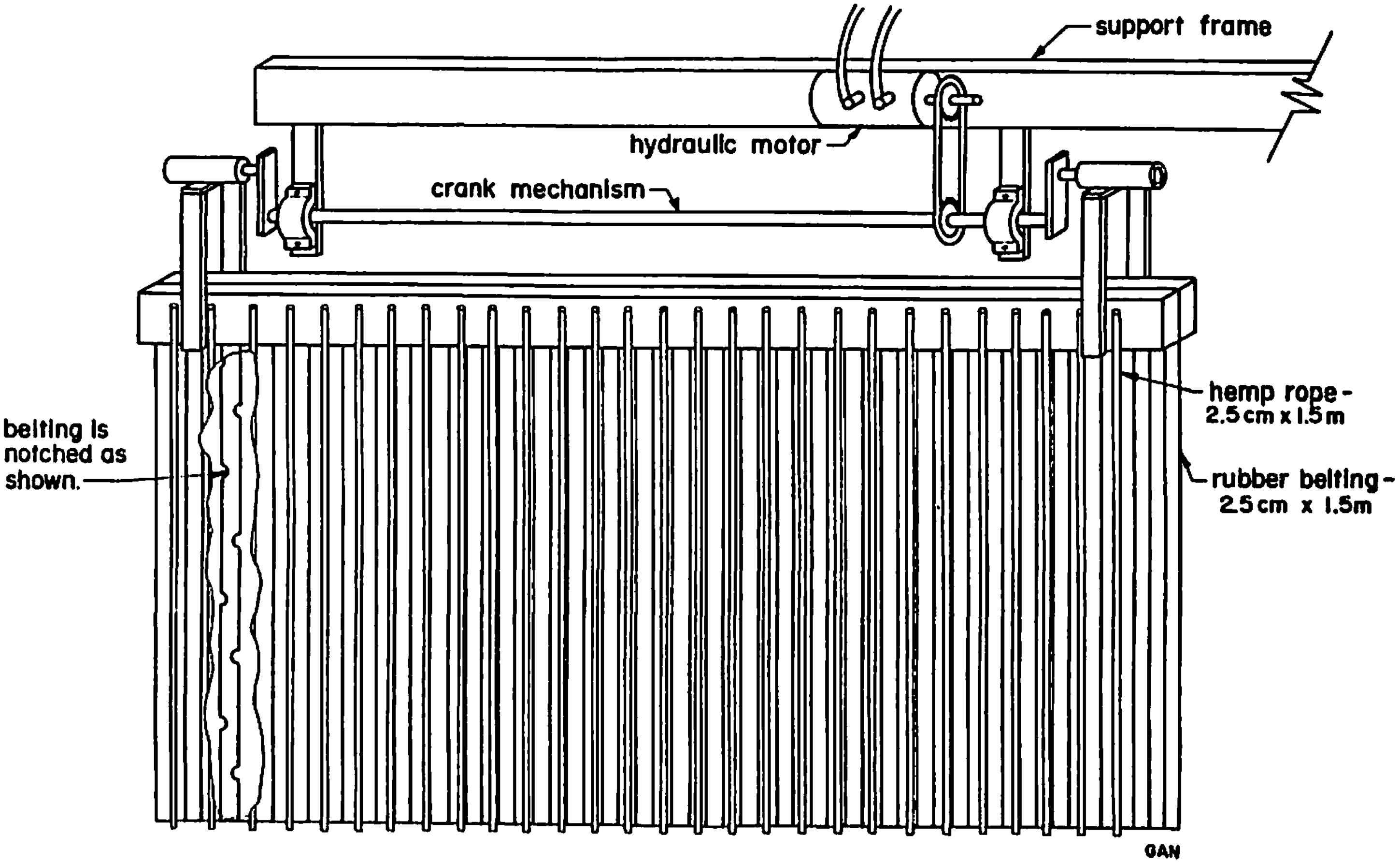


Figure 1. Schematic drawing of test unit used to mechanically bloom thin 'Early Loring' peach.

Table 1. Percentage flower removal in pretest, which was conducted to determine position in tree where optimum mechanical thinning occurred and to select best position for main test measurements.

	Flower removal (%)
Position of limb in tree	
Top	42
Middle	38
Bottom	26
LSD 0.05	13
Orientation of shoot	
Vertical	35
Horizontal	27
LSD 0.05	18
Position of flower on shoot	
Top	35
Underside	32
LSD 0.05	18

Table 2. Comparisons of thinning treatments tested in main experiment (1987).[z]

Treatment	% Flower (fruit) removal[y]	No.fruit·cm^{-2} limb CSA[y,x]	Estimated % crop load[w,v]	Hand thinning time min/tree[v]	Fruit diameter (cm) at harvest[u]
2 Passes,[u] belting and ropes pink	25	23	141	25	5.65
4 Passes, belting and ropes pink	36	17	143	27	5.59
2 Passes, belting and ropes full bloom	35	14	147	22	5.54
4 Passes, belting and ropes full bloom	51	11	137	22	5.66
2 Passes, notched belting full bloom	49	11	138	29	5.65
4 Passes, notched belting full bloom	52	13	138	27	5.65
4 Passes, rope full bloom	54	9	137	24	5.65
4 Passes, oscillating belting & ropes full bloom	45	11	130	20	5.70
8 Passes, belting and ropes full bloom	59	10	132	24	5.68
2 Passes, belting and ropes 30 days after bloom	18	15	148	25	5.55
4 Passes, belting and ropes 30 days after bloom	10	19	148	30	5.52
2 Passes 1.6 km·h^{-1}[t] belting and ropes, full bloom	26	14	-	-	-
2 Passes 3.2 km·h^{-1}[t] belting and ropes, full bloom	38	11	-	-	-
Hand Thinned[s]	-	18	152	28	5.57
LSD 0.05	10	6	8	7	0.11

---

[z] Randomized complete block with 6 whole tree replicates. Follow-up hand thinning was also conducted on mechanical thinning treatments.

[y] Determined on 2 pre-selected limbs per tree, 1.5 to 2.0 m height. Blossoms (fruit) counted day of thinning (Pink - April 10, Bloom - April 15, Post-bloom - May 14) for % removal and after physiological drop (June 5) for no. fruit·cm^{-2} area.

[x] Average crop load following hand thinning in controls was 4 fruit·cm^{-2} CSA.

[w] Full crop is 100%.

[v] Determined on June 8.

[u] Determined on 10 fruit/tree with a vernier caliper, on July 29.

[t] To maintain tractor travel speed, these treatments were on consecutive trees in the same row.

[s] Conducted on June 8.

A TRUNK IMPACTOR FOR HARVESTING APPLES FROM THE LINCOLN CANOPY

by

R.G. Diener, K.C. Elliott, S.H. Blizzard
P.E. Nesselroad, S. Singha, M. Ingle[1]

INTRODUCTION

The Lincoln Canopy and multiple tier trellises as established at the WVU Kearneysville Experiment farm have proven very adaptable to mechanical harvesting. An experimental, self propelled harvester has been developed at West Virginia University to harvest this trellis system. The harvester used an under-wire impactor to remove the fruit which was caught on a bucket conveyer. This conveyor also served as an automatic bin filler.

However, in the last two years the removal efficiency of the under-wire impactor has been steadily reduced due to the growth and interlocking of the laterals on the 10 wire system. As a result a new removal system described below, was built and tested this year.

THE TRUNK IMPACTOR

The trunk impactor used for the 1987 season (Figure 1) was based on a Cornell University design (Throop et al 1983). The impactor consisted of a 100 mm pipe barrel containing a spring compression assembly in the rear and an impactor tube and tree pad assembly at the front. The two assemblies made contact at the interface surface shown in Figure 1. When in use, the impactor was first preloaded by pressing the tree pad against the tree. Next the compression spring was retracted by an eccentric arm attached to a hydraulic motor located at the rear of the impactor. This was done by means of a roller on the end of the eccentric arm which engaged a yoke on the compression spring. As the roller left the yoke lip the spring was released and the tree was impacted.

---

[1] Professor Agricultural Engineering, Associate Professor Agricultural Engineering, Professor of Horticulture, Professor of Agricultural Economics, Professor of Horticulture, and Professor of Horticulture, respectively; College of Agriculture and Forestry, WVU, Morgantown, WV 26506.

A Type-P Charlynn hydraulic motor with 226 N-m of torque was used to drive the impactor. The crank eccentric arm was 45 cm which gave a spring compression distance of about 9 cm. A 20 cm Carrera compression spring was used having a 14 cm wire diameter and a compression constant of about 105N/mm This resulted in a peak recoil force of about 9450 N (2125 lbf).

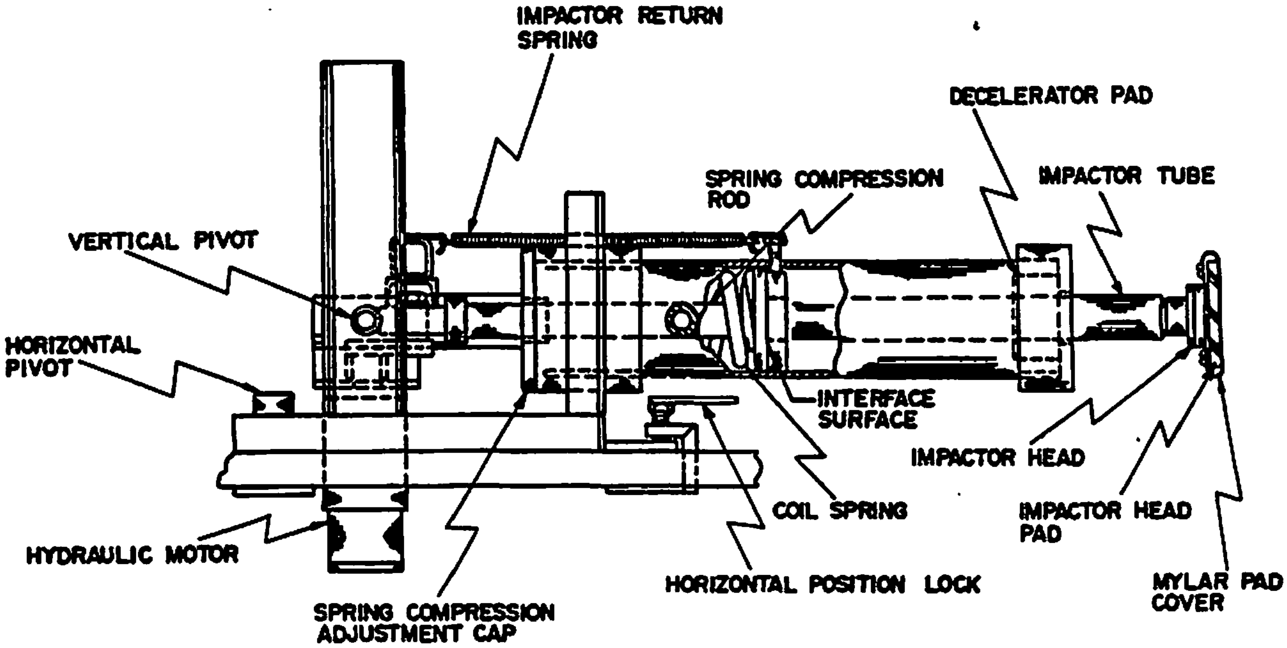


Figure 1. Trunk Impactor.

RESULTS

Preliminary tests with the Cornell trunk impactor in 1987 indicated truly excellent removal potential. The impactor was mounted on a small tractor which could position the impactor against the trunk about 30 cm below the wires (Figure 2). About 50 kg of preload were applied before releasing the spring to allow for "following through" (Throop 1987). Fruit removal was complete for the entire tree using four or less impact cycles. Fruit fall was immediate and straight down. This lack of fruit interaction should result in very low bruise levels. Fruit was removed from both sides of the tree which will require simultaneous fruit collection from the entire tree. Fruit was also removed from the center of the trellis which was not possible with the under-wire impactor.

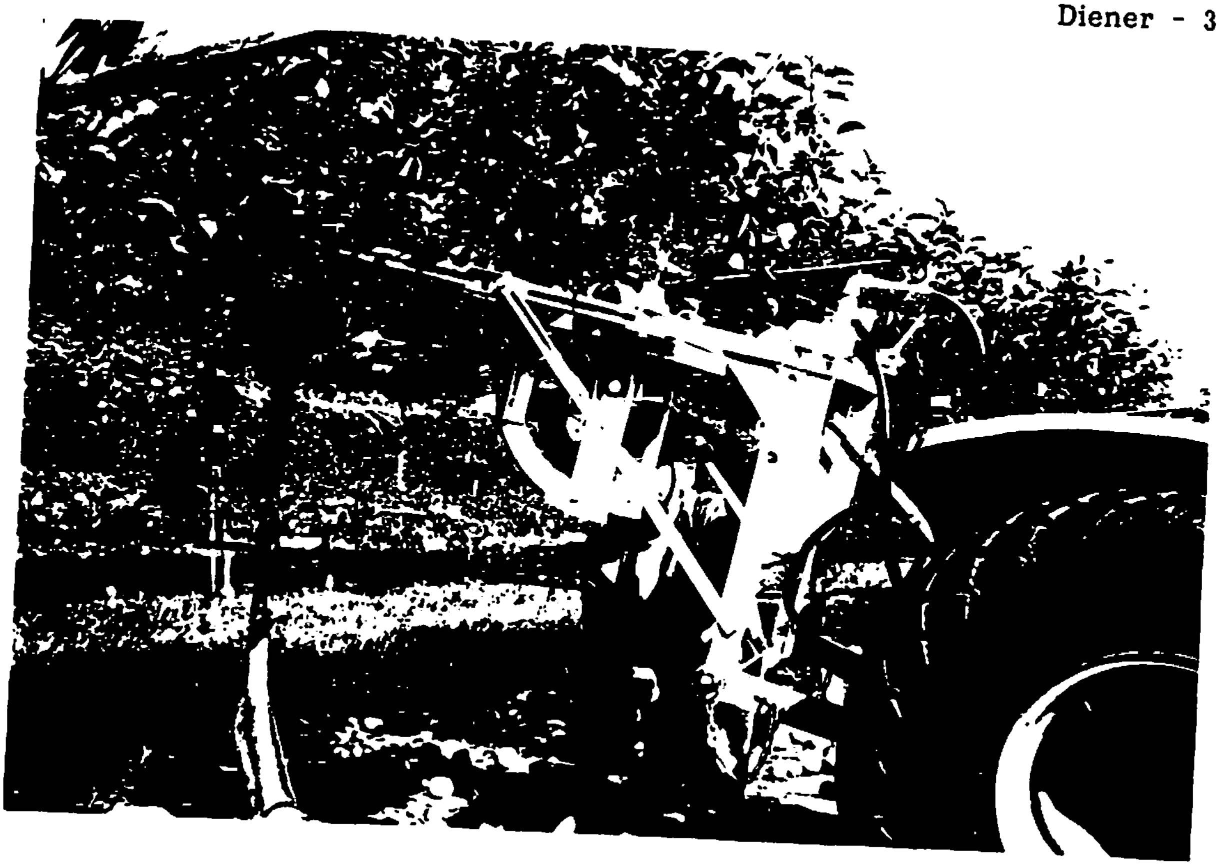


Figure 2. Impactor Positioned Against a Golden Delicious Tree Trained on the Lincoln Canopy

REFERENCES

Throop, J.A., Millier, W.F. and Rehkugler, G.E. "Progress of Work and Principal Accomplishments for Cornell University". Agricultural Experiment Station, Hatch # 414.
1983

Throop, R.S. Personal Correspondence.
1987

Alar Replacement Update

Edward Durner and Thomas Gianfagna

Rutgers Fruit Research Center
RD 2 Box 38
Cream Ridge, NJ 08514

Introduction.

At these meetings last year we presented a report on our attempt to find a suitable substitute for Alar that might increase red color, decrease ethylene and CO_2 production, increase fruit firmness or delay preharvest fruit abscission. We did not find any substitute. This study represents our continued effort to find an Alar replacement.

Materials & Methods.

Six year old trees of 'Empire' and 'Spur Red Delicious' on M7A trained to a modified central leader at Rutgers Fruit Research Center, Cream Ridge, NJ, were treated as follows: a.) control (water), b.) Alar (1 lb per 100 gal water, 25 August), c.) Promalin (1 pt per 100 gal, 14 September), d.) PPG-1721 (100 ppm, 14 September), e.) Promalin (15 Sept.) + Alar (25 August), f.) Promalin + PPG-1721 (15 September), g.) Silver thiosulfate (15 September) and h.) silver thiosulfate + promalin (15 September). Trees were arranged in a RCB design, and treated individually to runoff. Beginning September 15 and continuing at approximately four day intervals thereafter, fruit drop was recorded. At harvest, anthocyanin was determined spectrophotometrically. Ethylene and CO_2 evolution for individual apples was determined with gas chromatography. Fruit firmness was also measured. 'Red Delicious' were harvested on 7 October and 'Empire' on 21 October. All data were analyzed by ANOVA.

Results

No treatment effect was revealed for either cultivar for fruit firmness and anthocyanin production. Fruit abscission is presented in Figure 1. Alar or Promalin + Alar consistently decreased pre-harvest drop while PPG 1721 tended to increase it compared to other treatments or the control. Alar or Promalin + Alar reduced post harvest ethylene and CO_2 evolution in both cultivars compared to the control (Figure 2.). No other treatment was effective.

Conclusion.

No suitable substitute for 'Alar' has been found to date.

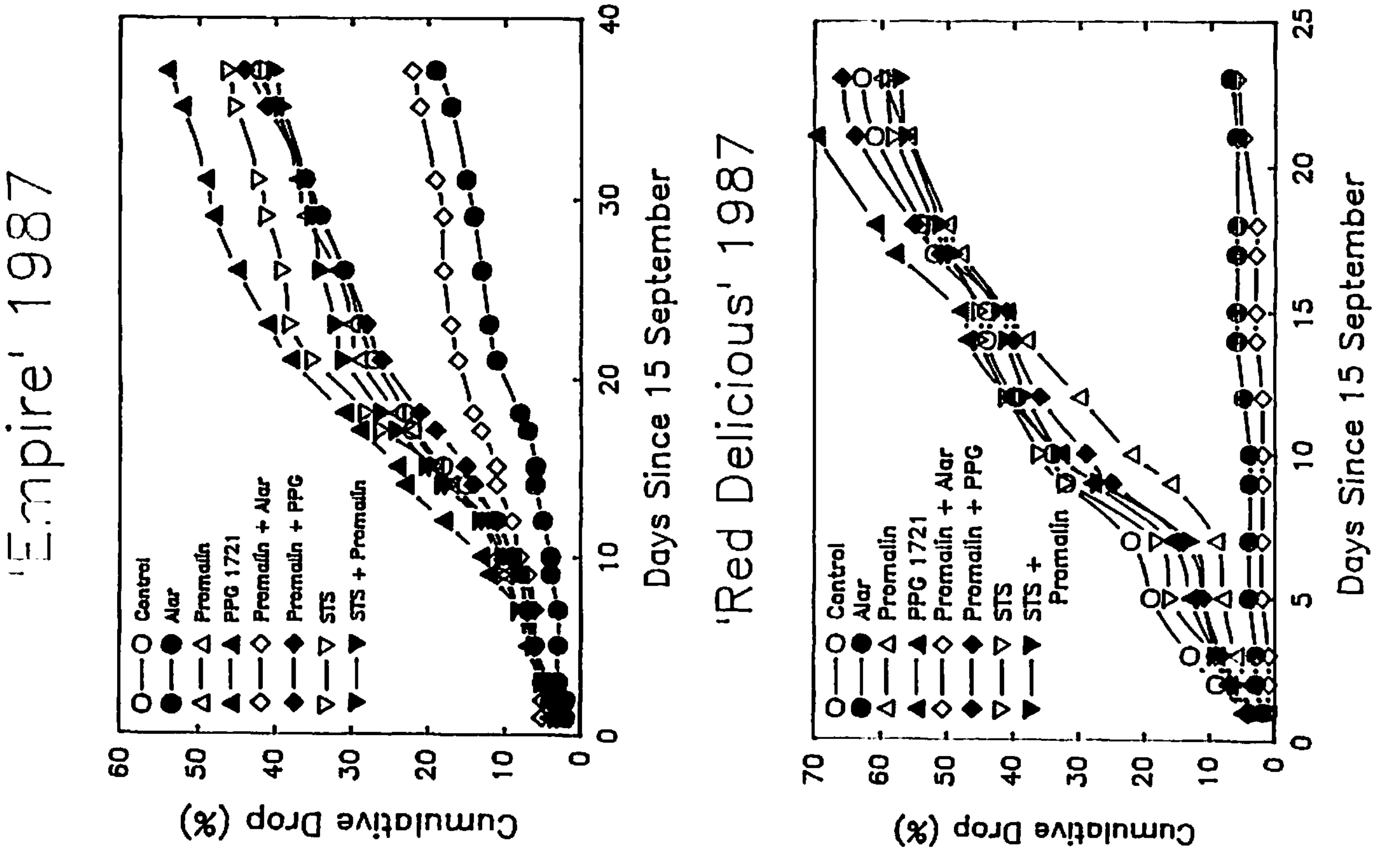


Figure 1. Cumulative pre-harvest fruit abscission for 'Empire' and 'Red Delicious' apples following treatment with PGR's.

