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PROCEEDINGS
CUMBERLAND-SHENANDOAH FRUIT WORKERS CONFERENCE

62ND ANNUAL MEETING

HARPERS FERRY, WEST VIRGINIA

NOVEMBER 20-21, 1986

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62ND ANNUAL MEETING
CUMBERLAND-SHENANDOAH FRUIT WORKERS CONFERENCE
Harpers Ferry, West Virginia
November 20-21, 1986

The 62nd Annual Meeting of the Cumberland-Shenandoah Fruit Workers Conference was called to order at 9:05 a.m. on November 20, 1986 by Chairman Roger Young. The meeting was hosted by West Virginia University. Chairman Young appointed John Ridley and Jerry Frecon as a nominating committee to select the 1987 slate of officers. The hosts for future meetings are as follows:

1987 - New Jersey - South Carolina
1988 - Virginia
1989 - Maryland
1990 - North Carolina
1991 - USDA
1992 - Pennsylvania
1993 - West Virginia

The morning joint session began at 9:15 a.m. with 65 persons in attendance. The discussion topic of "Spray Pesticide Disposal" was moderated by Roger Young, who opened the session with some introductory comments describing the problem. Jeffrey Karns (USDA) described microbial degradation processes and the operation of the USDA Pesticide Degradation Laboratory in Beltsville, MD. Currently used or proposed methods of pesticide disposal at the USDA and various university research facilities were presented by Bill Butt (USDA), 'Skip' Jubb (MD), Steve Blizzard (WV), Bob Horsburgh (VA) and Ken Hickey (PA). Jerry Frecon (NJ) discussed a "Pesticide Disposal Day" which was conducted as a means for farmers to dispose of unwanted or unregistered pesticides. The cost of disposal was funded by a grant from the New Jersey Department of Environmental Protection.

Following lunch, Entomology and Plant Pathology met in a joint session while Horticulture met separately. An evening meeting was held by Plant Pathology to discuss fire blight, while Horticulture had an evening discussion on bloom thinning of peaches and drop control. Entomology, Plant Pathology and Horticulture met in separate sessions on Friday morning, November 21, until 10:00 a.m. Following the submitted paper sessions, a joint 'rap 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. Roger Young moderated this session.

The closing business meeting was called to order at 11:30 a.m. by Roger Young. Jim Kotcon, Plant Pathology-Entomology secretary and Morris Ingle, Horticulture secretary presented their respective reports. Henry Hogmire presented the report for the Friday morning Entomology session, as well as the financial report. The nominating committee presented the following slate of officers for the 1987 meeting: Barbara Goulart, chairperson; John Ridley, general secretary Clyde Gorsuch, Entomology division coordinator; Jack Springer, Plant Pathology division coordinator; Tony Hopfinger, Horticulture division coordinator; Fred Swift, Entomology secretary; Eldon Zehr, Plant Pathology secretary; Ed Durner, Horticulture secretary.

It was decided to hold the 1987 meeting at the Cliffside Inn, Harpers Ferry, on November 19-20. There was some discussion about the problem experienced with meeting rooms due to the few number of people lodging at Cliffside. Quite a few individuals who waited until after the deadline to make reservations found that no rooms were available and were forced to stay elsewhere. Because of the Cliffside's proximity to historic Harpers Ferry, it is an attractive and rapidly booked meeting place for groups from the Baltimore and Washington, D.C. area. Rooms held for our group that were not reserved by the closing date were released and taken by another group. Because this group had proportionately more rooms reserved that the CSFW's, they were given preferential treatment in the assignment of meeting rooms. As a result, we experienced last minute meeting room changes which created some inconvenience. In order to avoid this problem in the future and to be ensured of available meeting rooms at no charge, participants were strongly encouraged to stay at the Cliffside and to make their room reservations prior to the closing date.

FINANCIAL REPORT

Income

Balance Forward, November 1985	$319.09
Proceeds from Spray Application Conference (Dec. 1984)	325.62
Interest	31.02
Registration - 86 @ $10.00	860.00
TOTAL	1,535.73

Expenses

Coffee Breaks	360.00
Proceedings (cover, binding and mailing)	345.23
Postage (mailing of meeting announcement and program)	68.00
Registration Clerks (2)	50.00
TOTAL	823.23
BALANCE	$ 712.50

Respectfully submitted,

Henry W. Hogmire, Jr.

Henry W. Hogmire, Jr.
General Secretary and Treasurer

1986 CUMBERLAND-SHENANDOAH FRUIT WORKERS CONFERENCE

ENTOMOLOGY

Paper No.

1. BROWN, M. W. Preliminary studies on the biology of *Lyonetia speculella*, a leafminer of apple.

2. HOGMIRE, JR., H. W. and L. CRIM. Kelthane phytotoxicity study, 1986.

3. HOGMIRE, JR., H. W. and L. CRIM. Cyhexatin formulation study, 1986.

4. HOGMIRE, JR., H. W. and L. CRIM. Apple, acaricide evaluation, 1986.

5. HOGMIRE, JR., H. W. and L. CRIM. Apple, insecticide evaluation, 1986.

6. HORSBURGH, R. L. and L. J. COBB. Report for the 1986 Cumberland-Shenandoah Fruit Workers Conference.

7. HORSBURGH, R. L. and L. J. COBB. Apple, early season aphicide evaluations, 1986.

8. HORSBURGH, R. L. and L. J. COBB. Apple, Evaluation of the effect of Savey and Pounce on early season mite populations, 1986.

9. HORSBURGH, R. L. and L. J. COBB. Apple, miticide evaluations, 1986.

10. HORSBURGH, R. L. and L. J. COBB. Apple, full season insecticide evaluations, 1986.

11. HORTON, D., J. PAYNE, A. AMIS and D. WARNOCK. Insect management in Georgia blueberries with emphasis on cranberry fruitworm.

12. KAAKEH, W., D. G. PFEIFFER and R. P. MARINI. Influence of spirea aphids, *Aphis citricola* (Homoptera: Aphididae), and sooty mold on net photosynthesis and chlorophyll content of apple leaves.

13. KNIGHT, A. L. and L. A. HULL. Residual control of tufted apple budmoth with Azinphosmethyl and Methomyl applied as alternate-row middle sprays.

14. PFEIFFER, D. G., M. W. BROWN and M. W. VARN. Incidence of spirea aphid versus apple aphid in orchards of Cumberland-Shenandoah region.

15. VARN, M. W. and D. G. PFEIFFER. Effects of Dysaphis plantaginea on phloem integrity of apple leaves.

16. PFEIFFER, D. G. and J. C. KILLIAN. Pheromone disruption for the control of Oriental fruit moth and lesser peachtree borer.

17. PFEIFFER, D. G. and J. C. KILLIAN. Grape root borer flight activity in Virginia.

18. BOUCHER, T. J. and D. G. PFEIFFER. Importance of Japanese beetle foliar feeding on grapevines.

19. PFEIFFER, D. G., R. P. MARINI and D. SOWERS. Apple, Kelthane 4MF phytotoxicity trial, 1986.

20. PFEIFFER, D., L. PONTON and M. VARN. Apple, mite control trial, 1986.

21. PFEIFFER, D., L. PONTON, M. VARN and M. BENSON. Apple, ABG-6162HV mite trial, 1986.

22. STUART, L. C., B. A. BUTT and F. TAKEDA. Leaf curl of Eastern thornless blackberry caused by blackberry psyllid, Trioza tripunctata Fitch.

23. SWIFT, F. C., E. J. HERMAN and V. STARNER. Effect of severe European red mite damage on yield, size, sugar content, and firmness of Red Delicious apples.

24. SWIFT, F. C., E. J. HERMAN and V. STARNER. Effect of Fenvalerate on populations and control of European red mite on peaches.

25. SWIFT, F. C. and E. J. HERMAN. Monitoring for resistance to Apollo and Savey using overwintering eggs of European red mite.

26. SWIFT, F. C., E. J. HERMAN and V. STARNER. Spray timing based on degree days for control of early generations of Oriental fruit moth on peaches.

27. SWIFT, F. C., E. J. HERMAN and V. STARNER. Insecticidal control of tarnished plant bug and Oriental fruit moth on peaches.

28. SWIFT. F. C., E. J. HERMAN and V. STARNER. Field evaluation of acaricides for control of European red mite.

PLANT PATHOLOGY

29. BARRAT, J. G. Bravo 720 fungicide trials on Blake peaches for the control of peach leaf curl, peach scab and brown rot.

30. BARRAT, J. G. Fungicide trials for apple disease control - 1986.

31. BARRAT, J. G. and T. VAN DER ZWET. Fire blight control trials - 1986. Block X - WVU Experiment Farm.

32. BARRAT, J. G. and T. VAN DER ZWET. Fire blight control trials - 1986. Nittany apples - Blocks G-6, J-5 - WVU Experiment Farm.

33. BARRAT, J. G. and T. VAN DER ZWET. Fire blight control trials - 1986.

34. BARRAT, J. G. and L. A. SCHWARTZ. ELISA indexing survey for Prunus necrotic ringspot virus in West Virginia peach orchards.

35. DRAKE, C. R. Management of apple diseases at Blacksburg, Virginia during 1986.

36. DRAKE, C. R. Management of peach diseases at Blacksburg, Virginia during 1986.

37. DRAKE, C. R. Management of nectarine diseases at Blacksburg, Virginia during 1986.

38. DRAKE, C. R. Effect of Vapor Guard, irrigation and tree topping on color, size and market quality of peach fruit at Blacksburg, Virginia during 1986.

39. HICKEY, K. D. and J. MAY. Apple scab and powdery mildew incidence on 'Rome Beauty' apple treated with post infection sprays applied with an airblast sprayer in 1986.

40. HICKEY, K. D., J. MAY and G. McGLAUGHLIN. Disease incidence on apple treated with seasonal dilute sprays of experimental fungicides in 1986.

41. HICKEY, K. D., J. MAY and G. McGLAUGHLIN. Efficacy of protective dilute fungicide sprays for disease control in 1986.

42. HICKEY, K. D., J. MAY and G. McGLAUGHLIN. Evaluation of fungicide sprays applied dilute and timed for post-infection control of scab or as protectants for scab and p. mildew in 1986.

43. HICKEY, K. D., J. MAY and G. G. CLARKE. Evaluation of fungicides for control of brown rot and Rhizopus rot control on peach in 1986.

44. HICKEY, K. D., J. MAY and G. G. CLARKE. Evaluation of fungicides for control of rusty spot on peach in 1986.

45. HICKEY, K. D., J. MAY and G. G. CLARKE. Control of brown rot and Rhizopus rot on peach with seasonal fungicide treatments in 1986.

46. HICKEY, K. D., J. MAY and G. G. CLARKE. Evaluation of fungicides for effects on fruit quality and disease control in 1986.

47. KOTCON, J. B. Peach nematode survey results from West Virginia.

48. SUTTON, T. B. and L. R. POPE. Sooty blotch and flyspeck control with combinations of fungicides, 1986.

49. YODER, K. S., A. E. COCHRAN II, J. R. WARREN, C. M. SCHMIDT and G. S. PALMER. Evaluation of fungicide combinations applied on protectant or after-infection schedules for control of scab on York Imperial apple, 1986.

50. YODER, K. S., A. E. COCHRAN II, J. R. WARREN, C. M. SCHMIDT and G. S. PALMER. Evaluation of sterol-inhibiting fungicides for powdery mildew control on Jonathan apple, 1986.

51. YODER, K. S., A. E. COCHRAN II, J. R. WARREN, C. M. SCHMIDT and G. S. PALMER. Evaluation of experimental fungicides on three apple cultivars, 1986.

52. YODER, K. S., A. E. COCHRAN II, J. R. WARREN, C. M. SCHMIDT and G. S. PALMER. Evaluation of concentrate applications of combined mildewcides on Jonathan apple, 1986.

53. YODER, K. S., A. E. COCHRAN II, J. R. WARREN, C. M. SCHMIDT and G. S. PALMER. After-infection control of cedar-apple rust by sterol-inhibiting fungicides, 1986.

54. YODER, K. S., A. E. COCHRAN II, J. R. WARREN, C. M. SCHMIDT and G. S. PALMER. Evaluation of fungicide combinations on three apple cultivars, 1986.

55. YODER, K. S., A. E. COCHRAN II, J. R. WARREN, C. M. SCHMIDT and G. S. PALMER. Evaluation of concentrate applications of Dithiocarbamate formulations on Golden Delicious apple, 1986.

56. YODER, K. S., A. E. COCHRAN II, C. M. SCHMIDT and J. R. WARREN. Control of penicillium blue mold by postharvest dip treatments, 1985-86.

57. YODER, K. S., A. E. COCHRAN II, J. R. WARREN, C. M. SCHMIDT and G. S. PALMER. Evaluation of experimental fungicides on peach and nectarine, 1986.

HORTICULTURE

58. BAUGHER, T. AUXT and S. WALTER. Effect of 2,4-DP on preharvest drop and firmness of 'Rome' apples.

59. BYERS, R. E. and S. J. DONOHUE. Bloom thinning peach trees with fertilizers.

60. BYERS, R. E. Tree-row-volume spraying rate calculator.

61. CARCATERRA, S., T. BAUGHER and A. SELDERS. Orchard deer damage control demonstration - an integrated approach.

62. CAYTON, B. D., S. SINGHA, S. H. BLIZZARD and T. A. BAUGHER. Fruit yield and quality of apple trees under three training systems.

63. DURNER, E., T. GIANFAGNA and A. HOPFINGER. PPG-1721 effects on color, maturity and abscission of 'Rome', 'Red Delicious' and 'Empire' apples.

64. FOY, C. L. and H. L. WITT. Lactofen in combination with other herbicides for weed control in young apple plantings in Virginia in 1986.

65. FRECON, J. L. Pesticide disposal days - another alternative.

66. FRECON, J. L. and B. GOULART. Table grape cultivar investigations in New Jersey.

67. GLENN, D. M. and W. V. WELKER. Growth patterns of peach trees as related to plant available water.

68. GOULART, B. L. Bramble research in the Eastern United States: a survey.

69. GREENE II, G. M. and R. H. ZIMMERMAN. Effect of own and clonal roots on the growth and productivity of apples.

70. INGLE, M., S. SINGHA, T. BAUGHER, M. D'SOUZA, S. WALTER and S. BLIZZARD. Observations on early crops of 'Red Delicious' strains.

71. MARINI, R. P., R. E. BYERS and D. SOWERS. Apple preharvest drop control.

72. MILLER, S. S., C. REEDER and B. J. ELDRIDGE. Observations on the use of paclobutrazol for bearing apple trees.

73. MYERS, S. C., D. HORTON, R. SHEWFELT and D. WARNOCK. Packinghouse loss and packout assessment of Coronet peach.

74. RIDLEY, J. D. and D. C. COSTON. Peach bloom thinning with ammonium thiosulfate.

75. SUN, X., S. Y. WANG, Y. TONG, R. KORCAK and M. FAUST. Metabolic changes in iron-deficient apple seedlings.

76. TUKEY, L. D. Fire blight infection on apple rootstocks in the field.

77. TUKEY, L. D. Triazole inhibitors and tree size controlling rootstocks.

78. TWORKOSKI, T. J., R. S. YOUNG and J. P. STERRETT. Effects of adjuvant concentration and formulation on triclopyr fate in Virginia creeper.

79. WELKER, JR., W. V. and D. M. GLENN. Growth and yield response of young peach trees to various levels of sod competition.

80. YOUNG. R. S. 1964 to 1986 Simazine treatments on a Weikert-Berks complex orchard soil.

Preliminary studies on the biology of *Lyonetia speculella*, a leafminer of apple.

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Lyonetia speculella Clemens (Lepidoptera: Lyonetiidae) was first reported to mine leaves of apple by Frost (1924). There has been little mention of this insect in the literature since the 1920's (Forbes 1923, Frost 1924) and it has gone largely without notice. Recently, however, growers in Virginia and West Virginia have voiced concern over the damage caused by this species (D. G. Pfeiffer, Virginia Polytechnic Inst. and State Univ.; and H. W. Hogmire, Jr., West Virginia Univ.; personal communication). Little is known about the biology, control, or injury caused by *L. speculella*. This study was conducted to gain preliminary information on which to base more intensive studies. Some observations are presented with little or no replication or confirmation, but in light of the relative dearth of knowledge, they are presented as observations to be confirmed or refuted by further research.

Every tree in a newly established orchard, planted 9 April, 1986, was examined for larvae of *L. speculella* monthly from mid-June to mid-September, 1986. The planting consisted of 273 'Northern Spy' and 351 'Triple Red Delicious' apple trees at a spacing of 4m x 5m, covering 1.34 ha (3.32 A). Trees of each cultivar were distributed throughout the planting. The orchard was located at the Appalachian Fruit Research Station, Kearneysville, WV. For each sample period, all active leafminer larvae were counted on every tree and recorded as number of larvae per infested leaf.

The most important aspect of the biology of *L. speculella* is its requirement for young foliage. Oviposition seems to be only on the underside of expanding leaves. Most of the development of the larva occurs during leaf expansion with the larva leaving the leaf to pupate prior to, or soon after, full leaf expansion. The preference for young leaves explains why Brown and Adler (unpub. data) found *L. speculella* more abundant in commercial than in abandoned orchards, the trees in commercial orchards being more vigorous and having more expanding shoots.

Although *L. speculella* overwinters as adults, leafmines were not found in the study area till early June, 1986. A few leafmines were found in a nearby block on 29 April, and again 22 May, 1986. Apparently, at least one generation was completed prior to the first sample on 10-14 June. Throughout the summer, development of the larval stage was completed within a month, so no individual was counted in more than one sample. In fact, some larvae developed completely between sample periods and were not counted at all. By the mid-July sample, there seemed to be completely overlapping generations as all sizes of leafmines were visable.

During the 10-14 June sample, 18% of the trees were infested with 475 leafminer larvae. The infestation was concentrated around the periphery of the study block. In the 7-11 July sample, leafminers were found on 40% of the trees and 976 larvae were counted. Infested trees were distributed more randomly throughout the orchard. On 5-6 August, 30% of the trees were infested with 748 larval leafminers. The infested trees were again distributed randomly throughout the block. The decrease in the number of leafminers between July and August was probably due to an application of Vydate® on 21 July, applied to control mites, leafhoppers, and aphids. A nearby block of 24 one-year-old 'Red Delicious trees', which was not sprayed with pesticide, experienced an increase in leafminer population over the same time period. Applications of Lorsban®, Plictran®, and Lannate® in the same study block did not seem to have an effect on L. speculella populations. The final sample, 8-11 September, revealed a large population increase to 6864 larvae with 53% of the trees infested. At this last sample, the majority of larvae were very young, either first instars initiating leafmines, or early instars prior to formation of the blotch stage of the mines. (L. speculella larvae initially make a serpentine mine, enlarging it to a blotch mine about halfway through development.) Earlier samples had a more equal distribution of age classes. The final generation came to an abrupt end the week of 6 October. No active larvae were found on 10 October; many mines contained dead larvae. The most plausible reason for this mortality is the first cold weather for the fall, 1°C (34°F) on the morning of 6 October.

From the distribution of infested trees during the June sample, it is evident that L. speculella adults came into the orchard from other apple orchards or alternate hosts. Initial population growth (June to July) (Fig. 1) took place solely through an increase in number of trees infested (Fig. 2). Number of infested leaves per infested tree (Fig. 3) and larvae per infested leaf (Fig. 4) stayed constant or decreased over the same period. Natural population growth was interrupted between July and August by the application of Vydate®, making it difficult to make inferences about population development during the July-August period. From August to September there was a nine-fold increase in number of leafminers compared to a two-fold increase from June to July (Fig. 1). This increase was accounted for only slightly by an increase in the number of trees infested (Fig. 2). Most of the increase was due to large increases in the number of infested leaves per infested tree (Fig. 3) and larvae per infested leaf (Fig. 4).

There is an apparent maximum of 50% of the trees infested with L. speculella. This is probably a result of the phenology of the trees rather than a population parameter. There was a prolonged drought throughout the summer, resulting in fewer flushes of growth. Because of the dependence of this species on young foliage, trees which are not producing new leaves escape infestation from L.

speculella. During the September sample, it was noticed that nearly every tree that had young leaves did have L. speculella leafmines. There were also significant differences between cultivars in the population variables measured in July and again in September. This, too, is primarily a result of differences in growth pattern and phenology between 'Northern Spy' and 'Triple Red Delicious'.

The statistical distribution of the data was analyzed using 8 data sets, each cultivar considered separately at each sample period. Number of L. speculella larvae per tree and number of infested leaves per tree were distributed as a negative binomial. The statistical distribution of the most appropriate variable for analyzing distribution patterns, number of L. speculella per leaf, could not be estimated; because, due to not knowing what constituted an acceptable leaf for oviposition, the number of leaves with no larvae could not be estimated. A regression of the log variance against log mean for the number of trees infested and number of infested leaves per tree from the eight data sets was conducted to estimate the proper normalizing transformation (Healy and Taylor 1962). The regression equations were log(variance) = 0.76 + 1.63 log(mean) (r^2=0.96) for leafmines per tree and log(variance) = 0.42 + 1.27 log(mean) (r^2=0.94) for infested leaves per tree. The suggested normalizing transformations are x' = (number of larvae per tree)$^{.18}$, and y' = (number of infested leaves per tree)$^{.36}$; where x' and y' are the transformed values.

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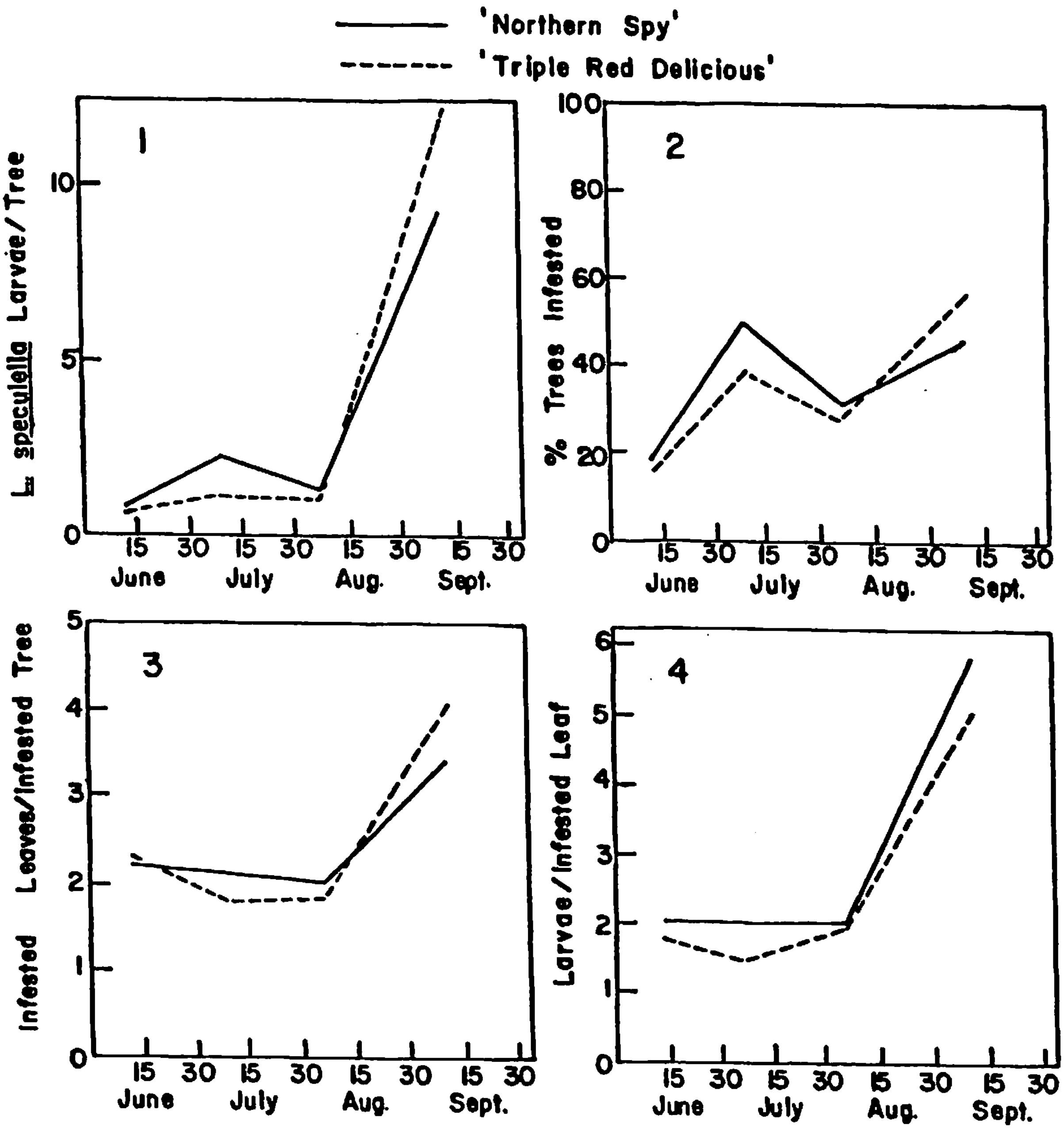

Figure 1. Number of Lyonetia speculella larvae per tree by cultivar using 273 'Northern Spy' and 351 'Triple Red Delicious' one-year-old trees, 1986.

Figure 2. Percent of 'Northern Spy' and 'Triple Red Delicious' trees infested with L. speculella, 1986.

Figure 3. Number of leaves infested with L. speculella per infested tree, 1986.

Figure 4. Number of larval L. speculella per infested leaf, 1986.

NOT FOR PUBLICATION
Table 1

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APPLE: Malus domestica Borkh., 'Golden Delicious'

KELTHANE PHYTOTOXICITY STUDY, 1986: Three formulations were applied at 3 lb ai/acre to 5 tree plots of 22-year-old trees in a single row. Applications were made with a Swanson DA500A airblast sprayer which traveled at 3.86 k/hr and delivered 935 l/ha. Dates of application were 9 May (petal fall) and 3 Jun. Other materials applied separately to all treatments were Benlate, Bordeaux mixture, Captan, Cygon, Dithane M-45, Dithane Z-78, Guthion, Lannate, Lorsban, Nudrin, Oil, Penncap-M, Phosphamidon, Polyram, Solubor, Streptomycin, Topsin-M and Trithion. Both leaves and fruit were examined for phytotoxicity. The degree of russeting (finish rating) was determined by sampling 100 fruit from each of 5 replications at harvest.

All formulations caused mottled chlorosis type injury on foliage, however, relatively few leaves were affected. There was significant difference in foliage injury among the 3 formulations. Significantly more fruit were russeted by XF-85017 and XF-85018 formulations. A greater percent of the fruit surface was russeted by all 3 formulations compared to the check, however, there was no significant difference among the formulations.

	17 Jun		15 Aug	17 Sep
Treatment	Chlorotic leaves/tree[a]	Russeted fruit/tree[a]	Russeted fruit/tree[a]	Finish Rating[a,b]
XF-86006 4F	28.6 c	16.2 a	82.0 ab	2.16 b
XF-85017 4F	39.8 d	21.2 a	138.4 c	2.17 b
XF-85018 4EC	19.0 b	36.8 b	122.6 bc	2.28 b
Check (Water)	3.0 a	13.6 a	65.8 a	1.96 a

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

[b]Finish rating is based on the percent of fruit surface russeted as follows: 1 = 0%, 2 = 1-25%, 3 = 26-50%, 4 = 51-75%, 5 = 76-100%.

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Table 2

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APPLE: Malus domestica Borkh., 'Red Delicious'
European red mite (ERM): Panonychus ulmi (Koch)

CYHEXATIN FORMULATION STUDY, 1986: Two formulations of cyhexatin miticide (Plictran 50W, XRM-4868 5F) were applied at 0.5 lb ai/acre to 5 row plots of 32-year-old trees at Swan Pond orchard. Applications were made with a FMC Bean 4000 CP airblast sprayer which traveled at 4.0 k/hr and delivered 935 l/ha. Dates of application were 10 Jul (after precount) and 15 Jul. Treatment effectiveness was determined by sampling 25 leaves from the periphery of each of 4 random replications selected from the center row of each treatment. ERM were removed from leaves with a mite-brushing machine and active stages were counted with a binocular microscope.

The flowable formulation of cyhexatin miticide provided more effective mite suppression than the wettable powder formulation. No phytotoxicity was observed.

		Mean No. ERM/leaf[a]		
No.	Treatment	10 Jul	14 Jul	24 Jul
1	Plictran 50W	16.2 a	17.0 b	2.1 a
2	XRM-4868 5F	11.1 a	6.2 a	0.3 a

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

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

APPLE, ACARICIDE EVALUATION, 1986: Acaricides were applied to 4 single-tree replications of 32-year-old trees in a randomized block design. Applications were made with a Swanson DA500A airblast sprayer which traveled at 3.86 k/hr and delivered 935 l/ha. Dates of application were 14 Apr [pink (P)] and/or 6 May [petal fall (PF)] and 11 Jul, or 27 Jun, depending upon treatment. Other materials applied separately to all treatments were Benlate, Bordeaux mixture, Captan, Dithane M-45, Manzate 200, Polyram, Solubor and Streptomycin. ERM 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. Treatment effect on SP was determined by counting adults and larvae on the periphery of test trees observed during a 3-minute period.

Apollo provided more effective mite suppression than Morestan following an early season application. No difference was detected in mite control due to rate or time of application (pink vs. petal fall) with Apollo. No rate effect was recorded for ABG-6162A following early season applications, however, the high rate was more effective in a summer application. The addition of Apollo to the high rate did not improve summer mite control. A summer application of Savey provided excellent reduction of a high mite population.

NOT FOR PUBLICATION
Table 3

No.	Treatment and rate/acre (lb ai)			Time of Application	European red mites/leaf[a] 9 Jun	25 Jun	8 Jul
1	Savey 50WP	57 g	(0.06)	27 Jun	0.8 ab	4.8 a	11.4 bcd
2	Savey 50WP	113 g	(0.12)	27 Jun	0.7 ab	5.1 a	5.1 d
3	Apollo 50SC	60 ml	(0.06)	PF,11 Jul	0.3 ab	0.6 d	11.2 cd
4	Apollo 50SC	90 ml	(0.09)	PF,11 Jul	0.3 ab	0.6 cd	12.5 cd
5	Apollo 50SC	120 ml	(0.12)	PF,11 Jul	0.4 ab	0.9 cd	12.7 bcd
6	Carzol 92SP	340 g	(0.69)	PF,11 Jul	0.5 ab	1.5 bcd	23.6 bc
7	ABG-6162A	4000 ml	(0.13)	P,PF,11 Jul	0.4 ab	0.8 cd	12.1 bcd
8	ABG-6162A	6000 ml	(0.20)	P,PF,11 Jul	0.2 b	0.7 cd	13.3 bcd
9	Apollo 50SC	120 ml	(0.12)	P	0.3 ab	0.6 d	13.2 bc
	Apollo 50SC ABG-6162A	60 ml 6000 ml	(0.06) + (0.20)	11 Jul			
10.	Morestan 25WP	1360 g	(0.75)	P	0.5 ab	1.6 bc	22.8 ab
	Savey 50WP	113 g	(0.12)	11 Jul			
11	Check	Unsprayed			0.9 a	2.8 b	46.1 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

Table 4

No.	Treatment and	rate/acre	(lb ai)	Time of Application	ERM/leaf[a] 21 Jul	SP/3 min[a] 24 Jul	ERM/leaf[a] 6 Aug	SP/3 min[a] 8 Aug
1	Savey 50WP	57 g	(0.06)	27 Jun	3.4 cd	5.3 c	0.6 bcd	5.0 ab
2	Savey 50WP	113 g	(0.12)	27 Jun	2.0 d	2.0 c	0.1 d	0.5 cd
3	Apollo 50SC	60 ml	(0.06)	PF,11 Jul	3.6 cd	3.0 c	0.2 cd	1.5 bcd
4	Apollo 50SC	90 ml	(0.09)	PF,11 Jul	4.4 cd	2.0 c	0.2 cd	0 d
5	Apollo 50SC	120 ml	(0.12)	PF,11 Jul	2.5 d	2.8 c	0.2 cd	1.0 cd
6	Carzol 92SP	340 g	(0.69)	PF,11 Jul	13.2 b	21.3 b	0.6 bcd	2.0 bc
7	ABG-6162A	4000 ml	(0.13)	P,PF,11 Jul	10.4 bc	5.8 c	1.9 a	7.0 a
8	ABG-6162A	6000 ml	(0.20)	P,PF,11 Jul	4.0 cd	3.3 c	0.7 bc	3.3 ab
9	Apollo 50SC	120 ml	(0.12)	P	2.7 d	3.0 c	0.3 cd	2.5 bc
	Apollo 50SC ABG-6162A	60 ml 6000 ml	(0.06) + (0.20)	11 Jul				
10	Morestan 25WP	1360 g	(0.75)	P	1.5 d	4.5 c	0.1 d	0.5 cd
	Savey 50WP	113 g	(0.12)	11 Jul				
11	Check	Unsprayed			44.5 a	37.3 a	1.1 ab	3.8 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.

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

APPLE, INSECTICIDE EVALUATION, 1986: Insecticides were applied to 5 single-tree plots (3 'Rome Beauty', 2 'Golden Delicious') of 32-year-old trees in a randomized block design. Applications were made with a Swanson DA500A airblast sprayer which traveled at 3.86 k/hr and delivered 935 l/ha. Dates of application were 3 Apr [delayed dormant (DD)], 12 Apr [pre-pink (PP)], 5 and 6 May [petal fall (PF)], 19 May [first cover (1C)], 3 Jun [second cover (2C)], 13 Jun [third cover (3C)], 27 and 28 Jun [fourth cover (4C)], 11 Jul [fifth cover (5C)], 28 Jul [sixth cover (6C)], 10 and 11 Aug [seventh cover (7C)] and 24 and 25 Aug [eighth cover (8C)]. Other materials applied separately to all treatments were Benlate, Bordeaux mixture, Captan, Dithane M-45, Manzate 200, Polyram, Solubor and Streptomycin. The effect of treatments on RAA was determined by counting colonies on the periphery of each tree. AA control was determined by counting infested leaves on each of 10 top terminals and AA/most infested leaf/terminal for each tree. Effect of treatments on ERM was determined by sampling 20 leaves from the periphery of each tree, removing mites with a mite-brushing machine and counting active stages with a binocular microscope. Treatment effect on SP was determined by counting adults and larvae on the periphery of test trees observed during a 3-minute period. Control of WALH was evaluated by counting nymphs found on 25 leaves selected from the periphery of each tree. Treatment effectiveness on fruit feeding insects was determined by scoring for injury 500 apples per treatment (100/replication) plus all fallen apples sampled on 18 Sep. Fruit picked from 'Golden Delicious' trees were rated for finish (1-9 worst).

A single application of Asana, and 2 applications of Orthene, Spur and Swat provided excellent control of RAA. Orthene was also the most effective treatment for AA control. Lorsban provided excellent ERM suppression. A high ERM and SP population occurred approximately 1 month after mid-season use of Spur. Lannate, Larvin and pyrethroid insecticides were very effective, while TD 2207 was weak, in the control of WALH. Larvin and TD 2207 provided excellent control of TABM and RBLR. Lorsban and TD 2207 were highly effective against SJS. Spur was a little weak in the control of CM. Although not statistically significant, daytime applications of Lorsban appear to cause more russeting of 'Golden Delicious' than applications at night. Pest pressure was moderate to heavy.

NOT FOR PUBLICATION
Table 5

No.	Treatment and rate/acre (lb ai)			Time of Application	RAA colonies/tree[c] 12 May	RAA colonies/tree[c] 28 May	28 May AA-inf. lvs/term[c]	28 May AA/most inf. leaf/term[c]
1	Lorsban 4E	710 ml	(0.75)	DD	0 b	8.8 b	3.3 abc	67.2 ab
	Guthion 50W	340 g	(0.38) +					
	Lannate 1.8L	710 ml	(0.34)	PF				
	Guthion 50W	680 g	(0.75)	1C,2C,5C,6C				
	Lorsban 50W[a]	1360 g	(1.50)	3C,4C,7C,8C				
2	Lorsban 4E	1420 ml	(1.50)	DD	0.6 b	3.0 bcd	3.3 abc	50.5 b
	Guthion 50W	340 g	(0.38) +					
	Lannate 1.8L	710 ml	(0.34)	PF				
	Guthion 50W	680 g	(0.75)	1C,2C,5C,6C				
	Lorsban 50W[b]	1360 g	(1.50)	3C,4C,7C,8C				
3	Danitol 2.4EC	474 ml	(0.30)	PP,PF,7C,8C	0.4 b	5.8 bc	3.6 abc	66.2 ab
	Guthion 50W	680 g	(0.75)	1C,2C,5C,6C				
	Lannate 1.8L	710 ml	(0.34) +					
	Penncap-M 2F	710 ml	(0.37)	3C,4C				
4	Orthene 75S	606 g	(1.0)	PP,PF	0 b	0 d	2.2 d	18.2 c
	Guthion 50W	680 g	(0.75)	1C,2C,5C,6C				
	Lannate 1.8L	710 ml	(0.34) +					
	Penncap-M 2F	710 ml	(0.37)	3C,4C,7C,8C				
5	Asana 1.9EC	50 ml	(.025)	PP,7C,8C	0.4 b	1.4 cd	3.7 ab	59.5 ab
	Guthion 50W	680 g	(0.75)	PF,1C,2C,5C, 6C				
	Lannate 1.8L	710 ml	(0.34) +					
	Penncap-M 2F	710 ml	(0.37)	3C,4C				

Table 5 continued

No.	Treatment and rate/acre (lb ai)			Time of Application	RAA colonies/tree[c] 12 May	RAA colonies/tree[c] 28 May	28 May AA-inf. lvs/term[c]	28 May AA/most inf. leaf/term[c]
6	Spur 22EW	114 ml	(0.06)	PP,PF,3C,4C, 7C,8C	0.6 b	1.2 bcd	3.2 bcd	65.1 ab
	Guthion 50W	680 g	(0.75)	1C,2C,5C,6C				
7	Cygon 400EC	710 ml	(0.75)	PP	1.8 b	8.0 bc	3.5 abc	80.0 ab
	Larvin 3.2F	948 ml	(0.80)	PF-8C				
8	Swat 8E	355 ml	(0.75)	PP,PF	0 b	1.6 bcd	2.9 c	54.5 b
	Guthion 50W	680 g	(0.75)	PF,1C,2C,5C, 6C				
	Penncap-M 2F	1420 ml	(0.74)	3C,4C,7C,8C				
9	Pounce 3.2EC	178 ml	(0.15)	PP	0.2 b	7.0 bc	4.2 a	92.0 a
	TD2207 3.7F	948 ml	(0.93)	PF-8C				
10	Check	Unsprayed			10.8 a	54.2 a	3.8 ab	79.8 ab

[a] Fast drying conditions - daytime applications

[b] Slow drying conditions - nighttime applications

[c] 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
Table 6

No.	Treatment and rate/acre (lb ai)			Time of Application	ERM/leaf[c] 1 Jul	SP/3 min[c] 7 Jul	ERM/leaf[c] 1 Aug	SP/3 min[c] 6 Aug
1	Lorsban 4E	710 ml	(0.75)	DD	0.5 f	3.0 b	0.4 c	5.4 bcd
	Guthion 50W	340 g	(0.38) +					
	Lannate 1.8L	710 ml	(0.34)	PF				
	Guthion 50W	680 g	(0.75)	1C,2C,5C,6C				
	Lorsban 50W[a]	1360 g	(1.50)	3C,4C,7C,8C				
2	Lorsban 4E	1420 ml	(1.50)	DD	0.9 ef	1.2 b	0.8 bc	3.6 bcd
	Guthion 50W	340 g	(0.38) +					
	Lannate 1.8L	710 ml	(0.34)	PF				
	Guthion 50W	680 g	(0.75)	1C,2C,5C,6C				
	Lorsban 50W[b]	1360 g	(1.50)	3C,4C,7C,8C				
3	Danitol 2.4EC	474 ml	(0.30)	PP,PF,7C,8C	3.7 de	2.6 b	1.4 bc	14.0 b
	Guthion 50W	680 g	(0.75)	1C,2C,5C,6C				
	Lannate 1.8L	710 ml	(0.34) +					
	Penncap-M 2F	710 ml	(0.37)	3C,4C				
4	Orthene 75S	606 g	(1.0)	PP,PF	14.3 bc	2.4 b	0.6 bc	5.6 bcd
	Guthion 50W	680 g	(0.75)	1C,2C,5C,6C				
	Lannate 1.8L	710 ml	(0.34) +					
	Penncap-M 2F	710 ml	(0.37)	3C,4C,7C,8C				
5	Asana 1.9EC	50 ml	(.025)	PP,7C,8C	12.1 abc	10.4 a	0.5 c	6.2 bc
	Guthion 50W	680 g	(0.75)	PF,1C,2C,5C,6C				
	Lannate 1.8L	710 ml	(0.34) +					
	Penncap-M 2F	710 ml	(0.37)	3C,4C				

Table 6 continued

No.	Treatment and	rate/acre (lb ai)	Time of Application	ERM/leaf[c] 1 Jul	SP/3 min[c] 7 Jul	ERM/leaf[c] 1 Aug	SP/3 min[c] 6 Aug
6	Spur 22EW	114 ml (0.06)	PP,PF,3C,4C, 7C,8C	9.7 c	1.0 b	43.3 a	59.2 a
	Guthion 50W	680 g (0.75)	1C,2C,5C,6C				
7	Cygon 400EC	710 ml (0.75)	PP	28.3 a	4.4 b	0.8 bc	11.0 bc
	Larvin 3.2F	948 ml (0.80)	PF-8C				
8	Swat 8E	355 ml (0.75)	PP,PF	23.3 ab	14.2 a	0.9 bc	2.8 cd
	Guthion 50W	680 g (0.75)	PF,1C,2C,5C,6C				
	Penncap-M 2F	1420 ml (0.74)	3C,4C,7C,8C				
9	Pounce 3.2EC	178 ml (0.15)	PP	6.2 cd	4.2 b	0.4 c	1.2 d
	TD2207 3.7F	948 ml (0.93)	PF-8C				
10	Check	Unsprayed		26.5 ab	4.0 b	2.6 b	4.6 bcd

[a] Fast drying conditions - daytime applications

[b] Slow drying conditions - nighttime applications

[c] 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

Table 7

No.	Treatment and	rate/acre (lb ai)		Time of Application	WALH/25 leaves[c] 12 May	22 Aug
1	Lorsban 4E	710 ml	(0.75)	DD	0.2 b	16.4 ab
	Guthion 50W	340 g	(0.38) +			
	Lannate 1.8L	710 ml	(0.34)	PF		
	Guthion 50W	680 g	(0.75)	1C,2C,5C,6C		
	Lorsban 50W[a]	1360 g	(1.50)	3C,4C,7C,8C		
2	Lorsban 4E	1420 ml	(1.50)	DD	0 b	3.6 cde
	Guthion 50W	340 g	(0.38) +			
	Lannate 1.8L	710 ml	(0.34)	PF		
	Guthion 50W	680 g	(0.75)	1C,2C,5C,6C		
	Lorsban 50W[b]	1360 g	(1.50)	3C,4C,7C,8C		
3	Danitol 2.4EC	474 ml	(0.30)	PP,PF,7C,8C	0 b	0 f
	Guthion 50W	680 g	(0.75)	1C,2C,5C,6C		
	Lannate 1.8L	710 ml	(0.34) +			
	Penncap-M 2F	710 ml	(0.37)	3C,4C		
4	Orthene 75S	606 g	(1.0)	PP,PF	0 b	0.4 def
	Guthion 50W	680 g	(0.75)	1C,2C,5C,6C		
	Lannate 1.8L	710 ml	(0.34) +			
	Penncap-M 2F	710 ml	(0.37)	3C,4C,7C,8C		

Table 7 continued

No.	Treatment and	rate/acre (lb ai)		Time of Application	WALH/25 leaves[c] 12 May	22 Aug
5	Asana 1.9EC	50 ml	(.025)	PP,7C,8C	0.2 b	0.2 ef
	Guthion 50W	680 g	(0.75)	PF,1C,2C,5C,6C		
	Lannate 1.8L	710 ml	(0.34) +			
	Penncap-M 2F	710 ml	(0.37)	3C,4C		
6	Spur 22EW	114 ml	(0.06)	PP,PF,3C,4C,7C,8C	0.2 b	0 f
	Guthion 50W	680 g	(0.75)	1C,2C,5C,6C		
7	Cygon 400EC	710 ml	(0.75)	PP	1.2 b	0.2 ef
	Larvin 3.2F	948 ml	(0.80)	PF-8C		
8	Swat 8E	355 ml	(0.75)	PP,PF	0 b	5.8 cd
	Guthion 50W	680 g	(0.75)	PF,1C,2C,5C,6C		
	Penncap-M 2F	1420 ml	(0.74)	3C,4C,7C,8C		
9	Pounce 3.2EC	178 ml	(0.15)	PP	1.0 b	22.6 a
	TD 2207 3.7F	948 ml	(0.93)	PF-8C		
10	Check	Unsprayed			3.2 a	6.8 bc

[a]Fast drying conditions - daytime applications.

[b]Slow drying conditions - nighttime applications.

[c]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
Table 8

No.	Treatment and rate/acre		(lb ai)	Time of Application	% Injury By:[c] CM	SJS	TABM & RBLR	% CLEAN[c]	Finish Rating[c]
1	Lorsban 4E	710 ml	(0.75)	DD	5.7 bc	0.3 d	12.7 ab	84.2 ab	3.2 a
	Guthion 50W	340 g	(0.38) +						
	Lannate 1.8L	710 ml	(0.34)	PF					
	Guthion 50W	680 g	(0.75)	1C,2C,5C,6C					
	Lorsban 50W[a]	1360 g	(1.50)	3C,4C,7C,8C					
2	Lorsban 4E	1420 ml	(1.50)	DD	3.8 c	0.6 d	12.5 ab	84.8 ab	1.9 ab
	Guthion 50W	340 g	(0.38) +						
	Lannate 1.8L	710 ml	(0.34)	PF					
	Guthion 50W	680 g	(0.75)	1C,2C,5C,6C					
	Lorsban 50W[b]	1360 g	(1.50)	3C,4C,7C,8C					
3	Danitol 2.4EC	474 ml	(0.30)	PP,PF,7C,8C	3.4 c	5.3 bc	6.0 a-d	86.8 ab	1.6 b
	Guthion 50W	680 g	(0.75)	1C,2C,5C,6C					
	Lannate 1.8L	710 ml	(0.34) +						
	Penncap-M 2F	710 ml	(0.37)	3C,4C					
4	Orthene 75S	606 g	(1.0)	PP,PF	4.1 c	6.4 bc	13.3 ab	82.1 ab	1.9 ab
	Guthion 50W	680 g	(0.75)	1C,2C,5C,6C					
	Lannate 1.8L	710 ml	(0.34) +						
	Penncap-M 2F	710 ml	(0.37)	3C,4C,7C,8C					
5	Asana 1.9EC	50 ml	(.025)	PP,7C,8C	3.6 c	7.7 bc	5.4 bcd	85.5 ab	2.0 ab
	Guthion 50W	680 g	(0.75)	PF,1C,2C,5C,6C					
	Lannate 1.8L	710 ml	(0.34) +						
	Penncap-M 2F	710 ml	(0.37)	3C,4C					

Table 8 continued

No.	Treatment and	rate/acre	(lb ai)	Time of Application	% Injury By:[c] CM	SJS	TABM & RBLR	% CLEAN[c]	Finish Rating[c]
6	Spur 22EW	114 ml	(0.06)	PP,PF,3C,4C,7C,8C	11.7 b	14.3 b	10.1 abc	74.2 b	1.6 b
	Guthion 50W	680 g	(0.75)	1C,2C,5C,6C					
7	Cygon 400EC	710 ml	(0.75)	PP	7.2 bc	7.0 bc	2.2 d	86.6 ab	1.8 b
	Larvin 3.2F	948 ml	(0.80)	PF-8C					
8	Swat 8E	355 ml	(0.75)	PP,PF	5.2 bc	5.3 bc	16.9 ab	77.6 b	1.6 b
	Guthion 50W	680 g	(0.75)	PF,1C,2C,5C,6C					
	Penncap-M 2F	1420 ml	(0.74)	3C,4C,7C,8C					
9	Pounce 3.2EC	178 ml	(0.15)	PP	4.4 c	2.9 cd	3.1 cd	92.8 a	1.5 b
	TD 2207 3.7F	948 ml	(0.93)	PF-8C					
10	Check	Unsprayed			75.3 a	28.5 a	15.7 a	13.9 c	1.6 b

[a]Fast drying conditions - daytime applications.

[b]Slow drying conditions - nighttime applications.

[c]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 1986 CUMBERLAND-SHENANDOAH FRUIT WORKERS CONFERENCE

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

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Warm, dry weather characterized the 1986 growing season. Precipitation came in the form of scattered showers so nearly the whole northern Virginia fruit region suffered from moisture stress throughout much of the season.

	Precipitation		Mean temperature	
	1986	73 yr avg	1986	65 yr avg
April	1.73	3.16	59.9	53.9
May	3.95	3.78	65.0	63.7
June	1.96	3.92	73.8	71.8
July	1.74	3.90	78.6	76.7
August	3.66	3.82	72.4	74.2

Rosy aphid populations were readily controlled in most orchards. European red mite populations increased steadily allowing predator populations to develop so that by late Jun, the predators Stethorus punctum and Orius insidiosus were making a major contribution toward mite control. Chrysopid larvae were very abundant in 1986 and exerted general predatory pressure on aphids, lepidoptera, mites, leafhoppers and other pests. Spotted tentiform leafminers continued to increase in some orchards. Codling moth populations continued to increase in some orchards and there are indications that some of the currently used spray schedules (materials and/or timing) are allowing increases in codling moth numbers. The leafroller complex was relatively well managed. An early harvest and excellent harvest weather enabled most growers to get fresh fruit off the trees before late generation fruit feeders did much damage.

Sources of materials used in these tests are:

Abbott Labs: ABG-6162 HV
Chevron Chemical Company: Danitol, Orthene
Ciba Geigy, Agri. Division: Supracide
Dow Chemical USA: Plictran
E. I. duPont deNemours & Company: Savey
FMC Corporation, Agr. Chem. Group: Elgetol, Pounce
Mobay Chemical Corporation: Guthion 50W, Guthion 3F, Morestan
Nor-Am Chemical Company: Apollo, Carzol
Pennwalt Corporation: Penncap M
Rohm & Haas Company: Kelthane
Shell Development Company: M0070616 (Asana)
Union Carbide Corporation: UC 84572, PA-10, Sevin

[1] Professor and Superintendent

[2] Agricultural Research Scientist

APPLE: *Malus domestica* Borkh 'York'
Rosy apple aphid; *Dysaphis plantaginea* (Passerini)

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APPLE, EARLY SEASON APHICIDE EVALUATIONS, 1986: Experimental materials were applied to mature semi-dwarf York trees using a Bean 35 gal/min hydraulic sprayer operating at 400 psi. Trees were sprayed to runoff. A randomized block design was used and each treatment was replicated 4 times. The Elgetol treatment was applied on Mar 24 while buds were still dormant. Other treatments were applied during the 1/4 inch bud stage on Apr 2. Effectiveness of the materials was evaluated by counting all rosy apple aphid colonies found on the tree during a 3 minute per tree count.

All treatments were found to be more effective than the control on Apr 21 and May 5. By May 16, all treatments were more effective than the control except Elgetol which was not significantly different from the control.

	Avg number RAA colonies/tree/3 min count		
Materials & amts/100 gal	Apr 21	May 5	May 16
Elgetol 1.6E 1.0 qt	0.16 b	1.00 b	4.81 a
Orthene 75S 5.3 oz	0.00 b	0.00 b	0.25 b
Pounce 3.2E 2.5 fl oz	0.00 b	0.00 b	0.37 b
Supracide 2E 1.0 pt	0.00 b	0.25 b	0.37 b
MO070616 1.9E 0.42 fl oz (12.4 ml)	0.00 b	0.00 b	0.45 b
Fungicides only	1.65 a	4.81 a	17.32 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.

APPLE: *Malus domestica* Borkh 'York'
European red mite; *Panonychus ulmi* (Koch)
Twospotted spider mite; *Tetranychus urticae* Koch
Predatory coccinellid sp.; *Stethorus punctum* (LeConte)
Anthocorid predator of mites; *Orius insidiosus* (Say)

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APPLE, EVALUATION OF THE EFFECT OF SAVEY AND POUNCE ON EARLY SEASON MITE POPULATIONS, 1986: Treatments were applied to mature York trees using single tree plots in a randomized block design and replicated 4 times. Trees were sprayed to runoff using a Bean 35 gal/min hydraulic sprayer operating at 400 psi. 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.

Treatments were applied to determine the most effective rate of Savey when applied at the pink stage. Savey at 1.0 oz/100 was as effective as 1.33 oz/100 and had significantly longer residual activity than the lower rates in this test. Savey at 1.0 oz/100 and 1.33 oz/100 was equally effective with either Guthion or Pounce as the seasonal insecticide until late Jul when TSSM populations were significantly higher where Pounce was used. By Jun 25 mites were above threshold levels on all treatments except where Savey was applied at 1.0 oz or 1.33 oz/100 and only the delayed dormant application of Pounce was significantly better than the full season Pounce treatment. By early Jul, *Stethorus punctum* had moved throughout the block so that only Pounce in full season schedule and Pounce applied Jun 13 did not have *S. punctum* populations building in response to mite populations. The response of mite populations to Pounce may have been somewhat obscured due to the mite consumption by the *S. punctum* populations which moved in rapidly from surrounding orchards to the plot trees. Some foliage bronzing occurred on all plots except the 1.0 oz and 1.33 oz rates of Savey. No phytotoxicity was observed.

Materials & amts/100 gal	Timing	Jun 10 Mites/leaf	Jun 10 Eggs/leaf	Jun 25 Mites/leaf	Jun 25 Eggs/leaf	Jul 24 ERM/leaf	Jul 24 TSSM/leaf
Savey 50W .33 oz (9.4 gm)[1,2,3]	pink	0.38 cde	2.12 bcd	8.78 abc	58.30 bcd	10.95	0.24 cd
Savey 50W .67 oz (18.9 gm)[1,2,3]	pink	0.38 cde	1.45 cde	5.85 bcd	43.95 cde	16.70	0.75 bcd
Savey 50W 1.0 oz (28.4 gm)[1,2,3]	pink	0.00 e	0.09 e	1.73 e	19.89 efg	7.00	0.23 cd
Savey 50W 1.33 oz (37.7 gm)[1,2,3]	pink	0.13 de	1.05 de	4.61 cde	27.93 def	5.70	0.27 cd
Savey 50W 1.0 oz (28.4 gm) Pounce 3.2E 2.0 fl oz seasonal program	pink	0.00 e	0.19 e	1.64 e	9.55 g	13.05	2.90 a
Savey 50W 1.33 oz (37.7 gm) Pounce 3.2E 2.0 fl oz seasonal program	pink	0.28 cde	0.58 de	1.98 d	15.22 fg	17.70	1.88 ab
Pounce 3.2E 2.0 fl oz seasonal program		1.28 bcd	6.55 ab	24.90 a	163.67 a	9.60	0.87 bc
Pounce 3.2E 2.0 fl oz[2,3]	DD	1.62 bc	5.59 abc	7.73 bc	73.22 abcd	12.95	0.45 cd
Pounce 3.2E 2.0 fl oz[1,2,3]	PF	1.26 bcd	6.56 ab	14.57 ab	133.56 ab	7.95	0.45 cd
Pounce 3.2E 2.0 fl oz[1,2,3]	2nd C	3.71 ab	10.24 a	16.47 ab	169.40 a	11.15	0.44 cd
Standard spray program[1,2,3]		1.50 bc	6.10 ab	9.58 abc	88.65 abc	3.55	0.00 d
Check		5.46 a	13.43 a	15.20 ab	81.72 abc	8.95	0.27 cd

[1] Supracide 2E 1.0 pt/100 - Apr 2 (delayed dormant).

[2] Guthion 50W 0.5 lb/100 - Apr 15 (pink), May 22, Jun 13 (except Pounce in 2nd cover).

[3] Guthion 50W 0.25 lb/100 + Lannate 12.0 fl oz/100 - May 6 (petal fall).

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 & amts/100 gal		Stethorus punctum (Jul 3) Adults	Larvae	Orius insidiosus (Jul 3)
Savey 50W .33 oz (9.4 gm)[1,2,3]	pink	5.25 abc	1.00 b	0.00 c
Savey 50W .67 oz (18.9 gm)[1,2,3]	pink	3.00 abc	0.00 b	0.25 bc
Savey 50W 1.0 oz (28.4 gm)[1,2,3]	pink	1.75 bc	0.00 b	0.00 c
Savey 50W 1.33 oz (37.7 gm)[1,2,3]	pink	2.00 bc	0.25 b	1.00 ab
Savey 50W 1.0 oz (28.4 gm) Pounce 3.2E 2.0 fl oz seasonal program	pink	0.25 bc	0.00 b	0.00 c
Savey 50W 1.33 oz (37.7 gm) Pounce 3.2E 2.0 fl oz seasonal program	pink	0.00 c	0.00 b	0.00 c
Pounce 3.2E 2.0 fl oz seasonal program		0.25 bc	0.00 b	0.25 bc
Pounce 3.2E 2.0 fl oz[2,3]	DD	8.75 a	4.00 a	0.25 bc
Pounce 3.2E 2.0 fl oz[1,2,3]	PF	6.00 ab	1.50 b	0.75 abc
Pounce 3.2E 2.0 fl oz[1,2,3]	2nd C	1.25 bc	0.00 b	0.00 c
Standard spray program[1,2,3]		8.50 a	2.50 ab	1.00 ab
Check		8.25 a	0.50 b	0.75 abc

1 Supracide 2E 1.0 pt/100 - Apr 2 (delayed dormant).

2 Guthion 50W 0.5 lb/100 - Apr 15 (pink), May 22, Jun 13 (except Pounce in 2nd cover).

3 Guthion 50W 0.25 lb/100 + Lannate 12.0 fl oz/100 - May 6 (petal fall).

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

Analysis was done on untransformed data.

APPLE: *Malus domestica* Borkh
'Red Delicious'
European red mite;
Panonychus ulmi (Koch)
Twospotted spider mite;
Tetranychus urticae Koch

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APPLE, MITICIDE EVALUATIONS, 1986: Treatments were applied to 9 year old Redspur Delicious trees using single tree plots arranged in a randomized block design and replicated 4 times. Trees were sprayed to runoff using a Bean 35 gal/min hydraulic sprayer operating at 400 psi. Treatment dates were Apr 15 (pink), Apr 28 (petal-fall), May 22 (2nd cover) and Jun 13. Refer to the table for treatment dates for each material. 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.

In this test, mite populations increased gradually throughout the growing season until early Aug. Population densities were never high, 6.15 mites/leaf on Jul 8 on the unsprayed check being the high count for the season. Mite densities on the check accounted for 320 mite days from early May until early Aug. All treatments kept mite populations below the economic threshold and all were significantly better than the check through Jun except Morestan. By Jul 8, Plictran and an Apollo treatment were not significantly different from the check and by mid-Jul only ABG-6162, Apollo applied in 2nd cover, and the two Kelthane treatments were significantly different from the check. All treatments provided good mite control and no phytotoxicity was observed. Fruit finish was rated from 1 to 5, 1 being the best. The range was from 1.56 to 2.10 with a mean of 1.80. When the data were analyzed, no significant differences were found.

Materials & amts/100 gal	Timing	May 8 Mites/leaf	May 8 Eggs/leaf	Jun 9 Mites/leaf	Jun 9 Eggs/leaf	Jun 24 Mites/leaf	Jun 24 Eggs/leaf
ABG-6162HV 1.5 W/W 1.0 qt	Apr 15, Apr 28	0 b	0.16 b	0 c	0.24 d	0.33 de	1.54 cde
ABG-6162HV 1.5 W/W 1.5 qt	Apr 15, Apr 28	0 b	0.22 b	0.04 c	0.17 d	0.33 de	0.55 e
Apollo 50 SC 1.0 oz	Apr 15	0.04 b	0.30 b	0.13 c	0.33 d	0.46 cde	3.43 cde
Apollo 50 SC 1.0 oz	Apr 15	0 b	0.19 b	0.41 bc	1.11 cd	0.99 cd	4.15 cd
Apollo 50 SC 1.0 oz	Apr 28	0 b	0.00 b	0 c	0.09 d	0.08 e	0.95 de
Apollo 50 SC 1.0 oz	May 22	-	-	0.09 c	0.67 cd	0.59 cde	2.75 cde
Carzol 92 SP 4.0 oz	Jun 13	-	-	2.23 a	3.02 abc	0.73 cde	1.54 cde
Kelthane 4F (XF 85017) 1.0 pt	Jun 13	-	-	2.97 a	5.51 ab	0.39 de	0.98 de
Kelthane 4F (XF 86006) 1.0 pt	Jun 13	-	-	3.97 a	6.95 ab	0.63 cde	2.78 cde
Morestan 25W 8.0 oz	Apr 15	0 b	0.61 b	1.79 ab	7.16 ab	3.05 ab	19.86 ab
Plictran 50W 4.0 oz	Apr 15	0.04 b	0.41 b	0.45 bc	1.70 bcd	1.69 bc	7.32 bc
Check		0.37 a	2.62 a	4.23 a	7.99 a	4.93 a	32.61 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 & amts/100 gal	Timing	Jul 8 Mites/leaf	Jul 8 Eggs/leaf	Jul 16 Mites/leaf	Jul 16 Eggs/leaf	Aug 5 Mites/leaf
ABG-6162HV 1.5 W/W 1.0 qt	Apr 15, Apr 28	0.48 bcd	1.52 cde	1.16 bcde	2.07 bc	0.81 a
ABG-6162HV 1.5 W/W 1.5 qt	Apr 15, Apr 28	0.42 bcd	0.75 e	0.98 cde	1.52 bc	0.25 abcd
Apollo 50 SC 1.0 oz	Apr 15	1.02 bcd	4.01 bcd	3.04 abcd	3.64 abc	0.19 cd
Apollo 50 SC 1.0 oz	Apr 15	2.10 ab	4.86 abc	3.73 ab	2.77 abc	0.22 bcd
Apollo 50 SC 1.0 oz	Apr 28	0.75 bcd	1.76 cde	2.07 abcd	2.20 abc	0.13 d
Apollo 50 SC 1.0 oz	May 22	0.09 d	1.06 de	0.89 de	1.46 c	0.40 abcd
Carzol 92 SP 4.0 oz	Jun 13	1.03 bcd	2.22 cde	1.71 abcde	4.39 ab	0.52 abcd
Kelthane 4F (XF 85017) 1.0 pt	Jun 13	1.02 bcd	1.79 cde	0.92 de	2.81 abc	0.69 abc
Kelthane 4F (XF 86006) 1.0 pt	Jun 13	0.31 cd	1.74 cde	0.43 e	2.04 bc	0.14 d
Morestan 25W 8.0 oz	Apr 15	1.80 bc	8.56 ab	3.42 abc	4.16 abc	0.22 bcd
Plictran 50W 4.0 oz	Apr 15	2.14 ab	8.70 ab	4.52 a	4.11 abc	0.25 abcd
Check		6.15 a	13.89 a	3.93 ab	5.94 a	0.80 ab

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.

APPLE: *Malus domestica* Borkh 'Red Delicious'
European red mite; *Panonychus ulmi* (Koch)
Twospotted spider mite; *Tetranychus urticae* Koch
Stethorus punctum (LeConte)
White apple leafhopper; *Typhlocyba pomaria* McAtee
Codling moth; *Cydia pomonella* (Linnaeus)
Spotted tentiform leafminer; *Phyllonrycter blancardella* (Fabr.)
Tufted apple budmoth; *Platynota idaeusalis* (Walker)
Variegated leafroller; *Platynota flavedana* Clemens
Redbanded leafroller; *Argyrotaenia velutinana* (Walker)
Plum curculio; *Conotrachelus nenuphar* (Herbst)
Plant bugs; *Lygus* spp.

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APPLE, FULL SEASON INSECTICIDE EVALUATIONS, 1986. Experimental insecticide treatments were applied in a comparative test to Redspur Delicious trees on Apr 14 (pink), Apr 30 (petal fall), May 22, Jun 12, Jul 11, Aug 2 and Aug 22. 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. White apple leafhoppers were counted on May 13 by randomly selecting 10 leaves per replicate and counting all adults and nymphs present. Effects on mite populations were evaluated by randomly selecting 25 leaves per replicate on several dates throughout the season, brushing with a modified Henderson-McBurnie brushing machine onto glass plates and counting mites and eggs under a binocular microscope. *Stethorus punctum* counts were made on Jul 2 and Jul 21 by counting adults and larvae in a timed count of 3 minutes per replicate. A sample of 50 apples per tree was examined on Aug 19 to evaluate codling moth damage. Spotted tentiform leafminer populations were evaluated for season long control on Aug 25 by counting the number of mines found on each tree in 3 min. A sample of 100 apples per tree was harvested on Sep 15 to evaluate insect damage and to rate fruit finish. Fruit finish was rated from 1 to 5 (1 being best).

Most materials tested gave adequate control of white apple leafhopper although some damage occurred on the two Penncap treatments and the check. By mid Jun, the mite populations on the unsprayed check, the Penncap treatments, the Guthion treatments, and the Sevin and oil thinning treatment were above action threshold levels. UC 84572 without PA-10 (a wetting agent) was not significantly different from the above listed treatments. By early Jul, *S. punctum* populations had responded to mite populations and were beginning to aid in suppression. Danitol 2.4E (applied Jul 11) reduced mite populations, but also reduced predator populations so that mites rebounded quickly. Apollo 50 SC applied either at petal fall or tank mixed with the Sevin-oil for thinning held mites at low levels until predator populations built up. By Jul 22, *S. punctum* had reduced mite populations to tolerable levels on all treatments. Codling moth populations were low on Aug 19. Spotted tentiform leafminer populations were not severe, but the organo-phosphates were less effective than Danitol and UC 84572. Populations of fruit feeding insects remained low throughout the season although pheromone trap captures indicated adequate populations of major fruit feeding pests. We can only hypothesize that males are being attracted from outside this experimental block. The only phytotoxicity observed as on UC 84572 with the wetting agent PA-10 where a drying ring is evident on the bottom of the fruit. PA-10 was unavailable for the pink and petal fall applications and Ortho X-77 4 oz/100 was used.

Materials & amts/100 gal	May 28 Mites/leaf[2]	May 28 Eggs/leaf[2]	Jun 17 Mites/leaf[2]	Jun 17 Eggs/leaf[2]	S. punctum/3 min/tree (Jul 2) Adults[3]	S. punctum/3 min/tree (Jul 2) Larvae[3]
Penncap M (TD 2215) 1.0 pt	1.06 abc	1.21 abc	5.06 ab	30.29 abc	7.00 abc	1.75 ab
Penncap M (TD 2214) 1.0 pt	0.54 cd	1.11 abcd	3.50 ab	20.58 c	6.00 bcd	1.50 ab
Danitol 2.4EC[1] 4.0 fl oz	0.14 d	0.27 de	0.57 c	7.70 d	4.00 cd	0.25 b
UC 84572 2.1 F 6.0 fl oz PA-10 32.0 fl oz	0.09 d	0.41 cde	0.95 c	6.85 d	4.25 cd	0.75 b
UC 84572 2.1F 3.0 fl oz PA-10 32.0 fl oz	0.16 d	0.49 cde	0.94 c	5.82 d	2.75 cd	0.25 b
UC 84572 2.1F 3.0 fl oz	0.62 bcd	0.54 bcde	2.25 bc	25.56 bc	2.75 cd	0.50 b
Guthion 3F 11.0 fl oz	1.88 ab	1.70 ab	5.73 ab	46.21 ab	10.00 ab	1.75 ab
Guthion 50W 8.0 oz	2.24 a	2.31 a	7.69 a	60.76 a	10.75 a	3.00 a
Check (fungicides only)	2.01 ab	1.93 a	6.65 ab	57.75 a	4.25 cd	1.00 b
Guthion 50W 8.0 oz Sevin 50W 1.0 lb[4] Oil 6E 1.0 qt Apollo 50SC 1.0 oz	0.00 d	0.16 e	0.60 c	5.15 d	1.50 d	0.25 b
Guthion 50W 8.0 oz Sevin 50W 1.0 lb[5] Oil 6E 1.0 qt	0.65 bcd	1.14 abcd	6.99 ab	34.97 abc	10.50 a	1.75 ab
Guthion 50W 8.0 oz Apollo 50SC 1.0 oz[6] Sevin 50W 1.0 lb Oil 6E 1.0 qt	0.00 d	0.13 e	0.96 c	4.17 d	5.25 cd	0.25 b

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

1 Guthion 50W .5 lb/100 gal applied on May 22 and Jun 12.
2 Data were transformed to $\log_{10}(X + .5)$ for analysis.
3 Analysis was done on untransformed data.
4 Sevin + oil + Apollo applied May 6.
5 Sevin + oil applied May 6.
6 Sevin + oil applied May 6; Apollo applied Apr 30.

