Project Number: 91-C14

**Annual Report, 1991**
**Almond Board of California**

**Insect and Mite Research**

Project Leader: Frank G. Zalom
Dept. of Entomology
Univ. of California
Davis, CA 95616

Cooperating Personnel: William Barnett and Walt Bentley as (CoInvestigators), J. Edstrom, J. Connell, W. Reil, C. Pickel, W. Krueger, J. Hasey, R. Beede, S. Sibbett, M. Freeman, R. Coviello, J. Grant, L. Hendricks, W. Asai

Objectives:

1. Purchase pheromone traps and lures, and other monitoring supplies for Farm Advisors as part of their ongoing monitoring efforts.

2a. Conduct a research trial to compare several dormant applications and bloom applications to control peach twig borer.

2b. Conduct large field trials to refine and validate 1990 research results which strongly suggest that *Bacillus thuringiensis (Bt)* applied during bloom can control peach twig borer.

2c. Document the impact of eliminating dormant sprays of oil and organophosphates on other pest and beneficial insects.

3a. Conduct large field trials to validate the potential of tree banding as a control for spider mites.

3b. Determine areas outside of Kern County where the banding technique might be applicable.

Plans and Procedures:

Objective 1. As in prior years, this project purchased pheromone traps and lures, and other monitoring supplies for Farm Advisors who requested them as part of their ongoing monitoring efforts. Traps were placed in 8 counties, and over 100 traps, 300 trap liners and 800 lures were purchased for this activity. The data from these plots are collected at the end of the season and assembled at Davis where they become part of an ongoing database of trapping information.

Objective 2. A replicated field trial was conducted by John Edstrom at the Nickels Estate in Colusa County to compare treatment timings of the *Bt* product Javelin,

Project Number: 91-C14

91-C14



**Annual Report, 1991**
**Almond Board of California**

**Insect and Mite Research**

Project Leader: Frank G. Zalom
Dept. of Entomology
Univ. of California
Davis, CA 95616

Cooperating Personnel: William Barnett and Walt Bentley as (CoInvestigators), J. Edstrom, J. Connell, W. Reil, C. Pickel, W. Krueger, J. Hasey, R. Beede, S. Sibbett, M. Freeman, R. Coviello, J. Grant, L. Hendricks, W. Asai

Objectives:

1. Purchase pheromone traps and lures, and other monitoring supplies for Farm Advisors as part of their ongoing monitoring efforts.

2a. Conduct a research trial to compare several dormant applications and bloom applications to control peach twig borer.

2b. Conduct large field trials to refine and validate 1990 research results which strongly suggest that *Bacillus thuringiensis (Bt)* applied during bloom can control peach twig borer.

2c. Document the impact of eliminating dormant sprays of oil and organophosphates on other pest and beneficial insects.

3a. Conduct large field trials to validate the potential of tree banding as a control for spider mites.

3b. Determine areas outside of Kern County where the banding technique might be applicable.

Plans and Procedures:

Objective 1. As in prior years, this project purchased pheromone traps and lures, and other monitoring supplies for Farm Advisors who requested them as part of their ongoing monitoring efforts. Traps were placed in 8 counties, and over 100 traps, 300 trap liners and 800 lures were purchased for this activity. The data from these plots are collected at the end of the season and assembled at Davis where they become part of an ongoing database of trapping information.

Objective 2. A replicated field trial was conducted by John Edstrom at the Nickel's Estate in Colusa County to compare treatment timings of the *Bt* product Javelin,

other *Bt* products applied at both popcorn stage and petal fall (the timing we consider to be optimum from preliminary data), late dormant and delayed dormant applications of carbaryl, and conventional dormant treatments. Efficacy was determined by counting twig strikes in the spring. As in prior trials to determine optimum *Bt* treatment timing, the popcorn plus petal fall application gave the most consistent results with a single application at petal fall also working well (Table 1). Javelin applied 3 times during this period was the best treatment of all. There was no significant difference between any of the treatment timings. Most *Bt* products gave roughly equivalent control to that obtained from the dormant treatments, and no significant difference in shhot strikes was noted (Table 2). Both dibrom and carbaryl (Sevin XLR) applications also gave good control (Table 3), and neither of these materials are currently under regulatory scrutiny with regard to red-tail hawks. It was especially interesting that carbaryl at both treatment timings gave good control of peach twig borer as many of us did not expect carbaryl residue to be present long enough to permit a late January treatment. The presence of residue during bloom, when most of the twig borers would contact the material, was confirmed by residue analysis conducted by Dr. Michael Stimmann.

Walt Bentley and Mario Viveros also conducted a replicated trial of various dormant, delayed dormant and bloom treatments for control of peach twig borer. All treatments significantly reduced twig strikes relative to the untreated control (Tables 4 and 5), however the organophosphate plus oil treatments generally gave the highest level of control in this trial. The diazinon plus oil treatment and the dibrom plus oil treatments gave significantly better control than the single applications of *Bt* without oil during bloom. Ambush also gave a high level of control, but we are cautious in recommending this pyrethroid because of past negative experiences with spider mites on permethrin treated trees. More research would need to be conducted to determine if a dormant treatment with this material would be safe with regard to spider mites.

The Yolo County trial conducted by Wilbur Reil was a replicated trial that was part of the large plot evaluation of an organophosphate and oil dormant spray, and oil alone control treatment, and *Bt* and oil bloom sprays which was conducted without replication in six other counties. This trial also included a treatment with carbaryl plus oil and with all of the previously mentioned treatments in the absence of oil. The plot was evaluated by counting shoot strikes and by determining damage by peach twig borer, navel orangeworm and total worms combined at harvest. No difference was observed when evaluated by percent damaged nuts (Table 6), but significant differences were observed when analysis was conducted on percentage reduction in damage where the untreated control was set to 0. The carbaryl treatment provided equivalent control to that of the Bt plus oil treatment, and both treatments were not significantly different from the dormant organophosphate plus oil treatment. A significant difference was observed between treatments with oil and without oil when analyzed as a split plot (Table 7), indicating that oil alone had an effect on twig borer.

The large field trials were coordinated by Bill Barnett and Carolyn Pickel, and involved Farm Advisors in 7 counties. Oil without an organophosphate insecticide was applied to a minimum of 12 rows at the time the dormant treatments were applied to the remainder of the orchard. The 12 rows receiving the oil alone were treated at popcorn and again at between full bloom and the beginning of petal fall with label rates of *Bt*. The *Bt* applications were combined with disease treatments when appropriate.

