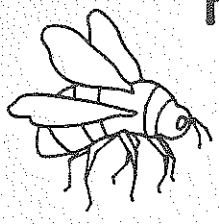
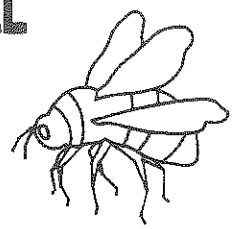
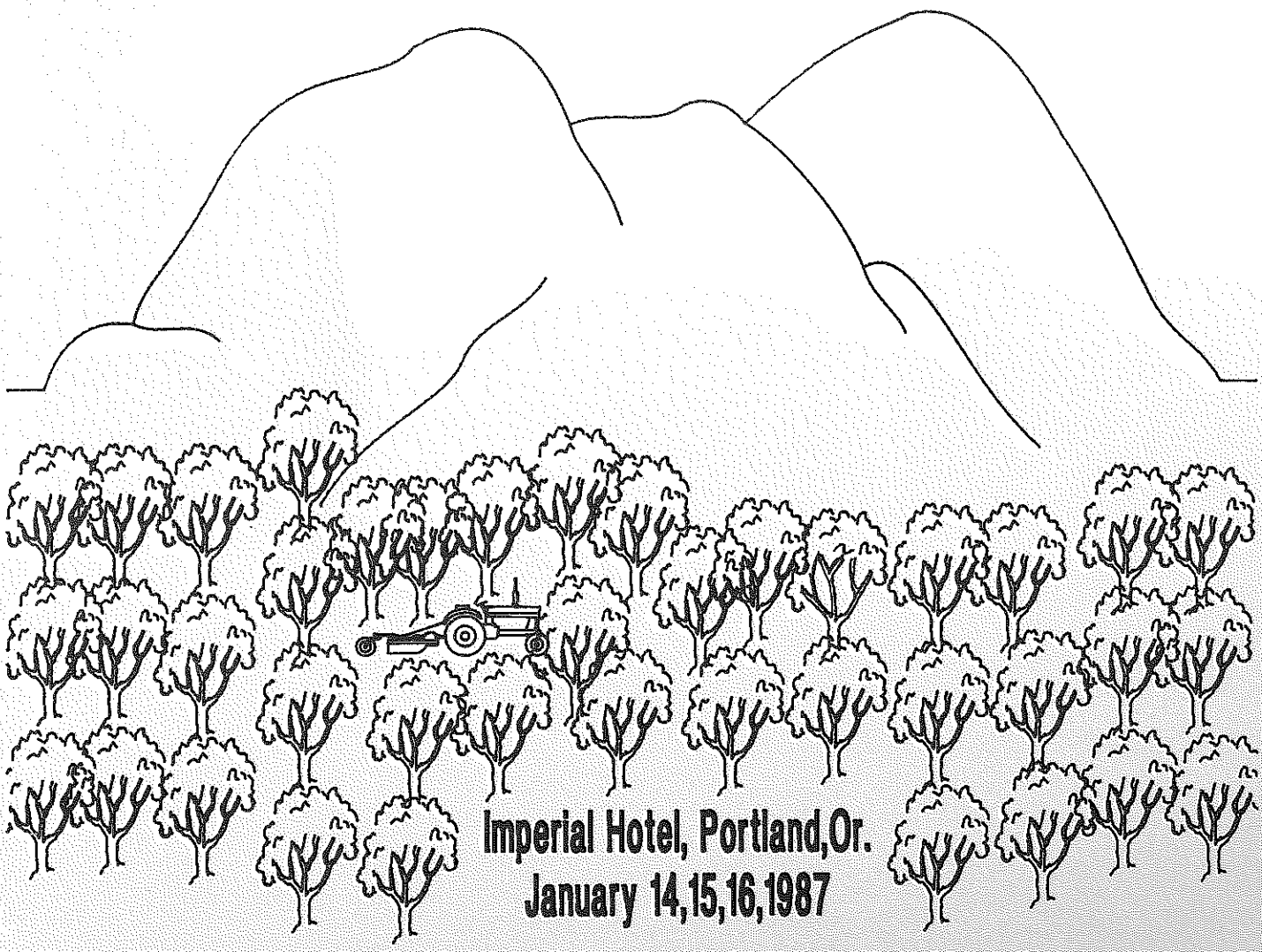
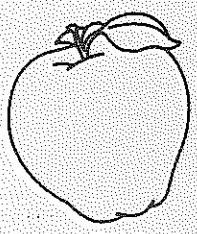


RESEARCH REPORTS FROM THE 61st ANNUAL *WESTERN ORCHARD PEST* AND *DISEASE MANAGEMENT CONFERENCE*

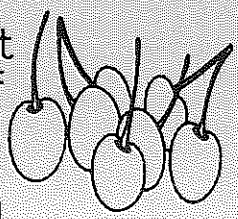




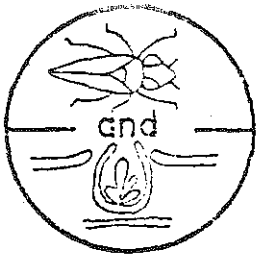
Imperial Hotel, Portland,Or.
January 14,15,16,1987



These reports on research conducted on the principle insect and disease pests of tree fruits and nuts in the states of California, Colorado, Idaho, Montana, Oregon, Utah, and Washington, and the province of British Columbia, are not intended to be recommendations by the conference. Official recommendations can only be made by public service entomologists and plant pathologists from their respective areas.



Western Orchard Pest
Harold Moffitt, Chairman
Pat Weddle, Chairman Elect
Gary J. Fields, Sec/Tres



Disease Management Conference

22 October 1986

Ladies and Gentlemen:

The 61st annual Western Orchard Pest and Disease Management Conference will be held at the Imperial Hotel, Portland Oregon, on January 14, 15 & 16, 1987.

NOTE The conference will convene at 1:00PM on the 14th. This is the second year for the 1 PM start time.

Tuesday the 13th and Wednesday morning are reserved for Research Planning and Coordination meetings by special interest groups. There will be no other time set aside during the scheduled meeting times of the conference for special group meetings.

The schedule for the 1987 meeting follows. Length of each section will depend on the number of reports and the discussion times that follow them.

Wednesday, 14 January 1987
1:00 - 1:20 PM Business meeting
1:20 - 4:30 PM Stone Fruits

Thursday, 15 January 1987
(1) 8:30 - 12:00 Orchard Diseases
1:30 - 5:00 PM Orchard Diseases
(2) 8:30 - 12:00 PM Pome Fruits
1:30 - 3:30 PM Pome Furits
3:45 - 5:00 PM Nuts

Friday, 16 January 1987
8:30 - 11:00 AM Nuts
11:00 - 12:00 PM Business meeting

When you present your report, please paraphrase your submitted written research report and then lead a discussion on your work. Our conference is designed as a time to discuss research and development information in the tree fruit industry. Emphasis will be on the discussion time. If you submit a proper written report to your section leader there will be no need to read every word of a table projected on the screen when you make your presentation. Academic advisors, instruct your students to exclude common knowledge life history data and have them get to the point of their research and then open the report for discussion.

The Research Report will be printed right after the first of the year and your report MUST be in Joe Cap izzi's office no later than 30 December, 1986. Follow the format given below.

(1) No more than 2 full pages of typed material, including tables and graphs.
(2) Any legible reproducable by photo-copy type on white paper is acceptable. Thermofax, hand written, or colored paper is not acceptable and will not be included in the Reports.
(3)Only reports conforming to the enclosed format will be accepted. Do not include the black lines - they are typing guides only. Copy the style and format of the enclosed example.

Two copies of your report should be prepared as soon as possible and mailed as follows:

Original to: Joe Capizzi
Extension Entomologist
Dept. of Entomology
Oregon State University

Copy to appropriate Section leader:

I. Deciduous Orchard Diseases
Harold Larsen
Orchard Mesa Research Center, CSU
3168 B½ Road
Grand Junction, CO 81503

II. Pome Fruits
J. Frank Howell
Yakima Agricultural Research Lab
USDA-ARS
3706 W. Nob Hill Blvd.
Yakima, WA 98902

III. Stone Fruits
Sharon Collman
Cooperative Extension
600 128th St., SE
Everett, WA 98204

IV. Nuts
Pat Weddle
2486 Rising Hill Rd.
Placerville, CA 95667

To insure clarity of pesticide designations, please submit on a seperate sheet of paper, the common name and trade name of any pesticide mentioned in your report. Use the names designated in the Entomological Society of America Special Publication 74-1, October 1974, or the List of Chemical and Common Names Suggested For Use by AR-GPA 900-622.

If you bring slides to be shown, mark them properly for projection. Hold the slide as you want it to be seen (bottom at the bottom). Mark the lower left corner oth the mount with a clearly visible spot or X. This will give the projectionist the proper orentation when loading the slide tray.

WOP&DHC membership lists will be handed out at the meeting. Those not in attendance will be mailed a copy.

THIS WILL BE THE ONLY MEETING NOTICE, therefore, PLEASE DO NOT FORGET THE REPOTS AND THE DECEMBER 30 DEADLINE.

Gary J. Fields
Sec/Tres

TABLE OF CONTENTS

RESEARCH REPORTS FROM THE 61st ANNUAL WESTERN ORCHARD PEST AND DISEASE MANAGEMENT CONFERENCE

Jan 14, 15 & 16, 1987

DECIDUOUS ORCHARD DISEASES--SECTION I

Biology

Quiescent Infection of *M. fructicola* on Friar Plum.... 2

Thresholds, Monitoring & Sampling

Powdery Mildew; Sour Cherry..... 3

Chemical Control

Apple Replant Disease..... 4
Replant Problem: Apple..... 5
Crown Gall: Apple..... 6
Powdery Mildew: Sour Cherry..... 7
Quiescent Infections of Sweet Cherry in California.... 8
Brown Rot/Russet Scab: French Prunes..... 9
Botryosphaeria panicle and Shoot Blight: Pistachios..11
Botrytis Shoot Blight: Pistachios.....13

Pesticide Resistance

Apple Scab: Apple.....15

POME FRUITS--SECTION II

Biology

Codling Moth.....17
Leafhoppers: Apple.....18
White Apple Leafhopper: Apple.....19

Threshold, Monitoring & Sampling

Evaluation of Traps for Apple Maggots in Oregon.....22
Comparative Effectiveness of Red Sphere and Pherocon® AM Traps for Monitoring Apple Maggot Activity in the PNW.....23
Decision Making Software for Apple Pest Management....24
Codling Moth - Pears.....25

Biological Control

Parasitoids of the Apple Maggot, *Rhagoletis pomonella* (Walsh), in SW Washington.....27

Chemical Control
White Apple Leafhopper: Apple.....28
Codling Moth: Apple.....31
Pear: Psylla.....33
Pear: Psylla, Rust Mite, European Red Mite.....39
Pear: Psylla, Rust Mite, European Red Mite, Twospotted Spider Mite.....43
Pear: Psylla, Rust Mite, Twospotted Spider Mite, Codling Moth, Apple Aphid.....46
Phytophagous Mites: Apples and Pears.....48
Pesticide Application Methods.....49

Implementation
Codling Moth-Apples, Quarantine Treatments.....51

STONE FRUITS--SECTION III
Biology
Apple Maggots - Cherries.....53

Thresholds, Monitoring & Sampling
Apple Maggots - Cherries.....54

Biological Control
Mating Disruption: Oriental Fruit Moth, Peach Twig Borer, Omnivorous Leafroller.....55

Chemical Control
Apple Maggots and Spider Mites - Cherries.....56
Mountain Leafhopper; Cherries.....57
Dormant: Peach Twig Borer, San Jose Scale and European Red Mite - Peaches and Almonds.....59

NUTS--SECTION IV

Biology
Spider Mites: Almonds.....62
Mirids on Pistachio.....64

Chemical Control
Mites: Almond.....67
Carob Moth: Dates.....68
Filbertworm Control - Filberts.....70
Citrus Flat Mite: Pistachios.....72
Scale Insects: Pistachios.....74

MISCELLANEOUS
Chemical Names.....76

SECTION I

DECIDUOUS ORCHARD DISEASES

****

Harold Larsen
Section Leader

I. Deciduous Orchard Diseases

a. Biology

1. Quiescent Infection of M. fructicola on Friar Plum

W. D. Gubler, B. T. Manji, J. M. Ogawa and F. Yoshikawa
Department of Plant Pathology, University of California
and UCCE, Fresno, CA

In April of 1986, brown rot was found on 2-3 wk-old green fruit of Friar plum. Infections resulted in small necrotic lesions and occurred randomly over the fruit surface. A survey conducted in the Fresno County district showed that only Friar plum was affected and even though Black Amber plum was being used as the grafted pollen source, no disease was observed on Black Amber fruit. Isolations from fruit lesions yielded only Monilinia fructicola. Beginning on May 1, and thereafter at 2 wk intervals up to harvest, 100 fruit were harvested for isolation studies. All spots considered to be brown rot infections on each fruit were plated onto acidified potato dextrose agar. The number of positive M. fructicola isolations were recorded (Table 1). Isolation data showed a significant decrease in positive isolations until by harvest, positive isolation were successful only from 2% fruit and from 0.3% of total lesions.

At harvest 1 tree in each of 2 locations was harvested and the fruit packed and placed at 4°C and 90% RH for 10 days after which fruit were rated for presence of brown rot storage rot. Storage data also confirmed the apparent low survival of M. fructicola in plum fruit. Postharvest rot incidence from orchard 1 was 1.4% and from orchard 2 was 1.2%.

Inoculum for early season infection apparently resulted from sporulating mummies. There was no blossom or twig blight associated with trees in orchards surveyed.

Table 1. Recovery of M. fructicola from brown rot lesions on Friar Plum.

Sample Date	Percent Recovery of M. fructicola from: Fruit	Lesions
May 1	30.0	6.9
May 14	60.0	7.2
May 28	31.0	4.4
June 12	16.0	2.1
June 28	2.0	0.3

I. Deciduous Orchard Diseases
b. Thresholds, Monitoring and Sampling
1. Powdery mildew; sour cherry

Sherman V. Thomson
Utah State University, Logan, UT 84322-5305

Powdery mildew of sour cherry does not overwinter in buds and, therefore, the first incidence of mildew varies depending on the environment. In some years mildew first appears during late bloom but in other years it is not present until fruit are well formed. This study was conducted to determine if powdery mildew could be controlled by delaying applications until mildew was first observed.

The trial was conducted on 15 and 7-year-old cherry trees in a commercial orchard in Santaquin, Utah in 1985 and 1986, respectively. The experimental design was randomized single-tree plots replicated six times. Benlate was applied at the rate of 2 pounds per acre (1 pound/100 gal) as a dilute spray with a handgun at 100 p.s.i. to the point of drip. Imidan was applied by the cooperator for insect control. The first mildew was observed on 31 May in 1985 and 5 June in 1986. Trees were on mahaleb rootstock, spaced 18 x 18 ft. The soil was a clay loam. Precipitation was abnormally high in both years. Ten terminals were examined from each of the trees on 9 July in 1985 and 8 July in 1986 and given a visual severity rating of 1 = healthy to 4 = heavy sporulation, severe distortion and some necrosis.

Applications of Benlate made prior to the first appearance of mildew lesions on leaves were not effective in reducing the severity of mildew infections. However, applications made after the appearance of mildew provided significantly better control than the unsprayed trees.

Timing of Fungicide Applications to Control Powdery Mildew of Sour Cherry.

No. of Benlate applications	Treatment dates	Severity[1]
1985		
4	21 May, 4 June, 19 June, 2 July[2]	1.3 a[3]
3	4 June, 19 June, 2 July	1.3 a
2	19 June, 2 July	2.9 b
1	2 July	3.4 b
0		3.4 b
1986		
3	27 May, 13 June, 25 June	1.5 a
4	15 May, 27 May, 13 June, 25 June	1.6 a
2	5 June, 25 June	1.6 a
2	13 June, 25 June	1.9 a
0		3.3 b

[1]Rating 1 = healthy, 4 = heavy sporulation, leaf twisting and necrosis.

[2]First mildew observed 31 May, 1985 and 5 June, 1986.

[3]Numbers followed by the same letter in the same year are not significantly different at P = 0.01 according to Duncan's multiple range.

I. Deciduous Orchard Diseases

Apple Replant Disease

John Yorston
B.C. Ministry of Agriculture and Fisheries
Box 639, Penticton, B.C. V2A 6P1

Five field trials were established in the spring of 1986 to test the effectiveness of various soil chemical treatments in overcoming apple replant disease. Three additional trials were established in the autumn of 1986. The second objective of the trials was to determine the correlation between field trials and greenhouse apple seedling tests carried out on soil from the field tests sites.

Measurements of tree diameter were taken at planting and in mid-October. Terminal shoot growth measurements were also recorded. In the greenhouse tests, seedling terminal growth measurements were recorded after ten weeks.

Analysis of the results has not been completed. Results for one location are given below:

Greenhouse Test Results

Treatment	Seedling growth (cm) after 10 weeks
1. Check (no treatment)	6.2
2. 11-55-0 (1 g/L soil)	13.6
3. Formaldehyde (1 mL/L soil) + 11-55-0 (1 g/L soil)	21.7
4. Captan (2 g/L soil) + 11-55-0 (1 g/L soil)	22.6

Field Test Results

Treatment	Increase in Diameter (mm)	Terminal Shoot Growth (mm)
1. Formaldehyde (200 mL in 15 L water/tree site) + 11-55-0 (150 g/tree)	4.75	75.9
2. 11-55-0 (150 g/tree)	2.6	47.0
3. Check (48.5 g 34-0-0)	2.3	44.8
4. Captan (150 g/tree) + 11-55-0 (150 g/tree)	4.75	60.5
5. Captan (150 g/tree) + 34-0-0 (48.5 g/tree)	2.35	50.4
6. Mancozeb (30 g/tree) + 11-55-0 (150 g/tree)	4.0	49.4

Measurements including fruit yield will be taken annually. First year results indicate that the greenhouse test has accurately predicted field growth responses.