Materials & amts/100 gal	Jul 9 Mites/leaf[2]	Jul 9 Eggs/leaf[2]	S. punctum/3 min/tree (Jul 21) Adults[3]	S. punctum/3 min/tree (Jul 21) Larvae[3]	Jul 22 ERM/leaf[2]	Jul 22 TSSM/leaf[2]
Penncap M (TD 2215) 1.0 pt	5.68 cd	33.17 cde	9.75 bcd	1.25 cde	0.89 bcd	0.16 b
Penncap M (TD 2214) 1.0 pt	9.35 bcd	36.78 bcd	13.25 abcd	4.00 a	1.49 bcd	0.23 b
Danitol 2.4EC[1] 4.0 fl oz	5.92 cd	36.64 bcd	1.00 e	0.00 e	0.58 d	0.04 b
UC 84572 2.1 F 6.0 fl oz PA-10 32.0 fl oz	8.87 bcd	43.59 bc	15.50 abc	0.25 e	2.49 abc	3.44 a
UC 84572 2.1F 3.0 fl oz PA-10 32.0 fl oz	4.00 d	21.33 de	8.75 cd	0.50 e	2.07 abcd	4.58 a
UC 84572 2.1F 3.0 fl oz	18.32 ab	80.76 a	19.25 a	1.25 cde	5.68 a	2.97 a
Guthion 3F 11.0 fl oz	25.83 a	68.13 ab	16.25 ab	3.00 ab	2.93 abc	0.38 b
Guthion 50W 8.0 oz	6.28 cd	38.41 bcd	7.50 d	1.25 cde	0.74 cd	0.09 b
Check (fungicides only)	5.67 cd	21.31 de	7.75 cd	2.25 bcd	3.55 ab	0.11 b
Guthion 50W 8.0 oz Sevin 50W 1.0 lb[4] Oil 6E 1.0 qt Apollo 50SC 1.0 oz	3.40 d	18.41 e	9.50 bcd	3.25 ab	1.47 bcd	0.24 b
Guthion 50W 8.0 oz Sevin 50W 1.0 lb[5] Oil 6E 1.0 qt	14.90 abc	42.76 bc	9.75 bcd	2.75 abc	1.15 bcd	0.33 b
Guthion 50W 8.0 oz Apollo 50SC 1.0 oz[6] Sevin 50W 1.0 lb Oil 6E 1.0 qt	4.11 d	22.05 de	9.50 bcd	1.00 de	1.00 bcd	0.48 b

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

[1] Guthion 50W .5 lb/100 gal applied on May 22 and Jun 12.

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

[3] Analysis was done on untransformed data.

[4] Sevin + oil + Apollo applied May 6.

[5] Sevin + oil applied May 6.

[6] Sevin + oil applied May 6; Apollo applied Apr 30.

Materials & amts/100 gal	Jul 31 ERM/leaf[2]	Jul 31 TSSM/leaf[2]	Jul 31 Eggs/leaf[2]	WALH/leaf May 13	Percent apples damaged by CM Aug 19	STLM/ 3 min/tree Aug 25
Penncap M (TD 2215) 1.0 pt	0.29 bc	0.00 c	2.00 c	0.54 ab	0	42.00 ab
Penncap M (TD 2214) 1.0 pt	0.09 c	0.04 c	1.69 c	0.53 ab	0	52.75 a
Danitol 2.4EC[1] 4.0 fl oz	2.98 a	0.04 c	26.33 a	0.00 c	0	0.75 d
UC 84572 2.1 F 6.0 fl oz PA-10 32.0 fl oz	0.99 b	3.09 a	5.09 abc	0.05 bc	0	0.25 d
UC 84572 2.1F 3.0 fl oz PA-10 32.0 fl oz	0.91 b	1.90 ab	6.39 abc	0.17 abc	1.5	0.75 d
UC 84572 2.1F 3.0 fl oz	5.47 a	1.06 b	18.98 ab	0.10 abc	1.0	12.25 cd
Guthion 3F 11.0 fl oz	0.37 bc	0.16 c	4.96 abc	0.15 abc	0	19.25 cd
Guthion 50W 8.0 oz	0.09 c	0.04 c	1.85 c	0.32 abc	0	14.25 cd
Check (fungicides only)	0.51 bc	0.00 c	3.71 bc	0.72 a	3.0	23.00 c
Guthion 50W 8.0 oz Sevin 50W 1.0 lb[4] Oil 6E 1.0 qt Apollo 50SC 1.0 oz	0.13 c	0.04 c	1.79 c	0.01 c	0	25.50 bc
Guthion 50W 8.0 oz Sevin 50W 1.0 lb[5] Oil 6E 1.0 qt	0.35 bc	0.04 c	3.22 bc	0.11 abc	0	22.00 c
Guthion 50W 8.0 oz Apollo 50SC 1.0 oz[6] Sevin 50W 1.0 lb Oil 6E 1.0 qt	0.59 bc	0.04 c	1.54 c	0.13 abc	1.5	22.25 c

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

1 Guthion 50W .5 lb/100 gal applied on May 22 and Jun 12.

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

3 Analysis was done on untransformed data.

4 Sevin + oil + Apollo applied May 6.

5 Sevin + oil applied May 6.

6 Sevin + oil applied May 6; Apollo applied Apr 30.

Materials & amts/100 gal	Percent fruit damaged by: Leafroller complex[2]	CM	Curculio	Plant bugs	% clean fruit	Finish[3] rating
Penncap M (TD 2215) 1.0 pt	0.25	0.50	0	0	99.25	1.74 cd
Penncap M (TD 2214) 1.0 pt	0	0.25	0	0.25	99.50	1.71 cd
Danitol 2.4EC[1] 4.0 fl oz	0	0	0	0	100.00	1.71 cd
UC 84572 2.1F 6.0 fl oz PA-10 32.0 fl oz	0	0.50	0.25	0.25	99.00	3.16 b
UC 84572 2.1F 3.0 fl oz PA-10 32.0 fl oz	0	0.75	0.50	0.75	98.00	3.64 a
UC 84572 2.1F 3.0 fl oz	0	1.00	0.25	0.25	98.50	1.80 c
Guthion 3F 11.0 fl oz	0	0	0.25	1.50	98.25	1.43 e
Guthion 50W 8.0 oz	0.75	0	0	1.00	98.25	1.49 de
Check (fungicides only)	1.50	1.50	0.50	0	96.50	1.45 e
Guthion 50W 8.0 oz[4] Sevin 50W 1.0 lb Oil 6E 1.0 qt Apollo 50SC 1.0 oz	0.50	0	0.50	0.25	98.75	1.52 cde
Guthion 50W 8.0 oz[5] Sevin 50W 1.0 lb Oil 6E 1.0 qt	1.75	0	0.25	0.75	97.25	1.45 e
Guthion 50W 8.0 oz Apollo 50SC 1.0 oz[6] Sevin 50W 1.0 lb Oil 6E 1.0 qt	0.25	0.25	0.50	0	99.0	1.62 cde

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

1 Guthion 50W .5 lb/100 gal applied on May 22 and June 12.
2 Leafroller complex includes redbanded leafroller, tufted apple budmoth and variegated leafroller.
3 100 apples/rep (400/treatment) were each rated from 1 to 5 (1 being the best). Analysis was done on untransformed data.
4 Sevin + oil + Apollo applied May 6.
5 Sevin + oil applied May 6.
6 Sevin + oil applied May 6; Apollo applied Apr 30.

PHEROMONE TRAP CAPTURES OF MAJOR APPLE PESTS

Date	STLM	RBLR	CM	VLR	TABM
Apr 10	508	98	-	-	-
Apr 18	164	79	-	-	-
Apr 24	348	32	-	-	-
May 1	208	27	-	-	-
May 9	13	1	17	1	4
May 16	0	0	1	3	19
May 23	0	0	6	40	20
May 30	90	0	3	29	25
Jun 6	354	1	3	54	48
Jun 13	616	105	2	15	34
Jun 27	1232	5	7	10	20
Jul 7	327	1	4	3	18
Jul 14	1016	0	7	6	1
Jul 21	1164	1	21	2	12
Jul 28	1012	3	6	6	20
Aug 4	-	1	4	0	53
Aug 11	1632	4	8	11	36
Aug 18	2652	18	16	12	73
Aug 25	3264	6	27	7	162
Sep 3	199	0	4	6	206
Sep 8	1108	3	4	16	164

Traps were placed in rows two tree spaces from the seasonal insecticide treatments. Capsules were changed at 4 week intervals and trap bottoms as necessary.

STLM = spotted tentiform leafminer
RBLR = redbanded leafroller
CM = codling moth
VLR = variegated leafroller
TABM - tufted apple budmoth

(NOT FOR CITATION)

Insect Management in Georgia Blueberries with Emphasis on Cranberry Fruitworm

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Rabbiteye blueberries, Vaccinium ashei Reade, are planted on some 5,000 acres in 10 southeast and midsouth states. Georgia has over 2,500 acres of rabbiteye blueberries. Survey work begun in 1985 by the authors has systematically examined the insects associated with rabbiteye blueberries. This work along with tests directed at examining the effects of cranberry fruitworm, leaffooted bug and rabbiteye pollinators have allowed for continued formation of insect pest management strategies for Georgia growers.

Cranberry fruitworm, Acrobasis vaccinii Riley, is a consistent pest statewide. At this time we have only begun to evaluate its seriousness and the conditions which truly justify insecticide treatment. Current recommendations suggest the use of malathion at 1 lb. ai/acre when more than 1 fruitworm-infested fruit cluster is found on every 5th bush. This provisional threshold is purposely conservative. We estimate that less than 15% of our acreage is treated each year. Yield losses are difficult to estimate. Frost and drought conditions in 1986 contributed to statewide yield reductions of approximately 30%.

Fruitworm spray test results reported here in 1985 suggested that applications made when fruitworms were in the 2nd or 3rd berry of a cluster were likely to significantly improve yield in varieties bearing a full crop.

Grower application of malathion to a planting in Monroe County near Macon on April 29, 1986 allowed us to bag plants and closely follow a fruitworm infestation in treated and untreated plants. Three rows of plants were left unsprayed. When observed on May 8 a mixed age infestation of mostly second instar cranberry fruitworms was present. Estimates of percent worm-infested fruit clusters were made from randomly selected bushes of each cultivar. Infestation estimates were: Climax 40-90%, Delite 30%, Woodard 5-10% and Tifblue ≤5%. A test examining berry consumption was begun on May 8. Ten single plant replicates were set up for sprayed and unsprayed in each of four cultivars. One randomly chosen infested fruit cluster was selected on each bush. Clusters were bagged in muslin and numbers of infested and uninfested berries were counted. Data were subjected to appropriate contingency analysis with χ^2. Sampling of fruitworms in the area sprayed and the area left unsprayed indicated the levels of infestation were comparable. As expected, spraying reduced the number of infested berries in a highly significant fashion.

Cultivar differences that became evident were perhaps more revealing. As previously observed the infestation was initially most severe in Climax. One week later Delite was the most heavily infested cultivar, this being more evident in the sprayed plots. Examination made on June 12, as berries matured, showed a reversal in varietal susceptibility. Examination of χ^2 values provides an indication of relative susceptibility (Table 1). In both sprayed and unsprayed plants fruitworm damage was lowest in Climax, with losses increasing progressively in Delite, Woodard and Tifblue. These observations are preliminary and yield data could not be attained, but varietal differences in the pattern and severity of infestation appear to exist.

Table 1. Cranberry fruitworm injury comparisons. Monroe County, GA, June 12, 1986.

	Sprayed			Unsprayed		
Cultivar	%Injured	#Fruit	Examined χ^2 (from 2x2 comparison with Climax)	%Injured	#Fruit	Examined χ^2 (from 2x2 comparison with Climax)
Climax	16	247		34	249	
Delite	32	177	13.2	54	209	13.9
Woodard	30	251	13.0	69	201	49.0
Tifblue	41	259	36.5	80	174	82.8

Harvest Interval: mid May – mid July

We feel that in some instances insecticide treatments for cranberry fruitworm are definitely appropriate. However, we in Georgia do not suffer damaging infestations of a number of insects reported as pests and sprayed for as such in states where highbush culture predominates. Insects that are pests elsewhere, but are either present in non-pest status or not found in cultivated Georgia rabbiteyes include: blueberry maggot, cherry fruitworm, plum curculio and scale. Table 2 (end of text) details sampling done on wild and cultivated Vaccinium spp. In light of the potential for elevating the pest status of insects not currently damaging to our rabbiteye industry we encourage considerable discretion and restraint in spraying until we have a better idea of our situation.

Other areas of interest include work with rabbiteye pollinators. Dr. Jim Cane of Auburn University has worked with us, and he suggests that the wild solitary bee Emphoropsis (Habropoda) laboriosa is the most effective rabbiteye pollinator. E. laboriosa vigorously sonicates blossoms and it is extremely active even at cool temperatures. The morphology of blueberry blossoms makes pollination by honey bees extremely inefficient. A simple exclusion study clearly illustrated the benefit of pollination (Table 3).

Table 3. Rabbiteye blueberry fruitset with blooms open to pollinators and with pollinators partially excluded. Bolingbroke, GA, 1986.

	OPEN			EXCLUDED		
	# Set	# Dropped	% Set	# Set	# Dropped	% Set
Tifblue	160	45	78	19	192	9
Climax	214	5	98	43	165	21
Woodard	203	23	90	45	166	21
Delite	175	13	93	26	185	12
All Cultivars Combined	752	86	90	133	708	16

Leaffooted bugs, Leptoglossus phyllopus (Linnaeus), may be present on blueberries throughout the season. They often build up to very high levels near harvest, which alarms growers. We caged leaffooted bugs on fruit clusters in muslin bags. There were 5 bags used on 4 cultivars for 4 time periods, 1-4 weeks. Data have not yet been analyzed, but there was little evidence of fruit drop. Studies to evaluate for possible loss of shelf life when fresh berries are shipped to distant market are planned.

Further work is planned for cranberry fruitworm, leaffooted bug, rabbiteye pollinators and on fire ant control in pick-your-own operations.

Table 2. 1986 Blueberry insect survey. Minimum 10 sweeps per sample, with 48 observations.

Vaccinium sp.	Stamineum Peach Co.	Arboreum Peach Co.	Elliottii Evans Co.	Elliotii Alachua Co. FL	Simulatum Brasstown Bald	Myrsinites Alachua Co. FL	Corymbosum Fletcher, NC & Blairsville	Ashei 4 sites Wild	Ashei 15 sites Cultivated	Ashei Monroe Co.	Ashei Peach Co.	Ashei Peach Co.
L. Phyllopus (A)								*				
L. Phyllopus (N)				*								**
Banasa Obmidiata (A)				**		*	*	*	*	*	**	*
Banasa Obmidiata (N)	*											*
Euschistus Servus												
Euschistus Tristigmus												
Pentatomid (A)				*		*						
Pentatomid (N)						*		*				
Red Mirid (A)	*											
Red Myrid (N)	*	*										
TPB							*					
Scaphytopius sp. (A)	**	*				*					**	*
Scaphytopius sp. (N)	**		*			**	*				*	*
CPW Eggs									*	**		
CPW Larva										***		
Lep. Larvae	**	**	*	**	**	*	**	*	*	**	*	*
Forest Tent Cat.										*		
Bagworm										*		
Leafminer												
Tip Midges									***			
Neuroptera Larva												
BB Maggot (A)	*											
BB Maggot (L)	**											
Casebearer	*											
Coccinellids	*	**			*				*	*		*
Misc. Coleop (A)	*	***	**	*				*	*	*	*	*
Misc. Coleop (L)	*			*		*			*	*		*
Anthonomus sp.	*			*					*			*
Chrysomelids	*			*	*		**	*	*			*
Cantharids	*	***						*	*	*		
Brown Beetles	**	***										
Scale						**		*	*			
Thrips	***	***	**	**		*	***	***	***	***	***	**
Crickets/Grasshoppers	**		**						*			*
Aphids	***	**	**	**	**		**	*	*		*	*
Midges/Flies	**	***	***	*	**	**	**		*		**	**
Ants	**	**	**		*	*	**	**	*	*		*
Spiders	***	***	***	***	*	***	**	***	***	***	***	***
Harvestmen	*	*	*								**	*

* – rare
** – moderate
*** – numerous

Not for Citation

Influence of Spirea Aphids, *Aphis citricola* (Homoptera: Aphididae), and Sooty Mold on Net Photosynthesis and Chlorophyll Content of Apple Leaves

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Abstract: Spirea aphid feeding caused a 24% and 30% reduction in net photosynthesis and leaf chlorophyll content, respectively. Sooty mold also reduced both, by 48% and 24%, respectively. Photosynthetic rates in this study were poorly correlated with chlorophyll content of the same leaves.

The effects of several leaffeeding arthropods (leafhoppers and mites) on Pn of apple have been previously studied. Recently it has been shown that aphids also affect Pn. Leaf chlorophyll content is an important plant component that may provide a measure of plant photosynthetic potential. The effects of spirea aphid on chlorophyll content and Pn of apple leaves have not been studied. The purpose of our study was to determine the effect of this aphid's feeding on these parameters and also to describe the relationship between these parameters to determine if a greater concentration of chlorophyll results in greater Pn.

Materials and Methods

Net photosynthesis experiment: Six fully-expanded terminal leaves infested with *A. citricola* were selected from six one-year-old apple trees. Another six leaves with various levels of sooty mold were also selected from the middle portion of the shoot (approximately 11-13 leaves from the shoot apex) to obtain relatively comparable values for photosynthesis.

Determinations of Pn were made in the greehouse using an Analytical Development Corporation CO_2 Analyzer. Pn is based on the amount of CO_2 the leaf fixes in the light and is determined by measuring the difference in CO_2 concentration entering and leaving the leaf chamber (Pn=mg CO_2 dm^{-2} hr^{-1}). The ADC CO_2 Analyzer measures the concentration of CO_2 directly after placing the leaf in the chamber for 25 seconds. The air flow rate into the chamber was

400 ml min^{-1} and photosynthetic photon flux density was 950-1150 mols $s^{-1}m^{-2}$. Air temperature in the leaf chamber was 30°C$\pm$2°C. Data were analyzed using ANOVA. Linear regression was used to determine the relationship between aphids/shoot and Pn.

Leaf Chlorophyll Content Experiment: The same number of leaves were selected as indicated above. Ten leaf disks (8.0mm diam.) were cut from the interveinal area of both sides of each leaf using a common paper punch. The disks were placed immediately in 10 ml of 80% methanol in darkness at room temperature for 96 hours (modified from Marini and Marini 1983). Concentrations of extracted chlorophyll a and b in the methanol were determined from absorption values at 645nm and 663nm using a double beam spectrophotometer.

Total chlorophyll content per unit-leaf area was calculated using the formula (Proctor 1979): Total chlorophyll (mg/cm^2)=(7.12 A_{663}+16.8 A_{645}) (V*10)/Nr , where A=the absorbance of the extract at a given wavelength, V=the volume in liters, N=the number of leaf dishes, and r=the radius of the disk.

Another method of measuring leaf chlorophyll content used the Minolta Chlorophyll Meter SPAD 501. This meter measures the optical densities at the two wavelengths of the light transmitted through the leaf. Data were analyzed as above.

Results and Discussion

The two studies of apple leaves with aphids or sooty mold gave similar results. Photosynthetic rates of infested leaves differed from control leaves. Table 1 shows reductions in Pn of 24% and 48% caused by aphid feeding and sooty mold, respectively.

The data for the two methods of measuring leaf chlorophyll are given in Table 2. Using the methanol extraction technique, there was a reduction in chlorophyll content of 30% and 26% caused by *A. citricola* and sooty mold, respectively. Regression analysis showed a decreasing amount of chlorophyll with increasing number of aphids/shoot. The same results were obtained with the SPAD 501 chlorophyll meter, where 26% and 21% reductions in chlorophyll were caused by aphids and sooty mold, respectively. Chlorophyll a, b, and total chlorophyll were significantly higher in control leaves than infested leaves (Table 3). Regression lines showed less variability using the SPAD 501 than with the methanol extraction technique.

In our study chlorophyll extraction was not complete. Therefore, differences in chlorophyll content were relative rather than absolute.

The rate of Pn increased with chlorophyll content. The relationship between chlorophyll content and Pn has been of interest for many years, but they do not always appear to be related (Buttery and Buzzell 1977). There appeared to be a quadratic relationship between Pn and chlorophyll content in soybean leaves. The results of Marini and Marini (1983) indicated that Pn of peach leaves is not linearly related to chlorophyll concentration.

From this study, one can demonstrate a low correlation between Pn and chlorophyll content. Although chlorophyll content may regulate Pn, plant age and nutritional status may limit the results. Substances injected by aphids (Dixon 1975) may also affect apple leaf structure and function.

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Table 1. Effect of A. citricola feeding and sooty mold on Pn of apple leaves.

Treatment	Pn (mg CO_2 dm^{-2} hr^{-1})
Infested leaves with aphids	10.31b
Control	13.53a
Infested leaves with sooty mold	8.17b
Control	15.16a

*Means followed by the same letter are not significantly different using ANOVA test for equal variance (P< .05).

Table 2. Effect of A. citricola feeding and sooty mold infestation on leaf chlorophyll content of apple leaves.

Treatment	Chlorophyll (mg cm^{-2})*	Chlorophyll(**)
Infested leaves with aphids	186.57b	40.33b
Control	264.94a	54.42a
Infested leaves with sooty mold	201.56b	43.79b
Control	264.40a	55.54a

*Means followed by the same letter are not significantly different using ANOVA test for equal variance ($P < .05$).
**Using chlorophyll meter.

Table 3. Levels of chlorphyll a and chlorophyll b as an indication of chlorophyll reduction by A. citricola feeding and sooty mold infestation.

Measurement	Infested leaves (aphids	Control	Reduction	Infested leaves (sooty mold)	Control	Ratio
At 645 wavelength	0.275	0.384	29%	0.290	0.373	23%
At 663 wavelength	0.660	0.961	31%	0.735	0.983	26%

*Using Double Beam Spectrophotometer.

* Not for citation or publication without consent from the authors *

Title: Residual Control of Tufted Apple Budmoth with Azinphosmethyl and Methomyl Applied as Alternate-Row Middle Sprays

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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). Sprays are usually applied to alternate-row middles (ARM) in which only one side of the tree is sprayed every 7-10 days. This spray practice promotes flexibility in decision making, allows control of spider mites by the coccinellid predator Stethorus punctum (LeConte) to develop, and reduces pesticide use and associated spray costs.

The utility of ARM sprays in providing refugia for S. punctum to remain active in checking mite outbreaks and in reducing miticide usage in commercial apple orchards has been demonstrated successfully over the last 15 years (Hull and Beers 1985). However, during this time period TABM has become a serious problem for many growers (Bode 1975, Hull et al. 1983). Results from early studies suggested that control of TABM with weekly ARM sprays was as good as with conventional complete sprays (L.A.H., unpublished data). But, growers in PA have stretched the ability of ARM sprays to provide adequate control by extending their average spray interval to over 10 days (L.A.H., unpublished data) and by often applying their last spray 2-4 weeks before the end of second brood egg hatch (Hull et al. 1982). These practices reduce pesticide residue levels and subsequently pest control is poor. In addition, the consequences of these practices may become more severe if TABM develops resistance to organophosphate insecticides, such as azinphosmethyl (Meagher and Hull 1986, A.L.K., unpublished data).

Clearly a great deal more study is needed to evaluate the effectiveness of the current ARM spray program for TABM. We feel a reasonable approach to this problem is to fashion a strong biological linkage between spray application and coverage with insecticide persistence and efficacy. The use of residue-bioassay tests allows one to view directly the pest-pesticide interaction which occurs in the orchard.

In 1986, we initiated a research program to evaluate ARM spray rates, timing, and chemical selection with a diverse array of experiments. These tests range in scope from measuring the decay in activity of a single spray, to assessing the seasonal accumulation of pesticide activity, to the residual control from the season's last spray. This paper reports our results on the residual control of first instar TABM with a single ARM spray of both azinphosmethyl and methomyl.

Materials and Methods

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 'Golden Delicious' trees (4.5 x 4.0 m) each were sprayed on 12 August 1986 from only one side with an air blast sprayer calibrated to deliver either 113g AI/acre/side of azinphosmethyl or 102g AI/acre/side of methomyl in 50 gal. water. Two control trees did not receive any insecticides after 30 June. Minimum and maximum temperatures and precipitation were recorded with standard meteorological equipment.

Two areas approximately 1 m^2 each were designated on either side of each tree. A small sample of 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 (20 mm 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. Data from residue analysis will be available later in the year (Dr. Ralph Mumma, Penn. State Univ. Pesticide Laboratory).

In addition, on each date, 4 samples of 20 first-instar TABM from both a laboratory colony and from field-collected egg masses were bioassayed with residues present on leaf disks. Two disks were placed with five larvae in 9 x 30 mm vials with cork stoppers. Mortality was assayed after storage at 20 °C for 24 hrs. Average percent mortality of larvae for each strain, tree side, and chemical was plotted as a function of days.

Results

Control mortality of the laboratory population was high in tests with both chemicals (Fig. 1). This may have resulted from pesticide residues present 43 days since the last spray or from spray drift in our experiment. Earlier tests demonstrated that the laboratory population developed normally on washed apple leaves.

Mortality of the laboratory population assayed with azinphosmethyl was high on the sprayed side, but never exceeded 50% on the opposite side of the tree. Control of the field-collected population with azinphosmethyl was poor. On the sprayed side, mortality peaked at 49% 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.

Higher mortality was achieved on trees sprayed with methomyl. Against the laboratory strain, nearly 100% control was achieved for up to 3 days before dropping off exponentially to 25% after 10 days. On the opposite side of the tree, mortality was less, decreasing from 70% on day 0 to 20% by day 10. Against the field-strain, methomyl was effective only on the sprayed side of the tree. Mortality levels were close to 100% initially and dropped off to 50% after 6 days. Mortality levels on the unsprayed side of the tree were not different from the control.

Precipitation occurred at 3 periods during this study with the heaviest accumulation on days 5 and 8. Larval mortality for both chemicals dropped sharply during these periods suggesting that pesticide residues were washed off leaf surfaces.

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 size and speed of the sprayer and size and foliage density of the tree 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 underestimates the complete efficacy of a spray under field conditions these experiments do suggest that ARM sprays may not be effective in managing leafroller populations at low levels. For example, Figs. 1A and 1C demonstrate that control of a susceptible strain on the unsprayed portion of the tree is poor with either chemical. During the 7 day recommended period between ARM sprays, larvae which survive on this side of the tree continue to feed and build protective larval shelters and become less susceptible to additional sprays (Travis et al. 1981).

Difficulty in controlling TABM with ARM sprays is compounded by the development of pesticide resistance. Assays of first instars from orchards throughout Adams County, PA, have demonstrated a widespread, high level of resistance (approximately 20-fold) to azinphosmethyl (A.L.K., unpublished data). Though the spray rate used in our test was twice what growers typically apply (Hull et al. 1983), Fig. 1B suggests that the level of suppression of field TABM populations which can be achieved with azinphosmethyl is low and strongly indicates that alternative chemicals or management tactics are needed to control this pest.

Methomyl appeared effective in controlling TABM at least on the sprayed side of the tree. In addition, resistance to this compound has not been detected in bioassays (A.L.K., unpublished data). However, persistence of this compound is shorter than azinphosmethyl, and maintaining close spray intervals may be a key to its successful use. Our results suggest that if TABM pressure is high or if precipitation exceeds 20 mm spray intervals should be shortened to 5 days.

Conclusions

The linkage provided by residue-bioassay tests between ARM spray rates and coverage with pesticide persistence and efficacy was clearly demonstrated in these experiments. We believe that viewing the pest-pesticide interaction at this level is appropriate to assess the effectiveness of control recomendations for TABM. What is now needed is to expand our study's focus to view the seasonal patterns of insecticide residue accumulation and degradation and resulting pest control efficacy.

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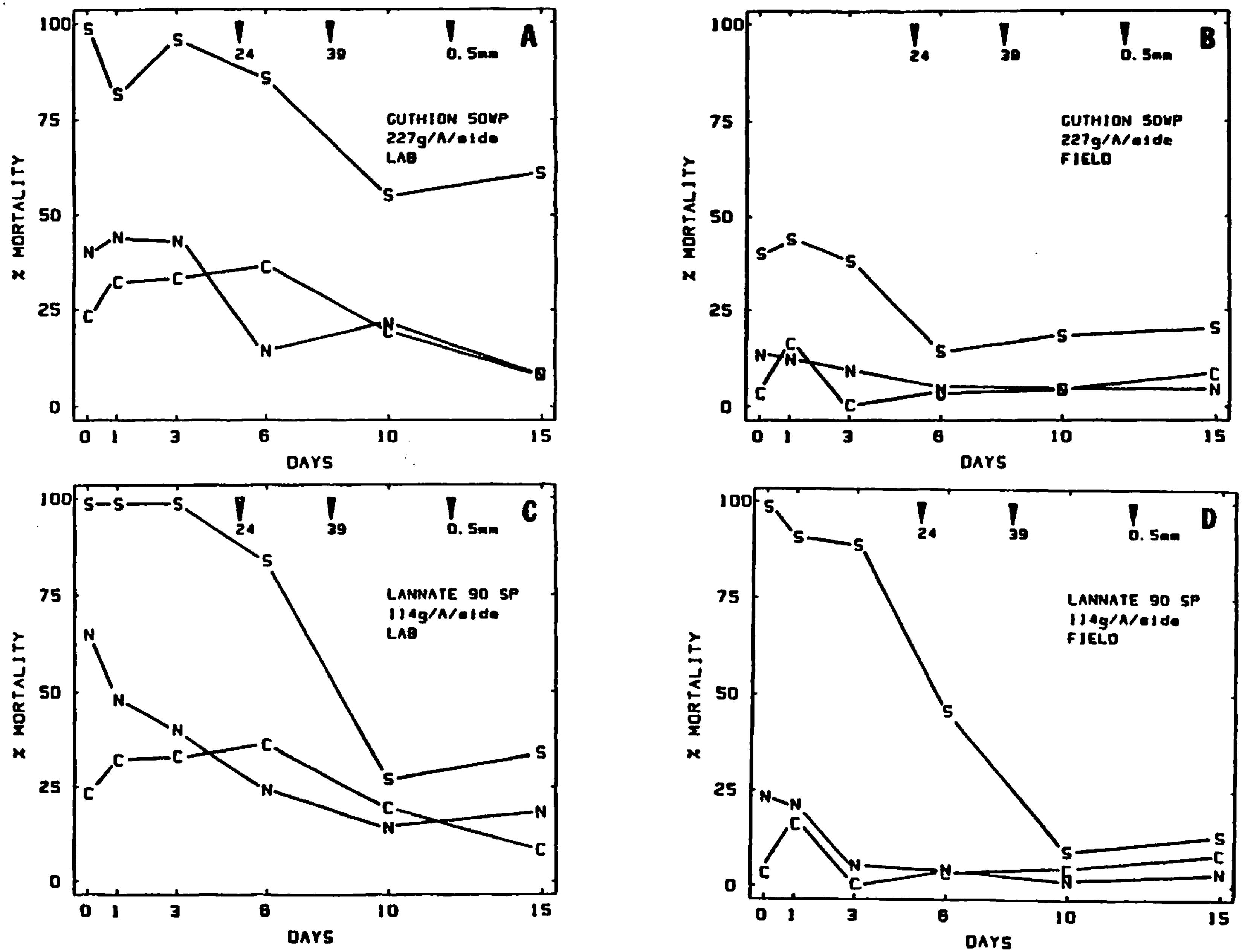

Figure 1. Comparative residual control of a laboratory-reared strain and field-collected TABM first instars with Guthion 50WP and Lannate 90SP applied as a single alternate-row middle spray to the south side (S) of four medium Golden Delicious trees (C = control, N = north side of sprayed trees, ▼ = precipitation).

Not for Citation

Incidence of Spirea Aphid Versus Apple Aphid In Orchards of Cumberland-Shenandoah Region

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Abstract: Spirea aphid, *Aphis citricola* Van der Goot, greatly out-numbers apple aphid, *A. pomi* DeGeer (80%: 20% average over 25 orchards) in most of the apple orchards sampled in Virginia, West Virginia and Maryland, ranging from 60-100% of the aphid colonies sampled. Based on this survey, we suggest future research with "apple aphids" include species determination. Use of apple as a primary host is indicated for the first time in *A. citricola*.

Introduction: Three species of Aphididae are commonly reported overwintering as eggs on apple (*Malus* x *domestica* Borkhausen): *Aphis pomi* DeGeer (apple aphid), *Dysaphis plantaginea* (Passerini) (rosy apple aphid), and *Rhopalosiphum fitchii* (Sanderson) (apple grain aphid) (Matheson 1919, Brunner and Howitt 1981). In our collections of sexual forms (oviparae and males) of aphids from an apple orchard at Shenandoah Valley Research Station (SVRS) at Steeles Tavern, Virginia, in the fall of 1983 and 1984, no *A. pomi* were collected. The only *Aphis* species in our samples was *A. citricola* Van der Goot (spirea aphid). Aphids collected at SVRS in the spring 1983 and 1984 and summer 1984 in Berkeley Co., W. Va., were also identified as *A. citricola*. Apple has previously been reported as a summer host for *A. citricola* (Blackman and Eastop 1985).

The purpose of this study was to estimate the extent of *A. citricola* occurrence in apple orchards in the Appalachian apple-growing region.

Materials and Methods: Aphids were collected in 15 orchards in Virginia: nine in the Piedmont (four each in Albemarle and Nelson Cos., one in Franklin Co.), two in the upper Shenandoah Valley (Rockbridge Co.), and four in the Roanoke Valley (Botetourt Co.). The Piedmont orchards are on the east side of the Blue Ridge; the remainder are on the west

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side. Eight orchards were sampled in West Virginia: six in the lower Shenandoah Valley (three each in Jefferson and Berkeley Counties), and two in the Potomac Highlands (Morgan Co.). Two orchards were sampled in the Cumberland Valley of Maryland (Washington Co.).

During the last week of May and the first week of June 1986, ten colonies were sampled per orchard. A second sample of the West Virginia and Maryland orchards was conducted in the last week of July. The leaf containing a colony was placed in a vial of 70% ethanol in the field. One adult aphid per colony (either apterous or alate vivipara) was identified, first using a dissecting microscope but identifications were confirmed after slide-mounting using the procedure of Baer and Kosztarab (1985).

Identifications were made using characters presented by Blackman and Eastop (1985). A. pomi was identified by the presence of lateral tubercles on abdominal segments two through four and presence of 14 or more setae on cauda. A citricola lacks lateral tubercles on those segments and has 12 or less setae on the cauda.

Results: In the spring samples, Aphis citricola comprised 80% of the aphid colonies sampled in Virginia, West Virginia and Maryland; A. pomi comprised the remaining 20%. Individual orchards had from 60-100% of the aphid colonies being A. citricola. A breakdown of the proportion of A. citricola colonies by geographical region is presented in Table 1. Preliminary identifications of aphids collected in July indicate an increase in the proportion of A. pomi.

Discussion: These findings are important because A. pomi has been considered an economically important species and has been the subject of research on integrated pest management and insect-plant relationships (Carroll and Hoyt 1986, Hamilton et al. 1986). The species are very similar morphologically. Patch (1923) considered A. citricola (=A. spiraecola Patch) to be a race of A. pomi because of their morphological similarity and because both colonize spirea as well as apple. The validity of the species is now recognized, Blackman and Eastop 1985).

Leonard and Bissell (1970) listed only one record for A. citricola on apple in this region, while multiple records were given for A. pomi.

Aphis citricola is the most common aphid pest of citrus in both Nearctic and Palaearctic regions (Neubauer et al. 1981, Univ. of California 1984), rising suddenly to pest status in the 1920's (Wolcott 1954). It is the vector of tristeza virus of citrus and mosaic virus of papaya. Its role in disease transmission in some fruits is unknown. Ciampolini (1978) reported a severe infestation of A. citricola on Vitis vinifera L. in Italy.

For years A. citricola was assumed to overwinter on spirea and disperse in the spring to other hosts. However this species was reported to overwinter on citrus in 1979 (Komazaki 1983). This is the first indication that A. citricola may use Malus as a primary host.

Although A. citricola has been known to colonize apple as a secondary host (Patch 1923, Parrella et al. 1981, Blackman and Eastop 1985), no research has been published on this species on apple trees. Any action threshold or economic injury level developed for A. pomi should be validated for A. citricola because of the preponderance of this species in apple orchards of the mid-Atlantic states. Population dynamics for A. citricola should also be determined on apple; several demographic and phenological parameters have been shown to vary with choice of host plant (Neubauer et al. 1981, Komazaki 1983). Steiner et al. (1985) found genetic differences between strains of A. citricola on different host plants. Because of the morphological similarity between this species and A. pomi, much research presumed to be performed on A. pomi has in reality utilized A. citricola (Blackman and Eastop 1985). The need to submit voucher specimens for systematic identification in the course of investigations is emphasized by this research.

Aphis pomi and A. citricola are most easily differentiated in the sexual generation (Palmer 1952). The ovipara of A. citricola has greatly swollen metatibiae covered with flat sensoria; these are not seen in A. pomi. Males of A. citricola are alate while those of A. pomi are apterous. Characters for differentiating viviparae are given above.

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Table 1. Percentage of *Aphis citricola* Van der Goot colonies in 10 *Aphis* spp. colonies sampled per orchard in Virginia, West Virginia and Maryland.

Region	Orchards (n=)	Mean percentage of *Aphis citricola* Colonies per orchard
Piedmont	9	83 (70-100)
Roanoke Valley	4	92 (80-100)
Shenandoah Valley (upper)	2	95 (90-100)
(lower)	6	87 (60-100)
Potomac Highlands	2	100 (100)
Cumberland Valley	2	90 (90)

Effects of *Dysaphis plantaginea* on Phloem Integrity of Apple Leaves

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Feeding by the rosy apple aphid, the most damaging of the aphids infesting apple causes leaves and twigs to curl. Accumulation of dry weight, elongation of the central leader, net photosynthesis and leaf chlorophyll content are also significantly reduced. Various species of aphids infesting pecan are known to induce accumulation of a carbohydrate, callose at the sieve plates of phloem tissue. It was the purpose of our study to determine the effect of feeding by rosy apple aphid on callose accumulation in apple.

Apple leaves with active colonies of rosy apple aphids were removed and immediately fixed in the field in acetic acid-alcohol (1:3 glacial acetic acid: 95% ethanol) cooled to approximately -74°c by dry ice. The leaves and fixative were allowed to return to ambient temperature in the laboratory. Leaves were then removed from the fixative and rinsed in tap water for 20 minutes. Longitudinal sections were made, by hand, through pieces of midrib pierced by stylets of rosy apple aphids. The sections were stained for ten minutes in resorcinol blue (10 drops/5 min tap water pH 6.0). The same procedure was followed for leaves not fed on by rosy apple aphid.

Longitudinal sections of midveins with actively feeding rosy apple aphids had numerous accumulations of callose within the phloem tissue. Sections of midveins of control leaves showed no accumulation of callose within the phloem tissue.

We speculate that the phloem tissue of leaves with active rosy apple aphid colonies respond to feeding by increased production of callose which accumulates at the sieve plates at the end of each phloem vessel element. This accumulation may impede translocation of photosynthates through the phloem. It is possible that the reduction in net photosynthesis we described last year at this meeting is related to decreased speed of translocation of materials through the phloem.

Not for Citation

Pheromone Disruption for the Control of Oriental Fruit Moth and Lesser Peachtree Borer

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Abstract: Placement of sex pheromone dispensers in a 4ha peach block totally disrupted attraction of *Grapholitha molesta* (Busck) and *Synanthedon pictipes* (Grote & Robinson) to conventional pheromone traps. Fruit damage by *G. molesta* was equivalent with levels achieved by applications of parathion; twig damage was significantly reduced relative to chemical control.

Introduction: Several studies (reviewed by Gentry et al. 1982) have employed the sex pheromone of *Grapholitha molesta* (Busck) in a variety of dispensers to disrupt olfactory communication in that species. Some studies have examined disruption of attraction to conventional traps but did not examine damage. Other studies have used small experimental orchard units which may have allowed immigration of gravid females from outside the treated area. Disruption using varying pheromone-release technology has been reported for periods ranging from two to five weeks (Gentry et al. 1974, 1975) to 121 days (Cardé et al. 1977).

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 *G. molesta* and *Synanthedon pictipes* (Grote & Robinson) to conventional traps, but also the feasibility of this technique for preventing damage by these species in the Appalachian fruit-growing region.

Materials and Methods: The treated area was a 4-ha 'Monroe' peach block at Batesville, Virginia. On April 4, 1986 (about petal fall stage), two dispensers of *G. molesta* pheromone were placed in each tree at ca. 2-m height to achieve a rate of 1000/ha. Dispensers for *S. pictipes* were placed in the block on July 11 and 15, at the rate of one per tree. This was prior to the onset of second generation flight. The treated block was unsprayed for the entire season, except for one spray applied mistakenly. No *S. pictipes* spray was applied in 1986.

The control area was a 4-ha block of 'Jefferson' 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 was applied for *S. pictipes* control.

As a means of determining disruption, nine commercially-available G. molesta pheromone traps were placed in each block on April 11, and four S. pictipes traps per block were placed on June 13. Each trap for a given species was separated by at least 60 m. Numbers of captured G. molesta, G. prunivora (which are also attracted to G. molesta traps), and S. pictipes were recorded weekly and the moths removed from the traps. Lures were replaced after six to seven weeks. Trap bottoms were replaced when they became excessively contaminated with insect parts, dust, etc.

Damage by Grapholitha spp. was evaluated on July 3 and on August 21 (harvest). On July 3, five trees per block were randomly selected for sampling; on August 21, ten trees per block were sampled. Twig damage was recorded as the number of affected twigs seen during a two-minute examination of each sampled tree. Fruit damage was recorded as the number of fruit damaged in a sample of 20 fruit per tree. Cast exuviae of S. pictipes will be counted in the spring of 1987.

Results and Discussion: Olfactory communication in both G. molesta and G. prunivora was totally disrupted for the entire growing season as determined by pheromone trap captures (Table 1). Attraction of S. pictipes to traps was also completely eliminated after dispensers were placed in the block. No fruit or twig damage was observed in the orfralure-treated block. Fruit damage was also very low in the conventionally-treated control block; more affected twigs were seen in the control block, however. Damage to twigs was lower on August 21 than on July 3. This is due probably to the majority of this damage being caused by larvae of earlier generations, and after weathering and plant development some affected twigs were not clearly recognizable as such. Random variation may also present a factor in the discrepency between the two dates since different trees were selected for sampling on each date. It was concluded that disruption of olfactory communication was at least as effective as a conventional insecticide program.

Insecticide application still retains the benefit of controlling other pests, such as catfacing insects and plum curculio in the early part of the season and Japanese beetle later in the season. However, this pheromone technology may lend flexibility to orchard pest management programs by eliminating the need to monitor and control a direct pest, thereby allowing orchardists to concentrate on other insect pests. An alternative emphasis of a pheromone-suppression program centers on young orchards. An early placement of dispensers could significantly reduce twig damage relative to insecticide applications. Twig damage is more important in young orchards than in bearing orchards because this is when initial tree training occurs. Actively-growing twigs are present on such young trees for a greater proportion of the growing season than mature trees. Lack of fruit in young orchards eliminates the need for insecticides directed against fruit pests, so an early placement of pheromone dispensers could greatly reduce control costs in addition to elimination of twig damage.

The potential savings from the use of dispensers for borers is great since pesticides applied for these insects are for these pests alone, necessitating a special trip through the orchard.

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Table 1. Trap capture and damage data for Grapholitha molesta and G. prunivora in a peach orchard at Batesville, Va.[1]

	Mean G. molesta per trap	Mean G. prunivora per trap	Infested twigs per tree		Damaged fruit per 20 fruit	
			Jul 3	Aug 21	Jul 3	Aug 21
Pheromone-treated	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a
Insecticide-treated	1.5b	1.0b	6.0b	2.0b	0.0a	0.1a

[1]Data transformed for analysis ($\sqrt{x+0.5}$). Means within a column followed by different letters are significantly different (alpha = 0.01).

Grape Root Borer Flight Activity in Virginia

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The grape root borer is a potentially very damaging insect pest of vineyards in the southeastern states. Virginia is near the northern edge of its range, although it does occur in the southeastern corner of Pennsylvania (Jubb 1982). At present this pest is not abundant in most commercial vineyards, but has been very destructive in a few cases and will likely be more frequently observed as our vineyards age.

The timing of pupation and adult eclosion are very important to the control of this species. The organophosphate insecticide Lorsban 4E is registered for the control of grape root borer. Label recommendations state that application should be made just before the pest emerges form the soil. Another control tactic is to mound the soil around the vine trunk after pupation but before adult emergence. A knowledge of grape root borer phenology, or seasonal life history is essential to its control

Pfeiffer and Schultz (1986) reported that larvae leave the roots and pupate in mid June and that adults appear in mid July. This information is based on work done in the Roanoke Valley, including searching the soil for larvae, pupae and the cast exuviae. This is tedious work and possibly not a very sensitive method for detecting the earlier developing individuals. In 1985, a pheromone trap for grape root borer became available for research purposes. The following information is based on the use of these traps.

In 1985 and 1986 USDA personnel in Georgia organized a regional study of grape root borer phenology using pheromone traps. We participated in this study, contributing data from Virginia. The pheromone used in the traps in 1985 was (E,Z)-2, 13-octadecadien-1-ol acetate (ODDA). In 1986, a blend of two compounds was used; the former material and (Z,Z)-3, 13-ODDA, in a proportion of 99:1.

The traps were checked weekly until it became apparent that trap bottoms became saturated at about 30 moths per trap. While moths were very active traps had to be serviced twice per week.

Two sites were used in 1985, one each in Botetourt and Rockbridge Counties. However only four moths were caught all season long, in three traps per vineyard.

Two sites were again used in 1986, the second being moved to Stafford County. With the improved formulation of the grape root borer pheromone, significantly more moths were captured in the traps. More borers were caught in the Botetourt vineyard. This is probably a reflection of the greater age of the vineyard. Vines were 10-20 years old compared to four and six years old in the Stafford vineyard. The first moths were caught in late June, rather than mid July as previously believed to be the emergence period. The pheromone traps provided a much more sensitive method of detecting early grape root borer flight. Male flight peaked in early August, and continued until late September.

This information is very important for grape root borer control. If the mounding technique is used, mounding should be accomplished in late June or early July. Timing of mounding is very important because if performed too early, larvae will simply crawl up into the mound to pupate. However, the period of emergence is protracted. Although first emergence is in late June, peak activity was in late July. Mounding timed only toward the first emergence date may be too early for the majority of the population. If Lorsban is to be sprayed it should be used before the adults appear. The earlier timing is more compatible with the preharvest interval for Lorsban (35 days before harvest).

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Importance of Japanese Beetle Foliar Feeding on Grapevines

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ABSTRACT: The natural infestation level for 1985 of the Japanese beetle, *Popillia japonica* Newman, in the Shenandoah Valley of Virginia failed to reduce berry quality, yield or shoot growth on a commercial vineyard. Intensive post-veraison feeding by the Japanese beetle resulted in fruit with lower soluble solids and higher total titratable acidity at harvest, but did not affect pH, sugar per berry, berry weight, yield, leaves per vine or shoot length. Intensive preveraison feeding also resulted in fruit with higher titratable acidity.

Introduction: Japanese beetle, *Popillia japonica* Newman, is common throughout most of the eastern United States and is abundant in Virginia where climatic conditions and both larval and adult food supplies favor large populations. Adult beetles feed voraciously on the leaves of grapevines, *Vitis* spp. Japanese beetle is the pest for which most insecticide applications are made on wine grapes in Virginia.

The first study described herein was undertaken to determine if natural or high population densities affect grape berry quality or yield, and to determine if there is a differential effect due to the timing of Japanese beetle damage. A second study was undertaken to quantify the effects of various levels of leaf area loss (LAL) on berry quality.

Materials and Methods: The studies were conducted in a three-year old vineyard in Rockbridge Co., Virginia, on the French hybrid *Vitis rupestris* x *vinifera* 'Seyval Blanc' trained to a bilateral cordon system. The first experiment utilized four adjacent vineyard rows, with at least one vine between each test vine. An RCB design was used with 14 single-vine replicates each for four treatments.

Adult beetles were caged onto vines for 2300 beetle-days both prior to and after veraison to measure the effects of damage at different periods during berry maturation. Veraison occurred between 25 and 28 July, while peak bloom occurred on approximately 31 May. Grapes were harvested on 3 September.

Vines were caged in the preveraison treatment from 8 July to 26 July, and in the postveraison treatment from 28 July through 20 August. At the start of each treatment, 100 beetles were added to each cage. This population density was maintained by replacing dead or moribund beetles on the bottom of the cage every two or three days. An additional 100 beetles were added to each cage of the preveraison treatment on 21 July to assure adequate damage before veraison. The nylon net cages produced approximately 8% shading.

Control vines were sprayed weekly with carbaryl from 7 July until a week prior to harvest. Vines in the pre- and postveraison treatments were also sprayed when the cages were not in place. A fourth treatment was left unprotected throughout the season to determine the effects of injury by the naturally occurring Japanese beetle population for the area in 1985.

At harvest, fruit clusters were collected (sampling techniques described in Boucher 1986) to obtain data on cluster weight, berry weight, yield per vine, berry soluble solids (SS), pH, and total titratable acids (TTA). Cane length was measured and the number of leaves per vine were estimated by counting the leaves on one cordon and doubling the count.

A visual leaf damage index was constructed by making an acetate photocopy of the damaged leaf and darkening the damage on the copy with a black felt tip marker. A leaf area analyzer was used to compare the total area of the copy with the area of the damaged leaf; percent LAL was thus obtained. Every fifth leaf of every shoot of one of the two cordons was rated for damage, and placed in one of seven classes of damage.

In the second experiment, vines were subjected to different levels of defoliation to study the effects on fruit quality. On 29 and 30 June, vines were artificially defoliated to four different levels: 0, 10, 20, and 33%. This consisted of removing no leaves, or every tenth, fifth or third leaf, respectively, from every shoot of the vine. Leaves on new shoot growth were removed on 28 July. All vines were protected from further damage by weekly applications of carbaryl.

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Kelthane 4MF Phytotoxicity Trial, 1986 - Christiansburg

APPLE: _Malus_ x _domestica_

APPLE, KELTHANE 4MF PHYTOTOXICITY TRIAL, 1986: Three formulations of dicofol were compared for phytotoxicity at the VPI & SU Horticulture Farm at Christiansburg. Six varieties were included in each treatment's plot: 'Delicious', 'Golden Delicious', 'Rome', 'York', 'Stayman', and 'Winesap'. Applications were made with a Swanson air-blast sprayer at 300 gal. per acre. Spray dates were 5 May (petal fall) and 6 June (second cover).

Three formulations of dicofol were applied: Kelthane 4F (XF-85017), a newer formulation of Kelthane 4F (XF-86006), and Kelthane 4MF (XF-35013). The rate used for all formulations was 3.4 kg AI/ha (3 lb AI/A). An untreated control group was included.

Because of frost damage in the block, some varieties had insufficient numbers of fruit for valid comparisons of damage. Where possible, 20 fruit per tree were examined for phytotoxicity. Twenty shoots were examined per tree for signs of foliar phytotoxicity. Four trees per cultivar were sampled per treatment.

Sample dates were 8 July and 11 September. No foliar phytotoxicity was seen on any variety in any of the treatments. No effect of Kelthane was seen on fruit finish. Further fruit information follows: Kelthane 4MF (XF-85013) - 'Delicious' 20 fruit examined in total block; 'Golden Delicious' 20 fruit/tree on three trees; 'Rome' 10-20 fruit/tree; 'York' 20 fruit/tree; 'Stayman' 20 fruit/tree; 'Winesap' no fruit. Kelthane 4F (XF-85017) - 'Delicious' 20 fruit/tree; 'Golden Delicious' 20 fruit/tree; 'Rome' 4 fruit total in block; 'York' 3-20 fruit/tree; 'Stayman' 5-20 fruit/tree; 'Winesap' no fruit. Kelthane 4F (XF-86006) - 'Delicious' 20 fruit/tree; 'Golden Delicious' no fruit; 'Rome' 4 fruit total; 'York' 2 fruit total; 'Stayman' 11 fruit total; 'Winesap' no fruit. 'Golden Delicious' fruit had heavy russet from frost damage; this was consistent across treatments, including the control.

RESULTS: The natural beetle population failed to produce significant reductions in any of the parameters tested (Table 1): SS, TTA, pH, sugar per berry, berry weight, leaves per vine or shoot length. At harvest, both pre- and postveraison treatments had significantly lower cluster weights and higher TTA than the control. Postveraison feeding also lowered the SS concentration.

Each treatment has significantly greater foliar damage than the control. Postveraison feeding produced the highest amount of injury (11%), followed by preveraison (9%), the natural level of feeding (6.5%), and the control (3%).

In the second experiment, linear regression analysis failed to show any relationship between SS, pH, or TTA, and the percent of artificial defoliation (graphic representations of these analyses are presented in Boucher 1986).

REFERENCE CITED

Boucher, T. J. 1986. Japanese beetle Popillia japonica Newman: Foliar feeding on wine grapes in Virginia. M.S. thesis, Va. Poly tech. Inst. State University, Blacksburg.

Table 1. Comparison of effects of foliar feeding by artificially high and natural Japanese beetle populations.

	Treatments			
	Control	Natural Infestation	Pre-veraison	Post-veraison
Shoot length	155	158	160	178
Leaves per vine	1355	1112	1175	1207
Yield (kg per vine)	5.1	5.3	4.0	4.3
Mean cluster weight (g)[a]	316a	295ab	255b	261b
Sugar per berry (mg)	438	454	454	437
Soluble Solids[ab]	19.5ab	19.8a	19.1bc	18.7c
TTA[abc]	0.89b	0.88b	0.94a	0.98a
pH	3.27	3.28	3.26	3.28
% leaf area loss[ab]	3.0d	6.5c	9.0b	11.0a

a Means within a row followed by the same letter are not significantly different at the 5% level using Fisher's Lease significant Difference Test.
b Percentage data were transformed using the arcsin.
c TTA = grams of tartaric acid per 100 ml of juice.

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Mite Control Trial, 1986 - Steeles Tavern

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, MITE CONTROL TRIAL, 1986: Several acaricides and pyrethroids were evaluated against an untreated control in a 'Delicious' apple block at Steeles Tavern. Four, single-tree replicates were used in a completely randomized design. Applications were made using a truck-mounted Swanson sprayer with a handgun attachment. Trees were sprayed to the drip point (roughly 1869 L/ha (200 gal/A)). Treatments were variously applied at half-inch green (HIG, 2 Apr), pink (P, 8 Apr), or petal fall (5 May). Spray timing for individual treatments are given in the tables. Mites were evaluated using a mite brushing machine and single, 20-leaf samples from each tree.

On the first sampling date (31 May) the control and Pounce groups had significantly more motile ERM than all of the other treatments. Brigade, an acaricidal pyrethroid, gave equivalent ERM control with the other acaricides. Pounce trees had more ERM eggs than the control. Savey caused greater ARM densities than Kelthane, Plictran, Apollo and both rates of Brigade. On 16 June, Pounce caused significantly more ERM than all other treatments. Apollo, Savey and Plictran trees had significantly fewer motile mites than the control; Kelthane, Brigade and Pounce with Savey were intermediate. Plictran, Kelthane, Apollo, Savey and the higher rate of Brigade led to lower ERM egg densities. Pounce with Savey, the lower rate of Brigade, and the control comprised a discretely intermediate group, with Pounce still associated with High ERM densities.

Brigade significantly decreased ERM densities relative to the control, except that late in the season ERM densities increased to higher levels than in any other treatment. Adding Savey to Pounce appeared to ameliorate the latter material's propensity to induce mite outbreaks. Plictran and Kelthane each gave good control in this experiment.

Table 1:

Treatment	Form/100 gal	Timing	ERM per leaf* 31 May motile	31 May eggs	16 June motile	16 June eggs	10 July motile	10 July eggs	31 July motile	31 July eggs	10 Sept. motile	10 Sept. eggs
Brigade 10W	104.3g	HIG,P,PF	0.0a	4.6a	0.6ab	15.3b	4.8cde	24.1bc	6.9d	20.0cde	2.4a	4.2b
Brigade 10W	248.6g	HIG,P,PF	0.0a	0.6a	0.6ab	9.0a	9.3e	39.4c	8.4d	22.9de	7.9b	9.4c
Pounce 25W	170.1g	P	2.5b	920.0c	11.1c	112.3c	7.0de	26.6bc	3.9abcd	16.0bcde	0.6a	3.8b
Pounce 25W	170.19	P	0.1a	0.3a	1.1ab	18.8b	1.1ab	8.7ab	1.3a	11.9abcd	0.2a	2.8ab
& Savey 50WP	56.7g											
Savey 50WP	56.7g	P	0.0a	0.2a	0.0a	5.4a	0.1a	3.9a	2.7abc	3.6a	0.1a	1.5ab
Apollo 50SC	59.1ml	P	0.0a	0.3a	0.0a	4.1a	0.5a	9.2ab	1.2a	8.7abc	0.1a	0.9ab
Kelthane 4F	236.6ml	PF	0.0a	1.0a	0.2ab	3.1a	2.9abc	9.6ab	2.1ab	7.7ab	0.2a	0.6a
Plictran 50W	113.5g	PF	0.0a	1.2a	0.1a	2.9a	3.1bcd	10.9ab	6.0cd	8.4e	0.2a	1.5ab
Control			1.1b	314.0b	2.2b	45.3b	6.7de	16.1ab	4.4bcd	13.7bcde	0.1a	0.9ab

*Data transformed for analysis ($\sqrt{x+0.05}$); Means followed by the same letter are not significantly different (DMRT; 5% level).

Table 2:

Treatment	Form/100 gal	Timing	ARM per leaf* 31 May	16 June	10 July	31 July	10 Sept	AF per leaf* 31 July	10 Sept.
Brigade 10W	104.3g	HIG,P,PF	0.4a	28.7ab	7.9abc	101ab	1.3ab	0.02ab	0.00a
Brigade 10W	258.6g	HIG,P,PF	0.2a	12.1a	17.3c	203c	1.6ab	0.01a	0.00a
Pounce 25W	170.1g	P	1.4ab	48.3ab	4.3abc	53a	1.8ab	0.02ab	0.00a
Pounce 25W	170.1g	P	150.0ab	264.0c	11.4bc	130bc	1.8ab	0.01a	0.04ab
& Savey 50WP	56.7g								
Savey 50WP	56.7g	P	350.0b	107.6b	1.9ab	75ab	5.0bc	0.00a	0.01ab
Apollo 50SC	59.1 ml	P	0.9a	9.1a	5.7abc	152bc	3.0abc	0.01a	0.00a
Kelthane 4F	236.6ml	PF	0.0a	7.6a	3.9ab	143bc	10.8c	0.05ab	4.24b
Plictran 50W	113.5g	PF	0.1a	7.8a	6.8abc	212c	0.8a	0.02ab	0.10ab
Control			72.0ab	95.9b	1.0a	46a	2.7abc	0.10b	0.04ab

*Data transformed for analysis ($\sqrt{x+0.05}$); Means followed by the same letter are not significantly different (DMRT; 5% level).

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ABG-6162HV Mite Trial, 1986 - Steeles Tavern

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

APPLE, ABG-6162HV Mite Trial, 1986: ABG-6162HV (1.5% W/W) an exotoxin derived from <u>Bacillus</u> <u>thuringiensis</u>, was applied to an apple block at Steeles Tavern, at two rates, and was compared with Apollo 50SC. The following treatments were applied at the pink stage of bud development (8 Apr): (1) ABG-6162HV at 60 g AI/A, (2) ABG-6162HV at 90 g AI/A, and (3) Apollo 50SC at 85 g AI/A. The first two treatments were repeated at petal-fall (5 May). Each plot consisted of ca. 0.1 ha (0.25 A). Applications were applied with a truck-mounted Swanson air-blast sprayer, calibrated at 59 gal/A (176 gal/A dilute equivalent). One plot comprised an untreated control.

Mites were sampled from four 'Delicious" trees per treatment. One twenty-leaf replicate was collected from each tree on each sampling date. Mites were removed from leaves using a leaf-brushing machine and counted under a binocular microscope.

The three chemical treatments each gave good control of ERM. There were no significant differences among the three treatments on most sampling dates in either motile forms or eggs, except for one date in July when control densities decreased to levels comparable to treated populations. This control continued through early August. The three treatments each were toxic to ARM on the first sampling date on which there were significant differences (10 June). After this date mite population dynamics apparently affected the results because the relative effects of each material, although significant, changed during the course of the season. AF densities were high enough to warrent statistical analysis on one date only (25 Aug); there were no significant differences among treatments. There were no significant differences detected on the first and last sampling dates, 20 May and 8 September, respectively.

Table 1.

ERM per leaf*

Treatment	gAI/A	10 June		30 June		16 July		1 Aug		25 Aug	
		motile	eggs	motile	eggs	motile	eggs	motile	eggs	motile	eggs
ABG-6162HV	60	0.0a	0.1a	0.0a	0.7a	0.1a	0.3a	0.1a	0.8a	0.3a	0.2ab
ABG-6162HV	90	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.1a	1.0a	0.1a	0.2ab
Apollo 50SC	85	0.0a	0.0a	0.0a	0.1a	0.0a	0.4a	0.4a	1.5a	0.0a	0.1a
Control		0.1a	3.2b	0.3b	2.7b	0.2a	3.5b	1.9b	4.3b	0.3a	0.3b

*Data transformed for analysis ($\sqrt{x+0.5}$). Means followed by the same letter are not significantly different (DMRT; 5% level).

Table 2.

ARM per leaf*

Treatment	gAI/A	10 June	30 June	16 July	1 Aug	25 Aug
ABG-6162HV	60	14.3a	316ab	128ab	373a	2.0a
ABG-6162HV	90	8.2a	216a	169b	323a	0.2a
Apollo 50SC	85	13.2a	364b	151b	271a	0.8a
Control		38.3b	416b	87a	263a	1.4a

*Data transformed for analysis ($\sqrt{x+0.5}$). Means followed by the same letter are not significantly different (DMRT; 5% level).

Leaf Curl of Eastern Thornless Blackberry Caused by Blackberry Psyllid, Trioza tripunctata Fitch

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INTRODUCTION

Last year we reported on damage to eastern thornless blackberry by blackberry psyllid, Trioza tripunctata Fitch (Stuart & Takeda, 1985). This damage appeared as stunting and malformation of canes. Blackberry psyllids have one generation per year. Eggs are deposited in spring, and nymphs feed on blackberry until fall. The nymphs reach adulthood in fall and migrate to evergreens to overwinter (Peterson, 1923). The purpose of this study was to increase our knowledge of the life cycle of Trioza tripunctata in eastern West Virginia and to pinpoint the beginning and development of abnormal blackberry growth.

FIELD OBSERVATIONS

Materials & Methods

Field plots of eastern thornless blackberries at the Appalachian Fruit Research Station (AFRS) in Kearneysville, WV, were monitored for adult blackberry psyllids from October, 1985, through May, 1986, to observe migration. These plots were established in 1983 on clay loam soil with 'Dirksen', 'Black Satin', 'Hull Thornless' and 'Thornfree' cultivars, arranged in a randomized complete block design with 12 replicates (rows). Plant spacing was 3.6 x 2.4 m. Plants were trained onto 3-wire vertical, 6-wire open "V", or 1-m high "T" trellises.

Samples from blackberry plants were taken in October and November, 1985, by beating canes with a rubber hose over a 45.7 cm^2 beating tray. A sample consisted of three beats per tray at each of two sites per plant, one site with normal growth and one with growth abnormalities. Data was analyzed using a paired t-test (Steele & Torrie, 1960). Various evergreens within ca. 1.6 km radius of the blackberry plot were surveyed in November, 1985, to determine adult overwintering sites. These sites were sampled throughout the winter. Samples from evergreens consisted of three beats per tray at each of four quadrant around the tree. Sex of all adults which did not escape during counting was determined. Examination of blackberry plants was begun in the field when new growth appeared (April) to detect arrival of adults and subsequent life cycle developments. In addition, red, white and yellow sticky traps were placed around the perimeter of the blackberry plots April through May. Monitoring ended in early July, when plants were being pruned, and resumed in September.

Results & Discussion

On October 15, 1985, the first blackberry psyllid adults emerged in the laboratory from nymphs collected in the field October 9. Large numbers of adults were found on blackberry plants on October 29. More adults were beaten from malformed canes than from undamaged canes (Table 1), suggesting that adults had not moved far from their sites of emergence. By November 7, 1985, populations in the blackberry plots had declined, due to either death or, more probably, migration (Table 1).

Table 1. Number of adult blackberry psyllids per beating tray sample collected from eastern thornless blackberry, in Kearneysville, WV.

Sample No.	Number of adults per 3-beat sample: October 29, 1985 Normal cane	October 29, 1985 Deformed cane	November 7, 1985 Normal cane	November 7, 1985 Deformed cane
1	0	22	0	3
2	4	77	0	0
3	0	127	0	2
4	1	38	0	11
5	0	4	0	3
6	1	6	0	0
7	0	136	0	6
8	0	53	2	0
9	1	32	0	0
10	0	41	0	1
Total	7	536	2	26

October 29, t=3.61. sig. p .01 ; November 7, t=2.033, n.s.

Surveys of various evergreens showed that Norway spruce was the preferred overwintering plant in this area (Table 2). An ornamental planting of Norway spruce approximately 0.4 km from the AFRS blackberry plot was sampled throughout the winter, although counts were only made to January due to weather. Male and female psyllids were present in approximately equal numbers to January 1986 (Table 3) and some males were found through March, suggesting that mating occurs in the overwintering sites. Only one instance of mating was observed, on November 19, 1985.

Table 2. Overwintering adult blackberry psyllids on various evergreens within 1.6 km of Appalachian Fruit Research Station, Kearneysville, WV, in November, 1985.

Tree	Number of Trees Sampled	Number With Psyllids	Total Number of Psyllids
Buxus sp. - boxwood	2	0	0
Ilex obaca - American holly	2	0	0
Juniperus sp. - ornamental creeping juniper	1	0	0
Juniperus virginiana - eastern red cedar	5	1	1
Picea pungens - Colorado blue spruce	4	0	0
Picea abies - Norway spruce	13	10	89
Pinus sylvestris - Scots pine	2	2	9
Pinus strobus - white pine	12	1	1
Pinus virginiana - Virginia pine	3	2	5
Taxus sp. - yew (hedges)	6	1	1
Thuga occidentalis - eastern white cedar	3	0	0
Tsuga canadensis - hemlock	3	1	1

Table 3. Sex ratio of blackberry psyllids before and after migration in fall and winter, 1985-86 in Kearneysville, West Virginia.

Date	Site	Sex Ratio Males:Females	# Psyllids
10/29/85	blackberry	1 : 1.3	361
11/7/85	blackberry	1 : 12	13
11/13/85	Norway spruce	1 : .8	62
11/19/85	Norway spruce	1 : 1	206
12/5/85	Norway spruce	1 : 1.1	258
1/10/86	Norway spruce	1 : 1	159

During the monitoring period for spring (1986) adult migration into the blackberries, a few adult female psyllids were captured on yellow traps but none on red or white. No males returned to the blackberries in spring. Adults on new blackberry canes were easy to see, and observation of plants was found to be a simpler method of monitoring than the use of sticky traps, which also trapped many non-targets. The first adults (all females) were found on blackberry canes during the week of May 12, 1986. Almost all were feeding on the tips of primocanes; very few were on floricanes. Adults were observed flying and landing on blackberry plants. At that time, the new primocanes were approximately 45 cm high. Flower buds were just beginning to break on the floricanes.

By May 22, curled leaves were observed, particularly in the rows nearest the overwintering sites, and some blackberry psyllid eggs were present. By June 6, curling and twisting was observed on plants throughout the plot. Eggs were found in curled leaves, and some were hatching. Growth distortion continued to increase throughout the summer.

Adult females were present in the field from May through June. No adult males were found during the spring or summer. Eggs were found from late May through mid-June. First instar nymphs were present mid- through late June, 2nd instars from mid-June to early July. Third instars began to appear in early July, 4th and 5th in August and September. At the end of September, 1986, a few scattered adults were found in spruce trees, although new adults were not yet found in the AFRS blackberry plot. During the first week of October, adults, primarily males, were beginning to appear in the blackberry plots, and increased numbers were found in the spruce trees.

LABORATORY TESTS

Experiment 1. Curling caused by adult females

Materials & Methods

Laboratory tests were conducted to determine the number of adult female blackberry psyllids it took to cause growth distortion, the length of time it took and when normal growth would resume if the psyllids were removed.

Dormant nursery-grown 'Black Satin' and 'Hull Thornless' blackberry plants were received on April 4, 1986, potted, and placed in a growth chamber at 24°C days, 20°C nights under 16:8 LD until they began vigorous growth. At the beginning of Experiment 1, 'Black Satin' and 'Hull Thornless' plants had mean heights of 50 cm and 38.1 cm respectively. On June 2, 1986, plants were individually caged in plastic cylindrical cages with screened tops and screened ventilation holes, and placed in a rearing room with a constant temperature of 25°C LD 14:10. One, three or five field-collected adult female blackberry psyllids were introduced to each cage. Controls were caged plants without psyllids. Each treatment was replicated four times. Plants were examined five days per week. Extent of growth distortion (number of leaves curled) and number and location of psyllids were noted. When growth distortion was apparent in all insect treatments, psyllids were removed from half of the plants to determine if and when normal growth would resume. Data was analyzed using a 2-way analysis of variance and linear contrasts.

Results & Discussion

Almost all of the psyllids settled on the growing tips of the plants and remained within 2.5 cm of the tips. Curling began by day four or five in all treatments, starting at the tip and proceeding downward. Young leaves curled into wrinkled balls over a period of approximately 24 hours from the first appearance of curl. Next, the apical portion of the stem began to twist. Older, fully-expanded leaves took several days to curl, first cupping, then becoming wrinkled, folding longitudinally, and finally rolling into balls (Figure 1).

Growth was normal on all control plants. Plants with one psyllid began to curl as rapidly as those with three or five, and there was no difference in the extent of leaf curl that developed. However, there was a linear relationship between psyllid number and time to maximum curl (Table 4). The quadratic relationship was not significant. There were no varietal differences.