Peach twig borer was monitored with pheromone traps, shoot strikes of overwintering generation larvae and/or first generation larvae, and by determining damage at harvest. Effect on nontarget species including navel orangeworm (damage at harvest), navel orangeworm parasitism (mummy nut and harvest samples), mites (leaf sampling) and San Jose scale (branch samples) were also evaluated. Treatments at each location included oil without an organophosphate insecticide applied at the time the dormant treatments are applied to the remainder of the orchard, the conventional oil plus organophosphate dormant spray, and oil applied in the dormant period plus label rates of Bt treated at popcorn and again at between full bloom and the beginning of petal fall. The Bt treatments appear to have worked fairly well at 4 of the 7 sites (Tables 8 and 9). Of the 3 remaining sites, neither the conventional dormant treatment nor the Bt treatment worked well at one location, the application methodology utilized for both treatments was suspect at another (split treatments were applied in Glenn County), and the level of peach twig borer damage was extremely low at the third (Yolo County). Because of variability in damage between orchards when data from all orchards were combined, no significant difference was observed between treatments (Table 10). However, significant differences were observed for peach twig borer when analysis was conducted on percentage reduction in damage where the untreated control was set to 0 (Table 11). Both the Bt plus oil and the conventional dormant treatment provided a significant level of control (Table 12). Although not significant, both the dormant and bloom treatments also appeared to provide some control of navel orangeworm. Although a direct effect of the treatment is unlikely, this could indicate that some of the navel orangeworm damage was observed in nuts that had been previously damaged by peach twig borer. No secondary effects from any of the treatments were seen on other pests such as spider mites, San Jose scales, or on predator mites (Table 13). Similarly, the cumulative number of peach twig borer male moths captured in the pheromone traps could not be correlated to shoot strikes or to damage at harvest.

This research is part of a much larger effort being coordinated by Bill Barnett, and also funded by the Cling Peach and Prune Advisory Boards and the Tree Fruit Agreement and we hope to continue the project for 2 additional years to help document the impact of eliminating the dormant sprays.

Objective 3. Walt Bentley and Mario Viveros conducted trials in one orchard in 1990 and three orchards in 1991 to determine the potential of excluding mites from trees by banding trees in February with duct tape covered with Tanglefoot. The

three 1991 trials consisted of two or three acres of trees (about 150-200 trees), anf these were not treated with an acaricide. Weekly sampling was initiated after leaves were present on the trees on six banded trees selected at random from different tree rows. Six additional trees (one from each of the same tree rows) chosen at random did not receive sticky bands, and were also sampled weekly for mites. From each sample tree in each orchard, ten leaves were selected at each of three heights (3', 6', and 9', thirty leaves total) beginning in March and continuing through August, and the number of spider mites and beneficial mites were counted. Significant differences were observed between treatments in 1990 (Figures 1 and 2). In 1991, differences were only observed in one orchard (Figures 3 and 4). The early season rains resulted in very low initial levels of spider mites in all trees, and the bands appeared to be excluding the mites but low populations masked any differences particularly early in the season. As mites began increasing again later in the spring, lower populations were generally observed on the banded trees.

The preliminary results obtained by Bentley and Viveros in 1990 were for Pacific spider mite, the predominant species in Kern County. Therefore, it is not possible to determine the potential for excluding mites from trees in areas where another spider mite species is dominant, or under different groundcover strategies. We proposed to place sections of black 2" PVC pipe ringed with Tanglefoot upright in at least eight orchards from Kern County to the Sacramento Valley to determine if and when mite movement occurs from the ground onto the trees. Six sections of pipe were provided to Farm Advisors in the counties, and they placed the pipes in tree rows in each orchard. This method of detection did not work as well as we had hoped in part because mite populations were generally low.

Additional Work: In both 1990 and 1991, we worked with Barry Wison, Bill Steinke and Jim Seiber on the large plots where different spray equipment was tested to determine the potential for reducing drift and impact on the red tailed hawk, however we did not ask for funding support from that project and travel, supplies and other expenses were taken from this project. We were responsible for determining the efficacy of the treatments on insect control. The results of this trial are presented in the report submitted by Barry Wilson.

**1991 Almond Peach Twig Borer Research**
**Nickel's Estate - Colusa Co.**
**($\bar{x}$ Twig Strikes/Tree)**

| | | |
|---|---|---|
| Untreated | 9.429 | A |
| Javelin - Budswell | 6.286 | B |
| Javelin - Petal fall | 1.286 | B |
| Javelin - Popcorn+Petal fall | 1.143 | B |
| Javelin - Petal fall | 0.714 | B |
| Javelin - Popcorn+Petal fall +Petal fall (+2 wks) | 0.000 | B |
| Diazinon - Dormant | 0.429 | B |

**1991 Almond Peach Twig Borer Research**
**Nickel's Estate - Colusa Co.**
**Popcorn and Petal Fall Timing**
**($\bar{x}$ Twig Strikes/Tree)**

| | | |
|---|---|---|
| Untreated | 9.431 | A |
| MVP - 1 qt./100 gal. | 2.429 | B |
| Javelin - 0.5 lb./100 gal. | 1.286 | B |
| Javelin - 0.25 lb./100 gal. | 1.143 | B |
| Dipel - 0.5 lb./100 gal. | 0.429 | B |
| Biobit - 0.67 lb./100 gal. | 0.143 | B |
| Diazinon - 1 lb./100 gal. | 0.429 | B |

**1991 Almond Peach Twig Borer Research**
**Nickel's Estate - Colusa Co.**
**($\bar{x}$ Twig Strikes/Tree)**

| | | |
|---|---|---|
| Untreated | 9.431 | A |
| Dibrom - 16 oz./100 gal. - Dormant | 0.714 | B |
| Sevin XLR - 1 qt./100 gal. - 1/24 | 0.571 | B |
| Sevin - 1 qt./100 gal. - 2/6 | 0.429 | B |
| Diazinon - 1 lb./100 gal. - Dormant | 0.429 | B |
| Dibrom - 12 oz./100 gal. - Dormant | 0.286 | B |

## PEACH TWIG BORER CONTROL
## KERN CO., 1991, SHOOT STRIKES

| TREATMENT [1] | STRIKES PER TREE | |
|---|---|---|
| DIAZINON 500 (1.5 pts) | 1.4 (1.1) | a |
| DIBROM 8E (.75 pts) | 1.8 (1.3) | a |
| DIBROM 8E (.50 pts) | 2.0 (2.4) | a |
| AMBUSH (6.4 oz) | 2.2 (2.2) | a |
| LORSBAN 4E (1 pt) | 3.0 (2.6) | ab |
| IMIDAN 50W (1 lb) | 3.6 (1.9) | ab |
| JAVELIN (1.25 lb), 2/23 & 3/8 | 5.0 (2.4) | ab |
| SEVIN 80S (1.25 lb) | 6.4 (4.5) | ab |
| JAVELIN (1.25 lb), 3/8 | 6.6 (3.2) | b |
| JAVELIN (1.25 lb), 2/22 | 6.8 (3.8) | b |
| UNTREATED | 20.4 (7.8) | c |

[1] All with 2 gal oil; all rates per 100 gal.

## PEACH TWIG BORER CONTROL
## KERN CO., 1991, PERCENT REDUCTION
## IN SHOOT STRIKES

| TREATMENT [1] | % (SD) OF CONTROL | |
|---|---|---|
| DIAZINON 500 (1.5 pt) | 91.9 ( 9.7) | a |
| DIBROM 8E (.75 pts) | 89.8 ( 8.2) | a |
| DIBROM 8E (.50 pts) | 87.4 (16.8) | ab |
| AMBUSH (6.4 oz) | 86.2 (15.6) | ab |
| LORSBAN 4E (1 pt) | 85.1 (10.0) | abc |
| IMIDAN 50W (1 lb) | 82.9 ( 7.0) | abcd |
| JAVELIN (1.25 lb), 2/23 & 3/8 | 74.3 (12.1) | abcd |
| SEVIN 80S, (1.25 lb) | 67.6 (26.8) | bcd |
| JAVELIN (1.25 lb), 3/8 | 64.6 (22.0) | cd |
| JAVELIN (1.25 lb), 2/22 | 64.3 (22.4) | d |
| UNTREATED | 0.0 ( 0.0) | e |

[1] All with 2 gal oil; all rates per 100 gal.