****

I. Deciduous Orchard Diseases
d. Chemical and biological control
1. Replant Problem; Apple

Raj Utkhede, Thomas Li, and Gerry Owen
Agriculture Canada[1]
Agricultural Research Centre
Summerland, B.C. V0H 1Z0

The tests were conducted at Summerland and Kelowna, British Columbia. Old apple trees with their roots were removed from the sites in the fall of 1985, then the ground was cultivated twice. The soils at both sites were sandy loam with 3% organic matter. The pH values of the soils at Summerland and Kelowna were 6.0 and 4.5, respectively. Five tons/ha lime was incorporated into the soil to bring the level of pH to 6.0 at Kelowna. Ammonium phosphate was thoroughly mixed with soil (approximately 100 L of soil) in each planting hole on May 5, 1986 at Summerland and on May 9, 1986 at Kelowna. Formalin was drenched at each planting site with 6 L of water on May 8, 1986 at Summerland and on May 13, 1986 at Kelowna. Plots at both locations were replicated 3 times, 10 trees per plot, in a randomised complete block design. Trees were planted on June 2, 1986 at Summerland and on June 5, 1986 at Kelowna. The biological treatments were applied as a soil drench in 2L of water per site immediately after planting. Tree spacing was 4.5 m between rows and 1 m between trees. Only the main shoot was allowed to grow during the growing season.

Current season growth was measured on October 20 and 21, 1986 at Summerland and Kelowna, respectively. Fumigation of soil with formalin increased the shoot growth at Kelowna site but not in Summerland. The application of ammonium phosphate improved shoot growth at both locations but the effect of ammonium phosphate was more pronounced at Summerland than at Kelowna. Enterobacter aerogenes significantly increased shoot growth in Kelowna but not in Summerland. Young apple trees treated both with E. aerogenes, an antagonist of Phytophthora cactorum and phosphate fertilizer at planting showed increased growth and may protect from P. cactorum infection.

Treatment*	Rate (ai/site)	Shoot growth (cm) Summerland	Kelowna
NF NP NB	-----	45.0 b†	38.9 d
NF NP B8	6 x 10^{10} CFU	45.5 b	47.0 c
NF P NB	100 g	68.8 a	50.0 bc
NF P B8	100 g + 6 x 10^{10}	70.8 a	45.0 cd
F NP NB	74 g	44.7 b	55.6 ab
F NP B8	74 g + 6 x 10^{10}	50.5 b	56.5 ab
F P NB	74 g + 100 g	69.1 a	57.7 ab
F P B8	74 g + 100 g + 6 x 10^{10} CFU	77.1 a	59.2 a

* NF = no fumigation, NP = no phosphate (11-55-0) fertilization, NB = no bacterial antagonist, F = Formalin (37%), P = ammonium phosphate, B8 = Enterobacter aerogenes, antagonist of Phytophthora cactorum.

† Numbers followed by the same letter are not significantly different (P = 0.05) DMRT.

I. Deciduous Orchard Diseases
d. Chemical and biological control
1. Crown gall; Apple

Raj Utkhede and Emmerson Smith
Agriculture Canada Research Station
Summerland, B.C. V0H 1Z0

Two fumigants and a biological agent were screened for efficacy against crown gall, caused by Agrobacterium tumefaciens on apple seedlings. Fumigants were sprayed on the surface of the soil, then the plots were irrigated for 4 hours by sprinkler irrigation to soak fumigants into the soil on April 18, 1986. The soil was loosened with a cultivator on May 20, 1986 to allow residual fumigants to escape. Antonovka seedlings were planted on May 20, 1986. The biological agent Galltrol-A was used as a root-dip before planting. Tree spacing was 4 m between rows and 30 cm within rows. There were four replications. Each plot had 60 trees. Trees were pulled out for gall observations on October 20, 1986.

Fumigation of soil with vapam or formalin with or without Galltrol-A treatment did not control crown gall on apple.

Treatment		Rate		
Chemical (Broadcast)	Biological (Root-dip)	Chemical (ai/ha)	Biological (Plates/gallon of H_2O)	Infection (%)
Vapam		278 L		45.5 a*
Vapam	Galltrol-A	278 L	3	30.8 a
Formalin		1233 g		18.9 a
Formalin	Galltrol-A	1233 g	3	25.7 a
	Galltrol-A		3	44.2 a
No treatment				30.2 a

* Numbers followed by the same letter are not significantly different (P = 0.05) DMRT. Analysis completed using arc sine transformation.

I. Deciduous Orchard Diseases
d. Chemical Control
1. Powdery mildew; sour cherry

Sherman V. Thomson
Utah State University, Logan, UT 84322-5305

Fungicides were applied to 6 and 12-year-old cherry trees in commercial orchards using a randomized block design with 5 and 6 single-tree replicates in Santaquin and Willard, Utah, respectively. Trees were on Mahaleb rootstock, spaced 18 x 18 ft and approximately 12 ft tall. The soil in Santaquin was a clay loam, in Willard, a sandy loam. The weather was abnormally hot in the spring and tree development was accelerated by approximately 3 wk. Treatments were applied as dilute sprays approximately every 2 wks with a handgun at 100 p.s.i. to the point of runoff. An average of 7.5 l was applied to each tree. Application dates were 15 May (shuck fall), 27 May (first cover), 13 June ($\frac{1}{2}$ in. fruit) and 25 June (first color) in Santaquin and 20 May (shuck fall), 11 June ($\frac{1}{2}$ in. fruit) and 27 June (first color) in Willard. The first mildew was observed in 10 June in Santaquin and 11 June in Willard. Ten terminals were examined from each of the treated trees on 8 July in Santaquin and 9 July in Willard and given a visual severity rating of 1 = healthy to 4 = heavy sporulation, severe distortion and necrosis.

The incidence of mildew was light in the Santaquin orchard and moderately heavy in the Willard orchard. The fungicides provided significantly better control when compared to the check trees in both orchards. Systhane, Nustar and Baycor provided better control than the two registered products Benlate and Sulfur, at the Willard location. However, in the Santaquin orchard Benlate controlled powdery mildew as good as Nustar, Systhane and Tilt. Sulfur and Benlate gave acceptable control in both locations. Applications made after mildew was evident are believed to be responsible for control. No phytotoxicity was observed.

Efficacy of Fungicides for Control of Powdery Mildew of Sour Cherry.

Treatment and rate/100 gal	Powdery Mildew Rating*	
	Santaquin	Willard
Nustar 40EC 2.5 oz	1.38 a**	1.72 ab
Benlate 50WP 16.0 oz	1.44 ab	2.51 de
Systhane 40WP 2.0 oz	1.48 ab	1.4 a
Nustar 40EC 0.625 oz	1.64 abc	2.0 bc
Tilt 3.6E 1.0 oz	1.76 bcd	2.2 cd
Baycor 50WP 4.0 oz	1.84 cd	2.08 c
That Sulfur 52F 56 oz	2.06 d	2.7 e
Check	3.32 e	3.5 f

*Rating 1 = healthy, 4 = heavy sporulation, leaf twisting and necrosis

**Numbers followed by the same letter within columns are not significantly different at P = 0.5 according to Duncan's Multiple Range test.

I. Deciduous Orchard Diseases
d. Chemical Control
Quiescent infections of sweet cherry in California

Billy T. Manji and Joseph M. Ogawa
Department of Plant Pathology
University of California, Davis, CA 95616

Previously from California, quiescent infections of stone fruits have been reported on French prune, nectarine, peach, and sweet cherry. Last spring quiescent infections were observed on Friar plum and again on sweet cherry.

Blossom brown rot (Monilinia fructicola) of sweet cherry is not common but blossom blight was observed in a number of cherry orchards in California. A study was initiated to 1) follow disease development and 2) attempt to suppress quiescent infections with fungicides.

A Bing sweet cherry orchard with quiescent infections ranging from 5-60% was used for the study. Beginning about 5 weeks before harvest, 100 fruit were sampled weekly to determine whether the fungus was still alive. A large percentage of lesions were still viable at harvest but only a small percentage of quiescent infections resumed growth to rot fruit on trees. Also fungicide sprays were applied on these sweet cherry trees 4 weeks and 2 weeks before harvest. Data are summarized in Table 1.

Table 1

EFFICACY OF PREHARVEST FUNGICIDE SPRAYS IN REDUCING POSTHARVEST DECAY OF BING SWEET CHERRY FRUIT

Treatment[x]	Rate/Acre	% Healthy	% Disease[y]			
			Brown Rot	Botrytis	Alternaria	Others
Rovral 50W	2 lb.	82.0	2.7 a[z]	1.0	13.0	1.3
Topsin M 70W	2 lb.	83.2	4.0 ab	3.2	9.1	0.5
Funginex 1.6 EC	48 fl oz	71.0	9.0 b	6.8	10.7	2.5
Check	-	64.4	27.3 c	3.1	5.1	0.1

[x]Two preharvest sprays (4/22 and 5/6) applied with hand gun sprayer, 5 gal/tree. Fruit harvest was 5/22/86.

[y]Healthy and disease percentage are average of 378 fruit replicated six times. Disease evaluation made after six days at 20 C, 90% RH.

[z]Numbers in vertical column followed by the same letter(s) are not significantly different, P = 0.05.

I. Deciduous Orchard Diseases
d. Chemical control
1. Brown rot/Russet scab; French prunes (Prunus domestica L.)

Themis J. Michailides and Joseph M. Ogawa
Department of Plant Pathology
University of California
Davis, CA 95616

ABSTRACT Among the fungicides tested chlorothalonil (Bravo 500) and captan were the most effective in reducing resset scab of green and ripe French prunes. Spotless, rovral, systhane, and ziram were moderately effective, while funginex was uneffective. Severity of russet scab on green fruit was about the same as that on ripe fruit, but lower on dried fruit. Level of brown rot twig and blossom blight was very low, thus, conclusions on the effectiveness of these fungicides on twig and blossom blight cannot be made.

PROCEDURE A randomized complete block design was set up in the Davis campus prune orchard with 6 single-tree replications. The fungicides listed in Table 1 were applied with a handgun sprayer on 5 March 1986, when prune trees were at 50-60% full bloom. Trees were recorded once for brown rot twig blight. For russet scab, prune fruits were recorded on 13 June (green fruit), on 19 August (ripe fruit), and after drying them in a dehydrator. For this recording, five (0, I, II, III, IV) disease categories were used with 0 = fruit with no russetting (healthy) and IV = the most severe russetting.

RESULTS AND CONCLUSION 1. Level of brown rot twig and blossom blight was very low, not allowing to make any comparisons among the fungicides.

2. Results for russet scab are given in Table 1. As expected captan was the best fungicide in controlling russet scab. In addition, chlorothalonil (Bravo 500) was as effective as captan in reducing russet scab in green and ripe fruit.

After drying russet scab disease index was reduced. This agrees with reports on previous years, in which we reported that essentially only III and IV categories of russet scab showed up on dried prunes and were scored by the inspectors. There was a good correlation between readings for russet scab on green, ripe, and dried fruit (Table 1). This agrees with the results of 1983 (1).

REFERENCE

1. Ogawa, J. M., T. J. Michailides, H. A. Bolkan, and R. M. Bostock. 1983. Chemical control of brown rot and russet scab of French prunes. Calif. Prune Board. Prune Research Reports - 1983. pp. 34-42.

Table 1. Evaluation of fungicides for controlling russet scab of French prunes.

Treatment[1]	Dosage per 100 gal water	Russet scab disease index on:[2] Green fruit (13 June 1986)	Ripe fruit (19 Aug. 1986)	After drying
Control	--	2.0 b[3]	2.1 a	0.5 a
Funginex 1.6 E.C.	12 fl. oz.	2.6 a	2.0 ab	0.4 ab
Spotless 24W+ X-77	1.7 fl. oz. + 240 ml	1.8 bc	1.6 c	0.3 bc
Rovral 50W	4 oz.	1.8 bc	1.5 cd	0.2 cd
Systhane 40W	2.5 oz.	1.7 bc	1.6 bc	0.2 cd
Ziram 76%	2 lb.	1.4 c	1.2 d	0.1 de
Chlorothalonil	1.5 pt	0.9 d	0.6 e	0.0 e
Captan 50W	2 lb.	0.9 d	0.5 e	0.0 e

[1] Fungicides were applied with a handgun sprayer on 5 March 1986, when prune trees were at 50-60% full bloom.

[2] Disease index values are the average of 6 replications and are based on 25, 100, and 100 fruits for green, ripe, and dried fruit, respectively. Five (0, I, II, III, IV) disease severity categories were used with 0 = healthy and IV = the most severe russetting.

[3] Means in each column followed by the same letter are not significantly different according to Duncan's Multiple Range Test ($P = 0.05$).

Section I. Deciduous Orchard Diseases
d. Chemical Control

Botryosphaeria panicle and shoot blight; pistachios (Pistacia vera L.)

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PROCEDURE During the 1986 crop season, field plots were established in a commercial pistachio orchard in Butte County. The effect of timing of captafol (Difolatan sprill 80S, at 4 lb/100 gallons) and chlorothalonil (Bravo 500; at 1.5 pt/100 gallons) was studied in a plot irrigated with high-angled sprinklers (body trajectory angle 23°). In a second plot irrigated with low-angled sprinklers (body trajectory angle 12°) the following fungicides were applied on 21 March 1986: chlorothalonil (1.5 pt/100 gallons), benomyl (Benlate 50W) (0.5 lb/100 gallons), mancozeb (Dithane M-45) (1.5 lb/100 gallons), and iprodione (Rovral 50W) (6 oz/100 gallons water). Shoot blight was recorded on 11 April and panicle blight on 10 randomly selected and marked shoots per tree on 5 September 1986.

RESULTS More frequent irrigations of the experimental plot in Durham, Calif., in 1986 than in 1985 (1) resulted in higher levels of Botryosphaeria panicle and shoot blight. On 5 September 95% of the nuts were totally infected in the untreated trees (Table 1). The percentage of infected fruits and blighted rachises of trees sprayed with captafol twice (fall & spring) and that of trees sprayed once (spring) was significantly lower than the percentage of infected fruit on the unsprayed trees (Table 1). Percentages of infected fruits, fruits with pycnidia, and blighted rachises did not differ significantly between unsprayed trees and those sprayed with chlorothalonil (Table 1).

In the low-angled sprinkler plot numbers of shoot blight on male and female trees did not differ significantly for sprayed and unsprayed trees (Table 2). However, clusters from trees sprayed with iprodione had significantly lower percentages of infected fruits, fruits with pycnidia, and infected rachises (Table 2).

CONCLUSIONS Our 1986 data suggest that in following a frequent irrigation schedule the benefits expected by using low-angled sprinklers will not be as great as those determined in the 1985 study (1). In addition, fungicide applications during a disease outbreak will be less effective. Under these conditions, other means for control should be investigated, possibly more frequent fungicide applications, the use of other kinds of fungicides, and biological control.

REFERENCE

1. Michailides, T. J., and J. M. Ogawa. 1986. Sources of inoculum, epidemiology, and control of Botryosphaeria shoot and panicle blight of pistachio. Calif. Pistachio Industry. Ann. Rep. Crop Year 1985-1986. pp. 87-91.

Table 1. Effect of timing of captafol and chlorothalonil sprays on Botryosphaeria panicle and shoot blight of pistachios in a high-angled sprinkler (body trajectory angle 23°) plot.

Treatment	Date of spray(s)	Infected fruit (%)[1]	Fruit with pycnidia (%)	Blighted rachises (%)[2]	Total wt. of infected fruit (%)
Control	-	95 a*	12 a	82 a	270 a
Captafol	11/4/85	92 ab	11 a	85 a	250 a
Captafol	11/4/85 & 28/3/86	86 bc	15 a	58 b	281 a
Captafol	28/3/86	83 c	14 a	52 b	261 a
Chlorothalonil	28/3/86	88 ab	14 a	74 a	268 a
Chlorothalonil	28/3/86 & 8/4/86	90 a	12 a	81 a	257 a

[1] Values are the average of eight 200-fruit samples harvested on 5 September 1986.

[2] Percentages include totally infected rachises. All rachises from 10 shoots marked per tree were harvested on 5 September 1986 and evaluated; values are the average of eight replications.

Table 2. Effects of fungicide application on Botrytis shoot blight and Botryosphaeria panicle and shoot blight of male and female pistachios in a low-angled sprinkler (body trajectory angle 12°) plot.

Chemical treatment	Shoot blight[1]		Infected fruit (%)[2]	Fruit with pycnidia[2]	Infected rachises (%)[3]	Total wt. of infected fruit (g)
	Male trees	Female trees				
Control	57.2 a*	0.0 a	75.9 a	10.0 a	64.4 a	258.0 a
Chlorothalonil	40.6 a	1.0 a	66.0 a	11.5 a	61.8 a	222.2 a
Benomyl	60.8 a	0.7 a	57.9 ab	7.9 ab	51.2 ab	220.8 a
Mancozeb	57.4 a	0.0 a	57.2 ab	7.2 ab	58.1 a	184.5 ab
Iprodione	36.0 a	1.7 a	32.6 b	2.4 b	20.7 b	117.8 b

[1] Shoot blight is the average of 5 male and 4 female replicate trees per treatment recorded on 11 April 1986; (shoot blight was due to Botryosphaeria dothidea [80%] and Botrytis cinerea [18%]).

[2] Values of infected fruit and fruit with pycnidia are the average of four 200-fruit samples harvested on 5 September 1986.

[3] Values of infected rachises are the average of four replicate trees with 21 to 47 rachises per tree.

*(For both Table 1 and 2): Means separation using DMRT at $P = 0.05$. (Statistical analysis was performed after a $\log_{10}$ transformation for data on shoot blight and total weight of infected fruit and an arc sine transformation for data on percentages).

Section I. Deciduous Orchard Diseases
d. Chemical Control

1. Botrytis shoot blight; pistachios (*Pistacia vera* L.)

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INTRODUCTION In the 1985 growing season we reduced Botrytis shoot blight on male trees in a commercial pistachio orchard in Butte County by spraying once with benomyl during blossoming. Residue analysis data obtained from samples collected in 1984, along with the efficacy date for Botrytis shoot bight for 1983 (1) and 1985 (3) and Botryosphaeria panicle and shoot blight for 1985 (2), were submitted to EPA. Registration of benomyl for one application during blossoming of pistachios is expected for the 1987 season.

PROCEDURE In the spring of 1986, we selected an orchard in Butte County that had a history of Botrytis shoot blight for at least 3-4 years to test the efficacy of the following fungicides: chlorothalonil (Bravo 500) at 1.5 pt/100 gallons, benomyl (Benlate 50W) at 0.5 lb/100 gallons, mancozeb (Dithane M-45) at 1.5 lb/100 gallons, and iprodione (Rovral 50W) at 6 oz/100 gallons water. Five male and three female trees per treatment were sprayed once during full bloom with a handgun sprayer on 21 March. Male trees consisted of two cultivars: 'Peters' and '02-16', and all female trees were 'Kerman'. The experimental layout was a randomized complete block design and shoot blight was recorded on 23 April.