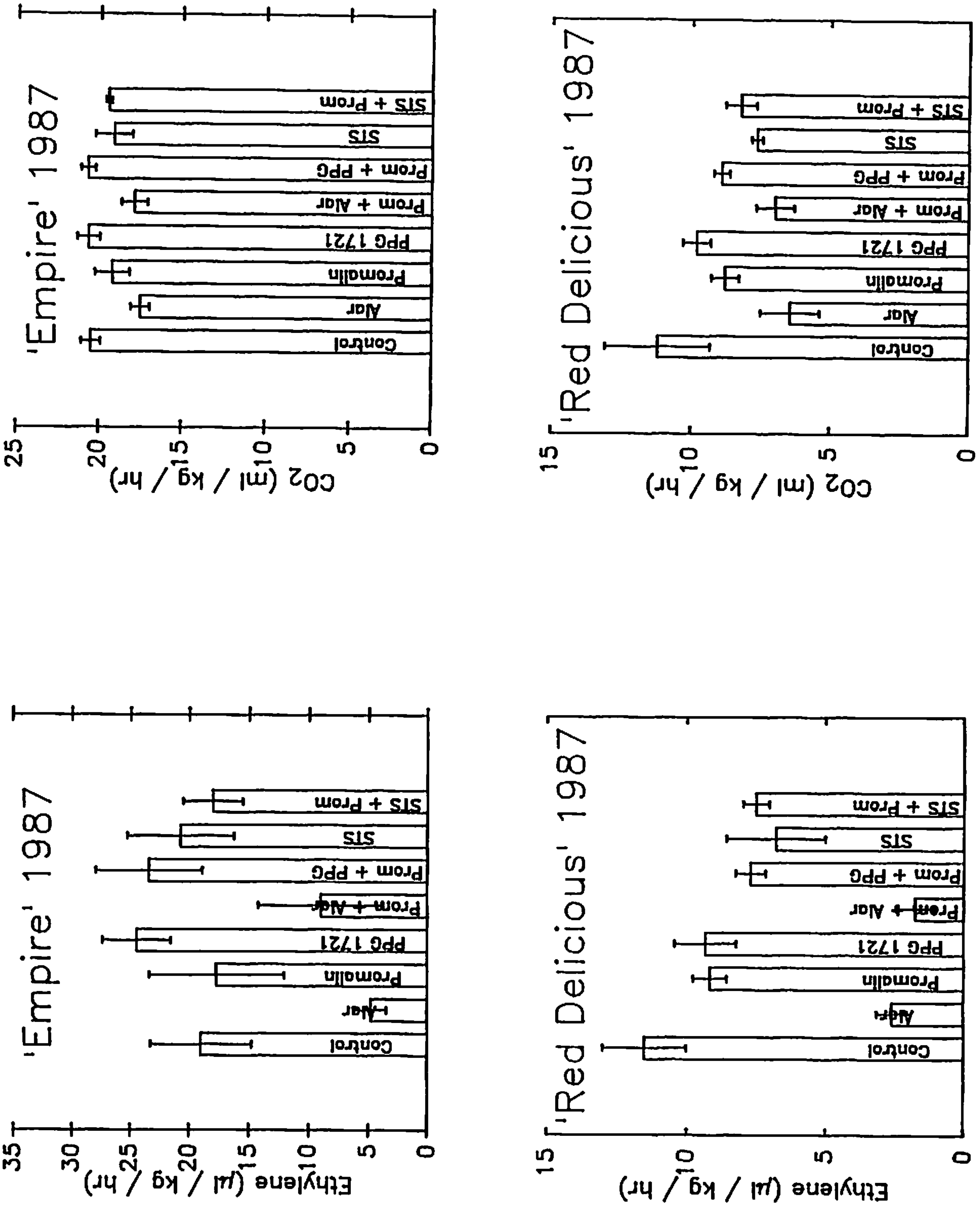


Figure 2. Post harvest ethylene and CO_2 production for 'Empire' and 'Red Delicious' apples treated with PGR's. Bars are standard errors.

Flower Bud and Wood Hardiness of 'Redhaven' Peach on Different Rootstocks

Edward F. Durner

Rutgers Fruit Research Center
RD 2 Box 38
Cream Ridge NJ 08514

Introduction.

A major problem preventing consistent cropping of peaches in the eastern US is insufficient resistance of flower buds to low temperature stress during late winter. Through selection of appropriate rootstocks, additional hardiness qualities may be imparted to the scion. This report examines the hardiness of 'Redhaven' on several rootstocks.

Materials and Methods

Fourth leaf 'Redhaven' peach (<u>Prunus</u> <u>persica</u> (L.) Batsch.) on it's own roots or budded to seven rootstocks (Bailey, GF 655.2, GF 677, Siberian C, Lovell, Halford, and Damas GF 1869) in a RCB design, at Rutgers Fruit Research Center, Cream Ridge, were used in this study. On 28 January 1987, the orchard temperature went below -23°C (thermograph limit) for 4 hours.

On 12 February 1987, unbranched terminal shoots 30 cm +-5 cm were sampled from the northeast, northwest, southwest and southeast sides of the periphery of three trees per rootstock at 3 within tree heights (0.5, 1.0 and 1.5 m) for each compass direction. Bud viability was determined by dissection. Data were analyzed using a split plot model, with rootstock as main plot, with compass direction and height within the canopy as a factorial sub-plot. Total live buds and percentage live buds were analyzed using an ANOVA. Rootstock main effect means were separated with the Ryan-Einot-Gabriel-Welsch multiple F test.

On 9 April 1987, blossoms were counted on 30 cm twigs at three within tree heights (0.5, 1.0 and 1.5 m). Data were analyzed as previously described. Fruit was harvested from 24 July through 5 August 1987 and yield analyzed by ANOVA.

Wood hardiness was determined on 3 test dates (7, 24 Jan and 4 March 1987) for scion wood from six of the rootstocks and self-rooted trees. Two cm sections of nodal tissue with flower buds attached were frozen at the rate of 10 C / hr, and removed at -10, -15, -20, -25 and -30 C. A non-stressed control sample was also taken. Samples were allowed to thaw slowly to room temperature (21 C), flower buds removed and woody tissue transferred to test tubes with 10 ml HPLC grade water. Samples were held at 21 C for 24 hrs and conductivity of the leachate measured. Samples were autoclaved at 120 C, 15 lbs pressure for 20 minutes, incubated for 24 hours and conductivity remeasured. Wood hardiness, (1 - (C1 / C2) where C1 = post stress conductivity and C2 = conductivity after autoclaving) was determined. Data were analyzed for each date and stion by regressing wood hardiness on stress temperature considering linear and quadratic components. Homogeneity of regression coefficients was tested within date to determine differences among stions.

Results

No significant compass direction main effect or interaction of compass direction with rootstock or sampling height portion was detected for live or % live flower buds.

Rootstock by sampling height means are presented in Table 1. The number of live flower buds per terminal shoot was not affected by rootstock at the 0.5 or 1.5 M sampling height. At a sampling height of 1.0 M, fewer live flower buds were found on GF 655.2 compared to all other rootstocks except GF 677. GF 655.2 and GF 677 did not differ from each other. Fewer live buds were found at lower sampling heights.

The proportion of flower buds living after a freezing stress gives a better indication of rootstock influence on hardiness than does the absolute number of living flower buds. No significant rootstock influence on hardiness was detected at the 0.5 or 1.5 M sampling height. At the 1.0 M sampling height, trees on Siberian C were significantly hardier than those on Bailey, GF 655.2, GF 677, Lovell, Halford and Damas GF 1869 (Table 1). Self-rooted trees were not different than Siberian C. GF 655.2 was significantly less hardy compared to all other stocks except Bailey.

Blossom counts at 0.5 and 1.5 M height indicated no significant influence of rootstock (Table 1). Counts at 1.0 M indicated that GF 677 had fewer blossoms compared to Siberian C, self-rooted, Lovell and Damas GF 1869. Blossom counts were consistent with live bud counts at 0.5 and 1.0 M height, however, live bud counts at 1.5 M tended to be greater than blossom counts, indicating that additional bud death occurred between February and April.

Rootstock did not significantly influence marketable yield (Table 1).

Rootstocks were categorized in terms of their influence on scion hardiness for each of the three test dates. On 7 January, two groups were detected; hardy, which included 'GF 677', 'Halford' and 'Lovell' and less hardy, which included 'Bailey', 'Damas GF 1869', 'GF 655.2' and self-rooted trees. By the end of January differences among rootstocks was not as apparent. By March, 'Bailey' was very hardy under lower stress (0 to -20 C) compared to the other rootstocks, but was more tender under higher stress (-20 to -30).

Conclusions

'Lovell' seems to be a superior rootstock for 'Redhaven' under New Jersey conditions, based on one years data. It is moderately vigorous, has good hardiness, blooms slightly later than most rootstocks and had excellent yield. In addition, self-rooted trees are neither superior nor inferior to other rootstocks tested.

Table 1. Mean number of live flower buds per average terminal shoot, percentage live flower buds per shoot, live blossoms, and mean yield for 'Redhaven' peach on its own roots or budded to 7 rootstocks.

Live Buds

Rootstock	Sampling Height Within Tree (M) 0.5		1.0		1.5	
Bailey	1.5	A[z]	7.3	A	12.3	A
GF 655-2	0.5	A	3.0	B	12.3	A
GF 677	3.2	A	5.5	AB	12.0	A
Siberian C	1.5	A	8.8	A	12.6	A
Self-rooted	1.2	A	8.0	A	11.3	A
Lovell	1.5	A	8.0	A	14.8	A
Halford	0.6	A	7.5	A	13.7	A
Damas 1869	2.3	A	6.4	A	14.5	A

Percent Live

Rootstock	Sampling Height Within Tree (M) 0.5		1.0		1.5	
Bailey	9.3	A	26.2	BC	60.5	A
GF 655-2	3.9	A	15.2	C	61.8	A
GF 677	16.1	A	27.4	B	68.9	A
Siberian C	7.1	A	44.7	A	67.4	A
Self-rooted	6.9	A	34.3	AB	65.4	A
Lovell	7.8	A	31.6	B	53.9	A
Halford	2.8	A	31.3	B	65.3	A
Damas 1869	10.7	A	28.0	B	57.5	A

[z] Mean separation within column by REGWF Multiple F Test at the 0.071 level for live, and 0.067 for percent live.

Live Blossoms

Rootstock	Sampling Height Within Tree (M) 0.5		1.0		1.5	
Bailey	1.6	A[z]	5.7	AB	8.2	A
GF 655-2	1.1	A	5.1	AB	7.2	A
GF 677	1.3	A	3.1	B	7.0	A
Siberian C	0.9	A	7.6	A	7.4	A
Self-rooted	0.7	A	7.2	A	9.7	A
Lovell	0.8	A	7.5	A	8.4	A
Halford	0.7	A	5.4	AB	7.5	A
Damas 1869	1.5	A	7.3	A	7.4	A

[z] Mean separation within column by REGWF Multiple F Test at the 0.05 level.

Rootstock	Mean Yield Per Tree (kg)
Bailey	22.0[z]
GF 655-2	18.2
GF 677	15.8
Siberian C	24.2
Self-rooted	24.7
Lovell	25.4
Halford	17.2
Damas 1869	16.0

[z] Rootstocks not significantly different.

West Virginia University
Division of Resource Management
Agricultural Sciences Annex
Morgantown, WV 26506

Elliott -1
Preliminary Report

UNDER TREE ROLLER TYPE SHIELDED HERBICIDE APPLICATOR

K.C. Elliott, T. A. Baugher, S.H. Blizzard

Trellis tree systems are generally structured close to the ground and then trained upward until the allotted space is filled with a productive scaffold. With each system, a different set of production problems develop which have to have a reasonable solution or alternative solutions if that trellis system is going to become commercially profitable. One such problem, common to most trellis systems, is under the tree weed control. Because of the low hanging branches, a conventional herbicide sprayer can only be used with difficulty after the first early application of a herbicide material.

Under development and test at Kearneysville is a shielded roller type herbicide applicator. The unit is eight inches high with a curved shield to go under the branches as the herbicide material is rolled on to the vegetation. The four and one-half inch diameter roller can be covered with a layer of indoor/outdoor carpet. A 110 degree wide (Tee Jet XR 110015) at 20 psi was selected, to spray the herbicide onto the roller. The nozzle, at the low pressure, should reduce misting. The nozzle check value will control after shut-off drip, and the shielding along the tree side of the applicator should prevent contacting the trunk.

The first application test was made August 12, 1987 using Round-up, two tractor speeds, two spray pressures and a carpet vs. no carpet covered roll.

The range of the variables were:

Tractor Speed		Spray Pressure	Roller
Gear	mph	( ) flow	
2	.50	20 (.11 gpm)	covered
3	.74		
4	1.04	40 (.15 gpm)	uncovered

The preliminary test gave twelve combinations for later observations of applicator performance. The test was the initial trial of the applicator. No attempt was made to replicate or determine weed counts alive or dead.

The spray rate (per acre applied) was:

$$GpA = \frac{495\ F}{SW}$$

Where GpA = Gallons per acre applied
F = pump (nozzle) flow in gal/min
S = speed in miles/hour
W = width in feet
495 = constant

example (1) $= \frac{495}{.5} \times \frac{.11}{2.5}$

$= 43.46$ gal per acre

Test	GPA (rounded off)
1	44
2	29
3	20
4	59
5	46
6	28

The tank mix was based on 2 nd gear and 20 psi (.74 and .11) and a round up rate of 1.5 quarts per acre. All tests were run with the same tank mix. We used a slower and faster speed and doubled the pressure to see what would happen. After the first six tests were run the roller cover was removed and the same six tests repeated.

Results: No appreciable differences were observed.

Future: Full scale tests will be conducted in the year 1988.

Comments: Researchers at Purdue University used a roller to apply herbicide in a forestry cut-over woodlot, with considerable success. They however did have difficulty with keeping a cover on the roller. Other researchers (Rogers et. al. ASEA Vol. 66, Number 11, November 1985) used a shield to control wind effect on a sprayer or used a "Covered Wagon" to spray herbicide in strawberry production.

It appears that this system can be used in a width need for many herbicide applications and to keep the material under cover.

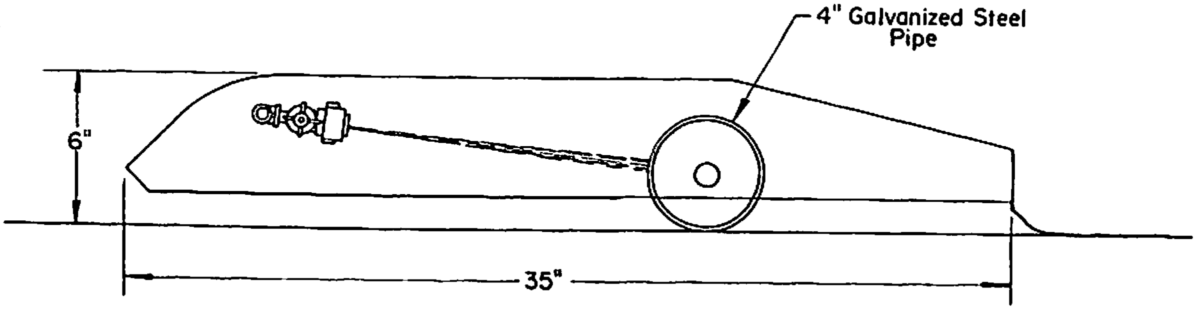


Figure 1. Cross section of the Roller Herbicide Applicator.

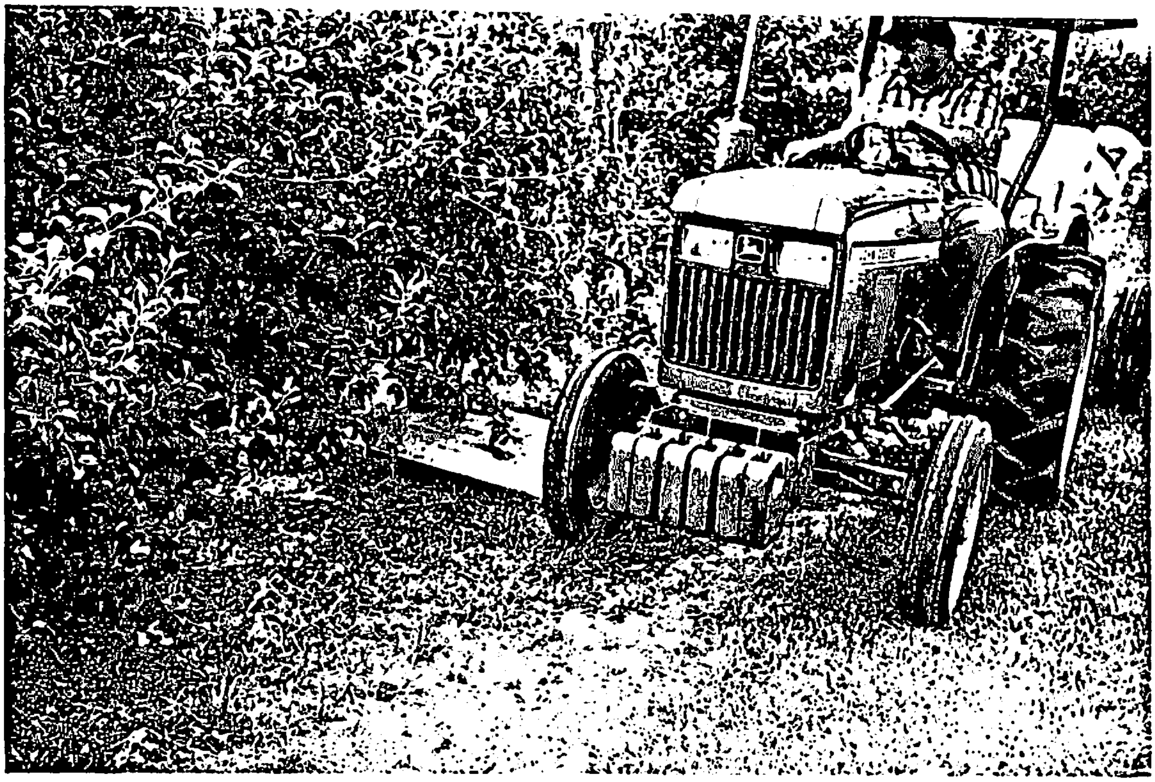


Figure 2. Roller Herbicide Applicator in the European three-wire trellis.

Evaluation of Herbicides for Control of Bermudagrass

C. L. Foy and H. L. Witt
Department of Plant Pathology, Physiology and Weed Science
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

Introduction

Bermudagrass (Cynodon dactylon Pers.), still sometimes referred to as wiregrass, is a pernicious perennial weed which spreads by both rhizomes and stolons. It occurs as a weed in numerous situations, including deciduous orchards, and is most troublesome on coarse-textured soils.

Some of the traditional approaches used to control bermudagrass, e.g. plowing to expose to freezing and desiccation in noncrop situations, and seeding cover crops in crop rotations are not entirely applicable, or have limitations, for use in Virginia orchards. Thus, recent emphasis has been placed on the use of herbicides.

Most of the preemergence herbicides recommended for orchard weed control in Virginia provide little or no control of bermudagrass; therefore, applications of postemergence herbicides are required. The purpose of this study was to evaluate the effectiveness of three postemergence herbicides currently recommended (glyphosate, fluazifop, and paraquat) and some promising, nonregistered compounds for the control of bermudagrass.

Materials and Methods

'Midiron' bermudagrass sod (6 x 6 inches) was planted in plastic pots 10 inches in diameter filled with Spasoff's potting mix. The bermudagrass had been mowed to a height of 2 inches prior to cutting the sod, which was placed in the pots with the maximum height of the grass even with the rim of the pot. Sulfosate (SC-0224), glyphosate (Roundup), imazapyr (Arsenal), glufosinate (Ignite), paraquat (Ortho Paraquat Plus) + Ortho X-77 at 0.125% (v/v), and fluazifop (Fusilade) + BASF Crop Oil Concentrate at 1% (v/v) were applied in 30 gallons of water per acre using a CO_2-charged hand sprayer equipped with a single 8004E nozzle and delivering 30 psi pressure.

The bermudagrass was 4 to 6 inches tall with runners extending 12 to 18 inches beyond the rim of the pots when treatments were applied, and was clipped even with the rim of the pots (approximately 2 inches above the soil level) at 0, 1, 2, 3 or 7 days following treatment. Bermudagrass clipped at 0 days after treatment was clipped approximately 5 min after treatment. Pots were watered individually and no water (including rainfall, dew) was allowed to contact the foliage of the bermudagrass in any pots until seven days after treatment (final clipping date).