**BLOOM AND DORMANT TREATMENT**
**PEACH TWIG BORER DAMAGE AT HARVEST**
**YOLO COUNTY**

| | PERCENT (SD) DAMAGE | | |
|---|---|---|---|
| TREATMENT | PTB [1] | NOW [2] | TOTAL [3] |
| Javelin | 0.258 | 0.555 | 0.813 |
| Javelin + OIL | 0.229 | 0.551 | 0.780 |
| Sevin XLR | 0.192 | 0.913 | 1.105 |
| Sevin + OIL | 0.267 | 0.313 | 0.580 |
| Diazinon 50W | 0.312 | 0.557 | 0.869 |
| Diazinon + OIL | 0.447 | 0.695 | 1.142 |
| OIL | 0.157 | 0.490 | 0.647 |
| Untreated | 0.083 | 0.806 | 0.889 |

[1] F=1.480, p=0.2432
[2] F=0.646, p=0.7123
[3] F=0.497, p=0.8231

**BLOOM AND DORMANT TREATMENT**
**PEACH TWIG BORER TWIG STRIKES 4/12/91**
**YOLO COUNTY**

| TREATMENT | STRIKES PER TREE[1] OIL [2] | NO OIL |
|---|---|---|
| Javelin, 1 lb. 2/23 + 3/9 | 9.3 ab | 16.0 bc |
| Sevin XLR, 2.9 qt. 2/9 | 7.0 ab | 8.0 ab |
| Diazinon 50W, 5 lb. 2/10 | 1.3 a | 5.3 ab |
| Untreated | 23.0 c | 47.0 d |

[1] means followed by same letter do not differ significantly by DMRT ($p<0.05$).
[2] 4 gal./acre applied 2/10.

**BLOOM AND DORMANT TREATMENT**
**PEACH TWIG BORER SHOOT STRIKES**

| COUNTY | TREATMENT | OVERWINTER GENERATION | 1ST SUMMER GENERATION |
|---|---|---|---|
| BUTTE | Bt + OIL | -- | 5.6 (46%) |
| | DORMANT | -- | 6.8 (23%) |
| | CHECK | -- | 8.8 ( 0%) |
| COLUSA | Bt + OIL | -- | 17.8 ( 0%) |
| | DORMANT | -- | 6.8 (35%) |
| | CHECK | -- | 16.5 ( 0%) |
| FRESNO | Bt + OIL | 13.2 (52%) | -- |
| | DORMANT | 5.2 (81%) | -- |
| | CHECK | 26.8 ( 0%) | -- |
| GLENN | Bt + OIL | 4.2 (78%) | 14.5 ( 0%) |
| | DORMANT | 13.4 (31%) | 11.5 (13%) |
| | CHECK | 19.5 ( 0%) | 13.2 ( 0%) |
| KINGS | Bt + OIL | 2.9 (37%) | 4.0 (52%) |
| | DORMANT | 0.1 (98%) | 1.7 (80%) |
| | CHECK | 4.6 ( 0%) | 8.4 ( 0%) |
| MADERA | Bt + OIL | 0.3 (93%) | 3.7 (75%) |
| | DORMANT | 0.2 (95%) | 2.5 (83%) |
| | CHECK | 4.3 ( 0%) | 15.0 ( 0%) |
| YOLO | Bt + OIL | 9.3 (61%) | -- |
| | DORMANT | 1.3 (94%) | -- |
| | CHECK | 23.0 ( 0%) | -- |

## BLOOM AND DORMANT TREATMENT
## PEACH TWIG BORER DAMAGE AT HARVEST

| COUNTY | TREATMENT | PERCENT DAMAGE PTB | NOW | TOTAL |
|---|---|---|---|---|
| BUTTE | Bt + OIL | 0.30 | 0.10 | 0.40 |
| | DORMANT | 0.81 | 0.08 | 0.89 |
| | CHECK | 1.48 | 0.15 | 1.63 |
| COLUSA | Bt + OIL | 0.10 | 2.80 | 2.90 |
| | DORMANT | 1.00 | 3.20 | 4.20 |
| | CHECK | 0.30 | 1.70 | 2.00 |
| FRESNO | Bt + OIL | 2.40 | 0.30 | 2.70 |
| | DORMANT | 1.20 | 0.10 | 1.30 |
| | CHECK | 2.70 | 0.00 | 2.70 |
| GLENN | Bt + OIL | 2.70 | 0.00 | 2.70 |
| | DORMANT | 2.40 | 0.00 | 2.40 |
| | CHECK | 2.90 | 0.00 | 2.90 |
| KINGS | Bt + OIL | 0.80 | 2.30 | 3.10 |
| | DORMANT | 1.40 | 2.80 | 4.20 |
| | CHECK | 3.20 | 1.40 | 4.60 |
| MADERA | Bt + OIL | 0.20 | 0.20 | 0.40 |
| | DORMANT | 0.00 | 0.30 | 0.30 |
| | CHECK | 1.10 | 0.70 | 1.80 |
| YOLO | Bt + OIL | 0.23 | 0.55 | 0.78 |
| | DORMANT | 0.45 | 0.70 | 1.15 |
| | CHECK | 0.17 | 0.49 | 0.66 |

**BLOOM AND DORMANT TREATMENT**
**PEACH TWIG BORER DAMAGE AT HARVEST**
**ALL ORCHARDS COMBINED**

| | PERCENT (SD) DAMAGE | | |
|---|---|---|---|
| TREATMENT | PTB | NOW | TOTAL |
| Bt + OIL | 0.97 (1.11) | 0.89 (1.15) | 1.86 (1.25) |
| DORMANT | 1.04 (0.76) | 1.03 (1.37) | 2.06 (1.59) |
| CONTROL | 1.70 (1.25) | 0.63 (0.68) | 2.33 (1.25) |

**BLOOM AND DORMANT TREATMENT**
**PEACH TWIG BORER, ANOVA STATISTICS**
**FOR PERCENT REDUCTION IN DAMAGE**
**ALL ORCHARDS COMBINED**

| | PERCENT (SD) OF CONTROL | |
|---|---|---|
| PEST | F-test | p |
| PTB | 4.721 | 0.023 |
| NOW | 1.850 | 0.186 |
| TOTAL | 2.535 | 0.107 |

**BLOOM AND DORMANT TREATMENT**
**PEACH TWIG BORER, PERCENT REDUCTION**
**IN DAMAGE FOR ALL ORCHARDS COMBINED**

| | PERCENT (SD) OF CONTROL | | |
|---|---|---|---|
| TREATMENT | PTB | NOW | TOTAL |
| Bt + OIL | 45.89 (37.75) a | 24.49 (32.81) a | 27.54 (35.47) a |
| DORMANT | 39.19 (36.16) a | 14.83 (25.51) a | 29.50 (31.55) a |
| CONTROL | 0.00 (00.00) b | 0.00 (00.00) a | 0.00 (00.00) a |

means in columns followed by the same letter are not significantly different by Fisher PLSD ($p<0.05$).