RESULTS AND CONCLUSIONS Because of the prolonged wet spring in 1986 in California, incidence of *B. cinerea* was high in this orchard in comparison with that in the same experimental plot in 1985 (3). Unfortunately, at the time we collected data for the fungicide trials we had not yet determined that there were two types of shoot blight [(a), blight of current-season shoots originated from infection of basal scales of emerging vegetative buds and (b), blight of current or past-season shoots caused by girdling from enlarged cankers that were initiated from the male inflorescences]. Therefore, no distinction between shoot blights was made and all shoot blights (strikes) were counted.

Among the treatments only trees treated with benomyl had a significantly lower number of strikes per tree than the untreated trees (Table 1). Shoot blight of 'Peters' and 'Kerman' trees was significantly lower than that of '02-16' male trees (Table 1). None of the other chemicals caused significant differences in comparison with untreated trees (Table 1), probably because of the girdling of shoots from cankers initiated from inflorescences the year before. These findings suggest that there is variability in the sensitivity to Botrytis shoot blight between two cultivars of male pistachios.

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3. Michailides, T. J., J. M. Ogawa, and H. R. Teranishi. 1986. Control of Botrytis blossom and shoot blight of pistachio with Benlate. Calif. Pistachio Industry. Ann. Rep. Crop Year 1985-1986. pp. 102-103.

Table 1. Effect of various fungicides on Botrytis shoot blight on male and female pistachio trees.

Treatment[1]	Average no. of shoot blight per tree[2]		
	'02-16'[3]	'Peters'[4]	'Kerman'[3]
		[5,6]	
Control	68.7 ab	2.5 a	0.3 a
Chlorothalonil	57.5 bc	1.0 a	0.7 a
Benomyl	46.7 c	5.5 a	0.3 a
Mancozeb	-	1.0 a	1.0 a
Iprodione	83.7 a	1.0 a	0.7 a

[1] Fungicides were applied on 21 March 1986 when male and female trees were at 60-80% full bloom.

[2] All shoot blights (current-season blights and blights due to girdling from enlarged cankers) were recorded on 23 April 1986.

[3] Shoot blight for '02-16' and 'Kerman' is the average of 3 trees.

[4] Shoot blight for 'Peters' is the average of 2 trees except for the mancozeb treatment which is the average of 5 trees.

[5] Numbers in each column followed by the same letter are not significantly different according to Duncan's Multiple Range Test at $P = 0.05$.

[6] ANOVA indicated that shoot blight recorded on '02-16' was significantly differing from that recorded on 'Peters' ($F = 914.7$; df = 1; $P = < 0.05$).

I. Deciduous Orchard Diseases
e. Pesticide resistance
1. Apple scab; Apple

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Resistance of *Venturia inaequalis* to Benomyl and Dodine in British Columbia

Samples of scab infected fruit were collected from 28 orchards throughout British Columbia in September 1986. Conidia from lesions on these samples were tested for resistance to benomyl and dodine by determining whether they would germinate on water agar amended with benomyl or dodine. Eight of the orchards were found to have greater than 50% of the viable conidia from randomly selected lesions germinate on water agar containing 1 ppm benomyl. Ten orchards had greater than 50% of the viable conidia from randomly selected lesions germinate on water agar containing 0.6 ppm dodine. The results of these germination tests for selected orchards are given in Tables 1 and 2.

Table 1. Germination of *Venturia inaequalis* conidia on water agar (WA) containing 1 ppm benomyl

Location	Av. Annual Rainfall (mm)	Av. Annual No. Scab Sprays	Percent Germination[1]
Vancouver Island	900	5-8	46
Creston	569	5-8	13
Coldstream	413	3-4	0
Vernon	348	3-4	100
Bella Vista	348	3-4	100
Rutland	312	2-3	0
Belgo	312	2-3	9
Kelowna	312	2-3	14
Naramata	283	0-2	2
Penticton	283	0-2	0

[1] The percentage "germination" was a measure of germination on WA-benomyl, relative to that on WA.

Table. 2 Germination of *Venturia inaequais* conidia on water agar (WA) containing 0.45, 0.6 and 1 ppm dodine.

Location	Av. Annual Rainfall (mm)	Av. Annual No. Scab Sprays	Percent Germination[1]		
			0.45 ppm	0.6 ppm	1 ppm
Vancouver Island	900	5-8	-	27	9
Creston	569	5-8	-	60	52
Coldstream	413	3-4	-	64	24
Vernon	348	3-4	81	23	0
Bella Vista	348	3-4	100	72	41
Rutland	312	2-3	48	33	0
Belgo	312	2-3	9	0	0
Kelowna	312	2-3	-	52	17
Naramata	283	0-2	30	0	0
Penticton	283	0-2	65	0	0

[1] The percentage "germination" was a measure of germination on WA-dodine, relative to that on WA.

SECTION II

POME FRUITS

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II. Pome Fruits
a. Biology
1. Pest and Host: Codling moth

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A respirometer (Sell et al. 1985) was used to monitor, continuously, the CO_2 production of codling moth larvae and pupae. The objective of measuring CO_2 respiration was to determine if a major change in CO_2 respiration was associated with the termination of diapause; and second to determine if the length of diapause had an influence on the duration of the reactivation period (changing from diapause to non-diapause development).

Codling moth larvae were collected from Yakima orchards in September and October 1985 and held in an open shed until November 4, 1985 at which time they were placed in a refrigerator (2°C). Larvae were removed from the refrigerator at age 50, 100, 150, 225, and 275 days and placed in the respirometer (20°C, 16:8 h photoperiod). The CO_2 respiration of the above larvae were compared to that of non-diapause larvae collected within 12 h of cocoon spinning.

CO_2 respiration of diapause larvae fluctuated between 30 and 60 units. At diapause break the CO_2 respiration increased to 75 and 85 units, signaling the onset of post-diapause development. The CO_2 respiration curves were identical for post-diapause and non-diapause codling moth development. The development period was also the same which tends to verify when diapause terminated.

The reactivation period for larvae that were in diapause for 50 or 100 days was 12 to 28 days; for 150 days it was 3 to 16 days; for 225 days it was 0 to 20 days; and for 275 days it was 0 to 5 days. These results indicated that ca. 33% of the larvae chilled 225 days had terminated diapause, 67% of those chilled 275 days, and did not need a reactivation period.

The thermal constant for development is correlated with length of diapause, but once diapause has been terminated, the thermal constant is the same for both post-diapause and non-diapause development.

Days in diapause	Days before diapause break	Days for post- and non-diapause development
0	0	23.5
50	15.2	20.2
100	18.8	20.4
150	7.2	22.2
225	6.3	21.6
275	2.0	22.1

II. Pome Fruits
a. Biology
1. Leafhoppers; Apple (cv. 'Delicious')

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Populations of leafhoppers on 'Delicious' apple in the central Washington region were sampled in 1986. Adult leafhoppers were collected with aspirators or sweep nets, preserved in 70% EtOH, and determined using published keys and species descriptions. Nymphal leafhoppers were collected on plant material and held until transformation to the adult stage. Species which were encountered very infrequently were considered 'strays' on apple unless there was evidence of reproduction or significant feeding injury on apple.

The most common species on 'Delicious' apple in 1986 was Typhlocyba pomaria McAtee, the white apple leafhopper (WALH). In many orchards this appeared to be the only leafhopper species infesting apple, especially early in the growing season. The rose leafhopper (RLH), Edwardsiana rosae (L.), was found infesting apple in several orchards. This species was not seen on apple during its first generation in 1986. Apparently, some female RLH move from wild rose to apple to lay second generation eggs. RLH populations on apple were generally lower than WALH populations at the same site; RLH were never found in a site which did not also have WALH populations. Leafhoppers in the genus Erythroneura were occasionally found on apple in 1986. Nymphs were found, indicating that these may not have been strays. However, their numbers were so low that no significant amount of injury could be attributed to them. The most frequently encountered Erythroneura species was E. dolosa Beam. & Griff.

Bushes of wild rose and sweet cherry trees were occasionally sampled in 1986. Only Edwardsiana rosae was found to infest wild rose, on which it completed at least two generations. Cherry was found to be infested with Typhlocyba pomaria, Edwardsiana rosae, and Erythroneura sp. (especially dolosa) in the Wenatchee area.

II. Pome Fruits
a. Biology
1. White Apple Leafhopper; Apple (cv. 'Delicious')

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Several orchard sites in the Wenatchee area were sampled bi-weekly for white apple leafhopper (Typhlocyba pomaria McAtee) populations in an effort to determine the seasonal phenology of this pest on 'Delicious' apple. Sampling began in mid-April and continued until late October frosts killed the last leafhoppers. Each sample consisted of a sufficient number of infested leaves (usually 25 to 50) to acquire a large number of individual leafhoppers for examination. With the aid of a binocular scope, the leafhoppers in each sample were sorted by age class (instars I-V and adults) and counted. Most adults avoided capture during sampling by flying off of leaves as soon as the tree canopy was disturbed. Fifth instar exuvia (cast skins) remain attached to the leaf surface after nymphs transform into adults; exuviae were assumed to be a better indicator of adult numbers with this sample technique.

First generation white apple leafhopper nymphs were present in samples for a shorter period of time than second generation nymphs (figure 1). A more distinct age (instar) structure was apparent for the first generation, probably due to relatively synchronous hatching of 1st instar nymphs from overwintering eggs. Second generation eggs, laid over a long period of time, also hatched over a long period, resulting in a broad mix of instars through most of the second generation. The great majority of first generation leafhoppers matured on spur leaves or the older leaves at the base of terminals. In order to avoid counting first generation leafhoppers, only leaves from newer terminal growth were sampled after 14 July.

Adult white apple leafhoppers apparently can live for a relatively long period under favorable conditions. As a result, there was a slight overlapping of generations in 1986. First generation adults were present in low numbers beyond the date indicated in figure 1, possibly to the end of July. As soon as early August second generation adults began to appear. By late August adults had become the majority age class in the population. Their numbers remained high until several frosts had occurred. In early November they could still be found on watersprouts in the orchard.

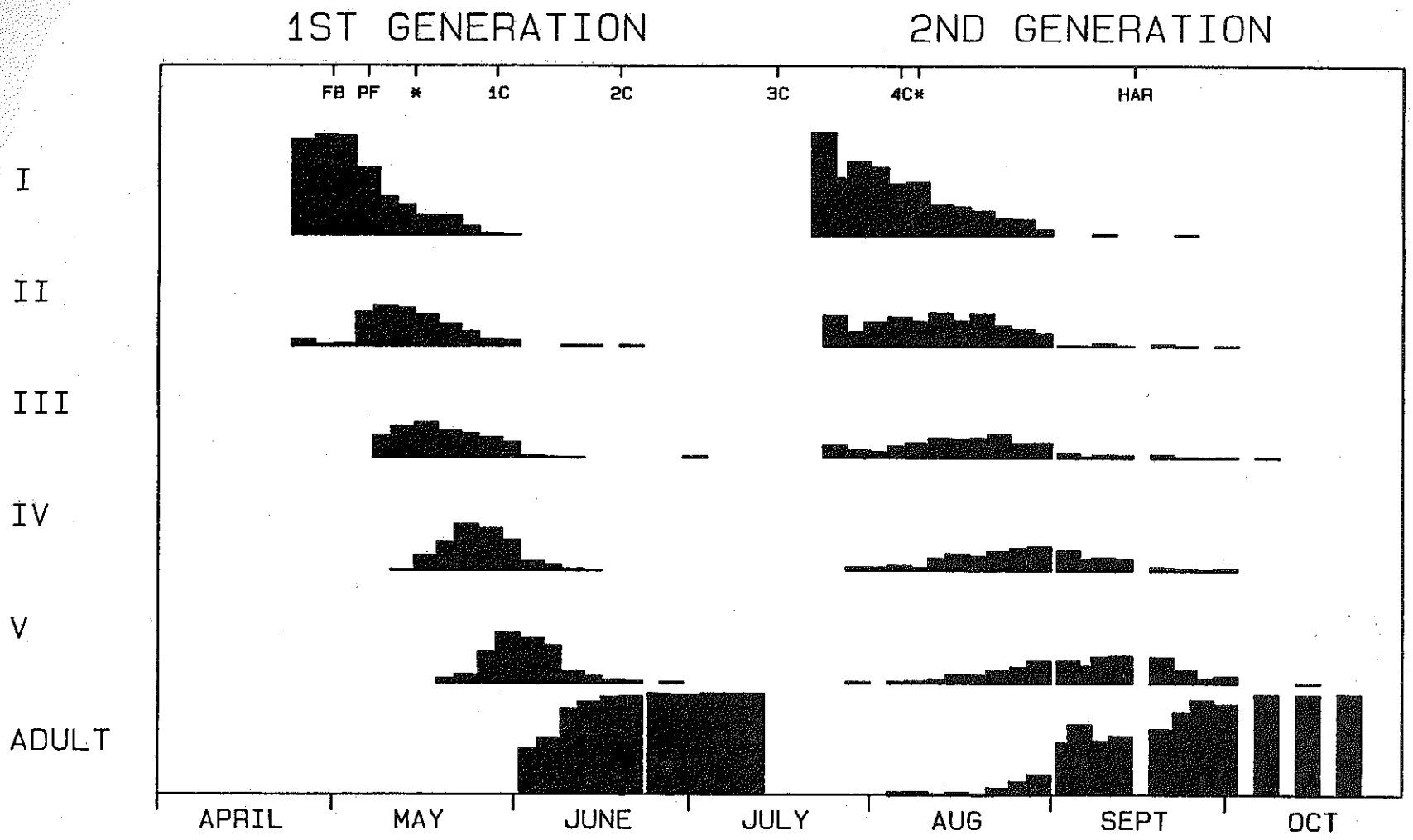

Figure 1. Seasonal phenology of white apple leafhopper (Typhlocyba pomaria McAtee) on 'Delicious' apple in Wenatchee, WA, 1986. Bars indicate the percentage of the population in each age class on the sample date. Adult values determined from counts of 5th instar exuviae on leaves.

II. Pome Fruits
a. Biology
1. White Apple Leafhopper; Apple (cv. 'Delicious')

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Various trap colors were tested for efficacy of trapping adult leafhoppers (second generation). All traps were 12.7 x 17.8 cm (5 x 7 inches) rectangles coated on both sides with Stikem Special Pest Glue. They were suspended in the tree canopy for a 24 hour period, collected, and counted.

Test 1: Traps were constructed of posterboard in various colors. The traps received an undercoating of Krylon acrylic spray coating to prevent saturation with the glue. In general, colors in the yellow, red, and orange range caught the most leafhoppers (Table 1). Colors in the green range (similar to that of an apple leaf) were less attractive. Black, white, and dark blue caught the fewest leafhoppers.

Test 2: Traps were constructed of either posterboard (prepared as in Test 1), tin sheets, or clear plexiglass. The tin sheets were undercoated with galvanized metal primer (Rustoleum #7702). The fluorescent colors received a second undercoating of flat white (Rustoleum #2190) to attain the proper brightness. As in Test 1, colors in the yellow range caught the most leafhoppers (Table 2). Fluorescent red and green caught fewer, and white and clear caught the fewest leafhoppers.

Table 1. Test of trap color for adult leafhoppers on sticky panels, 10 Sept. 1986.

Color	Type[a]	Mean adults/trap/24 hours[b]
Yellow	PB	466.8a
Fluorescent Orange	PB	365.3ab
Fluorescent Yellow	PB	284.3b
Fluorescent Red	PB	248.3b
Light Green	PB	161.5c
Dark Green	PB	105.8cd
Black	PB	65.8de
White	PB	56.3ef
Dark Blue	PB	37.3f

[a]PB = posterboard
[b]Means within columns followed by the same letter(s) are not significantly different ($P<0.05$, DMRT). Data analyzed using a log(x+1) transformation.

Table 2. Test of trap color for adult leafhoppers on sticky panels, 24 Sept. 1986.

Color	Type[a]	Mean adults/trap/24 hours[b]
Yellow	PB	289.0a
Light Green	PB	111.5bc
Fluorescent Yellow	PB	219.0ab
Fluorescent Yellow	Rust #2242	224.3ab
John Deere Yellow	Rust #7443	215.3ab
John Deere Green	Rust #7434	102.8bc
Fluorescent Red	Rust #2264	77.5c
Gloss White	Rust #7792	29.0d
Clear	Plex	27.8d

[a]PB = posterboard, Rust = Rustoleum spray paint on tin sheets, Plex = Clear Plexiglass.

[b]Means within columns followed by the same letter(s) are not significantly different, $P<0.05$, Tukey's HSD.

II. Pome Fruits
b. Thresholds, monitoring & sampling

Evaluation of Traps for Apple Maggots in Oregon

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Ten trap types were evaluated for their efficacy in trapping apple maggot flies in an unsprayed orchard during August and September 1986. Data indicate that a rectangular yellow colored panel with red hemispheres in the middle and an apple volatile attractant trapped the highest number of flies. Both in terms of total number of flies caught and the ratios of positive catches, this trap out performed all other traps tested, including Pherocon AM and red spheres. Analysis of two year's trapping data suggest that this trap is effective under both low and high population density conditions.

II. Pome Fruits

b. Thresholds, monitoring & sampling

Comparative Effectiveness of Red Sphere and Pherocon^{R} AM Traps for Monitoring Apple Maggot Activity in the PNW

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The relative efficiency of the Pherocon^{R} AM (baited yellow panel) and red sphere trap was directly compared at 46 apple and 22 imported hawthorn, Crateagus monogyna, sites in southwest Washington. On apple, the red sphere trap consistently caught more apple maggot flies as compared to the baited yellow panel trap ($\bar{x}$=38.4 to $\bar{x}$=13.6 flies). In contrast, the baited yellow panel was greater than 3 fold as effective as the red sphere on imported hawthorn ($\bar{x}$=43.8 to $\bar{x}$=13.0). In the majority of cases where traps caught flies, larvae were reared from fruit (76% for baited yellow panels and 74% for red spheres). Overall, apple maggot catch on the baited yellow panel correlated well with levels of fruit infestation in both imported hawthorn (r^2=.71) and apple (r^2=.73). In apple, correlation between catch on the red sphere and fruit infestation was good (r^2=.64) but on imported hawthorn correlation was poor (r^2=.22). Interestingly, a relatively high percentage of sites (22%) produced larvae from fruit when no flies were caught on at least one of the traps. However, at only one site were larvae (3) reared from fruit when neither trap caught an apple maggot fly. A combination of red sphere and baited yellow panel traps may provide the most effective method of monitoring apple maggot activity in some areas.