Estimates of the percent top kill of bermudagrass (prior to clipping) were made 3 and 7 days after treatment. Bermudagrass control ratings were made 7, 14, and 28 days after treatment and plant measurements were recorded 14 and 28 days after treatment.

Results

Paraquat and glufosinate provided the best top kill of bermudagrass (not clipped) three days following treatment (Table 1). Slight yellowing occurred with sulfosate and glyphosate while bermudagrass treated with imazapyr and fluazifop showed little to no herbicide effect. In pots where bermudagrass was clipped immediately after treatment, 30 to 40% green regrowth occurred in pots treated with paraquat after three days. Only slight regrowth occurred with glufosinate, and bermudagrass treated with sulfosate, glyphosate, imazapyr, or fluazifop was green with no regrowth.

Glufosinate provided the best top kill of bermudagrass (87 to 95%) while paraquat, the next best treatment, provided only 65% top kill seven days after treatment (just prior to clipping (Table 2). Sulfosate and glyphosate were about equally effective, but provided 45% or less top kill. Fluazifop at 0.5 lb/A was comparable to sulfosate and glyphosate at 2.5 lb a.i./A. Imazapyr was ineffective at that time.

Evaluations 28 days after treatment revealed that all herbicides except paraquat provided some control of bermudagrass clipped immediately after treatment. Regrowth of bermudagrass occurred with all treatments except fluazifop. Regrowth was significantly less with all treatments except paraquat and glufosinate (2.5 lb a.i./A) than regrowth in the untreated checks.

Clipping bermudagrass 1 day after treatment resulted in excellent control with glufosinate at 3.75 and 5.0 lb a.i./A. Fair to good control was achieved with other treatments except paraquat. Good to excellent control was achieved with all treatments except paraquat when bermudagrass was clipped 2 to 7 days after treatment.

Conclusion

Of the herbicides currently recommended for orchard weed control, glyphosate (at higher rates and/or with delayed clipping of bermudagrass) and fluazifop were very effective in controlling bermudagrass while paraquat, the faster acting herbicide, provided 33% or less control at the final evaluation 28 days after treatment. Results with sulfosate were very similar to those with glyphosate. Glufosinate, which was slightly slower acting than paraquat, provided excellent control at the rates tested when clipping was delayed from 1 to 7 days. Imazapyr was the slowest acting and control was best when clipping was delayed 2 to 7 days.

Table 1. Effect of herbicides on top kill of bermudagrass. Data are averages of 3 replications.[a]

Treatment	Rate	Time after treatment 3 days
	(lb a.i./A)	(% top kill)
Sulfosate	2.5	2 e
Sulfosate	3.75	6 cd
Sulfosate	5.0	8 c
Glyphosate	2.5	2 e
Glyphosate	3.75	5 d
Glyphosate	5.0	7 cd
Imazapyr	1.5	0
Glufosinate	2.5	60 b
Glufosinate	3.75	60 b
Glufosinate	5.0	60 b
Paraquat	1.0	82 a
Fluazifop	0.5	1 e
Untreated	---	0

[a] Means followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range test.

Table 2. Effect of herbicides on bermudagrass clipped at various intervals after treatment. Data are averages of 3 replications.[a]

			Time after treatment				
			7 days	14 days		28 days	
Treatment	Rate	Clipping interval	Bermudagrass control	Bermudagrass control	Plant[b] height	Bermudagrass control	Plant[b] height
	(lb a.i./A)	(days after treatment)	----------- (%) ----------		(cm)	(%) (%)	(cm) (cm)
Sulfosate	2.5	0	38 d	43 e	3.3 bc	38 d	6.8 cd
Sulfosate	3.75	0	43 cd	57 cd	2.8 b-d	48 b-d	6.7 cd
Sulfosate	5.0	0	48 bc	65 b-d	2.0 cd	68 ab	3.7 de
Glyphosate	2.5	0	40 d	42 e	3.2 bc	45 cd	6.4 cd
Glyphosate	3.75	0	42 cd	58 cd	2.3 cd	65 a-c	4.0 de
Glyphosate	5.0	0	48 bc	70 bc	1.2 de	75 a	2.2 ef
Imazapyr	1.5	0	40 d	52 de	2.0 cd	60 a-c	2.0 ef
Glufosinate	2.5	0	89 a	75 ab	4.3 b	32 d	10.5 ab
Glufosinate	3.75	0	94 a	87 a	2.0 cd	62 a-c	6.8 cd
Glufosinate	5.0	0	95 a	84 a	2.8 b-d	52 b-d	8.9 bc
Paraquat	1.0	0	27 e	17 f	9.3 a	0 e	13.5 a
Fluazifop	0.5	0	52 b	60 cd	0 e	80 a	0 f
Untreated	---	0	0 f	0 g	7.7 a	0 e	11.2 ab

[a] Means followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range test.

[b] Average height of regrowth above rim of pot.

Table 2. Continued.[a]

			Time after treatment				
			7 days	14 days		28 days	
Treatment	Rate	Clipping interval	Bermudagrass control	Bermudagrass control	Plant[b] height	Bermudagrass control	Plant[b] height
	(lb a.i./A)	(days after treatment)	(%)	(%)	(cm)	(%)	(cm)
Sulfosate	2.5	1	42 d	62 e	1.0	73 ef	1.2
Sulfosate	3.75	1	50 c	73 c	0.5	85 b-d	0.3
Sulfosate	5.0	1	52 c	73 c	0.5	87 b-d	0.3
Glyphosate	2.5	1	52 c	62 e	0.3	71 f	1.6
Glyphosate	3.75	1	50 c	68 cd	0	78 d-f	0.3
Glyphosate	5.0	1	52 c	80 b	0	93 a-c	0
Imazapyr	1.5	1	42 d	55 f	0.8	68 f	1.2
Glufosinate	2.5	1	89 a	100 a	0	86 b-d	2.4
Glufosinate	3.75	1	99 a	100 a	0.5	96 ab	1.8
Glufosinate	5.0	1	99 a	100 a	0	99 a	1.3
Paraquat	1.0	1	60 b	45 g	6.7	23 g	11.0
Fluazifop	0.5	1	53 c	65 de	0	83 c-e	0
Untreated	---	1	0 e	0 h	8.0	0 h	11.3

[a] Means followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range test.

[b] Average height of regrowth above rim of pot.

Table 2. Continued.[a]

			Time after treatment				
			7 days	14 days		28 days	
Treatment	Rate	Clipping interval	Bermudagrass control	Bermudagrass control	Plant[b] height	Bermudagrass control	Plant[b] height
	(lb a.i./A)	(days after treatment)	(%)	(%)	(cm)	(%)	(cm)
Sulfosate	2.5	2	48 c	72 de	0	86 d-g	0
Sulfosate	3.75	2	53 bc	78 bc	0	92 bc	0
Sulfosate	5.0	2	53 bc	82 b	0	94 ab	0
Glyphosate	2.5	2	50 c	68 e	0	81 g	0
Glyphosate	3.75	2	50 c	72 de	0	84 e-g	0
Glyphosate	5.0	2	48 c	75 cd	0	88 b-e	0
Imazapyr	1.5	2	45 c	62 f	0.6	82 fg	0.8
Glufosinate	2.5	2	98 a	100 a	0	91 b-d	1.9
Glufosinate	3.75	2	98 a	100 a	0	99 a	1.2
Glufosinate	5.0	2	99 a	100 a	0	100 a	0.7
Paraquat	1.0	2	60 b	55 g	4.3	33 h	9.0
Fluazifop	0.5	2	58 b	72 de	0	88 c-f	1.2
Untreated	---	2	0 d	0 h	7.5	0 i	11.0

[a] Means followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range test.

[b] Average height of regrowth above rim of pot.

Table 2. Continued.[a]

			Time after treatment				
			7 days	14 days		28 days	
Treatment	Rate	Clipping interval	Bermudagrass control	Bermudagrass control	Plant[b] height	Bermudagrass control	Plant[b] height
	(lb a.i./A)	(days after treatment)	----------- (%)	----------	(cm)	(%)	(cm)
Sulfosate	2.5	3	53 cd	82 c	0	82 cd	0.5
Sulfosate	3.75	3	53 cd	88 bc	0	88 a-c	0.5
Sulfosate	5.0	3	58 bc	90 b	0	90 a-c	0
Glyphosate	2.5	3	53 cd	82 c	0	89 cd	0.8
Glyphosate	3.75	3	53 cd	87 bc	0	91 bc	0
Glyphosate	5.0	3	62 bc	88 bc	0	95 a-c	0
Imazapyr	1.5	3	47 d	62 e	0	83 d	0.3
Glufosinate	2.5	3	99 a	100 a	0	99 ab	1.0
Glufosinate	3.75	3	99 a	100 a	0	100 a	0.3
Glufosinate	5.0	3	99 a	100 a	0	100 a	0
Paraquat	1.0	3	65 b	50 f	5.0	23 e	12.2
Fluazifop	0.5	3	57 bc	73 d	0	90 b-d	0.5
Untreated	---	3	0 e	0 g	6.7	0 f	10.5

[a] Means followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range test.

[b] Average height of regrowth above rim of pot.

Table 2. Continued.[a]

			Time after treatment				
			7 days	14 days		28 days	
Treatment	Rate	Clipping interval	Top kill of[b] bermudagrass	Bermudagrass control	Plant[c] height	Bermudagrass control	Plant[c] height
	(lb a.i./A)	(days after treatment)	(%)	(%)	(cm)	(%)	(cm)
Sulfosate	2.5	7	30 de	92 bc	0	93 ab	0
Sulfosate	3.75	7	43 c	98 ab	0	99 a	0
Sulfosate	5.0	7	45 c	97 a-c	0	99 a	0
Glyphosate	2.5	7	27 e	91 c	0	95 a	0
Glyphosate	3.75	7	38 cd	95 a-c	0	99 a	0
Glyphosate	5.0	7	43 c	95 a-c	0	98 a	0
Imazapyr	1.5	7	2 f	70 e	0	85 a	0
Glufosinate	2.5	7	87 a	100 a	0	100 a	0.3
Glufosinate	3.75	7	92 a	100 a	0	100 a	0
Glufosinate	5.0	7	95 a	100 a	0	100 a	0.3
Paraquat	1.0	7	65 b	62 f	3.2	32 c	8.3
Fluazifop	0.5	7	22 e	82 d	0	91 ab	0
Untreated	---	7	0 f	0 g	3.3	0 d	8.2

---

[a] Means followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range test.

[b] Just prior to clipping.

[c] Average height of regrowth above rim of pot.

Evaluation of Glufosinate for Orchard Weed Control

C. L. Foy and H. L. Witt
Department of Plant Pathology, Physiology and Weed Science
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

Introduction

Glufosinate (Ignite®) is a new nonselective herbicide for the control of a broad spectrum of broadleaf weeds and grasses. Glufosinate, a product of Hoechst-Roussel Agri-Vet Company, is formulated as an aqueous solution containing 1.67 pounds of active ingredient per gallon and is presently being examined in no-till soybeans and corn, orchards, and vineyards. Use rates in corn and soybeans ranged from 0.5 to 1.0 pounds active ingredient per acre and 1.0 to 2.0 pounds active ingredient per acre are suggested for deciduous fruits.

The purpose of this work was to evaluate glufosinate for "burn-down" of existing weed species and crop tolerance in a young apple orchard. Combinations with residual herbicides for longer lasting control were evaluated as well.

Materials and Methods

An experiment was conducted in 1987 on clayey soil (3.8% organic matter; pH 6.0) at Occanneechi Orchard, Boones Mill, Virginia (Franklin County). Glufosinate was applied alone and in combination with simazine (Princep), terbacil (Sinbar), or diuron (Karmex) in apple trees established in the field for three years. Paraquat (Gramoxone) and glyphosate (Roundup), each applied alone or in combination with simazine, were applied for comparison. All treatments were applied as directed sprays in 28 gallons of water per acre using a CO_2-charged hand sprayer equipped with a boom having two 11003 nozzles and delivering 30 psi pressure. The surfactant Ortho X-77 at 0.125% (v/v) was included in all paraquat sprays.

Individual plots were 6 feet wide by 16 feet long, centered over the tree row, and contained one apple tree. All treatments were replicated four times.

Common chickweed (blooming) was the predominant weed species present at the time of treatment. Other weed species present included mouseear chickweed (blooming), dandelion (blooming), redstem filaree (blooming), fleabanes, wild garlic, mustards (up to 2 feet tall and blooming), henbit (blooming), wild geranium, orchardgrass (15 to 18 inches tall), quackgrass, cheat, curly dock, prickly lettuce, and narrowleaf vetch. Weed species, except mustards and orchardgrass, ranged from 6 to 10 inches in height.

Weed control ratings were recorded 20 days after treatment and estimates of ground covered with broadleaf weeds and grasses were recorded 93 days after treatment.

Results

Weed control ratings and estimates of groundcover are shown in Table 1. Glufosinate was very effective on almost all species contacted. Some species escaped due to poor overlap or lower doses right in the tree row and small, newly germinating broadleaf weeds and grasses were coming in plots twenty days after treatment. Glufosinate applied in combination with simazine, terbacil, or diuron was very effective for "burn-down" plus early-season residual control of annuals and suppression of perennials. Regrowth from perennials and newly germinating weeds occurred in plots treated with paraquat only. Paraquat + simazine was satisfactory and no small annuals were present twenty days after treatment. Glyphosate was similar to glufosinate, but slower kill of weeds occurred (more chlorotic-greenish tissue was present). Untreated check plots contained a wide assortment of weeds including chickweed, Virginia pepperweed and other mustards, fleabanes, asters, curly dock, common milkweed, vetch, wild geranium, quackgrass, dandelion, wild garlic, buckhorn plantain, Pennsylvania smartweed, tall fescue, etc. Partly bare soil occurred around the base of the trees in the untreated check plots due possibly to (a) soil disturbance (weed seeds displaced), (b) high concentrations of NH_4NO_3 fertilizer or (c) related to a massive accumulation of cicadas and insecticides (10 or more sprayings in 1986 to control cicadas).

Large crabgrass was the predominant weed present in most treated plots while mature Virginia pepperweed and other broadleaf weeds were the most common in the untreated check plots 93 days after treatment. Other species present at that time included annual morningglory, wild buckwheat, common ragweed, horseweed, prickly lettuce, Pennsylvania smartweed, spotted spurge, fleabanes, buckhorn plantain, Virginia creeper, bindweeds, horsenettle, dandelion, pokeweed, hemp dogbane, whiteheath aster, sumac, red sorrel, foxtails, tall fescue, nimblewill, purpletop, and orchardgrass. Annual broadleaf weed groundcover was significantly lower in all treated plots than in the untreated check plots. Annual grass groundcover was significantly higher in plots treated with glufosinate alone, paraquat alone, or glyphosate (alone or plus simazine) than in the untreated check plots. Perennial broadleaved weeds and perennial grasses were present in most, plots and groundcover with these species was not significantly reduced with the majority of herbicide treatments.

Glufosinate burned the initial basal sprout growth (if small--killed; larger--only partial) of the apple trees; however, regrowth was green and normal 20 days after treatment. Less acute contact effect occurred with glyphosate, but growth regulator symptoms on new growth were observed later. No symptoms occurred with paraquat. No herbicide injury to the apple trees was observed 93 days after treatment.

Conclusion

Glufosinate and glyphosate, each used alone or in combination with a residual herbicide, were very effective for "burndown" of existing vegetation. Early-season residual control of annual weeds and suppression of perennial weeds was achieved when glufosinate or glyphosate were used in combination with a residual herbicide. Paraquat, alone or plus simazine, was not as effective 20 days after treatment. Fewer annual broadleaf weeds were present in all treated plots than in the untreated check plots 93 days after treatment; however, only glufosinate + terbacil provided satisfactory overall weed control. Although basal sprouts of the apple trees were affected by glufosinate and glyphosate early in the season, no injury to the trees was apparent later in the season.

Table 1. Effect of herbicides on weed control in three-year-old Red Delicious apple trees. Boones Mill, Virginia. Treated April 21, 1987. Data are averages of 4 replications.[a]

		20 days	Groundcover (93 days after treatment)			
			Broadleaf weeds		Grasses	
Treatment	Rate	Weed[b] control	Annual	Perennial	Annual	Perennial
	(lb a.i./A)	(%)				
Glufosinate	1.0	89 b-d	16 bc	7 a-d	54 a	5 ab
Glufosinate	2.0	95 a-c	8 bc	5 b-d	70 a	5 ab
Glufosinate + simazine	1.0 + 3.0	87 c-d	16 bc	9 a-d	21 cd	6 a
Glufosinate + terbacil	1.0 + 3.0	96 ab	2 c	2 cd	14 cd	2 ab
Glufosinate + diuron	1.0 + 3.0	94 a-d	25 bc	13 a-d	25 b-d	1 b
Paraquat	0.5	58 f	17 bc	18 a	50 ab	1 b
Paraquat + simazine	0.5 + 3.0	66 e	15 bc	16 ab	20 cd	4 ab
Glyphosate	1.0	88 b-d	23 bc	3 cd	66 a	2 ab
Glyphosate	2.0	99 a	28 b	1 d	62 a	6 a
Glyphosate + simazine	1.0 + 3.0	86 d	11 bc	10 a-d	43 a-c	3 ab
Untreated	-	7 g	50 a	14 a-cd	9 d	6 a

[a] Means within a column followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range test.

[b] "Burn-down" (0 = all green vegetation and 100 = all brown).

Design and Implementation of a Microprocessor-Driven Overhead Trickle Irrigation System for Evaporative Cooling and Chemical Injection*

Barbara L. Goulart and John F. Gardner
Dept of Horticulture
Rutgers University
Cream Ridge, N.J. 08514

John F. Gardner
Dept. of Mech. Engineering
The Penn. State University
University Park, PA 16802

Introduction

Eastern strawberies enjoy a reputation for excellent flavor, however other quality parameters, such as size and shelf life often limit marketability of the fruit. In Southern New Jersey, hot weather during harvest causes or exacerbates these problems via the buildup of field heat in the berries (resulting in shorter shelf life) and by reduction in water movement through the xylem (resulting in smaller fruit). These limitations are an increasing economic liability to eastern growers as California strawberries, which are large and firm become more prevalent on the Eastern market.

Evaporative cooling provides a means for reducing field heat buildup in the strawberry fruit, while also alleviating plant heat stress. Reduction of fruit field heat and plant heat stress should result in larger berries with better post-harvest longevity.

Currently, evaporative cooling is often employed by growers using existing overhead irrigation systems. Typically, overhead systems with fogging nozzles are turned on and off manually during the hot hours of the afternoon. A microprocessor driven overhead trickle injection system offers the following advantages over current practice:

1. Much less water is delivered, avoiding water-logging and it's consequences of increased disease activity, muddy aisles, etc.,
2. An overhead trickle system may also be employed for frost protection, unlike other trickle systems,
3. Microprocessor control allows precision in timing and the convenience of an automated system.

The objectives of this experiment were

---

*Special thanks to Dr. John K. Springer, Plant pathologist and Dr. Arthur J. Vrecenak, assistant professor, Horticulture, of Rutgers University for their generous contributions to this project. Also acknowledged is the N.J. Small Fruit Council who partially funded this project.

1. To design and implement a microprocessor driven overhead trickle system, and
2. To evaluate the effects of this system on fruit quality.

Materials and methods

In May, 1986, 'Raritan' strawberry plants were established on a sandy loam soil at the Rutgers Vegetable Research Farm in Bridgeton, New Jersey. Thirty foot plots were arranged in a randomized complete block design with rows planted 14 feet apart (to avoid irrigation drift) and plants 12" apart in the rows. Plants were maintained according to standard practices, forming matted rows and using the recommended pesticides.

In March, 1987, irrigation lines were installed. The four treatments were:

1. Control (no irrigation)
2. 16 mm bi-wall irrigation tubing, buried 2" beneath soil surface
3. 16 mm polyethylene irrigation tube with minisprinkler nozzles (model 7102 white, NAAN sprinklers, Cerritos, CA 90701)
4. 16 mm polyethylene irrigation tube with minisprinkler nozzles plus fungicide injection. (Fungicides were Captan, 360g; and Benlate, 120g per 40 gallon bucket. Rates were calculated such that one 40 gallon container equaled one spray at labeled rates of 3 lb Captan and 1 lb Benlate/A).

Pressure regulators maintained pressure between 25-30 psi.

To monitor field temperatures and to control the overhead irrigation, a microprocessor-controlled data logger was installed (Micrologger, model 21XL, Campbell Scientific, Logan, Utah 84321) as shown in Figure 1. The data logger/controller was battery driven and housed in a weather-proof enclosure at the periphery of the plot. Six Type-J (iron-constantan) thermocouples were placed throughout the plot to record field temperatures in both the sprinkler and control treatments. The data logger recorded hourly averages of the temperatures as well as daily maximum and minimum temperatures. This data was later transferred to a personal computer for further reduction.