## BLOOM AND DORMANT TREATMENTS FOR PEACH TWIG BORER, MITES PER LEAF (Late July/ Early August Sample)

| COUNTY | TREATMENT | ERM | 2 SPOT | Pred. |
|---|---|---|---|---|
| BUTTE | Bt + OIL | 0.10 | 0.00 | 0.10 |
| | DORMANT | 0.10 | 0.00 | 0.10 |
| | CHECK | 0.00 | 0.10 | 0.10 |
| COLUSA | Bt + OIL | 0.10 | 9.90 | |
| | DORMANT | 0.10 | 1.00 | |
| | CHECK | 0.00 | 26.00 | |
| FRESNO | Bt + OIL | 0.10 | 0.30 | 0.10 |
| | DORMANT | 0.00 | 0.10 | 0.10 |
| | CHECK | 0.00 | 0.10 | 0.10 |
| GLENN | Bt + OIL | 0.00 | 0.00 | 0.10 |
| | DORMANT | 0.00 | 0.00 | 0.10 |
| | CHECK | 0.00 | 0.00 | 0.10 |
| KINGS | Bt + OIL | 3.36 | 0.10 | 0.00 |
| | DORMANT | 3.00 | 0.00 | 0.00 |
| | CHECK | 2.80 | 0.10 | 0.00 |
| MADERA | Bt + OIL | 0.00 | 0.00 | 0.00 |
| | DORMANT | 0.00 | 0.00 | 0.00 |
| | CHECK | 0.00 | 0.00 | 0.00 |
| YOLO | Bt + OIL | 0.00 | 8.31 | 0.01 |
| | DORMANT | 0.00 | 5.15 | 0.01 |
| | CHECK | 0.00 | 4.39 | 0.07 |

Figure 1

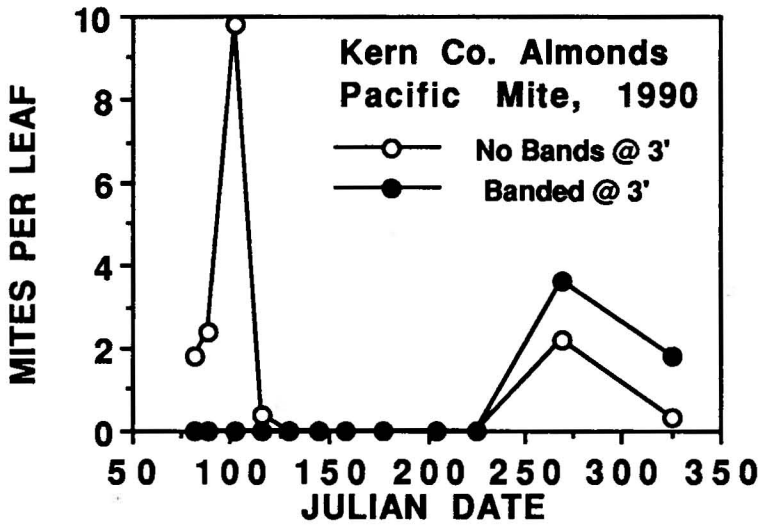
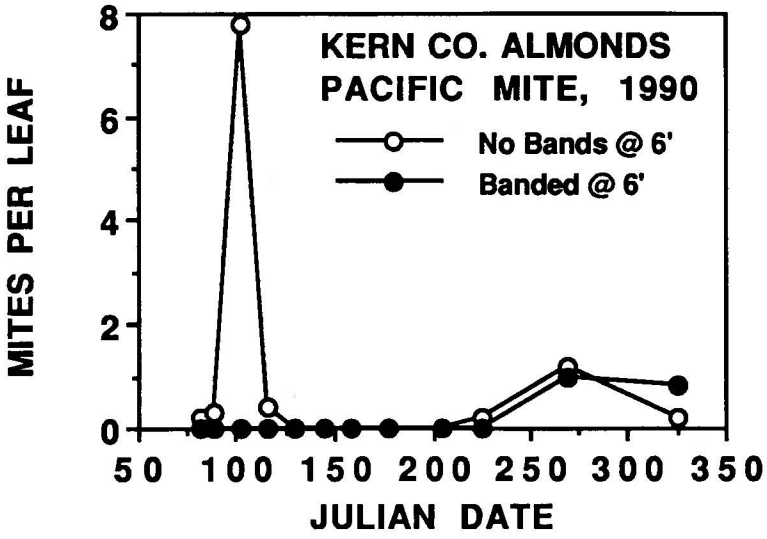
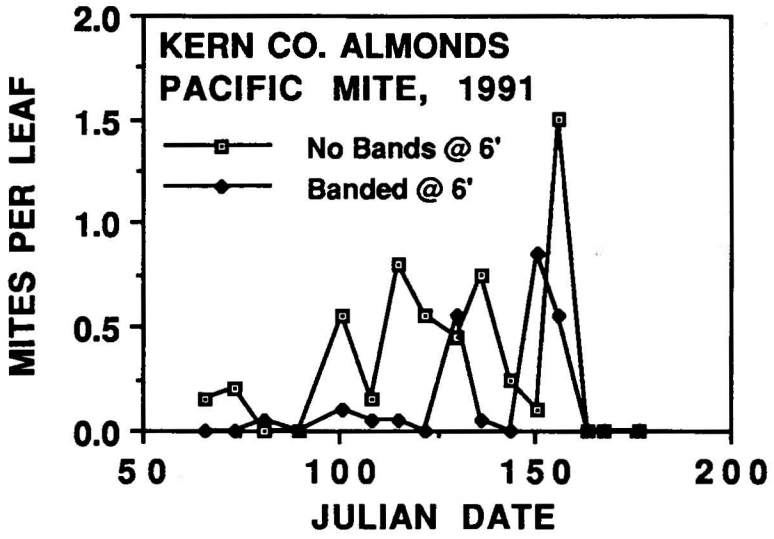
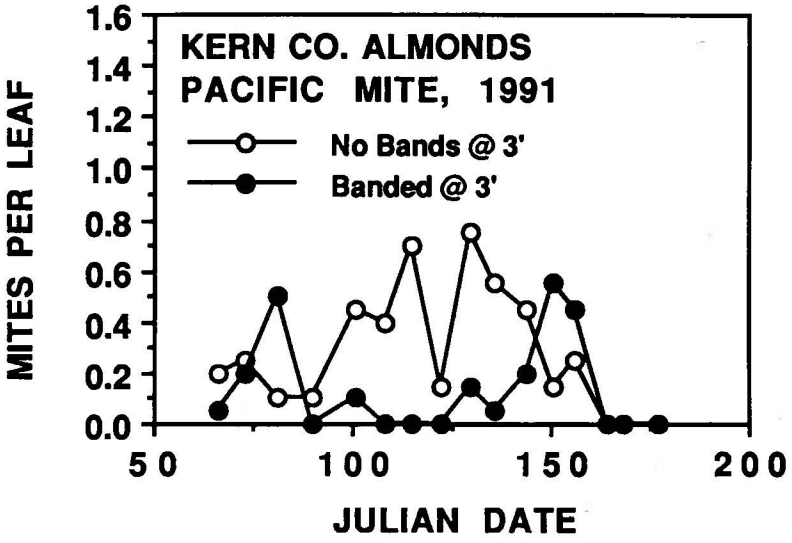