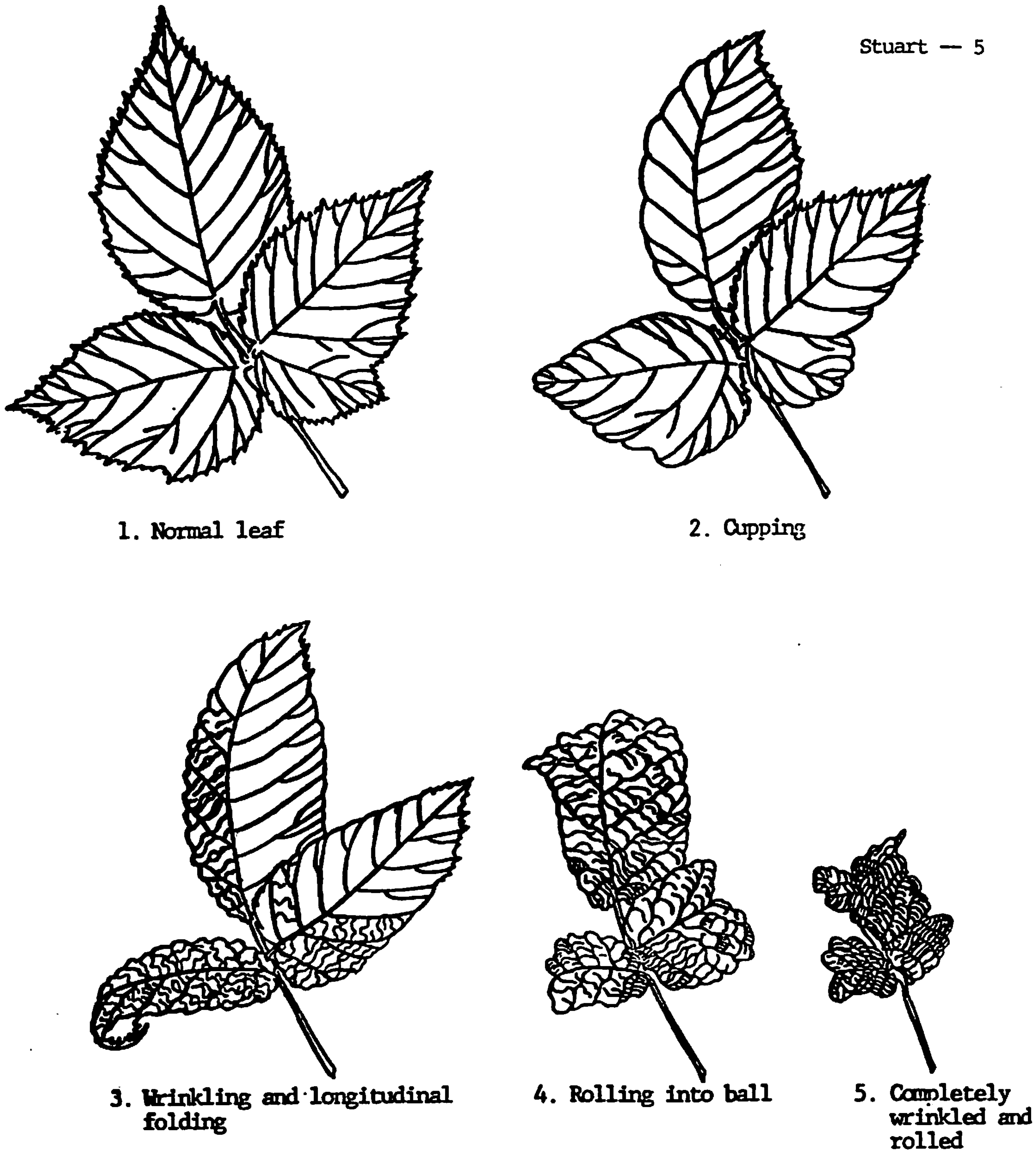

Figure 1. Progression of blackberry leaf curling caused by blackberry psyllid, Trioza tripunctata Fitch.

Table 4. Abnormal growth of eastern thornless blackberry fed on by adult female blackberry psyllids, Trioza tripunctata Fitch, in the laboratory.

Cultivar	No. of psyllids	Days to 1st curl	Number[1] of leaves curled by day 4	7	9	11	14	Days to max curl[2]
Black Satin	1	5.75ns	0.75ns	1.50ns	2.00ns	2.50ns	3.50ns	11.76
Black Satin	3	4.75	0.75	2.75	3.25	4.00	5.00	11.25
Black Satin	5	5.50	1.50	2.25	3.00	4.25	4.25	10.97
Hull	1	4.25	0.50	1.25	2.25	3.25	4.25	11.65
Hull	3	4.50	0.75	2.00	2.00	3.00	3.25	10.91
Hull	5	4.25	1.25	3.00	3.25	5.00	5.00	10.51

[1]Mean of 4 replications
[2]Significant linear relationship between number of psyllids & days to maximum curl. No differences between cultivars.
ns=no significant differences within columns

On day seven, all plants with insects showed growth distortion, so the psyllids were removed from half of the plants. For several days after removal, deformed growth continued. One week after removal, normal growth resumed.

After two weeks, growth of plants with psyllids became so distorted (canes twisting and internodes greatly shortened) that it was no longer possible to count the curled leaves. In addition, eggs were hatching, so it was no longer possible to separate adult damage from nymphal damage.

Experiment 2. Feeding duration by single adult female necessary to initiate curl

Materials & Methods:

Field-grown root sucker plants were potted in mid-June, 1986, and placed in a greenhouse for one week to become acclimated to the pots. Plants had a mean height of 30.5 cm. They were caged as in Experiment 1, with a single field-collected adult female T. tripunctata on each. Controls were caged plants without psyllids. Insects were removed at 24, 48 and 72 hours. There were four replications of each insect treatment. Plants were checked five days per week for two weeks for abnormal growth.

Results & Discussion

A single leaf curled on one plant in each of the 24 and 48-hour feeding groups on day 4. No further curl was seen until day 14 (Table 5), but at that time normal growth had also resumed. Single curled leaves were found on 2 plants in the 72-hour feeding group on day 4. This increased to 3 plants by day 8. Maximum curl for this group was 2 curled leaves on 2 of the plants by day 14, when normal growth was resuming. The curling was not as severe as that seen in Experiment 1. It should be noted that the root sucker plants taken from the field were not as vigorous as the nursery plants used in Experiment 1, and the female psyllids were several weeks older. However, as little as 24 hours of feeding by one adult female did cause visible growth abnormalities.

Table 5. Duration of feeding by single Trioza tripunctata Fitch adult females necessary to initiate growth distortions on eastern thornless blackberry in the laboratory.

Feeding Duration	Day	Number of Leaves Curled[1]									
		0	1	2	3	4	7	8	9	10	14
24 hours		0	0	0	0	.25	.25	.25	.25	.25	0.75
48 hours		0	0	0	0	.25	.25	.25	.25	.25	1.00
72 hours		0	0	0	0	.50	.50	.75	.75	.75	1.25

[1] Mean of 4 replications

Experiment 3. Leaf curling caused by nymphal feeding

Materials & Methods

The following experiment was conducted to determine whether nymphal feeding could cause growth abnormalities. Field-grown, root-sucker plants, 30.5 cm tall, potted on July 14, 1986 were used. Fifty nymphs were introduced to each plant on July 28. Psyllid nymphs at this time were 2nd-3rd instars. An attempt was made to transfer nymphs by attaching curled, nymph-infested leaves to new plants with staples, assuming the nymphs would move when the host leaves dried. They did not leave the curled leaves, so they were transferred by means of a single-hair brush after being prodded gently to insure that their mouthparts were retracted from the host plant. They were placed on the new plants as shown in Table 1. A plant without psyllids served as control.

Table 6. Placement of blackberry psyllid nymphs on plants, 50 nymphs per plant, for Experiment 3-B.

Plant	Description	Nymph placement: Leaf surface	Nymph placement: Location
1	3 fully open leaves	adaxial side	distal leaf
2	2 fully open & 1 unrolling leaf	abaxial side	middle leaf
3	3 fully open & 1 unrolling leaf	abaxial side	middle open leaf
4	4 fully open leaves	abaxial side	basal leaf
5	2 fully open leaves & 2 unrolling	abaxial sides	25 on each of 2 basal leaves

Plants were inspected 5 days per week for abnormal growth for three weeks. Every 3 to 5 days, plants were examined with a 10x hand lens and living nymphs were counted and positions noted.

Results & Discussion

Unlike adults, blackberry psyllid nymphs did not feed on the growing terminals of the plants. Of those placed on a distal leaf, ca. 1/3 moved to lower leaves; of those placed on basal leaves, ca. 1/4 moved to distal leaves. Those placed on the adaxial surface of a leaf moved to the abaxial surface, and those placed on a abaxial surface remained there. Very few nymphs moved to new, unopened leaves and none to the growing tips. In general, the nymphs did not feed on the midribs or major leaf veins. They tended to stay on the leaf blades, frequently near the margins.

The control plant grew normally. Very little abnormal growth developed with nymphal feeding. By the beginning of the first week, no leaf curling had developed, and hand lens counts showed that almost 75% of the nymphs were still alive on the leaves (Table 7). Slight leaf curling showed up on day 11, and nearly 70% of nymphs were present. The experiment was terminated at the end of three weeks. Over half of the nymphs were still alive and feeding, but leaf curling was slight to negligiole.

Table 7. Abnormal growth of eastern thornless blackberry plants fed on by *Trioza tripunctata* nymphs in the laboratory.

	Days since insect introduction						
	0	3	7	11	14	16	21
No.[1] leaves curled	0	0	0	0.8	1.6	1.6	1.8
No. nymphs present	50	38.4	37.2	34.6	ND[2]	32.4	29.2

[1]Mean of 5 replications
[2]ND=no data

When leaf curling began, nymphs did not move to the curled leaves (which developed first near the growing tips) on any of the plants, altnough, in nature, they feed within the protection of curled leaves. Apparently, once removed from curled leaves, the nymphs do not or cannot actively seek to return to such shelter. Comparison of Tables 5 and 7 shows that constant feeding by fifty 2nd-3rd instar nymphs causes only slightly more growth distortion in 2 weeks than 1-3 days' feeding by a single adult female on plants of similar quality.

CHEMICAL CONTROL MEASURES

Materials & Methods

Half of the plants (6 rows) were sprayed with insecticides as follows:

May 23	azinphosmethyl 50% WP	0.56 kg/ha AI
June 2	malathion 25% WP	0.7 kg/ha AI
June 21	demeton 66% EC	0.1 kg/ha AI

On May 29, June 6, and June 13, sprayed and unsprayed plants were examined for psyllid damage. Two plants of each of the four cultivars were checked in each of the six sprayed and six unsprayed rows. Five randomly selected primocanes were chosen per plant (or less if there were fewer than five primocanes). Damage was expressed as percent damaged primocanes. On July 1-2, 1986, randomly selected curled leaves from sprayed and unsprayed plants were examined under a dissecting microscope for blackberry psyllid eggs and nymphs. Data was analysed using 2-way analysis of variance (ANOVA) with cultivars and treatment as factors. Subsequently, one-way ANOVA was performed for sprayed and unsprayed data separately using cultivar as the factor, and means were separated using Duncan's New Multiple Range Test.

Results & Discussion

On May 29, 1986, curling and twisting was observed on plants throughout the field, and eggs were found. Live adults were seen only on unsprayed plants, and damage was greatest there. On June 6, eggs were hatching inside curled leaves of both sprayed and unsprayed plants. By June 13, new growth was normal beyond the curled leaves on sprayed plants, while plants in the unsprayed rows were becoming more deformed.

Two-way analysis of variance showed significant differences in primocane damage between sprayed and unsprayed plants on all three dates ($P=.033$, $.004$ and $.001$ respectively). There was no interaction with cultivars ($P>.05$). There were significant cultivar differences in damage for sprayed and unsprayed data analyzed separately. There was significantly more damage on 'Hull Thornless' (Table 8) than on the other cultivars. Least damage was consistantly found on 'Thornfree,' a cultivar exhibiting less vigorous growth and fewer primocanes than the other three, although the difference was not significant.

Table 8. The effect of azinphosmethyl (0.56 kg/ha AI May 23) and malathion (0.7 kg/ha AI June 2) sprays on blackberry psyllid damage to thornless blackberry primocanes.

	Damaged Primocanes (%)[1]					
	May 29		June 6		June 13	
Cultivar	Spray	No Spray	Spray	No Spray	Spray	No spray
Hull Thornless	40.0a	46.8ns	30.0a	56.7a	10.0ns	33.3a
Black Satin	11.7b	33.3	15.7ab	31.7b	10.0	15.0b
Dirksen	16.7b	33.3	23.3ab	21.7b	5.0	16.7b
Thornfree	11.2b	20.7	7.8b	16.7b	1.7	11.7b

[1]5 primocanes per plant, 12 plants per cultivar.
Mean separation within columns by Duncan's New Multiple Range Test, alpha=0.05

After the demeton spray, although there was less abnormal growth overall on sprayed plants, when individual curled leaves were examined, live nymphs were found feeding inside. It appears that once the leaves have curled, they provide a barrier to translocation of systemic insecticides, protecting the nymphs within from control measures. Alternatively, the nymphs may be resistant to the chemicals. This suggests that effective control measures should be directed at the adult females during the spring migration period, before they have initiated enough leaf curl to protect the nymphs.

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Effect of Severe European Red Mite Damage on Yield, Size, Sugar Content, and Firmness of Red Delicious Apples

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In New Jersey it is not unusual for orchards of spur-type 'Red Delicious' to show severe European red mite (ERM) damage by early July, despite efforts by growers to control the pest with acaricides. With resistance to Plictran, Vendex, and Kelthane widespread, ERM damage has been especially severe since 1983. In this experiment we are attempting to measure the effect that severe damage by mid-season, repeated annually, has on yield and growth of spur-type Red Delicious.

Single tree plots of 16-year old Starkrimson trees replicated 6 times and arranged in a split-plot design, were sprayed to runoff (ca 5 gal/tree) with a hydraulic sprayer equipped with a handgun and operated at 300 psi.

Three insecticide programs, each with and without ERM control, were used to establish different mite densities. The treatments were:

1) Pydrin 2.4 EC	0.05 lb ai/100 gals
2) Pydrin 2.4 EC	0.05 lb ai/100 gals
+ Plictran 5 L	2 oz ai/100 gals
3) Cygon 400	0.25 lb ai/100 gals
4) Cygon 400	0.25 lb ai/100 gals
+ Plictran 5 L	2 oz ai/100 gals
5) Lannate 1.8 L	0.225 lb ai/100 gals
6) Lannate 1.8 L	0.225 lb ai/100 gals
+ Plictran 5 L	2 oz ai/100 gals

Insecticides were sprayed on May 7, May 27, June 12, June 25, July 11 and August 25 (Thiodan 50 WP 0.5 lb ai/100 gal was added to all treatments on July 11). Plictran was applied on June 5, July 7, and August 25. In addition, plots 2, 4, and 6 were sprayed with Superior 70 oil, 2 gals/100 gals, at 1/2 inch green (April 4).

For disease control the orchard was sprayed with Captan and Polyram as needed. Weekly ERM counts were made by randomly picking 25 leaves/tree, brushing the mites onto glass plates coated with Triton B-1956 and counting the number of motile mites. Mite-days were calculated as follows: MD = MD1 + [(M1+M2)/2 x Y], where MD1 = mite-days already accumulated, M1 = avg ERM/leaf on a given counting date, M2 = avg ERM/leaf on the next counting date after M1 and Y = no. of days between M1 and M2. At harvest (September 24), measurements were made of sugar content, firmness, color, and yield. In the table, Sugar = avg % soluble solids/15 fruit/tree; Firmness = avg kg/15 fruit/tree; Diameter = avg diameter in inches/all fruit/tree; Color = avg % red color/15 fruit/tree; Weight = total weight in lbs of fruit/tree. Data were transformed to $\sqrt{x+1}$ before analysis of variance and comparison of means.

ERM population counts and accumulated mite-days are shown in Figure 1. Peak ERM densities for the insecticide-only plots were reached in late June. Total seasonal mite-days in the insecticide-only plots ranged from 1047 (Cygon) to 1901 (Pydrin). Although the total seasonal mite-days (1753) in the Lannate plots was somewhat less than that for the Pydrin-treated trees, ERM populations increased slightly faster in the Lannate plots. For example, Lannate-treated trees accumulated 500 mite-days by June 18 (vs. June 21 in Pydrin plots) and 1000 mite-days by June 25 (vs. June 30 in Pydrin plots).

In the plots where Plictran was used, less than 500 total mite-days were accumulated during the season.

ERM damage significantly reduced sugar content, fruit size, and total weight of fruit per tree, but not fruit color or firmness (Table 1). Expressed as a percent reduction, that is:

$$\frac{\text{Value (\%, Inches, or lbs) for insecticide only} - \text{Value for insecticide + Plictran}}{\text{Value for insecticide + Plictran}} \times 100$$

the difference in sugar, fruit size, and total weight of fruit/tree between insecticide-only plots and insecticide + Plictran plots were:

	% Difference		
Insecticide	Sugar content	Fruit Diameter	lbs fruit/tree
Pydrin	-2.3 %	-9.9 %	-6.0 %
Cygon	-1.8 %	-6.6 %	-54.6 %
Lannate	-11.4 %	-10.7 %	-40.5 %

Although there was a great deal of variation among replicates, nevertheless, where only insecticides were used (without ERM control), sugar content, fruit diameter, and yields in lbs/tree were invariably reduced.

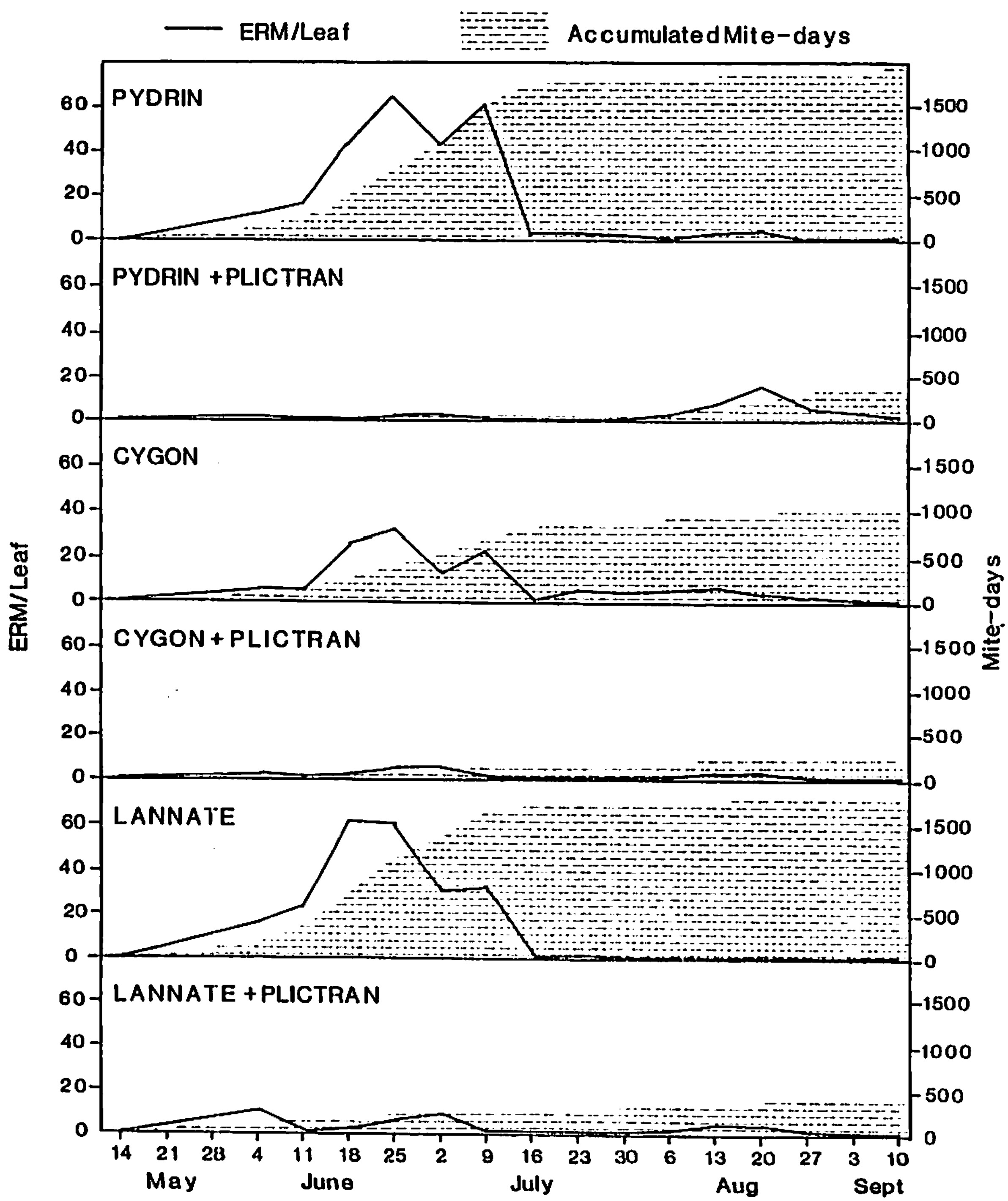
Rainfall for May and June was approximately 33% of normal (Figure 2), which may have increased the harmful effect of the mite feeding. Terminal growth had stopped by mid-June. Trees in the Pydrin, and especially the Lannate plots, were severely bronzed by early July.

Treatment and ai/100 gal		Sugar % *	Firmness kg	Diameter Inches *	Color %	Weight lbs/tree **	Total Mite-days
Pydrin 2.4 EC	0.05 lb	10.10	7.22	2.13	88.00	343.50	1900.89
Pydrin 2.4 EC +	0.05 lb						
Plictran 5 L	2 oz	10.33	7.16	2.34	89.50	364.25	414.46
Cygon 4 E	0.25 lb	9.77	7.12	2.26	89.56	323.33	1046.55
Cygon 4 E +	0.25 lb						
Plictran 5 L	2 oz	9.95	7.14	2.41	87.78	500.00	256.82
Lannate 1.8 L	0.225 lb	9.50	7.12	2.15	88.89	321.42	1753.37
Lannate 1.8 L +	0.225 lb						
Plictran 5 L	2 oz	10.58	7.17	2.38	85.50	451.58	385.46

* = Difference between insecticide-only treatments and insecticide + Plictran treatments statistically significant at 5 %.

** = Difference between insecticide-only treatments and insecticide + Plictran treatments statistically significant at 1 %.

Fig. 1



ERM/Leaf
Accumulated Mite-days
PYDRIN
PYDRIN +PLICTRAN
CYGON
CYGON+PLICTRAN
LANNATE
LANNATE +PLICTRAN
ERM/Leaf
Mite-days
0
20
40
60
0
500
1000
1500
14 21 28 4 11 18 25 2 9 16 23 30 6 13 20 27 3 10
May
June
July
Aug
Sept

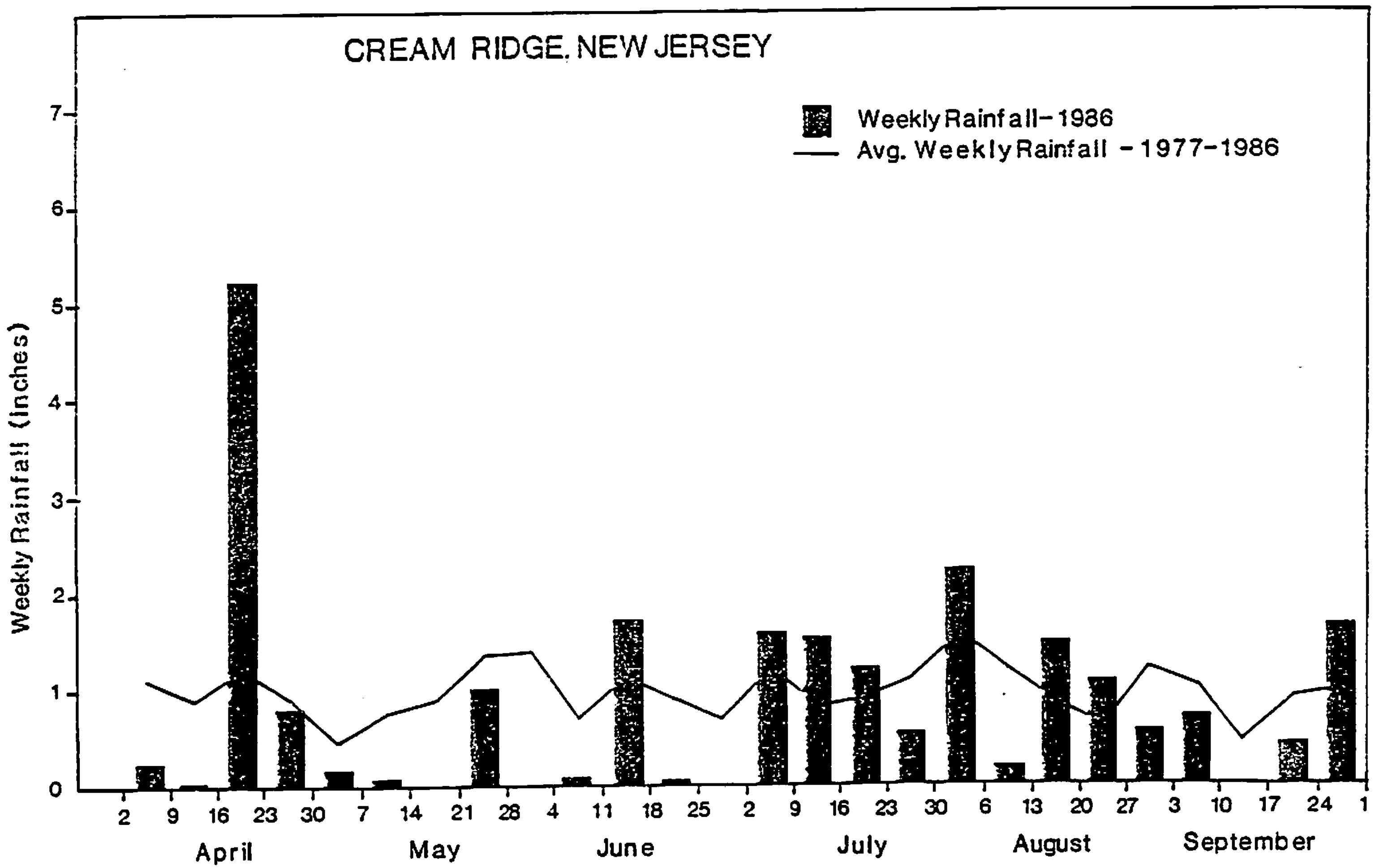


Fig. 2

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Effect of Fenvalerate on Populations and Control of European Red Mite on Peaches

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Synthetic pyrethroids, such as fenvalerate (Pydrin) and permethrin (Ambush, Pounce), are very effective against certain difficult-to-control insect pests on apples and peaches; however, their use usually leads to outbreaks of phytophagous mites. This undesirable side effect is well documented for apples, but less so for peaches. The purpose of this experiment was to measure the effect that a minimal pyrethroid (Pydrin) spray program would have on European red mite (ERM) populations and the subsequent performance of miticides in plots where Pydrin had been used relative to where it had not.

This test was conducted in a 11-year old peach orchard, variety `Red Haven'. Single tree plots, replicated 3 times and arranged in a split-plot design were sprayed to runoff (ca 3 gal/tree) with a hydraulic sprayer equipped with a handgun and operated at 300 psi. For disease control the orchard was sprayed with sulfur as needed. ERM counts were made by randomly picking 25 leaves/tree, brushing the mites onto glass plates coated with Triton B-1956 and counting the number of motile mites. Mite-days were calculated as follows: $MD = MD1 + [(M1 + M2)/2 \times Y]$, where MD1 = mite-days already accumulated, M1 = avg ERM/leaf on a given counting date, M2 = avg ERM/leaf on the next counting date after M1 and Y = no. of days between M1 and M2. Data were transformed to $\sqrt{x+1}$ before analysis of variance and comparison of means.

By July 8 there were significant differences in ERM counts among treatments that received Pydrin relative to those that did not. There was also a significant interaction between Pydrin x Miticide Treatments that was due almost entirely to the much greater density of ERM in the Pydrin-treated controls. This pattern of differences continued until August 21, at which time the significant interaction, Pydrin x Miticide Treatments, was due to the difference between ERM populations in the Pydrin-treated Apollo plots relative to the Apollo plots that did not receive Pydrin. Overall, the seasonal total of mite-days was increased ca 3 times in the controls and an average of 6.5 times in the miticide plots through the use of two applications of Pydrin. The main predators noted in the untreated controls were green lacewing larvae, anthocorid nymphs, and syrphid larvae.

Treatment and oz (AI)/100 gal			Time of Application	ERM/leaf							
				12 May	3 Jun	19 Jun	8 Jul	14 Jul	22 Jul	4 Aug	15 Aug
---No Pydrin Applications---											
Savey	50 WP	0.625	5/19	0.4	0.1	0.1	0.1	0.1	0.0	0.4	0.4
Savey	50 WP	1.0	5/19	0.8	0.1	0.1	0.1	0.0	0.1	0.2	0.1
Savey	50 WP	1.25	5 19	0.5	0.1	0.0	0.1	0.1	0.2	0.2	0.1
Plictran	50 WP	2.0	5/19	0.5	0.1	0.2	1.1	0.3	2.8	1.6	0.2
Plictran	5 L	2.0	5/19	0.2	0.0	0.1	0.4	0.2	0.2	0.4	0.1
Apollo	50 SC	1.0	5/19	0.5	0.1	0.0	0.1	0.1	0.1	0.2	0.4
Control	-----	-----	----	0.1	3.4	3.7	17.6	7.4	15.2	12.5	6.0
---Pydrin 2.4 EC 0.8 oz (AI)/100 gal applied 6/13, 7/15---											
Savey	50 WP	0.625	5/19	0.3	0.0	0.1	0.7	0.4	0.2	2.0	1.2
Savey	50 WP	1.0	5/19	0.2	0.1	0.0	0.1	0.1	0.1	0.4	0.4
Savey	50 WP	1.25	5/19	0.2	0.0	0.1	0.3	0.1	0.1	0.3	0.6
Plictran	50 WP	2.0	5/19; 7/16	0.2	0.1	0.1	3.8	1.6	0.1	0.6	1.2
Plictran	5 L	2.0	5/19, 7/16	0.3	0.1	0.1	3.4	3.3	0.1	0.6	1.1
Apollo	50 SC	1.0	5/19	0.1	0.0	0.1	0.8	0.2	0.1	1.7	5.1
Control	-----	-----	----	0.3	0.7	4.9	68.5	27.7	59.2	68.8	28.5

Treatment and oz (AI//100 gal			Time of Application	ERM/leaf						
				21 Aug	29 Aug	5 Sep	9 Sep	25 Sep	3 Oct	Mite-days
---No Pydrin Applications---										
Savey	50 WP	0.625	5/19	0.7	3.0	0.6	1.0	3.9	3.4	111.69
Savey	50 WP	1.0	5/19	0.5	2.0	0.6	0.9	3.5	2.5	95.73
Savey	50 WP	1.25	5 19	0.5	0.9	0.1	1.4	2.3	1.7	69.01
Plictran	50 WP	2.0	5/19	0.5	1.5	0.4	2.3	3.6	2.2	164.39
Plictran	5 L	2.0	5/19	1.1	3.5	1.1	2.1	6.4	4.6	166.98
Apollo	50 SC	1.0	5/19	1.3	2.2	1.0	2.4	5.0	5.8	146.23
Control	-----	-----	----	11.4	13.1	15.7	9.0	15.3	12.6	1336.28
---Pydrin 2.4 EC 0.8 oz (AI)/100 gal applied 6/13, 7/15---										
Savey	50 WP	0.625	5/19	5.5	14.9	7.0	10.1	27.8	24.2	744.56
Savey	50 WP	1.0	5/19	5.2	7.5	2.8	5.6	14.2	12.6	384.60
Savey	50 WP	1.25	5/19	1.7	11.4	6.4	8.6	17.8	8.2	467.90
Plictran	50 WP	2.0	5/19; 7/16	5.5	13.8	19.7	15.5	37.1	20.0	983.41
Plictran	5 L	2.0	5/19, 7/16	8.4	10.2	9.4	16.6	41.3	13.1	1020.63
Apollo	50 SC	1.0	5/19	25.4	38.9	22.6	15.8	34.2	17.3	1283.61
Control	-----	-----	----	57.4	40.5	26.7	16.8	9.1	6.4	3988.41

Monitoring For Resistance to Apollo and Savey Using Overwintering Eggs of European Red Mite

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With the expectation that either Apollo or Savey, or both, will be registered for European red mite (ERM) control on apples, we wished to obtain baseline toxicity data for both compounds prior to their widespread use in the field. These data will serve as a basis for determining changes in susceptibility in subsequent years; we anticipate that both compounds will be used intensively by growers once registration is obtained. Both Apollo and Savey are ovicides, and we used overwintering eggs of ERM in the tests. Since the overwintering eggs might vary in their susceptibility, depending on the extent of embryonic development, we related the toxicity data to stage of tree development and number of day-degrees to first egg hatch in the field (Threshold = 5.5°C). A total of 12 tests were done, over the period March 20 - April 24, as follows:

Test Period	Test Dates	Tree or Mite Phenology	Day-degrees to 1st egg hatch in field
I	March 20 March 24 March 27	Dormant - Green Tip	<311, >244
II	March 31 April 2 April 4	1/2 inch Green	<243, >133
III	April 8 April 11 April 15	Tight Cluster	<132, >74
IV	April 18 April 21 April 24	Pre-pink - Pink	<73, >0

First egg hatch in the field was April 25, 1986.

The tests are conducted at the Rutgers Fruit Research and Development Center, using overwintering ERM eggs collected from a 16 year-old apple block, variety 'Red Delicious'. Beginning on March 20, one to two-inch long apple twigs with ERM eggs on them were cut and brought into the laboratory ca twice weekly, until ERM egg hatch occurred in the field. After each collection, the ends of the twigs were dipped in liquid paraffin to retard water loss, and then the twigs were dipped for five seconds into a suspension of Apollo or Savey (10 twigs/dosage) and set out to dry. After drying for several hours at 75-85^{o}F, the twigs were placed into petri dishes along with a small piece of cotton saturated with water, and covered. A ring of vaseline was spread around the inside rim of each dish to retain moisture and to prevent the ERM larvae from escaping. All dishes were placed in 25^{o} C, 14L:10D conditions. ERM larvae counts were made three times a week until the eggs had stopped hatching, after which the remaining unhatched eggs were counted. Results are expressed as percent reduction in egg hatch, after correcting for unhatched eggs in the controls using Abbott's formula.

There was a significant decrease in egg susceptibility to Apollo from Time Period II to Time Period III (1/2 " Green to Tight Cluster); otherwise, differences in susceptibility as it relates to time period were not significant (Table 1). However, with both compounds there was a trend towards decreasing susceptibility as eggs got closer to first hatch. In part, this decrease in susceptibility might be due to length of exposure to the test compounds, since time to 50% hatch at 25^{o}C shortened considerably as the experiment progressed (Figure 1). For example, during Test Period IV the average time to 50% hatch was only 5.0 days, and some eggs hatched within one day of treatment.

When the % reduction in egg hatch is averaged for each dosage over all test periods, the dose response line is relatively flat for both compounds (Figure 2). Savey is more toxic than Apollo to overwintering ERM eggs.

Table 1

Dosage oz. ai/100 gals		% Reduction in Egg Hatch — Test Period I	II	III	IV
		Apollo			
2.67		100	99.7	87.1	75.0
1.34		100	99.7	89.4	86.0
0.67		99.8	98.9	68.7	53.5
0.33		99.9	95.7	73.5	82.1
0.17		95.8	90.5	41.3	6.0
0.08		86.2	73.5	43.0	10.7
0.04		85.4	67.0	31.3	6.9
0.02		84.8	53.5	22.0	14.0
	$\overline{x}$ =	94.0	84.8	57.0	41.8
		Savey			
2.00		100	100	95.1	90.8
1.00		100	99.6	96.8	83.9
0.50		99.9	99.1	91.5	63.9
0.25		99.5	99.0	92.1	34.5
0.13		97.7	94.9	87.5	21.0
0.06		90.4	84.4	77.6	43.5
	$\overline{x}$ =	97.9	96.2	90.1	56.3

Fig. 1

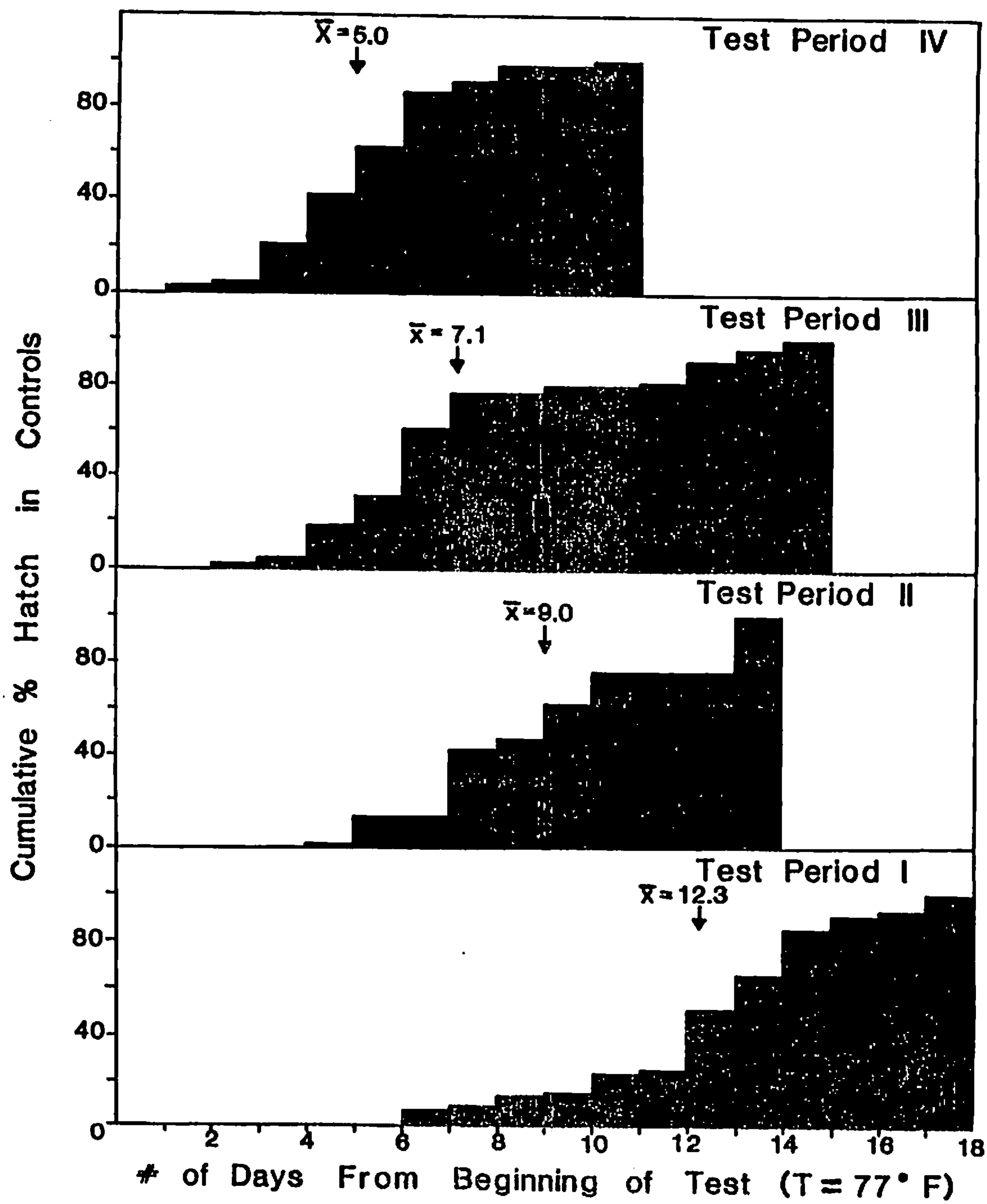
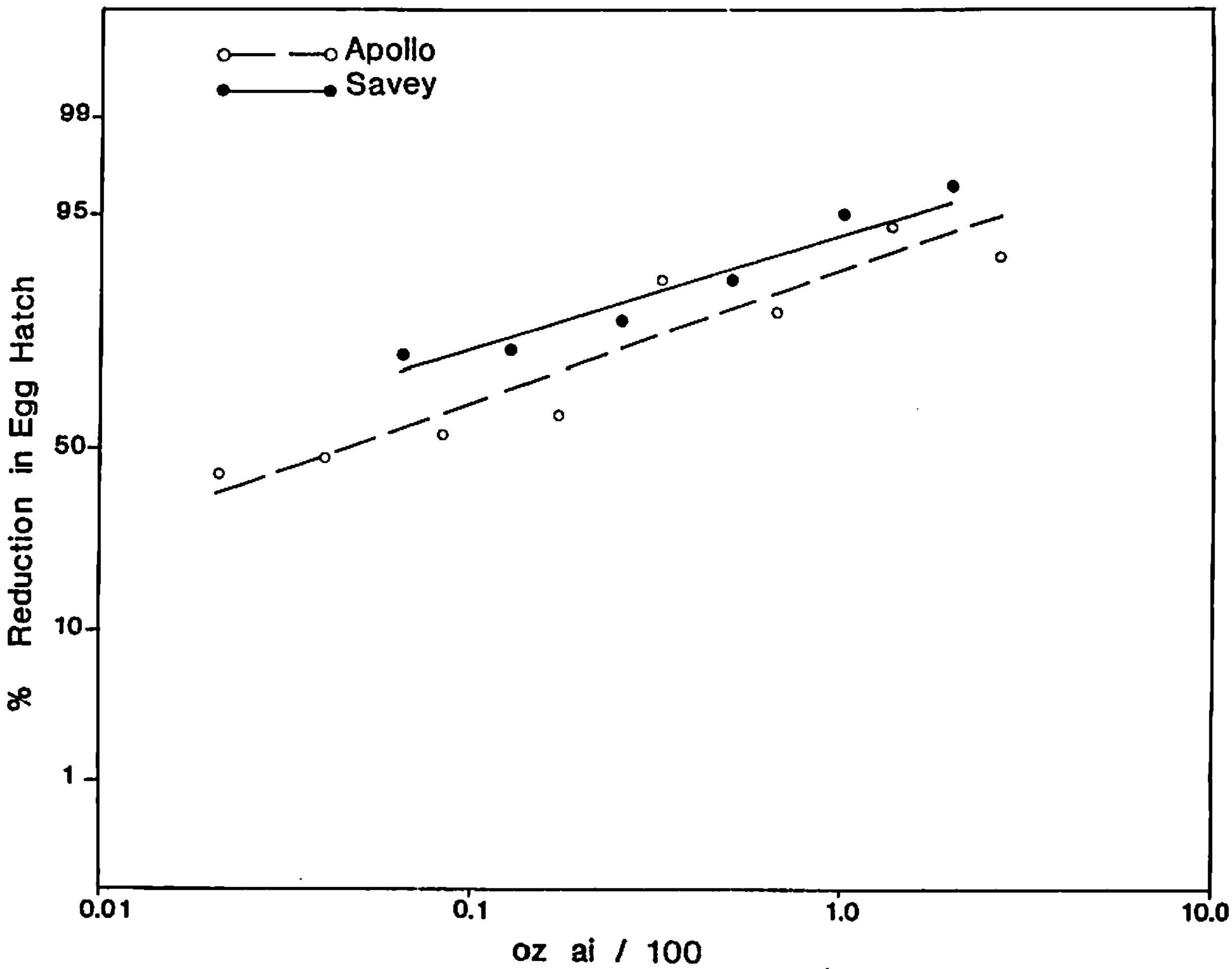

Test Period IV
X̄=5.0
Test Period III
X̄=7.1
Test Period II
X̄=9.0
Test Period I
X̄=12.3
0
40
80
2
4
6
8
10
12
14
16
18
Cumulative % Hatch in Controls
# of Days From Beginning of Test (T = 77° F)

Fig. 2


Apollo
Savey
99
95
50
10
1
% Reduction in Egg Hatch
0.01
0.1
1.0
10.0
oz ai / 100

Spray Timing Based on Degree Days for Control of Early Generations of Oriental Fruit Moth on Peaches

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Rice et al. (1982) proposed a model for oriental fruit moth (OFM) phenology based on the following values:

OFM development	Day-degrees (D°)
Lower threshold	45° F
Upper threshold	90° F
First moth catch - first egg hatch	193 D°
Average generation time	963 D°

In using their model they proposed that California growers apply the first spray for OFM control at 400 D°, based on the following reasoning:

> "we know that oriental fruit moth requires approximately 200 D° from the time the first moths are collected in pheromone traps in any given generation until the first eggs begin to hatch in that same generation.....At the same time we know that first egg hatch is generally too early to use as optimum timing for control of hatching larvae in that generation. Therefore, rather than timing chemical control treatments at the beginning of egg hatch (200 D°), we could begin treatment after an additional 200 D° into the generation.....The total of 400 D° from first moth would put the time of treatment closer to the observed or expected moth flight peak (current standard practice), and also when first-hatched larvae are in approximately the late second or early third instar stage."

This test was conducted in a 4-year old peach orchard, varieties `Red Haven' `Crest Haven' `Loring' and `Jefferson'. Single tree plots replicated 6 times in a randomized complete block design were sprayed to runoff (ca 2 gal/tree) with a hydraulic sprayer equipped with a handgun and operated at 300 psi. Treatments were applied May 7 and/or May 19. For disease control the entire orchard was sprayed with sulfur as needed.

Two equations were used for calculating D°:

(1) $DD = (T_{max} + T_{min})/2 - T_h$ where

T_{max} = daily maximum temperature

T_{min} = daily minimum temperature

T_h = threshold temperature

(2) $DD = (T_{max} + T_{min})/2 - T_h$ (where $T_{min} \geq T_h$)

$= (T_{max} + T_h)/2 - T_h$ (where $T_{min} < T_h$)

Number of D° that had accumulated by the two spray dates were as follows:

	Spray date	
Equation	May 7	May 19
(1)	207	384
(2)	242	436

Sampling methods for OFM and tarnished plant bug (TPB) were as follows: OFM = avg no. of OFM damaged terminals/tree; TPB = avg no. of TPB damaged fruit/100 fruit/tree. Data were transformed to $\sqrt{x+1}$ or arcsin $\sqrt{x}$ before analysis of variance and comparison of means. In the table, numbers followed by the same letter are not significantly different at alpha = 0.05, DMRT.

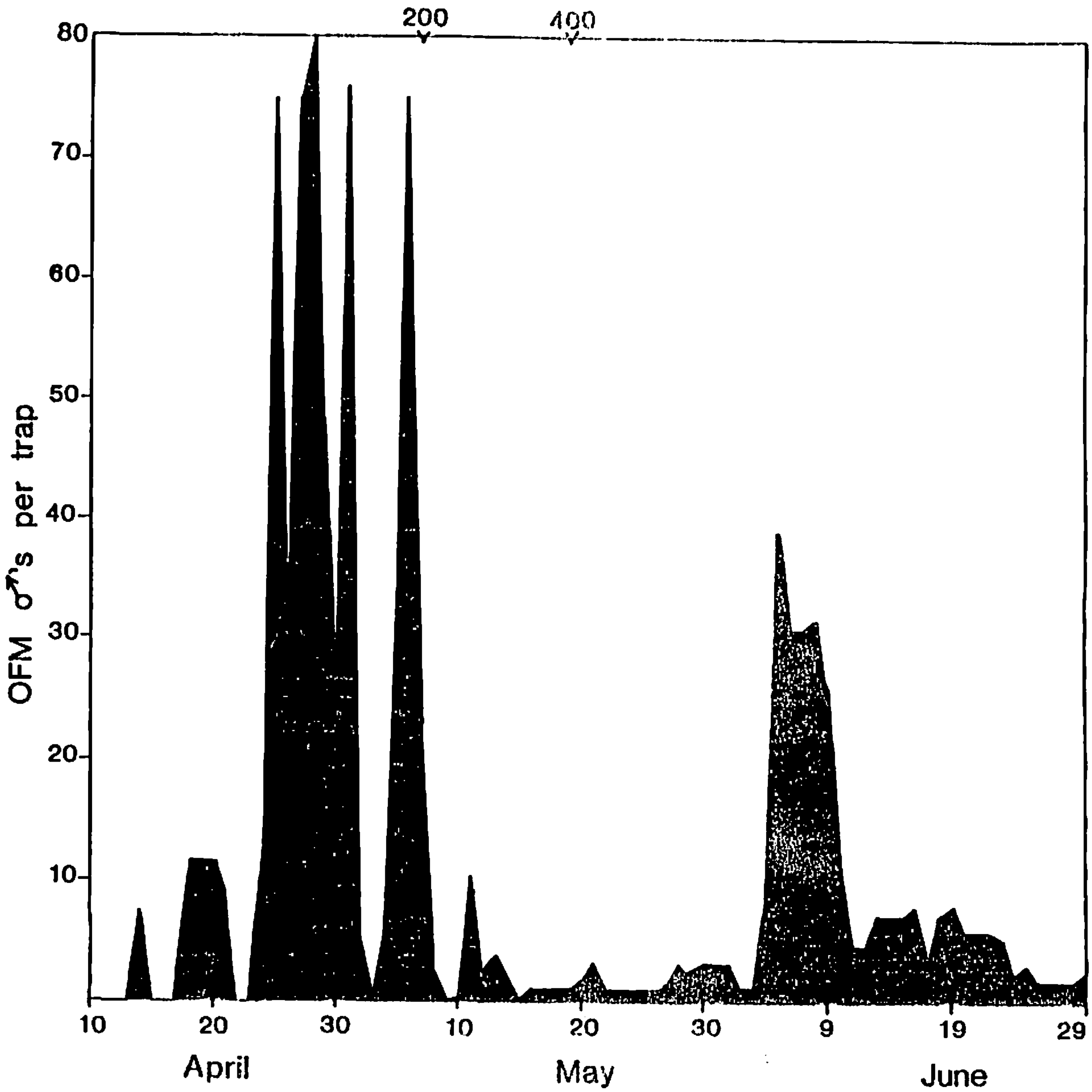
The May 7 spray was early enough to prevent entry by the earliest hatching larvae. However, one application made at this time was not sufficiently residual to prevent entry by late-hatching larvae (See June 11 counts, first six treatments). By May 19 ca 50% of the larvae had already entered the terminals; obviously, initiating OFM control at 400 D° into the generation would be much too late. We conclude that two applications of the most effective insecticides are required to provide at least 95 % control of first generation OFM in New Jersey. Comparing emergence of overwintering generation moths in New Jersey and California (Rice et al. 1982), moth emergence rapidly reaches a peak in New Jersey (within 2 weeks or by 100 D°), whereas in California maximum moth emergence is delayed for a month or more from the beginning of emergence. In California 400 D° coincides with maximum emergence, whereas in New Jersey, moth populations have declined to very low levels by 400 D°. The phenology of OFM seems to be quite different in the two regions.

Tarnished plant bug control was also improved, on average, by using two applications rather than one (See Table). Two applications of Ambush provided ca 97% control, but this treatment was not significantly better than any other treatment except one application of parathion. Delaying the first treatments until May 19 resulted in greater injury by TPB.

Literature Cited

Rice, R. E., W. W. Barnett, D. L. Flaherty, W. J. Bentley, and R. A. Jones. 1982. Monitoring and modeling oriental fruit moth in California. California Agriculture, January-February 1982.

Treatment and lb (AI)/100 gal		Time of Application	OFM 29 May	OFM 11 Jun	TPB 29 May
Parathion 8 F	0.25	5/7	4.2 a	12.0 b	12.6 b-e
Penncap-M 2 FM	0.25	5/7	1.8 a	9.6 b	4.6 a-d
Imidan 50 WP	0.5	5/7	0.2 a	5.8 ab	1.3 ab
Guthion 50 WP	0.25	5/7	0.7 a	8.3 ab	3.2 a-d
Ambush 25 WP	0.05	5/7	0.0 a	4.7 ab	3.1 a-d
Asana 1.9 EC	0.013	5/7	0.3 a	3.0 ab	6.7 a-d
Parathion 8 F	0.25	5/19	32.7 bc	----	11.3 b-e
Penncap-M 2 FM	0.25	5/19	50.3 cd	----	12.7 b-e
Imidan 50 WP	0.5	5/19	31.5 b-d	----	4.4 a-d
Guthion 50 WP	0.25	5/19	36.7 b-d	----	17.0 de
Ambush 25 WP	0.05	5/19	24.0 b	----	9.2 b-e
Asana 1.9 EC	0.013	5/19	21.5 bc	----	15.4 c-e
Parathion 8 F	0.25	5/7; 5/19	0.0 a	2.0 ab	3.4 a-d
Penncap-M 2 FM	0.25	5/7; 5/19	1.3 a	1.0 a	3.4 ab
Imidan 50 WP	0.5	5/7; 5/19	0.5 a	0.8 a	1.6 ab
Guthion 50 WP	0.25	5/7; 5/19	0.0 a	0.7 a	2.8 a-c
Ambush 25 WP	0.05	5/7; 5/19	0.0 a	0.5 a	0.7 a
Asana 1.9 EC	0.013	5/7; 5/19	0.2 a	0.2 a	2.7 ab
Control	-----	---------	63.8 d	67.3 c	21.5 e


200
400
80
70
60
50
40
30
20
10
OFM ♂'s per trap
10
20
30
10
20
30
9
19
29
April
May
June

Insecticidal Control of Tarnished Plant Bug and Oriental Fruit Moth on Peaches

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This test was conducted in a 11 year-old peach orchard, variety `Red Haven'. Single tree plots, replicated 4 times in a randomized complete block design, were sprayed to runoff (ca 3 gal/tree) with a hydraulic sprayer equipped with a handgun and operated at 300 psi. Treatments were applied on April 28 (PF), May 7 (SS), May 27 (1C), June 13 (2C), and July 11 (3C). For disease control the entire orchard was sprayed with sulfur as needed. European red mite (ERM) counts were made by randomly picking 25 leaves per tree, brushing the mites onto glass plates coated with Triton B-1956, and counting the number of motile mites. Mite-days were calculated as follows: MD = MD1 + [(M1 + M2)/2 x Y], where MD1 = mite-days already accumulated, M1 = avg ERM/leaf on a given counting date, M2 = avg ERM/leaf on the next counting date after M1 and Y = number of days between M1 and M2. Sampling methods for the other insects are as follows: Green peach aphid (GPA) = avg no. GPA colonies/tree; Oriental fruit moth (OFMa) = avg no. OFM - damaged terminals/tree; OFMb = avg no. OFM damaged fruit/100 fruit/tree; Tarnished plant bug (TPB) = avg no. TPB - injured fruit/100 fruit/tree. Data were transformed to $\sqrt{x+1}$ or arcsin $\sqrt{x}$ before analysis of variance and comparison of means. In the tables, numbers followed by the same letter are not significantly different at alpha = 0.05, DMRT.

Overall, the pyrethroids were superior to Imidan for the control of insect pests. Among the pyrethroids, Asana and Pydrin provided excellent control of GPA and OFM whereas Ambush appeared slightly more active against TPB. The use of Ambush, and to a lesser extent, Pydrin, resulted in increased ERM populations over those in the control, Imidan and Asana plots.

Treatment and lb (AI)/100 gal		Tree Stage	GPA	OFMa			OFMb	TPB			
										catfacing	gum and/or scars
			21 May	21 May	5 Jun	8 Jul	28 Jul	5 Jun	8 Jul	28 Jul	28 Jul
Asana 1.9 EC	0.0125	PF-3C									
Plictran 50 W	0.125	3C	0.0 a	0.0 a	0.5 a	3.5 a	0.5 a	3.8 ab	9.5 a	6.8 a-c	4.0 a
Pydrin 2.4 EC	0.05	PF-3C									
Plictran 50 W	0.125	3C	0.0 a	0.0 a	0.3 a	4.3 a	0.3 a	3.5 ab	7.7 a	5.8 ab	3.0 a
Ambush 25 WP	0.05	PF-3C									
Plictran 50 W	0.125	3C	12.3 bc	0.0 a	0.0 a	11.5 ab	0.8 a	1.3 a	6.0 a	3.8 a	1.5 a
Ambush 25 WP	0.1	PF-3C									
Plictran 50 W	0.125	3C	3.8 ab	0.0 a	0.0 a	18.3 ab	1.0 a	2.3 ab	4.5 a	2.0 a	4.0 a
Imidan 50 WP	0.5	PF-3C									
Plictran 50 W	0.125	3C	47.5 d	0.0 a	1.0 a	35.3 b	2.9 b	4.8 b	23.5 b	12.6 bc	14.3 b
Control	---	-----	27.5 cd	5.8 b	49.5 b	137.8 c	20.0 c	27.8 c	66.3 c	14.5 c	32.0 c

Treatment and lb (AI)/100 gal		Tree Stage	ERM/leaf					
			2 Jun	18 Jun	8 Jul	22 Jul	4 Aug	Mite-days
Asana 1.9 EC	0.0125	PF-3C						
Plictran 50 WP	0.125	3C	0.1 a	1.1	13.4	0.9 a	1.8 a	271.9
Pydrin 2.4 EC	0.05	PF-3C						
Plictran 50 WP	0.125	3C	0.1 a	0.7	19.2	3.5 ab	8.6 ab	443.4
Ambush 25 WP	0.05	PF-3C						
Plictran 50 WP	0.125	3C	0.1 a	2.3	32.0	13.2 b	24.9 bc	926.8
Ambush 25 WP	0.1	PF-3C						
Plictran 50 WP	0.125	3C	0.1 a	2.4	26.2	11.3 b	27.4 c	819.9
Imidan 50 WP	0.5	PF-3C						
Plictran 50 WP	0.125	3C	0.1 a	0.6	9.4	1.8 a	2.5 a	211.5
Control	---	-----	0.6 b	1.9	5.5	4.8 ab	5.3 a	231.4

Field Evaluation of Acaricides for Control of European Red Mite

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In New Jersey resistance of European red mite (ERM) to Plictran, Vendex, and Kelthane is widespread (Swift and Polk 1984). Although many growers practice integrated control there is a need for miticide applications at critical times during the season to establish a favorable balance of predators to prey. For this reason we continue to search for new compounds with novel modes of action that will be effective against resistant ERM. In these tests we evaluated 4 experimental acaricides: clofentezine (Apollo), hexythiazox (Savey), BAS 27600I, and RH-3486.

A 16 year-old apple orchard, varieties `Yellow Delicious', `Red Delicious', and `Stayman' was used in this test. Single tree plots, replicated 2 times (first table, Mid Season-Test) or 3 times (all other tables) in a randomized complete block design, were sprayed to runoff (ca 5 gal/tree) with a hydraulic sprayer equipped with a handgun and operated at 300 psi. In the All-Season Test, treatments were applied April 4 (1/2 G), April 25 (P), May 7 & 8 (PF), May 22 (1C), and other dates (on table). In the Post-Harvest Test, treatments were applied November 7, 1985 (PH), April 25, 1986 (P), and May 7 (PF). In the Apollo-Savey Series Dilution Test treatments were applied on July 9. For disease control the entire orchard was treated with Captan and Polyram as needed. European red mite counts were made by randomly picking 25 leaves/tree, brushing the mites onto glass plates coated with Triton B - 1956, and counting the number of motile mites. Mite-days were calculated as follows: $MD = MD1 + [(M1 + M2)/2 \times Y]$, where MD1 = mite-days already accumulated, M1 = avg ERM/leaf on a given counting date, M2 = avg ERM/leaf on the next counting date after M1 and Y = no. of days between M1 and M2. Stethorus = avg no. of *S. punctum* larvae, pupae and adults/3 min count/tree. Data were transformed to $\sqrt{x+1}$ before analysis of variance and comparison of means. In the tables, numbers followed by the same letter are not significantly different at alpha = 0.05, DMRT.

In the Post-Harvest Test both Apollo and Savey effectively controlled ERM when applied in November whereas Morestan showed little activity as a fall treatment. All three compounds were effective as spring treatments.

In the All-Season Test the most effective programs were 1) Kelthane and Savey at PF, followed by Savey on July 3 (85 MD), and 2) Carzol at PF, followed by Apollo at 1C and Apollo + Carzol on July 3 (89 MD). The least effective program consisted of 3 applications of Kelthane, the first at PF, and repeated on June 20 and July 3.

In Mid-Season trials BAS 27600I provided excellent control of ERM at rates down to 2.0 oz ai/100 gals. RH-3486 reduced ERM populations slowly as compared to other acaricides but was effective at rates as low as 1.0 oz ai/100 gals. RH-3486 was not toxic to Stethorus.

In the Series Dilution Test both Apollo and Savey reduced ERM populations slowly relative to Plictran but, except for the lowest rate of Apollo, provided significantly longer residual control. There was a relatively weak rate response for Apollo and Savey with respect to residual control. Over-all, Savey was slightly more effective than Apollo at comparable rates.

Literature Cited:

Swift, F. C. and D. Polk. 1984. Apple, European red mite, screening for resistance to acaricides, 1983. Insecticide and Acaricide Tests 9: 38-39.

Post-Harvest Test

Treatments and oz (AI)/100 gal		Tree Stage	ERM/leaf 13 May	30 May	18 Jun	Mite-days
Morestan 25 WP	4.0	PH	0.5 bc	6.3 b	36.0 b	458.7
Morestan 25 WP	4.0	PH, P	0.1 a	0.4 a	6.4 a	68.3
Morestan 25 WP	4.0	P	0.0 a	0.3 a	5.9 a	61.1
Apollo 50 SC	0.5	PH	0.1 a	0.2 a	5.6 a	58.2
Savey 50 WP	0.75	PH	0.1 a	0.3 a	4.9 a	51.5
Apollo 50 SC	0.33	PF	0.1 a	0.1 a	1.0 a	10.2
Savey 50 WP	0.33	PF	0.2 ab	0.1 a	0.3 a	6.6
Control	----	---	0.6 c	4.2 b	34.7 b	410.2

All-Season Test

Treatments and oz (AI)/100 gal		Time of Application	ERM/leaf: 21 May	30 May	16-19 Jun	25 Jun	1 Jul	10 Jul
Apollo 50 SC	0.33	P						
Apollo 50 SC	0.67	6/20	0.1 a	0.3 a	14.7 b-e	1.9 a	5.0 ab	3.4 a
Apollo 50 SC	0.67	P & 6/20						
Carzol 92 SP	4.0	6/20	0.2 a	0.9 a	19.0 c-e	0.6 a	2.3 ab	2.3 a
Apollo 50 SC	0.33	PF						
Apollo 50 SC	0.67	6/20	0.1 a	0.4 a	4.9 ab	1.7 a	3.6 ab	1.9 a
Apollo 50 SC	0.67	PF & 6/20	0.1 a	0.1 a	1.8 a	0.7 a	2.7 ab	2.2 a
Apollo 50 SC	0.33	1C						
Apollo 50 SC	0.67	7/3	1.1 b	0.9 a	1.0 a	1.9 a	5.1 ab	5.6 ab
Apollo 50 SC	0.67	1C & 7/3	0.8 b	0.4 a	1.3 a	0.8 a	3.3 ab	3.1 a
Carzol 92 SP	4.0	PF & 7/3						
Apollo 50 SC	0.33	1C						
Apollo 50 SC	0.67	7/3	0.1 a	0.1 a	0.7 a	1.3 a	3.7 ab	0.4 a
Carzol 92 SP	4.0	PF						
Apollo 50 SP	0.67	6/20	0.1 a	1.1 a	7.4 a-d	1.3 a	1.0 a	0.6 a
Savey 50 WP	0.33	P & 6/18	0.1 a	0.6 a	21.2 de	1.8 a	3.1 ab	1.5 a
Savey 50 WP	0.33	PF & 6/18	0.1 a	0.2 a	5.3 a-c	1.2 a	3.3 ab	2.8 a
Oil	1/2 gal	1/2 G						
Savey 50 WP	0.33	6/3	0.2 a	1.6 ab	0.7 a	1.3 a	2.8 ab	2.5 a
Oil	1/2 gal	1/2 G						
Savey 50 WP	0.5	6/3	0.2 a	4.5 b	1.0 a	0.7 a	3.7 ab	1.2 a
Kelthane 4 F	8.0	PF, 6/20 & 7/3	0.2 a	1.4 ab	23.8 e	1.1 a	8.1 b	0.9 a
Kelthane 4 F	8.0							
+ Savey 50 WP	0.33	PF						
Savey 50 WP	0.5	7/3	0.1 a	0.1 a	1.6 a	0.4 a	2.4 ab	1.2 a
Savey 50 WP	0.33	PF						
Kelthane 4 F	8.0	7/3	0.1 a	0.1 a	0.5 a	0.8 a	2.5 ab	3.1 a
Savey 50 WP	0.33	PF						
Kelthane 4 F	8.0	7/11	0.2 a	0.2 a	0.6 a	1.1 a	3.0 ab	11.6 bc
Plictran 50 WP	2.0	PF & 7/11	0.0 a	0.1 a	1.0 a	1.1 a	2.5 ab	15.7 c
Control	-----	------	1.3 b	27.4 c	54.6 f	26.8 b	39.4 c	22.4 c

All-Season Test (continued)

Treatments and oz (AI)/100 gal		Time of Application	ERM/leaf: 18 Jul	24 Jul	5 Aug	18 Aug	26 Aug	Mite-days	Stethorus: 30 May
Apollo 50 SC	0.33	P							
Apollo 50 SC	0.67	6/20	1.1 a	2.2 ab	2.1 a	6.6	7.3 a-c	428.7 a-c	0.0 b
Apollo 50 SC	0.67	P & 6/20							
Carzol 92 SP	4.0	6/20	0.5 a	1.0 ab	1.0 a	6.3	9.6 a-c	430.4 a-c	1.0 b
Apollo 50 SC	0.33	PF							
Apollo 50 SC	0.67	6/20	0.6 a	1.4 ab	1.7 a	8.8	10.8 a-d	299.2 ab	0.0 b
Apollo 50 SC	0.67	PF & 6/20	0.9 a	1.2 ab	1.6 a	6.4	5.9 ab	195.8 ab	0.0 b
Apollo 50 SC	0.33	1C							
Apollo 50 SC	0.67	7/3	1.1 a	0.8 ab	1.4 a	4.4	6.1 ab	232.4 ab	2.3 b
Apollo 50 SC	0.67	1C & 7/3	1.8 a	1.3 ab	2.2 a	6.5	8.0 a-c	235.1 ab	0.0 b
Carzol 92 SP	4.0	PF & 7/3							
Apollo 50 SC	0.33	1C							
Apollo 50 SC	0.67	7/3	0.1 a	0.2 a	0.4 a	1.6	3.3 a	89.0 a	0.0 b
Carzol 92 SP	4.0	PF							
Apollo 50 SP	0.67	6/20	0.3 a	0.4 ab	0.6 a	4.3	7.7 a-c	221.9 ab	1.3 b
Savey 50 WP	0.33	P & 6/18	0.2 a	0.3 ab	0.3 a	2.7	3.0 a	381.9 a-c	0.0 b
Savey 50 WP	0.33	PF & 6/18	0.3 a	0.2 ab	0.2 a	1.5	3.1 a	164.8 ab	0.0 b
Oil	1/2 gal	1/2 G							
Savey 50 WP	0.33	6/3	1.3 a	1.7 ab	1.0 a	2.3	10.2 a-d	186.0 ab	1.3 b
Oil	1/2 gal	1/2 G							
Savey 50 WP	0.5	6/3	0.6 a	0.7 ab	0.8 a	2.8	3.8 a	179.7 ab	1.0 b
Kelthane 4 F	8.0	PF, 6/20 & 7/3	0.7 a	2.6 ab	1.5 a	13.3	25.3 d	693.7 c	0.7 b
Kelthane 4 F	8.0								
+ Savey 50 WP	0.33	PF							
Savey 50 WP	0.5	7/3	0.3 a	0.3 ab	0.3 a	1.3	2.1 a	84.6 a	0.0 b
Savey 50 WP	0.33	PF							
Kelthane 4 F	8.0	7/3	0.9 a	4.9 b	3.0 a	9.0	20.6 b-d	324.8 a-c	0.0 b
Savey 50 WP	0.33	PF							
Kelthane 4 F	8.0	7/11	0.9 a	3.8 ab	8.0 b	14.7	24.1 cd	543.0 bc	0.0 b
Plictran 50 WP	2.0	PF & 7/11	0.3 a	0.3 ab	0.8 a	5.6	20.2 b-d	328.9 a-c	0.0 b
Control	-----	------	4.6 b	12.8 c	1.8 a	4.6	3.3 a	1990.0 d	10.0 a

Mid-Season Test - Table 1

Treatments and oz (AI)/100 gal		Spray Dates	ERM/leaf 23 Jun	1 Jul	7 Jul	11 Jul	16 Jul	25 Jul	Mite-days	S punctum 23 Jun
BASF 27600I	4.0	6/18	0.1 a	0.2 a	0.5 a	0.5 a	0.3 a	1.1 a	13.5	0.0
BASF 27600I	8.0	6/18	0.1 a	0.1 a	0.3 a	0.1 a	0.3 a	0.8 a	9.2	0.0
RH 3486	1.92	6/18; 7/3	3.1 a	5.0 b	4.9 a	3.5 a	2.3 a	1.9 a	112.6	0.5
RH 3486	3.84	6/18; 7/3	3.0 a	3.4 ab	3.2 a	3.9 a	2.9 a	1.2 a	94.8	5.0
RH 3486	7.68	6/18; 7/3	1.4 a	2.9 ab	1.9 a	0.5 a	0.9 a	1.4 a	50.4	12.0
RH 3486	15.36	6/18	0.8 a	0.8 a	0.7 a	0.6 a	0.6 a	2.1 a	28.0	2.0
Plictran 50 WP	2.0	6/18	0.1 a	0.1 a	0.3 a	0.4 a	2.3 a	3.4 a	36.2	0.5
Control	---	----	54.2 b	35.4 c	71.0 b	50.6 b	35.2 b	16.0 b	1365.8	7.5

Mid-Season Test - Table 2

Treatments and oz (AI)/100 gal		Spray Dates	ERM/leaf 7 Jul	11 Jul	21 Jul	25 Jul	7 Aug	18 Aug	Mite-days
BAS 27600I	1.0	7/3; 7/15	3.8 a-c	11.6 cd	0.1 a	0.2 a	0.6 a	9.4 ab	149.9
BAS 27600I	2.0	7/3; 7/15	1.1 a	1.2 ab	0.1 a	0.1 a	2.0 a	9.8 ab	89.7
BAS 27600I	4.0	7/3; 7/15	0.3 a	1.9 ab	0.1 a	0.1 a	1.8 a	7.8 ab	80.5
BAS 27600I	8.0	7/3; 7/15	0.2 a	1.4 ab	0.1 a	0.1 a	1.0 a	4.3 a	48.1
RH - 3486 50 WP	0.48	7/3; 7/15	12.0 d	18.9 de	3.4 b	7.4 b	13.0 bc	26.2 c	542.8
RH - 3486 50 WP	0.96	7/3; 7/15	8.4 cd	6.3 a-c	0.3 a	0.7 a	5.7 ab	18.6 bc	239.6
RH - 3486 50 WP	1.92	7/3; 7/15	6.2 b-d	8.4 bc	0.2 a	0.7 a	1.4 a	8.6 ab	143.1
RH - 3486 50 WP	3.84	7/3; 7/15	9.1 cd	4.9 a-c	0.2 a	0.2 a	0.7 a	5.8 a	95.0
Kelthane 4 F	8.0	7/3; 7/15	1.9 ab	4.3 a-c	0.2 a	0.5 a	1.2 a	6.6 ab	90.0
Plictran 50 WP	2.0	7/3; 7/15	0.5 a	0.3 a	0.1 a	0.1 a	1.5 a	4.8 a	49.6
Plictran 5 L	2.0	7/3; 7/15	0.6 a	0.6 a	0.1 a	0.1 a	0.3 a	3.4 a	28.6
Control	---	----	29.1 e	33.1 e	6.8 c	14.2 c	19.4 c	24.2 c	824.2

Apollo-Savey Series Dilution Test

ERM/leaf

Treatments and oz (AI)/100 gal		14 Jul	21 Jul	25 Jul	6 Aug	15 Aug	26 Aug	9 Sep	Mite-days
Apollo 50 SC	0.125	11.6	1.1 a	1.4 a	1.3 ab	2.5 a	10.8 d	8.4 c	290.4
Apollo 50 SC	0.25	9.9	0.9 a	1.9 a	1.4 ab	4.9 a	3.7 a-c	3.5 a-c	189.0
Apollo 50 SC	0.5	9.9	1.1 a	1.0 a	1.3 ab	2.5 a	3.5 a-c	3.9 bc	158.1
Apollo 50 SC	1.0	7.7	0.4 a	0.3 a	1.1 ab	3.5 a	0.4 ab	0.1 a	83.7
Apollo 50 SC	2.0	11.3	0.9 a	0.4 a	0.3 a	1.4 a	0.6 ab	0.2 a	74.2
Savey 50 WP	0.125	9.4	1.4 a	0.2 a	0.5 a	3.7 a	4.1 bc	3.1 a-c	158.2
Savey 50 WP	0.25	6.3	0.7 a	1.1 a	0.1 a	2.1 a	1.7 ab	1.0 ab	85.8
Savey 50 WP	0.5	7.1	0.3 a	0.3 a	0.2 a	0.9 a	0.3 a	0.1 a	46.2
Savey 50 WP	1.0	7.9	0.9 a	0.2 a	0.1 a	1.5 a	0.6 ab	0.8 ab	62.9
Savey 50 WP	2.0	7.3	0.2 a	0.2 a	0.2 a	0.8 a	0.2 a	0.1 a	40.4
Plictran 5 L	2.0	1.5	0.1 a	0.3 a	2.9 b	5.3 a	13.6 d	15.5 d	370.0
Control	---	10.5	18.3 b	25.0 b	46.1 c	25.4 b	8.6 cd	4.7 bc	1215.6

BRAVO 720 FUNGICIDE TRIALS ON BLAKE PEACHES FOR THE CONTROL OF PEACH LEAF CURL, PEACH SCAB AND BROWN ROT

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Seven-year old M. A. Blake peaches, planted 20 x 20 feet in two mini-blocks of 36 trees each were sprayed with various combinations of Bravo 720, SDS 64220, COCS, ferbam 76W, captan 50W plus wettable sulfur 95W and no spray in programs to control peach leaf curl, peach scab and brown rot. The materials were applied with a Bean TM1229 3-point hitch airblast sprayer delivering 300 gallons per acre while traveling at 1.3 mph. The dates of application and plant growth stages were: dormant 3/25, pink 4/3, full bloom 4/10, petal fall 4/18, shuck split 4/30, shuck fall 5/8, first cover 5/22, second cover 6/5, third cover 6/19, fourth cover 7/3, fifth cover 7/17 and sixth cover 7/31. Each trial had 3 replicates of 4 trees each randomized over the two mini-blocks.