An additional thermocouple (also Type J) was inserted into a firm-ripe strawberry. The data logger was programed to monitor this temperature such that if the five-minute average of the stawberry temperature exceeds 30° C (85° F), an output signal would be activated. This output signal would then actuate the solenoid valves by means of the relay driver. The relay driver is a device which can accept the low level data signals from the data logger and use them to switch 110 V circuits, such as the irrigation valves. The irrigation system would then remain on for at least five minutes until the data logger took another sample. If, by that time, the temperature had fallen below the threshold of 30° C, the solenoid valves would be deactivated.

Results and Discussion

The data logger worked well as a controller. During the time of the experiment, there were several days during which the field temperature exceeded 30° C. The sprinklers were activated by the data logger and the canopy temperature decreased rapidly. Usually, the data logger would shut off the sprinklers at the next sample time (5 minutes) since the temperature was below the threshold. It should be noted that such an automatic control system as described here may exhibit undesirable behavior if not implemented properly. A system of this type, where the controller is on/off in nature, might tend to cycle rapidly on and off if a suitable "dead band" is not chosen. A household heating system utilizes a dead band so that the furnace will stay on for a specified period of time beyond the time at which the desired temperature is reached. In the case of the irrigation controller, the five-minute sample interval acts effectively as a dead band (actually a dead time). If the data logger was programmed to executed and sample continuously, then the sprinklers would cycle on and off rapidly as the temperature of the controlling thermocouple just exceeds the threshold temperature and is rapidly cooled below it by the cooling effects of the irrigation system. Another solution to the problem would be to program the data logger to turn off the overhead irrigation at a somewhat lower temperature, say 27° C to introduce a dead band effect.

This controller was implemented using a sophisticated data gathering insturment however, a suitable controller could be implemented using less expensive and generally available hardware. A common household thermostat could easily be adapted to perform this function and a personal computer can be equipped with special-purpose cards and software to both monitor temperatures and perform actions accordingly.

In 1987, the system could not be evaluated for its effectiveness in controlling frost damage because no frost occurred.

Temperature was modified on hot days by the minisprinkler system (Figure 2). This modification appears to be biologically significant, since berry size was increased on several picking dates, and average size over the season was larger on minisprinkler treatments as compared to the control (Table 1). The bi-wall treatment plants yielded berries intermediate in size on all harvest dates, indicating that the effects were not due simply to applying water to the roots, but that there was a genuine cooling effect which relieved heat stress. Total yield was not affected by treatment.

Future research

The preliminary data obtained from this experiment indicates that it warrants further research. Several areas within the project need further definition:

1. Minisprinkler comparisons
2. Optimal Droplet size for evaporative cooling
3. Optimal injection rates for fungicides and other chemicals
4. Modeling of heat transfer characteristic of strawberry.
5. Less expensive thermostat based control systems.

Appendix. Budget

Campbell 21xl Micrologger[1]	2000	
Campbell Relay Driver	150	Injection pump
800 Sprinklers (1.20 ea)/a[2]		180
Misc. trickle line, etc./a	200	

Table 1.Evaporative cooling effects on strawberry yield and size.

	18 june		18 june	
treatment	wt(g)	sz(g)	wt(g)	sz(g)
control	1544.1	6.05b	171.8bc	4.22c
bi-wall	1573.8	6.49b	91.3c	5.36abc
microjets	1463.3	7.01ab	503.3a	7.07a
microjets + fungicide	1491.8	7.93a	423.0ab	8.23ab
pr>F	.97	.10	.06	.08

treatment	total yield(g)	average size(g)
control	5325.3	6.05c
bi-wall	6098.6	6.97bc
microjets	6089.3	7.40ab
microjets + fungicide	5264.8	8.14a
pr>F	.49	.03

*yield weight reported in g/10 ft plot.

---

[1] Readily replaced by less expensive instrumentation for non-experimental use.

[2] assuming 150 sprinklers/a

Figure 1.

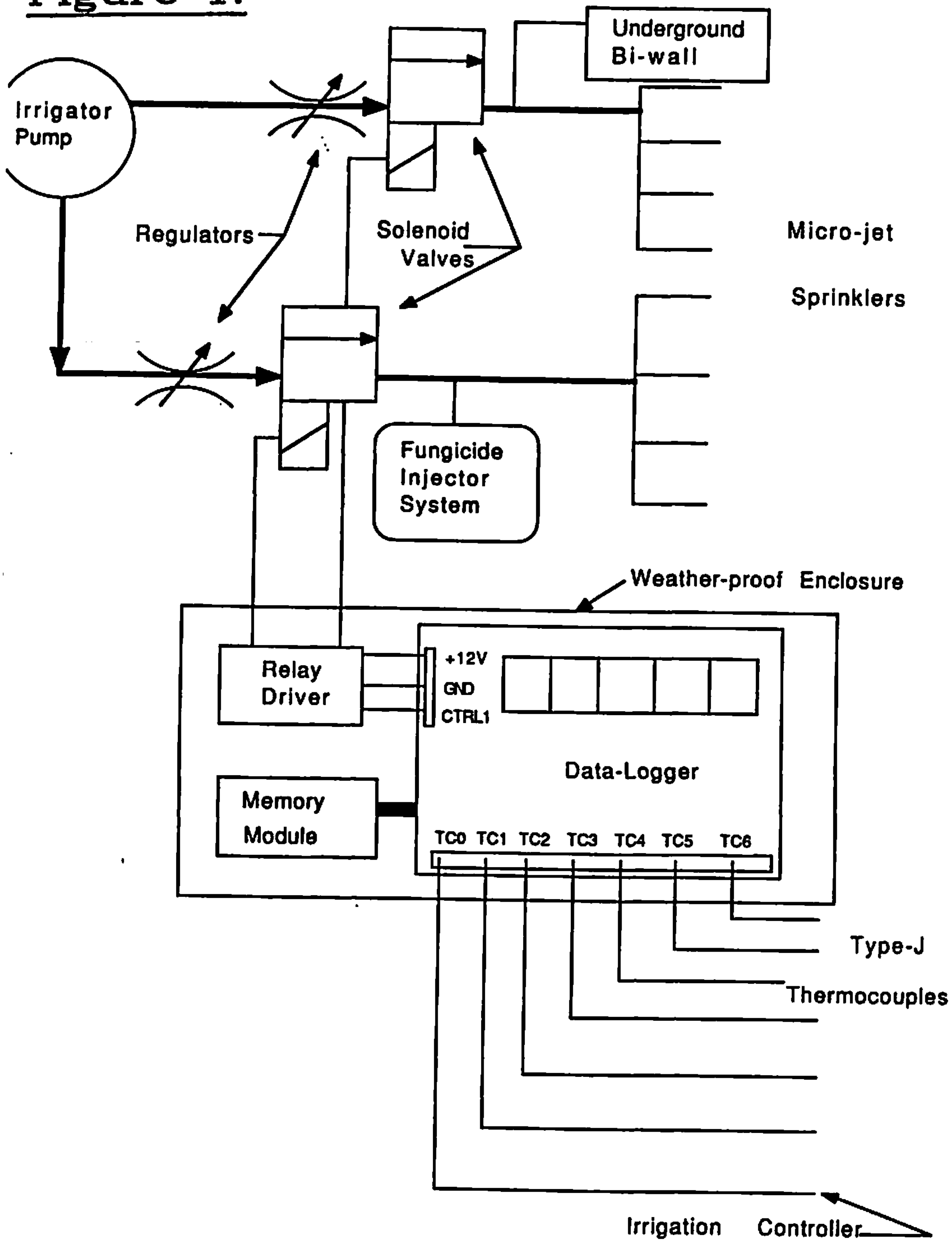
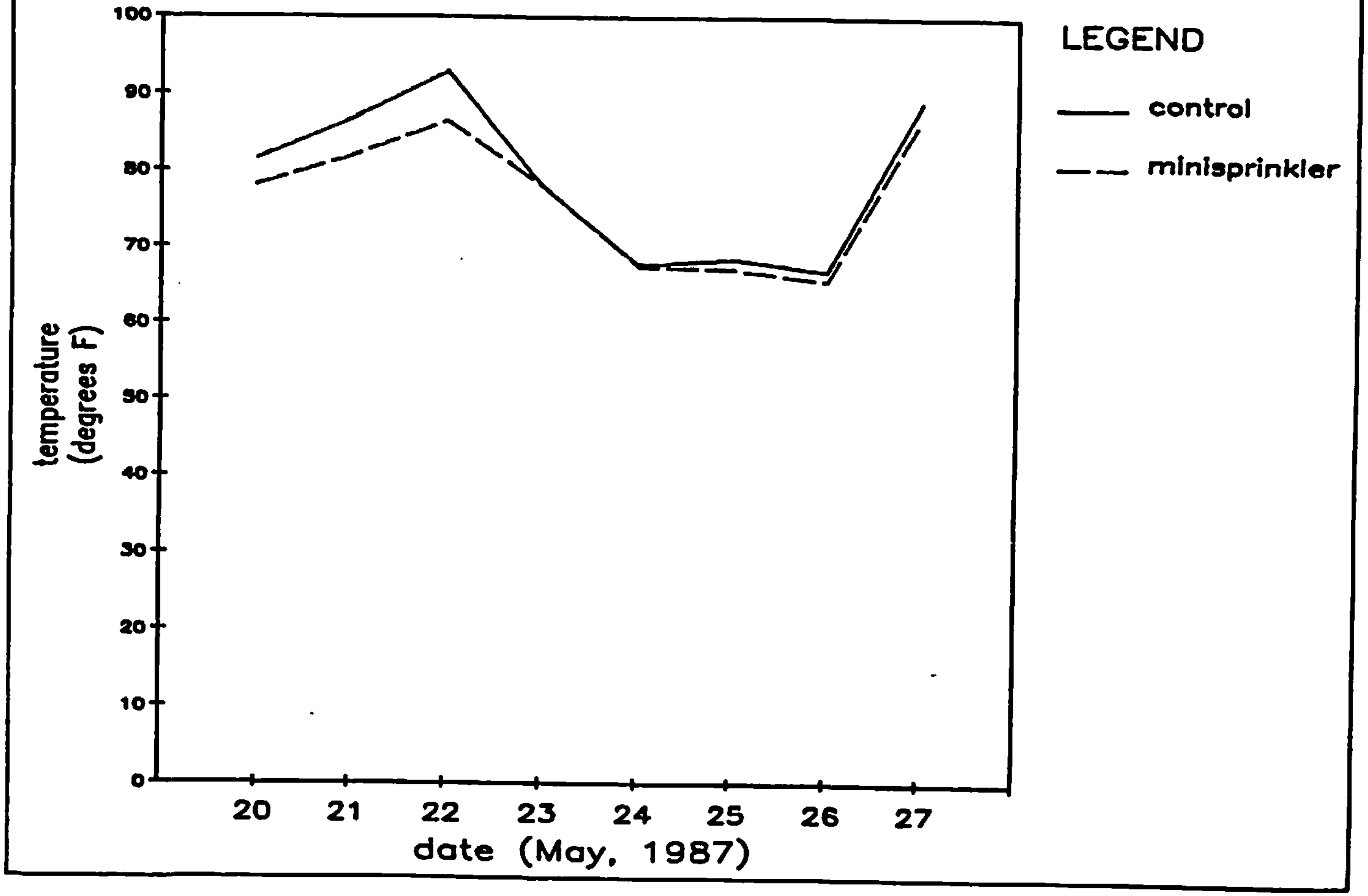

Underground
Bi-wall
Irrigator
Pump
Regulators
Solenoid
Valves
Micro-jet
Sprinklers
Fungicide
Injector
System
Weather-proof Enclosure
Relay
Driver
+12V
GND
CTRL1
Data-Logger
Memory
Module
TC0
TC1
TC2
TC3
TC4
TC5
TC6
Type-J
Thermocouples
Irrigation Controller

Figure 2. Minisprinkler effects on maximum daily canopy temperature



Not for Citation.

Proposed Standard Procedures for Electrical Conductivity Measurements of Winter Hardiness of Deciduous Fruit Crop Shoots

George M. Greene
Department of Horticulture
The Pennsylvania State University
Fruit Research Laboratory
P. O. Box 309
Biglerville, PA 17307

Introduction

The electrical conductivity of diffusates from frozen plant samples has been widely used to get an indication of the cold hardiness of those plants since the method was first used in 1932 (2). The technique has been used on the vegetative parts of a great many crops: agronomic (2), apples (7,10,11,12), peaches (1,3,8,9,13), pears (7), apricots (9), cherries (9), and citrus (6,7). The technique has been used successfully from the 1950's to the 1980's (3,12,7,8,9) and has been shown to be valid (13).

Several citations often have appeared in the deciduous fruit literature with papers by Dexter et al, 1932 (2), Ketchie et al, 1972 (7), or other papers by these authors being some of the most commonly cited. Ketchie et al (7) listed 14 steps in their recommended procedures. However, in a complicated process running 4 days in length and involving dozens of steps many processes are left up to the discretion of the research. Stem length used in these studies has ranged from 6.35 cm (12) to the more standard 1.0 cm (7,8,10,11). Weight of samples has ranged from 4 (10,11) to 40 grams (9) although the ratio of wood to water has usually been 1:5. Guidelines for selecting shoots have been proposed (1). The thaw rate can be critical and has ranged from 5.5 (12) to 25° C (8) or the temperature has not been specified (9,11,13). The duration of the thawing process has ranged from 1 (9) to 2-3 hrs (10,11,13) or has not been specified (3,12).

The method of expressing the data has evolved over the years since Dexter et al (2) used specific conductance (SC) expressed in reciprocal ohms. Rollins et al (12) recognized the difficulties caused by testing under variable conditions so they developed the percent diffusion of electrolytes which involved a ratio of the SC of a frozen sample to the SC of a boiled sample and partially accounted for the SC of a non-frozen sample. They then used the temperature associate with a 15% diffusion of electrolytes as a standard expression of hardiness. Flint et al (4) further refined the calculations and referred to their value as an index of injury. Ketchie et al (7) then recommended using temperatures associated with indexes of injury of 35 and 50 that would result in percents of survival of 10 and 90%, respectively, to compare results. Raese et al (11) used a T-50 as the temperature necessary to give an index of injury of 42.5 to compare treatments.

Acknowledgment: This research was partially funded by the Pennsylvania Department of Agriculture for a project entitled Winter Hardiness of Peach Trees and by the grower supported Pennsylvania Peach and Nectarine Research Program.

The purpose of this paper is to propose a standard procedure for determining the cold hardiness of deciduous fruit crop shoots by the electrical conductivity method. The method proposed is not intended as the only method to be used but rather as a starting place for the person beginning research with this technique. In addition, if these procedures were adopted, persons deviating from these procedures would be expected to define those deviations. Some professions have detailed procedures for standardized testing (5).

Materials and Methods

Following a review of the electrical conductivity literature, the author set up a lab to run several hundred samples per year that result from a cooperative peach tree winter hardiness project. The complexity of the process quickly became obvious and, in the process developing a set of instructions for technicians, the following procedures were outlined. They are presented as a proposed standarized procedure for using the electrical conductivity method to determine the cold hardiness of deciduous fruit crop shoot samples.

Step 1 - Cutting peach shoots and sample preparation (day 1)

1. Select ten shoots from all sections of the tree
2. Select ten non-branched (or weakly branched) shoots that are growing vertically (or nearly vertical).
3. Hold all shoots in styrofoam cooler over crushed ice.
4. make three 4 gram samples from each experimental unit.
5. Make all shoot segments 1 centimeter long.
6. Use only the basal 1/3 or 1/2 of each shoot.
7. When cutting 1 cm segments, place 1 cm pieces into different subsample cans (.1,.2,.3, etc) in rotation to make the most uniform subsamples possible. Take 1 cm pieces from all 10 shoots to make the most uniform subsamples. (Cans used were Thomas Scientific 0.5 oz flat, seamless cans, 13 mm ht. X 38 mm dia., Cat. No. 2366-C12).
8. Prepare all subsamples in cold room that does not go above 50° F or above the maximum temperature that the wood samples would have been exposed to during the previous 7 day period. Maintain wood samples over ice whenever possible.
9. Identify samples with paper sticky labels and put the label in the freezing cans.
10. Hold samples at temperature no higher than that specified in number 8.

Step 2 - Freezing samples (night 1)

1. Place 2 samples in a forced air, temperature programmed environmental chamber.
2. Reduce temperature no faster than 3.0° C/hour.
3. Hold samples at their designated treatment temperature for 30 minutes.
4. Select temperatures that would be expected to yield indexes of injury of 25 to 35 and 45 to 55.

Step 3 - Thawing of samples and transfer from metal cans to glass vials.

1. Transfer cans from freezer to a refrigerated space held at 10 ± 2° C that has still air.
2. Hold cans for 2 hours under these conditions.
3. Add 20 ml of distilled water to glass vials.
4. Transfer all 3 wood samples from cans to glass vials.

Step 4 - Shaking of samples in vials (night 2)

1. Shake vials for 24 ± 2 hours in space maintained at 21 ± 2° C.
2. Use 120 cycles per second for the shaker.

Step 5 - Determine electrical conductivity of solutions surrounding samples (day 3)

1. Using appropriate methodology, measure and record the electrical conductivity of the solutions surrounding the wood samples.

Step 6 - Boiling and cooling samples (day 3)

1. Transfer vials to 100 ± 1° C bath.
2. Maintain this temperature for 7 minutes.
3. Cool samples to 21 ± 2° C in a 10 ± 4° C water bath.
4. Make samples to initial volume if any water has been lost.

Step 7 - Shaking of samples in vials (night 3)

1. Shake samples as specified in step 4.

Step 8 - Determine electrical conductivity of solutions surrounding samples (day 4)

1. Determine electrical conductivity as specified in step 5.

Step 9 - Calculate index of injury and other electrical conductivity (EC) values

1. Calculate index of injury by method of Fline et al (4).
2. Calculate corrected EC values by subtracting the EC of the non-frozen, non-boiled sample from the EC of the 2 frozen, non-boiled samples.
3. Calculate the temperatures associated with indexes of injury of 50, 25, 12.5, 6.25 or other justifiable values.
4. Express data as raw EC values (3,9), corrected EC values, indexes of injury (7,8,10,11) or as T values (7,11)

Conclusions

The use of the electrical conductivity method to determine the cold hardiness of plants has been used for many years, on many crops and has proven to be very useful. The process can last for 4 days and involve many detailed steps. The proposed guidelines are given to aid new users of the technique, to encourage more uniformity of methods, and are not proposed to exclude the use of other methods. If the guidelines are adopted, it is expected that those scientists wishing to deviate from them would specify those deviations.

The author requests that researchers critique these procedures and communicate their constructive suggestions or criticisms to him.

Literature Cited

1. Cain, D. W. and R. L. Anderson. 1976. Sampling procedures for minimizing non-genetic wood hardiness in peach. J. Amer. Soc. Hort. Sci. 110(6):668-671.

2. Dexter, S. T., W. E. Tottingham, and L. F. Graber. 1932. Investigations of the hardiness of plants by measurement of electrical conductivity. Plant. Phy. 7:63-78.

3. Edgerton, L. J. 1960. Studies on cold hardiness of peach trees. Cornell Univ. Agr. Expt. Sta. Bull. 958.

4. Flint, H. L., B. R. Boyce, and D. J. Beattie. 1967. Index of Injury - a useful expression of freezing injury to plant tissue as determined by the electrolytic method. Can. J. Plant Sci. 47: 229-230.

5. Hickey, K. D. (ed). 1986. Methods for evaluating pesticides for control of plant pathogens. APS Press, St. Paul.

6. Ketchie, D. O. 1969. Methods of determining cold hardiness and cold injury in citrus. Proc. First Int. Citrus Symp. 2:559-563.

7. Ketchie, D. O., C. H. Beeman, and A. L. Ballard. 1972. Relationship of electrolytic conductance to cold injury and acclimation in fruit trees. J. Amer. Soc. Hort. Sci. 97 (3): 403-406.

8. Nesmith, W. C. and W. C. Dowler. 1976. Cultural practices affect cold hardiness and peach tree short life. J. Amer. Soc. Hort. Sci. 110(2):116-119.

9. Proebsting, E. L. and H. H. Mills. 1985. Cold resistance in peach, apricot, and cherry as influenced by soil applied paclobtrazol. HortScience 20(1):88-90.

10. Raese, J. T. 1977. Induction of cold hardiness in apple tree shoots with ethephon, NAA, and growth retardants. J. Amer. Soc. Hort. Sci. 102(6):789-792.

11. Raese, J. T., M. W. Williams, and H. D. Billingsley. 1978. Cold hardiness, sorbitol, and sugar levels of apple shoots as influenced by controlled temperature and season. J. Amer. Soc. Hort. Sci. 103(6):796-801.

12. Rollins, H. A., F. S. Howlett, and E. H. Emmert. 1962. Factors affecting apple hardiness and methods of measuring resistance of tissue to low temperature injury. Ohio Agr. Expt. Stat. Bul. 901.