Kern Co. Almonds
Pacific Mite, 1990
No Bands @ 3'
Banded @ 3'
MITES PER LEAF
10
8
6
4
2
0
50
100
150
200
250
300
350
JULIAN DATE

Figure 2


KERN CO. ALMONDS
PACIFIC MITE, 1990
No Bands @ 6'
Banded @ 6'
MITES PER LEAF
0
2
4
6
8
50
100
150
200
250
300
350
JULIAN DATE


KERN CO. ALMONDS
PACIFIC MITE, 1991
No Bands @ 6'
Banded @ 6'
MITES PER LEAF
2.0
1.5
1.0
0.5
0.0
50
100
150
200
JULIAN DATE


KERN CO. ALMONDS
PACIFIC MITE, 1991
No Bands @ 3'
Banded @ 3'
MITES PER LEAF
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
50
100
150
200
JULIAN DATE

Project Number: 91-C14

91-C14



**Annual Report, 1991**
**Almond Board of California**

**Insect and Mite Research**

Project Leader: Frank G. Zalom
Dept. of Entomology
Univ. of California
Davis, CA 95616

Cooperating Personnel: William Barnett and Walt Bentley as (CoInvestigators), J. Edstrom, J. Connell, W. Reil, C. Pickel, W. Krueger, J. Hasey, R. Beede, S. Sibbett, M. Freeman, R. Coviello, J. Grant, L. Hendricks, W. Asai

Objectives:

1. Purchase pheromone traps and lures, and other monitoring supplies for Farm Advisors as part of their ongoing monitoring efforts.

2a. Conduct a research trial to compare several dormant applications and bloom applications to control peach twig borer.

2b. Conduct large field trials to refine and validate 1990 research results which strongly suggest that *Bacillus thuringiensis (Bt)* applied during bloom can control peach twig borer.

2c. Document the impact of eliminating dormant sprays of oil and organophosphates on other pest and beneficial insects.

3a. Conduct large field trials to validate the potential of tree banding as a control for spider mites.

3b. Determine areas outside of Kern County where the banding technique might be applicable.

Plans and Procedures:

Objective 1. As in prior years, this project purchased pheromone traps and lures, and other monitoring supplies for Farm Advisors who requested them as part of their ongoing monitoring efforts. Traps were placed in 8 counties, and over 100 traps, 300 trap liners and 800 lures were purchased for this activity. The data from these plots are collected at the end of the season and assembled at Davis where they become part of an ongoing database of trapping information.

Objective 2. A replicated field trial was conducted by John Edstrom at the Nickel's Estate in Colusa County to compare treatment timings of the *Bt* product Javelin,

other *Bt* products applied at both popcorn stage and petal fall (the timing we consider to be optimum from preliminary data), late dormant and delayed dormant applications of carbaryl, and conventional dormant treatments. Efficacy was determined by counting twig strikes in the spring. As in prior trials to determine optimum *Bt* treatment timing, the popcorn plus petal fall application gave the most consistent results with a single application at petal fall also working well (Table 1). Javelin applied 3 times during this period was the best treatment of all. There was no significant difference between any of the treatment timings. Most *Bt* products gave roughly equivalent control to that obtained from the dormant treatments, and no significant difference in shhot strikes was noted (Table 2). Both dibrom and carbaryl (Sevin XLR) applications also gave good control (Table 3), and neither of these materials are currently under regulatory scrutiny with regard to red-tail hawks. It was especially interesting that carbaryl at both treatment timings gave good control of peach twig borer as many of us did not expect carbaryl residue to be present long enough to permit a late January treatment. The presence of residue during bloom, when most of the twig borers would contact the material, was confirmed by residue analysis conducted by Dr. Michael Stimmann.

Walt Bentley and Mario Viveros also conducted a replicated trial of various dormant, delayed dormant and bloom treatments for control of peach twig borer. All treatments significantly reduced twig strikes relative to the untreated control (Tables 4 and 5), however the organophosphate plus oil treatments generally gave the highest level of control in this trial. The diazinon plus oil treatment and the dibrom plus oil treatments gave significantly better control than the single applications of *Bt* without oil during bloom. Ambush also gave a high level of control, but we are cautious in recommending this pyrethroid because of past negative experiences with spider mites on permethrin treated trees. More research would need to be conducted to determine if a dormant treatment with this material would be safe with regard to spider mites.

The Yolo County trial conducted by Wilbur Reil was a replicated trial that was part of the large plot evaluation of an organophosphate and oil dormant spray, and oil alone control treatment, and *Bt* and oil bloom sprays which was conducted without replication in six other counties. This trial also included a treatment with carbaryl plus oil and with all of the previously mentioned treatments in the absence of oil. The plot was evaluated by counting shoot strikes and by determining damage by peach twig borer, navel orangeworm and total worms combined at harvest. No difference was observed when evaluated by percent damaged nuts (Table 6), but significant differences were observed when analysis was conducted on percentage reduction in damage where the untreated control was set to 0. The carbaryl treatment provided equivalent control to that of the Bt plus oil treatment, and both treatments were not significantly different from the dormant organophosphate plus oil treatment. A significant difference was observed between treatments with oil and without oil when analyzed as a split plot (Table 7), indicating that oil alone had an effect on twig borer.

The large field trials were coordinated by Bill Barnett and Carolyn Pickel, and involved Farm Advisors in 7 counties. Oil without an organophosphate insecticide was applied to a minimum of 12 rows at the time the dormant treatments were applied to the remainder of the orchard. The 12 rows receiving the oil alone were treated at popcorn and again at between full bloom and the beginning of petal fall with label rates of *Bt*. The *Bt* applications were combined with disease treatments when appropriate.

Peach twig borer was monitored with pheromone traps, shoot strikes of overwintering generation larvae and/or first generation larvae, and by determining damage at harvest. Effect on nontarget species including navel orangeworm (damage at harvest), navel orangeworm parasitism (mummy nut and harvest samples), mites (leaf sampling) and San Jose scale (branch samples) were also evaluated. Treatments at each location included oil without an organophosphate insecticide applied at the time the dormant treatments are applied to the remainder of the orchard, the conventional oil plus organophosphate dormant spray, and oil applied in the dormant period plus label rates of Bt treated at popcorn and again at between full bloom and the beginning of petal fall. The Bt treatments appear to have worked fairly well at 4 of the 7 sites (Tables 8 and 9). Of the 3 remaining sites, neither the conventional dormant treatment nor the Bt treatment worked well at one location, the application methodology utilized for both treatments was suspect at another (split treatments were applied in Glenn County), and the level of peach twig borer damage was extremely low at the third (Yolo County). Because of variability in damage between orchards when data from all orchards were combined, no significant difference was observed between treatments (Table 10). However, significant differences were observed for peach twig borer when analysis was conducted on percentage reduction in damage where the untreated control was set to 0 (Table 11). Both the Bt plus oil and the conventional dormant treatment provided a significant level of control (Table 12). Although not significant, both the dormant and bloom treatments also appeared to provide some control of navel orangeworm. Although a direct effect of the treatment is unlikely, this could indicate that some of the navel orangeworm damage was observed in nuts that had been previously damaged by peach twig borer. No secondary effects from any of the treatments were seen on other pests such as spider mites, San Jose scales, or on predator mites (Table 13). Similarly, the cumulative number of peach twig borer male moths captured in the pheromone traps could not be correlated to shoot strikes or to damage at harvest.