Peach leaf curl readings were taken on 6/3 by counting the number of infections per tree and consolidating for each trial. Peach scab readings were taken on 8/4 by collecting 25 peaches per tree at random, counting the number of infected fruit and consolidating for each trial. Brown rot readings were taken by collecting 50 fruits per each replicate totaling 150 fruit per each trial on August 19 and placing them on cardboard filler trays and grading for disease development after 7 and 10 days. The materials, rates and times of application are given in Table 2.

Table 1. Peach leaf curl infections per trial. Spray application 3/25.

	Material	Rate	Number infected leaves
1.	Bravo 720	3.0 pints/Acre	0
2.	Bravo 720	3.0 pints/Acre	0
3.	SDS 64220	10.0 lb/Acre	0
4.	Ferbam 76W (Carbamate)	6.0 lb/Acre	0
5.	No Spray		554
6.	COCS (50% metalic Cu)	6.0 lb/Acre	4

Peach leaf curl was erratic in behavior and symptoms did not appear evenly distributed over the blocks. The period for spray application was quite windy (10-20 mph) and considerable drift occurred. The high count occurred in one unsprayed replicate only.

Table 2. Peach scab, brown rot and *Rhizopus* rot infections per trial.

	Peach scab	Brown rot 8/25	Brown rot 8/28	Rhizopus rot 8/25	Rhizopus rot 8/28
1. Bravo 720 3 pt/A at pink 4/3, full bloom 4/10, petal fall 4/18, changing to Bravo 720 4.0 pt/A, at shuck split 4/30 and shuck fall 5/8, then a 2 week wait, then captan 50W at 4.5 lb/A plus sulfur 95W at 12 lb/A at first cover 5/22 and remaining cover sprays at two week intervals until 7/31.	10	1	4	12	22
2. Bravo 720 3.0 pt/A at pink 4/3, full bloom 4/10, petal fall 4/18, changing to 8 pt/A at shuck split 4/30, shuck fall 5/8, then a 4 week wait, then captan 50W at 4.5 lb/A plus sulfur 95W at 12 lb/A at second cover 6/5 and remaining cover sprays until 7/31.	9	0	0	11	30
3. SDS 64220 at 10.0 lb/A dormant only, then Bravo 720 3 pt/A at pink 4/3, full bloom 4/10, petal fall 4/18, changing to Bravo 720 at 4 pt/A at shuck split 4/30, shuck fall 5/8, then a two week wait, then captan 50W at 4.5 lb/A plus sulfur 95W at 12 lb/A at first cover on 5/22 and remaining cover sprays until 7/31.	12	0	0	5	16
4. Captan 50W at 4.5 lb/A plus sulfur 95W at 12 lb/A at pink 4/3, full bloom 4/10, petal fall 4/18, shuck split 4/30, shuck fall 5/8, first cover 5/22, second cover 6/5, third cover 6/19, fourth cover 7/3, fifth cover 7/17 and sixth cover 7/31.	5	1	2	11	31
5. Check, no fungicide.	181	3	8	16	30
6. COCS (50% metalic copper) dormant only.	197	1	4	6	16

FUNCICIDE TRIALS FOR APPLE DISEASE CONTROL - 1986

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Six-year old Stayman/MM106 apple trees set 20 x 20 feet in two mini-blocks of 36 trees each were sprayed with the following I. E. du Pont de Nemours, Inc. products or combinations for apple disease control: DPX 965 (6.0 oz/acre); DPX 965 (4.0 oz/A) plus Manzate 200 [Mancozeb] (32 oz/A); DPX H6573 [Nustar] (1.67 oz/A) plus Manzate 200 (32 oz/A); Benlate 50W [benomyl] (6.0 oz/A) and no fungicide. Three trees in each of three replicates were sprayed. A buffer row which received no fungicidal spray was between each sprayed row. The materials were applied with a Bean TM1229 3-point hitch airblast sprayer delivering 300 gallons of spray material per acre while traveling at 1.3 miles per hour. Insecticides were applied separately and included standard materials: Guthion 50W (azinphosmethyl), Lannate 1.8L (methomyl), Penncap-M, Kelthane 4F (dicofol). The dates of application and plant growth stages were: 4/3 ½-inch green; 4/10 late tight cluster; 4/18 pink; 4/25 full bloom; 5/5 petal fall; 5/15 first cover; 5/30 second cover; 6/12 third cover; 7/3 fourth cover; 7/17 fifth cover; 7/31 sixth cover; and 8/14 seventh cover.

Foliar disease readings were taken on July 15 by collecting 50 leaves per tree, recording disease incidence and consolidating the counts per trial. Fruit scab infections were recorded on September 4-5 by collecting 33 fruits per tree and consolidating per trial

Table 1. Foliar disease counts per trial on Stayman apples.

Material	Rate	Apple scab	Powdery mildew	Frogeye leafspot	% Fruit scab
DPX 965	6 oz/A	8	58	20	0.66
DPX 965 Manzate 200	4 oz/A plus 32 oz/A	5	54	5	0.66
DPX H6573 Manzate 200	1.67 oz/A plus 32 oz/A	1	54	3	0.33
Benlate 50W	6 oz/A	17	68	14	1.66
Check		19	95	8	4.25

FIRE BLIGHT CONTROL TRIALS - 1986
BLOCK X - WVU EXPERIMENT FARM

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Tom van der Zwet, ARS-USDA Appalachian Fruit Research Station

Several chemical materials at various concentrations were applied to 8-year old Golden Delicious and Rome Beauty apple trees to determine their value for fire blight control. The materials were applied to 3 trees of each variety and replicated three times. The applications were made at various times including the dormant D (3/28), tight cluster TC (4/14), pink P (4/21) and full bloom FB (4/29) with a Bean 1229 TM airblast sprayer delivering 300 gallons per acre while traveling at 1.3 mph. All trees were inoculated with fire blight bacteria (*Erwinia amylovora*) 5 x 10^8 cells/ml concentration using a 3-gallon handpump sprayer at the pre-pink stage (4/18) of blossom bud development. Pre-bloom and bloom weather conditions were dry. A severe rain storm passed through the area on May 20 depositing 2.3 inches of rain within a day of which 1.7 inches fell in 1.5 hours. Hail also occurred and damaged the fruit as well as cut some leaves. Fire blight began to appear about June 1st. Strikes per tree and trial were counted on May 20th and June 6th.

Table 1. Fire blight strikes per trial.

GOLDEN DELICIOUS VARIETY

	Materials and Rates	Time	Strikes/Three Replicates		Fruit Finish 6/16/86	
			5/20	6/3	Total	0-5 Heavy Russet
1	Bordeaux mixture 8-8-100	D	0	4	18	2.00
2	Kasumin 705 2%	TC	0	0	24	2.66
3	COCS + lime 4 lb/A each	TC	0	2	23	2.55
4	DC-5772 0.1%	TC	0	2	16	1.77
5	Bordeaux mixture 1.5-3-100	TC	0	1	23	2.55
6	Tribasic Cu + lime 1 lb/100 gal each	TC	0	0	26	2.88
7	Streptomycin 80 ppm 1.5 lb/A	TC	0	0	15	1.66
8	COCS + lime 1 lb/100 gal each	TC,P	0	1	30	3.33
9	DC-5772 0.1%	TC,P	1	0	14	1.55
10	Copac E Spec. 1 liter/A	TC,P	0	5	24	2.66
11	Check -- No Spray		0	0	11	1.375

ROME BEAUTY VARIETY

	Materials and Rates	Time	Strikes/Three Replicates 5/20	Strikes/Three Replicates 6/3	Fruit Finish 6/16/86 Total	Fruit Finish 6/16/86 0-5 Heavy Russet
1	Bordeaux mixture 8-8-100	D	0	108	0	0.00
2	Kasumin 706 Cu 2%	D	0	93	16	1.77
3	COCS 4 lb/A	D	0	37	1	0.11
4	DC-5772 2%	D	4	109	4	0.44
5	Bordeaux Mixture 1-3-100	TC,P,FB	0	57	10	1.11
6	Tribasic Cu + lime ½-1-100	TC,P,FB	0	87	0	0.00
7	COCS ½-1-100	TC,P,FB	0	111	2	0.28
8	DC-5772 0.5%	TC,P,FB	1	53	6	0.66
9	Streptomycin 60 ppm 1.2 lb/A	TC,P,FB	1	193	4	0.44
10	Copac E 4 liters/A	TC,P,FB	7	22	0	0.00
11	Check -- No Spray		0	40	2	0.22

FIRE BLIGHT CONTROL TRIALS - 1986
NITTANY APPLES - BLOCKS G-6, J-5 - WVU EXPERIMENT FARM

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Six spray materials were applied to 7-year old Nittany apples trees to determine their ability to control fire blight. The sprays were applied to 3 trees replicated three times each in 2 mini-blocks of 36 trees each. The materials were applied at the pink (P) 4/21 and the full bloom (FB) 4/29 stages of apple blossom development, and applied with a Bean 1229 TM airblast sprayer delivering 300 gallons per acre while traveling at 1.3 mph. The trees were inoculated with a suspension of fire blight bacteria (*Erwinia amylovora*) 5×10^8 cells/ml in the pre-pink stage on April 18th. Fire blight strikes were counted per tree and replicates on June 6th.

Table 1. Fire blight strikes per three replicates.

	Materials and Rates	Strikes/Three Replicates	Fruit Finish 6/17/86 Total	0-5 Heavy Russet
1	Kasumin 705 2%	9	17	1.88
2	Kasumin 706 Cu 2%	1	36	4.50
3	Streptomycin 60 ppm 0.3 lb/100 gal	36	4	0.44
4	DC-5772 0.2%	65	4	0.44
5	COCS 1 lb/100 gal	39	23	2.55
6	Check -- No Spray	78	9	1.00

FIRE BLIGHT CONTROL TRIALS - 1986

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Copac Spe. (BASF Corporation) was applied at three rates to 8-year old Rome Beauty/MM 111 apple trees in two mini-blocks of 36 trees each to determine its ability to control fire blight. Streptomycin sulfate 21.2% (Agri-mycin 17, Pfizer Chemical Corporation) at 60 ppm (1.2 lb/A) and non-bactericidal sprayed trees were also included in the test. The materials were applied to three adjacent trees and replicated three times. The applications were made with a Bean TM1229 airblast sprayer delivering 300 gallons per acre while traveling at 1.3 mph. All trees were inoculated with fire blight bacteria (Erwinia amylovora) 5×10^8 cells/ml concentration using a 3-gallon handpump sprayer at the pre-pink stage (4/18) of blossom bud development. Application dates and bud development stages were: dormant 3/28; pink 4/21 and full bloom 4/29. Dikar fungicide, azinphos-methyl (Guthion), methomyl (Lannate 1.8L) and Plictran were used during the season for general disease and insect control.

Pre-bloom and bloom weather conditions were dry with temperatures mostly below 65°F and unfavorable for fire blight development. A severe rain storm passed through the area on May 20 depositing 2.3 inches of rain in a day of which 1.7 inches fell in 1.5 hours. Only very light hail fell in these blocks. Fire blight began to appear on June 1st. Strikes per tree and trial were counted on June 6th and fruit finish counts on June 17.

Table 1. Fire blight strikes per trial on Rome Beauty apples.

Materials and Rates	Strikes/three replicates 6/14	Fruit finish 0-5 Heavy russet
Copac Spe. 1 liter/acre	0	0.2
Copac Spe. 2 liters/acre	4	0
Copac Spe. 3 liters/acre	2	0.8
Streptomycin 1.2 lb/acre	1	0
Check, no spray	1	0

ELISA INDEXING SURVEY FOR PRUNUS NECROTIC RINGSPOT VIRUS IN WEST VIRGINIA PEACH ORCHARDS

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INTRODUCTION

Enzyme-linked immunosorbent assay (ELISA) indexing of peaches for *Prunus* necrotic ringspot virus (PNRSV) infection during the past four years indicated the presence of this virus in variable quantities of infected trees in the orchards tested. PNRSV reduces the growth and yield of trees within the orchard (1, 7, 9, 10) and poses a danger for commerical growing of stone fruits (13). Transmission of PNRSV by insects, mites or nematodes in this country has not been recorded. However, transmission of PNRSV by pollen has been reported in several stone fruits; rapid spread in sour cherry in Midwestern and Northeastern states and slow spread in sweet cherry, prune and cling peach in the Western states (8). Little is known about the source of PNRSV infection, its persistence in the orchard and its spread by pollen in the freestone peach orchards of the mid-Atlantic fruit growing region.

Orchard spread of PNRSV varies within the *Prunus* species (2). The purpose of this paper is to present information on four years of ELISA indexing of peach trees to clarify some factors about source of infection, persistence and spread of PNRSV.

MATERIALS AND METHODS

Groups of peach trees from many orchards and varieties were indexed in 1983, 1984, 1985, and 1986 using the ELISA procedure of Clark and Adams (3). The PNRSV and antiserum was obtained from American Type Culture Collection (ATCC), Rockville, Maryland 20850.

Tissue samples were taken from terminal leaves on vigorously growing shoots located on a major scaffold limb in the central portion of the tree. Samples were collected and processed immediately or refrigerated overnight. Leaf samples were ground in a Brinkmann Homogenizer (Brinkmann Instruments Company, Westbury, New York 11590) in a 1:20 ratio (w/v) with PBS-tween PVP buffer. Enzyme-globulin conjugates were used at 1:500 v/v. Wells of microtiter plates were coated with 200 ul of globulin at 5 ug/ml. Reaction intensity was measured photometrically at 410 nm with a Dynatech Microelisa Mini Reader MR590 (Dynatech Laboratories, Inc., Alexandria, Virginia 22314). Controls included two healthy peach leaf samples and two diseased peach leaf samples per 60 sample wells. ELISA reactions giving absorbances equal to or greater than twice the average reading for healthy control samples were regarded as positive (6).

The survey compared five age groups of trees: #1) first year planted trees, #2) 1 to 4-year old trees (which had not bloomed), #3) 5 to 8-year old trees, #4) 9-year old and above trees, and #5) 5-year old and above trees (which had bloomed in all but the 1985 season). At least one year passed between comparative indexings.

#1) First year planted trees (222 trees, 8 orchard sites, 5 varieties: Early Sunhigh, Sunhigh, Redskin, Rio Oso Gem, and a mixture) were initially ELISA indexed less than two months after orchard planting.

#2) One to four-year old trees (791 trees, 29 orchard sites, 13 varieties: Garnet Beauty, Redhaven, Early Sunhigh, Sunhigh, Glohaven, Early Loring, Loring, Blake, Redskin, Rio Oso Gem, Baby Gold 5, Baby Gold 7, and a mixture) were indexed at least one year following initial indexing. Because of juvenile age and the complete freeze-out in 1985, fruit buds had not produced pollen on these trees.

#3) Five to eight-year old trees (467 trees, 17 orchard sites, 8 varieties: Earliglo, Redhaven, Sunhigh, Glohaven, Loring, Blake, Cresthaven and Redskin) were tested. Peach trees in this age group were vigorous, flowered normally, produced ample fruit buds and pollen (except in the 1985 season).

#4) Nine-year old and above trees (83 trees, 3 orchard sites, 2 varieties: Sunhigh and Loring) also flowered normally and produced fruit buds (except in the 1985 season).

#5) The five-year old and above trees were composed of 550 trees from groups #3 and #4.

RESULTS AND DISCUSSION

PNRSV indexed trees showed differences in the percent of initial infection in the orchard test blocks. Infection ranged from 9.5% to 22.9% in the five age groups of orchard trees. When grouped in four year increments younger trees had less infection than older trees.

First Year Planted Trees

No. trees tested	1st test no. pos.	% pos.	2nd test no. pos.	% pos.	Indexing change - to +	%	+ to -	%
222	21	9.5	20	9.0	1	0.4	2	0.9

The first year planted trees gave an initial 9.5% positive response to PNRSV infection. These trees were retested at least one year later and showed 9.0% positive response. The indexing indicated a change of 0.4% from a negative to a positive response and 0.9% from a positive to a negative response.

Since trees in this category had been planted less than two months when initially tested, and since no method is known which would permit transmission of PNRSV to occur within such a short period of time, the PNRSV-positive tested trees were considered to have been infected when obtained from the nursery. The second testing, a year later, indicated approximately the same number of infected trees with no evidence of spread of the virus. The change of index readings were a low percentage and within the range of experimental error (12).

One to Four Year Old Trees

No. trees tested	1st test no. pos.	% pos.	2nd test no. pos.	% pos.	Indexing change - to +	%	+ to -	%
791	116	14.7	114	14.4	8	1.0	10	1.3

The first testing of this group showed 14.7% of the trees being infected with PNRSV. The second testing showed 14.4% with a positive response. This was an indexing change of 1.0% from negative to positive and 1.3% from positive to negative.

This age category had no opportunity for fruit bud formation and pollen formation. No measurable increase in infection occurred. That PNRSV transmission by insects, mites or nematodes was not detected corresponds to data for other stone fruits in a one to four-year old age group (2, 4).

Five to Eight Year Old Trees

No. trees tested	1st test no. pos.	% pos.	2nd test no. pos.	% pos.	Indexing change - to +	%	+ to -	%
467	106	22.7	106	22.7	8	1.7	8	1.7

In this group 22.7% PNRSV infection was found to be present in both tests. The indexing change in each case was 1.7%.

These trees flowered normally and produced ample fruit buds and pollen for possible virus transmission. However, the data indicated a low percentage (1.7%) of indexing change from negative to positive (also within experimental error bounds) showing no significant transmission of PNRSV in peach orchards of this age group. These findings do not correspond to data for cherry indicating the number of infected trees to increase geometrically for the first four years of bloom (2, 5).

Nine Years of Age and Older Trees

No. trees tested	1st test no. pos.	% pos.	2nd test no. pos.	% pos.	Indexing change - to +	%	+ to -	%
83	19	22.9	21	25.3	3	3.6	1	1.2

This group exhibited 22.9% initial PNRSV infection and 25.3% in the second test. The indexing change was 3.6% from negative to positive and 1.2% from positive to negative. The indexing change remained within experimental error limits.

The initial infection level in this group was similar to the five to eight-year old trees but higher than in younger trees. The higher rate of initial infection was probably because the trees were planted before there was much attention to virus infection in nursery stock. In recent years greater attention has been given to virus content in budwood sources and propagation procedures in the nurseries. There was indication that the number of infections came with the nursery stock and remained stable during the years. These trees had ample opportunity to exhibit spread by pollen within the orchards. Schmitt, et al, 1977, reported that infections in California cling peach increased from 4% at planting to 27% in nine years, 48.5% in 12 years and 82% in 14 years resulting from pollen transmission. The freestone peach varieties in this study did not exhibit this increase in infection. The increase in indexing change remained low and within the range of experimental error.

Five Years of Age and Older Trees

No. trees tested	1st test no. pos.	% pos.	2nd test no. pos.	% pos.	Indexing change - to +	%	+ to -	%
550	125	22.7	127	23.1	11	2.0	9	1.6

In the five-year old and above group, 22.7% trees initially tested positive. The second test showed 23.1% trees positive. The indexing changes of 2.0% trees from negative to positive and 1.6% trees from positive to negative were within the range of experimental error.

The data from this group shows the comparision of trees which had not bloomed (one to four year old trees) with trees that had bloomed. The rates of indexing change were only slightly higher in the older trees.

The major source of PNRSV in freestone peach varieties in this area may be attributed to infected nursery stock. Trees infected with the virus remain infected for their lifetime. PNRSV has not been shown to spread by any means in this survey. Contrary to reports of rapid dissemination of PNRSV by pollen in stone fruits in other areas, PNRSV was not found to spread readily by pollen in peaches in the mid-Atlantic fruit growing area. The indexing change is such a low percentage that transmission may occur at a percentage less than the experimental error or not at all. Since pollen collected from infected freestone peach trees which indexed positive by ELISA for PNRSV (Barrat, unpublished data), the potential is present for pollen transmission in the orchards, although transmission was not indicated in this study.

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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
Golden Delicious leaf blotch; stress

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MANAGEMENT OF APPLE DISEASES AT BLACKSBURG, VIRGINIA DURING 1986: Seventeen fungicides and fungicide combinations were evaluated for disease control in a closely managed orchard of 21-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 14, 21, 28; May 5, 19; Jun 2, 16; Jul 1, 14, 28 and Aug 9, 25. 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. Demeton 6EC (Systox) 15.0 oz/A concentrate was used in the pink and petal fall stage of bud development for aphid control. For Japanese beetle control, carbaryl 50W (Sevin) 6.5 lb/A concentrate was used Jul 5, 20 and Aug 5. For mite control, Savey 50W 3.0 oz and Plictran 50W 12.0 oz/A dilute were used Jun 5. Data were recorded May 12 through 16, Jun 16 through 20, Jul 21 through 25 and Aug 27 through Sep 26.

Climatological conditions for high quality fruit production were extremely variable and undesirable. The temperature surrounding the orchard was at the freezing zone and/or below for four consecutive weeks during Apr and the first week in May (Apr 10, 11 - 29 and 31°F; Apr 17, 18 - 31 and 32°F; Apr 23, 24-28 and 30°F, respectively and May 4 - 28°F). The ambient temperature in the orchard was maintained at 4 to 5°F warmer than the temperature surrounding the orchard with a Tropical Breeze wind machine (100 HP electric motor with a 360° rotation). Precipitation was low in Apr through mid May; thus, apple scab and cedar apple rust infections were extremely reduced (Tables 1, 2, 3, 4). Scab on the check trees; however, did continue to develop throughout the growing season but was considerably reduced from an average scab infection year (Tables 1, 2, 3, 4). Although cedar apple and Quince rust inoculum were attached to bamboo poles around the perimeter of the orchard before and 10 days after bloom the inoculum; however, appeared to dry-up from the lack of moisture resulting in only minor rust development (Tables 1, 2, 3, 4). As a whole sooty blotch, fly speck and apple rots were extensive considering the relatively dry season (Tables 1, 2, 3, 4). As usual all sterol inhibiting fungicides were relatively ineffective for sooty blotch, fly speck and summer and late season apple rots control (Tables 1, 2, 3, 4). The effectiveness of Polyram for control of the summer and late season diseases seemed to be reduced from its normal activity (Tables 1, 2, 3, 4). Fruit finish, as a whole, was good with all treatments. High density Red Delicious (605 trees (/A) harvested 2118 bu/A of 95% US Extra Fancy Packout fruit.

Table 1.

Fungicide and rate/100 gal[1]	% Golden delicious 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	GDLB[4] affected	GDLB[4] defoliated	% Fruit[5] area russeted
Baycor 50W 4.0 oz + Polyram 80W 16.0 oz through PF, then Baycor 50W 2.0 oz + Polyram 80W 16.0 oz cover sprays..........	0	0	0	0	0	3	3	3	41	26	9
Baycor 50W 4.0 oz + Polyram 80W 16.0 oz through PF then Polyram 80W 2.0 lb rest of season............................	0	0	0	1	0	7	18	7	27	12	9
Baycor 50W 2.0 oz + Polyram 80W 16.0 oz.....	1	0	0	0	0	8	9	1	60	28	9
Polyram 80W 2.0 lb standard................	1	1	0	0	0	12	41	21	73	24	9
Uniroyal (UBI-A815 50W) 1.0 oz ai 72-96 hr Post Infection..........................	0	0	0	0	0	5	63	55	50	14	9
Uniroyal (UBI-A815 50W) 1.5 oz ai 72-96 hr Post Infection..........................	0	0	0	0	0	5	62	41	68	21	11
Uniroyal (UBI-A815 50W) 1.0 oz ai + Polyram 80W 1.0 lb.........................	0	0	0	0	0	2	10	2	41	16	9
Uniroyal (UBI-A815 50W) 1.5 oz ai + Polyram 80W 1.0 lb.........................	0	0	0	1	0	8	30	12	12	03	8
Rubigan 12.5% EC 4.0 oz + Polyram 80W 3.0 lb/A..................................	0	0	0	0	0	0	5	0	25	10	8
Rubigan 12.5% EC 6.0 oz + Polyram 80W 3.0 lb/A..................................	0	0	0	0	0	1	1	0	31	6	7
Systhane 40W 1.0 oz ai through 2nd cover, then Dithane M-45 80W 1.5 lb rest of season............................	0	0	0	0	0	1	4	0	35	7	11
Bayleton 50W 0.5 oz ai + Dithane M-45 80W 2.0 lb through 2nd cover, then Dithane M-45 80W 1.5 lb rest of season....................................	1	1	0	0	0	0	0	0	20	10	8
Topsin-M 70W 8.0 oz + Penncozeb 80W 64.0 oz/A.................................	0	0	0	0	0	0	0	0	27	10	10
Topsin-M 4.5F 10.0 oz + Penncozeb 80W 64.0 oz/A.................................	0	0	0	0	0	0	1	0	32	9	7
Penncozeb 80W 8.0 lb/A......................	0	0	0	0	0	0	1	0	33	10	7
Benomyl 50W 8.0 oz + Manzate 200 80W 64.0 oz/A.................................	0	0	0	0	0	0	2	0	46	6	9
Topsin-M 4.5F 14.5 oz + Bayleton 50W 8.0 oz/A..................................	0	0	0	0	0	0	2	1	55	3	12
Check.......................................	20	10	0	5	0	14	100	80	74	22	14

[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 (<u>Physalospora obtusa</u>), bitter (<u>Glomerella cingulata</u>) and white (<u>Botryosphaeria dothidea</u>); 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.

Fungicide and rate/100 gal[1]	% Delicious 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 russeted
Baycor 50W 4.0 oz + Polyram 80W 16.0 oz through PF, then Baycor 50W 2.0 oz + Polyram 80W 16.0 oz cover sprays	1	0	0	0	0	10	8	6
Baycor 50W 4.0 oz + Polyram 80W 16.0 oz through PF then Polyram 80W 2.0 lb rest of season	0	0	0	0	2	11	2	6
Baycor 50W 2.0 oz + Polyram 80W 16.0 oz	0	0	0	0	0	6	2	5
Polyram 80W 2.0 lb standard	1	0	0	0	2	10	4	5
Uniroyal (UBI-A815 50W) 1.0 oz ai 72-96 hr Post Infection	0	0	0	0	0	48	44	6
Uniroyal (UBI-A815 50W) 1.5 oz ai 72-96 hr Post Infection	0	0	0	0	2	44	33	5
Uniroyal (UBI-A815 50W) 1.0 oz ai + Polyram 80W 1.0 lb	0	0	0	0	0	13	3	5
Uniroyal (UBI-A815 50W) 1.5 oz ai + Polyram 80W 1.0 lb	0	1	0	0	0	20	2	5
Rubigan 12.5% EC 4.0 oz + Polyram 80W 3.0 lb/A	0	0	0	0	0	6	1	5
Rubigan 12.5% EC 6.0 oz + Polyram 80W 3.0 lb/A	0	0	0	0	0	3	1	6
Systhane 40W 1.0 oz ai through 2nd cover, then Dithane M-45 80W 1.5 lb rest of season	0	0	0	0	0	4	0	6
Bayleton 50W 0.5 oz ai + Dithane M-45 80W 2.0 lb through 2nd cover, then Dithane M-45 80W 1.5 lb rest of season	1	0	0	0	0	1	0	6
Topsin-M 70W 8.0 oz + Penncozeb 80W 64.0 oz/A	0	0	0	0	0	0	0	6
Topsin-M 4.5F 10.0 oz + Penncozeb 80W 64.0 oz/A	0	0	0	0	0	1	0	6
Penncozeb 80W 8.0 lb/A	0	0	1	0	0	5	0	6
Benomyl 50W 8.0 oz + Manzate 200 80W 64.0 oz/A	1	0	0	0	0	1	1	6
Topsin-M 4.5F 14.5 oz + Bayleton 50W 8.0 oz/A	0	0	0	0	0	7	1	6
Check	50	10	5	0	20	99	70	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*); 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.

Fungicide and rate/100 gal[1]	% Rome fruit, leaves or terminals affected with: scab[2] terminals	scab[2] leaves	scab[2] fruit	rust[2] leaves	rust[2] fruit	rots[3]	sooty[3] blotch	fly[3] speck	% Fruit[4] area russeted
Baycor 50W 4.0 oz + Polyram 80W 16.0 oz through PF, then Baycor 50W 2.0 oz + Polyram 80W 16.0 oz cover sprays..........	3	1	0	0	0	0	11	3	6
Baycor 50W 4.0 oz + Polyram 80W 16.0 oz through PF then Polyram 80W 2.0 lb rest of season...........................	1	1	0	5	0	0	15	13	6
Baycor 50W 2.0 oz + Polyram 80W 16.0 oz.....	2	1	0	0	0	0	16	27	6
Polyram 80W 2.0 lb standard................	2	1	0	2	0	8	23	12	6
Uniroyal (UBI-A815 50W) 1.0 oz ai 72-96 hr Post Infection........................	0	0	0	2	1	0	74	90	7
Uniroyal (UBI-A815 50W) 1.5 oz ai 72-96 hr Post Infection........................	0	0	0	0	0	1	58	81	7
Uniroyal (UBI-A815 50W) 1.0 oz ai + Polyram 80W 1.0 lb........................	0	0	1	3	0	1	11	18	7
Uniroyal (UBI-A815 50W) 1.5 oz ai + Polyram 80W 1.0 lb........................	0	0	0	0	0	0	15	9	7
Rubigan 12.5% EC 4.0 oz + Polyram 80W 3.0 lb/A..................................	0	0	0	2	0	0	5	5	7
Rubigan 12.5% EC 6.0 oz + Polyram 80W 3.0 lb/A..................................	0	0	0	0	0	1	7	5	6
Systhane 40W 1.0 oz ai through 2nd cover, then Dithane M-45 80W 1.5 lb rest of season...........................	1	1	0	2	0	0	4	1	7
Bayleton 50W 0.5 oz ai + Dithane M-45 80W 2.0 lb through 2nd cover, then Dithane M-45 80W 1.5 lb rest of season....................................	0	0	0	0	0	0	2	0	7
Topsin-M 70W 8.0 oz + Penncozeb 80W 64.0 oz/A................................	0	0	1	2	0	0	0	0	7
Topsin-M 4.5F 10.0 oz + Penncozeb 80W 64.0 oz/A................................	0	0	0	8	0	0	2	1	7
Penncozeb 80W 8.0 lb/A.....................	0	0	0	0	0	0	1	1	6
Benomyl 50W 8.0 oz + Manzate 200 80W 64.0 oz/A................................	0	0	0	3	0	0	5	0	6
Topsin-M 4.5F 14.5 oz + Bayleton 50W 8.0 oz/A.................................	1	0	0	0	0	2	5	1	6
Check......................................	80	20	5	40	0	9	90	91	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); 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.

Fungicide and rate/100 gal[1]	% Stayman fruit, leaves or terminals affected with: scab[2] terminals	scab[2] leaves	scab[2] fruit	rust[2] leaves	rust[2] fruit	rots[3]	sooty[3] blotch	fly[3] speck	% Fruit[4] area russeted
Baycor 50W 4.0 oz + Polyram 80W 16.0 oz through PF, then Baycor 50W 2.0 oz + Polyram 80W 16.0 oz cover sprays..........	3	1	0	0	0	1	35	22	7
Baycor 50W 4.0 oz + Polyram 80W 16.0 oz through PF then Polyram 80W 2.0 lb rest of season...........................	3	1	0	0	0	1	36	27	7
Baycor 50W 2.0 oz + Polyram 80W 16.0 oz.....	0	1	0	5	0	0	31	21	7
Polyram 80W 2.0 lb standard.................	0	0	0	0	0	6	10	8	6
Uniroyal (UBI-A815 50W) 1.0 oz ai 72-96 hr Post Infection........................	0	0	0	0	0	0	74	85	7
Uniroyal (UBI-A815 50W) 1.5 oz ai 72-96 hr Post Infection........................	0	1	0	0	0	1	39	32	7
Uniroyal (UBI-A815 50W) 1.0 oz ai + Polyram 80W 1.0 lb.......................	0	0	0	0	0	0	29	19	7
Uniroyal (UBI-A815 50W) 1.5 oz ai + Polyram 80W 1.0 lb.......................	0	0	0	3	0	0	16	11	7
Rubigan 12.5% EC 4.0 oz + Polyram 80W 3.0 lb/A................................	0	0	0	0	0	1	7	5	7
Rubigan 12.5% EC 6.0 oz + Polyram 80W 3.0 lb/A................................	0	0	0	0	0	0	18	6	7
Systhane 40W 1.0 oz ai through 2nd cover, then Dithane M-45 80W 1.5 lb rest of season...........................	0	0	0	0	0	0	19	14	7
Bayleton 50W 0.5 oz ai + Dithane M-45 80W 2.0 lb through 2nd cover, then Dithane M-45 80W 1.5 lb rest of season...................................	0	0	0	0	0	4	10	3	7
Topsin-M 70W 8.0 oz + Penncozeb 80W 64.0 oz/A................................	0	1	0	0	0	0	1	0	7
Topsin-M 4.5F 10.0 oz + Penncozeb 80W 64.0 oz/A................................	1	0	0	0	0	0	1	0	7
Penncozeb 80W 8.0 lb/A.....................	0	0	1	0	0	0	1	1	6
Benomyl 50W 8.0 oz + Manzate 200 80W 64.0 oz/A................................	0	0	0	0	0	0	0	0	7
Topsin-M 4.5F 14.5 oz + Bayleton 50W 8.0 oz/A.................................	0	0	0	0	0	1	3	2	7
Check.......................................	68	71	11	14	3	10	78	81	8

[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]Fruit russet was determined by counting 100 fruit/treatment/replicate.

PEACH (*Prunus persica* 'Redhaven',
Brown rot; *Monilinia fructicola*
Rhizopus rot; *Rhizopus* sp.
Scab; *Cladosporium carpophillum*

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MANAGEMENT OF PEACH DISEASES AT BLACKSBURG, VIRGINIA DURING 1986: Various fungicides and fungicide combinations were evaluated for their effectiveness for control of scab, brown and Rhizopus rot. Seven-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 most equipped with four guns. Treatments were applied Apr 7 (pink), 13 (full bloom), 18 (petal fall), 25 (shuck-split), May 6 (shuck-fall), cover sprays May 20, Jun 2, 16, Jul 1, 15, respectively and the last spray Jul 28 (one day of harvest). 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 18, 22, 25 as the fruit approached maturity.

Climatological conditions were widely variable with extremes as follows: cold and dry Apr through mid-May, 3 inches of rain occurred last week of May, mostly dry and hot Jun through mid-Jul, then 2.5 inches of rain occurred during the last week of Jul; thus, some brown rot pressure was present during harvest. Although there was some brown rot pressure it was of short duration predominantly during a 24 hr period. All treatments provided good to excellent disease control. Topsin-M 70W + captan provided the best control (Table 1). Color and shape of all fruit were average to above normal market fruit. Fruit treated with flowable Topsin-M seemed to have slightly superior color to fruit from other treatments.

Table 1.

	% Peach fruit affected with:				
	brown rot		rhizopus rot	scab	Fruit color and eye
Fungicide and rate per 100 gal[1]	at harvest	after 5 days[2]	after 5 days	at harvest	appeal[3]
Bravo 720 3.0 pt/A pink to petal fall, then 4.0 pt at shuck-split and shuck-fall, then 2 weeks later start Captan 50W 2.0 lb and continue rest of season	1	2	3	0	2
Bravo 720 3.0 pt/A pink to petal fall, then 8.0 pt/A shuck-split and shuck-fall, then 4 weeks later start Captan 50W 2.0 lb and continue rest of season	2	2	1	0	3
SDS 64220 10.0 lb/A dormant, then Bravo 720 3.0 pt/A pink to petal fall then 4.0 pt shuck-split and shuck-fall, then 2 weeks later start Captan 50W 2.0 lb and continue rest of season	2	4	3	0	3
Topsin-M 70W 4.0 oz + Captan 50W 1.0 lb	0	0	1	0	2
Topsin-M 4.5F 5.0 oz + Captan 50W 1.0 lb	2	1	2	0	1
Captan 50W 2.0 lb	2	3	1	2	2
Captan 50W 1.0 lb + Kolo Extra Dust or Spray 53W 3.0 lb	1	4	3	0	4
Check	5	7	8	51	5

[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.

NECTARINE (Prunus pesica var. nectaria 'Red Gold')
Brown rot; Monilinia fructicola
Rhizopsu rot; Monilinia fructicola
Scab; Cladosproium carpophilum

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MANAGEMENT OF NECTARINE DISEASES AT BLACKSBURG, VIRGINIA DURING 1986: Various fungicides and fungicide combinations were evaluated for scab, brown and Rhizopus rot control on 7-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 6 (pink), 13 (full bloom), 18 (petal fall), 25 (shuck-split), May 6 (shuck-fall), cover sprays May 20, Jun 2, 16, Jul 1, 15, 30, 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.

Although climatological conditions were drastically undesirable for production of high quality fruit an excellent crop of Red Gold nectarines developed in contrast to the weather. The environmental conditions were ideal for brown rot development as the fruit approached maturity (hot days 90°F and nights 70°F+ with high humidity and afternoon showers). All treatments provided commercial control of brown rot. The Bravo-captan combination seems to function satisfactory in that the Bravo applied in late dormancy (Mar 12 - Apr 18) provided good control of peach leaf curl followed by blossom blight and scab control, then cover sprays of captan provided brown rot control as the fruit approached maturity. The combination of Topsin-M and captan also provided excellent disease control for high quality nectarine production (Table 1). The Topsin-M + captan combination also was used for disease control in a high density (544 trees/A) 7-year-old Red Gold nectarine planting. The yield from the high density planting was 1,718, 38 lb boxes (1305 bu) of 95% US Extra Fancy fruit/A.

Table 1.

	% nectarine fruit affected with:[2]				
	brown rot		rhizopus rot	scab	Fruit color and eye appeal[4]
Fungicide and rate per 100 gal[1]	at harvest	after 5 days[3]	after 5 days	at harvest	
Captan 50W 2.0 lb.	3	9	5	3	2
Kolodust Extra Dust or Spray 53W 6.0 lb.	4	13	8	4	4
Captan 50W 1.0 lb + Kolodust Extra Dust or Spray 53W 3.0 lb.	5	9	7	3	4
Topsin-M 4.5F 5.0 oz + Captan 50W 1.0 lb.	2	4	3	0	1
Topsin-M 70W 4.0 oz + Captan 50W 1.0 lb.	1	3	4	0	2
Funginex 1.6E 16.0 fl oz.	2	6	7	5	5
SDS 64220 10.0 lb/A dormant, then Bravo 720 3.0 pt/A pink to petal fall then 4.0 pt shuck-split and shuck-fall, then 2 weeks later start Captan 50W 2.0 lb and continue rest of season.	3	16	5	4	4
Bravo 720 3.0 pt/A pink to petal fall, then 8.0 pt/A shuck-split and shuck-fall, then 4 weeks later start Captan 50W 2.0 lb and continue rest of season.	5	11	3	2	3
Bravo 720 3.0 pt/A pink to petal fall, then 4.0 pt at shuck-split and shuck-fall, then 2 weeks later start Captan 50W 2.0 lb and continue rest of season.	7	10	4	1	3
Check (no fungicide).	21	37	19	47	5

[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 cultivar and each treatment were held at room temperature (70-80°) for 5 da 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.

PEACH (Prunus persica 'Redhaven', 'Newhaven', 'Glohaven')

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EFFECT OF VAPOR GUARD, IRRIGATION AND TREE TOPPING ON COLOR, SIZE AND MARKET QUALITY OF PEACH FRUIT AT BLACKSBURG, VIRGINIA DURING 1986: Vapor Guard, an antitranspirant, was applied to 7-year-old Redhaven, Newhaven and Glohaven peach cultivars 14-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. Starting 18 days before harvest a pulse irrigation system delivering approximately 0.2 inch/emitter/hr (1 emitter/tree) was used on 75% of the planting to compare fruit quality with ideal moisture versus powdery dry soil. Further 14 days before harvest, 5 trees of Newhaven were topped (10-12 inches of all terminals removed) to permit better exposure of the fruit to sunlight during the maturity process. Control untreated trees, (Vapor Guard versus no Vapor Guard, irrigation versus no irrigation, and topped versus none topped) were established for each comparison.

There was a good response to Vapor Guard in fruit size and color. The color was remarkable with both Redhaven and Glohaven. Newhaven, being a highly colored peach at maturity, revealed less response to Vapor Guard than the other two cultivars. In general, it appeared that the growth swell was similar for the three cultivars. Also there was good response to pulse irrigation. The environment was extremely dry during the maturity process. There was some indication that irrigation may have been an additive affect to the response of Vapor Guard. Topping the trees 14 days before harvest did not prove beneficial to the fruit. Perhaps, if the trees had been topped 25 to 30 days of fruit maturity there might have been a better response.

	av. fruit color and size provided with the various treatments[2]					
	Glohaven		Newhaven		Redhaven	
Treatments	color[1]	size (inch)	color[1]	size (inch)	color[1]	size (inch)
Vapor Guard[3] + irrigation.........	2	3.25	1	2.83	2	2.67
Vapor Guard[3] + no irrigation	5	3.08	2	2.63	4	2.43
Topped + no Vapor Guard or irrigation.......................	--	--	3	2.41	--	--
Control (no treatment).............	8	2.88	4	2.42	8	2.26

[1]/Color was based on an index number of 1-10 with 1 being the most highly colored.
[2]/300 fruit were measured for each treatment.
[3]/One gallon of Vapor Guard was used/A.

Not for Publication

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APPLE: Malus domestica 'Rome Beauty'
Apple scab: Venturia inaequalis
Powdery mildew: Podosphaera leucotricha

APPLE SCAB AND POWDERY MILDEW INCIDENCE ON 'ROME BEAUTY' APPLE TREATED WITH POST INFECTION SPRAYS APPLIED WITH AN AIRBLAST SPRAYER IN 1986: Sterol inhibiting (EBI) fungicides were evaluated for control of both apple scab and powdery mildew when applied in 4 spray applications timed from 85-98 hours post infection for apple scab during the primary apple scab period. The trees used in this test were planted 7 X 10.7 m and pruned to a height of 5-6 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 with a Metters 36 inch fan orchard airblast sprayer at 50 gpa (467 L/ha) of spray mixture when operated at 2.5 mph (4.0 km/hr). There were 7 primary apple scab infection periods which occurred between 15 Apr and 12 Jun. Post-infection applications were made to both sides of the tree as follows: 19 Apr (96 hr), infection 1; 19 May (96 hr), infection 2, 3, 4; 31 May (86 hr), infection 5; 10 Jun (85 hr), infection 6. One additional protective spray was applied on 6 May (petal-fall). Captan was used in combination with several of the EBI fungicides in the post-infection applications and was continued alone during the summer sprays. Standard insecticides necessary for control of insects and mites were applied separately as needed. 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 7-8 Jul. To evaluate effectiveness of the post-infection applications, the youngest unfolded leaf on each of the 10 pre-selected terminals/tree were marked with colored tape at specific times of infection when applications were made. The percent scab incidence on susceptible leaves during specific infections was calculated along with a total incidence for the entire primary scab period. Mildew incidence was recorded for the entire season and the percent fruit infected with scab and fly speck and fruit size in length and diameter was determined on 100 fruits/tree at harvest on 29 Sep. The data were statistically analyzed using the appropriate transformation, standard analysis of variance for randomized block design and the Duncan Multiple Range Test for mean separation.

Scab incidence on the non-treated check was 30% on leaves and 26% on fruit. At least 3 distinct periods of infection occurred when from 40-53% of the susceptible leaves present at the time were infected with scab. Intervals between the 4 post-infection applications were 17, 13, 12, and 10 days. The interval affected fungicide performance for mildew control, particularly those fungicides with short residual activity. SAN 619 provided outstanding control of scab and mildew with no difference between the two rates tested. Procure used at 9.0 and 12.0 oz/A with Captan provided the same level of scab control but significantly less mildew control than SAN 619. The Baycor/Captan combination provided outstanding control of apple scab on leaves and fruit but only moderate levels of mildew control. Rubigan at 3.0 oz/A was significantly inferior to the 4.0 and 6.0 oz/A rates used in combination with Captan for scab control, but no difference in mildew control among the 3 rates was obtained. Rubigan at 6.0 oz/A applied in a protective schedule at intervals of 8-14 days provided scab and mildew control equal to the post-infection application schedule. Fly speck incidence was very light with only 14% on the non-treated check and very small differences among treatments. Baycor provided the best control with 3.5% infection, but was not significantly different from the Procure, SAN 619, and Rubigan treatments. There was no evidence of phytotoxicity to leaves or fruit or treatment effect on fruit length (range 2.88 in (7.3 cm) to 3.04 in (7.7 cm) or width (range 3.42 in (8.7 cm) to 3.61 in (9.2 cm).

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APPLE SCAB AND POWDERY MILDEW INCIDENCE ON 'ROME BEAUTY' APPLE TREATED WITH POST-INFECTION SPRAYS APPLIED WITH AN AIRBLAST SPRAYER IN 1986.

Fungicide and Amt ai/ha (Form/A)	Disease Incidence					
	Percent Apple Scab					% Powdery Mildew on leaves
	Terminal Leaves[1]					
	Inf 1	Inf 2,3,4	Inf 5,6	Mean Total	Fruit	
Spotless (XE-779) 25W 42 g (2.4 oz)	10.7de[3]	19.1bc	3.5bc	9.3cd	6.0b	33.0de
Ro 15-1297 ACR3567A 4E 75 g (2.0 fl oz) + Captan 50W 1680 g (3.0 lb)	6.7def	13.6bcd	1.3bc	5.6de	1.0b	18.1f
Baycor 50W 420 g (12.0 oz) + Captan 50W 1680 g (3.0 lb)	0.6g	0.0e	0.4c	0.5f	0.0b	36.9cd
Procure 50W 315 g (9.0 oz) + Captan 50W 1680 g (3.0 lb)	2.7fg	3.2de	0.5c	2.0ef	0.5b	22.1f
Procure 50W 315 g (9.0 oz)	15.9cd	24.1ab	3.7bc	13.0cd	3.5b	24.4ef
Procure 50W 420 g (12.0 oz) + Captan 50W 1680 g (3.0 lb)	1.6fg	0.0e	0.2c	1.0ef	0.5b	16.3f
SAN 619 10WG 37 g (5.3 oz)	3.5efg	2.7e	0.9c	2.6ef	3.0b	18.0f
SAN 619 10WG 55 g (7.9 oz)	2.0fg	7.5cde	1.7bc	2.6ef	4.0b	8.8g
Rubigan 1EC 26 g (3.0 fl oz) + Captan 50W 840 g (1.5 lb)	28.7ab	41.1a	7.2b	24.2b	7.8b	49.9b
Rubigan 1EC 35 g (4.0 fl oz) + Captan 50W 1680 g (3.0 lb).	23.7bc	28.3ab	2.2bc	17.2bc	7.0b	48.7b
Rubigan 1EC 52.5 g (6.0 fl oz) + Captan 50W 1680 g (3.0 lb)	16.3cd	14.0bcd	1.5bc	11.1cd	6.0b	40.3bcd
Rubigan 1EC 52.5 g (6.0 fl oz)2	17.4cd	14.9bc	8.4b	13.1bcd	6.8b	34.0d
No fungicide check	52.9a	41.1a	39.8a	39.3a	25.5a	64.7a

1 Percent leaves that were susceptible during specific scab infection periods. Post-infection applications made on 19 Apr (98 hr PI), infection 1; 19 May (98.5 hr PI), infection 2,3,4; 31 May (98.5 hr PI), infection 5; 10 Jun (85 hr PI), infection 6.

2 Applied as protectant sprays at 8-14 day intervals from open cluster (19 Apr) through 7th cover.

3 Numbers followed by the same letter within columns do not differ significantly, DMRT (P = 0.05).

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APPLE: Malus domestica 'Rome Beauty' 'Golden Delicious' 'Delicious'
Apple scab: Venturia inaequalis
Powdery mildew: Podosphaera leucotricha
Fly speck: Scizothyrium pomi

DISEASE INCIDENCE ON APPLE TREATED WITH SEASONAL DILUTE SPRAYS OF EXPERIMENTAL FUNGICIDES IN 1986: Seasonal fungicide treatments applied as dilute sprays were evaluated under light to moderate disease pressure in a block of semi-dwarf trees. The trees were planted in groups of 3 with one each of 3 cultivars in each tree site and were pruned to a height of 3 m. Experimental plots consisted of the 3 trees/site and were arranged in a randomized complete block design with 5 replicates. Each fungicide or fungicide mixture was suspended in water and applied to the point of run-off at 12 L/tree group (2800 L/ha) with a single nozzle spray gun at 2765 kPa (400 psi). Spray applications were applied at intervals of 9-11 days from the tight-cluster phenological stage through petal-fall and at 13-14 days during the post petal-fall sprays. The spray dates and phenological stages of tree development were as follows: 8 Apr (tight-cluster), 17 Apr (open-cluster), 28 Apr (full-bloom), 8 May (petal-fall), 1st through 7th cover sprays on 21 May, 4, 18 Jun, 1, 15, 30 Jul and 13 Aug, respectively. Insecticides needed for control of insect and mite pests were applied separately with an airblast sprayer at 50 gpa (470 L/ha) operated at 2.5 mph (4.0 km/hr). Natural inoculum of the apple scab pathogen was fairly uniform in the test block while the powdery mildew inoculum level was considered low. Scab and mildew incidence on leaves was recorded by observing all leaves on 10 terminals/single tree replicate on: 26 Jun ('Rome'), 30 Jun ('Delicious'), and 1 Jul ('Golden Delicious'). Percent fruit infected with scab and fly speck and fruit size measurements at harvest was recorded by observing 100 fruits/tree on 17 -18 Sep ('Golden Delicious' and 'Delicious') and 6 Oct ('Rome'). Fruit finish on 'Golden Delicious' was assessed by rating the percent surface affected with russet using the Horsfall-Barratt rating scale of 0-11 then converting to percentages. All data sets obtained were statistically analyzed using the appropriate transformation, standard analysis of variance per randomized block design and the Duncan's Multiple Range Test for mean separation.

Environmental conditions were moderately favorable for scab development with 7 primary apple scab infection periods. Because of low rainfall and above normal temperatures during the pre-bloom period, mildew development was highly favored. Fly speck development occurred late in Aug and Sep and was only moderate in severity. All of the fungicide treatments provided a high level of scab control on both leaves and fruit on the three cultivars. The level of mildew control was more variable. R_o 15-1297 used alone at 1.0 fl oz/100 gal or the combination with Dithane M-45 was as effective for mildew control as the 2.0 oz rate and provided a level of control superior to other treatments. There were only minor differences in mildew control among the treatments where Rubigan, Procure, UBI A-1055, and Nustar were evaluated. Differences among treatments in preventing fly speck development were not significant on 'Golden Delicious' at harvest on 17 Sep and only slight differences were apparent on 'Rome Beauty' at harvest on 6 Oct. Russet incidence on 'Golden Delicious' fruit was slight to moderate with only minor differences among the fungicide treatments. Measurements of 'Golden Delicious' and 'Rome Beauty' fruit showed no significant effect of fungicide treatments on fruit size or shape. There was no evidence of phytotoxicity to leaves or plant growth regulator effects on the trees.

DISEASE INCIDENCE ON APPLES SPRAYED WITH EXPERIMENTAL FUNGICIDES AT APPROXIMATELY 10-14 DAY INTERVALS. OLD 3-C BLOCK, BIGLERVILLE, PA

Fungicide and Amt mg ai/L (Form/100 Gal)	% Disease Incidence: Terminal Leaves: Scab: Del	Terminal Leaves: Scab: Rome	Terminal Leaves: P Mildew: Rome	Fruit: Scab: Rome	Fruit: Fly Speck: Rome	Fruit: Russet: G Del
Nustar 20 DF 6.2 (0.4 oz) + Manzate 200 80W 639 (10.7 oz)[1] DPX 965 50DF 50 (1.3 oz) + Manzate 200 80W 639 (10.7 oz)[2]	1.5bc[4]	0.6c	16.5b	0.2e	1.6def	12.4ab
Nustar 20 DF 8.2 (0.6 oz) + Manzate 200 80W 639 (10.7 oz)[1] DPX 965 50DF 50 (1.3 oz) + Manzate 200 80W 639 (10.7 oz)[2]	1.6bc	0.7c	11.7bcd	0.8e	3.5cde	13.2ab
Nustar 20 DF 12.5 (0.8 oz) + Manzate 200 80W 639 (10.7 oz)[1] DPX 965 50DF 50 (1.3 oz) + Manzate 200 80W 639 (10.7 oz)[2]	2.0bc	1.7c	4.9bcd	0.6e	1.0def	7.1b
UBI A-1055 10EC 75 (2.5 fl oz)[1] Dithane M-45 80W 1440 (1.5 lb)[2]	5.9b	2.3c	9.7bcd	5.1bc	8.4bc	15.4ab
UBI A-1055 10EC 300 (10 fl oz)[1] Dithane M-45 80W 1440 (1.5 lb)[2]	0.5c	0.6c	14.0bc	0.8e	11.8b	22.3a
Procure 50W 75 (2.0 oz) + Dithane M-45 80W 960 (1.0 lb)[1] Dithane M-45 80W 1440 (1.5 lb)[2]	2.5bc	4.7bc	6.8bcd	1.8cde	3.0cde	14.5ab
Procure 50W 112 (3.0 oz) + Dithane M-45 80W 960 (1.0 lb)[1] Dithane M-45 80W 1440 (1.5 lb)[2]	2.2bc	4.5bc	3.1cd	0.0e	1.1def	14.5ab
Rubigan 1EC 9.4 (1.0 fl oz) + Dithane M-45 80W 960 (1.0 lb)[1] Dithane M-45 80W 1440 (1.5 lb)[2]	2.2bc	7.4b	10.9bcd	0.4e	1.5def	7.6b
Ro 15-1297 4E 37 (1.0 fl oz)[1] Dithane M-45 80W 1440 (1.5 lb)[2]	1.8bc	3.1bc	1.6d	5.6b	4.5bcd	9.7b
Ro 15-1297 4E 37 (1.0 fl oz) + Dithane M-45 80W 960 (1.0 lb)[1] Dithane M-45 80W 1440 (1.5 lb)[2]	0.3c	0.9c	0.6d	0.6e	0.4ef	13.0ab
Ro 15-1297 4E 75 (2.0 fl oz)[3]	1.5bc	0.3c	0.2d	3.6bcd	0.0f	13.5ab
No Fungicide Check	28.5a	45.5a	29.6a	51.3a	54.3a	6.3b

1 Used in all sprays from tight-cluster through 3rd Cover
2 Used in all sprays from 4th through 7th Cover
3 Used in all sprays from tight-cluster through 7th Cover
4 Numbers followed by the same letter(s) within columns do not differ significantly, DMRT (P = 0.05).

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APPLE: Malus domestica 'Rome Beauty', 'Golden Delicious', 'Delicious'
Scab: Venturia inaequalis
Powdery mildew: Podosphaera leucotricha
Fly speck: Schizothyrium pomi

EFFICACY OF PROTECTIVE DILUTE FUNGICIDE SPRAYS FOR DISEASE CONTROL IN 1986: The fungicide treatments were evaluated in a mature block of trees on seedling rootstocks, each grafted with 3 cultivars and well pruned to a height of 5-6 m. Treatments were arranged in a randomized complete block designed with 4 single-tree (grafted to each of the 3 cultivars) replicates. Environmental conditions were moderately favorable for disease development with 7 primary apple scab infection periods and moderate rainfall amounts in Aug and Sep. Mildew development was favored by below normal rainfall and above normal temperatures during the pre-bloom period. Dilute fungicide spray applications were thoroughly applied to the point of run-off using 15 L/tree (3000 L/ha) applied with a single nozzle handgun at 2758 kPa (400 psi) on the following dates: 8 Apr (tight-cluster), 18 Apr (open-cluster), 29 Apr (bloom), 12 May (petal-fall), 1st - 7th cover on 23 May, 5, 19 Jun, 1, 16, 31 Jul, and 14 Aug, respectively. Insecticide treatments were applied separately as needed for insect and mite control with a Metters Airblast Sprayer at 50 gpa (470 L/ha) operated at 2.5 mph (4.0 km/hr). Mildew and scab incidence on leaves was obtained by observing all leaves on 10 terminals/tree section containing each of the cultivars. Disease observations were made on leaves on 20-23 Jun ('Rome Beauty'), 23, 25 Jun ('Delicious'), and 24-26 Jun ('Golden Delicious'). The incidence of scab and fly speck on fruit and fruit size measurements at harvest was recorded by observing 100 fruits/cultivar on 26 Sep ('Golden Delicious') and 7 Oct ('Rome Beauty'). Observations on 'Delicious' were not made because of inadequate number of fruit. Fruit finish on 'Golden Delicious' was determined by the Horsfall-Barratt rating scale with units transformed to percent surface affected with russet. All data sets collected were statistically analyzed using the appropriate transformation, standard analysis of variance for randomized block design and the Duncan's Multiple Range Test for mean separation.

Control of scab under moderate disease conditions on leaves and fruit was excellent with most treatments. The Spotless treatments allowed significantly more scab development than other treatments. Systhane, Bayleton, and Spotless treatments provided excellent control of mildew at levels significantly below those with Topsin M and Benlate when used at 2.0 oz/100 gal. Very good control of fly speck on 'Rome Beauty' fruit was obtained with Systhane, Dithane M-45, and combinations of Topsin M plus Penncozeb or Benlate plus Manzate 200. The interval between the last application and observation date was 54 days. Spotless failed to control fly speck during this long interval. Captec provided better control and was more effective at the 32.0 fl oz rate than the 24.0 fl oz rate/100 gal. There were no differences among treatments in fruit diameter or length measurements on 'Rome Beauty' and 'Golden Delicious' fruit. Fruit russet on 'Golden Delicious' was relatively low and no differences among treatments were evident. No phytotoxicity to leaves or plant growth regulator effects were observed during the growing season.

DISEASE INCIDENCE ON APPLE SPRAYED DILUTE WITH EXPERIMENT FUNGICIDES APPLIED AT 10-15 DAY INTERVALS IN 1986. GRAFTED BLOCK, BIGLERVILLE, PA.

Fungicide and Amt mg ai/L (Form/100 Gal)	Percent Disease on Terminal Leaves: Scab Del	Terminal Leaves: Scab Rome	Terminal Leaves: P Mildew G Del	Terminal Leaves: P Mildew Rome	Fruit: Scab Rome	Fruit: Fly Speck Rome
Systhane 40W 75 (2.5 oz)[1] Dithane M-45 80W 1440 (1.5 lb)[2] ..	0.2c[3]	0.2c	1.2c	1.4c	0.8c	3.0e
Systhane 40W 75 (2.5 oz) (TC-7th C) Dithane M-45 80W 1440 (1.5 lb)[2] ..	0.6c	0.4c	1.3c	1.2c	1.3c	5.5de
Systhane 40W 60 (2.0 oz) + Dithane M-45 80W 1440 (1.5 lb) ...	0.1c	0.0c	1.9b	1.4c	0.3c	0.3e
Bayleton 50W 37.4 (1.0 oz) + Dithane M-45 80W 1917 (2.0 lb)[1] Dithane M-45 80W 1917 (2.0 lb)[2] ...	0.9c	0.5c	1.6c	5.8c	0.5c	2.8e
Spotless 25W (XE-779) 10 (0.5 oz) ..	8.3b	11.0b	1.4c	9.1c	14.0b	25.0bc
Spotless 25W (XE-779) 15 (0.8 oz) ..	6.5bc	3.3c	2.1c	5.2c	15.1b	34.8b
Spotless 25W (XE-779) 20 (1.1 oz) ..	4.5bc	4.3bc	1.7c	6.3c	8.0bc	25.0bc
Spotless 25W 20 (1.1 oz)[1] Spotless 25W (XE-779) 15 (0.8 oz) + Captan 50W 600 (1.0 lb)[2]	6.0bc	0.9c	1.4c	3.1c	2.8c	23.8bcd
Captec 4L 900 (24 fl oz)...........	0.3c	0.6c	31.2a	46.7ab	0.3c	15.5cde
Captec 4L 1200 (32 fl oz)..........	0.7c	0.6c	20.5b	48.1a	0.3c	8.3cde
Captan 50W 1200 (2.0 lb) + Bayleton 50W 37.4 (1.0 oz)[1] Captan 50W 1200 (2.0 lb)[2]	0.3c	1.8c	0.7c	3.9c	0.3c	12.5cde
Topsin M 70W 105 (2.0 oz) + Penncozeb 80W 959 (1.0 lb).........	1.0c	1.9c	22.4b	33.6b	0.3c	2.3e
Benlate 50W 75 (2.0 oz) + Manzate 200 80W 959 (1.0 lb).......	2.5bc	0.3c	18.0b	39.0ab	0.3c	1.5e
Nontreated	46.6a	46.0a	36.4a	50.5a	53.6a	52.1a

[1] Applied only in the tight-cluster, open cluster, bloom, petal-fall, and first cover sprays.

[2] Dithane M-45 80W 1440 (1.5 lb) applied in 2nd-7th cover sprays.

[3] Numbers followed by the same letter(s) within columns do not differ significantly, DMRT (P = 0.05).

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APPLE: Malus domestica 'Rome Beauty', 'Golden Delicious', 'Delicious'
Scab: Venturia inaequalis
Powdery mildew: Podosphaera leucotricha

EVALUATION OF FUNGICIDE SPRAYS APPLIED DILUTE AND TIMED FOR POST-INFECTION CONTROL OF SCAB OR AS PROTECTANTS FOR SCAB AND P. MILDEW IN 1986: The efficacy of a new sterol-inhibiting fungicide (EBI) was evaluated for post-infection control of scab and protection against scab and powdery mildew when used in dilute sprays. The treatments were evaluated in a block of 11 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 pruned at a height of 3 m and yielded about 250 fruits/tree. Inoculum level for scab was low but moderate for powdery mildew. The fungicide treatments were applied dilute to the point of run-off at 10 L/tree (2475 L/ha) with a single nozzle spray gun at 2758 kPa (400 psi). The experimental fungicide FBC 39865 was evaluated at 3 rates and compared with Polyram at 2.0 lb/100 gal in protective sprays applied as follows: 14 Apr (tight-cluster), 21 Apr (open-cluster), 28 Apr (full-bloom), 12 May (petal-fall), 1st - 7th covers on 19 May, 2, 16, 30 Jun, 15, 28 Jul, and 11 Aug, respectively. Two treatments, FBC 39865 8.0 oz/100 gal and Funginex 10.0 fl oz/100 gal, were compared when used in post-infection sprays for apple scab control as follows: 19 Apr (98 hr), 19 May (96 hr), 30 May (72 hr), and 10 Jun (84 hr). Both protective and post-infection treatments were arranged in a randomized complete block design with 5 replicates. Control of insects and mites were controlled with routine insecticide sprays applied separately with a conventional airblast sprayer at 50 gal/A (470 L/ha). Scab and mildew incidence on leaves was determined by observing all leaves on 10 terminal shoots/tree of each cultivar on 17 Jun. Disease incidence on fruit and fruit size measurements at harvest were recorded by observing up to 100 fruits/tree (ranges from 30-100) on 26 Sep ('Golden Delicious') and 8 Oct ('Rome Beauty'). Fruit finish on 'Golden Delicious' was determined by the Horsfall-Barratt rating scale with units transformed to percent surface affected with russet. All data sets collected were statistically analyzed using the appropriate transformations, standard analysis of variance for randomized block design and the Duncan's Multiple Range Test for mean separation.

Scab incidence was light to moderate due to low rainfall during the pre-bloom period. There were 7 primary apple scab infection periods between 19 Apr and 10 Jun resulting in 31% of leaves infected and 57% fruit infection on untreated 'Rome Beauty' trees. FBC 39865 provided near perfect control of scab and mildew when used at the 4.0, 8.0, and 16.0 oz/100 gal in both protective and post-infection schedules. Funginex provided very good control of scab in the post-infection sprays allowing 1.4% fruit infection on 'Golden Delicious' and 14% on 'Rome Beauty'. There was only slight evidence of the development of sooty blotch and fly speck in this orchard. There was no significant difference among treatments in fruit diameter and length measurements on both 'Rome Beauty' and 'Golden Delicious' fruit. Fruit russet on 'Golden Delicious' was very low with no apparent differences among treatments. No phytotoxicity to leaves or plant growth regulator effects were observed on treated trees.

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INCIDENCE OF SCAB AND POWDERY MILDEW ON APPLE TREATED WITH FUNGICIDES APPLIED DILUTE AND TIMES AS PROTECTIVE OR SCAB POST-INFECTION SPRAYS IN 1986.

Fungicide and Amt mg ai/L (Form/100 gal)	% Disease Incidence				
	Terminal Leaves			Fruit	
	Scab		P Mildew	Scab	
	Del	Rome	Rome	G Del	Rome
Protective[1]					
FBC 39865 25W 75 (4.0 oz)	0.0d[2]	0.0d	0.4d	0.0b	0.0b
FBC 39865 25W 150 (8.0 oz).....	0.2d	0.2d	0.2d	0.0b	0.0b
FBC 39865 25W 300 (16.0 oz)....	0.0d	0.0d	0.2d	0.0b	0.0b
Polyram 80W 1920 (2.0 lb)......	0.0d	0.3d	15.9d	0.0b	2.0b
72-98 hr Post-Infection					
FBC 39865 25W 150 (8.0 oz)[3] Polyram 80W 1440 (1.5 lb)[4].....	0.0d	0.0d	4.2d	0.0b	0.0b
Funginex 1.6EC 150 (10 fl oz)[3] Polyram 80W 1440 (1.5 lb)[4].....	2.1c	0.9c	17.8c	1.4b	13.6b
No Fungicide Check	23.7a	30.7a	50.1a	24.6a	57.0a

1 Applied at approximately 7-14 day intervals from 14 Apr (tight cluster - 7th Cover as dilute sprays at 10 L/tree (2475 L/ha).