13. Yadava, U. L., S. L. Dowd, and D. J. Weaver. 1978. Evaluation of different methods to assess cold hardiness of peach trees. J. Amer. Soc. Hort. Sci. 103(3):318-321.

Preliminary Observations of Grape Cultivar Trial at WVU Experiment Farm

C.E. Hickman, R.K. Zimmerman, T.A. Baugher,
C.E. Niedziela and S.I. Walter

Introduction

West Virginia has the potential to produce high quality wine and table grapes. In 1982, a grape trial involving 30 different cultivars was initiated at the WVU Experiment Station at Kearneysville. The objectives of the trial are to identify the grape cultivars having the highest yield potential and the best quality based on several factors as shown in the accompanying tables.

Procedures

A total of ten plants of each cultivar were planted at a spacing of nine feet in the rows and ten feet between rows. High tensile steel wire was utilized in seven rows of 2-wire and three rows of 3-wire trellises. Two training systems were compared within each variety.

The cultivars were examined and rated for vine characteristics, fruit characteristics, and productivity. Fruit production per vine and soluble solids were compared between training systems as well as among cultivars. (Table 1).

Results and Discussion

Data collected thus far for the nine seedless table grape cultivars indicate that Lakemont, Suffolk Red, Himrod, Glenora and Canadice show the most promise for commercial production in the Eastern Panhandle. Lakemont, a white grape, has medium-sized berries, full medium-sized clusters, low incidence of black rot and high soluble solids. It matures early, ripens uniformly and ranked the highest in an initial taste test. Suffolk Red had medium-sized berries, loose medium-sized clusters, moderate susceptibility to black rot and high soluble solids. It matures relatively early, ripens fairly uniformly and ranked second in the taste test. Himrod, a white grape, has medium to large berries in loose medium-sized clusters. It is moderately susceptible to black rot, ranks high in soluble solids, matures early, ripens fairly uniformly and ranked third in the taste test. The yields for Himrod are low because it had to be replanted in 1985. Although fruit quality is excellent, Himrod, Suffolk Red and Canadice are less hardy than other promising cultivars. This factor should be a major consideration for colder locations.

As shown in the tables, Niagara, Concord and Buffalo show the most promise of the table grapes with seeds. Vidal 256, Seyval Blanc, Chelois, Villard Blanc, Cayuga white and Chambourcin have had the highest yields and fruit quality of the wine grapes.

Table 1. Evaluation of table and wine grapes in WVU Experiment Farm cultivar trial (1987).

CULTIVAR	COLOR	HARVEST DATE	MATURITY 1=early	VIGOR 1=weak	HRDNESS 1=poor	CLUSTERS 1=vr tight 2=loose 3=full	CLUSTER SIZE 1=small	BERRIES 1=small 2=medium 3=large	SEEDS 1=many OR lg 3=none	RIPENING 3=uniform	BLACK ROT 1=high	2,4-D INJURY 1=SEVERE 3-SLIGHT	PRUNING 1=short 2=either 3=long/ low wire
BACO NOIR	BLUE	8-26	2	3	3	2	2	1	1	2	3	3	3
LAKEMONT	WHITE	8-18	1	2	2+	3	2+	2	3	3	3	3	2
MARECHAL FOCH	BLUE	8-26	1	3	3	1	1	1	1	2	3	2+	2
CATAWBA	RED	9-1	3+	3	3	2	2	3-	1	2	3	2	3
NIAGARA	WHITE	9-1	3	3	3	3	2	3	1	3	3	2+	2
CONCORD SDLESS	BLUE	9-1	2+	2	2+	2	1	3	2	2	3	2+	2
BUFFALO	BLUE	9-1	2+	3	3	2	3	3	1	3	3	2	2
ROMULUS	WH-BRNZ	8-18	1+	2	1	3	3	2	3	2	2	2	2
HIMROD	WHITE	8-18	1	2	1	2	2+	2+	3	2	2	3	2
DELAWARE	RED	9-1	3	3	3	3	1	3	1	3	3	3	2
REMAILY	WH-BRNZ	8-27	1+	2	2	3	3+	3	3	2	2	3	2
FREDONIA	BLUE	8-27	1+	3	3	2	2	3	1	3	3	2	2
KAY GREY	WHITE	8-18	1	3	3	3	1+	2	1	2	1	3	2
CANADICE	RED	8-18	1	2	1	3	2	2-	3	2	2	3	1
GLENORA	BLUE	8-27	1+	3	3	2	2	2	2+	2	2	3	2
INTERLAKEN	WHITE	8-18	1	2	2	3	2+	2+	2+	2	2	3	2
ST. CROIX	BLUE	8-18	1	3	2	2	1+	1+	1	2	2	3	2
CONCORD	BLUE	9-1	2+	3	3	2	2	3	1	2	3	2	2
SUFFOLK RED	RED	8-18	1+	2	2	2	2	2	3	2	2	3	2
LEON MILLET	BLUE	8-18	1+	3	3	1	1	1	1	1	2	2+	2
DECHAUNAC	BLUE	9-1	3	2+	2	2+	2	2	1	2	2	3	2
SEYVAL BLANC	AMBER	8-27	1+	2	2	1	2+	2	1	2	2	3	2
CHELOIS	BLUE	9-1	3	2	2	1	1	2	1	2+	2	3	2
AURORE	WH-BRNZ	8-18	1	2	2	2	2-	2-	1	1	1	3	1
VILLARD BLANC	WHITE	9-1	3	2	2	3	2+	2+	1	2	2-	3	3
CAYUGA WHITE	WHITE	9-1	3	3	2	3	2+	3	1	2	2	3	3
CHAMBOURCIN	BLUE	9-1	3	2+	2	3	2+	2	1	3	2	3	2
PINOT CHRDNAY	WHITE	9-1	3	1	1	1	2	1+	1	2	2	3	3
SEYVAL 14117	BLUE	9-1	2+	2+	2+	1	2	2	1	2	2	3	2
VIDAL	WH-BRNZ	9-1	3	3	2+	3	2+	2-	1	2	2	2+	3

CULTIVAR	FRUIT WEIGHT / VINE (KG)		SOLUBLE SOLIDS (PERCENT)	
	CANE	CORDON	CANE	CORDON
BACO NOIR	9.63 GH ***	11.90 F	18.5 DEF	18.5 E
LAKEMONT	5.99 CDE	11.66 F	19.1 EFGb	17.3 Da
MARECHAL FOCH	0.91 Aa	6.73 CDEb	22.5 J	23.2 K
CATAWBA	9.67 GH	6.80 CDE	17.1 CDa	18.1 DEb
NIAGARA	11.04 H	11.52 F	14.6 AB	12.9 A
CONCORD SDLESS	7.14 DEFa	8.24 EFb	15.5 AB	14.7 BC
BUFFALO	4.94 BCD	8.42 EF	15.9 BCa	22.5 JKb
ROMULUS **	1.54 AB	0.94 AB	20.9 HI	21.3 HI
HIMROD **	0.00 A	0.60 A		21.2 HI
DELAWARE	5.55 BCDb	0.23 Aa	18.8 EFGa	23.1 Kb
REMAILY	8.03 EFG	11.34 F	21.1 HIJb	17.1 Da
FREDONIA	4.97 BCD	5.59 CDE	14.2 A	14.1 B
KAY GREY	5.91 CDE	6.33 CDE	17.8 DE	18.5 E
CANADICE *	0.00 A	2.57 ABC		20.7 GH
GLENORA	3.70 ABC	3.55 ABC	21.3 IJ	21.4 HIJ
INTERLAKEN	9.25 FGH	7.48 DEF	19.7 FGH	20.6 GH
ST. CROIX	2.30 ABCa	4.02 ABCb	19.8 GH	19.0 EF
CONCORD	5.97 CDE	5.61 CDE	16.0 BC	15.8 C
SUFFOLK RED *	8.50 EFG	5.14 BCD	18.3 DEFa	20.0 FGb
LEON MILLET	5.47 BCD	4.37 ABC	21.7 IJ	22.3 IJK
	LOW WIRE CORDON	UPRWIRE CORDON	LOW WIRE CORDON	UPRWIRE CORDON
DECHAUNAC	2.68 AB	4.16 AB	18.4 ABa	21.0 DEb
SEYVAL BLANC	10.17 D	4.76 ABC	21.6 C	21.9 E
CHELOIS	6.05 BC	7.63 BCD	17.8 AB	20.65 DE
AURORE	7.92 CD	6.42 ABC	19.3 B	21.1 DE
VILLARD BLANC	9.02 CD	8.95 CD	16.6 A	17.8 AB
CAYUGA WHITE	10.28 D	7.06 BCD	17.1 ABa	20.0 CDb
CHAMBOURCIN	10.13 D	10.39 DE	18.9 B	18.5 ABC
PINOT CHRDNAY	0.00 A	2.06 A		20.4 DE
SEYVAL 14117	3.78 B	8.01 BCD	17.4 AB	17.0 A
VIDAL 256	16.93 E	13.38 E	18.6 AB	18.6 BC

* Planted 1984. ** Planted 1985.
Rest planted 1982-83 (but some Chardonnay vines replaced 3 times). Ten vines/cultivar.

*** Means, within columns, followed by the same uppercase letter are not significantly different according to DMRT, 5% level.
Lower case letters designate mean separation (5% level) between training systems.

SUMMER PRUNING THE LINCOLN CANOPY

T.A. KEISER AND S.H. BLIZZARD
WEST VIRGINIA UNIVERSITY
KEARNEYSVILLE, WV

INTRODUCTION

The Lincoln Canopy was developed specifically to facilitate the mechanization of fresh fruit, high density, production system. Summer pruning has been the topic of a tremendous amount of research over the past several years and yet questions remain as to its effects. By virtue of design, the Lincoln Canopy provides an optimum opportunity to study the effects of summer pruning.

The objective of this research was to examine the effects of summer pruning on fruit quality, yield and yield efficiency of apple trees trained to the Lincoln Canopy trellis system.

PROCEDURE

Trees of Lincoln Canopy trained "Triple Red" on M26 rootstocks at West Virginia University were uniformly dormant pruned.

There were four treatments with five replications per treatment. Three trees constituted one experimental unit. Treatments and replications were arranged in a randomized complete block. There was one unpruned control treatment. The other treatments were carried out on July 1, August 1 and September 1, respectively. A treatment consisted of the removal of all vertical growth.

Data were collected from the center tree of each experimental unit. Twenty trees were tagged on the center tree of each experimental unit. The growth of these apples was recorded through harvest. Light readings and trunk diameter measurements were measured throughout the season. Following harvest, fruit size, firmness, starch and soluble solids were measured. Yield efficiency was also calculated.

RESULTS AND DISCUSSION

Data indicate that the September 1 treatment yielded the largest fruit in 1986, however in both 1986 and 1987 it resulted in the highest abscission rate and lowest yield efficiency. The July 1 treatment consistently resulted in the greatest yield, yield efficiency and firmness.

These data indicate that summer pruning does affect fruit quality, yield and yield efficiency. Further analysis of these data is currently underway.

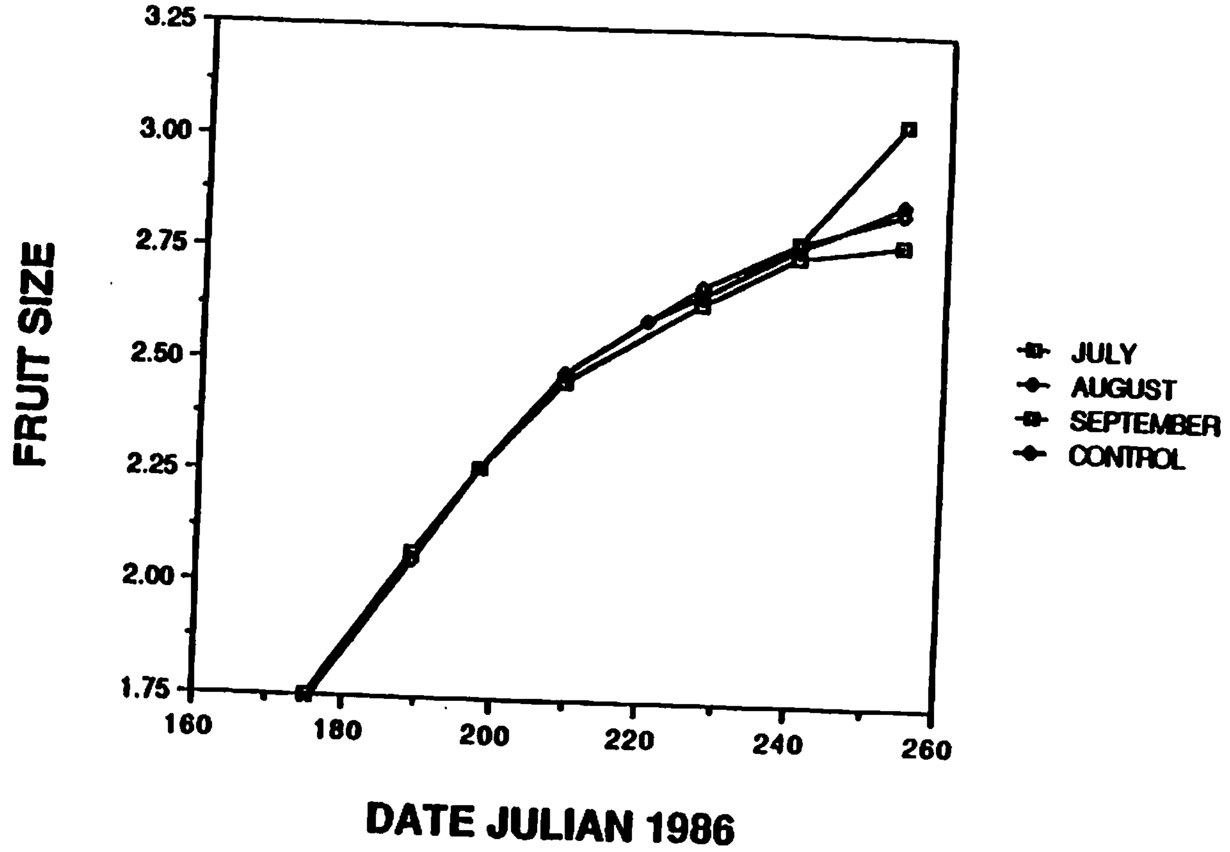


Figure 1. Effects of summer pruning and control treatments on fruit size.

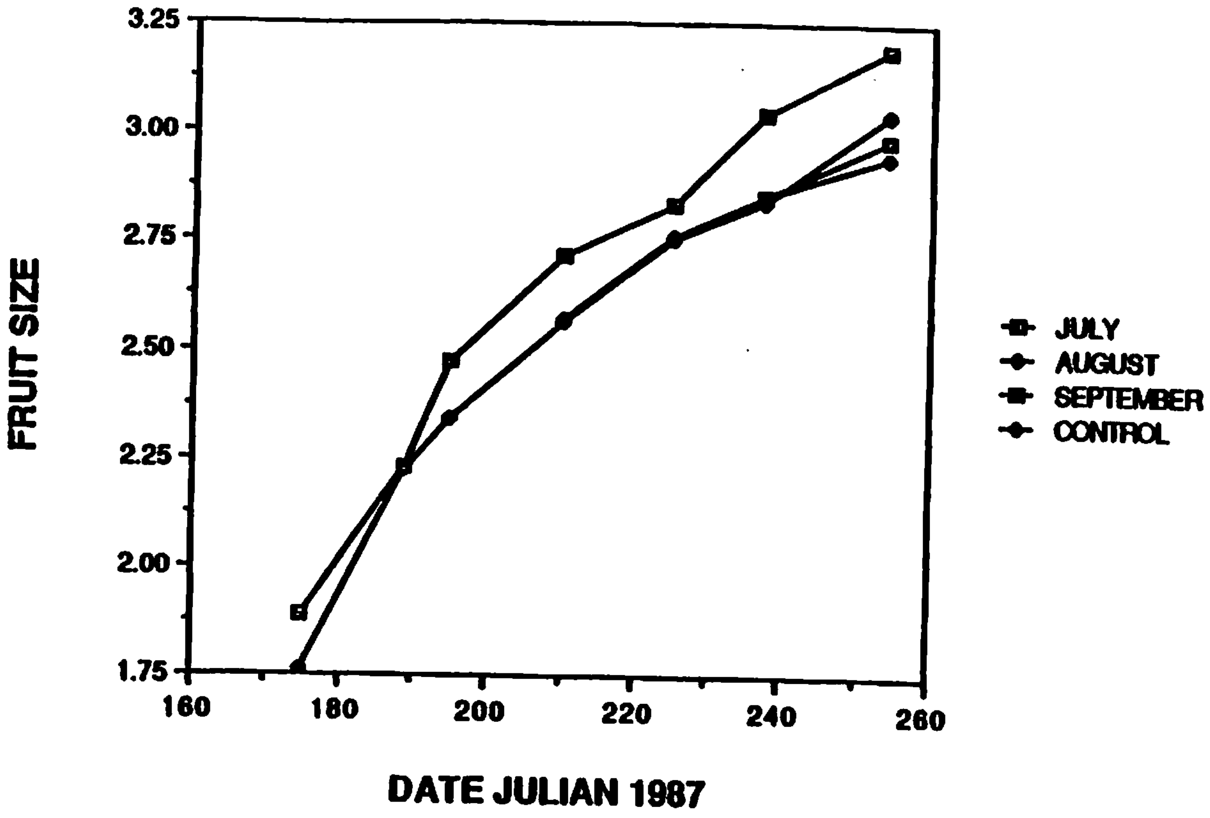


Figure 2. Effects of summer pruning and control treatments on fruit size.

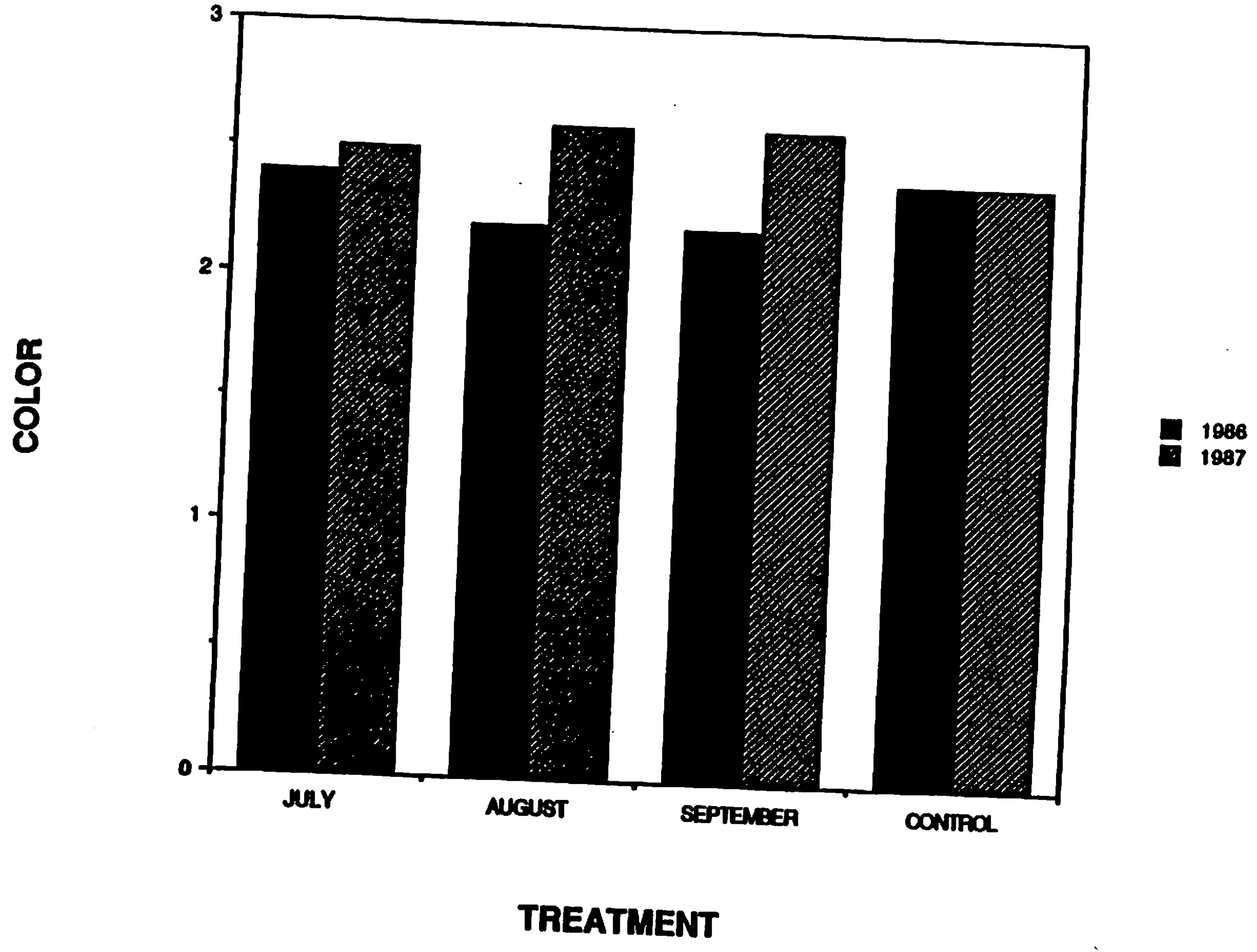


Figure 3. Effects of summer pruning and control treatments on fruit color.