This research is part of a much larger effort being coordinated by Bill Barnett, and also funded by the Cling Peach and Prune Advisory Boards and the Tree Fruit Agreement and we hope to continue the project for 2 additional years to help document the impact of eliminating the dormant sprays.

Objective 3. Walt Bentley and Mario Viveros conducted trials in one orchard in 1990 and three orchards in 1991 to determine the potential of excluding mites from trees by banding trees in February with duct tape covered with Tanglefoot. The

three 1991 trials consisted of two or three acres of trees (about 150-200 trees), anf these were not treated with an acaricide. Weekly sampling was initiated after leaves were present on the trees on six banded trees selected at random from different tree rows. Six additional trees (one from each of the same tree rows) chosen at random did not receive sticky bands, and were also sampled weekly for mites. From each sample tree in each orchard, ten leaves were selected at each of three heights (3', 6', and 9', thirty leaves total) beginning in March and continuing through August, and the number of spider mites and beneficial mites were counted. Significant differences were observed between treatments in 1990 (Figures 1 and 2). In 1991, differences were only observed in one orchard (Figures 3 and 4). The early season rains resulted in very low initial levels of spider mites in all trees, and the bands appeared to be excluding the mites but low populations masked any differences particularly early in the season. As mites began increasing again later in the spring, lower populations were generally observed on the banded trees.

The preliminary results obtained by Bentley and Viveros in 1990 were for Pacific spider mite, the predominant species in Kern County. Therefore, it is not possible to determine the potential for excluding mites from trees in areas where another spider mite species is dominant, or under different groundcover strategies. We proposed to place sections of black 2" PVC pipe ringed with Tanglefoot upright in at least eight orchards from Kern County to the Sacramento Valley to determine if and when mite movement occurs from the ground onto the trees. Six sections of pipe were provided to Farm Advisors in the counties, and they placed the pipes in tree rows in each orchard. This method of detection did not work as well as we had hoped in part because mite populations were generally low.

Additional Work: In both 1990 and 1991, we worked with Barry Wison, Bill Steinke and Jim Seiber on the large plots where different spray equipment was tested to determine the potential for reducing drift and impact on the red tailed hawk, however we did not ask for funding support from that project and travel, supplies and other expenses were taken from this project. We were responsible for determining the efficacy of the treatments on insect control. The results of this trial are presented in the report submitted by Barry Wilson.

**1991 Almond Peach Twig Borer Research**
**Nickel's Estate - Colusa Co.**
**($\bar{x}$ Twig Strikes/Tree)**

| | | |
|---|---|---|
| Untreated | 9.429 | A |
| Javelin - Budswell | 6.286 | B |
| Javelin - Petal fall | 1.286 | B |
| Javelin - Popcorn+Petal fall | 1.143 | B |
| Javelin - Petal fall | 0.714 | B |
| Javelin - Popcorn+Petal fall +Petal fall (+2 wks) | 0.000 | B |
| Diazinon - Dormant | 0.429 | B |

**1991 Almond Peach Twig Borer Research**
**Nickel's Estate - Colusa Co.**
**Popcorn and Petal Fall Timing**
**($\bar{x}$ Twig Strikes/Tree)**

| | | |
|---|---|---|
| Untreated | 9.431 | A |
| MVP - 1 qt./100 gal. | 2.429 | B |
| Javelin - 0.5 lb./100 gal. | 1.286 | B |
| Javelin - 0.25 lb./100 gal. | 1.143 | B |
| Dipel - 0.5 lb./100 gal. | 0.429 | B |
| Biobit - 0.67 lb./100 gal. | 0.143 | B |
| Diazinon - 1 lb./100 gal. | 0.429 | B |

**1991 Almond Peach Twig Borer Research**
**Nickel's Estate - Colusa Co.**
**($\bar{x}$ Twig Strikes/Tree)**

| | | |
|---|---|---|
| Untreated | 9.431 | A |
| Dibrom - 16 oz./100 gal. - Dormant | 0.714 | B |
| Sevin XLR - 1 qt./100 gal. - 1/24 | 0.571 | B |
| Sevin - 1 qt./100 gal. - 2/6 | 0.429 | B |
| Diazinon - 1 lb./100 gal. - Dormant | 0.429 | B |
| Dibrom - 12 oz./100 gal. - Dormant | 0.286 | B |

## PEACH TWIG BORER CONTROL
## KERN CO., 1991, SHOOT STRIKES

| TREATMENT [1] | STRIKES PER TREE | |
|---|---|---|
| DIAZINON 500 (1.5 pts) | 1.4 (1.1) | a |
| DIBROM 8E (.75 pts) | 1.8 (1.3) | a |
| DIBROM 8E (.50 pts) | 2.0 (2.4) | a |
| AMBUSH (6.4 oz) | 2.2 (2.2) | a |
| LORSBAN 4E (1 pt) | 3.0 (2.6) | ab |
| IMIDAN 50W (1 lb) | 3.6 (1.9) | ab |
| JAVELIN (1.25 lb), 2/23 & 3/8 | 5.0 (2.4) | ab |
| SEVIN 80S (1.25 lb) | 6.4 (4.5) | ab |
| JAVELIN (1.25 lb), 3/8 | 6.6 (3.2) | b |
| JAVELIN (1.25 lb), 2/22 | 6.8 (3.8) | b |
| UNTREATED | 20.4 (7.8) | c |

[1] All with 2 gal oil; all rates per 100 gal.

## PEACH TWIG BORER CONTROL
## KERN CO., 1991, PERCENT REDUCTION
## IN SHOOT STRIKES

| TREATMENT [1] | % (SD) OF CONTROL | |
|---|---|---|
| DIAZINON 500 (1.5 pt) | 91.9 ( 9.7) | a |
| DIBROM 8E (.75 pts) | 89.8 ( 8.2) | a |
| DIBROM 8E (.50 pts) | 87.4 (16.8) | ab |
| AMBUSH (6.4 oz) | 86.2 (15.6) | ab |
| LORSBAN 4E (1 pt) | 85.1 (10.0) | abc |
| IMIDAN 50W (1 lb) | 82.9 ( 7.0) | abcd |
| JAVELIN (1.25 lb), 2/23 & 3/8 | 74.3 (12.1) | abcd |
| SEVIN 80S, (1.25 lb) | 67.6 (26.8) | bcd |
| JAVELIN (1.25 lb), 3/8 | 64.6 (22.0) | cd |
| JAVELIN (1.25 lb), 2/22 | 64.3 (22.4) | d |
| UNTREATED | 0.0 ( 0.0) | e |

[1] All with 2 gal oil; all rates per 100 gal.