2 Numbers followed by the same letter within columns do not differ significantly, DMRT (P = 0.05).

3 Applied on 19 Apr (98 hr PI) 19 May (96 hr PI), 30 May (72 hr PI), and 10 Jun (84 hr PI).

4 Polyram 80W 1440 (1.5 lb) applied at 14-day intervals from 2nd C through 7th C.

** Not for Publication **

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Not for Publication

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PEACH: Prunus persica 'Redhaven'
Brown rot: Monilinia fructicola
Rhizopus rot: Rhizopus sp.

EVALUATION OF FUNGICIDES FOR CONTROL OF BROWN ROT AND RHIZOPUS ROT CONTROL ON PEACH IN 1986: Fungicide spray treatments were applied in a test orchard of 7 year old 'Redhaven' and 'Rio Oso Gem' trees planted in pairs 3.5 m apart in rows 9 m wide. Each fungicide plot consisted of 1 set of paired trees and was arranged in a randomized block design with 4 replicates. The 'Redhaven' tree in each pair was treated with dilute sprays applied to the point of run-off at 8 L/tree (1375 L/ha) with a single nozzle spray gun at 2758 kPa (400 psi). The trees were well pruned to a height of 2 m and thoroughly sprayed on the following dates and phenological stages: 12 Apr (pink), 21 Apr (bloom), 6 May (petal-fall), 15 Jul (21 da PHI (pre-harvest interval), 25 Jul (10 da PHI), and 31 Jul (0 PHI). Fruit decay caused by brown rot and Rhizopus was determined by observing 20 fruits/replicate collected from 4 replicated trees 1 hr after final fungicide spray was applied on 31 Jul (Test #1) and 5 da later (Test #2 & #3). Fruits were inoculated with Monilinia fructicola (90,000 conidia/ml, Test #1 and 200,000 conidia/ml, Test #2) and incubated at 29 - 32° C and 90 - 100% R. H. under polyethylene tarp for 14 da (Test #1) and 8 da (Test #2 and #3). Fruits observed in Test #3 were not inoculated and infections caused by Rhizopus were from natural inoculations occurring in the field before harvest. The data sets obtained were statistically analyzed using appropriate transformations, analysis of variance and the Duncan's Multiple Range Test for mean separation.

The conditions under which these tests were conducted were highly favorable for disease development on fruit. Fruits used for testing were uniformly tree-ripe but not soft and showed only 41% and 44% brown rot infection on the no fungicide check treatment in Test #1 and #2, respectively. The level of Rhizopus decay was very low on the untreated check and significantly higher on fungicide treated fruit. None of the fungicide treatments appeared to be effective against Rhizopus. Only slight effects of fungicide treatment against brown rot was evident in most treatments on fruits inoculated. On the uninoculated fruit significant control of brown rot was obtained with Procure, RH-7592, Tilt, and Bay HWG 1608. In this test there was no evidence of phytotoxicity to leaves or fruit caused by fungicide treatments.

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INCIDENCE OF FRUIT DECAY CAUSED BY BROWN ROT AND RHIZOPUS ROT ON 'REDHAVEN' PEACH SPRAYED SEASONALLY WITH FUNGICIDES IN 1986.

	% Rhizopus*			% Brown Rot Inoculated		% Brown Rot Uninocul
Fungicide and Amt mg ai/L (Form/100 Gal)	Test 1	Test 2	Test 3	Test 1	Test 2	Test 3
Procure 50W 150 (4.0 oz)	16.3ab**	26.3ab	23.8ab	33.8abc	37.5ab	17.5ab
Procure 50W 300 (8.0 oz)	15.0ab	11.3b	12.5ab	23.8abc	23.8b	11.3b
RH-7592 0.5EC 37.5 (8.0 fl oz)	10.0ab	11.3b	12.5ab	20.0abc	17.5b	5.0b
RH-7592 0.5EC 75 (16.0 fl oz)	17.5ab	45.0a	25.0ab	22.5abc	23.8b	10.0b
Systhane 40W 75 (2.5 oz)	10.0ab	13.8b	13.8ab	37.5abc	33.8ab	13.8ab
Systhane 40W 150 (5.0 oz).	12.5ab	23.8ab	32.5a	37.5abc	33.8ab	12.5ab
Tilt 3.6EC 23 (0.7 fl oz).	13.8ab	12.5b	7.5ab	27.5abc	33.8ab	12.5ab
Tilt 3.6EC 46 (1.4 fl oz).	11.3ab	7.5b	8.8ab	13.8c	39.9ab	10.0b
Tilt 3.6EC 23 (0.7 fl oz) + CGA-449 50W 75 (2.0 oz)	22.5a	16.3b	27.5ab	40.0ab	25.0b	13.8ab
Baycor 50WP 150 (4.0 oz)	12.5ab	17.5b	31.3a	37.5abc	52.5a	17.5ab
Bay HWG 1608 22.5DF 90 (5.3 oz).	17.5ab	18.8b	23.8ab	17.5bc	22.5b	10.0b
Funginex 1.6EC 240 (16.0 fl oz).	22.5ab	12.5b	22.5ab	27.5abc	22.5b	12.5ab
No Fungicide Check	2.5b	6.3b	3.8b	43.8a	41.3ab	30.0a

* <u>Rhizopus rot</u> observed on same fruit as in brown rot tests. No inoculum was added.

** Numbers followed by the same letter within columns do not differ significantly, DMRT (P = 0.05).

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PEACH (Prunus persica 'Rio Oso Gem')
Rusty spot; Podosphaera leucotricha

EVALUATION OF FUNGICIDES FOR CONTROL OF RUSTY SPOT ON PEACH IN 1986: Seven sterol-inhibiting (EBI) fungicides were evaluated for efficacy of the rusty spot disease when used in dilute sprays timed for control of early season brown rot (3 applications at low rates -- 6 applications at high rates) directed toward control of rusty spot. The test was conducted in a well pruned block of seven-year-old 'Redhaven' and 'Rio Oso Gem' trees planted in pairs 3.5 m apart in rows 9 m wide. Each fungicide plot consisted of one set of paired trees and was arranged in a randomized block design with 4 replicates. The 'Rio Oso Gem' tree in each pair was selected because of its susceptibility to rusty spot for this evaluation. The fungicides were applied as dilute sprays to the point of run-off at 8 L/tree (1375 L/ha) with a single nozzle spray gun at 2758 kPa (400 psi). The specific application timing for each treatment is given in the table and was applied on the following dates and phenological stages: 12 Apr (pink), 21 Apr (bloom), 6 May (petal-fall), 16 May (shuck-fall), 27 May (1st C), and 10 Jun (2nd C). Bayleton 50W 2 oz/100 gal was substituted for the Funginex treatment in the shuck-fall, 1st C, and 2nd C sprays. The test block was bordered at one end by a block of mature 'Rome Beauty' apple trees with a moderate level of overwintering powdery mildew infections presumed to be the inoculum source for the rusty spot disease on peach. Incidence and severity of rusty spot on fruit were obtained by observing 100 fruits/tree on each of the 4 replicates. A percentage of fruit showing diease, as well as the number of lesions per infected fruit, was recorded on 18 Jun. The data obtained were statistically analyzed using analysis of variance and the Duncan's Multiple Range Test for mean separation.

Rusty spot incidence on nontreated fruit was 95% with a mean of 4.5 lesions/infected fruit. The fungicides applied in only 3 applications had no significant effect on rusty spot control. All fungicides applied in 6 applications significantly reduced rusty spot incidence compared with the nontreated check. Systhane 5 oz/100 gal allowed only 10% of fruit infected with a mean of 0.1 lesions/fruit. Level of control among other treatments was not significantly different. The effect of fungicide rate and number of applications could not be determined with certainty because the rate used in treatments receiving 3 applications was one-half that of treatments receiving 6 sprays. None of the treatments were phytotoxic to leaves or fruit or showed signs of plant growth regulator effects.

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INCIDENCE OF RUSTY SPOT ON PEACH SPRAYED WITH FUNGICIDE TREATMENTS IN 1986.

Fungicide and Amt mg ai/L (Form/100 Gal)	Application Timing	Rusty Spot Incidence %	# Lesions/Fruit
Procure 50W 150 (4.0 oz)	Pink, bloom, petal-fall	87.3a*	3.0bc
Procure 50W 300 (8.0 oz)	Pink-2nd C (6 appl.)	49.3c	1.0d
RH-7592 0.5EC 37.5 (8.0 fl oz) . .	Pink, bloom, petal-fall	92.3a	3.9ab
RH-7592 0.5EC 75 (16.0 fl oz) . .	Pink-2nd C. (6 appl.)	56.0bc	1.2d
Systhane 40W 75 (2.5 oz)	Pink, bloom, petal-fall	85.3a	2.6c
Systhane 40W 150 (5.0 oz)	Pink-2nd C. (6 appl.)	9.8d	0.1d
Tilt 3.6EC 23 (0.7 fl oz)	Pink, bloom, petal-fall	95.0a	3.9ab
Tilt 3.6EC 46 (1.4 fl oz).	Pink-2nd C. (6 appl.)	58.7bc	1.3d
Tilt 3.6EC 23 (0.7 fl oz) + CGA-449 50W 75 (2.0 oz)	Pink, bloom, petal-fall	92.7a	3.5abc
Baycor 50WP 150 (4.0 oz)	Pink, bloom, petal-fall	92.8a	3.1bc
Bay HWG 1608 22.5DF 90 (5.3 oz). .	Pink-2nd C. (6 appl.)	67.0b	1.3d
Funginex 1.6EC 240 (16.0 fl oz)**.	Pink-2nd C. (3 appl.)	55.5bc	1.1d
No Fungicide Check	Untreated	94.5a	4.5a

* Numbers followed by the same letter within columns do not differ significantly, DMRT (P = 0.05).
** Treated with Bayleton 50W 75 (2.0 oz) in shuck-fall, 1st C and 2nd C sprays.

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PEACH: (Prunus persica , 'Rio Oso Gem')
Brown rot; Monilinia fructicola
Rhizopus rot; Rhizopus sp.

CONTROL OF BROWN ROT AND RHIZOPUS ROT ON PEACH WITH SEASONAL FUNGICIDE TREATMENTS IN 1986: Eight fungicides were evaluated for control of fruit decay on peach when used in seasonal dilute sprays. The test orchard was a mature block of well pruned seven-year-old 'Redhaven' and 'Rio Oso Gem' trees planted in pairs 3.5 m apart and in rows 9 m wide. Each fungicide plot consisted of one set of paired trees and was arranged in a randomized block design with 4 replicates. The 'Rio Oso Gem' tree in each of the pairs was treated with 9 fungicide applications from pink through harvest. The treatments were applied to the point of run-off at 8 L/tree set (1375 L/ha) with a single nozzle spray gun at 2785 kPa (400 psi). Application dates and phenological stages were as follows: 12 Apr (pink), 21 Apr (bloom), 6 May (petal-fall), 16 May (shuck-fall), 27 May (1st C), 10 Jun (2nd C), 15 Jul (21 da PHI, pre-harvest interval), 25 Jul (10 da PHI), 31 Jul (0 da PHI). Insecticides needed for insect control were applied separately with an airblast sprayer at 50 gal/A (470 L/ha). Because of low rainfall during the pre-bloom and blossoming periods no brown rot blossom blight occurred naturally. Brown rot inoculum was added to the test block by placing 5 infected fruit showing spore masses in polyethylene mesh bags 3 weeks before harvest.The data on fruit decay was obtained by observing fruit inoculated and uninoculated with the brown rot fungus. Two 20-fruit samples were taken from each replicated tree and observed after 5 and 10 days of incubation. Fruits were harvested the day of last application, and those inoculated were atomized with a suspension of M . fructicola (125,000 conidia/ml), incubated under clear polyethylene tarp at 100% RH and 70 °F before observations were made. The data obtained were statistically analyzed using appropriate transformations, analysis of variance and the Duncan's Multiple Range Test for mean separation.

Observations on fruits incubated for 5 da after inoculation showed 41% infected with brown rot while those uninoculated showed only 5%. Rhizopus incidence on uninoculated fruit was only 6%. The fungicide treatments were ineffective against Rhizopus fruit decay. Most of the fungicide treatments provided significant control of brown rot for 5 da after inoculation but failed to prevent decay from developing on the softer fruit during the 10 da incubation period.

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INCIDENCE OF FRUIT DECAY CAUSED BY BROWN ROT AND RHIZOPUS ROT ON 'RIO-OSO-GEM' PEACH SPRAYED SEASONALLY WITH FUNGICIDES IN 1986.

Fungicide and Amt mg ai/L (Form/100 Gal)	Percent Fruit Decay: 5-Day Incubation, Brown rot, Inoc [1]	5-Day Incubation, Brown rot, Uninoc	5-Day Incubation, Rhizopus, Uninoc	10-Day Incubation, Brown rot, Inoc [1]	10-Day Incubation, Brown rot, Uninoc	10-Day Incubation, Rhizopus, Uninoc
Procure 50W 150 (4.0 oz)	18.6ab[2]	3.8a	11.3a	48.8bc	37.5bc	21.3a
Procure 50W 300 (8.0 oz)	12.5b	1.3a	15.0a	37.5bc	27.5bc	18.8a
RH-7592 0.5EC 37.5 (8.0 fl oz)	7.5b	3.8a	18.8a	37.5bc	33.8bc	17.5a
RH-7592 0.5EC 75 (16.0 fl oz).	10.0b	2.5a	12.5a	27.5c	21.3c	23.8a
Systhane 40W 75 (2.5 oz)	13.8b	2.5a	8.8a	41.3bc	28.8bc	20.0a
Systhane 40W 150 (5.0 oz)	20.0b	5.0a	15.0a	43.8bc	45.0b	15.0a
Tilt 3.6EC 23 (0.7 fl oz).	18.8ab	2.5a	5.0a	47.5bc	25.0bc	16.3a
Tilt 3.6EC 46 (1.4 fl oz).	12.5b	0.0a	21.3a	31.3bc	25.0bc	11.3a
Tilt 3.6EC 23 (0.7 fl oz) + CGA-449 50W 75 (2.0 oz)	16.3ab	3.8a	5.0a	55.0b	36.3bc	16.3a
Baycor 50WP 150 (4.0 oz)	16.3ab	3.8a	15.0a	52.5b	36.3bc	13.8a
Bay HWG 1608 22.5DF 90 (5.3 oz). . . .	11.3b	2.5a	7.5a	27.5c	32.5bc	17.5a
Funginex 1.6EC 240 (16.0 fl oz)[3] . . .	8.8b	2.5a	15.0a	27.5c	16.3c	20.0a
No Fungicide Check	41.3a	5.0a	6.3a	80.0a	80.0a	13.8a

1 Inoculated at harvest (0-day PHI) with conidia of M. fructicola (2 x 10^4/ml).
2 Numbers followed by the same letter within columns do not differ significantly, DMRT (P = 0.05).
3 Bayleton 50W 75 (2.0 oz) applied in shuck-fall, 1st C and 2nd C sprays.

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CHERRY (RED TART): Prunus cerasus 'Montmorency'
Brown rot: Monilinia fructicola
Cherry leaf spot: Coccomyces hiemalis

EVALUATION OF FUNGICIDES FOR EFFECTS ON FRUIT QUALITY AND DISEASE CONTROL IN 1986: The experiment was conducted in a block of 7 year-old trees planted 9 X 9 m and pruned to a height of 3 m. Treatment plots consisted of a single tree and were arranged in a randomized block design with 5 replicates. The fungicide treatments were applied in dilute sprays with a single nozzle spray gun at 2758 kPa (400 psi) to the point of run-off using 10 L/tree (2475 L/ha). Each application was thoroughly applied on the following dates and phenological bud stages: 15 Apr (first-white), 22 Apr (bloom), 5 May (shuck-fall), 19 May (1st cover), 2 Jun (2nd cover), 16 Jun (3rd cover), 3 Jul (5 da PHI (pre-harvest interval), and 8 Jul (0 PHI). Insecticides were used as necessary for control of insects and were applied separately with a conventional airblast orchard sprayer at 50 gal/A (470 L/ha). Brown rot blossom blight results were based on observations of 20 blossoms/replicate tree collected from 10 blossoming shoots on each tree, inoculated with Monilinia fructicola (20,000 conidia/ml) and incubated at 24° C for 5 da in water-agar petri dish moist chambers. Blossom blight incidence and a severity rating based on area of blossoms affected were made. The rating scale was as follows: 1 = anthers showing fungus growth; 2 = anthers, stigma and filaments showing fungus growth; 3 = blighting of most floral parts; 4 = 75% of all floral parts showing blighting; 5 = complete blighting and mycelial growth on all floral parts. Percent fruit infected with brown rot was determined after harvest on a 100 fruit sample taken at random from each replicated tree. Fruits were harvested on the day of the last application, placed in trays, sprayed with a conidial suspension of Monilinia fructicola (90,000 conidia/ml) and incubated at 29 - 32° C and 90 - 100% R. H. under polyethylene tarp for 3 da. The number of fruits/km sample collected at random from each tree was determined. The percent soluble solids in fruit samples from each tree was determined on 8 Jul with a Bausch and Lomb ABBE-3L refractometer on a composite fruit juice sample from approximately 50 fruits/tree. Cherry leaf spot incidence on leaves was determined by observing all leaves on each of 10 terminal shoots/tree collected on 7, 25 Jul and 19 Aug. The same terminal was used for each observation. The data obtained were statistically analyzed using the appropriate transformations, analysis of variance and the Duncan's Multiple Range Test for mean separation.

Blossom blight incidence was 29% on the non-treated check trees and appeared to be a mixture of infections caused by the brown rot and Botrytis rot pathogens. Blossom blight incidence on the fungicide treated trees ranged from 7 - 13% and did not vary significantly among treatments. Brown rot incidence on untreated fruit was 41% and ranged from 0 - 12 % on treated trees. All treatments provided significantly better control of brown rot on fruit than the Folpet/Benlate standard but differences were not significant among most treatments. Leaf spot infections were 50% on the untreated trees at harvest on 7 Jul and increased to 92% by 19 Aug. All fungicide treatments provided very good control of leaf spot and were significantly better than the Folpet/Benlate standard treatment. Fruit size and soluble solids content were not affected significantly by fungicide treatment.

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BROWN ROT AND CHERRY LEAF SPOT INCIDENCE ON 'MONTMORENCY' TREES SPRAYED DILUTE WITH SEASONAL FUNGICIDE TREATMENTS IN 1986.

Fungicide and Amt mg ai/L (Form/100 Gal)	# Fruits/ kilograms	% Brown Rot		Percent Leaf Spot		
		Blossom	Fruit	7 Jul	25 Jul	19 Aug
Ro 15-1297 ACR 3567A 4E 37.5 (1.0 fl oz) + Captan 50W 600 (1.0 lb)..................	273a	7.0cd	8.8c	1.1b	3.4b	10.6bc
Ro 15-1297 ACR 3567A 4E 75 (2.0 fl oz) + Captan 50W 600 (1.0 lb)..................	257a	6.0d	2.4c	1.9b	3.0b	6.7bc
Ro 15-1297 ACR 3567A 4E 75 (2.0 fl oz)......	257ab	13.4b	4.4bc	1.2b	3.5b	8.5bc
RH-7592 0.5EC 37.5 (8.0 fl oz)	259ab	10.2bcd	1.4c	1.1b	2.7b	4.5c
RH-7592 0.5EC 75 (16.0 fl oz)	271a	13.4b	0.4c	1.0b	2.3b	4.2c
BAY HWG 1608 22.5 DF 89 (5.3 oz)	231b	12.6bc	0.0c	1.5b	3.5b	4.7c
Folpet 50W 900 (1.5 lb) (WB-3rd C)** Benlate 50W 225 (6.0 oz) + Captan 50W 900 (1.5 lb (5 & 0 da PHI)***..	266a	10.2bcd	12.4b	1.7b	3.4b	20.7b
No Fungicide Check	276a	29.1a	40.6a	50.3a	67.9a	92.0a

* Numbers followed by the same letter(s) within columns do not differ significantly, DMRT (P = 0.05).

** Applied from white bud (WB) stage through 3rd Cover spray.

*** Applied 5 and 0 days before harvest (PHI).

** Not for Publication **

Peach Nematode Survey Results from West Virginia

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Although nematode samples have been collected from individual peach orchards in West Virginia for many years, comprehensive surveys have not been conducted. Published data on nematode abundance and frequency are fragmentary. Yield loss assessments and/or predictions on a regional basis are, therefore, difficult and unreliable. The objectives of this study were to 1) to assess the frequency of occurrence and the abundance of plant-parasitic nematodes and 2) to assess correlations among cultural factors, plant-parasitic nematodes, and peach tree mortality in peach orchards in West Virginia. Preliminary results are reported, herein.

Materials and Methods: Between March 25 and May 5, 1986, 205 soil and root samples were collected from commercial peach orchards in Jefferson, Berkeley, and Hampshire counties. Each sample was a composite of 10-20 cores (2.5 by 15 cm) from a single-variety-block, usually representing 4 acres or less. Data on variety, rootstock, orchard age, herbicide and nematicide usage, and acreage were obtained from interviews with growers and was, therefore, often incomplete. Soil type was determined from survey maps. Tree mortality was determined from counts of declining, dead, and replanted trees in each plot.

Nematode population data were determined by extracting from 100 cm^3 soil using centrifugal-flotation. Root population density of *Pratylenchus* spp. was determined by incubating fibrous roots, up to 1.0 g fresh weight, in tap water for 5 days using a rotary shaker. Nematode genera were counted using a stereomicroscope. Nematodes in representative samples from each grower were identified to species.

Results: Plant parasitic nematodes were observed in 204 of 205 samples. Spores of vesicular-arbuscular mycorrhizae were always present and predaceous nematodes (Mononchidae) were observed in 71% of samples. Population densities of *Pratylenchus* spp. from roots were generally lower than from soil and were not evaluated further.

Nematodes from 75 samples were identified to species (Table 1). Twenty six species of plant parasites have been tentatively identified and several Criconematid species have been distinguished but not yet identified. Several unidentified species of predaceous nematodes in the family Mononchidae were also observed.

Nematode damage thresholds from apples in Michigan were used to evaluate the potential for yield losses in West Virginia peach orchards. (Table 2). Assuming these thresholds, 100, 1000, 10, 10, 15, and 1 nematode(s) per 100 cm^3 soil for *Criconemella*, *Helicotylenchus*, *Hoplolaimus*, *Meloidogyne*, *Pratylenchus*, and *Xiphinema*, respectively, are valid for peaches, damaging nematode population densities were found in 78% of the orchard blocks sampled. Many orchard blocks (35%) were found with two or more nematode problems.

Interpretation of correlation coefficients among nematode population densities and various cultural factors is a difficult task (Table 3). For example, the peach tree mortality rate declined with orchard age, increased with nematicide application, was greater in plots with high population densities of *Pratylenchus*, but was negatively correlated with Helicotylenchus population density. The influence of orchard age and number of nematicide applications varied substantially among nematode genera. Also, numerous correlations among nematode population densities suggest that interactions may be occurring to influence the long term population dynamics of the community.

Discussion:

This study has demonstrated the presence of a diverse community of plant-parasitic nematodes in West Virginia peach orchards. Many blocks contain population densities exceeding damage thresholds, indicating nematode control tactics are needed. Fewer than one half of the blocks sampled were treated with a nematicide during the last three years. Annual nematicide applications may be needed to provide nematode control; however, economic and environmental forces may dissuade many growers from such frequent applications.

Infestations of Xiphinema spp. are clearly the most important nematode problem identified. This is primarily because of the nematode's role as a virus vector. Infestations of Pratylenchus spp., Meliodogyne spp., and Hoplolaimus spp. are also common nematode problems and should not be overlooked. Damage thresholds should be re-evaluated for each nematode species to assess whether they reflect the potential for damage to peach orchards.

Table 1. Relative frequency of 26 species of plant parasitic nematodes identified in 75 samples from peach orchards in West Virginia.

Nematode species	Relative Frequency %
Helicotylenchus digonicus	15[a]
H. dihystera	41
H. platyurus	35
H. pseudorobustus	21
Hemicycliophora vidua	3
H. vivida	3
Hoplolaimus galeatus	16 (29)[b]
Meloidogyne hapla	5 (31)[b]
Paratylenchus ciccaronei	5
P. hamatus ?[c]	3
P. nannus	37
P. projectus	5
P. tenuicandatus ?[c]	1
Pratylenchus crenatus	39
P. neglectus	15
P. penetrans	31
P. pratensis ?[c]	3
P. scribneri	3
P. thornei	9
P. vulnus ?[c]	1
Quinisulcius capitatus	1
Rotylenchus buxophilus	1
Tylenchorhynchus pachys ?[c]	1
Xiphinema americanum	59
X. californicum	1
X. rivesi	52

a. Percent of 75 samples in which the species is present.
Sums of relative frequencies within genera may exceed 100% because samples with mixed populations are counted more than once.

b. Estimate based on frequency of genus and assuming only one species is present

c. Identification not yet confirmed.

Table 2. Frequency and density of nematode populations in peach orchards in West Virginia.

Nematode	Mean Density [a]	Relative Frequency of occurrence (%) [b]	Threshold (%) [c]
Xiphinema	8.0	74	74
Pratylenchus	8.4	77	19
Meloidogyne	7.5	31	13
Hoplolaimus	3.1	29	10
Criconematids	6.9	30	2
Helicotylenchus	75.7	84	1
Paratylenchus	44.9	85	_[d]
Hemicychliophora	0.9	6	_[d]
Mononchids	3.5	71	_[d]

a. Number of nematodes per 100 cm^3 soil.
b. Percent of samples in which the genus was found.
c. Percent of samples with population density exceeding the damage threshold.
d. No damage threshold reported, assumed to be nonpathogenic.

Table 3. Significant (P=0.05) correlation coefficients among nematode population densities and cultural factors.

	orchard age	# nematicide applications	tree mortality rate	Meloidogyne
orchard age	1.00			
# nematicide applications	-	1.00		
Tree mortality rate	-.21	.24	1.00	
Meloidogyne	-	-	-	1.00
Pratylenchus	-.16	-.17	.15	-
Helicotylenchus	.20	-	-.18	.16
Xiphinema	.29	-	-	-
Criconematids	.30	-	-	-
Hoplolaimus	-	-	-	-
Paratylenchus	-.21	.33	-	-
Mononchids	.23	-.20	-	.26
Hemicycliophora	.36	.22	-	-
V-A mycorrhizae	.29	-	-	-

	Pratylenchus	Helicotylenchus	Xiphinema	Criconematids	Hoplolaimus
Pratylenchus	1.00				
Helicotylenchus	-	1.00			
Xiphinema	-	-	1.00		
Criconematids	-	-	.29	1.00	
Hoplolaimus	.35	-	-	.15	1.00
Paratylenchus	-	-	-	-	
Mononchids	-	-	.43	-	-.15
Hemicycliophora	-	.19	-	-	-
V-A mycorrhizae	-	-	-	-	-

	Paratylenchus	Mononchids	Hemicycliophora	V-A Mycorrhizae
Paratylenchus	1.00			
Mononchids	-	1.00		
Hemicycliophora	-	-	1.00	
V-A mycorrhizae	-.19	-	-	1.00

Title: Sooty Blotch and Flyspeck Control with Combinations of Fungicides, 1986

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This experiment was conducted at the Central Crops Research Station, Clayton, NC (CC) and the Sandhills Research Station, Jackson Springs, NC (SS). At CC, treatments were applied dilute at 112 gpa and 180 psi with an airblast sprayer to two five-tree replicates of 6-yr-old trees. The second and fourth trees within each five-tree replicate were selected for data collection. Fungicides were applied on 29 Apr (1st cover), 13 and 27 May, 10 and 24 Jun, 8 and 22 Jul, and 5 and 21 Aug. At SS, treatments were applied dilute at 196 gpa and 150 psi with an airblast sprayer to blocks of 4 to 10 trees each. Four trees were chosen at random for data collection. Funginex 1.6 EC at 10 oz/100 gal was applied to all treatments 21 Apr for scab and cedar apple rust control. Fungicides were applied on 7 and 21 May, 4, 16, and 26 Jun, 9 and 22 Jul, and 6 and 21 Aug. At harvest at each location 25 fruit were chosen at random for each replicate and scored for sooty blotch and flyspeck incidence and the percent surface area covered was estimated on affected fruit. Fruit finish was determined at CC by rating fruit on a scale of 0 to 10, where 0=smooth fruit, no russet and 10=fruit rough, 100% covered with russet. Harvest at CC was on 12 Sep; harvest at SS was on 11 Sep.

The 1986 growing season at each location was characterized by unusually hot dry weather in May-Jul. Rainfall amounts for May-Aug for CC were 1.33, 1.48, 2.42, 10.49 in, respectively. Amounts for May-Aug for SS were 2.79, 1.32, 1.93, and 11.26 in, respectively. Sooty blotch and flyspeck did not develop in the control until Aug and overall disease development was light.

All treatments provided superior sooty blotch and flyspeck control compared to the Captan 50W 2 lb standard. Disease control with the Captan + Polyram combination was generally poorer than the other combinations. Disease control with the Dithane M45 + Benlate combinations were slightly better than Captan + Benlate combinations, although were no statistical differences. Fruit finish was generaly poorer in all combination treatments than the captan standard.

Treatment and Rate/100 gal	% fruit affected: Sooty blotch		% fruit affected: Flyspeck		% surface covered**		Finish
	CC*	SS	CC	SS	CC	SS	
Captan 50W 2.0 lb	42	27	64	19	2.98	1.6	1.6
Captan 50W 1.0 lb + Polyram 50W 1.0 lb . . .	5	7	4	12	0.50	1.8	2.3
Captan 50W 1.0 lb + Benlate 50W 2.0 oz . . .	1	-	2	-	0.75	-	2.3
Captan 50W 1.0 lb + Benlate 50W 4.0 oz . . .	0	3	0	0	0	0.5	2.5
Captan 50W 1.5 lb + Benlate 50W 2.0 oz . . .	1	0	0	0	0.25	0	1.9
Captan 50W 1.5 lb + Benlate 50W 4.0 oz . . .	0	0	1	0	0.25	0	2.0
Captan 50W 2.0 lb + Benlate 50W 2.0 oz . . .	3	-	11	-	1.40	-	1.8
Dithane M45 80W 2.0 lb . .	5	0	0	0	0.83	0	2.1
Dithane M45 80W 1.0 lb + Benlate 50W 2.0 oz . . .	0	-	0	-	0	0	2.3
Dithane M45 80W 1.0 lb + Benlate 50W 4.0 oz . . .	0	0	0	0	0	0	3.1
Dithane M45 80W 1.5 lb + Benlate 50W 2.0 oz . . .	0	1	0	0	0.25	0.5	2.3
Dithane M45 80W 1.5 lb + Benlate 50W 4.0 oz . . .	1	0	0	0	0.25	0	2.5
Dithane M45 80W 2.0 lb + Benlate 50W 2.0 oz . . .	0	0	1	0	0.25	0	2.5
Check (Insecticide only). .	100	87	100	70	31.74	4.4	1.5
LSD_{05}	5.4	6.7	8.8	12	2.37	1.1	.55

*CC=Central Crops Research Station; SS=Sandhills Research Station.
**% Surface of affected fruit covered with sooty blotch or flyspeck.

APPLE (*Malus domestica* 'York Imperial')
Scab; *Venturia inaequalis*

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EVALUATION OF FUNGICIDE COMBINATIONS APPLIED ON PROTECTANT OR AFTER-INFECTION SCHEDULES FOR CONTROL OF SCAB ON YORK IMPERIAL APPLE, 1986: Ten fungicide treatments were compared on protectant and after-infection schedules in an 11-yr-old block of trees spaced 4.6 m and 7.3 m, 6.0 m high and 5.5 m wide. The test was conducted in a randomized block design with five single-tree replications surrounded by treated border trees. Treatments were applied from both sides of the row or alternate middles, as indicated, on each application date with a Swanson Model DA-400 airblast sprayer (100 gal/A). An early, light infection period Apr 6 (half-inch green tip) was allowed to pass without treatment to permit a small amount of primary infection to develop in the trees. Treatments designated as protectants also were delayed until 3 days after the first test infection period Apr 16. After the treatment series was initiated, treatments designated as protectants were applied on a pre-set schedule regardless of the occurrence of infection periods. Treatments designated as post-infection + protection were based on Mills scab infection periods. Additional scab infection periods during the test treatment period occurred Apr 16-18, May 13-14, May 20, May 21 and May 27. Applications were not repeated when infection periods occurred during the indicated test protective period. Application dates were: 5 days post-infection + 6 days protection, Apr 21 (bloom) May 19, May 31; 3 days post-infection + 6 days protection, Apr 19, May 17, May 29; 10-day protectant, Apr 19, Apr 30, May 12, May 24; 5-day alternate middle protectant east side, Apr 19, Apr 30, May 12, May 24; west side, Apr 25, May 6, May 19, May 29. Dikar 76.7W 6.5 lb/A was applied to both sides of all treatment trees Jun 13, Jun 27, Jul 11, Jul 25 and Aug 13. Insecticides applied separately with the same equipment included Sun Oil 6E, Supracide, Lannate L, Guthion, Kelthane 4F, and Lorsban 50W.

Under moderate scab pressure all treatments gave significant leaf and fruit scab control compared to untreated trees. Treatments probably would have performed better had the test applications begun following the Apr 6 infection period, but treatment differences probably would have been less significant. In general, the protectant schedules gave better control, but required an additional application compared to post infection + protectant schedules. The 5-day alternate middle protectant Rubigan + Polyram treatment compared favorably with the 10-day both sides protectant treatment. Rubigan, Funginex and Benlate performed similarly in combination with Polyram. There was no evidence of fungus resistance to Benlate in this orchard.

Table 1. Evaluation of fungicide combinations applied to York Imperial apples on protectant or after-infection schedules for control of scab

Treatment through 2nd cover and rate/A*	Application strategy**	Total no. appl. (bloom-2nd C)	Scab incidence: cluster leaves Jun 9 % leaves	cluster leaves Jun 9 les/leaf	terminal leaves Jun 11 % leaves	terminal leaves Jun 11 les/leaf	terminal leaves Aug 16 % leaves	terminal leaves Aug 16 les/leaf	% fruit Oct 1
Untreated	--	-.......	32 c	0.82 c	45 e	2.72 b	79 d	13.22 b	26.8 c
Rubigan 1E 4 fl oz + Polyram 80W 3 lb	5 days post-infection + 6 days protection (both sides)	3.......	17 b	0.29 b	16 d	0.36 a	27 c	0.93 a	4.8 ab
Rubigan 1E 6 fl oz + Polyram 80W 3 lb	5 days post-infection + 6 days protection (both sides)	3.......	12 ab	0.17 ab	15 d	0.29 a	17 abc	0.48 a	9.2 b
Rubigan 1E 4 fl oz + Polyram 80W 3 lb	3 days post-infection + 6 days protection (both sides)	3.......	10 a	0.11 a	12 bcd	0.20 a	22 bc	0.77 a	4.8 ab
Rubigan 1E 6 fl oz + Polyram 80W 3 lb	3 days post-infection + 6 days protection (both sides)	3.......	11 ab	0.17 ab	13 cd	0.18 a	18 abc	0.69 a	3.2 ab
Rubigan 1E 4 fl oz + Polyram 80W 3 lb	10 days protectant (both sides)	4.......	8 a	0.09 a	7 abc	0.11 a	15 abc	0.67 a	2.0 a
Rubigan 1E 4 fl oz + Polyram 80W 3 lb	5 days alternate middle protectant	4.......	6 a	0.07 a	4 ab	0.06 a	8 ab	0.37 a	1.2 ab
Funginex 1.6E 36 fl oz Polyram 80W 3 lb	5 days post-infection + 6 days protection (both sides)	3.......	11 ab	0.15 ab	19 d	0.50 a	20 bc	2.17 a	1.2 ab
Benlate 50W 12 oz + Polyram 80W 3 lb + Sun Oil 6E 2 qt	5 days post-infection + 6 days protection (both sides)	3.......	13 ab	0.20 ab	12 bcd	0.23 a	17 abc	1.36 a	2.4 ab
Funginex 1.6E 36 fl oz + Polyram 80W 3 lb	5 days alternate middle protectant	4.......	6 a	0.06 a	3 a	0.05 a	6 ab	0.15 a	0.4 ab
Benlate 50W 12 oz + Polyram 80W 3 lb + Sun Oil 6E 2 qt	5 days alternate middle protectant	4.......	6 a	0.08 a	6 abc	0.08 a	3 a	0.04 a	2.0 ab

Mean separation by Duncan's Multiple Range Test (p = 0.05). Averages of ten leaf clusters or terminal shoots or 50 fruits from each of five replicate trees.

* Formulated fungicide per acre. Applied at 100 gal per acre from both sides (unless indicated as alternate middle) on each application date with a Swanson Model DA-400 airblast sprayer. Dikar 76W (6.5 lb/A) cover sprays were applied to all treatments.

** Treatments designated as protectants were applied on a pre-set schedule regardless of the occurrence of infection periods. Treatments designated as post-infection + protection were based on scab infection periods. An early light infection period Apr 6 (½" green tip) was allowed to pass without treatment to permit a small amount of primary infection to develop in the trees. Treatments designated as protectants also were delayed until 3 days after the first test infection period Apr 16. Later infection periods were followed by applications at the indicated intended interval. Infection periods immediately following an application were ignored during the indicated test protective period.

APPLE (Malus domestica 'Jonathan')
Powdery mildew; Podosphaera leucotricha
Fruit finish

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EVALUATION OF STEROL-INHIBITING FUNGICIDES FOR POWDERY MILDEW CONTROL ON JONATHAN APPLE, 1986: Ten treatments were applied at selected intervals to compare their residual effectiveness on powdery mildew in a heavily infected 19-yr-old block of trees. The test was conducted in a randomized block design with four single-tree replicates, each surrounded by treated 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: 1-wk and 2-wk treatments Apr 1 (1/2" green, excluding the 1-wk treatment initiated at pink); Apr 14 (early bloom); May 1 (1st cover), May 16 (2nd cover); May 29 (3rd cover); additional 1-wk applications: Apr 8 (pink), Apr 25 (bloom-petal fall), May 8, May 23, and Jun 6. Fourth-seventh covers were applied Jun 17, Jul 7, Jul 22, and Aug 8. Insecticides applied separately with the same equipment included Sun Oil 6E, Supracide, Lannate, Guthion, Lorsban 50W and Kelthane 4F.

Under heavy mildew pressure all treatments significantly reduced mildew incidence on foliage, but only Bayleton and Procure significantly reduced mildew on fruit. DPX H6573 and Dikar gave similar mildew control on leaves and fruit. Reducing the spray interval from two weeks to one week improved mildew control by Bayleton but not by DPX H6573. Delaying the first Bayleton application until the pink stage instead of half-inch green did not reduce mildew control even though mildew spores were present by green tip stage. No treatments deleteriously affected fruit finish compared to untreated trees. Two DPX H6573 treatments significantly reduced both russeting and opalescence.

Table 2. Evaluation of sterol-inhibiting fungicides for powdery mildew control on Jonathan apple

Treatment and rate/A[1]	Application schedule	Mildew incidence (%)[2]					Fruit finish[3]	
		May 30		Aug 13				
		leaves	area	leaves	area	fruit	russet	opalescence
Untreated	—	76 f	71 d	73 f	71 e	62 c	1.6 bcd	1.4 c
DPX H6573 20DF 1.75 oz + Manzate 200 80W 2.0 lb	1 wk, ½"G-3rd C	49 cde	16 abc	57 de	33 bcd	16 abc	1.0 a	0.8 ab
DPX 965 50W 4.0 oz + Manzate 200 80W 2.0 lb	4th-7th covers							
DPX H6573 20DF 1.75 oz + Manzate 200 80W 2.0 lb	2 wk, ½"G-3rd C	53 de	33 c	59 e	38 d	20 abc	1.3 abc	1.3 bc
DPX 965 50W 4.0 oz + Manzate 200 80W 2.0 lb	4th-7th covers							
DPX H6573 20DF 2.5 oz + Manzate 200 80W 2.0 lb	2 wk, ½"G-3rd C	52 de	25 abc	52 cde	21 a-d	24 abc	1.0 a	0.7 a
DPX 965 50W 4.0 oz + Manzate 200 80W 2.0 lb	4th-7th covers							
DPX H6573 20DF 1.25 oz + Manzate 200 80W 2.0 lb	1 wk, ½"G-3rd C .... 2 wk, 4th-7th C	63 ef	26 bc	59 e	34 cd	30 c	1.8 cd	1.3 bc
Procure 50W 9.0 oz Dikar 76.7W 6.5 lb	2 wk, ½"G-3rd C .... 4th-7th covers	37 cd	11 ab	40 bc	10 abc	13 ab	1.8 cd	1.2 abc
Procure 50W 12.0 oz Dikar 76.7W 6.5 lb	2 wk, ½"G-3rd C .... 4th-7th covers	41 cd	10 ab	43 bcd	9 ab	12 a	1.5 a-d	1.2 abc
Bayleton 50W 4.0 oz + Dithane M-45 80W 2.0 lb	1 wk, pink-3rd C ...	10 a	2 a	21 a	3 a	17 abc	1.9 d	1.2 abc
Dikar 76.7W 6.5 lb	4th-7th covers							
Bayleton 50W 4.0 oz + Dithane M-45 80W 2.0 lb	1 wk, ½"G-3rd C	19 ab	4 ab	27 ab	11 abc	11 a	1.3 abc	1.0 abc
Dikar 76.7W 6.5 lb	4th-7th covers							
Bayleton 50W 4.0 oz + Dithane M-45 80W 2.0 lb	2 wk, ½"G-3rd C	32 bc	8 ab	41 bcd	15 a-d	12 a	1.1 ab	0.8 ab
Dikar 76.7W 6.5 lb	4th-7th covers							
Dikar 76.7W 6.5 lb	1 wk, ½"G-3rd C .... 2 wk, 4th-7th C	50 de	18 abc	52 cde	15 a-d	27 bc	2.0 d	1.2 abc

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] Average of 10 terminal shoots or 25 fruit from each of four replications.

[3] Fruit finish excluding presumed mildew russet. Rated on a scale of 0-5 (0 = perfect finish; 5 = severe russet or opalescence).

APPLE (*Malus domestica*
'Red Delicious'
'Golden Delicious'
'Rome Beauty')
Powdery mildew;
Podosphaera leucotricha
Sooty blotch; *Gloeodes pomigena*
Fly speck; *Schizothyrium pomi*
Fruit effects

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EVALUATION OF EXPERIMENTAL FUNGICIDES ON THREE APPLE CULTIVARS, 1986: Seventeen fungicide treatments were evaluated for disease control and fruit effects on a 14-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: Apr 24 (bloom); 1st-6th covers, respectively: May 20, May 30, Jun 13, Jun 27, Jul 11, Jul 25. Insecticides, applied separately with the same equipment, included Supracide, Sun Oil 6E, Guthion, Lannate L, Lorsban 50W, and Sevin.

The early season applications were timed as after-infection for scab, but scab pressure was light and scab and rust incidence was relatively low on untreated trees. Primary powdery mildew inoculum was moderate, but weather conditions favored mildew development. The best control of mildew on foliage was provided by season-long schedules of Systhane, FBC 39865, Spotless and SAN 619. All treatments gave significant control of mildew on fruit, but treatment differences were not significant ($p = 0.05$). Summer disease pressure was only moderate, with near normal rainfall in August, but below average accumulation for most of the season. Under these conditions, SAN 619 and Spotless showed weakness on sooty blotch and fly speck. FBC 39865 and Ro 15-1297 gave considerable sooty blotch and fly speck control without the addition of mancozeb or captan. Several treatments significantly ($p = 0.05$) affected physiological aspects of the fruit compared to untreated fruit. Fruit wt. and soluble solids were lower on trees treated with season-long applications of Systhane 2 oz, but not of 2.5 oz. Fruit dimensions were slightly larger on trees treated with FBC 39865 16 oz, but % soluble solids was reduced. Fruit wt. was decreased by Spotless 17 g alone and firmness was increased. Fruit length was significantly reduced by the Spotless + captan treatment, but soluble solid content was significantly increased compared to untreated fruit. Fruit wt. was significantly reduced by Dikar. Fruit length and wt. were significantly reduced by Ro 15-1297 applied alone, but not in combination with Dithane M-45 or captan. Although the above fruit effects are noted as significant ($p = 0.05$) compared to untreated fruit, variation by results with different treatment rates of the same compound shows some inconsistency and many of these effects may also be related to other unmeasured factors such as crop load. No negative effects on fruit finish were observed on any cultivars by any treatment compared to untreated fruit, however, the addition of Dithane M-45 to Ro 15-1297 increased the amount of russet on Red Delicious, and the amount of opalescence on Red Delicious and Rome, compared to Ro 15-1297 applied alone or with captan. Treatments giving a positive finish effect compared to untreated fruit in one category or another included FBC 39865, Spotless, SAN 619, and Ro 15-1297. There was no significant difference ($p = 0.05$) among any of the treatments or untreated fruit in the amount of russet on Golden Delicious.

Table 3. Disease control by experimental fungicides

Treatment, rate/100 gal and schedule*	Mildew incidence (%) Rome Beauty leaves	leaf area	fruit	% fly speck G.Del.	Rome	% sooty blotch G.Del.	Rome
No fungicide	54.8 e	21.5 b	24 b	30 b	32 c	63 c	14 b
Systhane 40W 2.5 oz (B-1st C); Dithane M-45 80W 1.5 lb (2nd-6th C)	11.3 a-d	2.6 a	3 a	0 a	0 a	1 a	0 a
Systhane 40W 2.5 oz (B-1st C); Systhane 40W 2.5 oz + Dithane M-45 80W 1.5 lb (2nd-6th C)	3.5 a	1.1 a	8 a	0 a	2 a	1 a	0 a
Systhane 40W 2.0 oz + Dithane M-45 80W 1.5 lb (B-6th C)	11.6 a-d	1.9 a	7 a	0 a	0 a	0 a	0 a
FBC 39865 25W 4.0 oz (B-6th C)	4.3 ab	1.1 a	7 a	2 a	0 a	2 ab	0 a
FBC 39865 25W 8.0 oz (B-6th C)	7.2 abc	1.4 a	5 a	0 a	0 a	0 a	0 a
FBC 39865 25W 16.0 oz (B-6th C)	4.4 ab	0.9 a	5 a	0 a	1 a	1 a	0 a
Spotless 25W 11.3 g (B-6th C)	6.9 abc	1.7 a	9 a	0 a	1 a	5 ab	1 a
Spotless 25W 17.0 g (B-6th C)	17.9 bcd	3.1 a	11 a	8 ab	7 ab	23 b	0 a
Spotless 25W 17.0 g + Captan 50W 1.0 lb (B-2nd C); Captan 50W 2.0 lb (3rd-6th C)	14.3 a-d	2.7 a	6 a	2 ab	2 a	2 ab	0 a
SAN 619 DF 50.0 g (B-6th C)	11.1 a-d	2.3 a	6 a	1 ab	2 a	11 ab	0 a
SAN 619 DF 75.0 g (B-6th C)	7.0 abc	2.0 a	8 a	14 b	11 b	25 b	2 a
Rubigan 1E 1.5 fl oz (B-2nd C); Dithane M-45 80W 1.5 lb (3rd-6th C)	21.8 d	2.9 a	9 a	1 ab	2 a	1 a	0 a
Dikar 76.7W 2.0 lb (B-6th C)	20.0 cd	4.6 a	9 a	0 a	0 a	0 a	0 a
Ro 15-1297 4E 1.0 fl oz (B-6th C)	16.0 a-d	2.7 a	5 a	1 ab	0 a	7 ab	1 a
Ro 15-1297 4E 1.0 fl oz + Dithane M-45 80W 1.5 lb (B-2nd C); Dithane M-45 80W 1.5 lb (3rd-6th C)	18.6 cd	6.4 a	7 a	0 a	1 a	1 a	0 a
Ro 15-1297 4E 1.0 fl oz + Captan 50W 1.0 lb (B-2nd C); Captan 50W 2.0 lb (3rd-6th C)	20.5 cd	3.9 a	5 a	2 ab	0 a	2 ab	0 a
Baycor 50W 4.0 oz + Dithane M-45 80W 1.0 lb (B-2nd C); Dithane M-45 80W 1.5 lb (3rd-6th C)	22.5 d	5.6 a	7 a	0 a	0 a	0 a	0 a

Mean separation by Duncan's Multiple Range Test (p = 0.05). Averages of 10 terminal shoots Jun 26 or harvest counts of 25 fruit from each of four replicates.

*Formulated product per 100 gal dilute. Applied by handgun to runoff at 500 psi. B = bloom; C = cover spray.

Table 4. Fruit effects by experimental fungicides

Treatment, rate/100 gal and schedule*	Red Delicious fruit: width (cm)	length (cm)	weight (g)	firmness (Kg/cm^2)	% soluble solids	Finish ratings**: russet R.Del.	russet Rome	opalescence R.Del.	opalescence Rome
No fungicide	7.43 b-f	6.83 abc	189 ab	33.2 b-e	11.3 bcd	1.9 e	1.7 cd	1.5 cde	1.7 ab
Systhane 40W 2.5 oz (B-1st C); Dithane M-45 80W 1.5 lb (2nd-6th C).	7.43 a-e	6.84 abc	172 b-e	33.5 b-e	10.9 def	1.9 e	1.5 a-d	1.4 bcd	1.7 ab
Systhane 40W 2.5 oz (B-1st C); Systhane 40W 2.5 oz + Dithane M-45 80W 1.5 lb (2nd-6th C)	7.41 b-f	6.78 abc	180 a-d	34.2 a-d	11.7 abc	1.9 de	1.5 a-d	1.6 de	1.9 ab
Systhane 40W 2.0 oz + Dithane M-45 80W 1.5 lb (B-6th C)	7.18 ef	6.57 cde	158 e	32.6 cde	10.3 f	1.6 a-e	1.4 a-d	1.4 bcd	2.0 ab
FBC 39865 25W 4.0 oz (B-6th C)	7.27 def	6.68 a-e	176 a-d	32.3 cde	11.9 ab	1.5 a-e	1.3 a-d	1.1 ab	1.3 a
FBC 39865 25W 8.0 oz (B-6th C)	7.37 c-f	6.58 b-e	171 b-e	34.4 a-d	10.9 def	1.1 a	1.2 abc	1.1 abc	1.4 a
FBC 39865 25W 16.0 oz (B-6th C)	7.73 a	6.94 a	191 a	31.8 cde	10.6 ef	1.8 cde	1.4 a-d	1.5 b-e	1.6 a
Spotless 25W 11.3 g (B-6th C)	7.49 a-d	6.86 abc	181 a-d	31.6 cde	11.9 ab	1.2 a	1.5 a-d	0.9 a	1.5 a
Spotless 25W 17.0 g (B-6th C)	7.40 c-f	6.63 a-e	169 de	38.0 a	10.9 def	1.7 cde	1.0 a	1.3 a-d	1.4 a
Spotless 25W 17.0 g + Captan 50W 1.0 lb (B-2nd C); Captan 50W 2.0 lb (3rd-6th C)	7.29 c-f	6.46 de	171 b-e	32.5 cde	12.2 a	1.4 a-d	1.5 a-d	1.4 b-e	1.7 ab
SAN 619 F 10WG 50.0 g (B-6th C).....	7.59 abc	6.93 a	192 a	30.4 de	11.4 bcd	1.7 b-e	1.2 abc	1.1 abc	1.5 a
SAN 619 F 10WG 75.0 g (B-6th C).....	7.51 a-d	6.89 ab	186 a-d	35.5 abc	11.1 cde	1.4 abc	1.1 ab	1.1 abc	1.3 a
Rubigan 1E 1.5 fl oz (B-2nd C); Dithane M-45 80W 1.5 lb (3rd-6th C).	7.46 a-e	6.83 abc	188 abc	32.8 b-e	11.5 bcd	1.6 b-e	1.7 bcd	1.2 abc	1.9 ab
Dikar 76.7W 2.0 lb (B-6th C)	7.21 def	6.74 a-e	170 cde	34.4 a-d	11.5 bcd	1.8 cde	1.5 a-d	1.3 a-d	1.9 ab
Ro 15-1297 4E 1.0 fl oz (B-6th C) ..	7.15 f	6.45 e	155 e	37.2 ab	11.5 bcd	1.3 ab	1.4 a-d	0.9 a	1.3 a
Ro 15-1297 4E 1.0 fl oz + Dithane M-45 80W 1.5 lb (B-2nd C); Dithane M-45 80W 1.5 lb (3rd-6th C)	7.30 c-f	6.76 a-d	180 a-d	37.2 ab	11.5 bcd	1.8 cde	1.9 d	1.9 e	2.5 b
Ro 15-1297 4E 1.0 fl oz + Captan 50W 1.0 lb (B-2nd C); Captan 50W 2.0 lb (3rd-6th C)	7.48 a-d	6.88 abc	189 ab	32.5 cde	11.3 b-e	1.5 a-d	1.6 bcd	1.2 abc	1.6 a
Baycor 50W 4.0 oz + Dithane M-45 80W 1.0 lb (B-2nd C); Dithane M-45 80W 1.5 lb (3rd-6th C)	7.70 ab	6.89 ab	187 abc	29.3 e	11.9 ab	1.6 a-e	1.6 a-d	1.1 abc	1.8 ab

Mean separation by Duncan's Multiple Range Test (p = 0.05). Averages of 25 fruit from each of four replications for finish ratings, 20 fruit for width, length, weight and firmness, and juice from 10 fruit for soluble solids.

* Formulated product per 100 gal dilute. Applied by handgun to runoff at 500 psi. B = bloom; C = cover spray.

**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 finish

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EVALUATION OF CONCENTRATE APPLICATIONS OF COMBINED MILDEWCIDES ON JONATHAN APPLE, 1986: Four combined mildewcide treatments were compared for mildew control and fruit finish effects. Treatments were applied at 100 gal/A with a Swanson Model DA-400 airblast sprayer to adjacent 19-yr-old unreplicated blocks of 50-60 trees three rows wide. Both sides of the tree row were treated on each application date as follows: April 14 (early bloom); Apr 25 (bloom-petal fall); 1st-8th covers, respectively May 5, 20, 28, Jun 11, 26, Jul 10, 25, Aug 8. Insecticides applied separately with the same equipment included: Sun Oil 6E, Supracide 6E, Lannate L, Guthion, Lorsban 50W and Kelthane 4F. Leaf and fruit samples were collected from each of four trees in the middle row of each plot near the intersection of the plots. These provided the basis of the statistical analysis.

Heavy primary inoculum and favorable weather conditions contributed to a strong mildew test. Treatments involving Bayleton had significantly fewer leaves infected and less leaf area infected than the Dikar + Karathane combination, but fruit infection was similar for all four treatments. Dikar + Karathane and Dikar + Bayleton provided better fruit finish than Bayleton + Kolodust Xtra and Bayleton + Benlate.

Table 5.

	Mildew incidence (%)			Fruit finish**	
Treatment and rate/A*	leaves	leaf area	fruit	russet	opalescence
Dikar 76.7W 3.75 lb + Karathane 19W 1.25 lb......	80 b	80 b	39 a	0.8 a	1.2 ab
Bayleton 50W 2.0 oz + Kolodust Xtra 53% 6.0 lb ..	70 a	49 a	30 a	1.7 b	1.6 b
Bayleton 50W 2.0 oz + Benlate 50W 8.0 oz	61 a	40 a	32 a	2.1 b	2.3 c
Bayleton 50W 2.0 oz + Dikar 76.7W 5.0 lb	64 a	45 a	34 a	0.5 a	0.8 a

Mean separation by Duncan's Multiple Range Test (p = 0.05). Averages of leaves from 10 terminal shoots or 25 fruit from each of four trees per treatment.

* Formulated material per acre.

**Rated on a scale of 0-5 (0 = perfect finish; 5 = severe russet or opalescence, excluding presumed mildew russet).

APPLE (*Malus domestica* 'Rome Beauty')
Cedar-apple rust; *Gymnosporangium juniperi-virginianae*
Scab; *Venturia inaequalis*
Powdery mildew; *Podosphaera leucotricha*

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AFTER-INFECTION CONTROL OF CEDAR-APPLE RUST BY STEROL-INHIBITING FUNGICIDES, 1986: Thirteen fungicide treatments were applied as curative-protectant treatments May 19, one day after the start of an infection period (13 hrs wet at 15-21 C). An additional lighter infection period occurred May 20-21, however, infection on untreated, potted, monitoring trees exposed to an infection period in the orchard and incubated in the greenhouse indicated that approximately 90% of the lesions on untreated trees resulted from the May 19 infection period. Treatments were applied to previously untreated 6-yr-old trees with a single nozzle handgun to the runoff point at 500 psi in a five-replicate randomized block design. Foliage counts based on five terminal shoots from each tree were conducted Jun 16. Lesions were categorized by appearance as normal orange lesions or "suppressed" lesions purple in color and somewhat reduced in size. While it could not be confirmed that these lesions were in fact rust lesions, their general distribution on the leaf and shoot suggested that they were.

Rust developed from inoculum naturally present on three sides of the 100A orchard. Some untreated leaves had as many as 75 normal lesions per leaf. Rubigan and Bayleton (at rates as low as 0.25 oz/100 gal) gave excellent rust control. Bayleton 0.05 oz compared to Funginex 8 fl oz. Ferbam gave very little rust control in this after-infection test, and adding ferbam to Funginex did not improve rust control compared to Funginex alone. Purple "suppressed" lesions were also present on untreated trees in the orchard, but only normal, orange lesions developed on the monitoring trees which were in the orchard for the rust infection period and transferred to the greenhouse for incubation. A possible explanation for the "suppressed" lesions could be spray drift from Bayleton-treated border rows, but application conditions did not seem appropriate for drift. Rubigan also gave good control of scab and mildew, considering that this was the only fungicide applied until the foliar ratings were made Jun 16. Primary scab infection periods occurred in early and mid-April and the May 19 application came at an opportune time to reduce active secondary infection by both scab and mildew. Although such control would not be expected from a single application such as this every year, it does demonstrate the potential utility of well-timed applications of sterol-inhibiting fungicides in the non-bearing orchard.

Table 6. After-infection control of cedar-apple rust on Rome Beauty apple

Treatment	Rate/ 100 gal*	Cedar-apple rust, leaves: normal lesions, % leaves infected	Cedar-apple rust, leaves: normal lesions, lesions/ leaf	Cedar-apple rust, leaves: "suppressed" lesions**, % leaves	Cedar-apple rust, leaves: "suppressed" lesions**, lesions/ leaf	% leaves infected: scab	% leaves infected: mildew
No treatment	--	89 ef	20.8 c	99 g	28.2 ef	15 bcd	26 abc
Rubigan 1E	2.0 fl oz ...	6 a	0.2 a	62 ab	4.6 ab	0 a	12 a
Bayleton 50W	2.0 oz	6 a	0.2 a	58 a	3.1 a	14 bcd	17 abc
Bayleton 50W	1.0 oz	4 a	0.1 a	78 a-d	5.1 ab	19 cd	19 abc
Bayleton 50W	0.5 oz	5 a	0.2 a	74 abc	5.6 abc	22 d	21 abc
Bayleton 50W	0.25 oz	7 a	0.1 a	74 abc	5.9 abc	15 bcd	19 abc
Bayleton 50W	0.1 oz	43 a-d	1.8 ab	79 b-e	7.9 abc	17 cd	33 c
Bayleton 50W	0.05 oz	43 a-d	1.5 ab	81 c-f	9.3 abc	22 d	30 bc
Funginex 1.6E	1.0 fl oz ...	48 cd	3.6 ab	88 c-f	12.3 bc	11 a-d	16 ab
Funginex 1.6E	8.0 fl oz ...	42 a-d	2.8 ab	79 c-f	12.2 bc	12 a-d	23 ab
Funginex 1.6E	16.0 fl oz ..	11 ab	0.2 a	84 b-e	7.6 abc	7 abc	11 a
Ferbam 76W	1.0 lb	69 de	13.7 bc	94 efg	21.9 de	6 abc	22 ab
Ferbam 76W	2.0 lb	87 ef	15.9 c	90 d-g	21.3 cd	10 a-d	15 ab
Ferbam 76W + Funginex 1.6E	1.0 lb + 8.0 fl oz ...	51 bcd	13.3 ab	90 c-f	14.2 ab	3 ab	26 ab

Mean separation by Duncan's Multiple Range Test (p = 0.05). All data based on ratings of 5 shoots from each of five replicate trees Jun 16.

* Formulated product per 100 gal. Applied to runoff point with single nozzle handgun at 500 psi May 19.

** "Suppressed" lesions purplish in color and reduced in size.

APPLE (*Malus domestica*
'Red Delicious'
'Golden Delicious'
'Rome Beauty')
Cedar-apple rust; *Gymnosporangium juniperi-virginianae*
Powdery mildew; *Podosphaera leucotricha*
Sooty blotch; *Gloeodes pomigena*
Fruit finish

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EVALUATION OF FUNGICIDE COMBINATIONS ON THREE APPLE CULTIVARS, 1986: Ten treatments involving benzimidazole, maneb, mancozeb, Bayleton and captan fungicides were evaluated for disease control and fruit finish on mature semi-dwarf trees. Treatments were applied as dilute sprays to the runoff point with a single-nozzle handgun at 500 psi in a four-replicate randomized block design as follows: Apr 25 (bloom-petal fall); 1st-5th covers respectively: May 22, Jun 6, Jun 19, Jul 9, Jul 23. Cedar galls were suspended over the trees to provide rust inoculum. Insecticides applied separately included Ambush, Dipel, Lannate and Sevin. Karathane 19W 2 lb/A was included with the insecticide Jun 14 to reduce mildew pressure on the entire block.

Although early season treatments were delayed to encourage an increase in scab pressure, prolonged dry weather through mid-May and again in Jun and Jul permitted only a small amount of scab on untreated trees. Most of the rust infection occurred in late May just before and after the second fungicide application. Although rust incidence was quite variable, treatments involving maneb or mancozeb generally gave less control than Bayleton. Conditions were highly favorable for mildew development. Bayleton + captan was the only treatment that gave significant ($p = 0.05$) control of mildew on foliage compared to untreated trees. No treatments gave significant control of mildew or sooty blotch on fruit although incidence of these diseases on fruit was light. Sooty blotch did not develop until very late in the season. No treatments had a significant deleterious effect on fruit finish of any test cultivar. Manzate 200 significantly reduced the amount of russet on Golden Delicious. Considerable foaming in the tank, encountered with Manex and Captec, was overcome by adding a defoamer.

Table 7. Evaluation of fungicide combinations on three apple cultivars

Treatment and rate/100 gal*	Rome Beauty foliage: rust % leaves infected	Rome Beauty foliage: mildew % leaves	Rome Beauty foliage: mildew % area	% sooty blotch G.Del.	Fruit finish**: russet G.Del.	Fruit finish**: russet R.Del.	Fruit finish**: russet Rome	Fruit finish**: opalescence R.Del.	Fruit finish**: opalescence Rome
Untreated	17 ab	60 b	45 bc	7 ab	2.7 b	0.9 a	1.4 ab	0.9 a	1.5 a
Topsin-M 70W 2.0 oz + Penncozeb 80W 1.0 lb	16 ab	60 b	33 bc	2 ab	2.2 ab	1.2 a	1.6 ab	1.1 a	1.8 a
Topsin-M 4.5F 2.5 fl oz + Penncozeb 80W 1.0 lb	19 b	55 ab	27 ab	7 ab	2.1 ab	1.0 a	1.2 ab	0.8 a	2.0 a
Penncozeb 80W 1.5 lb	22 b	60 b	36 bc	1 a	1.9 ab	1.1 a	1.3 ab	1.2 a	2.0 a
Benlate 50W 2.0 oz + Manzate 200 80W 1.0 lb	22 b	55 ab	27 ab	1 a	2.1 ab	1.0 a	1.1 a	1.0 a	2.7 a
Manzate 200 80W 2.0 lb	16 ab	63 b	41 bc	6 ab	1.8 a	1.0 a	1.9 b	1.2 a	2.2 a
Manex 4F 38.4 fl oz	13 ab	62 b	48 c	1 a	2.1 ab	1.1 a	1.4 ab	1.0 a	1.7 a
Manex 4F 51.2 fl oz	13 ab	59 b	33 bc	3 ab	2.3 ab	1.1 a	1.6 ab	0.9 a	1.7 a
Captec 4L 24.0 fl oz + Bayleton 50W 0.5 oz	9 a	52 ab	29 ab	0 a	2.1 ab	1.5 a	1.1 a	1.1 a	1.8 a
Captec 4L 32.0 fl oz + Bayleton 50W 0.5 oz	8 a	55 ab	29 ab	4 ab	1.9 ab	1.0 a	1.1 a	1.0 a	2.1 a
Captan 50W 2.0 lb + Bayleton 50W 0.5 oz	8 a	45 a	14 a	10 b	2.3 ab	1.1 a	1.9 b	0.9 a	2.2 a

Mean separation by Duncan's Multiple Range Test ($p = 0.05$). Averages of leaves on ten terminal shoots Jul 3 or 25 harvested fruit from each of four replicate trees.

* Formulated product per 100 gal dilute. Applied to runoff with a single nozzle handgun at 500 psi.

** Rated on a scale of 0-5 (0 = perfect finish; 5 = severe russet or opalescence, excluding presumed mildew russet).

APPLE (*Malus domestica* 'Golden Delicious')
Scab; *Venturia inaequalis*
Sooty blotch; *Gloeodes pomigena*
Russet

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EVALUATION OF CONCENTRATE APPLICATIONS OF DITHIOCARBAMATE FORMULATIONS ON GOLDEN DELICIOUS APPLE, 1986: Five dithiocarbamate fungicide treatments were evaluated for disease control and fruit finish effects on an 11-yr-old block of trees spaced 4.6 m X 7.3 m, 5.0 m high and 5.5 m wide. The test was conducted in a randomized block design with three single-tree replications per treatment. The first application was delayed until some scab lesions were visible to provide a stronger test. 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) as the 1st-4th cover sprays, May 16, May 29, Jun 13, Jul 4. No other fungicides were applied throughout the season. Insecticides applied separately during the fungicide treatment period with the same equipment included Lannate, Guthion, Kelthane 4F, and Lorsban.

Although scab lesions were already sporulating when the first fungicides were applied, long drought periods resulted in a rather weak scab test with the greatest pressure occurring between the first and second applications. The last application was applied nearly 3 months before harvest, but sooty blotch did not appear on untreated trees until late in the season. All treatments gave significant disease control (p = 0.05) compared to untreated trees, but there were no significant treatment differences. Most of the physiological russetting developed as a result of rains the last two weeks in May, but there were no significant differences in the amount of russet on treated or untreated fruit.

Table 8. Evaluation of concentrate applications of mancozeb formulations on Golden Delicious apple

	Scab incidence				
Treatment and rate/A*	% leaves	lesions/ leaf	% fruit	% sooty blotch	Fruit russet rating**
Untreated	26 b	1.12 b	11 b	18 b	3.05 a
Dikar 76.7W 5.0 lb	4 a	0.08 a	0 a	0 a	3.24 a
Manzate 200 80W 5.0 lb ..	5 a	0.09 a	0 a	0 a	3.19 a
Manex 4F 5.0 qt	15 ab	0.24 a	0 a	0 a	2.60 a
Manex 4F 3.75 qt	6 a	0.08 a	1 a	0 a	3.24 a
Polyram 80W 5.0 lb	8 a	0.25 a	5 ab	1 a	2.84 a

Mean separation by Duncan's Multiple Range Test (p = 0.05).
Averages of 25 fruit or 10 terminal shoots, excluding the six oldest leaves, from each of three single-tree replicates.

* Formulated material per acre.
** Rated on a scale of 0-5 (0 = perfect finish; 5 = severe russet).

APPLE (<u>Malus domestica</u> 'Golden Delicious')
Blue mold; <u>Penicillium expansum</u>

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CONTROL OF PENICILLIUM BLUE MOLD BY POSTHARVEST DIP TREATMENTS, 1985-86: Fruit which had been stored 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 5 X 10^4 benomyl-sensitive conidia/ml, dipped in a fungicide suspension 30 sec., placed on fiber trays, boxed by treatment and stored at 1 C. Fruit were evaluated for blue mold after 69 days storage at 1 C for Test 1 (Table 9) or 77 days' storage for Test 2 (Table 10). Test 2 fruit were also evaluated after six additional days at 16 C.

Blue mold incidence was high in both tests. All wounded, inoculated fruit were infected. No unwounded fruit were infected. Although fruit were inoculated by dipping in a suspension of benomyl-sensitive condia, an unusually high incidence of infected fruit treated with Benlate suggested the possibility of resistant strain contamination from the commercial cold storage prior to treatment. This was confirmed by isolating onto potato dextrose agar containing 5 ppm benomyl. In Test 1, 40-80% of the isolates from individual replicates treated with Benlate were resistant. In Test 2, percent benomyl-resistant isolates recovered from sampled treatments were: Benlate, 93%; uninoculated check, 18%; inoculated check, 43%; Benlate + captan, 93%; captan, 56%. In Test 1, none of the treatments gave outstanding control. Fungaflor and Deccozil-289 (479 mg/L) and the Benlate + captan standard gave only fair control. Adding Spray-Aide to lower the dip water pH from 7.6 (typical of waters in the Shenandoah Valley) to 6.0 prior to adding the fungicide did not improve control by Fungaflor and significantly reduced control by Deccozil-289. In Test 2, CGA 449 provided excellent control and remained highly effective 6 days after fruit were removed from cold storage. DPX H6573 was quite effective at 16 mg/L, but was significantly poorer at 8 mg/L. Other materials which gave moderate control were: Deccozil-289, Fungaflor, Rovral and captan.