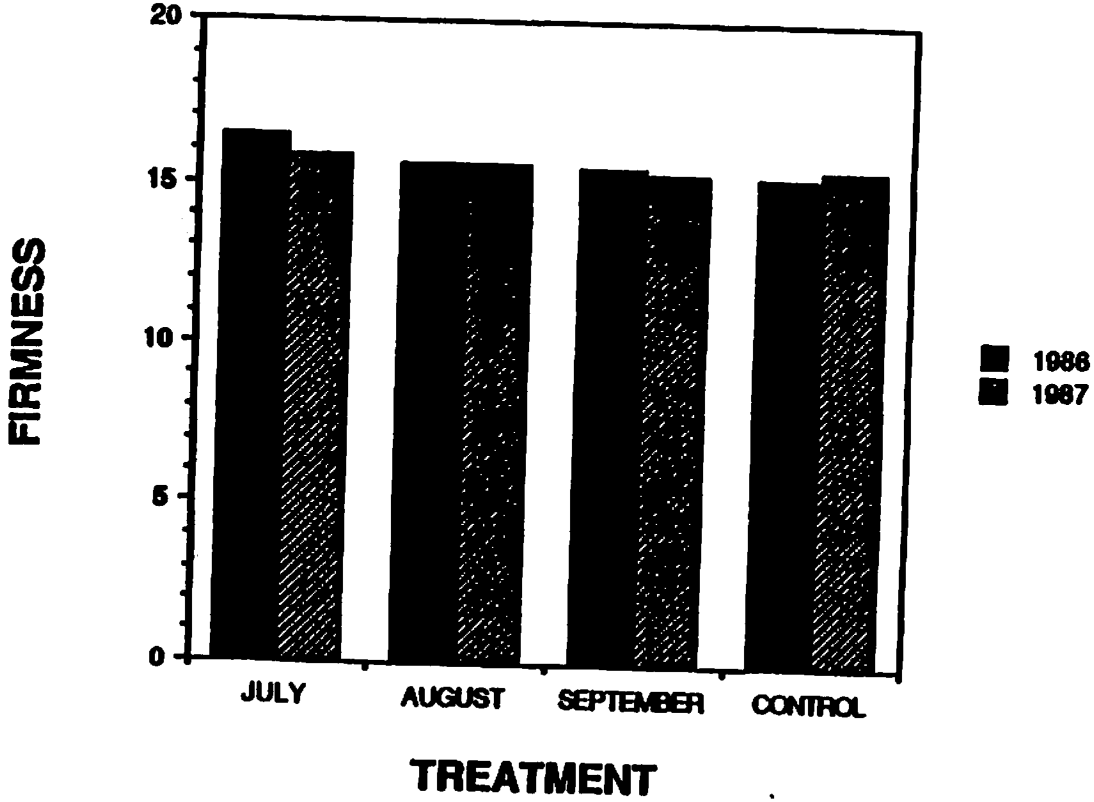


Figure 4. Effects of summer pruning and control treatments on fruit firmness.

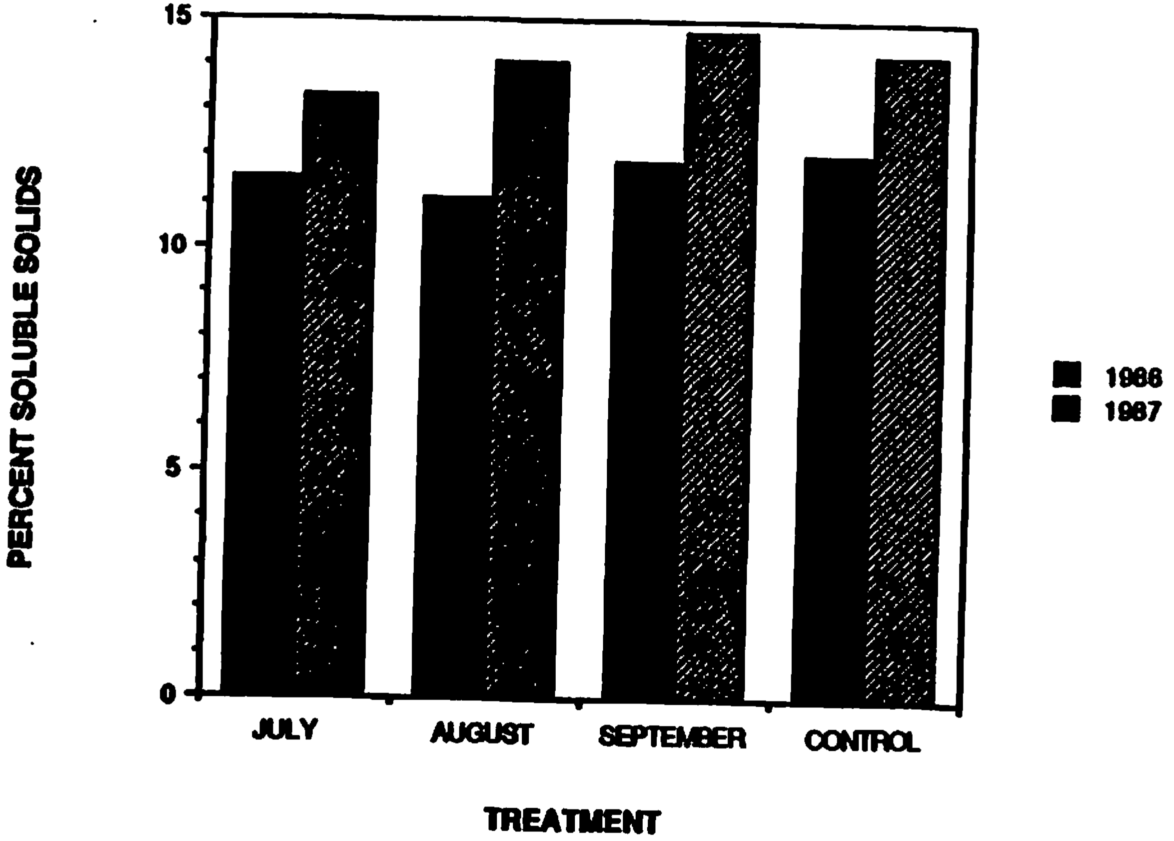


Figure 5. Effects of summer pruning and control treatments on fruit soluble solids.

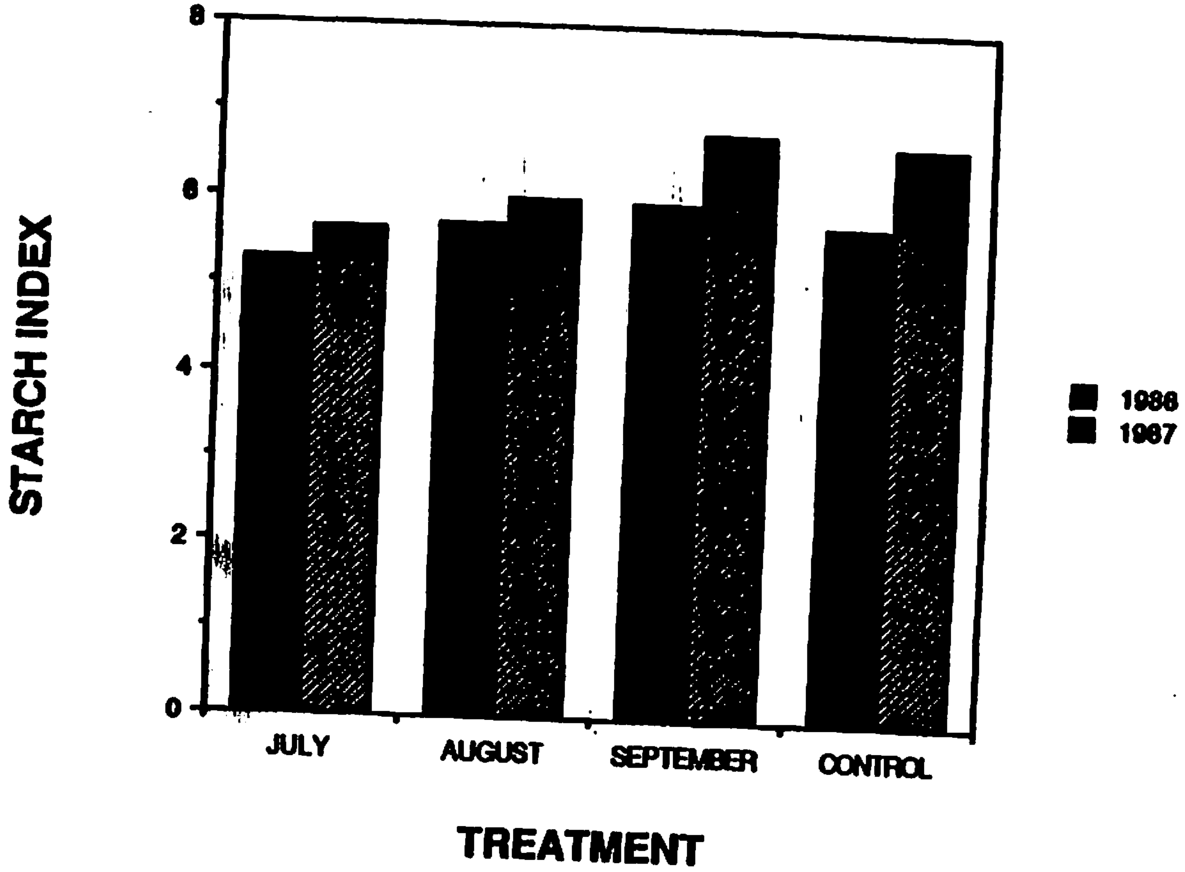


Figure 6. Effects of summer pruning and control treatments on fruit starch.

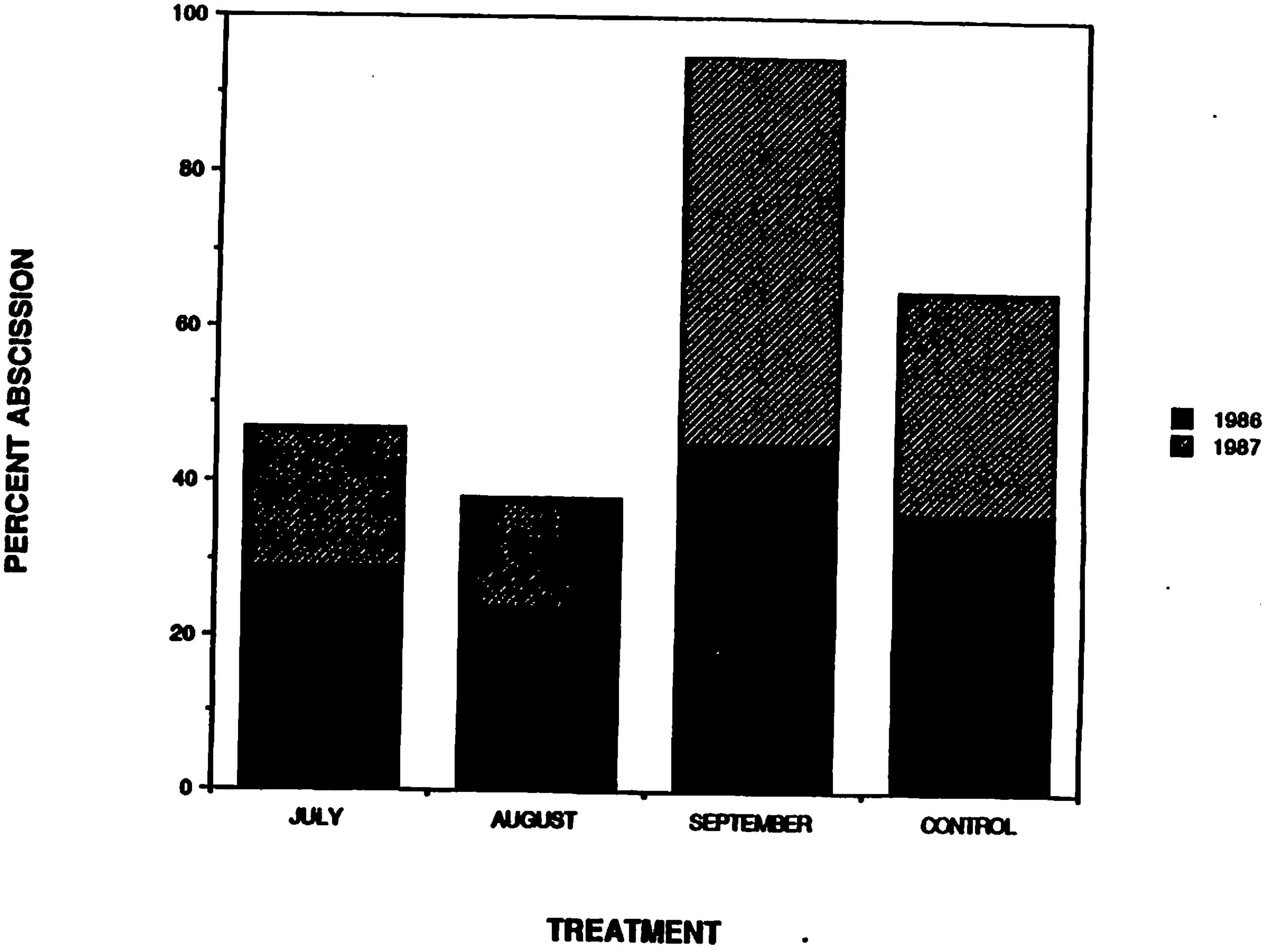


Figure 7. Effects of summer pruning and control treatments on fruit abscission.

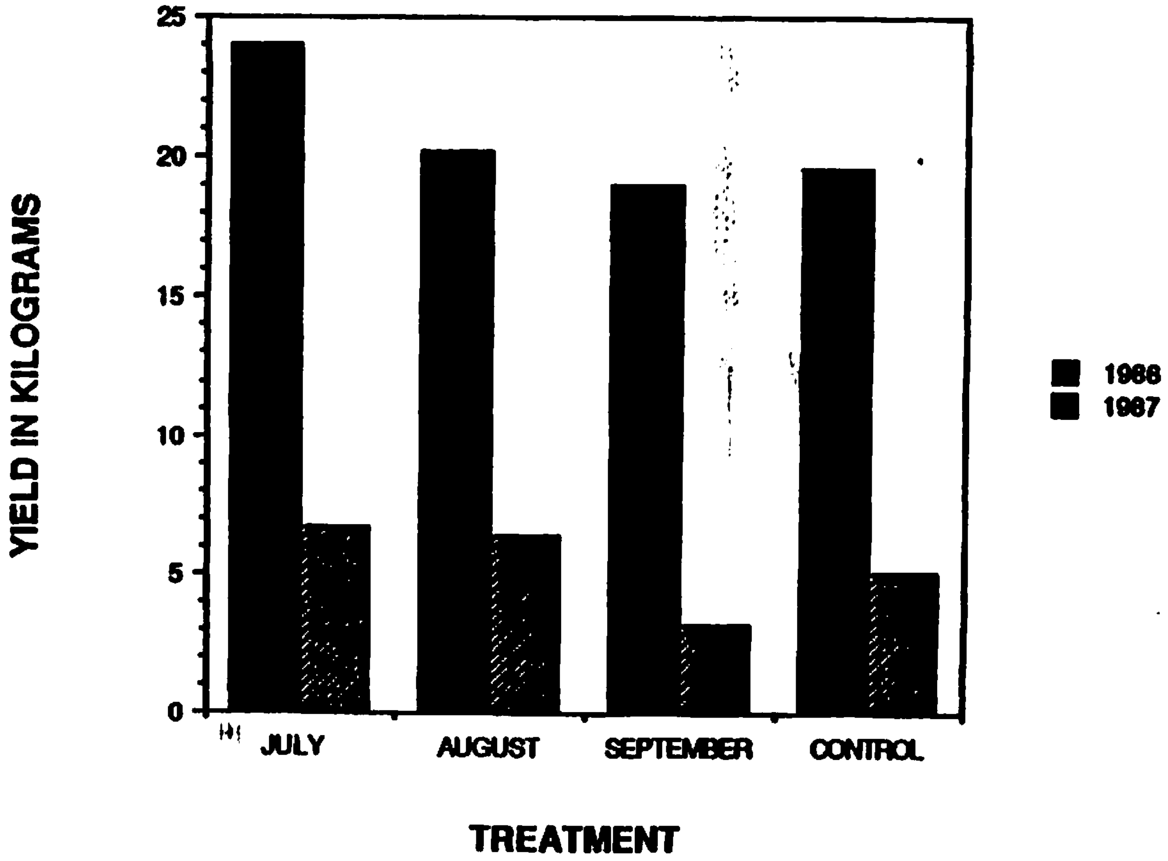


Figure 8. Effects of summer pruning and control treatments on fruit yield.

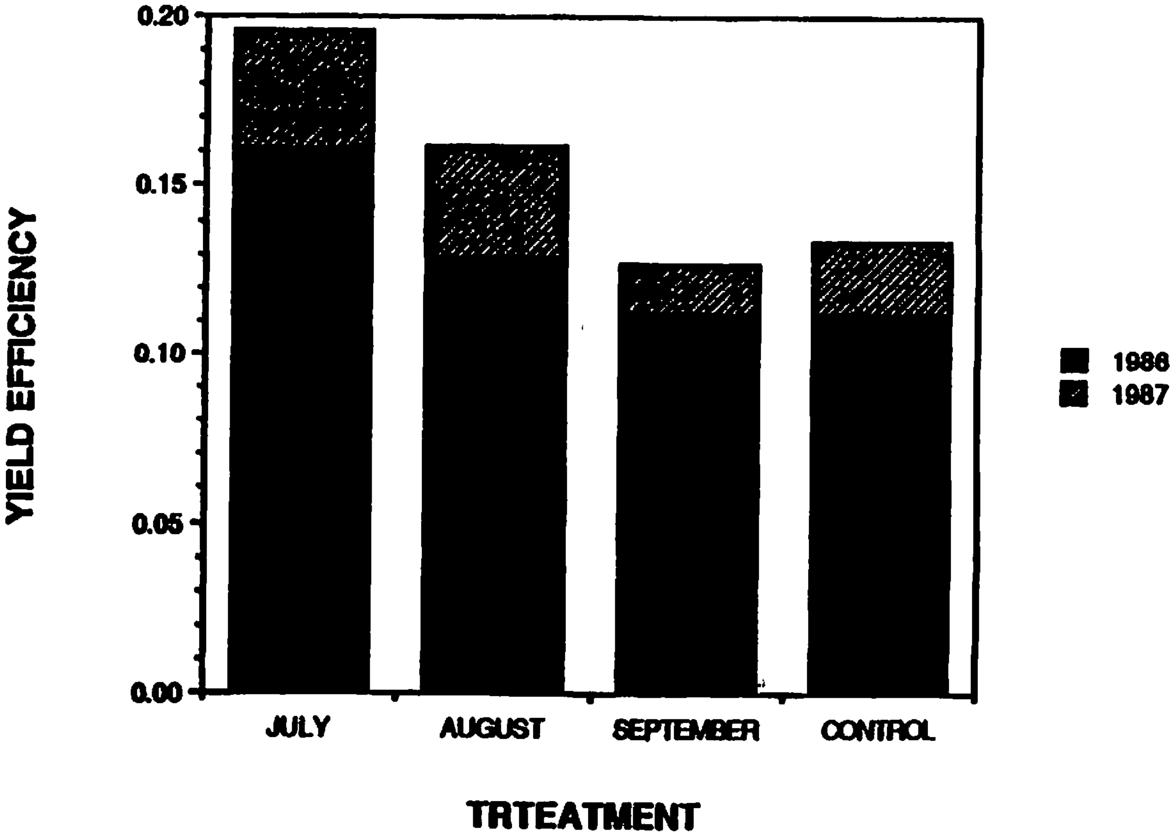


Figure 9. Effects of summer pruning and control treatments on yield efficiency.

Irrigation Requirement and Leaf Water Potential of Apple Trees Under High Density Management Systems

M.A. Myers, S. Singha, S.H. Blizzard
Division of Plant and Soil Sciences
West Virginia University
Morgantown, WV 26506

High density fruit plantings generally have shallow root systems. Water is absorbed largely from the upper 18 inches of soil occupied by roots. Without the supply of water from deeper soil or from irrigation, water may become a limiting factor in fruit production and tree growth. This paper summarizes the results of a trickle irrigation study conducted on apple trees trained to the European 3-Wire (3W), Lincoln Canopy (LC) and Spindlebush (SB) systems. Of interest, was the effect of irrigation on fruit yield, fruit quality and tree growth.