**BLOOM AND DORMANT TREATMENT**
**PEACH TWIG BORER DAMAGE AT HARVEST**
**YOLO COUNTY**

| | PERCENT (SD) DAMAGE | | |
|---|---|---|---|
| TREATMENT | PTB [1] | NOW [2] | TOTAL [3] |
| Javelin | 0.258 | 0.555 | 0.813 |
| Javelin + OIL | 0.229 | 0.551 | 0.780 |
| Sevin XLR | 0.192 | 0.913 | 1.105 |
| Sevin + OIL | 0.267 | 0.313 | 0.580 |
| Diazinon 50W | 0.312 | 0.557 | 0.869 |
| Diazinon + OIL | 0.447 | 0.695 | 1.142 |
| OIL | 0.157 | 0.490 | 0.647 |
| Untreated | 0.083 | 0.806 | 0.889 |

[1] F=1.480, p=0.2432
[2] F=0.646, p=0.7123
[3] F=0.497, p=0.8231

**BLOOM AND DORMANT TREATMENT**
**PEACH TWIG BORER TWIG STRIKES 4/12/91**
**YOLO COUNTY**

| TREATMENT | STRIKES PER TREE[1] OIL [2] | NO OIL |
|---|---|---|
| Javelin, 1 lb. 2/23 + 3/9 | 9.3 ab | 16.0 bc |
| Sevin XLR, 2.9 qt. 2/9 | 7.0 ab | 8.0 ab |
| Diazinon 50W, 5 lb. 2/10 | 1.3 a | 5.3 ab |
| Untreated | 23.0 c | 47.0 d |

[1] means followed by same letter do not differ significantly by DMRT ($p<0.05$).
[2] 4 gal./acre applied 2/10.

**BLOOM AND DORMANT TREATMENT**
**PEACH TWIG BORER SHOOT STRIKES**

| COUNTY | TREATMENT | OVERWINTER GENERATION | 1ST SUMMER GENERATION |
|---|---|---|---|
| BUTTE | Bt + OIL | -- | 5.6 (46%) |
| | DORMANT | -- | 6.8 (23%) |
| | CHECK | -- | 8.8 ( 0%) |
| COLUSA | Bt + OIL | -- | 17.8 ( 0%) |
| | DORMANT | -- | 6.8 (35%) |
| | CHECK | -- | 16.5 ( 0%) |
| FRESNO | Bt + OIL | 13.2 (52%) | -- |
| | DORMANT | 5.2 (81%) | -- |
| | CHECK | 26.8 ( 0%) | -- |
| GLENN | Bt + OIL | 4.2 (78%) | 14.5 ( 0%) |
| | DORMANT | 13.4 (31%) | 11.5 (13%) |
| | CHECK | 19.5 ( 0%) | 13.2 ( 0%) |
| KINGS | Bt + OIL | 2.9 (37%) | 4.0 (52%) |
| | DORMANT | 0.1 (98%) | 1.7 (80%) |
| | CHECK | 4.6 ( 0%) | 8.4 ( 0%) |
| MADERA | Bt + OIL | 0.3 (93%) | 3.7 (75%) |
| | DORMANT | 0.2 (95%) | 2.5 (83%) |
| | CHECK | 4.3 ( 0%) | 15.0 ( 0%) |
| YOLO | Bt + OIL | 9.3 (61%) | -- |
| | DORMANT | 1.3 (94%) | -- |
| | CHECK | 23.0 ( 0%) | -- |

## BLOOM AND DORMANT TREATMENT
## PEACH TWIG BORER DAMAGE AT HARVEST

| COUNTY | TREATMENT | PERCENT DAMAGE PTB | NOW | TOTAL |
|---|---|---|---|---|
| BUTTE | Bt + OIL | 0.30 | 0.10 | 0.40 |
| | DORMANT | 0.81 | 0.08 | 0.89 |
| | CHECK | 1.48 | 0.15 | 1.63 |
| COLUSA | Bt + OIL | 0.10 | 2.80 | 2.90 |
| | DORMANT | 1.00 | 3.20 | 4.20 |
| | CHECK | 0.30 | 1.70 | 2.00 |
| FRESNO | Bt + OIL | 2.40 | 0.30 | 2.70 |
| | DORMANT | 1.20 | 0.10 | 1.30 |
| | CHECK | 2.70 | 0.00 | 2.70 |
| GLENN | Bt + OIL | 2.70 | 0.00 | 2.70 |
| | DORMANT | 2.40 | 0.00 | 2.40 |
| | CHECK | 2.90 | 0.00 | 2.90 |
| KINGS | Bt + OIL | 0.80 | 2.30 | 3.10 |
| | DORMANT | 1.40 | 2.80 | 4.20 |
| | CHECK | 3.20 | 1.40 | 4.60 |
| MADERA | Bt + OIL | 0.20 | 0.20 | 0.40 |
| | DORMANT | 0.00 | 0.30 | 0.30 |
| | CHECK | 1.10 | 0.70 | 1.80 |
| YOLO | Bt + OIL | 0.23 | 0.55 | 0.78 |
| | DORMANT | 0.45 | 0.70 | 1.15 |
| | CHECK | 0.17 | 0.49 | 0.66 |

**BLOOM AND DORMANT TREATMENT**
**PEACH TWIG BORER DAMAGE AT HARVEST**
**ALL ORCHARDS COMBINED**

| | PERCENT (SD) DAMAGE | | |
|---|---|---|---|
| TREATMENT | PTB | NOW | TOTAL |
| Bt + OIL | 0.97 (1.11) | 0.89 (1.15) | 1.86 (1.25) |
| DORMANT | 1.04 (0.76) | 1.03 (1.37) | 2.06 (1.59) |
| CONTROL | 1.70 (1.25) | 0.63 (0.68) | 2.33 (1.25) |

**BLOOM AND DORMANT TREATMENT**
**PEACH TWIG BORER, ANOVA STATISTICS**
**FOR PERCENT REDUCTION IN DAMAGE**
**ALL ORCHARDS COMBINED**

| | PERCENT (SD) OF CONTROL | |
|---|---|---|
| PEST | F-test | p |
| PTB | 4.721 | 0.023 |
| NOW | 1.850 | 0.186 |
| TOTAL | 2.535 | 0.107 |

**BLOOM AND DORMANT TREATMENT**
**PEACH TWIG BORER, PERCENT REDUCTION**
**IN DAMAGE FOR ALL ORCHARDS COMBINED**

| | PERCENT (SD) OF CONTROL | | |
|---|---|---|---|
| TREATMENT | PTB | NOW | TOTAL |
| Bt + OIL | 45.89 (37.75) a | 24.49 (32.81) a | 27.54 (35.47) a |
| DORMANT | 39.19 (36.16) a | 14.83 (25.51) a | 29.50 (31.55) a |
| CONTROL | 0.00 (00.00) b | 0.00 (00.00) a | 0.00 (00.00) a |

means in columns followed by the same letter are not significantly different by Fisher PLSD ($p<0.05$).