Table 9. Test 1: Evaluation of imazalil formulations for control of Penicillium blue mold on apples

Treatment	Rate/100 gal	Active ingredient mg/L	% fruit infected with blue mold
Benlate 50W + Captan 50W	4.0 oz + 1.0 lb	150 + 600	44 bc
Benlate 50W	8.0 oz	300	63 bcd
Captan 50W	2.0 lb	1200	100 f
Fungaflor 50EC	25.6 fl oz	958	58 bcd
Fungaflor 50EC	12.8 fl oz	479	38 b
Fungaflor 50EC	10.0 fl oz	374	60 bcd
Fungaflor 50EC	6.4 fl oz	239	69 cd
Fungaflor 50EC added to acidified H_2O, pH 6.0	12.8 fl oz	479	61 bcd
Deccozil-289 22.2 EC	57.7 fl oz	958	64 bcd
Deccozil-289 22.2 EC	28.8 fl oz	479	46 bc
Deccozil-289 22.2 EC	22.5 fl oz	373	85 e
Deccozil-289 22.2 EC	14.4 fl oz	239	85 e
Deccozil-289 22.2 EC added to acidified H_2O, pH 6.0	28.8 fl oz	479	79 de
Kenopel 40% EC	31.996 fl oz	1000	99 f
Kenopel 40% EC	15.998 fl oz	500	100 f
Deccosol 122 14.5% 4 min dip; 30 sec rinse	2.27 gal	3156	80 e
Deccosol 122 14.5% 30 sec dip; 30 sec rinse	2.27 gal	3156	100 f
Deccosol 122 14.5% 4 min dip; no rinse	2.27 gal	3156	53 bc
Deccosol 122 14.5% 30 sec dip; no rinse	2.27 gal	3156	86 e
Spray-Aide (amount required to lower H_2O pH to 6.0)	29.2 ml		100 f
Untreated, not wounded, inoculated or dipped			0 a
Untreated, not wounded or inoculated; dipped in H_2O			0 a
Untreated, wounded, dipped in H_2O only			100 f
Untreated, wounded, dipped in inoculum			100 f
Untreated, not wounded, dipped in inoculum			0 a

Mean separation by Duncan's Multiple Range Test.
Averages of four replications of 20 fruit.

Table 10. Test 2: Evaluation of experimental postharvest dip treatments for control of Penicillium blue mold on Golden Delicious apple

Treatment	Rate/100 gal	Active ingredient mg/L	Blue mold incidence (% fruit infected) after 77 days cold storage	cold storage + 6 days at 16°C
Benlate 50W + Captan 50W	4.0 oz + 1.0 lb	150+ 600.....	56 ef	59 d
Benlate 50W	8.0 oz	300	75 gh	89 e
Captan 50W	2.0 lb	1200	34 cd	64 d
Funginex 50W	8.0 oz	300	100 l	100 f
DPX H6573 20DF	37.0 g	16	6 ab	16 ab
DPX H6573 20DF	18.5 g	8	34 cd	50 cd
RH 3866 40W	18.5 g	16	63 fg	86 e
RH 3866 40W	9.25 g	8	74 gh	90 e
CGA 71818 10W	5.0 oz	37	44 e	86 e
Ro 15-1297 4E	1.0 fl oz	37	84 hi	98 f
Rubigan 5110 1E	4.0 fl oz	37	90 ij	98 f
Rubigan 1AS	4.0 fl oz	37	83 hi	98 f
CGA 449 50W	8.0 oz	300	0 a	4 a
Rovral 50W	8.0 oz	300	21 bc	36 bc
XE-779 25W	14.8 g	8	91 ij	99 f
UBI A-815 50W	1.0 oz	37	93 jk	98 f
Fungaflor 50EC	12.8 fl oz	479	33 cd	64 d
Deccozil-289	28.8 fl oz	479	20 bc	65 d
Untreated, no dip			96 jk	100 f
Water dip			95 k	100 f

Mean separation by Duncan's Multiple Range Test.
Averages of four replications of 20 fruit.

PEACH (*Prunus persica* 'Redhaven')
NECTARINE (*Prunus persica* var. *nectarina*)
Brown rot; *Monilinia fructicola*
Scab; *Cladosporium carpophilum*

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EVALUATION OF EXPERIMENTAL FUNGICIDES ON PEACH AND NECTARINE, 1986. Experimental fungicide treatments were evaluated for disease control and phytotoxicity on 7-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 as follows: Mar 31 (early bud swell, Carbamate and Bravo treatments only); Apr 3 (pink); Apr 22 (petal fall - fruit set); first through sixth covers, respectively May 8, May 22, Jun 9, Jun 26, Jul 8, Jul 18. Seventh cover (nectarine only) was applied Aug 4. Treatments involving SAN 619 and SAN 675 were also applied as listed 2nd-4th cover on peach and 2nd-5th cover on nectarine. All other treatments received Kolodust Xtra 53W (5 lb/100 gal) for these mid-season cover spray treatments only. Insecticides applied separately with an airblast sprayer included Lannate L, Guthion and Sevin. After harvest one set of uniformly ripe fruit was inoculated by atomizing a suspension containing 2 X 10^4 benomyl-sensitive *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 indicated incubation period at 21 C. Peach fruit were harvested, rated for scab and inoculated Jul 28, and evaluated for brown rot Jul 31, Aug 1, and Aug 5. Nectarine fruit were harvested Aug 11, rated for scab and inoculated Aug 12, and evaluated for brown rot Aug 14, Aug 16 and Aug 20.

Although scab ioculum was high because fungicides had not been applied in 1985, 1986 weather was not very favorable for scab development with the only major infection periods occurring May 14, 20 and 27. Under these conditions and with considerable variability among replicates, the only treatments which were consistently weak for scab control were SAN 619 (applied alone throughout the entire season) and Funginex (applied at 1st cover, May 8, but followed with Kolodust in the mid-season cover sprays). Artificial inoculation resulted in a greater percent increase in brown rot infection on peach than on nectarine. The most effective brown rot treatments on nectarine involved RH-7592, SAN 619 F and SAN 675 F. Under heavier disease pressure on peach, these materials also showed good potential but were less outstanding. Funginex also gave good control on peaches throughout the three and five day incubation periods, but control started to break down after nine days' incubation. The effectiveness of the Benlate + Captan standard treatment was reduced by the presence of benomyl-resistant strains in the orchard as indicated by 50-75% of the cultures isolated from infected fruit after the final evaluation. There was no evidence of phytotoxicity by any treatment.

Evaluation of experimental fungicides on peach and nectarine

Treatment and rate/100 gal pink to 1st cover, 5th & 6th C, peach and 6th & 7th C, nectarine[1]	Disease incidence (%)												
	Redhaven peach							Redgold nectarine					
	brown rot, after indicated days incubation[2]							brown rot, after indicated days incubation[2]					
	non-inoculated			inoculated				non-inoculated		inoculated			
	3	5	9	3	5	9	scab[3]	4	8	4	8	scab[3]
Untreated	34 b	52 b	87 b	55 c	97 e	100 h	18 bc	30 b	54 c	30 b	75 d	32 ab
Tilt 3.6E 20 ml	3 a	12 a	47 a	5 ab	36 bcd	90 g	1 a	10 a	44 bc	5 ab	30 ab	1 a
Tilt 3.6E 40 ml	2 a	9 a	22 a	1 a	18 abc	77 efg	5 ab	2 a	16 abc	5 ab	31 ab	22 ab
Systhane 50W 2.5 oz	6 a	19 a	47 a	15 b	45 d	80 g	0 a	1 a	11 ab	2 a	12 ab	6 a
Systhane 40W 5.0 oz	0 a	18 a	48 a	8 ab	31 bcd	82 fg	6 abc	6 a	37 abc	14 ab	10 ab	10 a
RH-7592 0.5E 8.0 fl oz	0 a	6 a	26 a	0 a	14 ab	45 a-d	2 a	0 a	0 a	0 a	6 a	26 ab
RH-7592 0.5E 16.0 fl oz	5 a	12 a	31 a	8 ab	18 abc	53 a-g	1 a	0 a	4 a	0 a	1 a	4 a
SAN 619 F 10W 25.0 g*	2 a	7 a	24 a	4 ab	7 a	33 abc	7 abc	2 a	2 a	1 a	6 a	23 ab
SAN 619 F 10W 50.0 g*	1 a	2 a	12 a	4 ab	7 a	26 ab	19 c	0 a	0 a	0 a	3 a	32 ab
SAN 619 F 10W 25.0 g + Captan 50W 13.2 oz*	4 a	11 a	35 a	8 ab	24 a-d	48 a-e	1 a	1 a	1 a	0 a	3 a	18 ab
SAN 619 F 10W 50.0 g + Captan 50W 26.5 oz*	4 a	14 a	34 a	3 ab	18 abc	38 abc	1 a	0 a	1 a	0 a	5 a	0 a
SAN 675 F 80W 44.1 oz*	6 a	12 a	29 a	5 ab	11 ab	16 a	0 a	0 a	2 a	1 a	0 a	0 a
Funginex 1.6E 12.0 fl oz	1 a	3 a	21 a	2 a	9 ab	33 abc	17 bc	4 a	19 abc	2 a	16 ab	39 b
Carbamate 76W 2.0 lb (early bud swell only) Benlate 50W 4.0 oz + Captan 50W 1.0 lb	0 a	8 a	27 a	4 ab	17 abc	58 b-g	1 a	0 a	24 abc	0 a	16 ab	1 a
Rovral 50W 12.0 oz	8 a	17 a	37 a	6 ab	42 cd	74 d-g	1 a	16 a	45 c	21 ab	60 cd	7 a
Bravo 720 1.5 pt (early bud swell, pink, petal fall) Bravo 720 2.0 pt (shuck split, 1st cover) Benlate 50W 4.0 oz + Captan 50W 1.0 lb (5th & 6th C, peach and 6th & 7th C, nectarine	5 a	10 a	33 a	4 ab	19 abc	65 c-g	1 a	16 a	46 c	23 ab	38 bc	1 a

Averages of four replications. Column mean separation by Duncan's Multiple Range Test (p = 0.05).

1 Formulated material per 100 gal dilute. Applied to the runoff point with a single nozzle handgun at 500 psi. *Treatments involving SAN 619 and SAN 675 were also applied as listed 2nd-4th cover on peach and 2nd-5th cover on nectarine. All other treatments received Kolodust Xtra 53W 5 lb/100 gal only for these mid-season cover spray treatments.

2 Duplicate samples of 25 apparently uninfected fruit/replication harvested and placed on fiber trays Jul 28 (peach) and Aug 12 (nectarine). Inoculated fruit misted with suspension containing 2 X 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.

3 Counts of 50 fruit from each of four replications at harvest Jul 28 (peach) or Aug 12 (nectarine).

EFFECT OF 2,4-DP ON PREHARVEST DROP AND FIRMNESS OF 'ROME' APPLES

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INTRODUCTION

The loss of 2,4,5-TP (2,4,5-trichlorophenoxy propionic acid) and the questionable status of Daminozide (butanedioic acid mono-2,2, dimethyl hydrazide) have prompted renewed studies on delaying fruit abscission (1,2). Studies in Virginia and West Virginia have demonstrated that 2,4-DP (2-(2,4-dichlorophenoxy) propionic acid) is an effective alternative for 2,4,5-TP.

MATERIALS AND METHODS

In an effort to generate data needed for possible registration of 2,4-DP, a preharvest drop control study was conducted in 1986 on 'Law Rome'/MM 111. Four 2,4-DP treatments (5 ppm, 10 ppm, 15 ppm, 5 ppm plus wetting agent) and the recommended rate of the only abscission inhibitor currently registered for use at harvest, NAA (10 ppm), were compared to no treatment. The growth regulators were applied with a Swanson DA500A airblast sprayer traveling at 3.9 k/hr and calibrated to deliver 935 l/ha. The experimental design was randomized block with 8 single tree replicates. Application dates were 9/23 for 2,4-DP and 9/26 for NAA. Estimated optimum harvest dates, based on days from full bloom, were 10/7 - 10-17.

Following treatment, all fruit was removed from the ground under the trees. At four weekly intervals (10/1, 10/7, 10/13, 10/20) fruit was collected from under each tree and weighed. The fruit remaining on each tree was harvested on 10/20 and weighed. Drop was calculated as percent of the total fruit picked and picked up before and at harvest.

Ten apples were sampled from each tree at harvest. Firmness was determined on half the apples, and the remainder were held for post-storage quality evaluations. Fruit samples were also collected for residue analysis, but this information is not yet available.

RESULTS AND CONCLUSIONS

Fortunately for West Virginia growers, preharvest fruit drop in 1986 was minimal. The total drop in control plots was 16%, which was light compared to 46% in 1985 and 29% in 1984. The best drop control was achieved with an application of 15 ppm 2,4-DP, and 10 ppm NAA was the least effective treatment (Table 1). Four weeks following application the 15 ppm 2,4-DP treatment continued to provide excellent control of abscission (Figure 1). Addition of a wetting agent significantly improved the performance of 2,4-DP. The differences were statistically significant at the 5% level. No phytotoxicity was observed in any of the plots.

Fruit firmness at harvest was significantly decreased by 5 and 15 ppm 2,4-DP. As observed in other fruit abscission studies, monitoring of fruit maturity is of particular importance when auxins are used to delay fruit drop.

Based on these results and two prior years of work with drop inhibitors, 2,4-DP would be a valuable harvest aid for fruit growers in the Cumberland-Shenandoah region. The residue analyses, when completed, will be available upon request.

ACKNOWLEDGEMENTS

The assistance of James Locke and his staff is gratefully acknowledged. The 2,4-DP used in this study was a formulation provided by BASF Corporation and the NAA was supplied by Union Carbide Agricultural Products, Inc.

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Table 1. Influence of growth regulator treatments on weekly fruit drop and firmness of 'Law Rome'. Fall, 1986.

TREATMENT[z]	PREHARVEST DROP 10/1	10/7	10/13	10/20	TOTAL	FRUIT FIRMNESS (10/20)
			(%)[y]			(kg/cm^2)[x]
15 ppm 2,4-DP	2.1 a	0.9 a	0.8 a	2.6 a	6.5 a	6.2 a
10 ppm 2,4-DP	2.3 ab	1.6 a	1.7 ab	3.8 ab	9.3 ab	6.4 ab
5 ppm 2,4-DP	3.1 ab	1.7 a	1.7 ab	4.6 ab	11.1 b	6.2 a
5 ppm 2,4-DP+W[v]	2.3 ab	2.5 ab	1.2 a	2.5 a	8.6 ab	6.2 a
10 ppm NAA	5.3 c	1.3 a	2.8 bc	3.0 a	12.4 bc	6.5 ab
Control	4.0 bc	3.0 b	3.3 c	5.9 b	16.1 c	6.7 b

[z]Applied with a Swanson DA500A airblast sprayer, 935 l/ha, to 8 single tree replicates on 10/23 (2,4-DP) and 10/26 (NAA).

[y]Weight of fruit collected from under each tree as percent of total weight of fruit from tree.

[x]Measured with Effegi Pressure Tester.

[w]Mean separation within columns by DNMRT, 5% level.

[v]Wetting Agent added - 1 ml/l Balance (Precision Laboratories, Inc.).

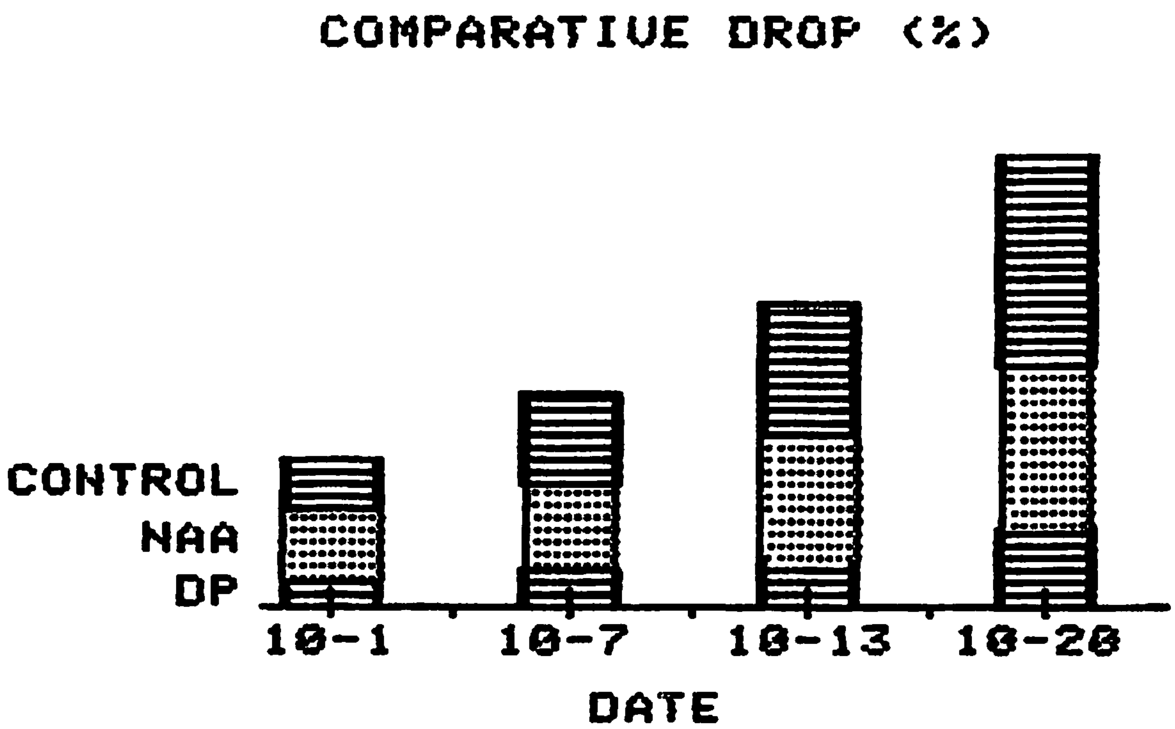

Figure 1. Comparison of 15 ppm 2,4-D, 10 ppm NAA, and no treatment on cumulative % fruit drop of 'Law Rome'.

BLOOM THINNING PEACH TREES WITH FERTILIZERS

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Abstract. Airblast application of several fertilizers reduced fruit set and increased fruit size of 'Redhaven' peach trees when applied in full bloom (Table 1). The addition of a surfactant, alkylaryl polyoxyethylene glyco phosphate ester (Spray Aide) to ammonium thiosulfate (ATS) at rates from 0 ml/l to 5 ml/l did not increase thinning.

Airblast application of ATS made to small blocks of 'Biscoe' peach trees (5 rows wide and 10 trees long) increased flower thinning (Figure 1) and increased fruit size (Figure 2) in the center row of 5 row wide blocks due to drift from adjacent rows when compared to applications made to single trees in a single row. Notice that there was no dose response to increasing concentration of ATS. We believe this was the result of light rain which occurred before the high concentrations had dried and the lowest concentration had dried and was re-wetted. The lowest concentration had the most flower and leaf injury observed 7 days later. A similar experiment on 'Redhaven' in 1984 showed a dose response and an increased effect when ATS was applied to a block when compared to a single row application (Figure 3). Ethylene-bisdithio carbamate (Zineb 78WP) was used to determine the amount of drifted chemical by airblast sprays to adjacent rows. Airblast spraying of a block of peach trees (two adjacent rows on both sides of a single row was sprayed) in full bloom contributed chemical deposits equal to 140% of that when a single row was sprayed. In the 1984 'Redhaven' experiment, airblast spraying of a block of peach trees contributed chemical deposits equal to 169% of that when a single row was sprayed.

Nutra leaf (20-20-20) fertilizer applied at 100 lbs/100 gallons to non-fertilized peach trees in full bloom did not cause significant fruit thinning or increase in fruit size, but slightly increased chlorophyll content of leaves. Nutrient levels of flowers were increased (N, P, K, Zn, Mu, Cu, Fe, B, Al, but not Mg and Ca) significantly when flowers were collected on the day of application, but nutrient levels of leaves and fruit 39 days after application were not different from non-treated trees (Table 2). Where ATS was used in 2 other experiments, nitrogen levels were not different from non-treated controls even where thinning occurred.

Table 1. Effect of airblast spray applications of fertilizers to 'Redhaven' peach trees in bloom on fruit set.

Treatment (April 9, 1986)[z]	Formulation rate	No. fruit/cm² cross sectional area of limb (FB + 51)[y]	Fruit diameter (cm) (FB + 92)	Leaf area (FB + 51) cm²/leaf	Chlorophyll (O.D. at 665 mu) (FB + 51)
1. Control	--	8.12 a	5.59 a	42.6 b	.66 ab
2. Bloom thinned	--	4.32 bcd	5.94 abcd		
3. Hand thinned (FB+51)	--	4.70 bc	5.97 abcd		
4. ATS	25 ml/l	3.07 cdef	6.35 def	41.7 bc	.67 a
5. ATS + Spray-Aid	25 ml/l 1.25 ml/l	1.87 ef	6.53 fg		
6. ATS + Spray-Aid	25 ml/l 5.0 ml/l	3.58 cde	6.32 def		
7. ATS + Spray-Aid	30 ml/l 1.25 ml/l	1.60 ef	6.48 ef		
8. ATS + Spray-Aid + GA_3	30.0 ml/l 1.25 ml/l 200 ppm	1.69 ef	6.63 g	46.0 a	.69 a
9. Nutra-Leaf (20-20-20) + Spray-Aid	120 g/l 1.25 ml/l	4.47 bc	6.02 abcde	42.1 bc	
10. 28-0-0 + 0-20-18 + X-77	100 ml/l 50 ml/l 1.25 ml/l	4.52 bc	6.12 bcde	42.5 b	.62 c
11. 28-0-0 + X-77	100 ml/l 1.25 ml/l	7.49 a	5.66 ab	40.0 c	.63 bc
12. 10-10-10 + X-77	100 ml/l 1.25 ml/l	6.22 ab	6.07 abcde		
13. 8-16-8 + X-77	80 ml/l 1.25 ml/l	8.09 a	5.79 abc	40.7 bc	.67 a
14. 16-4-4 + X-77	80 ml/l 1.25 ml/l	2.40 def	6.27 cdef		
15. NH_4NO_3 + X-77	90 g/l 1.25 ml/l	1.30 f	6.35 def		
16. N Mg + X-77	100 ml/l 1.25 ml/l	1.63 ef	6.48 ef		

[z]Full bloom occurred April 8, 1986. The airblast sprayer was calibrated at 1402 l/ha (150 gal/A).
[y]Mean separation within columns by Duncan's multiple range test, 5% level.

Table 2. Effect of Nutra leaf (20-20-20) on 'Loring' peach thinning and nutrient levels in flowers, leaves, and fruit (1986).

Paramater (days after full bloom)[z] (DAFB)	Control		Nutra leaf (20-20-20)[y] 120 g/l	
Fruit/cm^2 cross sectional area of limb (46 DAFB)	19.0	a[x]	15.2	a
Fruit weight (g) (39 DAFB)	76.0	a	84.0	a
Fruit diameter (cm) (119 DAFB)	6.2	a	6.5	a
Red color (%) (119 DAFB)	41.0	a	43.0	a
Background (0-5) (119 DAFB)	3.0	a	3.2	a
Firmness (neutons) (119 DAFB)	95.0	a	87.0	a
Soluble solids (%) (119 DAFB)	8.4	a	9.2	b
Leaf area (cm^2) (39 DAFB)	26.0	a	27.0	a
Leaf area (cm^2) (55 DAFB)	38.0	a	41.0	a
Leaf chlorophyll (O.D. 665 mu) (55 DAFB)	0.65	a	0.69	b
Nutrient levels of flowers (0 DAFB)				
% N	3.30	a	6.01	b
% P	0.40	a	2.24	b
% K	2.15	a	5.15	b
% Ca	0.43	a	0.37	a
% Mg	0.21	a	0.18	a
ppm Zn	64.3	a	143.7	b
ppm Mn	35.0	a	126.0	b
ppm Cu	9.3	a	110.7	b
ppm Fe	92.3	a	288.7	b
ppm B	56.3	a	70.3	b
ppm Al	51.7	a	57.3	b
Nutrient levels of leaves (39 DAFB)				
% N	3.29	a	3.56	a
% P	0.24	a	0.26	b
% K	2.88	a	2.98	a
% Ca	1.72	a	1.69	a
% Mg	0.45	a	0.44	a
ppm Zn	59.0	a	65.0	a
ppm Mn	37.0	a	36.0	a
ppm Cu	10.0	a	11.0	a
ppm Fe	111.0	a	104.0	a
ppm B	34.0	a	33.0	a
ppm Al	126.0	a	127.0	a
Nutrient levels of fruit (39 DAFB)				
% N	1.69	a	1.62	a
% P	0.20	a	0.19	a
% K	1.60	a	1.46	a
% Ca	0.23	a	0.23	a
% Mg	0.12	a	0.11	a
ppm Zn	95.0	a	66.0	a
ppm Mn	11.0	a	12.0	a
ppm Cu	10.0	a	11.0	a
ppm Fe	48.0	a	60.0	a
ppm B	30.0	a	26.0	a
ppm Al	30.0	a	36.0	a

[z] Full bloom occurred April 6, 1986.
[y] Nutra leaf contains N-20%; P_2O_5-20%; K_2O-20%; B-200 ppm; Cu-500 ppm; Fe-1000 ppm; Mn-50 ppm; Zn-500 ppm.
[x] Mean separation within columns by Duncan's multiple range test, 5% level.

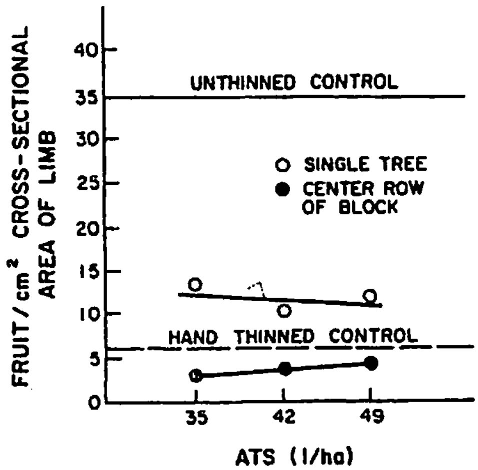

Figure 1. Effect of ammonium thiosulfate (ATS) applied to 'Biscoe' peach trees in full bloom on fruit/cm² cross sectional area of limb when applied to single trees or to a center row of a block of trees receiving spray drift from adjacent rows.

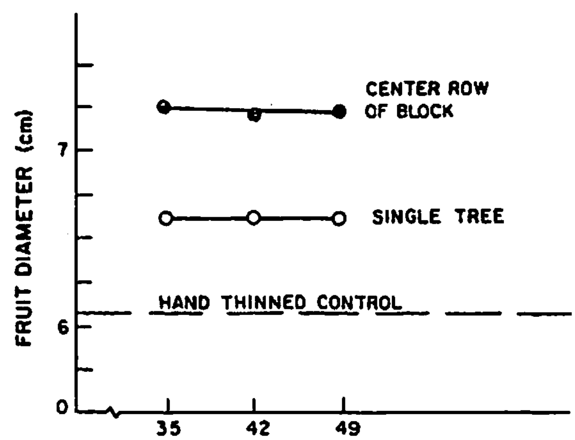

Figure 2. Effect of ammonium thiosulfate (ATS) applied in full bloom on fruit diameter of 'Redhaven' peach fruit when applied to single trees or to a center row of a block of trees receiving spray drift from adjacent rows.

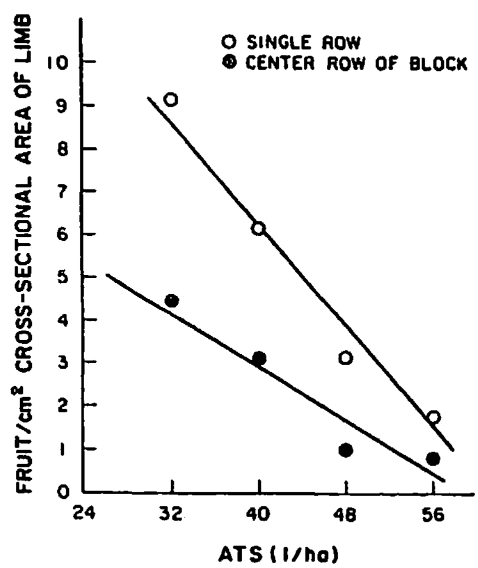

Figure 3. Effect of ammonium thiosulfate (ATS) applied to 'Redhaven' peach trees in full bloom on fruit/cm² cross sectional area of limb when applied to a center row of a block of trees receiving spray drift or to trees in a single row not receiving drift from adjacent rows.

TREE-ROW-VOLUME SPRAYING RATE CALCULATOR

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Most pesticide recommendations for apple orchards have been based on a specified rate per acre. These recommendations are usually based on dilute applications of materials in 400 gallons/acre to trees in a "standard" orchard, which are about 20 ft high, 23 ft wide, and 35 ft between rows. Most orchards today do not conform to this standard and many pesticides are applied at concentrations other than dilute.

In 1972, we proposed that smaller than "standard" trees be sprayed at rates proportional to the tree-row-volume space of a "standard" tree size as defined above. TRV rates were based on the assumption that each row is a rectangular box and the volume of air space occupied by foliage per acre was calculated on the basis of a simple rectangular box. For a "standard orchard", the TRV was calculated to be 580,331 ft3/acre.

In a subsequent study, we found spray chemical deposits to be inversely related to tree size and canopy density (canopy density was measured was as a function of light penetration through the canopy). In 1980 Herrera-Aguirre and Unrath of North Carolina State University reported reduced variability in thinning of spur-type 'Delicious' with ethephon by calibrating commercial airblast sprayers on a tree-row-volume basis. Sutton and Unrath (1986), using TRV calibration, reported that higher canopy densities resulted in lower pesticide deposits and that adjustments for canopy density would be important when using TRV spray calibration guidelines.

Grower acceptance of the tree-row-volume methods for estimating chemical rates/acre has been very slow since its first introduction in Virginia in 1972. One of the reasons was that most sprayer nozzles are not engineered to be rapidly adjustable when a change in tree size warrants a change in chemical rate/acre. Several state university spray guides now include the TRV concept for estimating the rate of chemical for differing tree sizes. Some growers are now adjusting the chemical rate in the tank and mixing different chemical rates rather than changing water rates/acre.

Previous studies have shown that chemical deposits and distribution depend on many factors other than tree size or canopy density; such as drift, tree shape, droplet size, water rate, tree volume, rate of sprayer travel, wind, type of equipment used, matching of sprayer nozzling to tree, sprayer air volume output, air velocity, and distance of sprayer to the target, etc.

The spraying rate calculator (Figure 1) was developed to provide a rapid method for estimating the chemical rate needed per acre based on changes in tree size. The calculator also provides a rapid method for determining the TRV chemical rate per acre from label rates/acre and will determine the amount of chemical required for different sprayer tank sizes at different water volumes per acre. If adjustments are desired for canopy density, pest pressure, drift, or any other reason, additional adjustments may be made by altering the % tree-row-volume calculated (i.e. $\pm$ 20%) before using the second slide of the calculator for estimating the TRV-chemical rate per acre from labelled rates.

The instructions are purposely designed to be as simple as possible and are to be used only as a guide to estimating the needed chemical rate per acre. The instructions read:

<u>Side # 1</u>

1) Set tree width at distance between rows
2) Read % tree-row-volume* at tree height
3) Set chemical labelled rate/acre at % tree-row-volume* (from spray guide or label)
4) Read TRV chemical rate/acre at arrow
5) Set water rate/acre at TRV of chemical rate/acre
6) Read TRV chemical required/tank at sprayer tank size

   * % tree-row-volume may be altered ± 20% if pest pressure, canopy density, or drift warrant.

The cautions read:

Do <u>not use chemical rates over or under those indicated on the pesticide label.</u> This slide rule should be used only as a guide for estimating chemical rates when a grower wishes to apply a chemical on a tree-row-volume (TRV) basis rather than on a specified rate/acre. If canopy density, pest pressure, or past experience dictate, % tree-row-volume may be adjusted up or down by as much as 20%. TRV-calibration will not compensate for poor chemical distribution, timing, chemical choice, weather, etc.

The tree-row-volume calibration slide rule is based on data which are believed to be reliable; but no warranty is expressed or implied by Virginia Polytechnic Institute and State University regarding accuracy or usage of this slide rule.

The slide rule is for sale in bulk to chemical companies, sprayer equipment dealers, or to universities for $3.00 each or $2.50 each in quantities over 200. Checks should be made payable to: <u>VPI and SU</u> and sent to Ross E. Byers, 2500 Valley Avenue, Winchester, VA 22601. A small window is provided on the front and a larger one on the back for a second party to place a sticker with a logo or advertisement.

The purpose for developing this slide rule was an attempt to standardize the many possible designs that might be built into a hand held calculator.

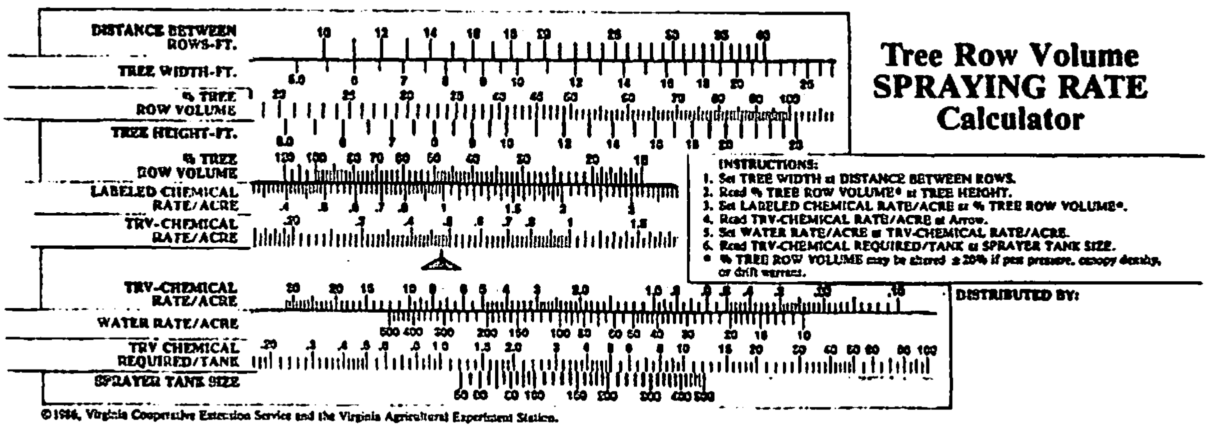

Figure 1. Tree-Row-Volume Calculator designed to estimate rate of chemical required per acre based on tree height, tree width, and row width. The calculator also will determine amount of chemical required for different spray tank sizes at different water volumes/acre.

ORCHARD DEER DAMAGE CONTROL DEMONSTRATION

AN INTEGRATED APPROACH

Steven Carcaterra, Tara Baugher, and Arthur Selders [1]

West Virginia University

Crop damage caused by the white-tailed deer (Odocoileus virginianus), continues to account for a very significant dollar loss to West Virginia farmers and orchardists. Deer damage is widespread in the state, with orchardists, nurserymen, home gardeners, Christmas tree growers, and field and forage crop producers carrying the burden of supporting the state's high deer population.

West Virginia University's Extension faculty recognized a need to provide viable alternatives for farmers experiencing excessive crop damage. A comprehensive integrated management scheme was compiled for landowners that emphasized population managment via hunting (buck and doe harvest), exclusion techniques (various high tensile electric fence designs), and chemical repellents.

The statewide educational project was designed to help landowners:

1) assess the deer damage problem on their property
2) plan and initiate an integrated control program for each farm site
3) maintain control through constant monitoring of deer, susceptible crop stages, and the condition of fences or repellents.

In response to a demand for information on deer damage control, the WVU Extension Committee on Deer Damage and Control established model deer control demonstration plots for four farm enterprises -- orchards, alfalfa, corn, and home gardens -- located in various parts of the state where deer depradation of crops is a problem. It became quickly apparent that an integrated pest management approach to deer damage control would need to be implemented. Managing deer populations included hunting and issuing of crop damage permits, construction of high tensile anti-deer fence, habitat management, and the use of repellents. Video tapes, fact sheets, news releases, and radio scripts were developed and distributed to Extension county faculty by the University deer committee. Presentations at agency and grower meetings encouraged discussion among hunters, farmers, and state wildlife managers on this very emotional and controversial subject.

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The orchard model demonstration site was located in Hampshire County, West Virginia, on a farm where severe deer damage was long known to be a problem. Both fencing and repellent studies were conducted at this site. The demonstration site itself is a commercial apple and peach orchard where six 65 ft. by 100 ft. blocks were established. Three of the blocks were fenced (April, 1984), and three were left unprotected. Twenty-one 'Golden Delicious'/seedling apple trees were planted in each of the blocks a week following fence construction. The three fencing designs chosen for the study were:

1) Eight-ft., non-electric fence using high tensile woven wire and seven strands of smooth wire. (Table 1)
2) Six strand vertical high tensile electric fence. (Table 1)
3) Single strand high tensile electric fence using peanut butter as a lure. In 1985, a second wire was added at 18 in. and peanut butter applications were discontinued.

Deer damage in each block was evaluated in July and September in 1984 and biweekly throughout the 1985 growing season. The incidence (percentage of trees browsed) and the severity of damage (mean number of shoots browsed per damaged tree) was determined. The 8-ft. non-electric fence and the six strand electric fence provided 100% control during the two-year test period. (Figure 1). During peak browsing periods, the incidence of damage in control blocks was 80-100%, with means of 4-11 shoots browsed per damaged tree (Figures 1 and 2). Following one year of high deer depradation, 42% of the trees in the check plots had died (Figure 1).

Due to the unpredictable nature of deer behavior, grower satisfaction with repellents has been quite varied. Moderate success has been reported in a number of long-term field studies conducted in New York (McAninch, 1980). Repellents available to growers include: Thiram-based materials, biologically-based materials such as fermented egg solids (Big Game Repellent), bonetar oil (Magic Circle), hot sauce extract (Miller's Hot Sauce), ammonia soap (Hinder), lime sulfur, human hair, bar soap, tankage, predator feces extracts, and pheremone extracts.

Researchers have tested repellents with largely inconclusive results. Most research previously done has shown repellents to be acceptable only in areas of low to moderate deer pressure. Many factors can confound the data collected in evaluating repellents as deer control measures. These exclude variations in deer pressure, weather severity, the proximity and availability of native deer browse, the size of the area needing protection, and the duration of the treatment period. Repellents deter deer either by taste or odor. Hinder[1], a 15% ammonium soap product that repels by odor, was chosen for evaluation in this project. It's compatibility with many other commonly used orchard pesticides and wide label uses for crops, made it an attractive option for fruit growers.

The demonstration site was a block of 125 Spartan/M.7a apple trees planted in May 1986, at a location in the same vicinity as the fencing plots. This block was immediately adjacent to a wooded area, in ideal deer habitat. The repellent was applied by handgun sprayer at bud break and approximately every three weeks throughout the growing season.

[1] Manufactured by Uniroyal Inc., Leffingwell, PO Box 1830, Brea, CA 92691.

In subsequent years of the study, the repellent will be applied in the regular tank mix cover sprays. "Piggybacking" the sprays in this manner eliminates additional labor costs, with the material cost the only additional input. As with the fencing study, efficacy of the repellent was evaluated by determining the percentage of trees browsed (incidence) and the number of browsed twigs (severity) (Figure 3).

Damage evaluations conducted in October of 1986 showed 63% of the trees treated with the repellent browsed, with 3.0 shoots browsed per tree (Figure 3). Although a high percentage of trees were browsed, the damage/tree was not severe compared to what the grower usually experienced, and he was pleased with the results. Figure 4 is a comparison of fencing vs. repellent costs. Costs for a six wire fence around a ten acre block and a fifty acre block, and for repellents under high deer pressure and moderate deer pressure are projected over a five-year period.

ACKNOWLEDGEMENTS

The authors wish to thank Richard Malcolm, Hampshire County fruit grower; Jay B. McAninch, Coordinator of Wildlife Resources, The Cary Arboretum; and Uniroyal Inc. for their contributions toward this project.

DISCLAIMER

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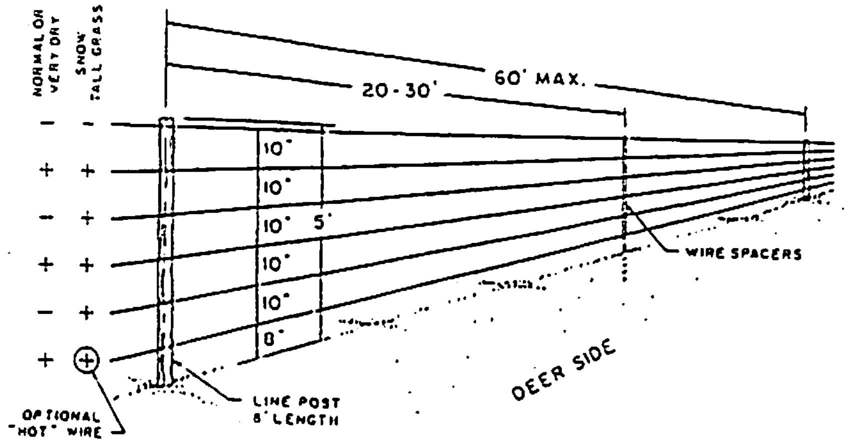
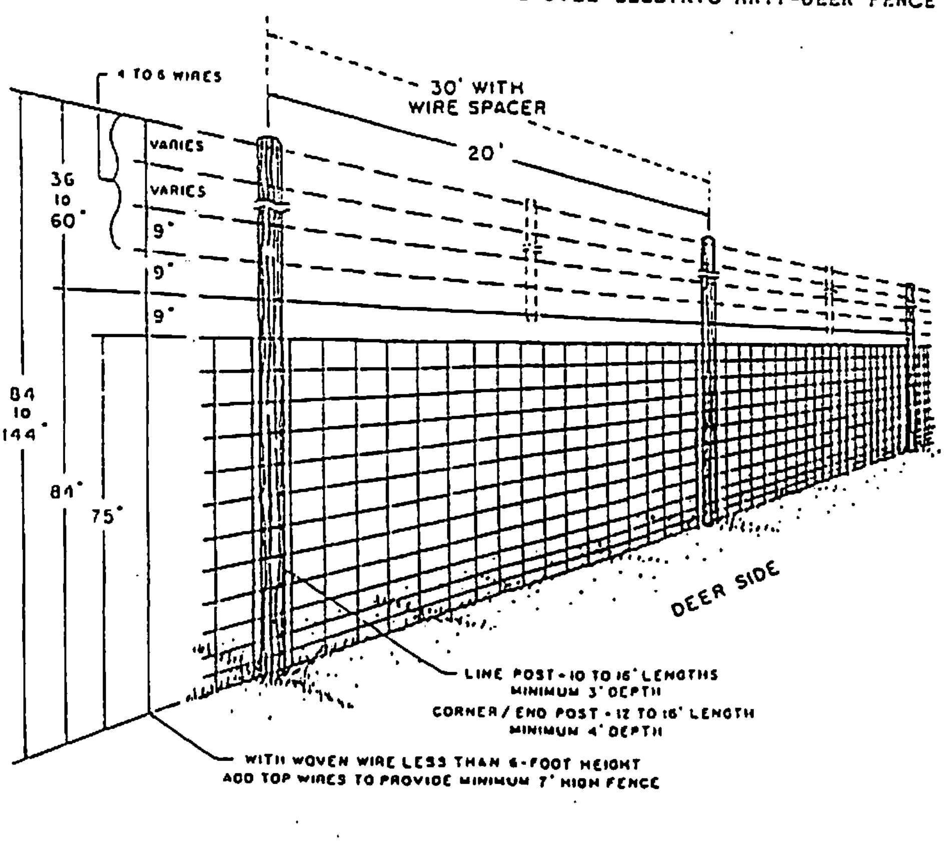
Table 1. Estimated material costs for 3 fencing designs in West Virginia deer control fencing demonstration (1985).

MATERIALS	COSTS 8-Ft Non-Elect. ($)	6 Str. Elect.	1 Str. Baited Elect.
Lineal Ft.	.86	.21	.05
Ea. Corner Assembly	71.88	29.56	9.37
Ea. End Post Assembly	46.10	35.24	9.85
Ea. Gateway	185.43	143.54	25.64
Accessories[z]	35.23	317.63	135.60

[z]Wire strainers and handle, crimping sleeves, energizer.



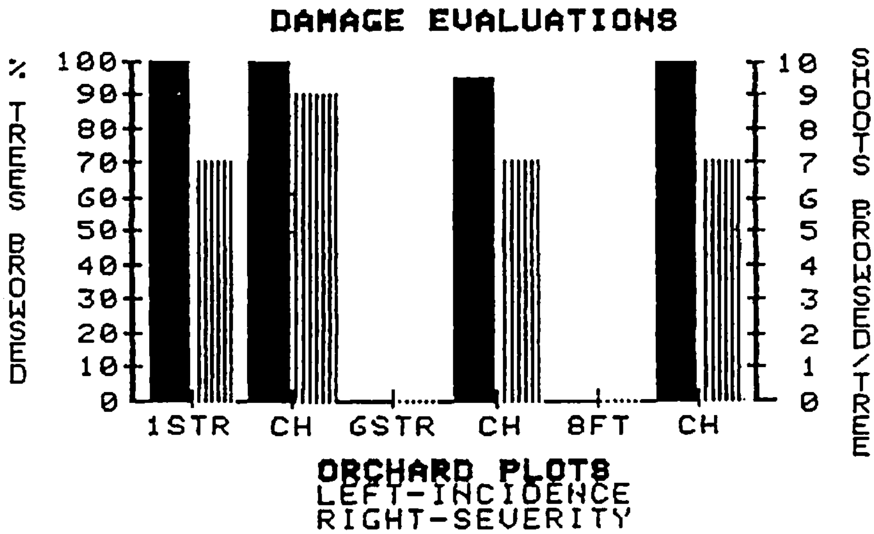
6-WIRE VERTICAL HIGH TENSILE ELECTRIC ANTI-DEER FENCE



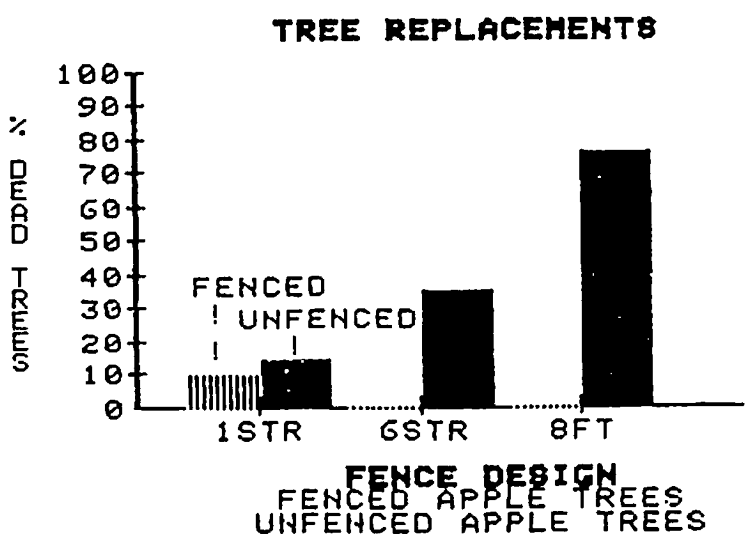
7 TO 10' HIGH TENSILE WOVEN AND SMOOTH WIRE

NON-ELECTRIC DEER FENCE

Figure 1. First year evaluations of the performances of 3 anti-deer fences.

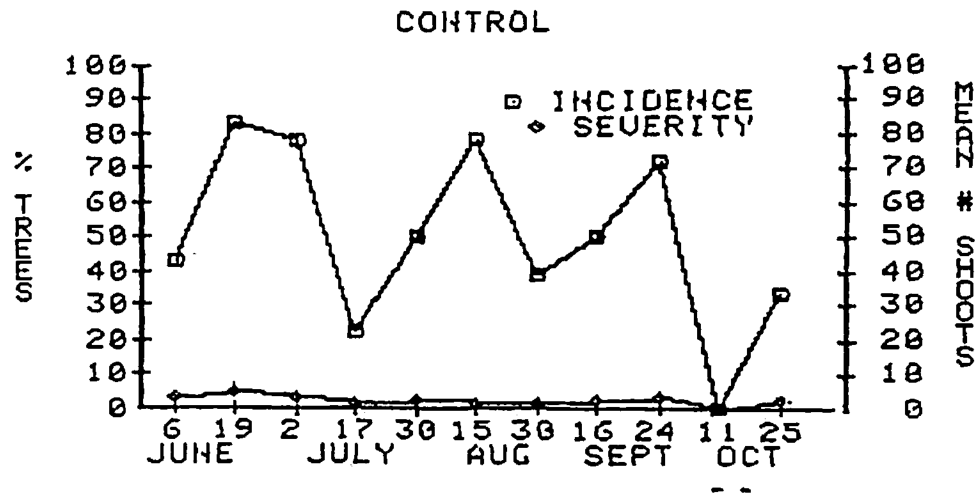


Incidence of deer damage (% of trees browsed) and severity of damage (mean number of shoots browsed/tree) in fenced vs. unfenced (CH) 'Golden Delicious' apple trees planted May, 1984.

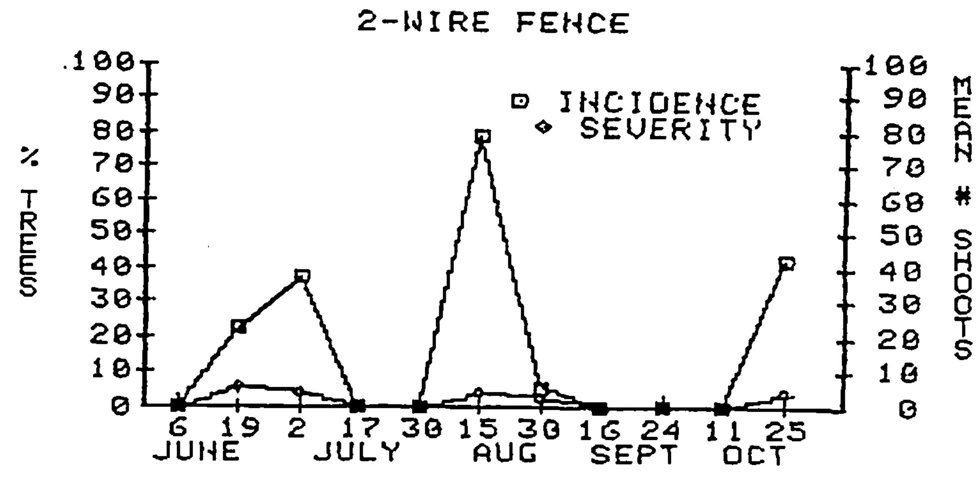


Tree mortality (% dead trees) in fenced vs. unfenced 'Golden Delicious'.

Figure 2. Deer damage evaluations conducted in fence demonstration plot 2 years following establishment of 3 anti-deer fence designs.



Seasonal changes in the incidence (% of trees browsed) and severity (mean number of shoots browsed/tree) of damage in unfenced 'Golden Delicious' apple trees planted May, 1984.



Seasonal changes in the incidence and severity of damage in 'Golden Delicious' protected by 2 strand high tensile electric fence. No damage was observed inside 8-ft non-electric fence or 6 strand vertical high tensile electric fence.

Fig. 3: Incidence of deer damage (% of trees browsed) and severity of damage (mean number of shoots browsed/tree) in fenced vs. repellent treated apple trees.

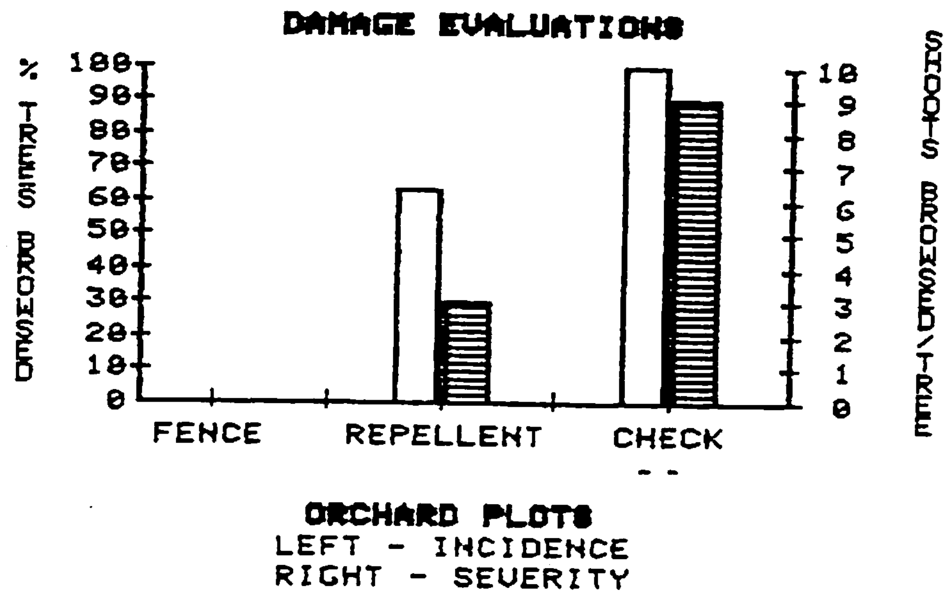
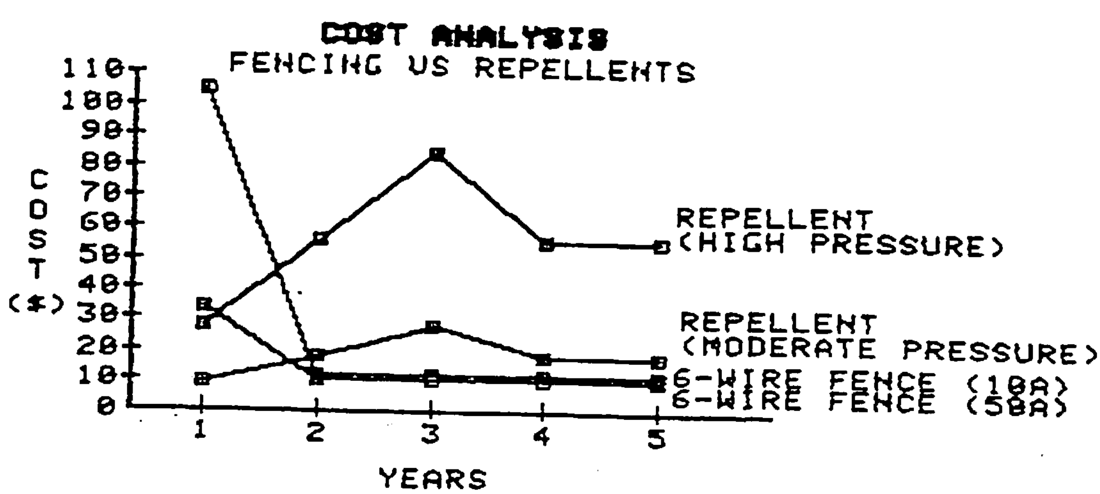


Fig. 4: Projected comparison of fencing vs. repellent costs based on data collected from orchard demonstration (labor and interest excluded).



Fruit Yield and Quality of Apple Trees Under Three Training Systems

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The need for increased production efficiency and better utilization of the orchard floor has resulted in increased planting densities. Recent trellising innovations have not only been directed towards early production of high quality fruit but also at mechanization, as with the Tatura trellis, Lincoln Canopy and the MIA. A number of these systems are being evaluated at the WVU Experiment Station at Kearneysville. This paper reports on the results of fruit yield and quality of apple trees trained to European 3-wire (3W), Lincoln Canopy (LC) and Spindlebush (SB) systems.

The 3-wire trellis and radially trained Lincoln Canopy were planted in March 1979 at a spacing of 6' x 12' (605 trees/acre). The Spindlebush was planted in December 1979 at a 3' x 9' spacing (1613 trees/acre). Trees of 3-wire and Spindlebush were on M.9 rootstock and those of Lincoln Canopy on M.26.

The cumulative yield of 'Golden Delicious' (from 1983 to 1986) was higher than other cultivars on 3-wire and Lincoln Canopy. The yields of 'Topred Delicious' and 'Starkrimson Delicious' on trellis trained trees and Spindlebush have shown an increase from 1983 to 1986. Yields for all cultivars and training systems in 1985 and 1986 are presented in Table 1.

Fruit size of 'Topred' on 3-wire was larger than on Lincoln Canopy (Table 2). A similar situation was observed in 'Golden Delicious' in 1985. Firmness of 'Starkrimson' on 3-wire was consistently higher than Spindlebush. Soluble solids in 'Topred' were higher on 3-wire as compared to Lincoln Canopy in both years (Table 2). The color and L/D ratio of 'Delicious' was not influenced by the training system.

Table 1. Influence of training systems on fruit yield and trunk circumference of Golden Delicious, Topred and Starkrimson apple trees.

System	1985 Golden	1985 Topred	1985 Starkrimson	1986 Golden	1986 Topred	1986 Starkrimson
	Yield (kg/tree):					
LC	31.21a[z]	13.43b	---	21.59A	21.33	---
3W	39.16a	10.43b	17.59b	12.54bB	21.81a	21.71a
SB	---	---	17.09	---	---	17.70
	Trunk circumference (cm^2):					
LC	21.4	23.4	---	37.5a	28.1b	---
3W	28.3a	27.1a	10.9b	38.8a	29.7a	17.3b
SB	---	---	13.5	---	---	15.9
	Yield/cm^2 trunk circumference:					
LC	1.48a	0.63bA	---	0.63	0.82	---
3W	1.49a	0.40bB	1.70aA	0.40c	0.75b	1.28a
SB	---	---	1.27B	---	---	1.20

[z]Means by year and parameter with dissimilar letters are significantly different at P = 0.05 (lower case for rows, upper case for columns).

Table 2. Influence of training systems on fruit quality of Golden Delicious, Topred and Starkrimson apple trees.

System	1985 Golden	1985 Topred	1985 Starkrimson	1986 Golden	1986 Topred	1986 Starkrimson
	Fruit diameter (cm):					
LC	7.36bB[z]	8.24aB	---	7.64	7.48B	---
3W	7.60cA	8.74aA	7.82b	7.71b	7.93aA	7.68b
SB	---	---	7.68	---	---	7.52
	Fruit firmness (kg):					
LC	6.94a	5.76b	---	6.74	6.57	---
3W	6.89a	5.48b	6.98aA	6.94a	6.65b	6.99aA
SB	---	---	6.53B	---	---	5.85B
	Soluble Solids(%):					
LC	13.5b	14.1aB	---	13.2aB	11.6bB	---
3W	13.5b	15.5aA	12.8c	14.9aA	13.8bA	12.6c
SB	---	---	12.4	---	---	12.6

[z]Means by year and parameter with dissimilar letters are significantly different at P = 0.05 (lower case for rows, upper case for columns).

PPG-1721 Effects On Color, Maturity and Abscission of 'Rome', 'Red Delicious' and 'Empire' Apples

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Introduction.

PPG-1721 is an experimental plant growth regulator from Pittsburgh Plate Glass Industries (Pittsburgh PA 15272). Preliminary studies have indicated a reduction in stress induced ethylene production. Application to maturing apples (cultivar not given) retarded abscission, however effects on maturity and quality have not been determined. (Interim Biochemical Product Bulletin, PPG Industries, Pittsburgh, PA, 1986).

This study investigated the effect of PPG-1721 on fruit abscission, anthocyanin production and maturity in 'Spur Red Delicious'and 'Law Rome' apples. Effects on abscission were also determined in 'Empire' apples.

Materials & Methods.

Experiment 1. Five year old trees of 'Empire' on M7A trained to a modified central leader at Rutgers Fruit Research and Development Center, Cream Ridge, NJ, were treated on 15 September, 1986. Treatments were applied to runoff to single trees in a randomized complete block design (6 replicates) as follows: a.) control (water), b.) 15 ppm NAA and c.) PPG-1721 at 100, 200, 400, 600 or 800 ppm. All treatments included X-77 surfactant. Beginning 19 September and at 2 or 3 day intervals thereafter, the number of fruit abscissed per tree was recorded. Two fruit per tree were evaluated for soluble solids and firmness weekly. Fruit was harvested and counted on 1 October. Total fruit per tree including drops was determined. For each counting date, a cumulative percentage total fruit abscissed was determined for each tree.

Experiment 2. Five year old 'Spur Red Delicious' and 'Law Rome' on M7A trained to a modified central leader at Cream Ridge were treated on 22 August 1986 as follows: a.) control (water), b.) Alar (1 lb per 100 gal water), c.) Promalin (1 pt per 100 gal), d.) PPG-1721 (100 ppm), e.) Promalin + Alar, f.) Promalin + PPG-1721 and g.) Promalin on 22 August and PPG-1721 on 15 September. Alar and Promalin treatments were included for comparison. Trees were arranged in a RCB design, and treated individually to runoff. Beginning September 12 and continuing at approximately four day intervals thereafter, fruit drop was recorded as with 'Empire'. At harvest, anthocyanin was determined spectrophotometrically and CO_2 evolution for individual apples was determined with gas chromatography. CO_2 was determined for 'Rome' apples only.

'Red Delicious' were harvested on September 18. Romes were harvested October 20.

All data were analyzed by ANOVA and means separated with the Waller-Duncan test, K ratio=100, when appropriate.

Results

Experiment 1. No treatment effect was revealed for either soluble solids or firmness in 'Empire'. Average soluble solids at harvest were 12.4 % brix and firmness was 14.5 lbs. No treatment differences in maturity date were detected. Rate of fruit abscission is presented in Figure 1. Compared to the control, NAA significantly reduced fruit abscission while PPG had no effect. No effect of rate of PPG was detected, thus PPG rates were combined in Figure 1. Total crop abscission was 9.4 % for NAA and 25.0% for PPG-1721 or the control.

Experiment 2. 'Red Delicious'.

Abscission. A significant treatment effect on percent total crop abscissed was detected (Table 1). Alar and Promalin + Alar tended to reduce fruit drop.

Color. A difference in anthocyanin production was detected between Alar and Promalin + PPG (split).

Firmness. No treatment effect on firmness at harvest was detected. Average firmness at harvest was 14.3 lbs.

Rome. Abscission. Promalin or PPG-1721 alone increased fruit abscission (Figure 2). However, when applied in combination, abscission was reduced compared to the control. When PPG-1721 was applied as a split, abscission was as low as with Alar.

Color. Anthocyanin production was decreased by Alar, PPG, or Promalin and PPG (split) compared to all other treatments (Table 2). Alar likely resulted in a decrease in anthocyanin due to a delay in maturity, although sampling to determine harvest did not reveal such an effect. This is partially supported by a tendancy towards lower CO_2 evolution in Alar treated apples. Promalin + Alar tended to have the highest level of anthocyanin. Promalin overcame the reduction in anthocyanin production associated with Alar's delay in maturity.

Firmness. Promalin apples were firmer than Promalin + PPG at harvest (Table 2).

Discussion.

PPG-1721 was ineffective as a stop drop on 'Empire', 'Red Delicious', and 'Rome'. However, there appears to be potential in 'Rome'; when applied with Promalin, PPG-1721 was effective in reducing fruit abscission. A split application was as effective as Alar in reducing abscission.

PPG alone or in combination with Promalin did not appear to greatly affect coloring in 'Red Delicious'. In 'Rome', a single application of PPG with Promalin or PPG alone reduced anthocyanin. Fruit firmness was unaffected by PPG-1721.

A combination of Promalin + PPG-1721 appears to have promise in reducing fruit abscission in 'Rome'. Further studies are warranted.

Table 1. Anthocyanin (nmoles / cm^2), firmness (lbs), and fruit abscission (% total crop abscised) for 'Red Delicious' apples treated with PPG-1721, Alar and Promalin.

Treatment	Anthocyanin ($nmoles/cm^2$)	Firmness (lbs)	Abscission (% abscised)
Control	55.9 ab[z]	15.0 a	33 ab
Alar	59.9 a	14.8 a	9 bc
Promalin	54.1 ab	14.4 a	16 abc
PPG-1721	50.6 ab	13.9 a	27 abc
Promalin + Alar	49.3 ab	14.6 a	5 c
Promalin + PPG	52.3 ab	13.4 a	37 a
Promalin + PPG(split)	47.2 b	14.5 a	22 abc

Table 2. Anthocyanin (nmoles / cm^2), firmness (lbs), and CO_2 evolution (ml/kg/hr) for 'Rome' apples treated with PPG-1721, Alar and Promalin.

Treatment	Anthocyanin ($nmoles/cm^2$)	Firmness (lbs)	CO_2 (ml/kg/hr)
Control	40.9 a	17.8 ab	10.7 a
Alar	33.7 b	18.2 ab	8.7 a
Promalin	43.2 a	19.3 a	10.3 a
PPG-1721	33.2 b	18.6 ab	10.3 a
Promalin + Alar	45.1 a	18.7 ab	9.5 a
Promalin + PPG	34.1 b	16.5 b	9.2 a
Promalin + PPG(split)	42.5 a	17.7 ab	9.1 a

[z]Mean separation within column by Waller-Duncan K ratio test.

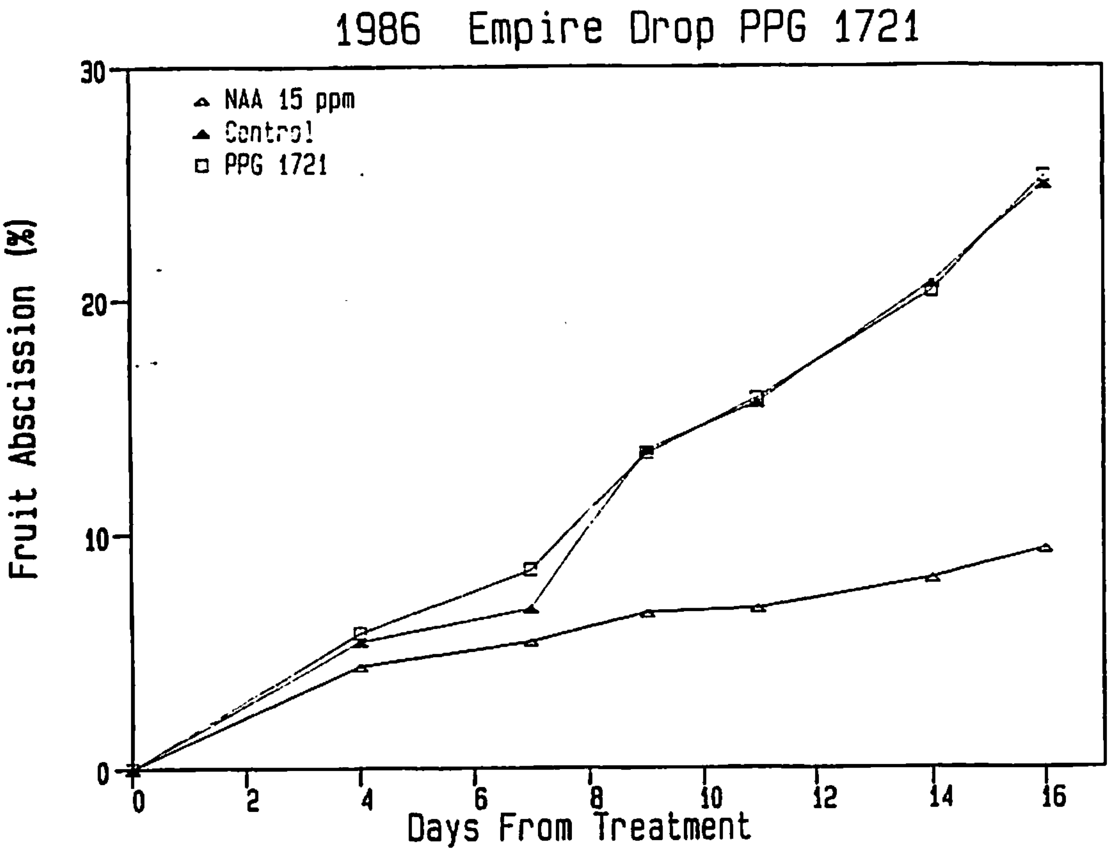

Figure 1. Fruit abscission for 'Empire' apples treated with NAA or PPG-1721.

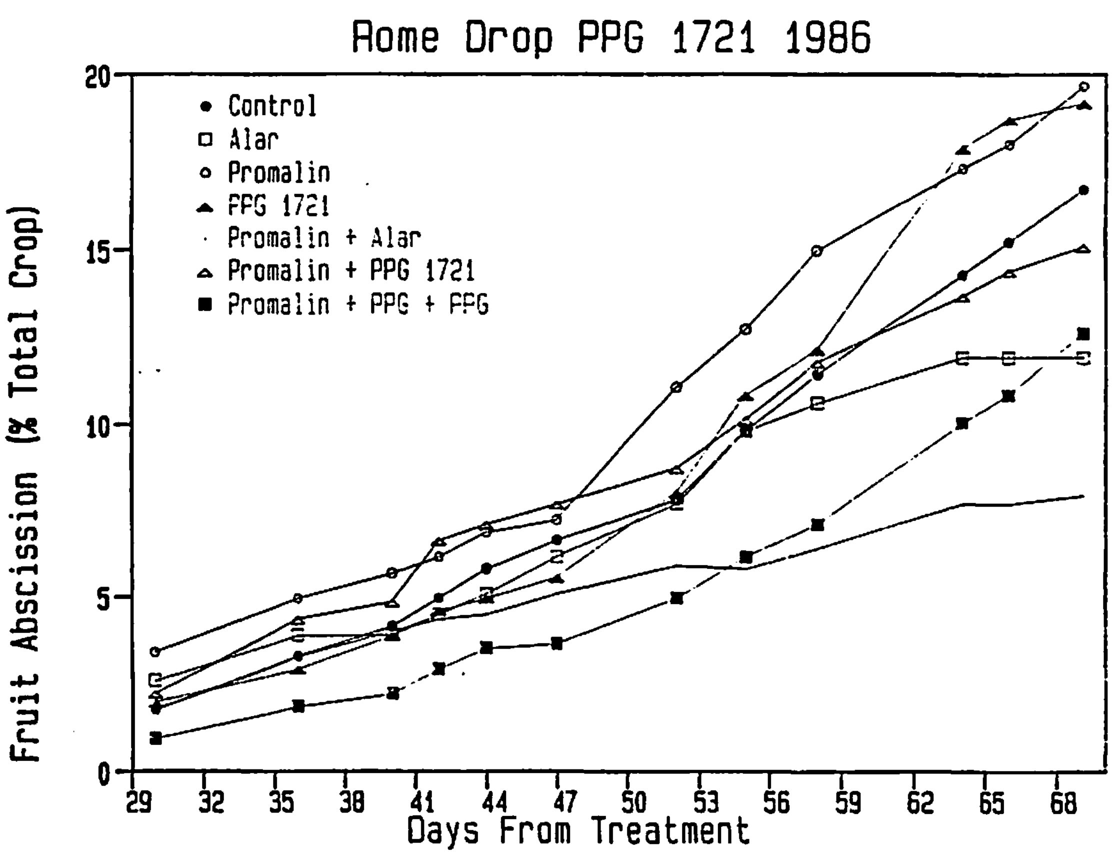

Figure 2. Fruit abscission for 'Rome' apples treated with Alar, Promalin or PPG-1721.