II. Pome Fruits

B. Decision making software for apple pest management

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We are developing a computer program to aid in apple pest management decision making. The program is being written in C lanaguage so that it may be run on UNIX minicomputers as well as MS-DOS microcomputers. It is designed to organize research models and findings with site-collected data and expert opinion by using a rule-based structure which is able to run models and retrieve records from databases as well as incorporate expert knowledge for diagnosis and crop damage estimation. At the end of a system run, the user manipulates estimates of crop damage and effects of controls to examine the costs and benefits of alternative control tactics.

Pome Fruits
b. Thresholds, monitoring & sampling
Codling moth - Pears

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Codling moth is the key pest of pear orchards in the Sacramento River Delta district. Though chemical controls are effective, they are increasingly expensive where codling moth populations are heavy. Pheromone baited traps offer the easiest method for evaluating codling moth populations. During the last 8-10 years, our firm has performed multi-tactic IPM consulting programs in 6 Delta orchards ranging in size from 40 to 200 acres and totaling 500 acres. During this time 32-34 pheromone baited BAB type traps were operated each season. The data in Table 1 represents a total of 278 individual trap years or 47 individual orchard years. Table 1 compares the average per year trap numbers to the amount (lbs.) of chemicals and the number of applications between 1977 and 1986.

TABLE 1
Codling Moth (CM) Population Levels
and Chemical Controls Applied to 6 Sacramento
Delta Pear Orchards
1977-1986

CM Avg./Trap-yr.	Lbs. Chemical/Orch. Yr. Tot.	Avg.	N	# Applications Tot.	Avg.
<23	6	1.2	5	3	0.6
24-50	36.5	2.4	15	35	2.3
51-150	54	4.5	12	34.5	2.9
150>	106.3	7.1	15	63	4.2

These data and trap data from many other commercial pear orchards under our programs reflect codling moth populations that were economically managed to provide for commercially acceptable #1 cannery fruit (below 5% worms) even at very heavy population densities ranging from 300 to 900 moths per trap per season. Field experience has demonstrated the following strategies are successful in the management of heavy codling moth populations on commercial pears in California;

1. Less than 100 moths per trap per season - standard 3 spray program works well and allows a margin for poor timing due to

breakdowns, weather, etc. Rates of chemicals and number of applications can sometimes be reduced.

2. 100-200 moths - standard programs work well but margin for error decreases. Some reduction in chemical rates may be appropriate if coverage and timing are exact.

3. 200-300 moths - standard programs can work well with excellent timing and coverage. Full label rates should be used. Populations may increase the following season.

4. 300-450 moths - extra sprays become necessary to keep damage at harvest low. If only one extra spray is used, populations will probably increase the following season.

5. 450-600 moths - Damage will probably be noticeable on trees at harvest if only one extra spray is applied. Populations will continue to increase in following season. At least 5-6 cover sprays, at full label rates, may be needed to minimize damage and reverse the population trend.

6. Over 500-600 moths - Spraying needs to be done on an 18-21 day cycle to keep harvest damage below 5%. Even more frequent spraying is needed to reverse the trend and bring codling moth populations down to more efficiently managed levels.

Summary

When annual populations of codling moth become increasingly heavier, as monitored by pheromone traps, additional applications of increasingly higher rates of conventional insecticides have kept damage to within commercially acceptable levels. However as populations of codling moth increase, there are corresponding increases in the costs of control measures, in the disruption of beneficial arthropods, in the damage risk potential, in worker exposure and in environmental contamination.

Conclusions

In our client orchards we are attempting to reduce seasonal codling moth trap totals to below 50 moths per trap per year. In doing so, the chemical and application costs of managing codling moth can be reduced by up to $65.00 per acre based on the Sacramento Delta programs. Additional savings can be realized in orchards requiring more than 4 applications per year. As codling moth populations are reduced, the secondary costs associated with pesticide use are also reduced and the ability to conduct multi-tactic IPM is enhanced.

II. Pome Fruits

c. Biological Control

Parasitoids of the Apple Maggot, *Rhagoletis pomonella* (Walsh), in Southwest Washington

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Four species of parasitoids have been reared from apple maggot (AM) pupae or AM infested fruit collected in southwest Washington. *Opius downesi* Gahan and *Opius lectoides* Gahan parasitized AM larvae feeding in fruits of an introduced species of hawthorn, *Crateagus monogyna*. *O. downesi* was particularly abundant, attacking AM in 8 of 12 sites sampled in the Vancouver area. At one location, the level of parasitism exceeded 50%. *Biosteres* cfr. *melleus* (Gahan) and an unidentified species of Chalcidoid primarily parasitized AM larvae infesting fruits of a native species of hawthorn, *Crateagus douglasii*. We believe this is the first record of parasitism of a western population of AM by *B. melleus*. Levels of parasitism on individual trees generally were below 10%, although in a few cases they approached 50%. The Chalcidoid also is a new western record and, moreover, appears to be the first detection of an ectoparasitoid of AM. We have not recorded parasitism of AM larvae or pupae reared from apple.

II. Pome Fruits
d. Chemical Control
1. White Apple Leafhopper; Apple (cv. 'Delicious')

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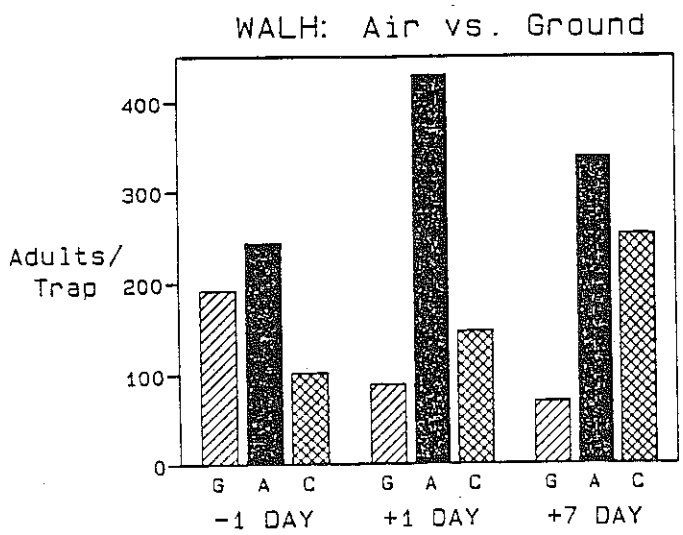
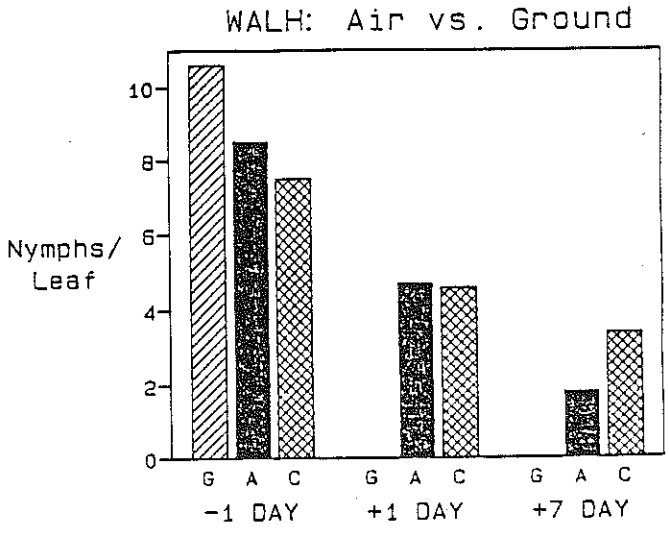
Two methods of application (helicopter and airblast sprayer) were evaluated for 2nd generation white apple leafhopper control. Helicopter or aerial spraying is popular later in the season because of concerns (fruit damage or prop poles) with ground equipment. Adult leafhoppers are an annoyance to harvesters, and often high populations go unnoticed or uncontrolled until harvest is near.

Sevin XLR (4 pt/acre) was applied on 27 August 1986 to unreplicated 1 acre plots. Treatments were check (untreated), helicopter (7 gallons/acre) and Parker airblast sprayer (400 gallons/acre). Nymph populations were assessed by examining 20 injured terminal leaves/tree (6 trees/plot). Adult populations were assessed by yellow sticky panels suspended in the tree canopy for 24 hours (6 traps/plot). Age class distribution on 25 August was: I - 16%; II - 18%; III - 15%; IV - 22%; V - 16%; adult - 13%.

The helicopter application was ineffective at reducing adult and nymphal leafhopper populations. The airblast sprayer did an excellent job in reducing nymphs, and moderately well in terms of adult reduction.

TRADE NAME	COMMON NAME
Sevin XLR (4F)	carbaryl





II. Pome Fruits
d. Chemical control
1. White Apple Leafhopper; Apple (cv. 'Delicious')

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A number of experimental and registered chemicals were screened for activity against the white apple leafhopper, Typhlocyba pomaria McAtee. All treatments were applied to the point of drip with a handgun to 4 single-tree replicates per treatment. Leafhopper populations were assessed by counting the number of nymphs on 20 injured leaves per tree (80 leaves per treatment).

First generation, registered insecticides: All treatments were applied 15 May 1986 (Table 1). Initial leafhopper populations were quite high, ca. 8-18 nymphs/leaf. The increase in the check population during the posttreatment period is probably due to continued hatching of the overwintering eggs. The instar distribution on the date of application was: I - 48%; II - 35%; III - 16%; IV - 1%. Sevin XLR Plus, Thiodan, and Phosphamidon gave excellent control of leafhoppers. Dimethoate gave good control, but Diazinon, Lorsban, and Guthion were weaker. Although individual materials vary, the organophosphates in general appear to be less effective.

Table 1. First generation, registered insecticides, 1986.

Compound	Rate per acre	Mean nymphs/injured leaf pre-treatment (13 May '86)	Mean nymphs/injured leaf post-treatment (23 May '86)	% reduction
Sevin XLR Plus 4F	4 pt	17.45	0.00	100
Sevin XLR Plus 4F	2 pt	11.48	0.00	100
Thiodan 50WP	3 lb	18.20	0.00	100
Phosphamidon 8EC	1 pt	11.90	0.04	100
Dimethoate 2.67EC	4 pt	17.93	0.69	96
Diazinon 50WP	4 lb	18.23	2.10	88
Lorsban 50WP	3 lb	8.30	1.05	87
Guthion 50WP	2 lb	9.80	2.58	74
Control (Untreated)		9.63	13.40	(-39)

Second generation, registered insecticides: All treatments were applied 9 Aug 1986 (Table 2). Pretreatment counts were lower than the first generation's, due to perhaps a protracted hatching period of the summer eggs, and a "dilution factor" (increased numbers of leaves in mid-summer). The instar distribution at the time of application was: I - 29%; II - 19%; III - 24%; IV - 16%; V - 9%; Adult - 3%. Sevin XLR Plus again provided excellent control, along with Carzol and Phosphamidon (1 pt/acre). Thiodan did not perform as well as in the first generation. Other materials and rates did not provide adequate commercial control. The long hatching

period, plus the higher proportion of older instars at the time of application reduced the overall level of chemical control of this generation.

Table 2. Second generation, registered insecticides, 1986.

Compound	Rate per acre	Mean nymphs/injured leaf pre-treatment (7 Aug '86)	Mean nymphs/injured leaf post-treatment (16 Aug '86)	% reduction
Sevin XLR Plus 4F	4 pt	4.04	0.06	99
Sevin XLR Plus 4F	1 pt	3.70	0.11	97
Sevin XLR Plus 4F	2 pt	4.71	0.19	96
Carzol 92SP	1.5 lb	3.40	0.18	95
Phosphamidon 8EC	1 pt	3.25	0.33	90
Thiodan 50WP	2 lb	3.13	0.33	89
Thiodan 50WP	3 lb	4.41	0.73	83
Vydate 2L	2 pt	3.84	1.09	72
Phosphamidon 8EC	0.5 pt	3.53	1.08	69
Lorsban 50WP	1.5 lb	3.61	1.71	53
Lorsban 50WP	3 lb	5.00	2.68	46
Guthion 50WP	2 lb	3.10	2.30	26
Control (Untreated)		6.15	5.19	15

Second generation, experimental compounds: Experimental procedure and application date was the same as for second generation (registered insecticides). None of the compounds tested showed sufficient activity to be commercially acceptable as a single application (Table 3).

Table 3. Second generation, experimental insecticides, 1986.

Compound	Rate/ Acre	Mean nymphs/injured leaf pre-treatment (7 Aug 86)	Mean nymphs/injured leaf post-treatment (16 Aug 86)	% reduction
Guthion 50WP + Tween-20	2.0 lb 1.5 pt	3.28	1.01	69
DiBeta 1.5%	0.7 gal	4.21	2.91	31
Avermectin 0.15EC + oil	0.167 gal 1.0 gal	3.54	2.03	43
Fenoxycarb 25WP	0.52 lb	4.20	3.80	10
Ro 08-4947 44WP	2.3 lb	3.26	2.93	10
SD115110 0.4EC	0.5 lb	2.83	0.93	67
Check		6.15	5.19	16

II. Pome Fruits
d. Chemical control
1. Codling moth; apple

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Three insecticides were evaluated for the control of the codling moth: ALSYSTIN 25 WP (triflumuron), DIMILIN 25 WP (diflubenzuron) and GUTHION 50 WP (azinphos-methyl). Treatments were applied to single-tree plots of mature Red Delicious, Golden Delicious, Spartan, Newtown, Winesap, McIntosh or Red Rome apple trees. Each insecticide was sprayed on two or three varieties. Plots were replicated 3 times in a randomized complete block design. At least one guard tree separated adjacent plots within rows. Trees were spaced at 2.3 x 4.6 m. A high-volume application was made using a hand-held gun sprayer at a pressure of 1380 kPa to and beyond run-off. Treatments were timed according to various parts of the adult emergence periods and to egg hatch periods as defined by a degree-day codling moth development program. After harvest in October all apples from each tree plot were inspected for codling moth damage. Data on damage were transformed using $\sqrt{x + 0.5}$.

Given a rather high damage potential, both ALSYSTIN and DIMILIN reduced codling moth damage at least to the level obtained by treating with GUTHION, the treated control. Control with GUTHION in this experiment, however, was not very good, probably because no application was made in September when damage suddenly increased. In this experiment, the lower dose of each insect growth regulator was as effective in protecting the fruit as the higher dose.

Treatment	Rate (g ai/ 100 L)	Application date (day/month) First brood			Second brood		Codling moth damaged apples at harvest[1] (%)
ALSYSTIN	15	12,25/5	15/6		28/7	2,9/8	0 a
ALSYSTIN	40	12,25/5	15/6		28/7	2,9/8	0.6 ab
DIMILIN	10	25/5				2/8	1.9 abc
DIMILIN	15	25/5				2/8	5.7 c
GUTHION	18.5		14/6	5/7		9,29/8	3.8 bc
Untreated	--						22.7 d

[1]Means followed by the same letter are not significantly different ($P<0.05$, LSD).

II. Pome Fruits
d. Chemical control
1. Codling moth; apple

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Three insecticides were evaluated for control of the codling moth: RO 13-5223 25 WP (fenoxycarb), DIMILIN 25 WP (diflubenzuron) and GUTHION 50 WP (azinphos-methyl). Treatments were applied to single-tree plots of mature McIntosh, Newtown or Red Rome apple trees spaced at 2.3 x 4.6 m. Each treatment was applied to each variety at least once. Plots were replicated 4 times in a randomized complete block design. At least one guard tree separated adjacent plots within rows. A high-volume application was made using a hand-held gun sprayer at a pressure of 1380 kPa to and beyond run-off. Spraying was timed by a degree-day program to occur at the beginning of moth emergence (May 17 and July 19) and the beginning of egg hatch (June 4, July 26 and Sept. 10) (with some repeat sprays after a 3-week interval). After harvest in September-October all apples from each tree plot were inspected for codling moth damage - damage of all kinds as well as deep-entry damage where larvae had tunnelled into the apple away from the peel. Data on damage were transformed using $\sqrt{x + 0.5}$. On Sept. 19, 25 leaves/tree were collected, brushed and the predacious mites counted.

There was a low damage potential in this experiment. Almost all treatments reduced codling moth damage to the level obtained by treating with GUTHION, the treated control. If applied frequently, fenoxycarb and DIMILIN provided good control. Control was also as good as GUTHION if DIMILIN was applied at the beginning of egg hatch in the first brood (June 4, treatment #6), but not as good as GUTHION if applied when moths first emerged (May 17, treatment #7). Only a few leaves had developed on the trees by May 17, and leaves developing later would not have had insecticide residue to kill oviposited eggs. DIMILIN provided good control if applied only once in the second brood and treatment with GUTHION was made during the first brood (treatments #3 and #4). Predacious mite numbers were not significantly reduced by application of fenoxycarb, DIMILIN or GUTHION.

Treatment	Rate (g ai/ 100 L)	Application date (day/month)					Codling moth damaged apples at harvest[1] (%)	
		First brood		Second brood		Third brood	All damage	Deep-entry damage
1. Fenoxycarb	50	17/5	4,25/6	19,26/7	17/8	10/9	0.4 a	0 a
2. GUTHION	18.5		4,25/6	26/7	17/8	10/9	0.2 a	0 a
3. GUTHION + DIMILIN	18.5 10		4,25/6	19/7			0.3 a	0.1 ab
4. GUTHION + DIMILIN	18.5 10		4,25/6	26/7			0.4 a	0.2 ab
5. DIMILIN	10	17/5	4,25/6	19,26/7	17/8	10/9	0.7 ab	0 a
6. DIMILIN	10		4/6	26/7			1.4 ab	0.4 ab
7. DIMILIN	10	17/5		19/7			2.1 b	0.9 b
8. Untreated	-						5.5 c	3.3 c

[1]Means in the same column followed by the same letter are not significantly different (P<0.05, LSD).