Trees were planted on a Hagerstown silt loam soil in 1979 at the West Virginia University Experiment Station at Kearneysville. Trees trained to the 3-wire trellis and Lincoln Canopy, were spaced 6' x 12' (605 trees/acre). The Spindlebush was planted at a 3' x 9' spacing (1613 trees/acre). Scion - rootstock combinations were Golden Delicious and Topred on M. 9 for the 3-wire trellis, Golden Delicious on M. 26 for Lincoln Canopy and Bisbee on M. 9 for Spindlebush.

A split-split plot design was used with a randomized complete block of treatments. The main treatments were a) no irrigation, b) 1.8 liters/hr/tree, c) 3.5 liters/hr/tree, d) 7.0 liters/hr/tree. The trellis system and variety were the fixed factors.

Irrigation was applied manually in 1986 and automatically in 1987. In both years, soil moisture was monitored with tensiometers.

Spindlebush required the greatest volume of water in 1986 and 1987 (table 1.). Increase in fruit size was higher on Spindlebush than on the 3-wire trellis and Lincoln Canopy in both years. Fruit yield in the 3-wire trellis and Lincoln Canopy was highest with the 7.0 liter treatment. The largest increase in tree growth occurred on Spindlebush in 1986 (table 2).

Although firmness and soluble solids in the 3-wire trellis decreased with irrigation, a similar response was not observed in the Lincoln Canopy (table 3).

The automated irrigation system used in 1987 was designed to increase irrigation frequency while maintaining desirable soil water levels. Soil water levels were held between 0.20 - 0.25 bars near the tree, but the volume of water applied in 1987 was substantially reduced compared to 1986. The automated system had a single tensiometer at 17.3 cm to control the irrigation. It may have been beneficial to use a dual tensiometer control system, with the second tensiometer at a greater depth.

Table 1. Amount of water applied per week with 7.0 liter/hr/tree to three training systems in 1986 and 1987.

	Water applied (liters/wk)	
System	1986(Manual irrigation)	1987(Automated irrigation)
3W	105.6	28.2
LC	104.4	14.2
SB	109.3	35.6

Table 2. Influence of irrigation on fruit yield, fruit size and trunk growth of three training systems.

	1986				1987			
	Irrigation (liters/hr/tree)				Irrigation (liters/hr/tree)			
System	0.0	1.8	3.5	7.0	0.0	1.8	3.5	7.0
Yield (kg/tree):								
3W	17.9	---	21.5	23.4	11.6	---	12.2	14.2
LC	23.4	---	23.3	28.6	13.4	---	6.7	16.2
SB	18.5	12.2	16.4	---	38.0	39.6	30.1	---
Fruit diameter (cm):								
3W	8.5	---	8.5	8.7	8.8	---	8.9	9.0
LC	7.3	---	7.2	7.4	7.8	---	7.8	7.7
SB	7.4	8.0	7.9	---	8.2	8.3	8.9	---
Increase in trunk circumference (cm^2):								
3W	0.01	---	0.06	0.07	0.10	---	0.12	0.12
LC	0.06	---	0.00	-0.01	0.13	---	0.15	0.13
SB	0.00	0.03	0.80	---	0.08	0.07	0.09	---

Table 3. Influence of irrigation on fruit quality of three training systems in 1987.

	Irrigation (liters/hr/tree)				Irrigation (liters/hr/tree)			
System	0.0	1.8	3.5	7.0	0.0	1.8	3.5	7.0
	Firmness (kg):				Soluble solids (%):			
3W	15.9	---	15.7	15.5	16.1	---	14.8	14.7
LC	17.4	---	18.2	17.5	14.2	---	15.0	14.0
SB	15.9	15.7	15.3	---	12.8	13.2	13.0	---

Not for publication

Strawberry (*Fragaria* x *ananassa* Duch.) Nitrogen Fertilization Study

C. E. Niedziela Jr. and C.E. Hickman,
Division of Plant and Soil Sciences,
West Virginia University, Morgantown, WV 26506

Introduction

Strawberries in the northeastern United States have been traditionally grown using a matted row system. The current fertilizer recommendations are based on studies using this system. Many growers are now planting newer, more productive cultivars at higher densities using the single ribbon row system of production. These changes in cultural practices may affect the N requirement for growth and fruit production. The objective of this study was to determine the effect of N fertilizer rate and application method on strawberry plant growth, yield, and fruit quality using the single ribbon row system.

Materials and Methods

This field study was conducted at the West Virginia University Horticulture Farm, Morgantown, WV on a Tilsit silt loam from 1986 to 1987. The cultivar 'Redchief' was planted May 15-17, 1986 on ridges.

The experimental design was a completely randomized block with twelve fertilizer treatments and one untreated check replicated four times. Each plot measured 3.66 m by 2 m. Plants were spaced 0.91 m by 10 cm apart. The sampling area consisted of a 1.83 m by 1 m rectangular area in the center of each plot. The border area was provided to allow for fertilizer leaching.

The treatments, N sources, rates and dates of application are given in Table 1.

Fruit Harvest Since the strawberry plants were planted to a close spacing, ribbon system, they were allowed to bloom and bear fruit in the first growing season. In 1986 and 1987, fruit was separated into two USDA grades (US #1 and US #2) and culls. Weights and berry counts were recorded on the USDA grades. Only weights were recorded for the culls. Mean weight per berry was calculated for the USDA grades.

Soluble Solids An Atago N-1 hand-held refractometer was used to measure soluble solids on the US #1 berries on the first two harvests in 1986 and the second and third harvests in 1987.

Fruit Firmness Two harvests (June 1 and 4) in 1987 were tested using an Instron TM. A 500 kg mass of fruit was placed in a plexiglass test chamber (249 mm high by 119 mm inside diameter with a sealed bottom). The plunger (51 mm in diameter by 5 mm thick, on a 18 mm graduated rod 427 mm long) was driven through the fruit at a rate of 0.5 cm/sec. The force was measured using a Daytronic 152A-50 differential transformer load cell. This device supplied output to a Daytronic 9130 LVDT conditioner which received and conditioned the signals for the Daytronic 9010 Mainframe. Output was produced graphically on a Hewlett-Packard 7034A X-Y Recorder (Fig. 1). THe X-Y recorder was set to travel horizontally at a rate of 2.0 sec/cm. Thus, 1 cm travel of the plunger was equivalent to 1 cm on the force graph. Slopes were calculated for each 2.54 cm of travel. Maximum points were also recorded (Fig. 2).

Vegetative Analysis Runners were removed on July 31, August 22, September 9, and October 30, 1986. Runner counts and fresh and dry weights were recorded for each harvest area.

Two plants were dug at random from the harvest area of each plot on July 2, 1987. The number of branch crowns and the fresh and dry weights of the roots and shoots of these plants were recorded. The runners were counted and fresh and dry weights were also recorded.

Foliar Analysis Leaf samples were collected from the harvest area of each plot on September 10, 1986. All samples were analyzed for P, K, Ca, Mg, Mn, Fe, B, Cu, and Zn using a dry ashing procedure. These nutrients were measured with an inductively coupled plasma (ICP) spectrograph. Nitrogen was determined using an automated Kjiedehl.

Statistical Analysis A randomized complete block analysis of the orthogonal polynomials was performed to determine the shape of the response ($p = 0.05$).

Results and Discussion

Yields for the first growing season (1986) were lower than expected, but other researchers have had similar results (3,4). Increased N applications showed a decrease in the weight of US #1 berries (yield), number of US #1 berries, and weight of culls in 1986 (Table 2). Less fruit (marketable and unmarketable) was produced with increasing N fertilization in the planting year on ribbon rows. No significant differences were observed in US #2 berries.

In the second season, yields were similar to those considered as good commercially in West Virginia. Yield showed interactions with respect to N application method (Table 3). Above 100 kg N/ha, the yield increased as N rate increased for split applications and Osmocote applications. The preplant and foliar treatments both declined in yield above 100 kg N/ha; however, the preplant treatments declined more rapidly. The number of US #1 berries also showed interactions with respect to N application method. The preplant and foliar treatments produced less berries/ha as N rate increased; again, the preplant treatments declined more rapidly. The mean weight per berry increased significantly as N rate increased. No significant differences were observed in the weight of US #1 berries, number of US #1 berries or weight of culls.

There were no significant differences in the soluble solids in either harvest season. Yields were low in 1986 which made soluble solid sample sizes very small. This may have affected the statistical significance of differences in soluble solids.

Although significant differences were found in the firmness tests conducted with the Instron, these differences were not repeatable from one harvest to the next and between variables tested within the same harvest. Several researchers have observed a softening of strawberries due to N application, but only when applied in the spring of the fruiting year (2). Firmness testing could not be conducted in 1986 due to insufficient fruit.

A large number of berries was used to eliminate the variability between berries and decrease testing time. While eliminating variability, this test may have lost some of its validity. To have confidence in any test, repeatable results are necessary. Perhaps the wrong variables were measured. The area under the curve would give the energy necessary to penetrate the mass of fruit. Since the 500 g samples were of different volumes, the starting points were different. For this reason, areas under the curves could not be compared. Using the same volume of fruit might solve this problem. Further study of this problem is needed.

No significant differences were found in total counts and fresh and dry weights of runners in 1986. Final vegetative analysis in 1987 revealed the number of runners per plant showed a significant linear increase to increased N. No significant differences were observed in root fresh or dry weights, runner fresh or dry weights, shoot fresh or dry weights, or branch crown numbers.

Abbott (1) stated an increase in branch crown formation would provide additional sites for flower bud formation and improved yield. Researchers generally agree that N applications in the fall increase branch crown formation. The observed yield increases with split applications of N cannot be attributed to more branch crowns being formed.

Increased N application showed an increase in leaf N (Table 5). Kongsrud (6) previously reported on the increase in leaf N with increased N applications. In the current study, no interactions were observed with respect to application methods. Nitrogen uptake appears to be similar for all application methods.

Boron increased in leaf samples of Osmocote treatments with increased N application.

Nitrogen response of strawberries depends on several environmental factors (5,7,8). Year to year changes in the environment may affect any of the variables measured in this study. Repeating this study or conducting similar studies in the future would allow for this annual variation.

Literature Cited

[1]Abbott, A.J. 1968. Growth of the strawberry plant in relation to nitrogen and phosphorous nutrition. J. Hort. Sci. 43:491-504.

[2]Boyce, B.R. and D.L. Matlock. 1966. Strawberry nitrition. p. 518-548. In: N.F. Childers (ed.). Temperate to tropical fruit nutrition. Horticultural Publications, New Brunswick, NJ.

[3]Clay, D.E., R.L. Mahler and H.A. Menser. 1984. The influence of N sources and rates on soil N parameters related to strawberry production in northern Idaho. Commun. in Soil Sci. Plant Anal. 15(7):819-832.

[4]Hancock, J. and Rouechc. 1983. A comparison of ribbon and matted row strawberry culture. Adv. Strawberyy Prod. 2:7-8.

[5]Kolb, K.A. 1986. Putting together a balanced commercial strawberry fertilization program. E.E. Burns and E.J. Burns. ed. Proceedings 1986 winter conference North American Strawberry Growers Assoc. Monterey, CA, 8-13 Feb, 1986.

[6]Kongsrud, K.L. 1980. Nitrogen fertilization and irrigation of the strawberry cultivar Senga Sengena. Forskning og Forscek i Landbruket 31(4);381-389.

[7]Pritts, M. 1985. Strawberry nutrition. A seminar presented in Mexico during the summer of 1985. Reprinted by the North Amer. Strawberry Growers Assoc.

[8]Voth, V, K. Uriu and R.S. Bronghurst. 1967. Effect of high nitrogen application on yield, earliness, fruit quality, and leaf composition of California strawberries. Proc. Amer. Soc. Hort. Sci. 91:249-256.

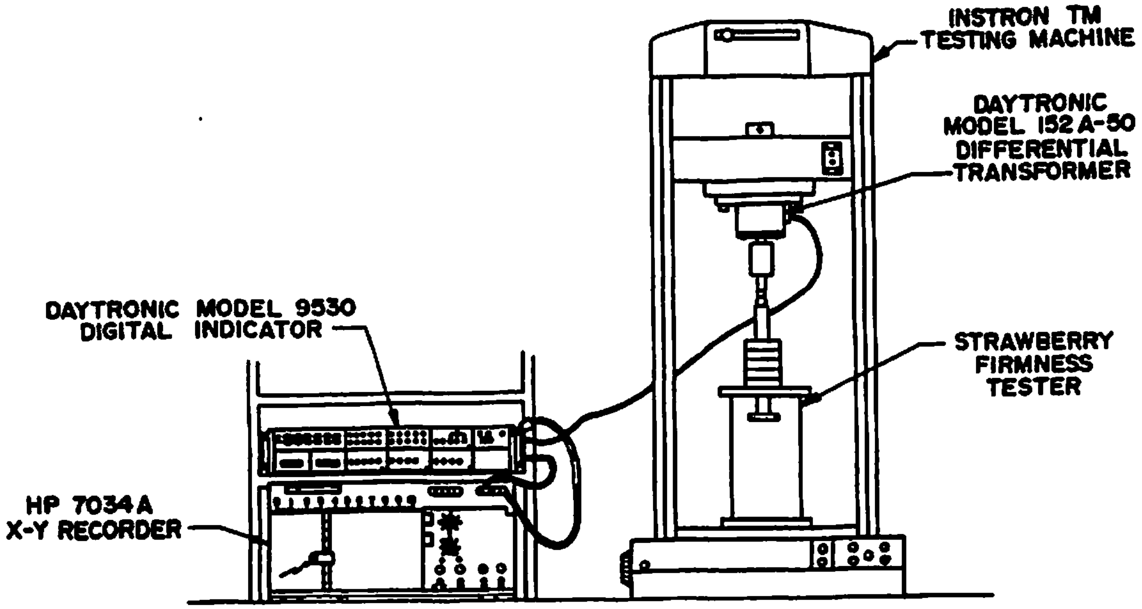


Figure 1. Instron equipment used for strawberry firmness testing.

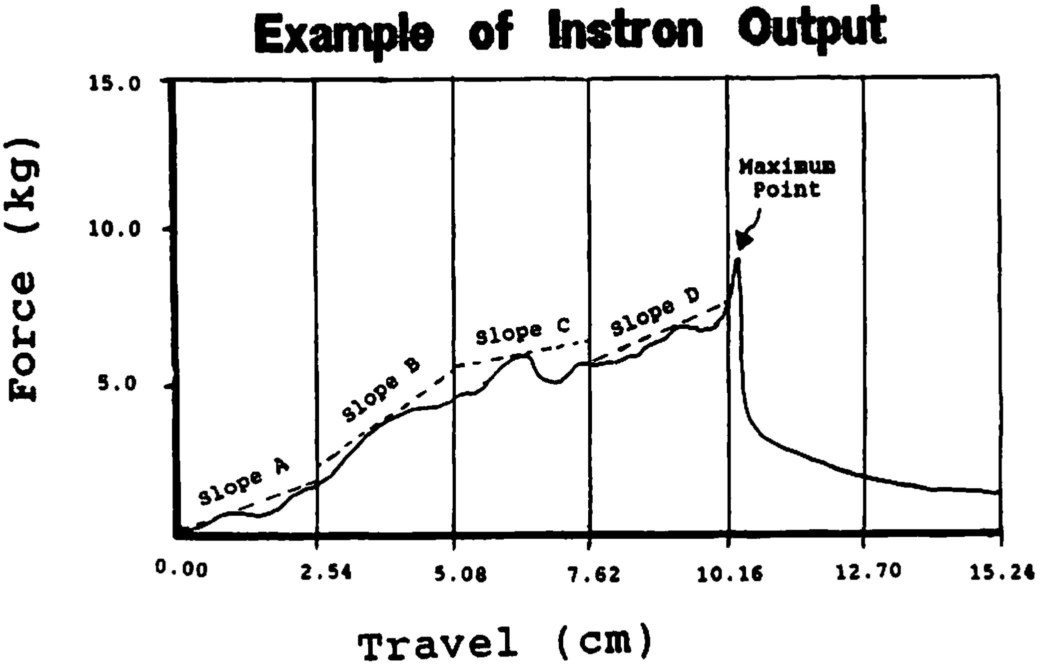


Figure 2. Example of the graphic output from the Instron TM.

Table 1. Fertilizer Treatments and Dates of Application

Total N (kg/ha)	Actual N[z] (%)	Rate[y] (kg N/ha)	Source[x]	Method	Date
0	-	untreated	-	control	-
50	33.5	50	NH_4NO_3	preplant	5/13/86
50	40	50	Osmocote[w]	preplant	5/13/86
50	33.5 33.5	25 25	NH_4NO_3 NH_4NO_3	preplant sidedressed	5/13/86 8/16/86
50	33.5 46	20 30	NH_4NO_3 urea	preplant foliar	5/13/86 [v]
100	33.5	100	NH_4NO_3	preplant	5/13/86
100	40	100	Osmocote	preplant	5/13/86
100	33.5 33.5	50 50	NH_4NO_3 NH_4NO_3	preplant sidedressed	5/13/86 8/16/86
100	33.5 46	40 60	NH_4NO_3 urea	preplant foliar	5/13/86 [v]
150	33.5	150	NH_4NO_3	preplant	5/13/86
150	40	150	Osmocote	preplant	5/13/86
150	33.5 33.5	75 75	NH_4NO_3 NH_4NO_3	preplant sidedressed	5/13/86 8/16/86
150	33.5 46	60 90	NH_4NO_3 urea	preplant foliar	5/13/86 [v]

[z] These sources did not contain P or K.

[y] Each rate is the kg actual N/ha from the listed source.

[x] Each treatment was replicated four times.

[w] Osmocote is a resin coated slow release fertilizer manufactured by Sierra Chemical Co. of Milpitas, CA.

[v] Foliar treatments were applied on the following dates: 6/5/86, 6/18/86, 6/29/86, 7/10/86, 7/18/86, 7/30/86, 8/11/86, 8/22/86, 9/2/86, and 9/16/86.

Table 2. Average Total Fruit Yields for Each Treatment in 1986.

Total N (kg/ha)	Method	Weight of US#1 Berries* (kg/ha)	No. of US#1 Berries* (1000's/ha)	Weight of Culls* (kg/ha)
0	Control	548	86.1	975
50	Preplant	557	92.9	1185
50	Split	549	87.4	1098
50	Osmocote	776	13.0	1344
50	Foliar	451	77.9	888
100	Preplant	485	82.0	938
100	Split	537	88.8	1057
100	Osmocote	637	102.4	1095
100	Foliar	681	113.4	948
150	Preplant	132	23.2	459
150	Split	396	71.0	934
150	Osmocote	392	73.8	967
150	Foliar	266	45.1	671

*Each value represents the mean of 4 replications.

Analysis of Variance			
Control vs. Treatment	ns	ns	ns
Form	ns	ns	ns
Linear	**	**	**
Quadratic	ns	ns	ns
Form x Linear	ns	ns	ns
Form x Quadratic	ns	ns	ns

Significant at 5% (**) level or nonsignificant (ns)

Table 3. Average Total Fruit Yields and Mean Weight per Berry for Each Treatment in 1987.

Total N (kg/ha)	Method	Weight of US#1 Berries* (kg/ha)	No. of US#1 Berries* (1,000's/ha)	Weight of Culls* (kg/ha)	Mean Weight per Berry* (g)
0	Control	13,355	1,807	2,106	7.42
50	Preplant	13,436	1,846	1,982	7.43
50	Split	13,300	1,865	1,698	7.03
50	Osmocote	12,749	1,833	2,269	6.83
50	Foliar	12,777	1,739	1,398	7.00
100	Preplant	12,573	1,161	1,701	7.71
100	Split	13,276	1,774	1,805	7.49
100	Osmocote	12,728	1,831	1,929	6.85
100	Foliar	13,701	1,780	2,545	7.76
150	Preplant	8,980	1,112	1,307	7.22
150	Split	16,038	2,061	2,146	7.45
150	Osmocote	14,232	1,873	1,637	7.82
150	Foliar	11,862	1,523	1,851	7.85

*Each value represents the mean of 4 replications.

Analysis of Variance

Control vs. Treatment	ns	ns	ns	ns
Form	ns	**	ns	ns
Linear	ns	ns	ns	**
Quadratic	ns	ns	ns	ns
Form x Linear	**	**	ns	ns
Form x Quadratic	ns	ns	ns	ns

Significant at 5% (**) level or nonsignificant (ns)

Table 4. Final Vegetative Analysis of Each Treatment Collected on July 2,1987.