Lactofen in Combination with Other Herbicides for Weed Control in Young Apple Plantings in Virginia in 1986

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Introduction

Lactofen, a two pound per gallon emulsifiable concentrate with the trade name Cobra, is a product of PPG Industries, Inc. Lactofen has shown selectivity in several crops and was available for experimental use in 1986 as a postemergence treatment for weed control in soybeans.

In an earlier experiment in a young apple orchard, we found that lactofen used in combination with paraquat did not provide adequate control of broadleaf weeds and no control of the perennial weeds encountered. Excellent control of the annual broadleaf weeds was achieved when lactofen was applied in combination with simazine + paraquat. No injury to apple trees occurred. The purpose of this work was to further evaluate lactofen used in combination with other herbicides for weed control in young apple plantings. Selected herbicide treatments recommended for use in tree fruit in Virginia were included for comparison.

Materials and Methods

Three experiments were conducted in 1986 on loamy soil at Murray Harman's Orchard in Woolwine, Virginia (Patrick County). The following herbicides were applied with or without paraquat in a two-year-old apple nursery as well as in apple trees established in the field for one year: lactofen + fluazifop-butyl, lactofen + napropamide, lactofen + oryzalin, and lactofen + norflurazon. Napropamide, oryzalin and norflurazon, each in combination with paraquat, were applied also. Lactofen + 2,4-D amine + simazine, lactofen + simazine, and lactofen + terbacil were applied with and without paraquat in a three-year-old planting of Red Delicious apple trees. Lactofen + simazine + glyphosate, and simazine, terbacil, and 2,4-D amine (each in combination with paraquat) were included in this experiment also.

Individual plots were 6 feet wide and 8.5 feet long in the nursery and were 6 ft wide and 18 ft long in the one- and three-year-old trees. All treatments were replicated four times except in the three-year-old trees where there was space for only three replications. 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 0.25% (v/v), was included in all paraquat sprays and in lactofen + fluazifop-butyl sprays.

Dandelion (blooming), orchardgrass (12-15 inches tall), and red clover (10-12 inches tall) were the predominant species present when treatments were applied April 8 or 11, 1986. Other weed species present were brambles, tall fescue (up to 15 inches tall), Carolina geranium (8-10 inches tall), and wild garlic (18 inches tall).

Estimates of ground covered by broadleaf weeds and grasses were recorded May 20, 1986 (approximately 6 weeks after treatment).

Results

(Nursery). Estimates of ground covered with broadleaf weeds and grasses are shown in Table 1. Perennial broadleaf species including brambles, bigroot morningglory, yellow woodsorrel, horsenettle, red clover, dandelion, wild carrot, and white clover were predominant in the majority of plots, treated or untreated. Common ragweed, Carolina geranium, and common chickweed were the annual broadleaf species present and all treated plots except those treated with lactofen + oryzalin (1.0 + 2.0 lb/A), lactofen + norflurazon, or oryzalin + paraquat contained significantly fewer annual broadleaf weeds than did the untreated check plots. Infestations of annual grasses (foxtails and cheat) and the perennials, orchardgrass, tall fescue, and common bluegrass, were spotty and no definite patterns of control could be determined. No herbicide injury was observed on the apple trees.

(One-year-old trees). Estimates of ground covered with broadleaf weeds and grasses are shown in Table 2. Although plot outlines were visible, no treatment provided satisfactory control of orchardgrass, red clover, or tall fescue, the most common species present. Other perennials present included buckhorn plantain, dandelion, red sorrel, wild carrot, brambles, and common yarrow. Due to heavy pressure from perennial species, the annual species, Carolina geranium, common ragweed, cheat, and narrowleaf vetch, were sparse. No herbicide injury symptoms were observed on apple trees.

(Three-year-old trees). Estimates of ground covered with broadleaf weeds and grasses are shown in Table 3. Very few annual weeds were present; however, orchardgrass, tall fescue, brambles, bigroot morningglory, dandelion, and red clover were common in many plots. Treated plots except those treated with lactofen + simazine or simazine + paraquat contained significantly fewer perennial broadleaf weeds than did the untreated check plots. Lactofen + terbacil (with or without paraquat), lactofen + simazine + glyphosate, and terbacil + paraquat provided excellent control of perennial grasses and were the most effective treatments overall. Slight chlorosis of new growth was observed on only one tree with lactofen + terbacil. No other herbicide injury symptoms were observed.

Conclusion

Lactofen used in combination with fluazifop-butyl, napropamide, oryzalin, or norflurazon was not effective against the wide assortment of perennial species encountered. Fewer weeds were present in some instances when paraquat was included with these treatments; however, weed pressure was not reduced significantly. Combinations of lactofen with terbacil, terbacil + paraquat, or simazine + glyphosate resulted in good early-season control of the mixed perennial species, particularly orchardgrass and tall fescue. Terbacil + paraquat was very effective as well. Crop tolerance to the herbicide treatments was very good overall.

Table 1. Effect of herbicides on weed control in a two-year-old apple nursery. Woolwine, Virginia. Treated April 8, 1986. Data are averages of 4 replications.[a]

Treatment	Rate	Surfactant[b]	May 20, 1986 Groundcover: Broadleaf weeds Annual	Broadleaf weeds Perennial	Grasses Annual	Grasses Perennial
	(lb a.i./A)		(%)			
1. Lactofen (Cobra 2EC) + fluazifop-butyl (Fusalide 1E)	1.0 + 0.2	X-77	2.5 b	60.0 a-c	3.8 ab	3.0 ab
2. Lactofen + fluazifop-butyl + paraquat (Ortho Paraquat +)	1.0 + 0.2 + 0.5	X-77	0.0 b	35.0 bc	3.8 ab	1.3 ab
3. Lactofen + napropamide (Devrinol 50WP)	1.0 + 4.0	None	1.8 b	65.0 a-c	1.0 b	8.0 a
4. Lactofen + napropamide + paraquat	1.0 + 4.0 + 0.5	X-77	1.3 b	33.8 bc	4.0 ab	0.3 b
5. Lactofen + oryzalin (Surflan 4AS)	1.0 +2.0	None	3.8 ab	47.5 a-c	11.3 a	3.0 ab
6. Lactofen + oryzalin + paraquat	1.0 + 2.0 + 0.5	X-77	0.5 b	32.5 c	3.3 ab	0.3 b
7. Lactofen + oryzalin	1.0 + 4.0	None	1.3 b	48.8 a-c	1.0 b	0.3 b
8. Lactofen + oryzalin + paraquat	1.0 + 4.0 + 0.5	X-77	0.8 b	46.3 a-c	10.5 a	1.3 ab
9. Lactofen + norflurazon (Solicam 80W)	1.0 + 3.0	None	4.3 ab	70.0 ab	3.0 ab	0.3 b
10. Lactofen + norflurazon + paraquat	1.0 + 3.0 + 0.5	X-77	0.0 b	42.5 a-c	5.3 ab	0.3 b
11. Napropamide + paraquat	4.0 + 0.5	X-77	0.3 b	60.0 a-c	0.8 b	3.8 ab
12. Oryzalin + paraquat	4.0 + 0.5	X-77	5.5 ab	62.5 a-c	5.3 ab	0.5 b
13. Norflurazon + paraquat	3.0 + 0.5	X-77	0.3 b	55.0 a-c	0.5 b	0.0 b
14. Untreated	---		8.8 a	73.8 a	2.8 ab	0.3 b

[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]Ortho X-77 at 0.25% (v/v).

Table 2. Effect of herbicides on weed control in one-year-old Red Delicious apple trees. Woolwine Virginia. Treated April 11, 1986. Data are of 4 replications.[a]

Treatment	Rate	Surfactant[b]	May 20, 1986 Groundcover: Perennial broad-leaf weeds	May 20, 1986 Groundcover: Perennial grasses
	(lb a.i./A)		(%)	(%)
1. Lactofen (Cobra 2EC) + fluazifop-butyl (Fusilade 1E)	1.0 + 0.2	X-77	57.5 a	26.3 bc
2. Lactofen + fluazifop-butyl + paraquat (Ortho Paraquat +)	1.0 + 0.2 + 0.5	X-77	48.8 ab	20.8 c
3. Lactofen + napropamide (Devrinol 50WP)	1.0 + 4.0	None	40.0 ab	51.3 a
4. Lactofen + napropamide + paraquat	1.0 + 4.0 + 0.5	X-77	40.0 ab	33.8 a-c
5. Lactofen + oryzalin (Surflan 4AS)	1.0 +2.0	None	40.0 ab	51.3 a
6. Lactofen + oryzalin + paraquat	1.0 + 2.0 + 0.5	X-77	41.3 ab	31.3 a-c
7. Lactofen + oryzalin	1.0 + 4.0	None	36.3 b	53.8 a
8. Lactofen + oryzalin + paraquat	1.0 + 4.0 + 0.5	X-77	37.5 ab	33.8 a-c
9. Lactofen + norflurazon (Solicam 80W)	1.0 + 3.0	None	41.3 ab	46.3 ab
10. Lactofen + norflurazon + paraquat	1.0 + 3.0 + 0.5	X-77	32.5 b	41.3 a-c
11. Napropamide + paraquat	4.0 + 0.5	X-77	41.3 ab	35.0 a-c
12. Oryzalin + paraquat	4.0 + 0.5	X-77	48.8 ab	33.8 a-c
13. Norflurazon + paraquat	3.0 + 0.5	X-77	40.0 ab	36.3 a-c
14. Untreated	---		57.5 a	40.0 a-c

[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]Ortho X-77 at 0.25% (v/v).

Table 3. Effect of herbicides on weed control in three-year-old Red Delicious apple trees. Woolwine, Virginia. Treated April 11, 1986. Data are averages of 3 replications.[a]

Treatment[b]	Rate	May 20, 1986 Groundcover: Broadleaf weeds Annual	Broadleaf weeds Perennial	Grasses Annual	Grasses Perennial
	(lb a.i./A)	(%)			
1. Lactofen (Cobra 2EC) + 2,4-D amine (Formula 40) + simazine (Princep Caliber 90)	1.0 + 1.5 + 2.0	0.0 c	6.7 d	3.3 b	71.6 a
2. Lactofen + 2,4-D amine + simazine + paraquat (Ortho Paraquat +)	1.0 + 1.5 + 2.0 + 0.5	0.0 c	15.0 cd	0.3 c	53.3 ab
3. Lactofen + simazine	1.0 + 2.0	2.0 b	36.7 ab	0.0 c	46.6 ab
4. Lactofen + simazine + paraquat	1.0 + 2.0 + 0.5	0.0 c	20.7 b-d	0.7 c	48.3 ab
5. Lactofen + terbacil	1.0 + 1.6	0.0 c	25.0 b-d	0.0 c	5.7 de
6. Lactofen + terbacil + paraquat	1.0 + 1.6 + 0.5	0.0 c	15.3 cd	0.0 c	1.0 e
7. Lactofen + simazine + glyphosate (Roundup)	1.0 + 2.0 + 1.0	0.0 c	18.3 b-d	0.0 c	0.3 e
8. Simazine + paraquat	3.0 + 0.5	0.0 c	30.0 a-c	0.0 c	18.3 c-e
9. Terbacil + paraquat	3.0 + 0.5	0.0 c	18.3 b-d	0.0 c	0.3 e
10. 2,4-D amine + paraquat	1.5 + 0.5	0.0 c	15.0 cd	6.7 a	38.3 bc
11. Untreated	---	5.0 a	46.7 a	5.0 ab	30.0 bcd

[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]Ortho X-77 at 0.25% (v/v) was included in all paraquat sprays.

PESTICIDE DISPOSAL DAYS
ANOTHER ALTERNATIVE

by

Jerome L. Frecon
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New Jersey farmers have historically burned pesticide bags or buried containers empty or containing small quantities of pesticides. Occasionally old or unlabeled pesticides are mixed, diluted and sprayed on non-target sites. All of these methods are illegal in New Jersey.

Empty bags and triple rinsed crushed containers can be sent to a DEP[1] approved landfill. Labeled (new or old) pesticides can be applied to target plants according to label instructions. Unlabeled or "banned" pesticides can only be disposed by hiring a DEP approved hazardous waste disposal firm at an exhorbitant fee. These disposal firms will not handle some unlabeled materials including those with 2,4,5T. Many farms in Gloucester County, NJ as well as other areas of the state have pesticide storage areas containing old, unusable or banned pesticides. They have limited financial resources or are unwilling to take necessary steps for disposal.

A application was submitted and approved by the DEP to study the concept of pesticide disposal days in Gloucester County in 1985. This the first grant awarded to Cooperative Extension in New Jersey for this purpose. Later grants were awarded to other county agencies throughout New Jersey to gather research data from diverse areas and segments of the population.

PROCEDURE

The following steps were utilized in organizing the disposal:

(1). Approval was solicited and received from the Gloucester County Board of Chosen Freeholders to use a county facility to stage the disposal day with assurance that necessary liability insurance was available.

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[1]New Jersey Department of Environmental Protection. Acknowledgment is given Mark Robson, Ray Ferrarin and Fran Gerding of the Bureau of Pesticide Control, Division of Environmental Quality for providing information for this report.

(2). Bid sheets were prepared and sent to a list of hazardous waste disposal firms prepared by DEP.

(3). Financial and moral support was solicited from agricultural groups in Gloucester County.

(4). Local police and fire companies were notified to be on location or on call in case of emergency .

(5). Lowest bidder and disposal firms properly bonded were selected. Their contract was approved by DEP and county.

(6). An EPA permit was received for staging the day.

(7). The disposal day was promoted and advertised to farmers and to small quantity users in Gloucester County.

(8). Other expenses and costs were estimated and other contractors hired handle services such as clean up and trash removal.

(9). All contracts were signed after final discussion were held with contractors, the disposal firm and DEP officials. Determination were made on disposal procedures and locations.

(10). Research and registration forms were prepared to determine data to be collected.

RESULTS

The disposal day was held on a cool, rainy day on June 8, 1985. Radiac Research Corp of Brooklyn, New York was the disposal firm selected. Two chemists and three technicians were available from Radiac to inspect and package all pesticides in 30 and 55 gallon drums for incineration near Chicago, Illinois. Three people in the DEP and the Gloucester County Agricultural Agent were on duty to register participants and collect information on:

(1). Occupation or avocation;
(2). Where or how they heard about disposal day;
(3). Distance traveled to disposal day;
(4). Items collected by pesticide category;
(5). Willingness to pay for disposal day;
(6). Pesticide Accidents;
(7). Was the program beneficial.

Six firemen plus equipment, two policemen and various health department and environmental officials was also on site for observation purposes.

Thirty seven participants bought 94 gallons of liquid and 847 pounds of solid pesticides. Ninety percent of the participants were farmers. Thirty-30 gallons drums and two-55 gallon drums were prepared for incineration at a cost of $9,700. The total grant was $10,000.

Equal numbers of participants heard about disposal day from my mailings and newspaper. All thought the program was somewhat to very beneficial. Eighty percent of the non-farmers were willing to pay for future disposal programs. Most of the farmers were not. Most participants never had an accident with pesticides. All participants were from Gloucester County. Three were turned away because they were from other counties. Data was lost on types of pesticides although a majority were insecticides like DDT, Dieldrin, Chlorodane, Gultion, etc.

CONCLUSIONS

This is a viable way to dispose of old or "banned" pesticides if someone foots the bill. Farmers are not willing to pay for disposal. No solution has been found to handle disposal of unlabeled pesticide or those containing 2,4,5T.

Research Report: New Jersey Pesticide Disposal Project for the entire state is available from this office or the New Jersey Department of Environmental Protection on Pesticide Disposal days in all seven counties.

NOT FOR PUBLICATION

Table Grape Cultivar Investigations in New Jersey

Jerome L. Frecon

and

Barbara Goulart [1]

Introduction

A number of new seedless table grape cultivars adapted to Eastern United States growing conditions have been developed in breeding programs in Arkansas, New York, Missouri, and Vineland Ontario. These cultivars are seedless and each has at least one fruit characteristic comparable to readily available and popular western and European seedless table grape cultivars.

Table grape comsumption has increased dramatically over the past ten years due to improved cultivars and handling as well as importation from the southern Hemisphere. New Jersey fruit growers have land suitable for peach production (major cash fruit crop), and with extensive overhead investment need another cash fruit crop to meet this demand and diversify their operations.

Twenty four cultivars have been planted and will be evaluated for comparison to western "vinifera" cultivars.

Materials and Methods

Fourteen table grape cultivars were planted in 1984 and an additional seven in 1985 in a randomized block with three triple plant replicates in Sewell, New Jersey (Gloucester County). Some replacements were planted in the spring of 1986.

Grapes were evaluated and rated for low temperature injury on May 12 of 1985 after -12°F temperatures during the winter of 1984-85. Fruit was evaluated and rated for fruit characteristics and vigor in July and

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August of 1985. All plants were cut back severly in March of 1986 to retrain as a 4 arm Kniffin system on a two wire trellis.

Plants were well maintained and sprayed five times in 1986. Fruit was evaluated throughout July, August, and September 1986 and all plants rated on August 21 for powdery mildew, Uncinula necaitor, downy mildew, Plasmopara viticola, black rot, Guignardia bidwellii, and oxidant stipple caused by ozone and other air pollutants.

Data was also collected on yields and fruit characteristics from a grower planting in Richwood, NJ in 1985 and 1986.

Results

Arkansas 1448

Vines have not yielded fruit yet. They are vigorous but insufficient replication has not allowed us to get a reading on disease susceptibility.

Arkansas 1844

Vines have not yielded fruit. They are vigorous, have high susceptibility to downy mildew, medium susceptiblity to block rot, but have low susceptibility to oxidant stipple.

Canadice

Berries are small, round uniform with a washed out red to deep red skin color. The flesh is melting, pulpy, and seedless. The skin is moderately tender to tough. Clusters are small to medium in size, tight, well filled but non-uniform. Berry adhesion is fair indicating fair storage potential. They matured during the second week of August in 1986 and the first week of August in 1985. Flavor is sweet, acid, "labrusca" and excellent. Canadice averaged 18.5% SS in 1986.

Vines of Canadice are low to medium in vigor. Canadice will overbear and must be cluster thinned to maintain vigor. It is very highly susceptible to oxidant stipple, has low susceptibility to downy mildew and medium susceptibility to black rot.

Productivity was good in our replicated trials. Canadice was heavy yielding on our grower trial although all fruit did not mature because of low vigor and oxidant stipple susceptibility.

Challenger

Berries are large, ovate to tear-shaped, uniform with a washed out white to partially red to deep red color. The flesh is melting firm and seedless. A few berries had crunchy seeds.

Clusters are large to very large, loose, not always well filled and non-uniform. Challenger responds well to girdling. Berry adhesion was good but skin split badly about 1 week after maturity. The fruit matured the 4th week in August in 1986 and the third week of August in 1985. Flavor is good, mild "uniform" but the skin is very tough. The fruit averaged 15.2% SS in 1986.

Vines of Challenger are vigorous to very vigorous, highly susceptible to downy mildew, have medium susceptibility to black rot and low susceptibility to oxidant stipple. Challenger was injured by low temperatures January of 1985 and had very low productivity in our replicated plot in 1986. It was unproductive in 1985 grower trials but very productive in 1986 although all fruit could not be harvested because of bad cracking and bunch rot.

Einset (NY 63.878.1)

Berries are oval, medium to large, non uniform and deep red to purple. The skin is moderately tough. The flesh is melting crisp and seedless. A few berries had soft seeds. The clusters are large, loose, well filled and shouldered. Berries adhered to cluster well suggesting storage potential. The flavor was fruity, somewhat tart, very good but not as good as some other New York selections. Fruit matured the fourth week in August and averaged 18% SS.

Vines of Einset are vigorous, have low susceptibility to downy mildew and oxidant stipple but medium susceptibility to black rot. Einset has been one of our more productive varieties.

Festivee

Vines have not yielded fruit. They are very vigorous with low susceptibility to black rot and downy, medium susceptibility to oxidant stipple and very high susceptibility to powdery mildew.

Flame

Berries are medium, round and deep red. The flesh is melting crisp and seedless. Skin is tough. Clusters are large, well filled and loose. The flavor is excellent, mild, sweet. The SS in 1985 was 21%.

Vines are not vigorous and 50% were killed in the winter of 1984-85. Twenty percent were injured and killed in the winter of 85-86. Only two vines are now living and did not have fruit in 1986. Data could not be collected on disease susceptibility.

Glenora

Berries are medium size, uniform, round with a blue black skin. The flesh is melting, pulpy and seedless. The skin is tender. The clusters are medium to large, loose and uniform. The fruit matured the third week of August in 1986. The flavor is very good, "labrusca" type.

Vines are vigorous, with high susceptibility to oxidant stipple, black rot, and powdery mildew and medium susceptibility to downy mildew.

Glenora has only had light production in our replicated trials. It was injured during the winter of 1984/85 but is now growing well.

Lakemont

Berries are medium in size, roundish-oval with a washed out green to amber skin color. The flesh is melting, pulpy and seedless. The skin is moderately tender. The clusters are medium to large, loose, shouldered and respond well to gibercillic acid treatments. The flavor is very good, sweet and acid, "labrusca" and averaged 18.5 SS in 1986. The fruit matured the first week of August in 1985 and the second week of August in 1986.

Vines of Lakemont are low to moderate in vigor with medium susceptibility to downy mildew and oxidant stipple and high susceptibility to black rot.

Mars

Berries are round and dark blue skinned. They are large, round but non-uniform. The skin is tough. The flesh is melting non-pulpy and seedless. A few berries had soft seeds. The clusters are small, tight to loose (non-uniform) with some poorly formed. The flavor was good, slightly "labrusca" but mild. Berries ripened the third week of August in 1986 and averaged 14.4% SS.

The vines are very vigorous with low susceptibility to oxidant stipple, and downy mildew but with medium susceptibility to black rot.

McCampbell

Berries are round and blue skinned. They are medium in size like Fredonia and seedly. The skin is tough. The flesh is pulpy and melting. The cluster is medium to large in size and very loose. Clusters are non-uniform in shape. The flavor is a strong "labrusca" and good. Berries ripened the 4th week in August in 1985 and the first week in September in 1986. The SS averaged between 14% - 16%.

The vines are very vigorous with low susceptibility to oxidant stipple, downy mildew and black rot. This varieity has been very productive in our replicated trials.

NY 63.878.6

Berries are medium to large in size, ovate, non uniform with a purple to blue skin color. The flesh was melting but crisp and seedless with a few [redacted] soft seeds. The skin was moderately tender. The clusters were large to very large with a loose well filled shouldered cluster. Berries adhered to the cluster well suggesting storage potential. The fruit matured the third and fourth week of August and was hard to pinpoint because plants kept producing on secondary and tertiary shoots. Flavor is very good with 17.5% SS.

Vines of NY 63.878.6 were vigorous with low susceptibility to oxidant stipple but medium susceptibility to downy mildew and black rot. A few plants were severly injured by low temperatures during the winter of 1984 & 85. This has been one of the most productive varieties in our replicated block.

NY 65479.1

Berries are medium, round and blue. The flesh is melting, pulpy and seedless. The skin is moderately tough. Clusters are large, shouldered, well filled and tight to loose. The flavor is very good, sweet and "labrusca". Fruit matured in late August. Was difficult to determine since clusters were produced on secondary and tertiary shoots.

Vines are vigorous with low susceptibility to downy mildew and black rot and medium susceptibility to oxidant stipple.

NY 65493.1

. Berries are medium to small in size, ovate, non uniform with a purple to blue skin color. The flesh is melting, crisp, and seedless. The skin is moderately tender. The clusters are large, well filled, tight and shouldered. Fruit matured the last week of August in 1986. Flavor was excellent, very fruity and pleasing. The vines are vigorous. Not enough replication was available to get readings on downy mildew, black rot and oxidant stipple and productivity.

Reliance

Berries are medium in size, round, uniform and a washed out red to bright red color. The skin is moderately tough. The flesh is melting and seedless. The clusters are medium in size, very loose and non uniform. The flower is slightly "labrusca", mild but sweet and excellent.

Fruit ripened the last week of July in 1985 and the first week of August in 1986 and averaged 19.7% SS.

Vines of Reliance are vigorous with low susceptibility to downey mildew and black rot but high susceptibility to oxidant stipple.

Remailly

Berries are large, ovate to tear-shaped, uniform with a washed out green to speckled amber skin color. The flesh is crisp, melting and seedless. The clusters were large to very large, loose but well filled, some shouldered. The adhesion was good suggesting storage potential. The fruit matures the last week of August to the first week of September. Flavor is good but not excellent, mild with a little acid and an average of 14.2% SS in 1986.

Remailly vines are vigorous. It has low susceptibility to downy mildew but medium susceptibility to oxidant stipple and black rot.

Remailly has been unproductive in our replicated trials but has yielded 12,000 lbs per acre in our grower trial. Remailly was injured during the winter of 1984/85 but is now growing well.

Romulus

Vines have not yielded fruit. They are very vigorous with low susceptibility to black rot and downy mildew and medium susceptibility to oxidant stipple. It is highly susceptible to powdery mildew.

Suffolk

Berries are large, round, uniform with a bright red skin color. The flesh is melting and seedless. The skin is moderately tender. Berry adhesion to the cluster is fair to poor. Clusters are medium to large shouldered, loose to very loose, well filled but non uniform. The fruit matured the 2nd week in August in 1985 and 1986. Flavor is excellent slightly "labrusca" very sweet and the best tasting grape in our trial.

Vines are vigorous, with low susceptibility to downy mildew and oxidant stipple but high susceptibility to black rot. Suffolk Red has been one of the most productive varieties in our replicated trials.

Thompson

Berries are medium, ovate and a washed out green to amber color. The flesh is non melting, crisp and seedless. The skin is moderately tender to tough. Clusters were medium in size, loose, non uniform and well filled. Fruit matured during the third week in August in 1985. Flavor is sweet, mild, typically "vinifera".

Vines of Thompson are vigorous when not damaged by winter injury. It has low susceptibility to oxidant stipple and downy mildew but high susceptibility to black rot and powdery mildew. Some plants of Thompson also had Phylloxera. All replicates were severly injured by low temperatures in the winter of 1984-85 but fruited in the summer of 1985. It was unproductive in 1986.

Vanessa

Berries are small to medium, ovate and bright red. The skin is moderately tough. The flesh is melting and seedless. An occassional berry had a crunchy seed. The clusters were few in number, small and very good. Fruit ripened the third week of August in 1986 and averaged 17.8% SS.

Vines are vigorous with low susceptibility to downy mildew and high susceptibility to black rot and oxidant stipple.

Venus

Berries are large, round, uniform with a blue to black skin color. The flesh is melting and pulpy with a few seedless, but most berries contained small crunchy but edible seeds. The clusters are medium to large, tight, uniform and well filled. Fruit adhesion was excellent suggesting storage potential. Venus hangs very well the first picking the 4th week of July in 1985 and the first week of August in 1986. Fruit was still being picked during the third week of August in 1986. Flavor is fair to poor, low in sugar, acid "labrusca" but medicinal with an average of 12.2% SS.

Vines of Venus are very vigorous with medium susceptibility to downy mildew and black rot, but high susceptibility to oxidant stipple. Venus has been of low productivity on our replicated plot but yields of over 15,500 lbs/acre have been harvested our grower trial in 1986. Venus was injured during the winter of 1984/85 but all plants are now growing well.

Table 1: Relative susceptibility of Eighteen Table Grape Cultivars to Downy Mildew, Black Rot and Oxidant Stipple

Cultivar	Black Rot*	Downy Mildew*	Oxidant Stipple*
Festivee	1.00a	1.00a	2.67bcd
NY 65.479.1	1.33a	1.00a	3.00de
Romulus	1.33a	1.00a	2.00abc
Reliance	1.33a	1.00a	3.67de
McCampbell	1.67a	1.00a	1.67ab
Canadice	2.00ab	1.00a	5.00e
Arkansas 1844	2.00ab	3.33c	1.33a
NY 63.878.6	2.00ab	2.33bc	1.33a
Einset	2.67bc	1.00a	1.67ab
Remailly	2.67bc	1.00a	2.67cd
Mars	2.67bc	1.00a	1.67ab
Venus	2.67bc	2.33bc	3.00de
Challenger	2.67bc	3.00bc	1.00a
Glenora	3.00cd	2.33bc	3.33de
Vanessa	3.00cd	1.00a	3.67de
Suffolk	3.00cd	1.00a	2.00abc
Thompson	3.00cd	1.67ab	1.33a
Lakemont	3.00cd	2.00abc	2.00abc

5% Duncans Mulitple Range Test
*Key to ratings 1=low susceptibility 0-24%, 2=medium susceptibility 35-49%, 3=high susceptibility 50-74% and 4=very high susceptibility 75-100%.

Table 2: Relative Yield Ratings in 1986 of 15 Table Grape Culitvars*

Cultivar	Yield Rating
Thompson	1.00a
Remailly	1.00a
Vanessa	1.33a
NY65479.1	1.33a
Venus	1.33a
Challenger	1.33a
Glenora	1.67ab
NY 63.878.6	1.67ab
Lakemont	2.00abc
Reliance	2.00abc
Canadice	2.67bc
Einset	2.67bc
McCampbell	3.00c
Suffolk	3.33c
Mars	3.33c

5% Duncans Multiple Range Test
*Key to yield rating 1 = no cluster/plant, 2 = 1 to 2 clusters/plant, 3 = 3 to 5 clusters/plant, 4 = 7 to 10 cluster/plant, 5 = over 10 clusters/plant

Discussion and Conclusion

More evaluations will be made at Cream Ridge and Sewell. Flame and Thompson are of little value because of their lack of productivity. McCampbell is seedy and will not compete with western table grapes. Canadice has a small berry tight cluster, weak vine, and is very susceptible to oxidant stipple. It does not appear to posess characteristics rendering it to be manipulated by growth regulators or girdling and thus has little commercial potential. Venus is seedy, has a tight cluster and inferior quality. It appears to have little potential for commercial production.

Growth patterns of peach trees as related to plant available water.

D. M. Glenn and W. V. Welker

Water stress management has been used experimentally to minimize vegetative growth and increase yield and quality in peach. Chalmers et al. (1981), imposed water stress at specific stages of fruit development and found reduced vegetative growth accompanied by better light penetration but no measureable effect on fruit development. The sensitivity of terminal growth to water stress and soil water depletion however has not been quantified. The purpose of this study was to determine how peach terminal growth rate responds to the level of plant available soil water.

Methods and Materials

<u>1985</u>.

Soil management studies were established in 1983 and 1984 with peach trees ('Sunglo/Halford', 'Redhaven/Halford', respectively) planted on a 4.5 x 3 m spacing. The soil management systems were: cultivation, herbicide, and killed sod. Details of these soil management systems were reported by Glenn and Welker (1985). Soil water levels were determined using a calibrated neutron probe with one access tube/tree located 100 cm from the tree within the row. Fruit was absent from these trees due to winter bud damage in 1985.

<u>1986</u>.

A randomized complete block design with 6 replications was used with two treatments: a) fruit thinned to a 10-15 cm spacing, b) all fruit removed.

There was one tree/plot. The twelve trees were grown in the center of vegetation-free squares 180cm on a side. The trees ('Loring/Halford') were planted in 1983 and kept vegetation-free using contact and residual herbicides. These 12 trees were border trees from the study of Welker and Glenn (1985). A neutron probe access tube was located 100 cm from the tree on the diagonal of the vegetation-free square.

In the spring of 1985 and 1986 six dominant,upright terminal shoots/trees were flagged, their length measured weekly and converted to mm growth day^{-1}. Soil water content was determined using a neutron probe at 3-7 day intervals to a 90 cm depth. The drained upper limit of available soil water (DUL) or field capacity was determined to be the soil water content for each access tube 2 days following a major rainfall event in the early spring before growth was initiated or the soil water content 2 days following surface irrigation. The lower limit of available water (LL) was calculated based on textural characteristics of the soil (Cassel et al., 1983). The percentage of plant available water in the soil (PAW) was calculated as:

$$PAW = \frac{(\text{measured water content} - LL)}{DUL - LL} \times 100$$

The PAW level for a 3-7 day period was the mean of the initial and final water level.

Results and Discussion

The terminal growth rate of fruiting and non-fruiting trees was not correlated with PAW in the surface 30 cm but was linearly related to PAW for the 0-90 cm depth. Terminal growth of fruiting and non-fruiting trees was most strongly correlated to PAW levels in the 30-90 cm depth (Fig. 1). The curvilinear form of this relationship indicates that there is a critical zone of PAW necessary for terminal growth in peach. Using a contingency Chi-square test for interactions (Steel and Torrie, 1960) a critical zone of 76-87% PAW was determined. Above 87% PAW terminal growth rate increases at a rapid and linear rate. Below 76% PAW the terminal growth rate is poorly defined and approaches 0 mm day^{-1}.

The 1985 growing season was characterized by average precipitation for the area; 1986 was droughty. The similarity in response of terminal growth rate for the 2 years suggests that rainfed peach trees are more dependent on sub-soil PAW (30-90 cm) than on surface PAW (0-30 cm). Summer rainfall can supplement existing PAW levels but the peach tree is apparently sustained on sub-soil plant available water. Sub-soil water levels will only need to be depleted to about 87% of PAW to significantly reduce vegetative growth. If water stress management to reduce vegetable growth in peach is to be successful in areas where sufficient rainfall occurs for production, then our knowledge of root physiology and activity must be expanded as strategies are developed to either rapidly deplete the sub-soil PAW level and/or inhibit root development and activity in the sub-soil.

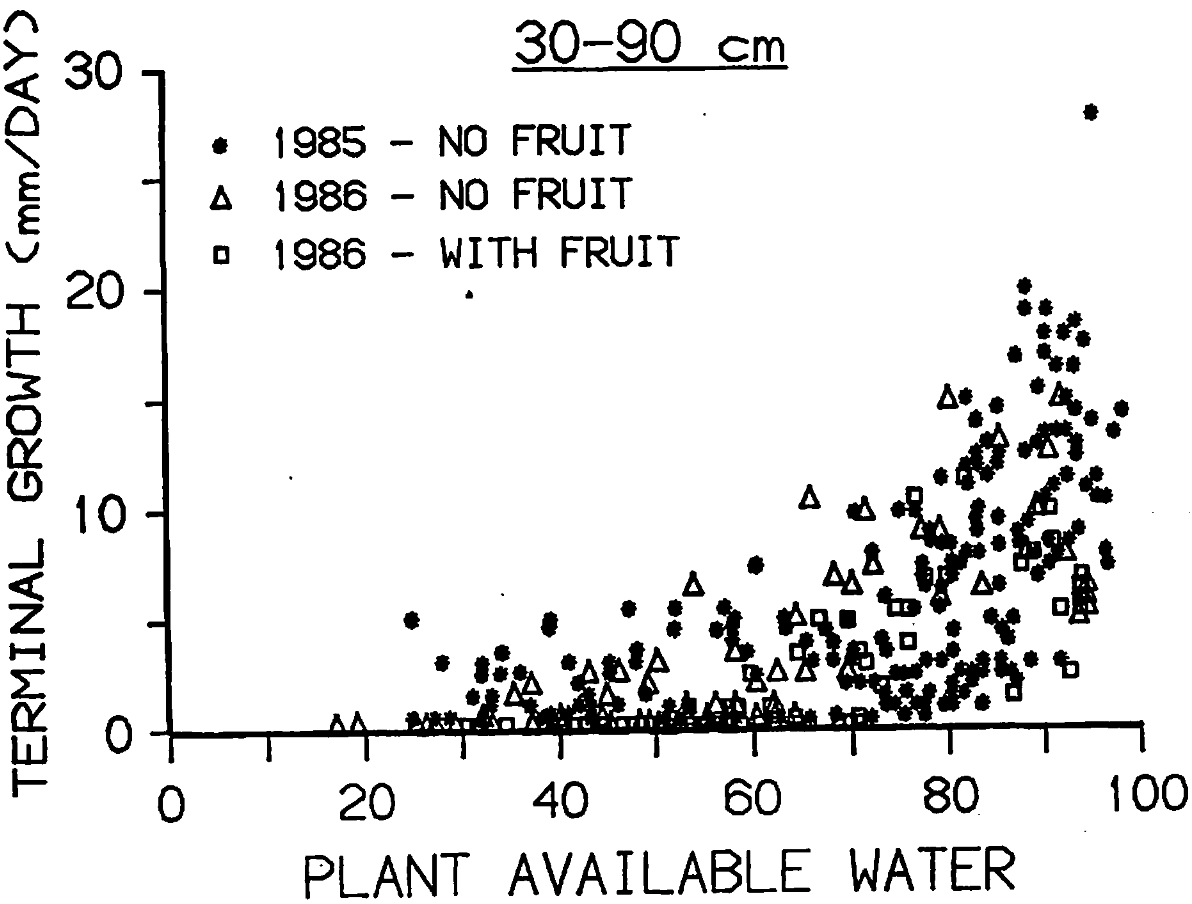

Figure 1. Relationship between terminal growth rate and plant available water.

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BRAMBLE RESEARCH IN THE EASTERN UNITED STATES: A SURVEY

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Introduction: Interest in raspberry production in the Eastern United States has increased dramatically in the past five years, fueled by the high market value of raspberries, improved methods of propagation and improved (virus vector resistant) cultivars. In May of 1986, a regional committee of researchers was organized (NEC 64: Bramble Marketing and Production) primarily to identify current research efforts and discuss problems associated with bramble production and marketing.

It was determined at this meeting that a survey was required to identify areas of ongoing bramble research before cooperative efforts could be effectively initiated.

The purpose of this paper is to summarize the results of that survey, which identifies bramble research currently in progress, and to advocate areas where future work will be required in order to build a viable Eastern bramble industry.

Survey Results and Discussion:

The survey (appendix) was developed primarily to establish current sites of cultivar evaluation as well as current cultivar recommendations by state; the thinking being that the first step to developing a healthy industry is planting appropriate cultivars. Twelve states in the Northeast and mid-west are currently evaluating raspberry cultivars (Table 1). A total of thirty-two red, 2 gold, 7 purple, and 12 black raspberries are being evaluated by more than one state, with New York and New Jersey testing additional cultivars and selections. 'Heritage' and 'Taylor' (red), 'Brandywine' and 'Royalty' (purple), and 'Bristol' (Black) were the most commonly evaluated cultivars.

Standards included 'Heritage', Latham' and 'Brandywine'; all of which appear to be widely adapted, however all have notable limitations. 'Heritage' fruits too late to obtain high yields for most New England states, and poor quality (low sugar, small size) is often a complaint. 'Latham', while extremely cold hardy, is often considered of only moderate quality. 'Brandywine' is extremely vigorous, however many consider it tart.

Blackberries, in comparison, are being evaluated by only 7 states, with 'Hull' and 'Chester' thornless most widely tested (Table 2). Kansas is conducting extensive trails on thorny blackberries.

Parameters used to evaluate fruit varied widely from state to state, with a total of 25 different fruit and vegetative characteristics evaluated.

A future task of the committee should be to establish a uniform set of characteristics to measure, enabling a more thorough comparison of a given cultivar in several locations.

As expected, current commercial recommendations varied widely from state to state (Table 4). 'Heritage' and 'Latham' red raspberries were recommended in most states, while 'Brandywine' purple- and 'Bristol' black raspberries were most often recommended. Blackberry cultivars most often recommended were 'Chester', 'Dirksen' and 'Hull' (Table 5).

Acreage represented by states participating in the survey is listed in Table 6. Total acreage was 2,750 acres for raspberries and 462 acres for blackberries. While this acreage is low relative to other fruit crops, the market value of the crops is high, with red raspberries wholesaling for $3.00/pint or higher in many areas.

Table 7 lists specific bramble research projects by state. While many varied problems are being addressed, several areas receive less attention than needed if brambles are to again become a prevalent Eastern crop.

1. Breeding. There are to date only 3 traditional breeding programs in programs in the east and mid-west: University of Maryland, USDA, Beltsville (blackberries only) and Iowa State University. While some Canadian or Northwestern cultivars perform well in New England, the mid-Atlantic states are in dire need of a wider range of new plant material.

2. Post harvest studies. Many believe that the single most limiting factor for bramble production is the fruit's inherently short shelf life. Both basic and applied research is needed if brambles are to become an important Eastern crop.

3. Mechanized production systems. Another limiting factor for bramble production is the intensive hand labor currently required to produce the crop. Other regions and countries have pioneered such innovations as mechanical harvestors. These may offer potential in the future industry of the Eastern United State.

4. Marketing studies. As with any crop, the potential market of raspberries radically influence their production potential. If bramble producers are to avoid some of the mistakes of the past, marketing needs to be a part of this growing industry.

In conclusion, the survey identifies many locations in the Eastern United States where bramble research is being conducted. While cultivars vary widely over the region, 'Heritage', 'Latham' and 'Brandywine' are standards over a wide geographical area. While many areas of research are ongoing, several areas (specifically breeding, post-harvest physiology, mechanization and marketing) need more emphasis if the bramble industry in the Eastern United States is to grow.

TABLE 1. Raspberry cultivars currently being tested in the Eastern United States (1986).

*indicates standards

Red

STATE	Amity	August Red	Boyne	Canby	Carnival	Citadel	Comet	Dunham	Fall Gold	Festival	Heritage	Hilton	Killarney	Latham	Liberty	Matsqui	Madawaska	Md 449	Newburgh
Maine		X	X*	X	X		X		X	X	X	X	X	X*		X	X		X
Maryland											X*							X	
New Jersey[z]	X			X	X	X			X	X	X	X		X				X	X
New York[z]	X	X	X	X*				X	X	X	X*	X	X	X*	X	X	X		X*
Pennsylvania																			
Virginia																			
W. Virginia						X					X			X					
Iowa			X	X					X*		X*			X*	X*				X*
Kansas	X									X	X*			X					
Michigan	X							X	X		X*								
N. Carolina																			
Ohio			X	X					X		X	X		X	X				X

Red (continued)

STATE	Nova	Prestige	Redwing	Reveille	Sceptor	Sentinel	Sentry	September	Southland	Taylor	Titan	Trent	NY114	449AB
Maine	X	X		X	X					X*	X	X		
Maryland							X*							
New Jersey[z]		X		X	X	X	X	X		X	X			
New York[z]				X			X	X	X	X*	X	X	X	
Pennsylvania														X
Virginia										X				
W. Virginia						X								
Iowa				X				X*		X				
Kansas				X					X	X	X			
Michigan			X		X			X						
N. Carolina														
Ohio							X	X	X					

Gold, Purple and Black

STATE	Amber (Gold)	Fallgold (Gold)	Amethyst (Purple)	Brandywine (Purple)	Lowden Sweet Purple (Purple)	Royalty (Purple)	Sodus (Purple)	Success (Purple)	NY43 (Purple)	Allen (Black)	Blackhawk (Black)	Black Knight (Black)	Bristol (Black)	Cumberland (Black)	Dundee (Black)	Earlyblack (Black)	Haut (Black)	Huron (Black)	Jewel (Black)	Munger (Black)	Hewlogan (Black)
Maine	X	X		X		X		X													
Maryland												X	X*				X*				
New Jersey[z]		X		X	X	X			X	X	X		X	X	X	X	X		X	X	X
New York[z]				X		X			X	X	X		X	X			X	X	X		
Pennsylvania				X*							X		X*	X	X	X					X
Virginia						X															
W. Virginia				X	X	X							X	X						X	
Iowa		X	X*	X*	X	X*	X			X	X*		X								
Kansas				X*		X															
Michigan		X																			
N. Carolina																					
Ohio				X		X				X			X	X	X		X	X	X		

[z] New York is also evaluating Chikotin, Gratineau, Indian Summer, Skeena, Willamette and NM 629, 637, and 659.
New Jersey is also evaluating Summer, Chilcotin, Skeena, Nootka, Haida, Washington State Univ. 738, and Willamette.

TABLE 2. Blackberry Cultivars currently being tested in the Eastern U.S. (1986).

* indicates standards.

Region	STATE	Thornless: Austin Thornless	Black Satin	Chester	Dirksen	Hull	Marian	Ponzer	Thornfree	VS PBI	Thorny: Cherokee	Cheyenne	Darrow	Shawnee	A-713[y]	A-731	A-830	A-878	A-897	A-1012	A-1172
NE Region	Maryland	X		X*	X*	X*	X	X						X							
	New Jersey			X		X			X				X	X							
	Virginia		X*			X*															
	USDA (W. Virginia)		X		X	X			X												
Outside NE Region	Kansas		X	X	X	X					X	X	X*	X	X	X	X	X	X	X	X
	No. Carolina			X		X						X		X							
	Ohio[z]				X	X						X									

[z] Ohio is also testing 68-0-6, 61-24-6, 61-21-6, C-62, C-65.

[y] Arkansas selections

TABLE 3. Parameters Evaluated in Bramble Cultivar Trials by State (1986).

	STATE	Fruit Characteristics												Vegetative Characteristics												
		Yield (Wt./area)	Number	Size	Quality	Sol. Solids	Firmness	Fruit Detachment Force	Color	pH	Cohesion	Titr. Acidity	Flavor	Bud Break Date	Cold Hardiness	Cane Number	Cane Length	Bud Mortality	Primocane Production	Florocane Production	Vigor	Disease Resistance	Drought Tolerance	Spininess	Plant Productivity	Cane Diameter
NE Region	Maine	X	X	X	X																					
	Maryland[z]	X							X		X		X								X			X	X	
	New Jersey[y]	X		X	X	X	X		X	X					X						X			X		
	New York	X		X	X										X							X				
	Pennsylvania																									
	Virginia[y]				X	X	X			X		X			X		X									X
	West Virginia	X				X	X								X											
	USDA (W. Virginia)							X						X												
Outside NE Region	Iowa	X			X										X							X	X			
	Kansas	X				X									X						X	X				
	Michigan	X		X												X										
	No. Carolina	X	X	X											X											
	Ohio	X																								

[z]For advanced selection testing.

[y]Parameters measured vary with experimental objectives.

TABLE 4. Current Commercial Raspberry Cultivar Recommendations by State (1986).

Region	STATE	Red																				Gold	Purple		Black					
		August-red	Boyne	Canby	Festival	Hilton	Heritage	Kilarney	Latham	Liberty	Madonaska	Newburgh	Nova	Prestige	Reveille	Sceptor	Sentry	Southland	Taylor	Titan	449AB	Fallgold	Brandywine	Royalty	Blackhawk	Bristol	Cumberland	Dundee	Haut	Jewel
NE Region	Maine		X		X	X		X	X		X	X	X	X	X				X	X										
	Maryland						X										X	X						X		X			X	
	New Hampshire	X	X		X		X	X						X																
	New Jersey					X	X		X			X			X				X	X		X	X	X		X				X
	New York			X			X					X							X	X				X						
	Pennsylvania						X		X						X		X				X	X	X	X	X	X	X	X		
	Virginia						X								X	X	X	X		X						X			X	
	West Virginia						X		X														X			X	X			
NE Region	Iowa						X		X			X											X		X					
	Kansas						X		X														X							
	Michigan			X			X		X																					
	Ohio						X		X	X					X			X		X			X	X		X		X	X	X

TABLE 5. Current Commercial Blackberry Recommendations by State (1986).

	STATE	Black Satin (Thornless)	Chester (Thornless)	Dirksen (Thornless)	Hull (Thornless)	Thornfree (Thornless)	Cherokee (Thorny)	Cheyenne (Thorny)	Darrow (Thorny)
NE Region	Maryland		X	X	X				
	New Hampshire								X
	New Jersey		X		X				
	Virginia	X	X	X	X				
	West Virginia						X	X	
Outside NE Region	Kansas						X	X	X
	Michigan			X		X			
	No. Carolina			X	X			X	
	Ohio	X	X	X				X	X

TABLE 6. ESTIMATED COMMERCIAL RASPBERRY AND BLACKBERRY ACREAGE BY STATE

	Commercial Acreage (A)	
	Raspberry	Blackberry
Maine	100	0
Maryland	60	60
New Hampshire	150	0
New Jersey	350	50
New York	400	30
Pennsylvania	85	0
Virginia	60	87
West Virginia	50	40
Kansas	25	25
Michigan	700	30
North Carolina	20	100
Ohio	750	40
Northeast	1,255	267
Outside Northeast	1,495	195
TOTAL	2,750	462

TABLE 7. OTHER AREAS OF BRAMBLE RESEARCH BY STATE

Maine	Evaluation of Tarnished Plant Bug feeding damage to raspberry flowers and fruit.
	Plastic mulch for pruning and week control (J. Harker).
	Roundup for weed control (J. Harker).
Maryland	Use of biotechnology to improve bramble germplasm.
	Breeding brambles.
	Basal bud fruiting of black raspberries.
	Effects of cultural practices.
New Hampshire	Use of row covers fall bearing types.
New Jersey	Water relations of red raspberry.
	Post-harvest studies on red raspberry.
	Bramble disease control (J. Springer).
	Plant spacing effects on hedge establishment (G. Pavlis).
	Trellising and cultural effects on raspberry (G. Pavlis).
New York	Pruning and trellising systems.
	Weed control during establishment.
	Insect pest management (G. Schaeffers).
	Resistance of red and purple raspberries to Phytophthora species (W. Wilcox).
Pennsylvania	Fertility (rate and timing).
	Trellising.
	Pest management (E. Rajotte).
	Developing educational programs about bramble production.

Virginia	Preplant site preparation (nematode/virus complex).
	Plant insect effects on fruit set.
	Blackberry handling and marketing.
	Chemical pruning.
West Virginia	Training systems.
	Postharvest handling studies.
USDA (West Virginia) ..	Trellis design.
	Mechanical harvesting.
	Fruit development and biochemistry.
Iowa	Calcium nutrition and fruit firmness and storage life.
	Training systems for purple raspberries.
	Breeding for cold tolerance (E. Denisen). higher yields color improvement anthracnose resistance
	Propagation by tissue culture (E. Denisen)
Kansas	Heat tolerance of raspberry.
	Cold hardiness of blackberry, including selecting for improved hardiness.
	Investigations of chilling requirement, dormancy and cold hardiness.
Michigan	N Nutrition of Heritage.
	Herbicide evaluation.
North Carolina ...	Herbicide screening.
Ohio	Cultural systems for winter protection.
	Herbicides.

NEC 64: BRAMBLE PRODUCTION AND MARKETING RESEARCHER SURVEY

1) Name: ________________________________

2) Position: ________________________________

3) Address: ________________________________

____

____

4) Phone No: ________________________________

5) Are you currently conducting cultivar evaluations on blackberries or raspberries?

6) What specific cultivars or selections are you testing?
(please * cultivars that you consider standards)

Blackberry: Thorny

Thornless

Raspberry: Red

Gold

Purple

Black

7) What cultivars do you have data on for any of the past 15 years?

Blackberry: Thorny

Thornless

Raspberrry: Red

Gold

Purple

Black

8) Specifically, what data parameters do you evaluate for each cultivar or selection?

9) What cultivars of brambles are currently recommended for commercial production in your state?

<u>Blackberry</u> <u>Raspberry</u>

10) Approximately how many acres of brambles are currently grown in your state?

Raspberries: ____________________

Blackberries: ____________________

11) Please list areas of bramble research <u>other than cultivar evaluation</u> that you are active in:

EFFECT OF OWN AND CLONAL ROOTS ON THE GROWTH AND PRODUCTIVITY OF APPLES

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Introduction

The use of own or self-rooted apple trees has been proposed as a possible method to produce cheaper trees, thereby allowing the more rapid adoption of high density orchards. In addition, some have suggested that these trees would be more disease-resistant since they would be more free of diseases at planting time. However, more conservative pomological wisdom would dictate that since each cultivar is genetically diverse, the environmental adaptability of each own-rooted cultivar should be investigated. The objective of this research was to compare the growth and productivity of own-rooted trees to that of conventionally budded trees on one or more clonally propagated rootstocks.

Materials and Methods

In 1982, own-rooted trees of 'Northern Spy', 'Stayman', and 'Ozark Gold' were planted in Block 3B of the Horticulture Department at The Penn State University, Fruit Research Laboratory in Biglerville, PA. In addition, commercially produced trees on either M-7a, M-26, or M-106 were also planted in the block in a completely randomized statistical design (Table 1).

The trees were grown according to commercially recommended practices. Prior to growth in 1982 and following the growing seasons of 1982-86 trunk circumference was measured 20 cm above the soil line. Total fruit yield was measured in 1985 and 1986 and mean fruit weight was determined in 1986. Following the 1986 growing season tree height and width were measured and the number of rootsuckers and watersprouts on the trunk were counted. All data were analyzed as a completely randomized design using an analysis of variance and, when the F ratio was significant, the means were separated using the Duncan's Multiple Range Test.

Results and Discussion

Prior to planting, there were no differences in trunk circumference within each cultivar (Table 1). At the end of 1986, the trunk circumference of the 'Northern Spy' trees were not influenced by rootstocks but the own-rooted trees of 'Stayman' and 'Ozark Gold' were larger than the trees on any clonal rootstocks.

For unexplained reasons, 25% of the own-rooted 'Northern Spy' trees in one treatment died (Table 2). There were no statistically significant differences in the number of watersprouts on the trunks of the trees but within 'Stayman' and 'Ozark Gold' only the own-rooted trees had these watersprouts (Table 2).

The mean number of rootsuckers per tree, of 'Northern Spy' trees were somewhat variable with own-rooted trees having the same number as trees on M7a, while trees on M26 had none (Table 3). 'Stayman' trees on M7a had 20 rootsuckers per tree while all other rootstocks had very few.

The data for percent of trees with rootsuckers could not be statistically analyzed. 'Northern Spy' trees on M26 had no rootsuckers while 100% of the Stayman/M7a had rootsuckers. The mean number of rootsuckers per tree with rootsuckers was calculated (Table 3). 'Northern Spy'/M7a trees had 39 rootsuckers per tree, own-rooted trees had intermediate numbers while 'Northern Spy'/M26 trees had no rootsuckers.

Tree height was not dramatically influenced by the treatments except that 'Stayman'/M26 trees were shorter than own-rooted trees. The diameter or width of the trees was not influenced by rootstock treatments. Tree shape (height/width ratio) of 'Stayman' and 'Ozark Gold' trees was not influenced by rootstock but M26 produced 'Northern Spy' trees with a much lower H:D ratio than any of the other rootstocks.

Fruit yield was not significantly influenced by treatments in 1985, the fourth year of the study. In 1986, 'Northern Spy' trees did not produce very much fruit. However, 'Stayman' trees on M106 and M7a produced bigger crops than own-rooted trees or trees produced on M26. 'Ozark Gold' trees on M26 were much more productive than own-rooted trees. Fruit size, in the sixth year in the orchard, was not influenced by treatments.

Summary

This preliminary report documents the test being conducted to evaluate own-rooted apple trees in comparison to trees propagated on clonal rootstocks. It appears that the growth and performance of own-rooted apple in comparison to conventional trees will be cultivar specific. 'Northern Spy', a vigorous cultivar that comes into bearing slowly, may be similar on its own roots as it is on M7a.

On the other hand, 'Stayman' trees on their own roots were larger than M106 or M7a trees and bore smaller crops. 'Ozark Gold' on its own roots produced a bigger tree that bore a smaller crop than trees produced on M26.

Since each cultivar on its own roots is a genetically unique rootstock, no assumptions on field performance should be assumed. Further trials of more common cultivars are in place.

Table 1. List of Treatments

Treatment No.	Cultivar	Rootstock	Tree Source	Cultural Treatments
1	Northern Spy	Own roots	Dr. R. Zimmerman, USDA	Standard
2	Northern Spy	Own roots	Dr. R. Zimmerman, USDA	Option 1
3	Northern Spy	M7a	Adams County Nursery	Standard
4	Northern Spy	M26	Adams County Nursery	Standard
5	Stayman	Own roots	Dr. R. Zimmerman, USDA	Standard
6	Stayman	M106	Adams County Nursery	Standard
7	Stayman	M7a	Adams County Nursery	Standard
8	Stayman	M26	Adams County Nursery	Standard
9	Ozark Gold	Own roots	Dr. R. Zimmerman, USDA	Standard
10	Ozark Gold	M26	Adams County Nursery	Standard

Table 2. Influence of stions on the trunk circumference, mortality and number of watersprouts on the trunks of apple trees[a].

Trmt. No.	Cult.	RS	Trunk circumference (cm) 1982	1982	1983	1984	1985	1986	Mortality following 1986 (%)	Watersprout on trunk (No.)
1	NS	Own	4.5ab	5.7	8.5	14.7	20.0abc	26.7abc	25	1.0
2	NS	own	3.7ab	5.7	9.3	16.1	21.6ab	27.7ab	0	2.6
3	NS	M7a	3.6ab	4.1	6.6	12.2	19.3abc	23.6bcd	0	0.0
4	NS	M26	3.6ab	5.2	7.6	12.8	19.8abc	24.3bcd	0	1.3
5	Stay	own	5.2a	6.0	9.4	14.3	23.7a	30.5a	0	4.0
6	Stay	M106	4.9ab	5.0	8.6	14.8	21.0ab	24.4bcd	0	0.0
7	Stay	M7a	3.8ab	4.6	8.0	11.6	18.7abc	21.4cde	0	0.0
8	Stay	M26	3.7ab	6.0	9.0	14.1	15.5c	17.4e	0	0.0
9	OG	own	3.3ab	5.3	8.4	13.7	20.5abc	26.4abc	0	3.2
10	OG	M26	2.7b	5.5	8.4	14.0	17.4bc	20.0de	0	0.0
F ratio			2.07	0.39	0.41	0.76	3.08	6.05	-	1.45
Sign			3.4%	96.9%	96.3%	70.6%	0.2%	0.0%	-	0.17

[a] Mean values within each column followed by the same letter are not significantly different at the 5% level according to the Duncan's Multiple Range Test.

Table 3. Influence of stions on rootsuckers, tree size, and fruiting of apple trees[a].

			Rootsuckers			Tree Size			Fruit		
				% of	#/Tree	meters		H/D	Yield	Yield	Weight
Trmt. No.	Cult.	RS	Mean /tree	Trees With	on Trees with	Ht.	Diam.	ratio	1985-Kg	1986-Kg	1986-g
1	NS	Own	12.2abc	50	18.2b	3.4ab	2.3cd	1.58a	0	0.0d	0
2	NS	Own	1.9bc	38	5.0b	3.7a	2.9a-d	1.34ab	0	0.0d	0
3	NS	M7a	13.0ab	33	39.0a	3.2ab	2.1d	1.57a	0	0.7d	210a
4	NS	M26	0.0c	0	0.0	3.0bc	2.6bcd	1.17bcd	1.8	4.4d	200a
5	Stay	Own	0.8c	40	2.0b	3.3ab	3.4ab	0.96cd	9.4	11.9cd	153bc
6	Stay	M106	0.3c	33	1.0b	2.8bc	3.3ab	0.85d	14.8	35.4a	135bc
7	Stay	M7a	20.0a	100	20.0b	2.8bc	3.2ab	0.93cd	7.9	27.0abc	133bc
8	Stay	M26	0.7c	33	2.0b	2.4c	2.8a-d	0.84d	9.9	14.5bcd	141bc
9	OG	Own	5.8bc	80	7.2b	3.2ab	3.5abd	0.94cd	0	12.2cd	132c
10	OG	M26	0.3c	33	1.0b	2.8bc	3.1abc	0.95cd	5.2	30.0ab	150bc
F ratio			2.73	--	3.67	3.31	3.14	5.69	1.18	4.55	7.43
Sign			0.5%	--	0.1%	0.1%	0.3%	0.0%	36.4%	0.0%	0.0%

Observations on Early Crops of 'Red Delicious' Strains

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Red Delicious strain evaluations were started at the West Virginia University Experiment Farm in 1959 with bud material submitted and collected throughout the United States and Canada. Experiments were added until 1977. By 1981 the original trees had become overly crowded and useless. It was elected to establish a new block incorporating all of the commercially available strains. Some nurseries that were solicited also submitted strains that had not been released for sale. This block was planted for two functions: For demonstration to growers and for data about productivity and fruit characteristics. Each of two duplications contains five trees. All of duplicates one of each strain are in one row adjacent to a farm lane and marked with a name plate for easy observation. The strains planted in each year are randomized. Since fewer strains have been planted each successive year, randomization has become less meaningful but at least it has not been necessary to plant the ten trees of a strain in the same row. It was intended to use only EM 7a as the rootstock; however, some strains were only available on MM106, MM111, or seedling. Scion/stock combinations probably will affect yield and other parameters and a attempts are made continuously to keep track of those effects.

In 1986, 6 of the strains planted in 1981 yielded over 20 Kg tree $^{-1}$ (Table 1) while 9 of them yielded less than 10 Kg tree^{-1}. All of the trees from the 1982 planting were averaging less than 10 Kg. Trunk growth so far has not been correlated with fruit yield but as expected yield and yield efficiency are well correlated. Although there have been significant differences because of the large number of strains, average fruit diameters and length/diameter have been within a narrow range and describe juvenile fruit. There have been large color differences as determined by a visual rating system. So far, Ultrared, Nured, Royal, Scarlett Spur, Ultrastripe, and Redchief (last two not included on table) have been among the better colored strains. From the firmness, soluble solids, and starch index data, it is not yet possible to identify possible maturity differences, particularly since these characteristics change with tree age. This will be a unique opportunity to document those changes over a number of years.

Table 1. Some 1986 tree and fruit characteristics of 'Red Delicious' Strains planted in 1981 and 1982 at the West Virginia University Experiment Farm, Kearneysville.

STRAIN	Trunk Growth cm year^{-1}	Yield Kg Tree^{-1}	Yield Efficiency Kg cm^{-2}	Fruit Diameter cm	Length/ Diameter
<u>Planted 1981</u>					
Ace	.50	7.66	1.08	7.75	.885
Imperial	.78	22.43	.88	8.13	.840
Oregon Spur II[x]	.89	23.03	.72	7.70	.875
Scarlett Spur[x]	.70	6.68	.23	7.83	.860
Ruby Red	.65	9.07	.44	7.35	.865
Alred	.60	10.98	.54	7.75	.850
Bright N'Early	.71	4.77	.21	7.60	.860
Rose Red[z]	.62	10.50	.50	7.90	.855
Spur Red[z]	.71	10.98	.58	7.45	.870
Sharp Red	.62	4.78	.16	8.20	.850
Starkrimson[z]	.61	4.77	.23	7.63	.860
Silver Spur[z]	.62	22.27	1.38	7.93	.850
Ruby Stripe[z]	.66	9.07	.25	7.93	.865
Apex	.66	12.41	.77	7.83	.830
Oregon Spur[y]	.71	10.50	.41	8.28	.845
Wellspur	.63	12.41	.47	7.58	.855
Red Prince	.77	12.41	.37	8.03	.840
Wayne Spur[y]	.69	23.39	1.20	7.80	.840
Triple Red	.72	7.64	.31	7.83	.840
Sturdee Spur	.69	20.17	1.13	7.55	.830
Topspur	.83	3.34	--	7.50	.850
Improved Ryanred	.84	15.75	.70	7.70	.825
Classic Red	1.17	11.45	.38	7.80	.860
Nured Royal	1.07	10.98	.44	8.00	.875
Hardi-Brite Spur[y]	1.03	24.34	1.12	7.80	.830
Ryanred Spur	.87	13.84	.82	7.95	.850
Redspur	.98	19.09	.97	7.85	.865
Topred	1.14	8.12	.35	7.83	.885
<u>Planted 1982</u>					
Ultrared	1.90	8.11	.70	8.33	.840
Dixie Red[x]	1.13	4.29	.25	7.98	.850
Supreme	1.10	9.07	.55	7.85	.885
Real McCoy[a]	1.32	5.61	.26	8.23	.825
Cascade Spur[x]	1.12	6.20	.25	7.75	.855
Cascade Spur[y]	1.33	17.66	.11	8.03	.885
Cascade Spur[z]	1.20	14.32	.82	8.13	.850
Aomori	1.33	5.73	--	8.18	.860
Duncan's Multiple Range Test 5% Difference	--	--	.60	.53	.06

[x]Seedling rootstock.
[y]MM 106 rootstock.
[z]MM 111 rootstock.
[a]EM 26.

Table 2. Some fruit characteristics of 'Red Delicious' Strains planted in 1981 and 1982 at the West Virginia University Experiment Farm, Kearneysville.

STRAIN	Color	Firmness lbs.-F.	Soluble Solids-%	Starch Index	Water Core-%
Planted 1981					
Ace	6.73	15.8	12.0	4.4	25
Imperial	6.80	14.2	14.3	5.1	0
Oregon Spur II[x]	7.13	14.8	12.9	4.6	25
Scarlett Spur[x]	7.47	15.6	11.9	4.8	10
Ruby Red	5.60	15.8	12.2	4.4	30
Alred	--	15.1	13.8	4.8	30
Bright N'Early	5.40	15.0	13.0	4.7	35
Rose Red[z]	5.93	15.4	13.9	4.1	20
Spur Red[z]	--	14.7	12.6	3.7	0
Sharp Red	6.87	14.7	15.0	4.7	70
Starkrimson[z]	4.87	16.1	13.0	4.5	35
Silver Spur[z]	6.93	15.0	12.9	3.4	0
Ruby Stripe[z]	5.93	14.8	12.1	4.2	10
Apex	5.87	15.6	12.3	3.7	20
Oregon Spur[y]	6.13	15.2	12.3	4.0	20
Wellspur	5.93	15.1	14.1	3.6	0
Red Prince	3.33	14.7	15.2	4.9	0
Wayne Spur[y]	5.87	15.4	12.5	4.2	0
Triple Red	--	15.3	14.0	4.5	0
Sturdee Spur	6.60	15.0	12.6	4.6	25
Topspur	7.00	15.5	13.0	4.3	25
Improved Ryanred	6.67	14.9	13.9	4.4	30
Classic Red	5.13	16.2	13.6	4.1	20
Nured Royal	7.73	15.4	14.3	4.4	25
Hardi-Brite Spur[y]	4.80	15.6	12.4	4.3	15
Ryanred Spur	5.47	15.6	13.1	4.4	0
Redspur	5.87	14.7	11.4	5.0	25
Topred	5.67	15.5	14.4	4.3	0
Planted 1982					
Ultrared	8.40	14.0	13.2	4.3	0
Dixie Red[x]	6.20	15.2	13.2	4.6	35
Supreme	6.93	16.1	13.2	4.3	.0
Real McCoy[a]	5.27	14.6	15.0	5.4	25
Cascade Spur[x]	6.27	15.4	11.5	4.4	15
Cascade Spur[y]	--	15.0	12.7	4.8	20
Cascade Spur[z]	--	15.0	13.2	4.7	40
Aomori	7.07	15.9	14.0	4.6	--
Duncan's Multiple Range Test 5% Difference	1.07	.8	1.6	1.0	30

[x]Seedling rootstock.
[y]MM 106 rootstock.
[z]MM 111 rootstock.
[a]EM 26.
[b]10 Greatest color.

Table 3. Red Delicious strains in the West Virginia University Experiment Farm Kearneysville block outstanding for various characteristics, 1986.

YIELD Kg Tree

Hardi-Brite	24.3
Oregon Spur II	23.0
Wayne Spur	23.4
Imperial	22.4
Silver Spur	22.3
Sturdeespur	20.2

YIELD EFFICIENCY (yield/trunk CSA)

Silver Spur	1.3 a
Wayne Spur	1.2 ab
Sturdeespur	1.1 abc
Hardibrite	1.1 abc
Cascade Spur	1.1 abc
Ace	1.1 abc

"SPURINESS" (#/m)

Redspur	33
Ace	33
Redchief	31
Sturdeespur	31
Bisbee	27

L/D RATIO

ACN 501	.90 a
Ace	.89 ab
Topred	.89 ab
S. Supreme	.89 ab

COLOR (Panel 1-10)

Ultrastripe	9
Red Chief (C)	8
Ultrared	8
Nured Royal	8

COLOR (cont)

Ace	7
Oregon Spur II	7
Scarlett Spur	7
Silver Spur	7
Topspur	7
Imp. Ryanred	7
Bisbee	5

WATERCORE (%)

Sharp Red	70 a
Bright 'N Early	35 bc
Bisbee	35 bc
Dixiered	35 bc

STARCH INDEX

Silver Spur	3.4 g
Wellspur	3.6 fg
Apex	3.7 efg

SOLUBLE SOLIDS (%)

Red Prince	15.2 a
Sharp Red	15.0 a
The Real McCoy	15.0 a

FIRMNESS (lbs + f)

Classic	16.2 a
S. Supreme	16.1 ab
Bisbee	16.1 ab

Apple Preharvest Drop Control

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Introduction

Daminozide and 2,4,5-TP have recently become unavailable for control of preharvest drop of apple. A recent survey of Virginia apple producers indicated that approximately 14% and 22% of fresh market and processing cultivars, respectively, will be lost annually to preharvest drop if a new stop drop material is not registered. Since little preharvest drop research has been conducted during the last 20 years, we have initiated a research program to identify new materials to delay fruit abscission.

Methods

Experiment 1. Ten-year-old spur 'Delicious' trees in Winchester, VA, were used for airblast applications of several materials applied at 300 gallons per acre on 9 September 1986 (140 DAFB). Treatments were applied to 6 trees per treatment in a randomized complete block design. The treatments were (1) control, (2) NAA at 10 ppm, (3) 2,4-DP at 5 ppm, (4) 2,4-DP at 10 ppm, and (5) 2,4-DP at 15 ppm. Three limbs per tree, each carrying 10 to 20 fruit, were tagged and fruit were counted at 3- or 7-day intervals. One week after treatment, 10 fruit per tree were sampled for evaluation of maturity (red color, firmness, soluble solids, and starch).