II. Pome Fruits
d. Chemical Control
1. Pear psylla (PP); Psylla pyricola Foerster
PEAR: Pyrus communis L. 'Bartlett', seedling

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PEAR: PEAR PSYLLA, SCREENING OF INSECT GROWTH REGULATORS, 1986. Tests were conducted on pear seedlings (small nursery liners) growing in 4-inch pots and on terminal shoots of 'Bartlett' in a Research Center orchard. Seedlings were infested with PP eggs by caging 20 adults on each for 5 days. Shoots in the orchard were naturally infested with mixed stage populations. Treatments were applied to seedlings one day before adults were caged on them by dipping them for 5 s in water dilutions of candidate pesticides. Shoot tests were replicated 3 times and were sprayed with a hand pump sprayer. Treated seedlings were held post-treatment in a growth room at ca. 75°F and 16 h photoperiod for 4 weeks. Treated shoots remained in the orchard post- treatment. Treatments were evaluated by counting eggs and nymphs on the entire sample using a dissecting microscope.

Tests on seedlings indicate that SD 115110 prevents egg hatch and kills newly hatched nymphs. Thuringiensin treatments did not reduce egg or nymph survival. Sprays of these two materials applied to growing shoots in the orchard did not reduce egg or nymph survival. Further testing of SD 115110 as orchard spray is needed to determine if this material has potential for control of PP, but there is no evidence from these tests to support further testing of Thuringiensin against this pest.

Seedling Dip Tests

Treated 24 July pre-oviposition Sampled 21 August - 4 weeks post-treatment

Compound	PPM (AI)	Eggs	Dead Nymphs	Live Nymphs
SD 115110 .4 lb EC	240	28	0	0
	120	44	14	0
	60	14	16	0
	30	17	1	10
	15	29	1	3
Control	0	29	3	61
Thuringiensin 1.5% EC	75	4	2	20
	37.5	13	1	33
	18.8	5	0	2
	9.4	6	0	33
	4.7	9	2	14
Control	0	29	3	61

Shoot Sprays

Treated 12 June Sampled 3 July - 3 weeks post-treatment

Compound	PPM (AI)	Eggs	Dead Nymphs	Live Nymphs
SD 115110 .4 lb EC	240	412	160	64
	120	443	161	81
	60	908	66	288
	30	482	27	70
	15	238	19	66
Control	0	485	42	341
Thuringiensin 1.5 %	EC 75	679	14	479
	37.5	177	21	108
	18.8	104	16	72
	9.4	559	8	548
	4.7	391	15	261
Control	0	485	42	341

II. Pome Fruits
d. Chemical control
1. Pear psylla (PP); Psylla pyricola Foerster
PEAR: Pyrus communis L. 'Bartlett', seedling;

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PEAR: PEAR PSYLLA, LABORATORY SCREENING OF INSECT GROWTH REGULATORS, 1986. Tests were conducted on pear seedlings (small nursery liners) growing in 4-inch pots and on elongated fruiting spurs at cluster bud to popcorn stage of development collected from an unsprayed orchard. Seedlings were infested with PP eggs by caging 20 overwintered adults on each for 3 days. One set of seedlings was treated one day before adults were caged on them while the other set was treated after oviposition. Fruiting spurs were infested with eggs and a few nymphs when collected. Pesticides were applied to seedlings and spurs by dipping them in test dilutions for 5 s. Four serial dilutions of each IGR were tested. Controls were dipped in water. Treated samples were held in a growth room at ca. 75°F and 16 h photoperiod until most eggs on controls had hatched or until spur foliage began to wilt. Treated spurs were placed in 200 ml beakers with water to keep them fresh. Treatments were applied to single seedlings or 5 spurs. Treatments were evaluated by counting eggs, dead and live nymphs on entire samples using a dissecting microscope.

All compounds tested reduced nymph numbers. Data indicate that eggs, especially those deposited on treated foliage, are more susceptible than nymphs. Insegar is very active against eggs deposited on treated foliage but less active than Dimilin or CME 13406 when applied to 72 h old eggs or to nymphs. Of the materials tested, PH 70-23 was least active against PP. Although these materials produce significant kills of pear psylla in lab tests, orchard sprays may not be effective because it would not be practical to keep new foliage covered with residue during the spring when trees grow rapidly. PP deposit most of their eggs on expanding leaves and growing shoot tips. Nymphs may be more susceptible to these compounds than these tests show. Because additional mortality occurs with successive moults, a longer post-treatment period may be necessary to demonstrate maximum effect.

Seedling Dip Tests

Treated 19 Mar Post-oviposition Sampled 31 Mar

Compound	PPM (AI)	Eggs	Dead Nymphs	Live Nymphs
Dimilin 25% WP	600	265	12	1
	300	14	1	0
	150	118	10	5
	75	138	14	0
	0	8.25	3.5	4.5
CME 13406 15% SC	300	3	0	0
	150	39	0	6
	75	64	9	2
	37.5	0	0	0
	0	8.25	3.5	4.5
Insegar 25% WP	600	0	0	0
	300	0	0	0
	150	300	6	38
	75	180	2	44
	0	8.25	3.5	4.5
CGA 45128 10% EC	300	256	3	9
	150	15	0	2
	75	205	1	11
	37.5	35	11	25
	0	8.25	3.5	4.5
PH 70-23 10% EC	300	3	1	31
	150	14	37	70
	75	36	1	20
	37.5	23	36	123
	0	8.25	3.5	4.5

Treated 20 Mar Pre-oviposition Sampled 4 Apr

Compound	PPM (AI)	Eggs	Dead Nymphs	Live Nymphs
Dimilin 25% WP	600	315	27	17
	300	20	3	0
	150	71	7	8
	75	156	44	116
	0	68	19.8	63
CME 13406 15% SC	300	348	25	11
	150	224	6	2
	75	226	39	30
	37.5	107	3	3
	0	68	19.8	63
Insegar 25% WP	600	222	0	0
	300	251	0	0
	150	164	0	0
	75	146	0	0
	0	68	19.8	63
CGA 45128 10% EC	300	11	1	1
	150	36	12	21
	75	267	16	24
	37.5	141	16	18
	0	68	19.8	63
PH 70-23 10% EC	300	234	14	7
	150	114	75	213
	75	101	34	83
	37.5	59	12	22
	0	68	19.8	63

Twig (elongated spurs) tests

Treated 24 Mar Post-oviposition Sampled 3 Apr

Compound	PPM (AI)	Eggs	Dead Nymphs	Live Nymphs
Dimilin 25% WP	600	62	0	2
	300	81	11	0
	150	80	12	1
	75	138	7	0
	0	21.4	0.6	78.2
CME 13406 15% SC	300	121	3	7
	150	84	4	9
	75	87	3	16
	37.5	66	4	10
	0	21.4	0.6	78.2
Insegar 25% WP	600	132	1	2
	300	109	8	4
	150	82	11	17
	75	128	8	16
	0	21.4	0.6	78.2
CGA 45128 10% EC	300	77	1	4
	150	93	1	10
	75	82	0	1
	37.5	117	3	11
	0	21.4	0.6	78.2
PH 70-23 10% EC	300	52	1	28
	150	47	1	33
	75	39	1	27
	37.5	21	4	46
	0	21.4	0.6	78.2

Twig Dip Tests

Treated 14 Apr Sampled 21 Apr

Compound	PPM (AI)	Eggs	Dead Nymphs	Live Nymphs
CGA 45128 10% EC	300	416	29	205
	150	500	88	193
	75	536	49	197
	37.5	638	23	355
	0	442	14	513
CME 13406 15% SC	300	366	36	66
	150	450	74	83
	75	375	88	169
	37.5	348	51	94
	0	169	15	467
Dimilin 25% WP	450	313	114	64
	225	509	93	208
	112.5	411	133	380
	56.2	221	98	249
	0	227	55	383
Insegar 25% WP	300	450	50	370
	150	578	20	256
	75	242	16	180
	37.5	324	8	128
	0	243	35	338

II. Pome Fruits
d. Chemical control
2. Pear psylla; pears

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In all of the tests, plots consisted of 4 single-tree replicates in a randomized block. Sprays were applied by handgun operating at 200 psi. Pear psylla (PP) populations were sampled at 2- to 4-week intervals by counting nymphs and/or by beating tray counts of adults. Fruit was evaluated for PP russet in some tests.

Prebloom control with pyrethroids: Asana, Pydrin and Pounce were applied 19 Mar together with superior oil. All 3 pyrethroids had similar knockdown effect on PP adults. The initial nymph counts in the Pounce treatment were the same as in the check indicating poor ovicidal activity. Through April, the nymphs in the Pounce treatment were higher than in the other pyrethroid treatments. By mid-May control by all 3 pyrethroid treatments was comparable. Asana, applied at less than one-fourth the rate Ai of the other 2 pyrethroids, provided control equal to Pydrin.

Abamectin 0.15 EC: Treatments were applied 24 Apr (petal fall), 17 Jun and 31 Jul. Two rates of abamectin (2.7 and 5.3 oz form/100 gal) plus 0.5% superior oil were compared to amitraz and a check. Both rates of the 1st abamectin treatment were as effective as amitraz and provided control during the 1st PP generation before PP moved to the new terminal growth. The 2nd abamectin application (17 Jun) initially gave control similar to amitraz but appeared to be less persistent. The 3rd abamectin application in late July was the least effective of the 3 timings compared to amitraz and PP populations recovered very quickly. There was no difference in control efficacy between the 2 abamectin rates except for the 3rd application where the higher rate gave better suppression. No fruit was downgraded due to PP russet in the abamectin (higher rate) and amitraz treatments. Some downgrading occurred in the abamectin treatment at the lower rate.

CME 13406 15 SC: Three cover sprays of this IGR (2 rates: 1.3 and 2.6 oz form/100 gal) were timed about 150 to 250 degree-days earlier than Guthion. The standard treatment was Guthion plus amitraz. Nymph counts in both CME 13406 plots began to increase in June and were not different from the check for the rest of the season. Although nymph densities were similar, total downgrading due to PP russet was considerably lower in the CME 13406 treatments than in the check. Both CME 13406 treatments had some codling moth damage.

II. Pome Fruits
d. Chemical Control
1. Pear psylla (PP); Psylla pyricola Foerster
Pear rust mite (PRM); Epitrimerus pyri (Nalepa)
European red mite (ERM); Panonychus ulmi (Koch)
PEAR: Pyrus communis L. 'Bartlett' and 'Anjou';

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PEAR: SOFT PESTICIDE TEST, 1986. Trees were sprayed with handguns operating at 600 psi to compare a seasonal program of soft pesticides with a standard chemical spray program for control of insect and mite pests of pear. Plots consisted of 4 25- to 30-tree replications in 2- or 3-row blocks. Four replications of an untreated control were included in randomized block design. PP adults, PP predators and the parasite Trechnites insidiosus densities were monitored by the limb-tap method. Through 24 Apr PP nymphs were counted on fruiting spurs. After that date PP nymph and phytophagous mite densities were monitored by brushed leaf samples. Counts of pest and beneficial species were made at 2-week intervals, but counts made when densities were low are not included in the table. Pest damage to fruit was measured by examining 250 fruit/rep. at harvest. Fruit firmness, size and soluble solids content were compared on 2 10-fruit samples/rep.

The soft pesticide program controlled most pests as well as or better than the standard program. PP was the notable exception; the soft program allowed substantial damage from this pest. Phytophagous mite populations were suppressed in the control plot by abundance of honeydew on foliage and leaf drop resulting from PP feeding. None of the sprays caused injury to fruit or foliage, but the oil-sulfur-copper combination did not mix well and sludged out of suspension during application.

TREATMENT HISTORIES

Plot	Date	Materials	Rate/100 gal
Plot 1	18 Mar	Superior type oil	1 gal
		Sulfur 6 lb/gal F	3 qt
Soft		Fixed copper 53% WP	.5 lb
Pesticides	7 Apr	Sulfur 6 lb/gal F	3 qt
		Dimilin 25 % WP	6 oz
	30 Apr	Dimilin 25% WP	6 oz
		X77	2 oz
	28 May	Dimilin 25 % WP	6 oz
		X77	2 Oz
	19 Jun	Dimilin 25% WP	6 oz
		X77	2 oz
	1 Jul	Avermectin B .15 lb/gal EC	175 ml
		Superior type oil	1 qt
	18 Jul	Dimilin 25 % WP	6 oz
		X77	2 oz
Plot 2	18 Mar	Pydrin 2.4 lb/gal EC	4 oz
		Superior type oil	1 gal
Standard	7 Apr	Pydrin 2.4 lb/gal EC	4 oz
Pesticides		Parathion 4 lb/gal F	4 oz
		Morestan 25% WP	1 lb
	28 May	Guthion 50% WP	8 oz
		Amitraz 50% WP	12 oz
	19 Jun	Guthion 50% WP	8 oz
		Amitraz 50% WP	12 oz
	18 Jul	Guthion 50% WP	8 oz
		Amitraz 50% WP	12 oz
		Plictran 50% WP	6 oz
Plot 3			
Control - no sprays applied			

	PP nymphs/100 leaves*									
Plot	9 Apr	24 Apr	7 May	20 May	2 Jun	16 Jun	30 Jun	16 Jul	29 Jul	14 Aug
1	40b	30b	15b	0b	42b	57b	57ab	2b	0b	0b
2	40b	10b	2b	0b	10b	60b	7b	12b	2b	7b
3	797a	2642a	465a	375a	137a	352a	205a	220b	35a	35a

* Means within columns followd by the same letter are not significantly different (P=0.05; LSD).

		PP adults/25 limb taps							
Plot	Pre-bloom	1 May	15 May	29 May	9 Jun	23 Jun	7 Jul	24 Jul	4 Aug
1	167b	43b	13b	191a	394b	149b	19b	66b	125a
2	21c	13b	27b	100b	168b	17c	27b	41b	106a
3	427a	100a	424a	1955a	2421a	497a	241a	232a	151a

* Means within columns followd by the same letter are not significantly different (P=0.05; LSD).

	Phytophagous mites/100 leaves					
	ERM		TSM		PRM	
Plot	Seasonal mean	Peak	Seasonal mean	Peak	Seasonal mean	Peak
1	11.0	32.0	3	7.5	6	30
2	86.0	167.0	46	90.0	6	20
3	0.5	2.5	3	15.0	24	110

	Percent fruit damage from pests						
	PP russet						
Plot	US2	Cull	PRM	CM	GMB	PLR	SJS
1	13.0	2.5	0.5	0.0	3	0.0	0.5
2	3.5	0.0	1.0	1.5	0	0.0	0.0
3	34.0	29.5	6.0	42.5	2	7.5	8.5

Plot		Predators/25 limb taps				
		9 May	17 Jun	3 Jul	14 Jul	28 Jul
1	Anthocorus	0	0	1	1	2
2		0	0	0	0	0
3		8	101	285	280	205
1	Deraeocoris	9	100	37	33	14
2		0	0	1	4	5
3		18	150	177	162	230
1	Trechnites	6	0	0	13	0
2		4	0	0	0	0
3		47	16	0	215	91

II. Pome Fruits
d. Chemical control
1. Pear psylla (PP); Psylla Pyricola Foerster
Pear rust mite (PRM); Epitrimerus pyri (Nalepa)
European red mite (ERM); Panonychus ulmi (Koch)
Twospotted spider mite (TSM); Tetranychus urticae Koch
PEAR: Pyrus communis L. 'Bartlett';

Everett Burts
WSU Tree Fruit Research Center
Wenatchee, WA 98801

PEAR: PEST CONTROL, 1986. Mature pear trees were sprayed with handguns operating at 600 psi to evaluate pesticides for control of pear pests. Plots consisted of 5 2-tree replicates in randomized block design. Treatments were applied 4 times during the season, on 11 Apr, 1 May, 4 Jun and 22 Jul. Treatments were evaluated for PP and mite control by counts made at 2-week intervals, but PP populations declined in late Jul so counts made afterwards are not included in tables. Adult PP were counted from a 5 beating-tray sample/rep. Psylla nymphs and mites were counted from a 50-leaf sample/rep. Leaf samples through 27 May were collected from fruiting spurs. Later samples consisted of the proximal, distal and 3 leaves from between on each of 10 growing shoots. Leaves were brushed and resulting slides were examined using a dissecting microscope. PP and pear rust mite russet were rated according to US grade standards for fresh market Bartlett pears on 2 samples of 25 mature fruits/rep. Fruit and foliage were examined after each spray for phytotoxicity.

Avermectin B and amitraz provided satisfactory control of PP. Fenoxycarb controlled PP better than CME 13406 or diflubenzuron. These materials kill only newly deposited PP eggs and early instar nymphs; therefore applications to mixed stage populations do not provide economic control. Avermectin B and amitraz also controlled all three species of phytophagous mites. TSM density in the check remained low because the large amount of PP honeydew interfered with mite development. Mite counts were condensed in this report to seasonal mean densities to save space.

Treatment and (AI)/100 gal	Pear psylla nymphs/100 leaves*					
	5 May	14 May	27 May	10 Jun	25 Jun	9 Jul
CME 13406 15% SC 6 g	192bcd	28cd	70b	34bcd	30ab	36ab
CME 13406 15% SC 12 g	134de	28cd	34bc	44bc	10bc	50a
Fenoxycarb 25% WP 57 g	240bc	156b	38bc	4cd	0c	24ab
Diflubenzuron 25% WP 57 g	246bc	112bcd	24bc	18bcd	4bc	30ab
Diflubenzuron 25% WP 28 9	294b	120bc	46bc	50ab	16bc	18ab
Avermectin B .15 EC 2.8 g**	28f	14d	2c	0d	0c	18ab
Oil 1 qt						
Avermectin B .15 EC 1.4 g**	50ef	18cd	8bc	0d	2c	14b
Oil 1 qt						
Amitraz 50% WP 170 g**	134de	40cd	6c	2d	2c	14b
Control	816a	496a	238a	86a	56a	28ab

* Means within columns followed by the same letter are not significantly different (P = 0.05; LSD).

** Not applied on Apr 11.

Treatment and (AI)/100 gal	Adult pear psylla/25 trays*					
	20 May	2 Jun	17 Jun	30 Jun	14 Jul	28 Jul
CME 13406 15% SC 6 g	88ab	12b	44b	36b	13abc	10ab
CME 13406 15% SC 12 g	66bc	26b	16b	48ab	18ab	12ab
Fenoxycarb 25% WP 57 g	36bc	24b	12b	34b	14abc	5ab
Diflubenzuron 25% WP 57 g	30bc	4b	6b	26b	14abc	14a
Diflubenzuron 25% WP 28 g	64bc	28b	14b	84ab	9bc	12ab
Avermectin B .15 EC 2.8 g**	8c	4b	6b	26b	7c	3b
Oil 1 qt						
Avermectin B .15 EC 1.4 g**	14c	2b	12b	48ab	10abc	3b
Oil 1 qt						
Amitraz 50% WP 170 g**	60bc	14b	10b	46b	9bc	5ab
Control	136a	238a	120a	106a	20a	12ab

* Means within columns followed by the same letter are not significantly different (P = 0.05; LSD).