## BLOOM AND DORMANT TREATMENTS FOR PEACH TWIG BORER, MITES PER LEAF (Late July/ Early August Sample)

| COUNTY | TREATMENT | ERM | 2 SPOT | Pred. |
|---|---|---|---|---|
| BUTTE | Bt + OIL | 0.10 | 0.00 | 0.10 |
| | DORMANT | 0.10 | 0.00 | 0.10 |
| | CHECK | 0.00 | 0.10 | 0.10 |
| COLUSA | Bt + OIL | 0.10 | 9.90 | |
| | DORMANT | 0.10 | 1.00 | |
| | CHECK | 0.00 | 26.00 | |
| FRESNO | Bt + OIL | 0.10 | 0.30 | 0.10 |
| | DORMANT | 0.00 | 0.10 | 0.10 |
| | CHECK | 0.00 | 0.10 | 0.10 |
| GLENN | Bt + OIL | 0.00 | 0.00 | 0.10 |
| | DORMANT | 0.00 | 0.00 | 0.10 |
| | CHECK | 0.00 | 0.00 | 0.10 |
| KINGS | Bt + OIL | 3.36 | 0.10 | 0.00 |
| | DORMANT | 3.00 | 0.00 | 0.00 |
| | CHECK | 2.80 | 0.10 | 0.00 |
| MADERA | Bt + OIL | 0.00 | 0.00 | 0.00 |
| | DORMANT | 0.00 | 0.00 | 0.00 |
| | CHECK | 0.00 | 0.00 | 0.00 |
| YOLO | Bt + OIL | 0.00 | 8.31 | 0.01 |
| | DORMANT | 0.00 | 5.15 | 0.01 |
| | CHECK | 0.00 | 4.39 | 0.07 |

Figure 1

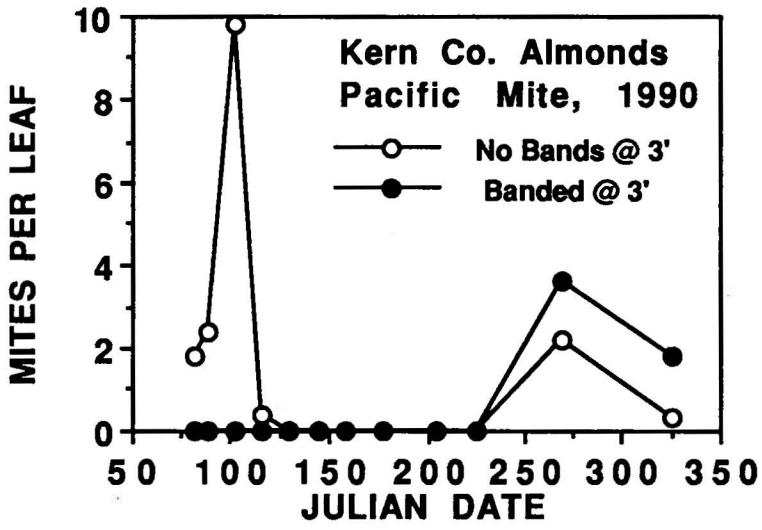
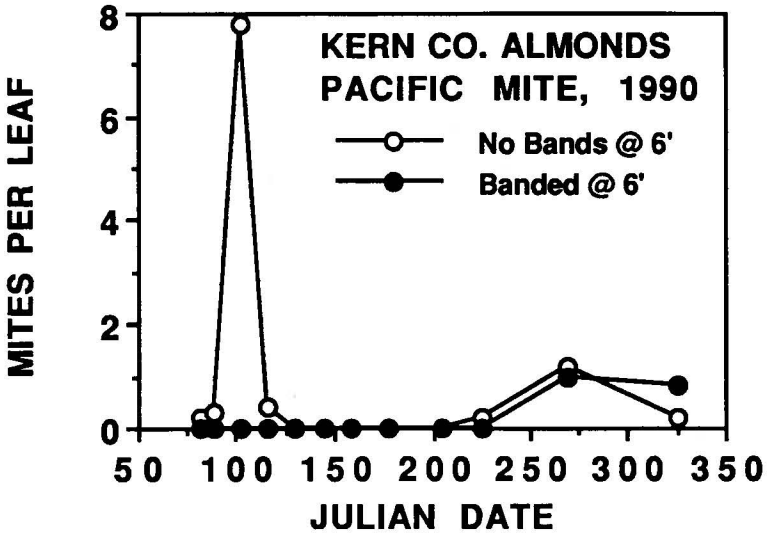
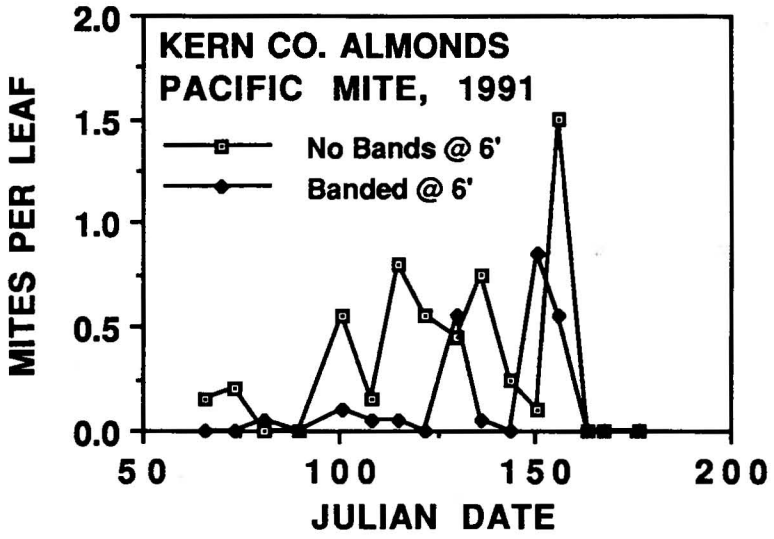
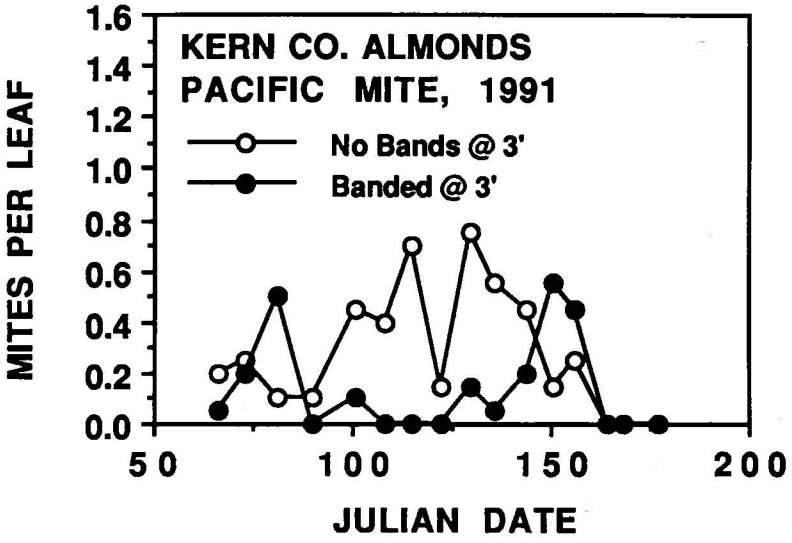

Kern Co. Almonds
Pacific Mite, 1990
No Bands @ 3'
Banded @ 3'
MITES PER LEAF
10
8
6
4
2
0
50
100
150
200
250
300
350
JULIAN DATE

Figure 2


KERN CO. ALMONDS
PACIFIC MITE, 1990
No Bands @ 6'
Banded @ 6'
MITES PER LEAF
0
2
4
6
8
50
100
150
200
250
300
350
JULIAN DATE


KERN CO. ALMONDS
PACIFIC MITE, 1991
No Bands @ 6'
Banded @ 6'
MITES PER LEAF
2.0
1.5
1.0
0.5
0.0
50
100
150
200
JULIAN DATE


KERN CO. ALMONDS
PACIFIC MITE, 1991
No Bands @ 3'
Banded @ 3'
MITES PER LEAF
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
50
100
150
200
JULIAN DATE