Experiment 2. Similar 'Delicious' trees were used in a randomized complete block design with 5 single tree replicates per treatment. The treatments were (1) control, (2) Banvel at 20 ppm, (3) Garlon at 20 ppm, (4) Embark at 100 ppm, and (5) 2,4,5-TP at 10 ppm. Fruit drop and fruit maturity were evaluated as described for Experiment 1.

Experiment 3. Mature 'Waynespur Delicious' trees in Blacksburg, VA, were used to evaluate PPG-1721 for prevention of preharvest drop. Treatments were applied with a handgun at 150 psi to runoff. Quarter-tree units were treated with 25 or 100 ppm plus X-77 at 0.25% (v/v) on either 26 August (127 DAFB) or 8 September 1986 (140 DAFB). Five trees were treated on each date and one quarter of each tree served as an untreated control. Data were analyzed as a randomized block design, where trees served as blocks. Fruit on the ground under each tree quarter were periodically counted and cumulative % fruit drop was calculated from the total number of fruit on each tree section. Fruit were sampled from each quarter on 15 September to evaluate fruit maturity.

Experiment 4. Mature 'Vance Delicious' trees in Blacksburg, VA, were used to evaluate 6-BA and GA_{4+7}, alone or in combination, and in combination with NAA. Treatments applied to quarter tree units of 5 trees on 8 September 1986 were (1) control, (2) 6-BA at 100 ppm, (3) GA_{4+7} at 100 ppm, and (4) 6-BA plus GA_{4+7}. An additional 5 trees received the same treatments after being sprayed with NAA at 10 ppm. X-77 at 0.01% was included in all treatments. Fruit drop and fruit maturity were evaluated as in the previous experiment.

Results

Experiment 1. NAA and 2,4-DP effectively prevented fruit abscission for 10 days, but NAA started to lose effectiveness 2 weeks after treatment. 2,4-DP at all concentrations prevented fruit drop longer than NAA, but 10 and 15 ppm were most effective 6 weeks after treatment. None of the parameters of fruit maturity were significantly influenced by the treatments.

Experiment 2. Embark at 100 ppm did not delay fruit abscission. Banvel at 20 ppm inhibited fruit drop as effectively as 2,4,5-TP at 10 ppm. Garlon at 20 ppm did not significantly reduce fruit drop during the week after application, but further fruit drop was inhibited for 4 weeks. Banvel, Garlon, and 2,4,5-TP did not influence fruit soluble solids when measured 2 or 4 weeks after treatment, however, Garlon significantly reduced flesh firmness 4 weeks after treatment.

Experiment 3. PPG-1721 did not reduce preharvest drop and did not significantly influence fruit maturity.

Experiment 4. Preharvest drop and fruit maturity were not significantly affected by 6-BA or GA_{4+7}. NAA, alone or combined with 6-BA or GA_{4+7}, dramatically reduced fruit drop but had little effect on fruit maturity.

Discussion

2,4-DP at 5 ppm prevented fruit abscission to a greater extent than NAA, and results from 1985 indicate that 2,4-DP is as effective as 2,4,5-TP. Although the studies are still in progress, 2,4-DP at 15 ppm also appears extremely effective on 'Stayman', 'Winesap', and 'Rome'.

Banvel and Garlon both show promise as stop drop materials. Both materials at 20 ppm induced phytotoxicity and studies are in progress to determine the appropriate concentrations that will delay fruit abscission without leaf injury.

PPG-1721, 6-BA, and GA_{4+7} showed little promise as stop drop materials and will not be included in future experiments.

OBSERVATIONS ON THE USE OF PACLOBUTRAZOL FOR BEARING APPLE TREES.

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OBJECTIVE: Evaluate the response of young and mature bearing apple trees to paclobutrazol over several years with various application techniques.

BACKGROUND: The effect of paclobutrazol on growth and fruiting of apple trees during the year following a single ground treatment is well documented. We report some of the observed responses over a period of 3 or 4 years following a single ground application of paclobutrazol. Results with foliar sprays are compared to ground applications.

METHODS AND RESULTS: The initial trial was conducted on non-spur 4-year-old 'Golden Delicious' and 'Delicious' apple trees on M.7a rootstock. Ground sprays of paclobutrazol (50 WP) at 0, 5, 10, 20, or 30 g ai tree^{-1} in 1 liter of solution was applied uniformily to a 9.3 m^2 weed free area under the tree on 10/12/82. The experimental design was RCB with 4 replications of single tree treatments. In 1983, terminal growth, dormant pruning time, fruit weight, L/D ratio, fruit flesh firmness, and soluble solids were reduced. Fruit set and flesh Ca were increased. The 30 g treatment produced an overdose response characterized by little or no new shoot growth, exceptionally small leaves, and severe reduction in fruit size. Rates at a given concentration produced uniform responses. The effect of paclobutrazol diminished each year after 1983 first in the 5-g-trees, and later (1985-1986) in the trees treated at 10 and 20 g rates. Shoot growth of trees treated at 5 or 10 g ai was the same as control trees in 1986. The gradual loss in response to paclobutrazol was characterized by several shoots randomly producing vigorous growth, generally on the periphery of the canopy. During the next season there was no inhibition of growth on those trees affected. The results indicate that a ground spray of 5 to 10 g tree^{-1} (1.5 to 3 lb/A) could provide acceptable growth control on young trees of this vigor and rootstock for 1 to 3 years.

To evaluate the effect of the same rates on mature trees, paclobutrazol (50 WP) was applied to 14-year-old 'Topred Delicious'/MM106 on 10/21/82. Two methods were used to deliver the chemical to the target: 1) a 30 cm wide by 4.5 m long band spray (BS) within the drip line on each side of the tree within the row; and, 2) a collar drench (CD) in which the desired rate was applied in 1.5 liter of solution in a narrow trench around the base against the tree. The design was RCB with 3 replications of single tree treatments. In contrast to results with young trees, no response was observed in 1983, on the 14-year-old trees. In 1984 paclobutrazol induced typical effects on some of the CD treated trees at all rates and a few of the BS treated trees at the 10, 20, and 30 g rate; however, the response was erratic. No response ocurred at the 5 g rate except that observed in 1984 on CD trees which resumed apparently normal growth in 1985. More uniform growth inhibition was noted on CD trees treated at 10, 20, or 30 g in 1985 and 1986. Collar drench treatments were more effective than BS's in reducing growth. Fruit size was reduced in proportion to shoot growth inhibition. The results of this study indicate that soil applications may not provide a uniform response for the growth control desired in mature trees.

In order to evaluate the CD treatment on young trees, paclobutrazol (50 WP) was applied to 5-year-old 'Stayman' and 'York Imperial' trees on M.7a rootstock on 11/18/83. Treatments were applied in 250 ml of solution at 0.13, 0.25, or 0.5 g ai tree^{-1} cm^{-1} trunk cross sectional area or cm^{-1} trunk diameter. Trunk size made application rates range from 0.28 to 1.90 g ai tree^{-1}. In contrast to the earlier study on 4-year-old trees, no response was observed during the first growing season (1984) after treatment . Response was observed at all rates in 1985; however, in several cases the effect was localized. Response diminished in 1986 but the localized effect was still evident, particularly on the 'York Imperial' trees. The results from this study support our previous conclusion that uniform response may be difficult to obtain with soil applications.

To further evaluate the effect of paclobutrazol, foliar and ground treatments of the 2SC formulation (Cultar) were applied in 1985 to 5-year-old 'Starkspur McIntosh'/M.7a, non-spur 'Winter Banana'/MM 111, and 'Topred Delicious'/M.7a. Foliar sprays were applied at 0.56 kg ha^{-1} (0.5 lb/A) in a carrier solution of 750 liters ha^{-1} (80 gpa) with a handgun sprayer. Individual sprays were applied at the tight cluster stage and again at petal fall + 2 wks or PF + 4 wks. Sprays were repeated at 14-day intervals through PF + 12 weeks at the 0.56 kg ha^{-1} rate (total of 3.4 kg ha^{-1}). On 'Winter Banana' a collar drench treatment of 6 g tree^{-1} or a soil band spray at 3.4 kg ha^{-1} (3 lb/A) was applied at the tight cluster stage. Based on the number of trees ha^{-1}, the 6 g tree^{-1} rate was equal to the 3.4 kg ha^{-1} application. Foliar sprays were repeated in 1986 on selected treatments but at a lower rate, 0.28 kg ha^{-1} in each of 4 sprays beginning at the PF + 2 week period and repeated at 14-day intervals. Sprays ('86 only) were applied with a 3-pt.-hitch PTO air blast sprayer at 935 l/ha (100 gpa).

In 1985 the degree of response differed among cultivars. Foliar sprays reduced shoot growth about 50%. Paclobutrazol tended to flatten the fruit but did not affect the L/D ratio. Fruit firmness was increased slightly and soluble solids were reduced by foliar sprays. Overall, the response was comparable to our initial soil spray treatments at about the 10 g rate except in the case of foliar sprays there were more medium vigor shoots that resulted in a better shoot:spur ratio. In 1986 fruit set was increased on 'Starkspur McIntosh' from 92% for control to an average of 185% for treated trees. Fruit quality generally was not affected in 1986 except for soluble solids which was reduced in 'Topred Delicious' trees. Fruit L/D ratio was decreased by most treatments. Shoot growth has not been measured, however, a carry-over from 1985 foliar sprays was observed in 1986. CD and BS treatments on 'Winter Banana' did not affect shoot growth or fruit quality in 1985 but produced typical overdose effects in 1986.

<u>CONCLUSIONS</u>: Response to ground applications of paclobutrazol on bearing apple trees requires 6 to 18 months depending on time, method and rate of application and tree age. Root distribution, soils, and environmental factors might also play a major role in response. Sprays of 1.7 to 3.4 kg ha^{-1} are effective during the year of application when applied in several sprays of 0.28 to 0.56 kg ha^{-1} each on young trees. Foliar sprays appear to offer better control of shoot growth and a better shoot:spur ratio. Overdose is reduced with multiple foliar sprays.

Packinghouse Loss and Packout Assessment of Coronet Peach

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Introduction

In most peach operations, yields are considered in terms of overall bins of fruit as well as number of packed boxes produced in an orchard. Little attention is given to fruit sampling that could predict potential market value of fruit, predict upcoming packouts to facilitate marketing, identify specific cause of losses, and provide data to modify management practices. Detailed sampling procedures, which can be relatively time consuming, must be simplified and shown to be economically beneficial in order to be implemented by industry.

Preliminary sampling procedures were evaluated during the 1986 season at selected peach packinghouses in Fort Valley and Byron, GA. Data in this paper represents one such procedure, sampled in detail and presented to allow practical evaluation and recommendations.

Materials and Methods

The orchard evaluated in this sampling procedure was a nonirrigated, 4th leaf block of 'Coronet' peach trees, located in Fort Valley, GA. The orchard consists of 2939 trees planted on an 18' x 20' spacing (approximately 24 acres). During the 1986, season 256.25 bins (18 bushel bin) were picked from the orchard on the following dates: June 1, 5 bins; June 6, 34 bins; June 9, 87 bins; June 11, 37 bins; June 13, 64 bins; and June 16, 27 bins.

On June 9, 1986, fruit samples were taken throughout the day. Four groups of four 18-bushel bins were grading by clearing the packing line before and after the sample. Total number of 3/4 bushel packages were recorded for the following grades: U.S. No. 1 2 1/2" UP, 2 1/4" UP, and 2" Minimum; U.S. No. 2; and culls. Within the U.S. No. 2 and cull grades, all fruit were evaluated for specific characteristics related to their downgrading. Random samples of U.S. No. 1 fruit were sampled prior to mechanical sizing. Ground color was rated, based on color chip values developed at Clemson University. The weight of each fruit in each color chip category was then determined.

Following collection of packout figures, a market value was calculated using market prices as listed in the June 10, 1986 issue of Southeastern Peach Report, S.C. Department of Agriculture, Columbia, S.C. The following values per 3/4 bushel package were used: U.S. No. 1 2 1/2" UP, $14.00; U.S. No. 1 2 2/14" UP, $12.00; U.S. No. 1 2" Minimum, $7.00, U.S. No. 2, $7.00; and culls, no value.

An adjusted value was also calculated to demonstrate the effect of raising fruit size in each U.S. No. 1 grade by a 1/4" increment. Values used were: U.S. No. 1 2 3/4", $16.00; U. S. No. 1 2 1/2" UP, $14.00; U.S. No. 1 2 1/4" UP, $12.00; U.S. No. 2, $7.00; and culls, no value.

Results and Discussion

Packouts of each four bin samples reveal significant variation, largely in the number of U.S. No. 1 packages between the samples (Table 1). Differences were, in part, attributed to topographical differences in the field and resulting damage of spring frost. Spring frost injury was prevalent in U.S. No. 2 fruit (Table 3). Although all areas in the field had a full crop, one end of the field received a heavier thinning shortly after bloom. This early thinning may have promoted an increase in fruit size.

However, examination of color chip values and fruit weight as well as loss assessment of U.S. No. 2 and cull fruit suggests that other factors contributed to differences (Tables 2, 3, 4). Data suggest that smaller fruit sizes being harvested were also less mature. Better management of harvest might have reduced the percentage of small, less mature fruit picked on June 9, leaving such fruit to attain increased size and maturity.

The economic significance of the variation in packout between samples is apparent (Table 5). There is a $148.00 difference in value between fruit represented in the first and fourth sample. This difference in value of fruit between two areas of the orchard (each representing approximately 144 trees) indicates additional expenditure of time and/or money would have been justified.

Conversely, inputs such as bloom thinning, irrigation and strict harvest management justify serious consideration. Adjusting values of sample fruit by raising fruit size in each U.S. No. 1 grade by 1/4" increment has a significant effect on dollar value (Table 5). In general, this is due to a tremendous jump in value from 2" to 2 1/4" peaches. This relationship is common in most years.

The preliminary study indicates that sampling can provide benefits in management of peach production. Such sampling can be a useful tool in determining effects on return of certain inputs, such as irrigation, bloom thinning and increased middle management. Development of a simple in-field sampling procedure which would predict packout and market value of fruit in a given orchard is needed.

Table 1. Grade and size distribution of 'Coronet' peaches, Fort Valley, GA, June 9, 1986.

	3/4 Bu. Box Count/Run[z]				
U.S. No. 1	1	2	3	4	Total
2 1/2" UP	14.5	12.0	6.5	5.0	38.0
2 1/4" UP	63.5	62.0	53.0	46.0	224.5
2" MIN	10.5	15.0	25.5	36.0	87.0
U.S. No. 2	1.9	3.5	4.5	3.6	13.5
Culls	2.5	3.5	3.3	2.5	11.8

[z] Each run consisted of four 18 bushel bulk bins.

Table 2. Relationship between color chip value and fruit weight of U.S. No. 1 'Coronet' peach, Ft. Valley, GA, June 9, 1986.

Color Chip Value[z]	Average Wt (g)
6	148 a[y]
5	147 a
4	141 a
3	132 b
2	120 c
1	108 d

[z] Color chip scale of 1-6 with 1 being greenest, least yellow and 6 least green, most yellow. In general, maturity increases with increasing value.

[y] Compare means by Duncan's Multiple Range Test, .05 level.

Table 3. Loss assessment of U.S. No. 2 grade 'Coronet' peaches, Ft. Valley, GA, June 9, 1986.

Category	Percent fruit exhibiting characteristic by run[z]				
	1	2	3	4	Avg.
Immature	62	46	56	45	52
Bruised	6	10	8	9	8
Decay	1	<1	-	<1	<1
Too Soft	<1	<1	<1	<1	<1
Cold Injury	33	24	17	21	23
Bird	2	2	2	<1	<2
Limb Rub	6	10	10	11	9
No. 1	4	8	10	19	8
Other	6	5	4	2	4

[z] Each run consisted of four 18-bushel bulk bins.

Table 4. Loss assessment of cull grade 'Coronet' peaches, Ft. Valley, GA, June 9, 1986.

Category	Percent fruit exhibiting characteristic by run[2]				
	1	2	3	4	Avg.
Immature	21	28	25	25	25
Bruised	7	6	9	7	7
Decay	40	50	42	48	45
Too Soft	40	50	42	48	45
Cold Injury	12	10	14	7	11
Bird Injury	14	8	16	5	11
Limb Rub	3	1	-	<1	1
Under Size	6	<1	-	<1	2
Split Pit	<1	2	2	4	2
Catface	<1	-	-	<1	<1
Late Stink Bug	2	<1	2	1	<1
Curculio	<1	-	<1	<1	<1
No. 1	3	2	-	<1	2
No. 2	6	8	2	4	5
Other	2	2	1	<1	2

[2] Each run consisted of four 18-bushel bulk bins.

Table 5. Market value of 'Coronet' peaches by grade and size categories, Ft. Valley, GA, June 9, 1986.

Grade Category	Dollar Value/Run[z] 1	2	3	4	Total
U.S. No. 1					
2 1/2" UP	203[y]	168	91	70	532
2 1/4" UP	762	744	636	552	2694
2" MIN	73	105	175	252	605
U.S. No. 2	9	5	32	25	90
Culls	0	0	0	0	0
Total	1047	1042	934	899	3922
Adjusted[x]	1256	1140.50	1184	1181	4761

z Each run consisted of four 18-bushel bulk bins.

y Based on market price, June 10, 1986, Southeastern Peach Report. SC Department of Agriculture, Columbia, SC; U.S. No. 1 2 1/2" UP, $14.00; U.S. No. 1 2 1/4" UP, $12.00; U. S. No. 1 2", $7.00. Value rounded to nearest dollar.

x Adjusted value by raising each U.S. No. 1 grade-size category up by 1/4" increment using market price of U.S. No. 1 2 3/4", $16.00; U.S. No. 1 2 1/2" UP, $14.00; U.S. No. 1 2 1/4" UP, $12.00.

PEACH BLOOM THINNING WITH AMMONIUM THIOSULFATE

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Ammonium thiosulfate (ATS) solutions were tested for blossom thinning in 1986 at several locations in South Carolina. Results of these tests are summarized in the accompanying tables.

In one test (Table 1), ATS effectively thinned six cultivars. Several required some follow-up hand thinning, primarily clusters or limbs that were poorly covered by spray. In a similar test (Table 2), ATS application greatly reduced the number of fruit on two other cultivars with minimal hand thinning necessary.

In a third test (Table 3), 'Redhaven' was sprayed with ATS. No follow-up hand thinning was done on sprayed trees. ATS treatment greatly reduced the number of fruit on trees. Yields on treated and nontreated trees were equivalent, fruit numbers were less on treated trees, and fruit size was larger on trees thinned at flowering with ATS than on those hand-thinned at the normal time.

Observations from these tests and others indicate the following: (1) ATS sprays at approximately full bloom or just prior cause fruit thinning. (2) Some cultivar response differences were noted though the greatest shortcoming was lack of thinning on limbs which were not sprayed because of poor coverage. As with any spraying operation, adequate equipment and proper calibration are essential. (3) In several plots where ATS had been applied, more young fruit survived frosts than on nontreated plots.

TABLE 1. ESTIMATION OF CROP FOLLOWING PHYSIOLOGICAL DROP.

CULTIVAR	DATE OF APPLICATION[z]	PERCENT CROP TREATED	PERCENT CROP NONTREATED
Candor	3/27	120	700
Redhaven	4/1	200	800
Redglobe	3/29	140	800
Winblo	3/27	100	600
Belle of Georgia	4/1	100	500
Nectar	3/27	120	500

[z]Air blast sprayer application at 90-95% flowering, with 3 gallons ATS/acre applied at 166 gallons/acre.

TABLE 2. ESTIMATION OF CROP FOLLOWING PHYSIOLOGICAL DROP.

CULTIVAR	DATE OF APPLICATION[z]	PERCENT CROP		FRUIT LOAD[y]	
		TREATED	NONTREATED	TREATED	NONTREATED
Blake	4/1	130	250	6.3	24.4
Rio-Oso-Gem	4/1	200	600	8.0	25.8

[z]Air blast sprayer application of 90-95% flowering, with 3 gallons ATS/acre applied at 166 gallons/acre.

[y]Fruit/cm^2 limb cross sectional area.

TABLE 3. THINNING OF 10-YEAR-OLD 'REDHAVEN' PEACH TREES WITH ATS[z].

	TREATED	NONTREATED
Crop Load (after physiological drop-fruit/cm^2 limb cross sectional area)	9.2 a	20.5 b
Weight of fruit harvested (Kg/tree)	88.1 a	88.0 a
Number of harvested fruit/tree[y]	1069 a	1284 b
Mean fruit weight(g)	83.9 a	68.7 b

[z]Air blast sprayer application at 95% flowering with 150 gallons/acre of 3 gallons ATS/100 gallons solution.

[y]Nontreated trees were hand-thinned following crop load counts (i.e., early pit hardening.

Metabolic Changes in Iron-Deficient Apple Seedlings

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Iron deficiency in fruit trees has been investigated for hundreds of years and to this date still remains a serious world wide problem. It has been reported in separate experiments that chlorophyll of chlorotic apple leaves do not develop sufficiently (Zhou et al, 1984) and the rate of net photosynthesis of these plants is low and the apple roots require energy to reduce Fe^3 (Tong et al, 1985). This raises the question, how can a Fe deficient plant generate sufficient energy to reduce Fe^3 when its photosynthetic activity is insufficient.

Romheld and Marschner (1985, 1986) have proposed that iron mobilization by dicots is done by a proton efflux pump in response to iron-deficiency stress. Iron deficient roots display an increased activity of NADPH-dependent plasma-membrane-bound reduction (Sijmons 1989,) and the proton pump is regulated by auxin (Landsberg 1981). The proton pump also requires energy. Obviously, the above findings somehow relate to each other in an intact plant. Thus, we proved how the above events may be related in apple seedling.

Material and Methods

'York Imperial' apple seeds were germinated and grown in flats of sand to the four leaf stage. Then seedlings were transfered to a nutrient solution with iron (1.3 ppm) or without iron. The basic solution composition was as follows in ppm: N 47, P 31, K 62.5, Ca 64, Mg 19.2, B0.50, Zn 0.10, Mn 0.33, Cu 0.03, Mo 0.03 S 25.6 Cl 14.6. The pH of the solution was 5.4 -6.0. Solutions were changed weekly and aerated continously. Daily water loss was replenished by addition of deionized water. The experiments were carried out in the greenhouse (about 25°C). Seedlings were grown in an iron-stress nutrient solution for 2 weeks developing chlorosis and various tests were concluded.

Measurement of Fe^3 reduction The nutrient solution was mixed with agar (65%) to desolve the agar. The agar medium was gradually cooled to 35-38°, added with FeEDTA (0.1 mM) (Ethylenedinitrilo tetraacetic acid) and BPDS (0.3 mM) (Bathophenanthroline disulfonate) adjusted to pH 5.4. The semisolid medium was poured into shallow dishes. The roots of intact plants were rinsed with deironized water, carefully submerged into the seemisolid agar medium (about 30°C). Roots were oriented with a glass rob and covered with aluminum film. Reduction of Fe^3 in the medium around the roots of Fe-stress plants were observed after 3 hours (formation of red colored Fe^2 BPDS) appeared. However, around the root zone of Fe-sufficient plants reduction of Fe^3 could be observed only after longer incubation times.

Measurement of conductivity The roots of intact plants were rinsed several times with deironized water. Roots of two plants were submerged into deionized water in a paper cup. Conductivity of the solution was measured in 10 minute intervals.

Measurement of photosynthesis The measurements were by a LiCor portable photosynthesis instruments. CO_2 concentration was 380-430; light level was 800-830 uE cm $^{-2}S^{-1}$; relative humidity was 52-54%; leaf temperature was 27-29°C; seedling age was 15 days.

Since bicarbonate ions influence the development of iron chlorosis 1g $CaCO_3$/lites was added to the normal Fe (1.3 ppm), low Fe (0.13 ppm) and no Fe solutions.

Respiration measurements Respiration of roots were measured with a Yellow Spring Instr. Co. oxygen electrode. Roots were rinsed and cut with only one or two cuts to provide 0.1 g f.w. Root samples were placed into deionized water at 25°C for oxigen measurements.

Chlorophyll determination Chlorophyll was extracted by 90% alcohol from five leaf dishes of 0.5 cm diameter optical density was measured at 649 and 665 nm.

Non-structure carbohydrate analysis

The extraction, purification, and derivatization procedures have been described previously (Wang et al. 1985). A Hewlett-Packard 5880 gas chromatograph equipped with a flame ionization detector and a fused silica capillary column (methylsilicone fluid, 12.5 x 0.2 mm) was used for separation of sugars. Separated sugars were compared with derivatized sugar standards for qualitative and quantitative determinations. A known amount of ∂ -phenyl-D-glucopyranside was included in all samples as an internal standard.

Organic acid analysis

A Baker-10 extraction system was used for purification of organic acid in apple tissue. An aliquot of ethanol extract was adjusted to pH 7.0 and placed onto a 3-ml quaternary amine column. The columns were conditioned with hexane and methanol. Organic acid was eluted with 3-ml 0.1 N HCl. The eluate was concentrated to dryness under vacuum. Derivatization and determination of organic acid were similar to that for sugars except that the initial oven temperature was reducted to 100°, held isothermal for 3 min, temperature program rate was 4° min^{-1}, and final oven temperature was 230°.

Results

Seedlings usually developed chlorosis after growing in the Fe-stressed nutrient solution for 2 weeks. Nitrogen was supplied at NO_3, consequently, the pH of the nutrient solution was expected to rise during the experiment. However, the pH of the solution imposing Fe-stress on the plants was lower than that supplying sufficient Fe. This may indicate that NO_3 uptake of Fe-stressed plants was lower or there was also a concomitant leakage of compounds acidic in nature to lower the solution pH. (Table 1).

Roots and leaves of Fe-stressed plants contain more acid than Fe-sufficient plants (Table 2). It is apparent that leakage from the Fe deficient roots is higher as expressed by the higher conductivity measurements of the solution surrounding the roots (Fig 1). The higher conductivity from the Fe-stressed plants has been associated with a higher rate of Fe^{3+} reduction in the root zone as measured by Fe^{3+} reduction on the agar plates (Fig. 2).

As iron chlorosis developed the chlorophyll content of the young leaves of Fe-stressed plants was considerably lower than the chlorophyll content of the Fe-sufficient plants. This effect was magnified by $CaCO_3$ addition to the nutrient solution. Net photosynthesis also decreased reflecting the amount of chlorophyll present in the leaves. (Table 3). This is further reflected in the sugar concentration of the leaves (Table 4). However, the old leaves developed before the imposition of Fe-stress and continued to produce sugars and the roots were apparently supplied with carbohydrates to the level of the control plants (Table 4). Respiration of roots of iron stressed plants increased and this was magnified by the inclusion of $CaCO_3$ to the solution (Table 3).

When malic acid concentration was measured in distilled water into which roots of 4 plants were immersed, a 30% increase in leakage was noted over the leakage from Fe sufficient plants. However plants were not sterile and bacterial utilization and or transformation of malic acid cannot be discounted.

Discussion

The release of hydrogen ions by iron stressed plants has been discussed by several authors (reviewed by Korcak 1987) Landsberg (1981) postulated that the acidification of the nutrient media by Fe deficient dicots was due to the release of organic acids. This contrasted with the ion pump mechanism of monocots which could not acidify the nutrient media when nitrogen was supplied in NO_3 form.

In our studies we have shown that apple seedlings released organic acids to the media when they were stressed for Fe and nitrogen was supplied as NO_3. Analysis of the plant has shown that not only the roots but all other parts of the plant were high in organic acids. Landsberg (1982) proposed that the regulation of H^+ efflux was regulated by auxins and removal of the chlorotic shoot tip or application of TIBA (tri-iodo-beuzoic-acid) prevented the auxin movement to the root. He also measured organic acid accummulation in the roots which ranged from 1-4 fold increase in the Fe deficient plants compared to controls.

Our data substantiated the fact that organic acid are released from the roots of Fe deficient apple seedlings and the hydrogen ions were able to reduce Fe in situ in the medium. However, the roots are not the exclusive source of the acids. All parts of the plants contain higher levels of malic acid and lower levels of quinic acid. Photosynthesis of the Fe stressed plants is much lower than the ion sufficient plants (Zhou et al. 1984a) and the total sugar supply is also less. This possibly explains lowering the quinic acid levels. Quinic acid is produced through the activity of the pentose phosphate pathway which is in turn very responsive to the high carbohydrate levels (Faust et al. 1966). The reasons for the high levels of malic acids cannot be explained at the present time in the entire plant. It may have something to do with the decreased Pn or it may have something to do with the altered hormonal balance that Landsberg (1982) associated with Fe stress.

It must be noted that inclusion of $CaCo_3$ into the solution decreased Pn and increased the Fe stress chlorosis but it did not affect the ability of plants to lower the pH of the nutrient solution. Sigmons et. al. (1984) reported that NADP level of iron deficient roots increased under iron-deficiency and if redox state was altered by addition of ferry cyanide. They postulated that NADPH dependent Fe containing reductive synthetases may be inhibited by Fe deficiency. Our data indicate an increased respiratory activity and an increased acid content throughout the plant. Thus we conclude that the source of reducing power of the plant is not necessarily the root, but acids could be transported from the leaves and stem which leak out from the apoplast of the root.

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Table 1. pH of nutrient solutions of Fe sufficient and Fe stressed apple seedlings.

Treatment	pH (Initial)	pH (After 5 days)	Δ
+ Fe	5.2	5.7	0.5
L Fe	5.0	5.3	0.3
- Fe	5.0	5.3	0.3
+ Fe + $CaCO_3$	6.8	7.4	0.6
L Fe + $CaCO_3$	6.7	7.0	0.3
- Fe + $CaCO_3$	6.8	7.3	0.5

Table 2. Organic acid concentration in Fe sufficient and deficient apple seedlings

	ug/g fresh wt					
Young leaves	Succ	Malic	Quinic	Citric	Total	Ratio $(S+M+C)Q^{-1}$
Control	23.3	249.8	6421.4	164.2	6858.7	0.07
-Fe	84.1	2670.9	465.0	4286.0	7506.0	15.14
Old leaves						
Control	0.0	285.3	3982.7	275.8	4543.8	0.14
-Fe	2.4	1792.5	3320.3	2035.7	7150.9	1.15
Fibrous roots						
Control	0.0	760.4	213.4	1020.9	1994.7	9.34
-Fe	83.4	1822.2	113.8	3593.7	5613.1	48.32

Table 3. Photosynthesis, root respiration and leakage from the roots of Fe sufficient and Fe stressed apple seedlings

Treatment	Pn	Chlorophyll ($mgcm^{-2}$)			Root respiration
	($mgdm^2 S^{-1}$)	a	b	a+b	O_2ul/g(fw)hr
+ Fe	35 ± 4.2	0.130	0.033	0.163	360 ± 0
+ Fe+$CaCO_3$	30.0 ± 4.8	0.095	0.022	0.120	416 ± 64
L Fe	24.7 ± 2.1	0.071	0.016	0.087	520 ± 64
L Fe+$CaCO_3$	19.8 ± 7.0	0.035	0.0073	0.042	544 ± 88
− Fe	6.3 ± 3.7	0.018	0.0031	0.021	520 ± 104
− Fe+$CaCO_3$	2.7 ± 5.8	0.0046	0.001	0.006	544 ± 136

Table 4. Concentration of various sugars in parts of Fe sufficient and deficient apple seedlings.

	mg/g - fresh wt				
	Sorbital	Fructose	Glucose	Sucrose	Total
Young leaves					
control	16.71	0.90	11.57	0.12	29.30
-Fe	6.86	0.31	3.89	0.04	11.10
Old leaves					
control	15.76	1.20	8.83	0.13	25.92
-Fe	15.74	1.26	7.19	0.10	24.29
Fibrous roots					
control	3.16	1.14	2.49	0.01	6.80
-Fe	4.72	0.96	2.24	0.04	7.96

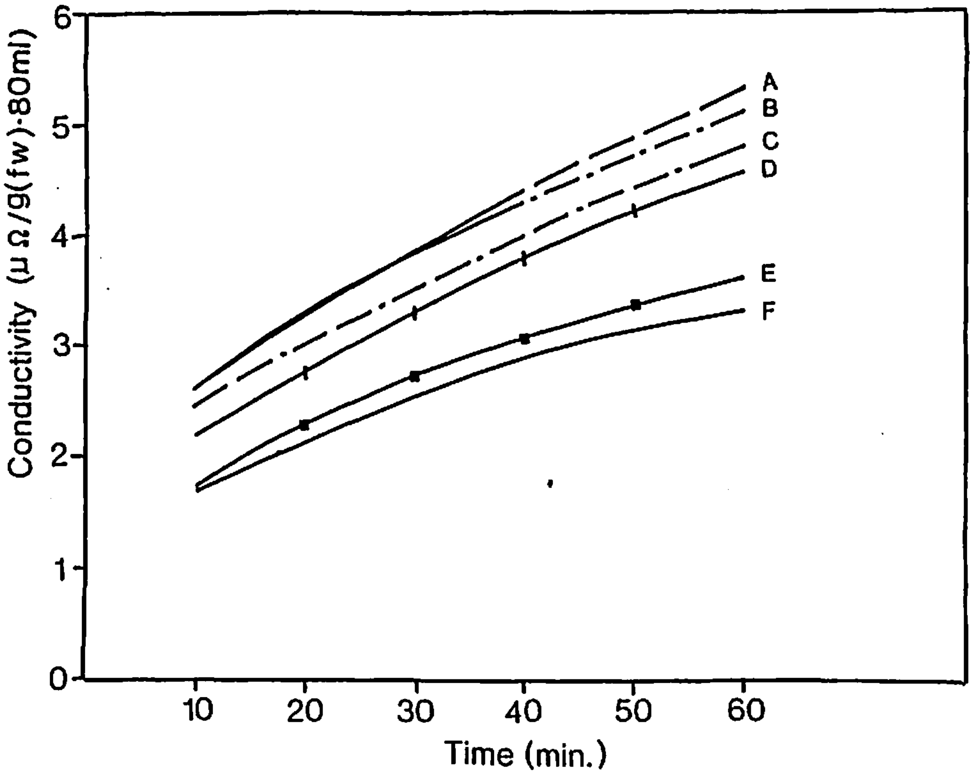

Fig. 1. Conductivity of solutions surrounding the roots of Fe-sufficient and Fe-deficient apple seedlings.
A(NOFe+$CaCO_3$), B(NO Fe), C(Low Fe+$CaCO_3$), D(Normal Fe+$CaCO_3$), E(Low Fe) F(Normal Fe).

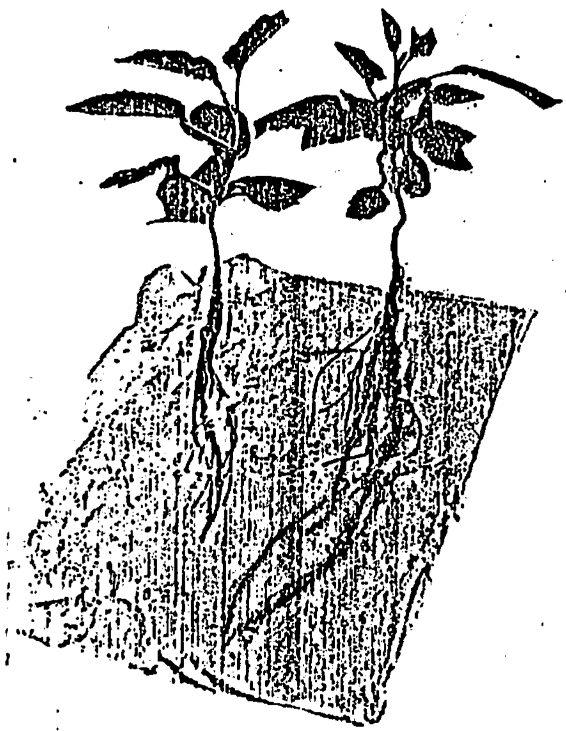

Fig. 2. Iron reduction by roots of Fe-sufficient and Fe-deficient apple seedlings. Roots of 'York Imperial' apple seedlings were embedded for 3 hrs in an agar medium with FeEDTA and BPDS.

Fire Blight Infection On Apple Rootstocks In The Field

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Fire blight (Erwinia amylovora, Burr.) is a bacterial disease which can affect apple cultivars and rootstocks (Van Der Zwet and Keil, 1979). Susceptibility varies with the cultivar, environmental conditions and cultural practices. Cummins and Aldwinckle (1982) have indexed apple rootstocks as to their susceptibility to fire blight. This is of concern when they are used either as the rootstock or as an intermediate stempiece, e.g., M.9 on M.111. M.9 appears to be more susceptible than M.27. Infection can occur through the suckers, if not adequately controlled. Infection can also occur directly through the bark of the rootstock when used as an intermediate stempiece, or through the exposed rootstock trunk of M.9 when the graft union is above ground (Rom and Slack, 1971).

In 1986 a fire blight attack occurred in the apple research orchard and nursery at the Agricultural Research Center at Rock Springs. This was mainly as shoot blight. Of special interest was the infection on cv Nittany where stions were being evaluated with M.9, M.27 and M.111 rootstocks, and with intermediate stempieces of M.9 or M.27 on M.111 (15 or 30 cm). There were 4 single tree replicates. Fire blight also occurred in the nursery where several rootstocks were growing in stoolbeds. Differences in susceptibility to infection were noted. Also, some young apple trees with exposed rootstock trunks of M.9 exhibited symptoms of fire blight.

The purpose of this paper is to report on observations made of fire blight infestation to apple rootstock cultivars.

The Nittany Planting. Stions were planted in 1980 and 1981, and were bearing heavily. When shoot blight appeared, a program of control was initiated, including breaking out of infected wood and foliar applications of streptomycin. Suckering was occurring on interstem trees, especially with M.27, but were being controlled with 1% NAA treatments. These were arising from the M.111 rootstock trunk. The lower union of the stempieces had been placed just below the soil line. No vegetative growth was occurring from the intermediate stempieces. Single worked trees of M.9, M.27 or M.111 were planted with the union at the ground level. Tree trunks were not infected with fire blight nor were any of the suckers that having been treated with 1% NAA. However, all of the intermediate stempieces of M.9 at 30 cm were dead, and 3 out of 4 of those at 15 cm were dead. Infection appeared to be limited solely to the stempiece, not appearing in the adjourning scion trunk. Conversely, none of the stions with M.27 as the intermediate stempiece, either 15 or 30 cm in length, showed infection by death of the wood. Further, none of the stions with M.9, M.27 or M.111 as the rootstock showed symptoms of fire blight infecting the rootstock.

Apparently, fire blight bacteria can readily penetrate the exposed wood of M.9 as a stempiece causing its death, while not readily that of M.27. Thus, M.27 would be preferred to M.9 as an intermediate stempiece for dwarfing on a vigorous rootstock (e.g., with M.111), where fire blight can be a problem. Further, M.27 has been as effective as M.9 in controlling tree size on a vigorous rootstock (Tukey, unpublished data). Although suckering with M.27 on M.111 can be severe, it is manageable.

Rootstock Stoolbeds. In the nursery different rootstocks were being propagated using stoolbeds. In late July, fire blighted shoots (layers) were noted with differences appearing among the beds. The severity of infection or resistance to fire blight has been expressed as a percentage of the layers with strikes (Table 1). Percentages were based on the number of fire blight strikes and the estimated number of layers in that bed. Total layer population was determined by counting the number of layers per 40 cm of the stoolbed, and extrapulating for bed length.

The most severely infected rootstocks were MAC 24 (25%) and EMLA 26 (22.6%). M.9R (regular) had 10% of the layers infected, while EMLA 27 had 1.1%, and M.27, 0.2% and 0.0%. Many of the rootstock stoolbeds had no strikes, including MAC 9, J9, M.9 Bonn, and EMLA 9. Beds had been located at random, and were in the same general area of the nursery. The stoolbed number indicates the general placement of beds among several rows. For example, bed #24 (MAC 9) was located between beds #23 (M.9R) and #25 (MAC 24). Based on these observations, the resistance of M.27 and the susceptibility of M.9 to fire blight was indicated. These field observations confirm those reported by Cummins and Aldwinckle (1982).

Height of Graft Union. In young plantings of trellised and slender spindle stions with M.9 (3-4 years old), early defoliation, dark purple colored leaves, and tree death were observed in September. Upon examination for a possible cause, all such trees had the union located above the soil line, about 10 cm, and the tissues of the rootstock trunk dead or dying. Stions with the rootstock trunk covered (soil or mulch), or older stions with an exposed trunk, were alive. Death of the rootstock was attributed to fire blight since the disease was present in the orchard or in the trees as shoot blight. Suckers had been controlled with 1% NAA.

As with the M.9 interstem trees of cv Nittany, young exposed tissue of M.9 appeared to be susceptible to fire blight infection even though shoot blight may or may not have been present in the trees. These observations confirm those of Rom and Slack (1971).

Conclusions. M.9, as an intermediate stempiece, can be highly susceptible to fire blight infection, while M.27 appears to be resistant under severe fire blight conditions. The less susceptibility of M.27 to fire blight as compared to M.9 was confirmed in the rootstock stoolbed observations. Further, stions with M.9 should be planted with the union at ground level. If planted with the union above ground, the rootstock trunk should be covered with soil or mulch to reduce the potential for infection, especially during the early years in the life of the tree. Painting or spraying 8-8-100 Bordeaux is suggested as a preventive measure in the control of fire blight.

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Table 1. Fire Blight Strikes In Stoolbeds Of Various Apple Tree Size Controlling Rootstocks On July 24, 1986 At Rock Springs, Pa.

Roostock	Stool-bed	Bed Length (m)	Total Layers (no.)	Fire Blighted Layers (no.)	Fire Blighted Layers (%)
EMLA 9	#22	1.0	62	0	0.0
M.9 Bonn	(VF984)	2.1	38	0	0.0
J9	#17C	2.7	65	0	0.0
MAC 9	#24	2.0	124	0	0.0
EMLA 7	#27	1.5	84	0	0.0
M.27	#17B	4.3	128	0	0.0
M.27	#16	20.0	600	1	0.2
M.2	#31	4.7	291	1	0.3
EMLA 27	#21	1.5	93	1	1.1
LANCEP	#18	6.0	336	8	2.4
CEPILAND	#17	6.0	300	11	3.7
OAR 1	#26	1.0	36	2	5.6
M.9R	#23	1.0	50	5	10.0
EMLA 26	#29	5.3	399	90	22.6
MAC 24	#25	3.5	114	29	25.0

*Based on the number of layers per 40 cm of bed length.

Triazole Inhibitors and Tree Size Controlling Rootstocks

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Introduction

Plant growth regulators of the triazole type appear to inhibit growth by suppressing or blocking the biosynthesis of gibberellin (GA), a growth stimulator in plants (Dalziel and Lawrence, 1984). Absorption of triazoles for the inhibition of vegetative growth and development can occur through plant roots (Tukey, 1986). Thus, the availability of root-produced GA to the buds and shoots could be an important factor in the degree of tree size control provided by apple dwarfing rootstocks.

Ibrahim and Dana (1971) have shown that GA-like substances were lowest in the root xylem exudate of M.9 and a higher level in M.1, a more vigorous rootstock. Dwarfing was suggested to be related to the production of GA-like substances in the roots. Robitaille and Carlson (1971) found that the most dwarfing apple rootstocks responded to injections of abscisic acid (ABA) than more vigorous rootstocks. Their data supported the hypothesis of Carr et al. (1964) and Jones and Lacey (1968) that the differential dwarfing effects of fruit tree rootstocks might be explainable on the basis of GA synthesis transport from the roots to the shoots. More vigorous trees would contain a greater amount of GA in the transport stream than less vigorous ones.

Consequently, it was hypothesized that apple tree size controlling rootstocks differing in their dwarfing effect would be dwarfed still further by chemicals suppressing or blocking GA biosynthesis (triazoles) in roots, and that at a given rate of the chemical, a very dwarfing rootstock (low GA biosynthesis) would be affected more than a less or semi-dwarfing rootstock (greater GA biosynthesis). This was tested using 3 apple rootstocks differing in tree size control (vigor), and 3 triazole plant growth regulators applied to the roots at a low, medium, or high rate.

Materials and Methods

Paclobutrazol, flurprimidol and uniconazole were applied at 3 rates to the roots of M.27, M.9, and M.7 (Table 1). A split-split block design was used with rootstocks randomized within chemical rate plots and non-treated plots. There were 4 replicates.

M.27, M.9 and M.7 were layers obtained from the orchard nursery stoolbed at the Agricultural Research Center at Rock Springs. Only M.27 was known to be virus free. These were planted in the spring of 1985, and cut back to a single bud in mid-March 1986, several weeks prior to being treated. Only a single terminal shoot was allowed to develop.

The triazoles were applied on April 2, 1986 by a trunk soil-line pour (TSLP) (Tukey, 1986). Paclobutrazol and flurprimidol were at the low, medium and high rates of 20, 40 and 80 mg ai per plant. Because uniconazole is twice as active on a unit weight basis, rates were 10, 20, and 40 mg ai. There were 3 non-treated plots per replicate which corresponded to the low, medium, and high rates.

TSLPs were made with 100 ml of water. Rewetting of the application area at the base of the layer was only from normal precipitation which was below normal for about the first 2 months after treatment, and then normal to above normal for the balance of the summer.

During the growing season all lateral shoot growth was removed, leaving only the terminal shoot (leader) to develop. In September, the amount of terminal shoot elongation was determined. Throughout the growing season observations were made on the general growth of the layers. The data in Table 1 have not been statistically analysed, but differences were evident.

Results and Discussion

Apple rootstock layers varying in dwarfing vigor responded to the triazole plant growth regulators when applied to the roots by a TSLP. Leaves on treated plants were noticeably more intense in green color and appeared as a rosette on M.27 and frequently on M.9, especially at the highest rate. Leaf symptoms of greener leaves, indicating absorption of the chemical, were evident first on lateral and spur-type shoot growth arising in the lower part of the layer. Also, some weeds in the treatment area showed triazole uptake, dwarfed plants with dark green leaves.

The length of terminal shoots, or the amount of total growth occurring in 1986, was related to rootstock vigor with M.7 having the longest shoots and M.27 the shortest ones (Table 1). This was irrespective of the triazole or the quantity of triazole used. In general, the higher the rate used the less was the amount of shoot growth. Further, paclobutrazol appeared to be most inhibitory, followed by flurprimidol and then uniconazole. Doubling the rate from 20 to 40 mg, or 10 to 20 mg, was more effective generally in inhibiting shoot growth than doubling from 40 to 80 mg, or 20 to 40 mg. However, inhibition with uniconazole was more uniform throughout than that with the other two trizoles, although some differences due to rootstock vigor were evident. Rate differences for uniconazole were evident with M.27 and M.9, but not with M.7, being more similar.

GA biosynthesis appears to occur in plant roots, and the quantity or rate of biosynthesis of GA appears to be directly associated with the development of plant size or degree of dwarfing in apple rootstocks. Root applications of chemicals, such as the triazoles which suppress or block GA biosynthesis, caused or increased dwarfing still further. However, the amount of vegetative suppression at a given rate of triazole was less for a more vigorous rootstock (M.7) than for a rootstock not as vigorous (M.27). Thus, the degree of dwarfing or tree size control in apple rootstocks produced by a chemical which suppresses or blocks GA biosynthesis in roots appears to be related to (a) the vigor of the rootstock, (b) the chemical (triazole), and (c) the quantity or rate of the chemical applied to the plant's roots. The proposed hypothesis appears to be correct.

Implications. Based on these results, it would appear that for producing a certain degree of vegetative growth control, the optimum rate or concentration used for a triazole should vary with the stionic vigor of the apple tree. In foliar applications, a higher rate would be required for cv Golden Delicious than for cv Delicious, and for a cultivar on M.26 than the same cultivar on M.9. In retrospect, such appeared to be the case for paclobutrazol plots at Rock Springs (Tukey, unpublished data). Golden Delicious has been suppressed more with M.9 than with M.26. A similar difference has been noted for cv Rome Beauty on M.9 vs. M.111. For stions with M.9, cv Ryan Red Delicious has been suppressed more than cv Golden Delicious. The same concentration and timing were used in each example.

Thus, when using a particular triazole (e.g., paclobutrazol) to control vegetative growth and development in apple trees, both the scion and rootstock vigor should be taken into consideration in establishing the optimum rate for treatment. Since chemical absorption of plant growth regulators such as paclobutrazol can occur through the roots, even though foliar applied (leaching from the foliage by rain to the soil and roots), the vigor of the rootstock would appear to have special significance in the degree of growth control provided, especially over time. For example, paclobutrazol has a half-life of 12 to 18 months, acting like a slow release compound. Increased dwarfing would be related more to the vigor or GA biosynthesis level of the rootstock rather than to that provided through the above ground portions of the tree. Very dwarfing rootstocks would appear to be affected more by a given rate than a semi-dwarfing or a semi-standard rootstock. That is, triazole absorption can occur through the roots of a tree, with less vigorous rootstocks being affected more than vigorous rootstocks for a given amount of a triazole.

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Table 1. Effect of triazole plant growth inhibitors on the extent of terminal shoot elongation of apple rootstock cultivars differing in vigor when applied in a trunk soil-line pour (TSLP) on April 2, 1986 to layers planted in 1985.

Chemical TSLP	Rate/tree[z] (mg)	Rootstock layer average terminal shoot elongation and percent inhibition[y] M.27 (mm)		M.9 (mm)		M.7 (mm)	
non-treated	0	583	0.0%	623	0.0%	771	0.0%
paclobutrazol (PP-333)	20	165	71.7%	554	11.1%	631	18.2%
	40	54	90.7%	182	70.8%	248	67.8%
	80	58	90.1%	122	80.4%	282	63.4%
flurprimidol (EL-500)	20	82	86.0%	526	15.6%	800	0.0%
	40	72	87.7%	205	67.1%	442	42.7%
	80	30	94.9%	170	72.7%	285	63.0%
uniconazole (XE-1019) (S-3307)	10	215	63.1%	296	52.5%	391	49.3%
	20	181	69.0%	286	54.1%	460	40.3%
	40	150	74.3%	240	61.5%	378	51.0%

z/The respective quantity of chemical was applied in 100 ml of water to the base of each layer as a TSLP. The rate of uniconazole was half that of paclobutrazol and flurprimidol because of being twice as active on a unit basis.

y/Terminal shoot elongation was that determined at the end of the growing season after each layer was cut back to a single bud in mid-March 1986 prior to treatment. A single shoot was retained on each layer. Values are based on 4 replications.

EFFECTS OF ADJUVANT CONCENTRATION AND FORMULATION ON TRICLOPYR FATE IN VIRGINIA CREEPER

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Virginia creeper (Parthenocissus quinquefolia) is a perennial vine that reduces fruit tree productivity by growing into crowns, causing shading and limb breakage. Previously, we found that triclopyr could control Virginia creeper. Three experiments were conducted to evaluate triclopyr fate in creeper with respect to formulation type and dilution and the lowest effective rate for creeper control.

Formulation. An experiment was performed to determine formulation effect on triclopyr absorption, movement, and metabolic fate. Six-month-old Virginia creeper received a topical application (1.12 kg ae/ha) of either triclopyr alone (Garlon 4 formulation) or 2,4-D plus triclopyr (Crossbow formulation). One central leaf per plant received 0.1 µCi ^{14}C-triclopyr and 7 days later plants were analyzed for ^{14}C distribution and metabolic fate. More ^{14}C was absorbed following Garlon (7,228 dpm/gm) than Crossbow (6,348 dpm/gm) treatment. Significantly more ^{14}C translocated to creeper roots following Garlon treatment (725 dpm/gm) than with Crossbow (555 dpm/gm). Greater translocation was associated with a metabolite that was prevalent following Garlon treatment.

Dilution. A growth chamber experiment was conducted to quantify effects of adjuvant dilution on triclopyr absorption. ^{14}C-triclopyr was dissolved in blank Garlon formulation diluted to 1.1 or 0.28 kg/ha and applied to the basal leaf of eight-week-old creeper (0.05 µCi/plant). One week later, plant parts were analyzed for ^{14}C activity. Adjuvant dilution did not reduce triclopyr adsorption or translocation (approximately 3,500 dpm/gm in the shoot and 2,300 dpm/gm in the root).

Field. An experiment was performed to identify the lowest triclopyr rates effective for creeper control. Triclopyr was applied by Teejet nozzles attached to a jeep-mounted boom (280 L/ha) at rates of 0.14, 0.28, 0.56, and 1.11 kg ae/ha. Blank Garlon adjuvant formulation was held constant at 1.11 kg/ha. One month following treatment (Sept. 1986), creeper control was evaluated in terms of percent ground area covered. The lowest triclopyr rate reduced creeper coverage to 10% compared to 80% on control plots. Creeper was almost eradicated at rates of 0.28 kg/ha and the lowest effective range probably was between 0.28 and 0.56 kg/ha.

These experiments indicate that Garlon is more efficacious against creeper than Crossbow; a mobile metabolite is more prevalent following Garlon than Crossbow treatment. Garlon can be diluted from 1.1 to 0.28 kg/ha without interfering with adjuvant effects on triclopyr uptake and appears to be efficacious in controlling Virginia creeper at rates between 0.28 and 0.56 kg ae/ha.

GROWTH AND YIELD RESPONSE OF YOUNG PEACH TREES TO VARIOUS LEVELS OF SOD COMPETITION

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Appalachian Fruit Research Station

ABSTRACT

Young peach trees are sensitive to competition from weeds or from sod. This study was established to determine the effect of the size of the vegetation-free area beneath young peach trees on tree growth and yield. Uniformly-sized nursery trees (1.0 cm diamter) of the cultivar 'Loring' on 'Halford' rootstock were planted in hand-dug holes in a Kentucky 31 Tall Fescue sod in April 1983. The trees were planted 4.5 m apart within rows, spaced 6 m apart. Each plot consisted of 3 trees with a guard tree between plots within the row. A randomized complete block design with 6 replications was used. All trees were cut back to a height of 100 cm at planting. The soil type was a Hagerstown silt loam. Six different sized vegetation-free squares were established, ranging from .6 m to 3.6 m per side. The herbicide glyphosate, at 2.2 kg a.e./ha was used to kill the sod within the squares. Once the sod was dead, a residual herbicide treatment of diuron, plus terbacil was applied to maintain the squares free of vegetation for the entire growing season. No fertilizer or supplemental irrigation was applied. Trunk diameter, tree height, canopy width and canopy height were measured in October each year. Fruit weight/tree was recorded in August 1986.

The analysis of variance was based on a randomized complete block design, with 6 replications. Linear and quadratic regression components were analyzed for significance at the 5% probability level. Tree height resulted in the least separation of treatments and was considered the poorest indicator of tree response of those factors measured. Trunk diameter and canopy width resulted in good separation of treatments. The size of the vegetation-free area was found to be a critical factor in the growth of young peach trees. Growth increased as the size of the vegetation-free area increased. The impact of the sod proximity upon yield was similar to that found for the impact upon growth. The study showed that sod promixity can be used to control tree size. This can be used as a management tool, if limiting tree size is a prime objective. This strategy will, however, result in less yield per tree.

1964 to 1986 Simazine Treatments on a Weikert-Berks Complex Orchard Soil

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Materials and Methods

This experiment was initiated in 1964 for the purpose of observing the response of simazine applications under droughty orchard conditions using apple [Malus domestica (Borkh.) 'Golden Delicious'/seedling] planted 1954. The orchard site selected was in the low rolling foothills and lower mountain slopes of Hampshire County near Augusta, West Virginia in the soil association known as Berk-Weikert. The Weikert-Berks complex is about 45% Weikert shaly silt loam and 40% Berks channery silt loam. Both of these soil types were formed in acid material weathered from shale, siltstone, and limestone. The surface layer of about 12.7 cm (5 inches) is a brown channery (thin, flat fragments as much as 15.2 cm (6 inch) in length of sandstone, limestone or schist) shaly silt loam with a yellowish-brown, friable very shaly channery type silt loam subsoil extending for 12.7 to 25.4 cm (5 to 10 inch) and a substratum of yellowish-brown very shaly silt loam underlain by shale bedrock. Permeability is moderately rapid. Since available water capacity is very low, many small springs develop when precipitation approaches 2.5 cm (1") in a 24-hour period. The soil is also low in fertility.

Annual applications of 4.48 and 8.96 $kg{\cdot}ha^{-1}$ of simazine [2-chloro-4,5-bis(ethylamino)-s-triazine] was applied as a square to a 13m^2 area (3.6m on a side) under the tree canopy from 1964 to and including 1983 with the exception of the year 1978 when no herbicide was applied. Applications were made with flat fan nozzles on a boom mounted to a 4-wheel drive Jeep and calibrated to deliver in the range of 280 $liter{\cdot}ha^{-1}$ spray. Ten trees were treated at the low rate and four trees at the higher rate with ten non-herbicide treated trees used for control. Amitrole (3-amino-s-triazole) was applied tank mixed with the simazine at the rate of 2.24 $kg{\cdot}ha^{-1}$ from 1964 to 1967 and at 1.12 $kg{\cdot}ha^{-1}$ from 1968 to 1971. The time of application ranged from April 12 to May 18. Paraquat (1,1'-dimethyl-4,4'-bipyridinum ion) + an adjuvant (usually X-77) was applied tank mixed with the simazine at the rate of 0.56 $kg{\cdot}ha^{-1}$ from 1972 to 1983 (except for 1978). The time of application varied from May 18 to June 29. Weed control information was recorded from the entire sprayed area (13 m^2) each year in September to early October and again in the spring at time of herbicide application. Weed control (WC) rating is based upon the scale of 0 to 100, where 0 is no control (ground area completely covered with live vegetation) and 100 is complete control (no live vegetation present).

Previous treatment of the ground cover in the orchard was mowing with the mowed material being raked and placed under the tree canopy giving a very light mulch. This mowing and mulching practice continued through 1968, when the orchard was sold. The vegetation on the orchard floor consisted of 70% grasses and 30% broadleaf plants. Before herbicide treatments were started, the following identified plants (63) were found under the canopy of the apple trees and throughout the orchard: orchardgrass 50%, large and smooth crabgrasses 7%, purpletop 7%, dandelion 4%, poison-ivy 4%, small flower and cutleaf geranium 3%, Virginia pepperweed 3%, nimblewill 3%, heath aster 1%, Silene spp. 1%, red sorrel 1%, yellow toadflax 1%, shepherdspurse 1%, and the remaining 14% include: green and yellow foxtails, downy brome, bluegrass sp, quackgrass, broadleaf and curly dock, bouncingbet, horsenettle, broadleaf and buckhorn plantain, common vetch, yarrow, black medic, asparagus, ragweed, chickweed, clammy groundcherry, brambles, prostrate knotweed, common mallow, pokeweed, lambsquarters, red clover, Virginia creeper, hedge smartweed, yellow woodsorrel, hemp dogbane, common speedwell, garlic, redroot pigweed, tumble pigweed, field pennycress, horseweed, Canada goldenrod, common milkweed, hemp dogbane, field bindweed, wild carrot, black nightshade, Carolina geranium, common burdock, fall panicum, meadow campion, catnip, timothy, common tansy, spotted spurge, and chicory.

Precipitation was recorded on a 24-hour basis at the orchard site during the months of April through September during the years of the experiment (Table 1). The six month mean precipitation (19.98 inch) calculated from the orchard record was near normal for the Weather Bureau climatological data at Romney, West Virginia. Many of the monthly rainfall amounts appear to have been sufficient for adequate moisture during the month to maintain uniform fruit growth. However, over the 22 year period, 22% of the recorded rainfall periods had precipitation amounts of 1.0 to 5.0 inches. The interval between precipitations of at least 0.25 inch per 24-hour period ranged from zero days to 27 days. The average interval was 7.6 days with a standard deviation of 6 days. With the low water holding capacity of the soil a quantity of water was not retained by the soil, thus, resulting in less fruit and vegetative growth due to insufficient moisture throughout a portion of the month.

Table 1. Monthly precipitation (inch) and total for the six month period with departures from normal (19.98") based upon measurable precipitation of 0.01 inch and greater recorded for each 24-hour precipitation period.

Year	April	May	June	July	August	September	Total(departure)
1964	5.12	0.56	2.39	4.76	2.60	5.25	20.68 (+0.69)
1965	3.04	1.77	2.75	2.58	2.84	1.79	14.77 (-5.21)
1966	4.19	2.18	1.02	1.73	2.19	6.43	17.74 (-2.24)
1967	2.10	4.99	1.44	6.44	3.12	2.29	20.38 (+0.39)
1968	1.09	6.18	2.27	0.88	3.28	2.06	15.76 (-4.22)
1969	1.04	1.45	4.25	6.63	2.44	3.32	19.13 (-0.85)
1970	4.05	1.59	5.75	4.69	2.44	2.62	21.14 (+1.15)
1971	2.33	3.52	4.22	3.14	5.41	4.75	23.37 (+3.38)
1972	1.68	5.20	12.41	3.45	1.70	1.18	25.62 (+5.63)
1973	5.99	3.11	4.26	3.07	6.00	1.55	23.98 (+3.99)
1974	2.31	2.85	6.53	1.50	2.27	2.20	17.66 (-2.32)
1975	2.16	4.37	4.81	2.75	5.91	9.68	29.68 (+9.69)
1976	0.95	2.70	3.74	1.14	4.90	4.50	17.93 (-2.05)
1977	2.75	1.25	1.97	2.29	3.55	0.90	12.71 (-7.27)
1978	1.29	5.71	1.71	7.40	3.35	3.92	23.38 (+3.39)
1979	1.95	4.34	4.56	5.12	2.83	4.57	23.37 (+3.38)
1980	2.07	3.64	3.19	5.33	1.98	3.92	20.13 (+0.14)
1981	2.87	4.19	4.07	3.75	1.28	5.95	22.11 (+2.12)
1982	1.57	1.36	4.85	3.40	0.83	3.82	15.83 (-4.14)
1983	4.40	5.03	3.40	0.55	2.52	1.10	17.00 (-2.98)
1984	5.02	2.15	1.76	4.57	5.07	1.32	19.89 (-0.09)
1985	1.07	5.72	3.14	3.87	3.30	0.26	17.36 (-2.62)
Mean	2.68	3.36	3.84	3.59	3.17	3.34	19.98

Results

The trees treated with 8.96 kg/ha^{-1} of simazine had from 95 to 99+% weed control throughout the life of the treatment applications and at the time of the May 26, 1983 application and the fall observation on September 26, 1983 had one bramble plant, one poison-ivy plant, and several dandelion and apple root sprouts for a 95% weed control rating The year of no herbicide application (1978) the 8.96 kg/ha^{-1} treated trees averaged 80% weed free with orchardgrass seedlings 30%, red sorrel 30%, dandelion 20%, and [purple top, bramble, tumble pigweed, fall panicum, redroot pigweed] 20% present in the 20% of soil covered with vegetation. The 95% WC in the 8.96 kg/ha^{-1} simazine treatment observed on September 26, 1983, following the last herbicide application of May 26, 1983 was reduced to 50% WC as observed in September 1985 (2.34 years after last application) and to 5% WC in September 1986 (3.34 years after the last application). Weeds present at the observation in 1986 were: downy brome 30%, bramble 20%, orchardgrass 15%, yellow woodsorrel 10%, and [dandelion, red sorrel, field pennycress, horsenettle, horseweed, prostrate knotweed, green foxtail, lambsquarters, poison-ivy, buckhorn plantain, ragweed, Canada goldenrod, red clover, common vetch, and meadow campion] 25%.

Weed control in the 4.48 kg/ha^{-1} simazine treatments varied more from year to year than did the 8.96 kg/ha^{-1} treatment (Table 2).

Table 2 Weed control ratings for the 4.48 kg/ha^{-1} Simazine treatment as observed in September to early October period from 1964 through 1985.

Year	WC rating	Year	WC rating	Year	WC rating
1964	87.4	1972	82.7	1979	90.4
1965	88.9	1973	88.1	1980	94.7
1966	92.8	1974	94.5	1981	95.1
1967	95.7	1975	90.3	1982	80.7
1968	87.4[a]	1976	87.3	1983[d]	89.2
1969	84.8	1977	85.8	1984	58.8
1970	86.2	1978[c]	61.4	1985	7.0
1971	93.6[b]	1979	90.6	1986	0.5

a. Last mulch applied
b. Last amitrole application
c. No herbicide applied in 1978.
d. Last year herbicides were applied.

Each year that the 4.48 kg/ha^{-1} simazine was applied under the tree canopy the weed control averaged 89.3% with a standard deviation of 4.2%. The eight years when amitrole was tank mixed with simazine averaged 89.6 % weed control with a standard deviation of 3.9%. The twelve years of the paraquat/simazine mixture having an 89.1% weed control rating with a standard deviation of 4.6% was equally effective in weed control. For the five years when the mulch was placed under the tree limb spread the average weed control was 90.4%. Variation in the vegetation control under the canopy of the herbicide treated trees is difficult to associate with the precipitation patterns or the timing of the application.

Following the eight years of amitrole + 4.48 kg/ha^{-1} simazine applications, the vegetation population in the treated area (September 1971) consisted of the following: red sorrel 40%, clammy goundcherry 20%, yellow foxtail 10%, tumble pigweed 10%, and [hemp dogbane, purple top, horsenettle, spotted spurge, orchardgrass, common vetch,, bouncingbet, and Virginia creeper] 20%. The average weed control rating at the 1971 September observations was 93.6%.

Following the twelve paraqual and twenty 4.48 kg/ha^{-1} simazine applications, the vegetation, as observed September 26, 1983 (124 days after the last herbicide application), consisted of: red sorrel 30%, yellow toadflax 20%, purple top 10%, poison-ivy 5%, bramble 5%, dandelion 5%, and [hemp dogbane, nimblewill, spotted spurge, bouncingbet, orchardgrass, chicory, small flower geranium, and apple sprouts] 25%. The average weed control rating in September 1983 for the paraquat-simazine applications was 89.2%.

The average weed control rating under the control (non-herbicided) trees on September 26, 1983 was 8.0% with a standard deviation of 6.3%. The slight weed control for the non-herbicided trees is most likely associated with the shading effect as the trees became older. The vegetation under the canopy of the non-herbicided trees included: orchardgrass 40%, downy brome 10%, red sorrel 10%, white campion 5%, heath aster 5%, bramble 5%, ragweed 5%, poison-ivy 5%, small flower geranium 5%, and [broadleaf dock, dandelion, horsenettle, red clover, hedge smartweed, purple top, bluegrass, nimblewill, Canada goldenrod, common mallow, garlic, chickweed, Virginia pepperweed] 10%.

The excellent weed control resulting from the twenty annual spring applications of 4.48 $kg \cdot ha^{-1}$ simazine was reduced to a 58.8% weed control rating at 1.34 years after the last application, to a 7.0% weed control rating at 2.3 years after the last application and to a 0.5% weed control rating 3.3 years following the last application. The vegetation in the 4.48 $kg \cdot ha^{-1}$ simazine treated area at 3.3 years following the last application include the following: orchardgrass 17%, purple top 17%, downy brome 16%, bramble 12%, poison-ivy 10%, yellow toadflax 5%, red sorrel 5%, nimblewill 4%, yellow woodsorrel 2%, red clover 1%, Canada goldenrod 1%, and [small flower geranium, broadleaf dock, black medic, heath aster, lambsquarters, buckhorn plantain, dandelion, ragweed, yellow and green foxtail, Virginia creeper, redroot pigweed, meadow campion, bladder campion, hedge bindweed, common vetch, horsenettle, pokeweed, field pennycress, timothy, horseweed, prostrate knotweed, large crabgrass] 10%. The vegetation under the canopy of the non-herbicided trees include: orchardgrass 20%, downy brome 19%, nimblewill 9%, horsenettle 7%, purple top 6%, poison-ivy 6%, red sorrel 6%, yellow woodsorrel 3%, bramble 2%, dandelion 2%, field pennycress 1%, broadleaf dock 1%, lambsquarters 1%, heath aster 1%, yellow toadflax 1%, small flower geranium 1%, meadow and bladder campion 1%, and [red clover, ragweed, hemp dogbane, common vetch, pokeweed, timothy, redroot pigweed, tumble pigweed, horseweed, buckhorn plantain, Canada goldenrod, hedge bindweed, large crabgrass, prostrate knotweed] 13%.

The year, 1978, when no herbicide was applied and observations were made in September for the 4.48 $kg \cdot ha^{-1}$ simazine treatments, resulted in a drop from an average weed control rating of 89.3% to 57.2% with a standard deviation of 20.4%. The 32.1% reduction in effectiveness of weed control resulted in a considerably less than a satisfactory weed control rating going into the winter months due to a greater chance for a higher vole population to become more active near the trunks of some of the trees. The vegetation population in the treated area was: fall panicum 15%, Virginia pepperweed 12%, small flower geranium 10%, red sorrel 10%, purple top 8%, yellow foxtail 7%, orchardgrass 5%, dandelion 5%, common vetch 3%, and [buckhorn plantain, red clover, bramble, prostrate knotweed, redroot pigweed, common chickweed, broadleaf dock, tumble pigweed, hedge smartweed, horsenettle, poison-ivy, yellow toadflax, heath aster, Carolina geranium, catnip] 25%.

The 8.96 $kg \cdot ha^{-1}$ simazine treatment observed in September 1978 had 80% weed control with the following vegetation present: downy brome 35%, red sorrel 20%, dandelion 20%, orchardgrass 10%, and [purple top, tumble pigweed, redroot pigweed, fall panicum, bramble] 15%.

The non-treated area under the tree canopy had a 0% weed control rating with the following vegetation present: orchardgrass 40%, lambquarters 10%, poison-ivy 5%, white campion 5%, red sorrel 5%, horsenettle 5%, heath aster 5%, ragweed 5%, broadleaf dock 3%, yellow toadflax 3%, curly dock 2%, hedge smartweed 2%, and [asparagus, dandelion, bramble, small flower geranium, common burdock, clammy groundcherry, red clover, Virginia pepperweed, prostrate knotweed, buckhorn plantain, goldenrod, common chickweed, Virginia creeper, common tansy] 10%.