** Not applied on Apr 11.

Treatment and (AI)/100 gal	Seasonal mean mites/100 leaves*		
	PRM	ERM	TSM
CME 13406 15% SC 6 g	920a	268bc	38ab
CME 13406 15% SC 12 g	598ab	382ab	54a
Fenoxycarb 25% WP 57 g	460ab	181cd	18bc
Diflubenzuron 25% WP 57 g	288bc	470a	40ab
Diflubenzuron 25% WP 28 g	426bc	172cd	30ab
Avermectin B .15 EC 2.8 g**	52c	9d	1c
Oil 1 qt			
Avermectin B .15 EC 1.4 g**	54c	22d	1c
Oil 1 qt			
Amitraz 50% WP 170 g**	396bc	24d	17bc
Control	420bc	118cd	14bc

* Means within columns followed by the same letter are not significantly different (P = 0.05; LSD).

** Not applied on Apr 11.

Treatment and (AI)/100 gal	Percent fruit russet		
	PP		PRM
	US2	Cull	
CME 13406 15% SC 6 g	21.6	15.6	64.4
CME 13406 15% SC 12 g	20.4	13.6	70
Fenoxycarb 25% WP 57 g	15.2	8.4	29.2
Diflubenzuron 25% WP 57 g	17.2	6.8	39.6
Diflubenzuron 25% WP 28 g	21.6	23.2	57.6
Avermectin B .15 EC 2.8 g*	.8	0	0
Oil 1 qt			
Avermectin B .15 EC 1.4 g*	4.4	.4	0
Oil 1 qt			
Amitraz 50% WP 170 g*	10.8	2.8	5.6
Control	21.2	36.4	80

* Not applied on Apr 11.

II. Pome Fruits
d. Chemical Control
1. Pear psylla (PP); Psylla pyricola Foerster
Pear rust mite (PRM); Epitrimerus pyri (Nalepa)
Twospotted spider mite (TSM); Tetranychus urticae Koch
Codling moth (CM); Cydia pomonella (Linnaeus)
Apple aphid (AA); Aphis pomi DeGeer
PEAR: Pyrus communis L. 'Bartlett', 'Anjou';

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PEAR: PEAR PSYLLA CONTROL, 1986. Five-year-old pear trees were sprayed with handguns operating at 600 psi to evaluate pesticides for control of PP. Plots consisted of unreplicated blocks two rows wide containing ca. 48 trees. In the standard plot trees were sprayed as follows: 18 Mar - fenvalerate 2.4 lb/gal EC .075 lb (AI)/100 gal plus superior oil 1 gal/100 gal; 7 Apr - oxythioquinox 25% WP .25 lb (AI) plus fenvalerate 2.4 EC .075 lb (AI) plus parathion 4F .25 lb (AI)/100 gal; 28 May and 19 Jun - azinphosmethyl 50% WP .25 lb (AI)/100 gal; and 17 Jul - amitraz 50% WP .375 lb (AI) plus azinphosmethyl .25 lb (AI)/100 gal. The three insect growth regulators (IGR's) (first three treatments in tables) were applied 7 Apr, 30 Apr, 28 May, 19 Jun and 17 Jul. PP eggs, nymphs and adults were counted at 2-week intervals. Eggs and nymphs were counted on 2 samples of 5 fruiting spurs/plot from 8 Apr through 8 May and 2 50-leaf samples/plot thereafter. All spur tissues were examined under a dissecting microscope; leaf samples were processed using the standard leaf brushing technique. Adults were counted by the limb-tap method. Phytophagous mites were also counted on the brushed-leaf samples. AA infestations were rated by determining the percent infested terminals and the average number of infested leases/terminal. PP, PRM russets and CM damage were rated according to US grade standards for fresh pears on 2 samples of 25 fruit/rep.

Although the IGR's did not adequately control first generation PP nymphs, they did reduce their density to about half that of the control. Second and subsequent generation nymphs were held to near the damage threshold of .5/leaf by these compounds. In orchards where standard sprays for control of post-hibernating adults are applied the IGR's would probably control summer populations of PP. There was more PP russet on fruit in the standard plot because nymph density was high late in the growing season. Fenoxycarb was the most effective IGR tested. Data from this plot and lab studies from this and other locations point out the potential for IGR's in controlling PP. These compounds seem to be stage selective; newly deposited eggs and eggs laid on residues are highly susceptible, newly hatched nymphs are slightly less susceptible, but late instars and adults are highly tolerant. The challenge for commercial use of IGR's to control PP is to keep new shoot growth covered during periods of oviposition because summer adults feed and lay eggs on growing terminals. Since there was not a significant rate response for the dosages tested in lab studies, multiple, low dosage sprays may provide better control than a single high rate application. Another point to consider is that PP densities in commercial orchards are much lower than those in this test.

Post-hibernation winter form adults are destroyed by oil and/or pyrethroid sprays at late dormant to cluster bud stage of tree growth before they deposit eggs. As a result of this early season control, first summer generation nymphs usually do not exceed the damage threshold (about .5/leaf). Control of second and third generation PP was better than that obtained against first generation in this test. AA density was not affected by any of the treatments. Although control plot fruits were heavily infested, CM was controlled by all IGR's tested. IGR treatments did not affect phytophagous mite densities. The lower mite densities in the control plot were caused by PP honeydew on leaves interfering with mite development.

		PP nymphs/100 leaves							
Treatment and lb (AI)/100 gal		8 Apr	22 Apr	1 May	19 May	4 Jun	17 Jun	1 Jul	15 Jul
Diflubenzuron 25% WP	.0625	137	318	470	175	70	105	40	40
CME 13406 15% SC	.0313	194	317	160	40	5	90	5	20
Fenoxycarb 25% WP	.0468	119	164	120	40	5	0	0	0
Standard program*		11	1	0	5	15	45	45	35
Control		216	718	550	295	155	100	60	175

		PP eggs/100 leaves							
Treatment and lb (AI)/100 gal		8 Apr	22 Apr	1 May	19 May	4 Jun	17 Jun	1 Jul	15 Jul
Diflubenzuron 25% WP	.0625	1107	2004	80	15	40	45	30	35
CME 13406 15% SC	.0313	2357	2056	220	60	30	10	25	40
Fenoxycarb 25% WP	.0468	1125	1774	310	130	10	5	30	25
Standard program*		0	88	15	10	55	25	45	40
Control		1176	1705	240	40	15	40	65	55

		PP adults/25 limb taps									
Treatment and lb (AI)/100 gal		13 Mar	27 Mar	14 Apr	1 May	15 May	29 May	9 Jun	23 Jun	8 Jul	24 Jul
Diflubenzuron 25% WP	.0625	620	625	247	166	62	208	138	55	173	85
CME 13406 15% SC	.0313	628	595	180	165	53	44	70	18	109	117
Fenoxycarb 25% WP	.0468	720	528	158	135	48	25	50	18	79	143
Standard program*		650	20	1	41	23	18	106	18	163	9
Control		583	568	242	135	159	735	730	127	239	113

II. Pome Fruits

d. Chemical control

1. Phytophagous mites; apples and pears

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Mite control with Apollo 50 SC on apple: Test plots consisted of 4 single tree replicates arranged in a randomized block. Trees were sprayed by handgun at 200 psi. The whole orchard received sprays of Guthion and fungicides. Each treatment was evaluted by brushing 100 leaves at 1- to 3-week intervals. Early season test - Efficacy of 3 rates (0.5, 1 and 2 oz/100 gal) at petal fall and 4 different timings (delayed dormant, pink, petal fall, and 1st cover) of the 1 oz rate were compared to superior oil (delayed dormant) and a check. Of the three 'petal fall' sprays, the high rate (2 oz/100 gal) provided longer lasting control than lower rates. All prebloom as well as 'petal fall' timings of the 1 oz rate suppressed ERM until the end of June; the '1st cover' timing gave control through July. Superior oil at 'delayed dormant' was as effective as the prebloom Apollo sprays against ERM. Early-season Apollo sprays suppressed ARM initially; superior oil did not. Mid-season test - In this test, combination sprays of Apollo and Carzol were compared to Apollo alone, Vendex 4 F and a check. All treatments provided effective ERM control through August. Combination sprays with Carzol did not improve control over Apollo alone. Vendex was slower acting than other treatments. Phytoseiids survived well in all treatments except where Carzol was used. The '1st cover' spray of Apollo aided by phytoseiid mites was effective through August. None of the summer treatments affected rust mites.

Early season evaluation of Savey 50 WP on pear: Five different timings were compared: early bloom, full bloom, petal fall, 3 wks after petal fall and 1st cover. Trees were inoculated with European red mite (ERM) in early April. Plot lay-out and sampling was the same as for the Apollo test. Mite pressure was moderate. Twospotted spider mites never built up. ERM control provided by the early timings when little foliage was present lasted surprisingly long and was not different from the later treatments. Savey had no effect on pear rust mite.

II. Pome Fruits
d. Chemical Control
1. Pesticide Application Methods

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Work conducted in 1985 to evaluate the efficiency of the application of azinphosmethyl (Guthion) to apples by commercial growers indicated that tank mixes of azinphosmethyl and calcium nitrate ($CaNO_3$) may cause azinphosmethyl residues on apple to degrade at a slower rate than when azinphosmethyl was applied alone. Because of this, and because growers oftentimes apply mixtures of materials to apples, work was conducted in 1986 to evaluate the effect of a variety of tank mixtures on the degradation of azinphosmethyl residues from apple leaves.

Tank mixtures of azinphosmethyl, $CaNO_3$ and/or urea. As shown in Table 1, there were no statistical differences in azinphosmethyl residues on apple leaves sampled at an interval of 21 days after application from plots sprayed with azinphosmethyl only or plots sprayed with mixtures of azinphosmethyl + urea, azinphosmethyl + urea + $CaNO_3$, or azinphosmethyl + $CaNO_3$ (Plots S-1, S-2, B-1). It was also determined that these mixtures did not produce higher initial residues on the leaves than did the azinphosmethyl only application. Although these tank mixes did not increase the amount of applied residue or extend its life, it does appear that the first degradation half-life was extended by 2 to 9 days, thus enhancing the efficiency of the residues in the early period after application.

Tank mixtures of azinphosmethyl and S&A. In plots O-1 and OD-1 where tank mixes of azinphosmethyl and S&A (a leaf feed) were compared to azinphosmethyl only, it was found that in plots where S&A was added, the 21 day azinphosmethyl residues were higher than in the azinphosmethyl only treated plot. Also, with this mixture, the first half-life was extended, but as in the previously discussed mixtures, the initial residues were not increased. The first half-life in the azinphosmethyl-S&A plot (O-1) was increased by only one day, but in the OD-1 plot the half-life was increased by 9 days. This difference could have been due to the increase of the amount of water that was applied per acre or to the interval after treatment that these plots were rained on (Table 1).

Effect of ph on azinphosmethyl residues. The addition of S&A produced a tank solution with a ph of 4.6 as compared to a ph of 7.7 in tank solutions of azinphosmethyl only. It was considered that this ph change may have been more responsible for the results obtained with the S&A misture than was the S&A. Therefore, in plot O-2, citric acid was mixed with azinphosmethyl to evaluate this phenomenon. The ph 4.6 citric acid-azinphosmethyl tank mix neither increased initially applied residues, extended the first half-life, or increased the amount of residue remaining at the 21 day interval.

Table 1. Degradation of azinphosmethyl residues from apples leaves sprayed with different tank mixes of azinphosmethyl and other materials.

Plot	Tank mixture applied	Rate applied (lb/A)	H_2O/A (gallons)	Initial residue ($\mu g/cm_2$)	% Residue remaining after 21 days	1st half-life (days)	Days of rain after application
S-1	Guthion	2.22	44	3.97	22 a	7	5 & 19
	Guthion + Urea	2.22 8.22	44	3.81	27 a	9	5 & 19
	Guthion + Urea + $CaNO_3$	2.22 8.22 17.60	44	3.45	32 a	16	5 & 19
S-2	Guthion	1.00	40	3.24	36 a	15	15
	Guthion + $CaNO_3$	1.00 10.00	40	3.36	33 a	18	15
B-1	Guthion	2.00	150	2.29	36 a	7	1
	Guthion + $CaNO_3$	2.00 16.00	150	1.58	44 a	10	1
O-1	Guthion	1.25	15	2.44	12 a	4	3
	Guthion + S&A	1.25 5.00	15	2.34	23 b	5	3
OD-1	Guthion + S&A	2.00 4.00	75	2.35	67 c	13	6
O-2	Guthion	1.25	20	1.79	31 a	11	5
	Guthion + Citric acid	1.25 20 grams	20	1.67	25 a	10	5

II. Pome Fruits

f. Implementation

1. Codling Moth-Apples, Quarantine Treatments

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ARS-USDA, Wenatchee, WA

Japan is the only major fruit-producing country in the world in which the codling moth, Cydia pomonella (L.), does not occur and research has been underway for several years to develop methods which would meet their stringent import quarantine requirements for fruits and nuts which are reported hosts of the insect. Fumigation with methyl bromide alone cannot be used on Red Delicious apples because we have found that the treatment regimes required for complete mortality of the egg, the most tolerant stage of the insect associated with commercially-produced apples, cause unacceptable levels of damage to the fruit. A two-component treatment has been developed consisting of exposure to low temperatures, 2°C (35.6°F) or below, for ca. 42 days against the egg and subsequent fumigation with methyl bromide at 32 g/m^3 for 2 hours at 20°C (68°F) or 56 g/m^3 at 6°C (42.8°F) against the larvae. This treatment is effective against the stages of the codling moth associated with commercially-produced apples with minimal effect on Red or Golden Delicious apples. Minimal residues of methyl bromide on the apples can be achieved using adequate aeration and holding periods.

SECTION III

STONE FRUITS

****

Sharon Collman
Section Leader

III Stone Fruits
a. Biology
Apple maggots - Cherries

Donald Davis, Wilford Hanson, Vincent Jones, Frank Messina and Nabil Youssef
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No infested apples were detected in Utah orchards during either 1985 or 1986. Cherry and hawthorn infestations were common. Apple maggots occurred in Crataegus douglasii wherever extensive fruiting was found from central Utah to southern Idaho and eastward to the Colorado border. Native hawthorns do not occur in all parts of Utah. Cherry infestations were common only near Provo. Tart cherries are later maturing fruit and were usually more heavily infested than sweet cherries. More than 80% damaged fruit can occur. Low level infestations were in plums, apricots, pyracantha, ornamental hawthorns and crabapples. No apple maggots were found in apples, pears, service berries, mt. ash, cotoneaster, snowberries or chokecherries.

Besides apple maggots, we caught the following Rhagoletis species in Utah orchards. Western cherry fruit flies occurred from June 13 to August 8 and were most common north of Salt Lake City. R. ribicola, R. completa and R. tabellaria were common. No snowberry maggots have been collected.

About 5% of the apple maggots from hawthorns were parasitized. There were 2 species of parasites, which as yet, have not been identified.

Laboratory behavior of apple maggot females exposed hawthorns, cherries and apples was studied. Apples were accepted, but much less frequently than cherries or hawthorns. Apple maggots from both hawthorns and cherries would oviposit in apples when preferred fruit was not available. Some maggots have developed to puparia from the apples. Maggots removed from other host fruit and placed in apples, also completed development.

During 1985, we found a distinct bimodal emergence curve. Populations in cherries were earlier, both chronologically and by degree day, than those from hawthorns. At that time we used a 5°C lower threshold which had been suggested by some workers. It now appears that the lower threshold should be near 8.6°C. A reexamination of the 1985 data and information from 1986, did not indicate a bimodal curve with the 8.6°C threshold. Our first apple maggot catches occur at about 650 DD, the peak catches near 1100 DD, and the last major flight near 1500 DD.

A rather interesting, but as yet unexplained, flight pattern occurs in the cherry populations but not the hawthorn populations. After the normal seasonal flight pattern was completed, a second flight occurred during September and October. We think that it indicates a partial second generation, but as yet have not verified that fact.

III Stone Fruits
b. Thresholds, monitoring and sampling
Apple Maggots - Cherries

Vincent P. Jones and Donald W. Davis
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Data from several publications, plus preliminary information from 1985 and 1986 in Utah, served as the basis for the calculation of degree days. The most valuable published data came from Dean and Chapman's work in New York. The threshold for apple maggot development was calculated to be 47.5°F or 8.6°C. This means that, in °C, apple maggot pupae require 848 DD and the pre-oviposition period in adults 78 DD. Our first catches, measuring the accumulated degree days from March 1, occur very close to 650 DD. Most of the work from eastern USA fits the calculated parameters, but as noted from the Utah studies, the cherry-infesting biotype in Utah does not fit as precisely.

Replicated trapping using 10 different types of traps, was conducted at three sites in Utah during 1986. One site was in a heavily infested tart cherry orchard, one in a lightly infested sweet cherry orchard, and one in a stand of native hawthorns (Crataegus douglasii). The 10 trap types were:

Standard Pherocon AM traps
Unbaited Pherocon traps with ammonium carbonate packets added
Concept membranes Biolure traps
Unbaited red croquet balls
Red croquet balls baited with apple volatiles
Unbaited black croquet balls
Black croquet balls baited with apple volatiles
Red golf balls baited with apple volatiles
Unbaited black golf balls
Ladd traps

Early in the season the AM traps with ammonium carbonate and the Ladd traps were most efficient. Late in the season the croquet balls were nearly as effective. The presence of apple volatiles had little effect on croquet ball trap effectiveness. Golf ball traps caught far fewer flies than the croquet balls. Black ball traps and red ball traps were similar in the numbers of flies caught, but the black color made it difficult to count flies.

The Biolure traps are advertised as being effective for 20 weeks. In both field and laboratory work they lasted for about 2 weeks only, during which time they performed well. Also, the yellow color faded rapidly.

The standard Pherocon trap, while somewhat less efficient than some of the other traps, was easy to use and relatively cheap. The Ladd trap was more effective, but far more expensive. Croquet balls were reasonable effective, but messy and harder to use than Pherocon traps. The possibility of using some other ammonia releasing attractant, other than ammonium acetate which is currently in Pherocon traps, should be investigated. In the above work, ammonium carbonate clearly improved Pherocon trap efficiency.