Total N (kg/ha)	Method	No. of Branch Crowns (#/plant)	Shoot Weights Fresh (g/ plant)	Shoot Weights Dry (g/ plant)	Root Weights Fresh (g/ plant)	Root Weights Dry (g/ plant)	No. of Runners (#/plant)	Runner Weights Fresh (g/ plant)	Runner Weights Dry (g/ plant)
0	Control	3.25	39.0	12.2	28.0	7.8	0.50	0.75	0.25
50	Preplant	4.25	52.6	16.1	33.8	8.9	0.50	1.62	0.50
50	Split	4.12	47.9	14.0	26.8	7.6	0.00	0.00	0.00
50	Osmocote	3.62	53.1	16.1	29.0	8.9	0.75	1.12	0.25
50	Foliar	3.37	46.9	14.1	31.9	9.2	0.62	1.25	0.38
100	Preplant	3.38	57.5	18.0	28.2	8.0	0.88	5.12	2.00
100	Split	3.38	44.8	12.8	22.9	6.8	0.38	1.50	0.50
100	Osmocote	5.50	65.1	18.4	39.2	11.4	1.00	2.25	0.75
100	Foliar	4.50	67.4	20.5	34.1	10.1	1.38	3.12	0.88
150	Preplant	3.88	61.1	17.8	32.0	9.0	1.75	5.50	1.25
150	Split	4.50	52.8	18.8	34.5	9.8	0.62	1.38	0.50
150	Osmocote	3.88	47.1	14.4	30.6	9.1	1.12	2.00	0.38
150	Foliar	3.25	46.6	15.0	27.1	7.8	1.50	7.50	1.88

*Each value represents the mean of 4 replications.

Analysis of Variance

Control vs. Treatment	ns	ns	ns	ns	ns	ns	ns	ns
Form	ns	ns	ns	ns	ns	ns	ns	ns
Linear	ns	ns	ns	ns	ns	**	ns	ns
Quadratic	ns	ns	ns	ns	ns	ns	ns	ns
Form x Linear	ns	ns	ns	ns	ns	ns	ns	ns
Form x Quadratic	ns	ns	ns	ns	ns	ns	ns	ns

Significant at 5% (**) level or nonsignificant (ns)

Table 5. Mean Levels of N and B Measured in Leaf Samples Collected September 10, 1986.

Total N (kg/ha)	Method	N* (%)	B* (ppm)
0	Control	2.32	26.7
50	Preplant	2.40	27.0
50	Split	2.39	27.0
50	Oscomote	2.26	25.7
50	Foliar	2.30	28.0
100	Preplant	2.54	29.0
100	Split	2.42	28.7
100	Osmocote	2.43	27.6
100	Foliar	2.50	25.0
150	Preplant	2.54	25.0
150	Split	2.29	37.3
150	Osmocote	2.60	28.0
150	Foliar	2.56	25.3

*Each value represents the mean of 3 replications.

Analysis of Variance		
Control vs. Treatment	ns	ns
Form	ns	ns
Linear	**	ns
Quadratic	ns	ns
Form vs. Linear	ns	**
Form vs. Quadratic	ns	ns

Significant at 5% (**) level or nonsignificant (ns).

CULTURAL MODIFICATION OF THORNLESS BLACKBERRY FOR MECHANIZED FRUIT HARVEST.

Takeda, Fumiomi, Donald L. Peterson, Tadeusz Kornecki, and Jerry D. Franklin.

USDA/ARS, Appalachian Fruit Research Station, Kearneysville, West Virginia 25430

Semi-erect tetraploid cultivars of thornless blackberries are highly productive, and their fruit quality is acceptable for processing. The large number and size of berries per inflorescence and numerous fruiting laterals per floricane contribute to a high yielding capacity. However, these fruiting characteristics extend the range of fruit maturity and harvest to 4-5 weeks. This wide range in fruit maturity increases the number of harvests required to remove the bulk of the crop. It also requires that mature fruit be harvested selectively without disturbing immature fruit. To develop this crop for the processing industry, a mechanical harvester was developed and has been field-tested.

In 1987 'Hull Thornless' and 'Thornfree' eastern thornless blackberry cultivars trained to an "I" (3-wire, vertical) trellis and "T" (1.0m high Lincoln canopy) trellis were shake-harvested with a prototype, tractor mounted harvester at 3-4 day intervals. In the "I" trellis, floricanes and primocanes were trained close in proximity, which caused a number of primocane lateral shoots to be damaged or broken by the harvester. In the "T" trellis where floricanes and primocanes were spatially separated, damage was minimal. The harvester detached most of mature fruit in both trellis systems. Immature fruit comprised less than 10% of harvested fruit.

Although the "T" trellis was better adapted for machine harvesting, initial tests indicated that a number of modifications in the trellis design and cultural practices would be required for a mechanized harvesting system. It was observed that when only 6 wires were used on 2m wide cross-arms, many fruit clusters were hanging too far below the trellis canopy and not accessible to the harvester. If more wires were installed to reduce the distance between adjacent wires, the probability of having more fruit clusters at the wire height and accessible to the shaking mechanism would be increased. Also, lateral shoot development below the cross-arm must be eliminated so a collection system can be properly positioned. Basal lateral shoots can be hand suckered as they appear in May, June, and July. However, in the case of "T" trellis with its wide cross-arms, the basal portion of the primocane was not readily accessible for manual suckering. Also, periodic hand suckering could become cost prohibitive. Use of certain growth regulators may resolve this problem.

Cultural practices will have to be modified to facilitate eastern thornless blackberries for harvest mechanization. We will continue attempts to improve the potential for mechanical harvesting by manipulating flowering and fruiting processes. Different cane training systems with various trellises to position fruit for machine harvesting are being studied. Preliminary field test demonstrated a promising harvesting concept for eastern thornless blackberries, however, additional research will be needed to make mechanization acceptable.

EFFECTS OF PHOTOPERIOD ON VIRGINIA CREEPER GROWTH AND SENESCENCE: IMPLICATIONS FOR CONTROL

T. J. Tworkoski and R. S. Young
USDA-ARS, Frederick, MD 21701
and
West Virginia University, Morgantown, WV 26506

Two-month-old Virginia creeper (Parthenocissus quinquefolia) was grown in controlled environment chambers with 16- or 8-hour photoperiods in order to simulate early and late-season growing conditions. Following 2 weeks in the shortened photoperiod, shoot growth and leaf area were reduced 64 and 36%, respectively, but senescence was not induced. Foliar protein concentration (32 mg/g) and chlorophyll concentration (1 mg/g) were unaffected by photoperiod. These conditions of reduced growth, prior to senescence, typically occur in the field during late August and September. The effect of the 2 photoperiods on herbicide movement within the weed was evaluated by tissue combustion and liquid scintillation spectroscopy after foliar applications of ^{14}C triclopyr. The decreased Virginia creeper growth associated with an 8-hour photoperiod did not cause a reduction in absorption or movement of triclopyr.

In a companion field study, Virginia creeper was most effectively controlled following applications of triclopyr in August, rather than in July or September. These results indicate that late season herbicide applications, prior to senescence, may be an opportune time for Virginia creeper control. In addition, long-term control may require herbicide treatment in two consecutive years.

Collecting and Manipulating Field Data Using a Polycorder

George D. Vass and William V. Welker, Jr.
U.S. Department of Agriculture
Agricultural Research Service
Appalachian Fruit Research Station
Kearneysville, WV 25430

Collecting data in the field using computer technology has resulted in increased speed and accuracy. It has provided the means to immediately process data and gather data not otherwise practical. This paper describes an electronic data recorder and small computer (the Polycorder) that we use for field data collection. The Polycorder is an electronic field notebook that substitutes a keyboard and electronic circuitry for pencil and paper. Certain models of the Polycorder are capable of communicating with instruments and sensors. These models provide inputs for analog and digital signals and outputs for digital signals. The following are examples of some of the uses we have employed over the past 5 years with this device at the Appalachian Fruit Research Station.

We have used the Polycorder in our fruit tree experiments to take standard growth measurements. This included trunk diameter, tree height, and canopy width. From these measurements, the Polycorder, under program control, calculated trunk cross-sectional area, average canopy width from measurements down and across each row, and the height + width of each tree. Since data were collected systematically within experiments, identification codes were pre-entered in the data file and displayed prior to data entry to reference location within the experiment.

An electronic caliper attached to the Polycorder was used to measure trunk diameters of young trees at periodic intervals throughout the growing season. When the caliper jaws were properly engaged on the trunk, pressing a small button on the caliper transferred the measurement directly to the data file.

Another instrument used with the Polycorder was an infrared pyrometer. Temperatures were recorded from the canopy tops of peach trees. The Polycorder was programmed to scan the pyrometer output 30 times at 1/4 second intervals and to store the mean value.

The small fruit research program has used a strain gauge to measure weight. This analog device was connected to the Polycorder to record strawberry yield. The mean voltage was converted to grams, displayed on the screen briefly, then stored in the data file automatically.

Another analog device used with the Polycorder is a thermocouple. These temperature sensing devices were placed in potted strawberry plants and in controlled temperature water bath chambers. The water baths were used to control the soil temperature in the strawberry containers. The Polycorder was programmed to turn itself on at specified intervals and record the temperature in the soil and water. The Polycorder contains a clock and calendar, thus the time and date may also be recorded for each temperature record.

These are only a few examples of the uses we have made of electronic data collection. They have resulted in improved efficiency and accuracy in recording data.

Unofficial Report

GLYPHOSATE, TRICLOPYR, 2,4-D RESPONSE ON VIRGINIA CREEPER

Roger S. Young
West Virginia University Experiment Farm
Kearneysville, WV 25430

ABSTRACT

Virginia creeper [Parthenocissus quinquefolia (L.)Planch], a woody plant species, has the capability of making a solid ground cover under the canopy of an orchard tree as well as climbing the tree to envelop the entire canopy. Creeper has been observed to climb to the top of 100 foot forest trees.

All treatments have been made at Jefferson Orchards in a 1963 'Starkrimson' apple planting and a 1967 'Loring' peach planting both planted 6.7 by 7.6 m (22 by 25 feet) and seeded to orchardgrass for the ground cover. The Virginia creeper in the apple planting has had, on occasion, a considerable canopy of hemp dogbane and other tall weeds above the creeper foliage which has restricted spray coverage. Spray coverage of creeper has been excellent in the peach planting. Both plantings have had the same type of orchard floor management. A residual herbicide with paraquat has been applied in the spring followed by one or two under tree cutter bar mowings and an additional one or two rotary mowings in the median during the growing season. Both plantings have creeper in the tree canopy. The peach tree being more open appeared to have a greater proportion of creeper to tree canopy than is present in the apple canopy.

Four to six trees were used for each treatment. The treated area was a band 2.4 by 6.7 m per tree (16.9 square meters per tree) having a 90 to 100% Virginia creeper coverage. The systemic materials (glyphosate, 2,4-D, triclopyr) have occassionally translocated a large enough quantity to the terminals of the creeper vine growing in the tree canopy to cause vine kill.

1983 TREATMENTS

Single applications were made May 25 and June 13 of sulfosate 4.48 kg/ha (4.0 lb/A), glyphosate 4.48 kg/ha, and glufosinate 1.68 kg/ha (1.5 lb/A) with a Floodjet TK-5 nozzle at 10 psi, 16 liter/ha (150 gal/acre). Creeper extension growth averaged 68 cm one year posttreatment.

1984 TREATMENTS

Micron Herbi applied using the 0.5 mm orifice applying approximately 11.5 liter/ha (1.2 gal/acre).

June 6: undiluted glyphosate 4.6 kg/ha (4.1 lb/A) and a 50% glyphosate solution (2.3 kg/ha) reduced the 100% creeper green foliage coverage for a 2 meter square area to 1% 13 weeks posttreatment (September 10). One replication had three nodes of stems producing regrowth. An average of 4.3 (range 1 to 9) seedling Virginia creeper plants were present in the six two square meter replications. Vines in trees had varying responses: a) two trees had all vines with no green foliage, b) one tree had five of seven vines with no green foliage, The vines on trees which showed response in 1984 were not completely killed. Observations of the treated areas made September 10,1985 (16 months posttreatment) showed new ground vine growths of one to two meters in length spreading from the trunk area of trees having creeper vines in the tree canopy. Seedling plants had grown to lengths of two meters. Some encroachment occurred from creeper outside of the treated areas. Observations made August 1987 (38 months posttreatment) showed 100% of the area to be reinfested with creeper.

June 6: Herbi applied triclopyr 0.9 kg/ha (0.8 lb/A) showed complete wilting response of contacted foliage 24 hours posttreatment and reduced the 100% creeper coverage to less than 1% at the September 10, 1984 observation. Reinfestation as with glyphosate was occurring 16 months posttreatment.

June 6: Herbi applied NAA 1.12 kg/ha (1.0 lb/A) resulted in no response to creeper.

August 31: Herbi applied — glyphosate 2.24 and 4.48 kg/ha both + 0.5% X-77 and triclopyr 0.56 and 0.896 kg/ha (0.5, 0.8 lb/A) had 0 to 75% creeper control 12 months posttreatment.

September 18: Herbi applied at 72.9 liter/ha (7.8 gal/A) glyphosate 1.12 and 2.24 kg/ha had 99% control 9 months posttreatment but was completely reinfested at the June 1987 observations.

Boom applied with flat fan nozzle tips OC02 + 15002 calibrated at 112.2 liter/ha (12 gal/A) and tips OC08 + 11008 calibrated at 252.4 liter/ha (27 gal/A).

August 31: (A) glyphosate 2.24 and 4.48 kg/ha both+ 0.5% X-77; (B) triclopyr 0.56 and 0.896 kg/ha (0.5, 0.8 lb/A).
Even the high rates of glyphosate and triclopyr were not as effective as the Herbi applications of September 18.

1985 TREATMENTS
Boom applied with flat fan nozzle tips OC02 + 15002 calibrated at 51.4 and 95.4 liter/ha (5.5 and 10.2 gal/A) and tips OC08 + 11008 calibrated at 261.8 liter/ha (28 gal/A) were used with each chemical rate.

June 12: (A) glyphosate 1.12 kg/ha, 1.12 + Frigate, 2.24 and 4.48 (1.0, 2.0, 4.0 lb/A); (B) sulfosate 1.12, 1.12 + Frigate, 2.24 kg/ha; (C) triclopyr ester + 2, 4-D ester 1 to 2 ratio (Crossbow) 1.68, 2.8 kg/ha (1.5, 2.5 lb/A).

July 17: (A) glyphosate 2.24 kg/ha + X-77, Frigate; (B) glyphosate 4.48; (C) sulfosate 4.48

Aug. 13: (A) glyphosate 2.24 kg/ha + X-77 0.5%, 3.36 + X-77 0.5%.

Sept. 29: 51.4, 95.4 and 261.8 liter/ha: glyphosate 2.24 4.48; sulfosate 2.24 kg/ha. Some fall leaf coloration present at application on creeper foliage.

Evaluations made one year posttreatment (June 12, 1986):

Glyphosate or sulfosate.12 kg/ha — 0% control of creeper, 2.24 kg/ha + adjuvant — 0 to 90% for 51.4, 95.4 liter/ha (5, 10 gal/A) application rate and 70 to 95% for 261.8 liter/ha (28 gal/A) application rate, 3.36 kg/ha + adjuvant — 0 to 98% for 51.4 liter/ha rate (5.5 gal), 50 to 98% for 261.8 liter/ha (28 gal).

Crossbow 1.68 kg/ha — 90 to 95% for 93.5 liter/ha, 95–99% for 261.8 liter/ha. As of August 1987 all treatments had unsatisfactory control of Va. creeper due to lack of complete kill of sprayed area and encroachment from vines in trees or non sprayed creeper in drive middle or adjacent trees.

1986 TREATMENTS

All herbicide treatments were applied at diluent rates of 93.5 and 261.8 liter/ha (10 and 28 gal/A) using flat fan nozzles OC02 + 15002 and OC08 + 11008 respectively. All triclopyr treatments had the adjuvant XRM 4823 added at the rate of 0.08 ml/ml of triclopyr. Spray coverage of Va. creeper was hampered by the taller canopy of hemp dogbane.

June 13: application in apples seven days postmowing with sickle bar — (A) glyphosate 1.68 and 3.36 kg/ha; (B) triclopyr amine + Dacamine (1:2 ratio) 2.24 and 3.36 kg/ha; (C) Envy 2,4-D 2.24 kg/ha; (D) Hi-Dep 2.24 kg/ha.

Observation made 14 months posttreatment: all 93.5 liter/ha treatments gave 0% control; the 261.8 liter/ha application rate only triclopyr amine + 2,4-D (1:2) 3.36 and Envy 2,4-D responed with 10% control. All other treatments resulted in no control.

July 15: application in apples — (A) glyphosate 2.24 and 3.36 kg/ha; (B) triclopyr + Dacamine (1:2) 2.24 and 3.36; (C) Envy 2,4-D 2.24; (D) Hi-Dep 2.24 and 2.24 + X-77.

A one hour 15 minute rainfall of 0.71 cm (0.28") occurred twenty hours following applications.

These treatments responded poorly due to the rainfall and poor sprayer coverage of creeper. Observations made 13 months posttreatment showed 60% control for glyphostae 3.36 kg/ha; 30 and 70% control for triclopyr amine + 2,4-D (1:2) 2.24 and 3.36 kg/ha respectively. All other treatments resulted in 0 to 10% control.

September 18: application in peaches — (A) triclopyr amine + 2,4-D (Envy) (1:2 ratio) 2.24 and 2.69 kg/ha; (B) glyphosate 2.24; (C) glyphosate 2.24 + X-77 and 2.24 + Exhalt 800.

A light frost occurred on September 17.

Observation of 23 Sept '86 showed a response from the triclopyr amine + 2,4-D amine. Observation nine months posttreatment:for 261.8 liter/ha applications — glyphosate 2.24- 20%, 2.24 + X-77- 75%, 2.24 + Exhalt 800- 70%; triclopyr amine + 2,4-D (1:2)2.24 and 2.88- 50%; for 93.5 liter/ha applications — triclopyr + 2,4-D (1:2) 2.24- 35%; glyphosate 2.24- 25%, 2.24 + X-77- 30%, 2.24 + Exhalt 800- 15%.

1987 TREATMENTS

All treatments were applied at 280 liter/ha (30 gal/A) using flat fan nozzles OC08 and 11008 at 275.6 K Pa (40 psi). All triclopyr treatments had the adjuvant XRM 4823 added at the rate of 0.08 ml/ml of triclopyr. The June 10 and August 14 applications were made in the apple orchard and the July 16 application in the peach orchard. Virginia creeper bloomed June 28 to July 12.

June 10: (A) triclopyr amine 0.28 and 0.43 kg/ha; (B) triclopyr amine + 2,4-D amine (1:2 ratio - Turflon II Amine) 1.34, 1.61 and 2.15 kg/ha; (C) glyphosate 0.56 + adjuvant XRM 4823 and 2.24 kg/ha + adjuvant XRM 4823; (D) glyphosate 0.56 + triclopyr 0.43; (E) glyphosate + 2,4-D (Dacamine 4D) 1.12 +1.12 and 2.24 + 2.24 each with 0.5% X-77; (F) 2,4-D (Dacamine 4D) 1.12 and 2.24 kg/ha.

Observations made Sept. 10,1987: glyphosate + 2,4-D 1.12 and 2.24 each - 35 and 40% control respectively; 2,4-D (Dacamine 4D) 1.12 and 2.24 - 0% and 18% control respectively; Turflon II 1.34, 1.61 and 1.92 - 20, 7 and 68% control respectively; the rest of the treatments less than 10% control.

July 16: (A) triclopyr amine 0.28 and 0.43 kg/ha; (B) triclopyr amine + 2,4-D amine (Turflon II Amine) 1.34, 1.61 and 2.15 kg/ha; (C) glyphosate 0.56 + adjuvant XRM 4823 and 2.24 kg/ha, (D) glyphosate 0.56 + triclopyr 0.43; (E) glyphosate + 2,4-D (Dacamine 4D) 1.12 +1.12 and 2.24 + 2.24 each with 0.5% X-77; (F) 2,4-D (Dacamine 4D) 2.24 kg/ha.

Observations six weeks posttreatment (Aug. 27)—percent green creeper foliage: glyphosate 2.24 + XRM 4823- 42%; glyphosate 0.56 + triclopyr amine 0.83- 0%; glyphosate 2.24 + 2,4-D 2.24- 0.5%; triclopyr 0.28- 0.5% and 0.43- 10%; Turflon II all rates- 0 to 0.5%.

August 14: (A) triclopyr amine + 2,4-D amine (1:2 ratio - Turflon II Amine) 2.24 and 2.80 kg/ha; (B) triclopyr amine + 2,4-D (Dacamine 4D) 1:2 ratio 3.36 and 3.92; glyphosate 3.36 kg/ha; (C) glyphosate + 2,4-D (Envy 2,4-D) 2.24 + 2.24; (D) 2,4-D (Dacamine 4D; Envy 2,4,D; Hi-Dep) each at 3.36 kg/ha.

The ground floor vegetation had been sickle bar mowed August 13 with most of the creeper not being disturbed; however, some of the areas had a very light and scattered covering of grass on top of the creeper.

Observations made Sept. 10,1987: glyphosate 3.36 kg/ha had 28% green creeper foliage, Dacamine 4D had 1% green creeper foliage, all other treatments had 0 green foliage. A later observation not recorded noted other treatments with one or more new shoot growths arising from the spray contacted stems.