III. Stone Fruits
c. Biological control-mating disruption
1. Oriental fruit moth, peach twig borer, omnivorous leafroller

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Synthetic pheromone dispensers (Isomate-M) for the oriental fruit moth (OFM) provided by BioControl Ltd., Warwick, Queensland, Australia, were placed into eleven test plots between Arvin, Kern County, and Escalon, San Joaquin County during 1986. Two of the OFM test plots also used pheromone dispensers containing a mixture of OFM and peach twig borer (PTB) pheromones, in order to get an initial evaluation of the potential for PTB mating disruption along with OFM disruption. In addition, three test plots were treated with omnivorous leafroller (OLF) pheromone for a "firts-look" at the disruption and control potential using this pheromone system.

In general, the results of mating disruption and control of OFM larvae in fruit were quite encouraging, confirming the initial results seen from five OFM test plots in California in 1985. Disruption and shut-down of male OFM response to standard pheromone monitoring traps during 1986 was excellent. Concurrent evaluations of mating success by female OFM collected in bait traps in most cases showed marked reductions in mating during the 1st through 3rd moth flights, with some increase in mating success in late season moth collections.

Evaluations of infested fruit showed that in most cases the pheromone treatments reduced OFM damage at harvest to levels competitive with standard control programs. The effects of the Isomate treatments were especially dramatic at the Parlier and Kingsburg locations where no insecticides were applied in the conventional or check blocks.

In the two plots where the PTB pheromone was applied (Kingsburg and Parlier Fld. 24), male moth response to PTB pheromone traps was somewhat higher than expected, particularly when compared to OFM trap collections in pheromone treated blocks. Surprisingly, however, harvest fruit samples did show significant reductions of PTB infested fruit in the Isomate treatments. These results suggest that disruption and control of PTB with pheromones may have some potential; however, questions on costs compared to standard dormant sprays for PTB control still must be answered.

The first field evaluations of pheromones as a disruptant technique for OLR looked encouraging. Male OLR moths were prevented from responding to standard pheromone monitoring traps almost to the same extent as with OFM. There was a 90% reduction in fruit damage in the OLR-Isomate test plot at Parlier, but no difference in damage at the Sultana location. While these data, particularly the pheromone trap results, suggest some potential for OLR control with pheromones, serious questions regarding alternate hosts and migrations of mated females must be considered.

III Stone Fruits
d. Chemical control
Apple maggots and spider mites - Cherries

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In spite of the fact that neither the Utah State Department of Agriculture nor Utah State University can find any apples infested naturally by apple maggots in Utah, in order to ship apples to most other states we are forced into an intensive chemical control program. California, in particular, requires insecticide rates and application frequencies in excess of any IPM compatible programs. Currently, growers are allowed a choice between Guthion, Zolone and Imidan.

In order to assess the level of apple maggot control and the resultant effects on spider mite populations, 5 acres of tart cherries were treated using single tree replicates. The orchard had been heavily infested by apple maggots during 1984, but maggots had been effectively controlled during 1985. In addition to the 3 approved insecticides, Lorsban was included. The controls were sprayed with water.

All four insecticides gave almost complete control of the apple maggot and the western cherry fruit fly. Few flies occurred in control trees. Except for Zolone which reduced two-spotted spider mite numbers, the insecticides caused significant increases in mite populations.

Effects of Insecticides, Applied June 16, 1986, on Two-Spotted Mite Numbers at Mapleton, Utah in Tart Cherries. (5% significance)

Treatment	Lbs AI/Acre	Mean mites per 40 leaves		
		14 July	22 July	29 July
Guthion 50W	1.0	91.48 a	165.50 a	438.22 a
Imidan 50W	3.0	30.82 a	38.06 ab	207.51 a
Lorsban 50W	1.5	25.26 ab	19.52 ab	126.47 a
Control	---	3.50 bc	5.63 b	19.64 b
Zolone 25W	1.5	1.85 c	4.44 b	6.67 b

III. Stone fruits
d. Chemical control
1. Mountain leafhopper; cherries

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Two tests were conducted on 5-year-old 'Bing' cherry trees in a commercial orchard near Lodi, CA. Both tests were replicated 4 times in a randomized complete block design. Each replicate consisted of a single tree. Treatments in both tests were applied with a hand-held orchard sprayer operating at 270 psi and delivering 250 gal water/acre. Treatments were applied on May 15 in Test A and on Aug. 5 in Test B. Control in both tests was evaluated by caging 20 laboratory-cultured adult mountain leafhoppers (Colladonus montanus) on the foliage of treated trees. In Test A the leafhoppers were placed on the foliage for 24 h at 2-week intervals for 10 weeks after treatment. In Test B the leafhoppers were placed on the foliage for 12 h (6:00 p.m. to 6:00 a.m., to reduce leafhopper mortality in the untreated check) at 1/2, 2-1/2, 7-1/2, 14-1/2, 28-1/2 and 42-1/2 days after treatment.

In Test A, all materials tested except Diazinon caused significantly more leafhopper mortality than the untreated check for 6 weeks post treatment and gave very good control for 10 weeks post treatment. However, an increase in leafhopper mortality in the check plots prevented significant differences from occurring after week 8. The increase in check mortality is attributed to an increase in maximum daily temperature as the season progressed. Even under favorable environmental conditions, the mountain leafhopper does not survive well on cherry. Thus, in Test B leafhoppers were placed on the foliage for only 12 hours during the evening.

In Test B, all insecticides caused significantly more leafhopper mortality than the untreated check after 1/2 day post treatment while only Guthion, Pydrin and Zolone caused significantly more mortality than the check after 2-1/2 days post treatment. By 7-1/2 days post treatment the differences in mortality among Zolone, Diazinon, Thiodan and the check were not significant and evaluation of Thiodan and Diazinon was discontinued. By 42-1/2 days post treatment, only Guthion and Pydrin caused significantly more leafhopper mortality than the untreated check. No phytotoxicity associated with any treatment was observed.

Treatment and lb AI/ac	Mean* percent mortality of 20 leafhoppers caged on treated foliage: for 24 h at weeks post-treatment:				
Test A	2	4	6	8	10
Brigade 10WP, 0.10	100.0a	97.5a	97.3a	88.8a	74.0a
Asona 1.9EC, 0.08	98.8a	71.8b	97.5a	83.3a	71.3a
Pydrin 2.4EC, 0.30	94.8a	87.3ab	95.0a	94.5a	78.5a
Diazinon 50WP, 2.00	24.5b	36.5c	-	-	-
Untreated check	14.5b	45.5c	60.5b	72.3a	45.8a

	for 12 h at days post-treatment:					
Test B	1/2	2-1/2	7-1/2	14-1/2	28-1/2	42-1/2
Guthion 50WP, 1.0	86.5a	66.2b	71.9a	85.2a	62.8a	42.4a
Pydrin 2.4EC, 0.1	81.0a	82.3a	82.2a	74.5ab	46.6ab	40.4a
Zolone 3.0EC, 3.0	63.2b	52.9bc	46.7b	50.2bc	47.0ab	25.4b
Diazinon 50WP, 1.0	86.5a	39.7cd	39.9b	-	-	-
Thiodan 50WP, 1.0	63.4b	35.0d	33.0b	-	-	-
Untreated check	36.9c	31.0d	36.3b	39.4c	32.6b	20.2b

*Means followed by the same letter in a vertical column are not significantly different (P=0.05) DMRT. Data analyzed after an arcsin transformation.

III. Stone Fruits

d. Chemical control, dormant

1. Peach twig borer, San Jose scale and European red mite; peaches and almonds

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The performance of standard chemicals used for dormant treatment were evaluated at the request of farm advisors and PCAs. A fear of unsatisfactory performance plus a need to compare products due to cost relationships prompted this interest. PTB, SJS and ERM are all common pests that are treated in the dormant season.

Applications were all made in January, 1986. Each test location was standardized as closely as possible using Diazinon, Parathion, Lorsban and Supracide. A narrow range superior oil was included with most treatments. Applicatoins were made with a Kinkelder air carrier sprayer at 50 gpa and 1.8 mph.

These plots set up last winter through the aid of Farm Advisors Lonnie Hendricks and Maxwell Norton, Merced County; Joe Grant, Madera County; Rich Coviello and Mark Freeman, Fresno County; Steve Sibbett, Tulare County; and Walt Bentley and Mario Viveros, Kern County, some of which were not applied due to wet weather, gave us performance ratings for the previous mentioned materials. Although not included in the attached table, parathion (8E @ 2 lbs. aia) and Lorsban (4E @ 2 lbs. aia) plus oil showed the same degree of control as diazinon and oil. Lorsban 50W (@ 2 lbs. aia) was less effective and even further down was the half rate (3 & 4 pints) of Supracide combined with only 1 gallon of oil. The 4 pints plus 4 gallons of oil would probably be a more competitive mix (only 3 pts. + 4 gals. was tested).

1986
Dormant Spray Application
Peaches/Almonds

Material[1/]	Form	Rate/Acre	Crop		Pest % Control[2/]		
			Peach	Almond	PTB	SJS	ERM
Diazinon	50 WP	4 lbs.	X		94.6	-	97.1
+ oil		4 gals.		A	95.2	96.8	94.6
				B	86.6	-	89.8
				C	89.7	92.4	-
Supracide	2 E	1 gal.	X		97.0	-	34.4
				A	95.4	99.8	24.6
				B	87.2	-	35.0
				C	91.6	97.2	-
Supracide	2 E	2 qts.	X		84.5	-	60.1
+ oil		1 gal.		A	82.1	84.1	54.2
				B	77.4	-	46.6
				C	83.2	80.2	-
Supracide	2 E	3 pts.	X		79.1	-	57.6
+ oil		1 gal.		A	74.8	66.4	44.2
				B	78.2	-	56.2
				C	73.3	73.2	-
Supracide	2 E	3 pts.	X		86.6	-	89.4
+ oil		4 gal.		A	79.6	81.2	92.2
				B	85.8	-	85.6
				C	83.2	86.4	-

1/ Applications @ 50 gpa by air carrier sprayer.
Peaches (15 yr. Merricle Var.), Merced Co., application 1/28, counts 5/30, 4 reps. and 12 trees/rep.
Almonds (orchard A - 7 yr. Nonpareil Var.), Merced Co., application 1/29, counts 5/19, 4 reps. and 5 trees/rep.
Almonds (orchard B - 8 yr. Nonpareil Var.), Fresno Co., application 1/24, counts 4/24, 4 reps. and 12 trees/rep.
Almonds (orchard C - 6 yr. Nonpareil Var.), Kern Co., application 1/27, counts 5/21, 4 reps. and 6 trees/rep.

2/ PTB counts = shoot strikes/tree.
SJS counts = number of crawlers/6" twig.
ERM counts = number of mites/leaf.
Ave. % control as compared against check.

SECTION IV

NUTS

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Pat Weddle
Section Leader

IV. Nuts
a. Biology
1. Spider mites; almonds

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Spider mite outbreaks along roadsides in almond orchards and other crops have often been attributed to the dusty conditions that occur in these locations. A previous study has shown that water stress can result in higher leaf surface temperatures, and consequently lead to faster spider mite development times on water stressed trees. To examine the effect of water stress as a factor of spider mite outbreaks in roadside almond trees, a field study was run in July 1986 to correlate leaf surface temperatures with the water status of the trees relative to the distance from the road. Leaf surface temperatures and water status were estimated by measuring mid-afternoon leaf canopy temperatures with an infrared thermometer, and measuring predawn leaf water potentials with a pressure bomb, respectively. These measurements were taken from 5 trees per row, which were blocked across rows 1, 4, 7, 10, and 13, with row 1 being adjacent to a paved road to minimize the effect of road dust. The dust level from each tree was determined on the basis of dust weight per 40 leaf sample surface area. Since dust levels in row 1 were expected to be higher than the other rows, another tree in row 1 within each block was sprayed with water to remove dust. Measurements were taken 1, 2, 6, and 10 days after rows were flood irrigated to monitor possible differences in leaf canopy changes and leaf water potential changes over time. To determine if road dust has an immediate, short term effect on leaf canopy temperatures, one tree from each of 13 pairs of dusty roadside almond trees was sprayed with water to remove dust, and comparisons of leaf canopy temperatures, leaf water potential, and dust levels were made between the dusty and sprayed trees. Interaction between water stress and dust on leaf surface temperatures and spider mite devleopment was examined in a greenhouse study using potted almond trees. Factorial treatment combinations of water stress and nonwater stress, and dust and no dust were assigned within 5 blocks of 4 trees. Water stressed trees were maintained in a wilted state diurnally, and single leaf surface temperatures were monitored hourly on 16 of the trees using thermocouples that were connected to a datalogger. Dust was applied with a manual duster that deposited approximately 0.28 mg dust/sq cm of leaf area. Due to difficulties with the mite arenas, insufficient data was obtained on spider mite development times, however degree-hours were calculated from the leaf surface temperatures for the duration of the experiment (8 days).

Based on orthogonal regression contrasts, significant linear and quadratic trends were found among the leaf canopy temperatures and leaf water potentials relative to road distance. Initially leaf canopy temperatures in row 1 averaged about 4 degrees F higher than the other rows. While the leaf water potential of the trees indicated a slightly poorer water status in row 1 than in the other rows, the trees were not yet water stressed, thus indicating that the temperature difference may probably have been due to greater incident solar radiation, or radiated ground heat. However, as trees became more water stressed, leaf canopy temperatures began to follow the pattern of the water status of the trees. When all trees were water stressed

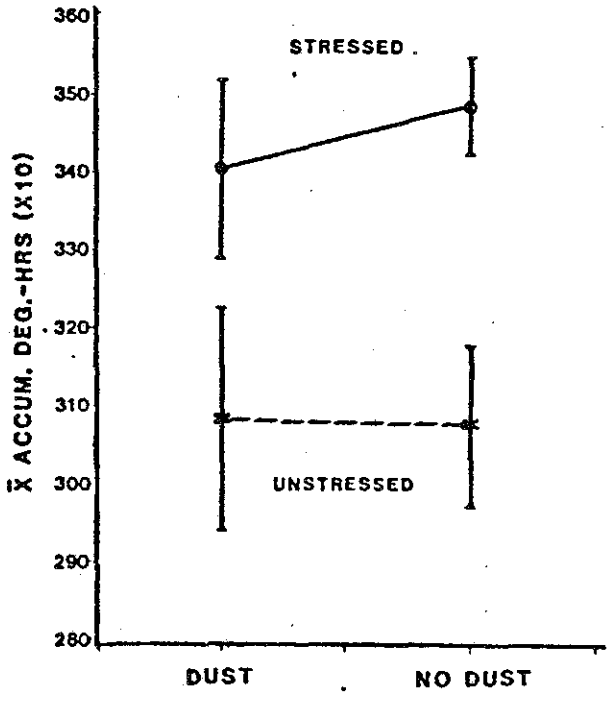
(≤14 bars), the roadside trees were only about 2 degrees F hotter than the interiorly located trees, again indicating that the roadside location was generally hotter regardless of water status. Differences in the rate of decrease in leaf water potential among the rows were not apparent. Dust levels were generally similar among rows 4 to 13. Row 1 had consistently higher dust levels, however the washed trees in row 1 had significantly lower levels than all other trees. Since leaf canopy temperatures and leaf water potentials for the washed and unwashed trees in row 1 were similar, dust at these levels did not seem to have been a confounding factor. The lack of a significant difference between washed and control trees that had much higher levels of dust provided more evidence that dust does not effect leaf surface temperatures (Table 1). Results from the greenhouse experiment showed significantly more accumulated heat units from the water stressed trees, and there was no evidence of interaction among the treatments (Fig. 1).

Table 1.

	Washed	Control
Avg. dust/leaf area (mg/sq cm)	0.113	0.877 ***
Avg. leaf water potential (bars)	-6.54	-6.45 ns
Avg. leaf canopy temperature (F)	83.4	83.4 ns

*** P<0.001 ns P>0.05
N=13 Paired t-test

Fig. 1.



IV. Nut Crops
a. Biology
1. Mirids on pistachio

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Research during 1985 on epicarp lesion and kernel necrosis led to the discovery that insects in two relatively unknown genera, Neurocolpus and Phytocoris, were closely associated with pistachios throughout California. Feeding trials with these hemipterans showed that they were capable of causing extensive damage to soft-shelled nuts. Literature searches for information on Neurocolpus and Phytocoris produced either very little information, or conflicting reports on the biology and behavior of these groups on nut crops.

I. Neurocolpus spp.

Beating tray samples for hemipterans in pistachios were initiated in early March 1986 in Kern and Fresno counties. On March 25, first instar Neurocolpus were collected from nut clusters at Tejon, Kern Co. The appearance of Neurocolpus nymphs seemed to be closely correlated to pistachio bloom. By late April, 2nd - 5th instar nymphs were present in beating tray samples, and the first adults were collected at Tejon on April 29, 1986. By mid-May, Neurocolpus nymphs were no longer present in beating samples; but adults were collected through the end of May at the Tejon orchard.

The presence of Neurocolpus nymphs in nut clusters prior to the appearance of adults indicated that Neurocolpus overwinters in the egg stage on the host plant. Review of published literature on Neurocolpus spp. confirmed this, and also suggested a variety of plants that might serve as native hosts for Neurocolpus, including wild grape, elderberry, tree tobacco, coffeeberry, and buckeye.

Beating tray and sweep net sampling, along with visual observations for Neurocolpus, was initiated on native plants in late April. These samples included buckthorn, Rhamnus spp.; Ceanothus spp.; California buckeye, Aesculus californica; poison oak, Rhus diversiloba; oak, Quercus spp.; wild grape, Vitus sp.; Acacia sp.; willow, Salix sp.; and manzanita, Arctostaphylos spp. Of native hosts sampled in 1986, Neurocolpus was collected only from California buckeye, and only from the flower clusters, not from the foliage of this plant.

Once the close association of Neurocolpus with buckeye was identified, it was relatively easy to collect large numbers of Neurocolpus nymphs and adults from locations throughout California. Collections were made in the foothill areas only 2.0-4.0 miles SE of the pistachio test plot orchard at Tejon, at Tehachapi, at Auckland, Dunlap, and Snowline Lodge east of Orange Cove, at Winters and Lake Berryessa west of Davis, and at Chico. These collections were made only during the bloom period of buckeye; as flowers dried, Neurocolpus populations on individual plants declined and disappeared. There was a predictable succession of buckeye bloom and Neurocolpus development, and flower/insect decline with increasing elevations in the Sierra Nevada foothills up to ca. 4500 ft. It was also found that Neurocolpus eggs were being laid at the base of new buds on the

current (1986) growth of buckeye twigs. There was no indication that these eggs, laid in late April to early July, hatched during 1986. Rather, they apparently diapause through the summer and winter, only to hatch the following Spring when their buckeye host blooms again.

Following these observations Neurocolpus adults were caged on pistachio twigs at Parlier between May 1 and June 6, 1986. These cagings resulted in 21 Neurocolpus eggs being laid, most of which were laid in 1985 leaf or bud scars, or at the base of 1986 lead petioles or buds.

Specimens of Neurocolpus adults and nymphs, collected from pistachio and buckeye from several locations throughout central California, have been sent to taxonomic specialists at the USDA Systematics Laboratory in Beltsville, MD. Although we are presently referring to our California specimens as Neurocolpus longirostris Knight, there is apparently some basis for believing we are actually dealing with more than one species. Cooperative studies with the USDA systematists will help clarify the species status of Neurocolpus in California.

II. Phytocoris spp.

In the 1985 annual report it was noted that Phytocoris spp. also overwinter in the egg stage on their host plants. The first collections of Phytocoris nymphs appeared in pistachio beating tray samples at Tejon on March 25, 1986, with additional collections of first-instar nymphs in Fresno County on March 28. Phytocoris collections were relatively high during April, declined to low levels in May, then increased again in June and remained at detectable levels in pistachios through mid-September (Fig. 1).

In addition to collections from pistachio, Phytocoris spp. were collected in 1986 from oak, Acacia, almonds, quince, and prunes. Thus it appears that this group of insects has a fairly wide host plant association in the Central Valley. The difficulty with this is that insect identification specialists still have not developed taxonomic keys for our closely related species of Phytocoris which would enable us to separate and identify species in the field. We are dealing with a complex of at least two, and perhaps as many as four, species of Phytocoris. At least one, but perhaps more, of these are associated with pistachio.

Phytocoris has previously been shown to cause epicarp lesion (EL) when caged on soft-shelled pistachio nuts; various literature reports on this genus also refer to them as predators on various insects and mites. Preliminary observations with Phytocoris as predators on other insects showed that they would readily attack and feed on eggs of the navel orangeworm, Amelois transitella (Walker) in the laboratory. When placed in a Petri dish with NOW eggs, adult Phytocoris would exhibit food-searching behavior by constantly probing the host surface with the tip of the rostrum (mouth-parts). When the rostrum would contact an egg, Phytocoris would almost immediately insert the stylets into the NOW egg and suck out the egg contents. This feeding process would last for 10-30 seconds on each egg. Eggs of all types were attacked - new, old, fertilized, and unfertilized. Stylet entry was usually through the laterial edge of the egg rather than directly through the top.

In one feeding test, 2 adult Phytocoris were placed into a Petri dish with 42 NOW eggs. Twenty-four hours later all these eggs had been attacked and consumed. In a second test with NOW eggs, 2 adult Phytocoris consumed

25 of 34 eggs in a 5½ hour period. Another observation in Petri dishes was made on possible hosts, using two immature Phytocoris nymphs and several mature female frosted scale attached to small pistachio twigs. The Phytocoris nymphs began probing the scale almost immediately, but were unable to penetrate the hardened scale with their stylets. Phytocoris did not attempt to probe or feed on exposed scale eggs in this test.

These observations indicate that Phytocoris spp. as suggested in literature reviews, can be and perhaps prefers to be, predaceous in its feeding behavior: they can, however, obviously feed and induce EL on small, soft pistachio nuts, but perhaps only when more preferred food (other insects) is scarce or absent. There are also indications from several insecticide trials in 1986 that reductions or control of Phytocoris populations did not necessarily lead to comparable reductions in epicarp lesion, which suggests that Phytocoris was not feeding to a great extent on nuts but was utilizing some other food source. It is apparent that the feeding behavior and food preferences of Phytocoris are very complex and require additional studies.

IV. Nuts
d. Chemical Control
1. Mites; Almonds

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Savey, Apollo and ABG6162-A at various rates plus a Standard, Vendex, were evaluated for the control of European red and Pacific mites on almonds. A four year old 24'x24' planting of Nonpariel almonds located near Kerman, Fresno County California were utilized for this test. Treatments were applied on July 2 with a handgun operated at 250 PSI. Each tree received approximately 5.5 gallons per tree which equaled approximately 400 gallons/acre. Plots consisted of 5 single-tree replicates in a randomized block design.

Treatments were evaluated by picking 20 leaves per tree at random. Samples were immediately refrigerated, returned to the laboratory and brushed using a mite brushing machine and counted under a binocular microscope.

All the treatments except ABG6162-A at the 20 and 10 g. per acre rates provided significantly better Pacific Mite control than the check 7 days after treatment. However, by day 15 no differences existed among the treatments, because the check had decreased due to the impact of predaceous mites principally Metasieulus occidentalis and the six-spotted thrips Scolothrips sexmaculatus.

European red mites were present in low numbers at the beginning of this test. All treatments except the low rate ABG6162-A were significantly better than the check 7 days after treatment. After 15 days, European red mites had also declined in the check and only the high rates of Savey, Apollo, and ABG6162-A was significantly lower than the check. Three weeks after treatment ERM was significantly higher in the ABG6162-A treatments but in very low numbers. ERM numbers remained low or missing in all treatments until approximately 7 weeks following treatment when significantly higher numbers were again present in the ABG6162-A 40 g and 20 g treatments. Eight weeks following treatment significantly higher numbers of European red mites were present in all ABG6162-A treatments with numbers increasing as the rate increased. This relationship remained throughout the time data were collected. Numbers also increased in the Vendex treatment beginning 8 weeks after treatment, and at the conclusion of the test was significantly higher than the check.

IV. Nuts
d. Chemical control
1. Carob moth, Spectrobates ceratoniae; dates

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Carob moth control on dates, 1986. Timing of the initial application, frequency and application interval of 5% malathion/50% sulfur dust on Deglet Noor date palms were tested in a date garden near Indio, California for the control of the carob moth, Spectrobates ceratoniae (Zeller). A randomized block design was used in which each single tree treatment was replicated 8 times. The dust was applied with a backpack power duster to twelve year old trees at a rate of 80 lb/ac. At the time of initial dusting the bunches had already been wrapped with brown Kraft paper which is the normal practice used to protect the bunches from the sun and rain. When the bunches are wrapped, the bottoms of the bunches are left exposed. Dusting was accomplished by placing the dusting tube in close proximity to the bottom of the bunch and removed when dust began to be expelled from the brown paper wrap. Dusting of one treatment began 11 August to simulate grower dusting practices that typically begin in mid August. The remaining treatments began 22 August with the appearance of "glossy khalal" dates that precede the development of the ripening stage, which is the susceptible stage of the sound date crop. Harvest was 13 November in which each tree was sampled by removing the lower 6 inches of 5 outside strands and 1 inside strand from each bunch of the tree. Percent infestation was based on a 200 date subsample randomly selected from the field sample for each treatment.

The dust application 11 August was not necessary as the date stage present in early to mid August was not susceptible to carob moth infestation. Two factors, rain and high humidity, can turn this normally nonsusceptible date stage into an important substrate for carob moth development. This date garden received little if any rainfall this year, thus this date stage was not affected. The remaining treatments all began just prior to the ripening stage of the date crop in late August when the dates become susceptible to the moth. Three applications of the dust provided equivalent control of the carob moth when compared to the treatments of 4 and 5 total applications. No differences were indicated between the two treatments receiving a total of 3 applications. The slight though insignificant increase in the 4 week interval treatment was due to a high infestation in one replicate. Three applications of 5% malathion/50% sulfur dust at 4 week intervals beginning prior to the ripening stage provides adequate control of the moth in years with little or no rainfall.

Mean Percent Date Infestation by the Carob Moth Following Different Treatments of 5% Malathion/50% Sulfur Dust.

Treatment [a]	Application	Treatment date	Percent infestation [b,c,d]
1. 5% malathion/50% sulfur	2 weeks	8/11, 8/22, 9/5, 9/19, 10/4	0.3b
2. 5% malathion/50% sulfur	2 weeks	8/22, 9/5, 9/19, 10/4	0.3b
3. 5% malathion/50% sulfur	3 weeks	8/22, 9/12, 10/4	0.3b
4. 5% malathion/50% sulfur	4 weeks	8/22, 9/19, 10/17	1.6b
5. 5% malathion/50% sulfur	-	8/22	6.7a
6. Control	-	-	5.1a

a. 80 lb/acre
b. Means are based on 8 replicates of 200 dates/tree.
c. Harvest 13 August
d. Means shown are untransformed data. Means were transformed by arcsine transformation and used in Duncan's NMRT. Means followed by the same letter are not signifiicantly different at the P=0.05 level.

Section IV Nuts

d. Chemical Control

FILBERTWORM CONTROL - FILBERTS (HAZELNUTS)

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Six insecticides were screened for efficacy against filbertworm in an abandoned orchard. A completely randomized design with three single tree replications was used. Tree spacing was 20 x 20 ft. Tree age was approximately 40 years. The main variety was Barcelona; the pollinizer was Daviana. Adjuvants were not used. Treatments were applied with either an Amerind McKissick or Bean sprayer with a handgun attachment using 2 gallons of water per tree (ca. 218 gallons per acre). Pretreatment monitoring of filbert nut development, weather, and adult flight activity of filbertworm were used to time insecticide applications. Pheromone trap data from the orchard indicated flight activity began June 13 with double peak flight activities occuring on approximately July 11 and August 4.

Insecticide applications were made on June 19, July 11 and August 4, 1986. Although moth flight continued following the third application, we chose not to apply a fourth spray. This was done to evaluate the experimental insecticides under a "heavy pressure" situation. Samples consisting of 100 nuts per tree were collected by randomly picking nuts from branches on September 3, 1986. These were inspected for (1) internal filbertworms, and (2) external tracking by larvae.

The synthetic pyrethroids were the statistically superior treatments for worm control. However, all treatments would have been docked for the presence of filbertworm. Pydrin (0.2 lbs. ai/A) and Asana (0.05 lbs. ai/A) treated nuts would have escaped a sorting charge at the processor.

FILBERTWORM CONTROL 1986 (Albany, Linn Co. OR)

Treatment and lbs. ai/A	Average for 100 Nuts Inspected/Rep.	
	External[2/]	Worms[1/]
1. UTC	76.00 a	50.33 a [3/]
2. Dimilin 25W (0.05)	28.00 b	19.33 b
3. Dimilin 25W (1.0)	30.33 b	15.33 bc
4. Lorsban 50W (1.5)	17.33 cd	13.67 bc
5. Lorsban 4EC (1.5)	21.67 bc	12.33 cd
6. Ambush 2EC (0.1)	10.67 def	10.00 cd
7. Brigade 10WP (0.04)	4.00 f	9.67 cd
8. Ambush 25W (0.1)	11.00 def	7.00 de
9. Pydrin 2.4 EC (0.1)	10.33 def	3.00 e
10. Ambush 2EC (0.2)	6.33 def	3.00 e
11. Brigade 10WP (0.06)	4.67 f	2.00 e
12. Ambush 25W (0.2)	3.33 f	1.33 e
13. Asana 1.9EC (0.025)	4.67 f	1.00 e
14. Brigade 10WP (0.04)	4.00 f	1.00 e
15. Pydrin 2.4EC (0.2)	3.33 f	0.67 e
16. Asana 1.9EC (0.05)	4.67 f	0.67 e

1/ 3 reps

2/ Presence of feeding under the husk.

3/ Means with same letter are not significantly (P<.05) different. Means compared with FPLSD.

IV. Nut Crops
d. Chemical control
1. Citrus flat mite, pistachio

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In 1985, data from several insecticide test plots in which a formulation of permethrin was used (Pounce EC) indicated that this material was having a controlling effect on populations of the citrus flat mite, Brevipalpus lewisi. The plots in 1985 were evaluated by counting and comparing damaged nut clusters in the various chemical treatments and untreated checks (see 1985 Annual Report).

In a further evaluation of the 1985 results, a test plot using five formulations of permethrin was established at Dudley Ridge Farms near Kettleman City. The insecticides (Table 1) were applied on June 11, 1986 using handgun equipment at 400 gpa and 250 psi.

Table 1. Effect of permethrin formulations on populations of citrus flat mite, Brevipalpus lewisi, on pistachio nut clusters. Dudley Ridge, Kern County, 1986.

Treatment	A. I. per Acre	Avg. No. 1/ mites per rep.	
FMC Peach Flowable	Pounce 0.4 lb. Sulfur 24.0 lbs.	3.3	a
Pounce EC	0.4 lb.	50.6	b
Ambush WP	0.4 lb.	56.7	b
Ambush EC	0.4 lb.	68.3	b
Check	-	98.7	b
Pounce WP	0.4 lb.	119.7	b

1/ 5 reps per treatment, 3 trees per rep. Sprayed by handgun on June 11, 1986. 10 nut clusters per rep washed, and mites counted on Sept. 2, 1986. Means followed by the same letter are not significantly different at p.=.05, Duncans New Multiple Range Test.

Five 3-tree replicates were treated per insecticide formulation. On September 2, 1986, ten nut clusters per replicate were picked at random (disregarding obvious rachis damage) and washed in 200 ml of a 1.0% Toximul solution to remove the mites from the nuts and rachis. After washing with agitation for 2 minutes, the solution was filtered through filter paper in a Büchner funnel and vacuum

flask apparatus. Mites washed from the nuts and retained on the filter paper were then counted with a binocular microscope.

The results of this experiment (Table 1) showed that FMC Pounce Peach Flowable EC gave very good control of citrus flat mite. This material is formulated as an insecticide-fungicide with 0.1 lb. a.i. permethrin and 6.0 lbs. a.i. sulfur per gallon. In comparison to the other permethrin formulations in this test, it is apparent that the sulfur in the Pounce Peach Flowable material provided the major controlling factor against flat mite.

The other four permethrin formulations in this test showed varying numerical levels of flat mite compared to the untreated check; none of these treatments were statistically different from the check.

Although the Pounce EC formulation did show an approximate 50% reduction in flat mite populations compared to the check, the effect was not nearly as dramatic as suggested by the 1985 data.

IV. Nut Crops
d. Chemical control
1. Scale insects, pistachio

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Lecanium scale:

With the greatly increased use of insecticide in 1985-86 to control sucking bugs, pistachio growers have experienced dramatic increases in scale insect populations. These scale build-ups, which are believed to be primarily due to loss of predators and parasites which formerly held the scale populations in check, have been observed in all pistachio producing districts, particularly where early season and/or multiple applications of insecticides have been used.

The scale species involved are predominantly soft scales in the genus Lecanium, family Coccidae. The common European fruit lecanium, L. corni Bouché, and the frosted scale, L. pruinosum Coq., have been the species most often found on pistachios, along with occasional collections of the black scale, Saissetia oleae, and the latania scale, Aspidiotus lataniae. There have been several observations that male pistachio trees appear to be more heavily infested with Lecanium scale than female trees.

Observations of scale development and crawler emergence in 1986 were made on a mixed population of the two lecanium species in a heavily infested pistachio orchard near Chowchilla. The overwintered immature scales began to harden and form their protective covers in February and March. The first emerging crawler was collected on sticky tape traps on May 6, followed by rapidly increasing collections which peaked between May 20-27. The orchard was treated with carbaryl in early June which reduced scale crawler collections by ca. 90%. However, crawlers continued to emerge at low levels until the first week in August.

An insecticide test plot has been established in Madera County to evaluate several materials for scale control. Insecticides included in this plot are two rates of a narrow range oil, one carbamate and three organo-phosphate insecticides, and several combinations of oil and insecticide. A post-harvest series of treatments was applied in early November; a second series of treatments was applied as full dormant sprays in January. The plots will be evaluated on the basis of crawler emergence in the spring of 1987.

MISCELLANEOUS

ABG-6162 1.5% EC
common name: thuringiensin
source: Abbott Laboratories, Agricultural and Veterinary Products Division, Sheridan Road, North Chicago, IL 60064
composition: extract of Bacillus thuringiensis containing B-exotoxin

Avid .15 lb/gal EC
common name: avermectin B^1
source: Merck, Sharpe & Dohme, P. O. Box 2000, Rahway, NJ 07065
composition: ((2aE,4E,5'S,6S,6'R,7S,8E,11R,13R,15S,17aR,20R20aR,20bS)-6'-((R)-sec-Butyl)-7-((2,6-dideoxy-4-O-2,6-dideoxy-3-O-methyl--L-arabino-hexopyranosyl)-3-O-methyl- -L-arabino-hexopyranosyl)oxy)-5'6,6',7,10,11,14,15,17a,20,20a,20b-dodecanydro-20,20b-dihydroxy-5,6,8,19-tetramethylspiro (11,16-methano-2H,13H,17H-furo(4,3,2-pg)(2,6) benzodioxacyclooctadecin-13,2'-(2H)pyran)-17-one)

CGA 45128 10% EC
common name: none
source: CIBA-GEIGY, P. O. Box 11422, Greensboro, NC 17409
composition: undisclosed

CME 13406
common name: none
source: EM Industries, Plant Protection Division, 5 Skyline Drive, Hawthorne, NY 10532
composition: 1-(3,5-Dichloro-2,4-difluorophenyl)-3-(2,6-difluorobenzoyl)-urea

Dimilin 25% WP
common name: diflubenzuron
source: Uniroyal Chemical, 75 Amity Road, Bethany, CT 06525
composition: (N-[[(4-chlorophenyl)amino]carbaryl]2,6-difluorobenzamide)

Insegar 25% WP
common name: fenoxycarb
source: MAAG Agrochemicals, Research and Development, HLR Sciences, Inc., King's Highway, P. O. Box X, Vero Beach, FL 32960
composition: Ethyl[2-(phenoxyphenyl)ethyl] carbamate

PH 70-23 10% EC
common name: none
source: Duphar B.V., Crop Protection Division, Boekesteyn, Noordereinde 56, P. O Box 4, 1243 IG'S, Graveland, Holland
composition: undisclosed

SD 115110 .4 lb/gal EC
common name: none
source: Shell Development Company, P. O. Box 4248, Modesto, CA 95352. Now a part of DuPont, E.I. du Nemours, Inc., 1007 Market Street, Wilmington, DE 19898
composition: undisclosed