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Project No. 92-C15 - Insect and Mite Control

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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 prior 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.

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

Results:

Objective 1. As in prior years, this project purchased pheromone traps and lures, and other monitoring supplies for UC Farm Advisors who requested them as part of their ongoing monitoring efforts. In 1992, materials to monitor navel orangeworm, peach twig borer and San Jose scale were purchased for and distributed to Farm Advisors in 9 counties, and the cost of these materials was a little over $2,000. The data from these plots are collected at the end of each year, and are assembled at Davis where they become part of an ongoing database of trapping information that can be used for population dynamics and sampling studies of these important almond insect pests.

Objective 2. A replicated field trial was applied by John Edstrom at the Nickel's Estate in Colusa County to compare efficacy of registered and unregistered *Bt* products, efficacy of *Bt* with and without oil, *Bt* treatment timing, *Bt* dilution rate, and *Bt* application rate for control of peach twig borer. These studies are necessary to provide recommendations for use of *Bt* as a bloomtime treatment. Previous studies by Bill Barnett, Rich Coviello and Edstrom indicated that *Bt* applied at a rate of 1.0 lb. AI per acre (0.33 lb. per 100 gal.) with dormant oil at both popcorn stage and petal fall (the timing we consider to be optimum) gave good control of overwintering peach twig borer. Efficacy in these trials was determined by counting twig strikes in the spring (April). All registered *Bt* products compared (Biobit, Dipel, Javelin) gave roughly equivalent results, and control was not significantly different from that obtained from the conventional dormant treatment of diazinon and oil (Tables 1 and 2). In the prior year, the large field trial in Yolo Co. indicated a possible synergistic effect of *Bt* applied following a dormant application of oil alone. In our small plot trial this year, the *Bt* plus dormant season oil application gave better results than the *Bt* application alone, however, the difference was not statistically significant (Table 3). In the same trial, the bloomtime *Bt* application was shown to be compatible with the fungicide Rovral when applied as a tank mix. 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 full bloom not working quite as well (Tables 4 and 5). *Bt* applied 3 times during this period was the best treatment of all giving the same results as the conventional Diazinon and oil dormant treatment. Gallonage did not significantly alter the level of control achieved from the *Bt*, but the best results were consistently obtained at a rate of 80 gallons per acre with AI per acre held constant (Tables 6 and 7). Similar results were obtained with the dilution rate held constant, but the gallonage varied (Table 8). Conventional wisdom is that more concentrated rates result in better *Bt* efficacy as long as good coverage is obtained.

Most of our research to date has been with the registered *Bt* materials Biobit, Javelin and Dipel. Several companies have *Bt* products registered on other crops and may soon have registration on almonds as well. Table 9 gives a comparison of three of these materials to the diazinon and oil dormant spray and to Javelin in trials in Colusa Co. applied by John Edstrom. There was no significant difference in efficacy in any of the products, but Cutlass gave the most similar results to that obtained with Javelin.

Other potential alternatives to conventional organophosphate and oil dormant sprays are carbamates such as carbaryl (Sevin) and pyrethroids (such as Asana and Pounce). This is the second year we have tested treatment timing of carbaryl for peach twig borer control, and the results were very similar to that obtained last year. In both years, shoot strikes in trees treated with carbaryl were not significantly different from those found in those treated with *Bt*. Treatment timing was best when applied in mid or late January rather than in early February immediately before bloom (Table 10). This does not make intuitive sense as it seems that more residues should be present at the time most peach twig borer larvae emerge with the later timings, however, residue tests conducted on our samples by Dr. Michael

Stimmann of the UC Davis Department of Environmental Toxicology confirm our bioassay results. One question from last year's trial was whether Sevin XLR and Sevin 80S would give similar results in a late January treatment since the XLR formulation is supposed to have better residual activity. The results of this small plot study shows no difference in efficacy between the two materials (Table 11). Both pyrethroid materials tested (Asana and Pounce) as dormant sprays gave good results in reducing shoot strikes compared to the conventional diazinon and oil dormant spray (Table 12). We remain very cautious in recommending the use of any pyrethroids in orchards because of the possibility of inducing spider mites. Several past studies have shown that pyrethroid use induces spider mites, and a study we conducted in 1983 showed that predator mites were killed on bark by residues of permethrin (Pounce) applied to an orchard the previous season.

Large field trials were coordinated by Bill Barnett, Carolyn Pickel and UC Farm Advisors in 7 counties. Treatments were standardized as much as possible between sites. 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* applications were combined with disease treatments when appropriate. Peach twig borer abundance 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) was also evaluated.

The *Bt* treatments appeared to have worked well at all sites where comparisons to untreated controls were possible and sufficient populations of peach twig borers were present to obtain meaningful data (Tables 13, 14, 15, 16, 17 and 18). At the remaining sites, the *Bt* and oil treatment gave comparable results to that obtained from the conventional dormant treatment. Damaging levels of mites and San Jose scale have not been found in any of the orchards to date, so it is not possible to determine positive or negative non target effects from the application of *Bt* instead of the conventional dormant spray. It is interesting to note that significant levels of oblique banded leaf roller larvae (up to 3.6% of almond hulls with larvae and 0.7% of meats damaged) were found in hulls and meats of almonds in two of the orchards (Butte and Glenn Counties). The populations of this insect detected was lowest in the conventional dormant treatment area of both orchards.

Two large (minimum 10 acres per treatment replicate) aerial applications of *Bt* were made to determine the feasibility of applying *Bt* by air at ultra low volume (ULV). This is a necessary application method if large acreages are to be treated in the relatively small timing window. Our prior work with Bill Steinke and Barry Wilson indicated that aerial applications of conventional dormant sprays were not very effective, and that much of the insecticide spray was deposited on the ground rather than the tree. Employing ULV methods widely utilized by the US Forest

Service to treat forests for gypsy moth with *Bt*, one orchard was treated in Colusa County with John Edstrom, Jack Barry of the US Forest Service, and Gary Kirfman of Entotech Inc. (Biobit) and one in Fresno County by Bill Barnett, Rich Coviello and Phil Grau of Abbott Labs (Dipel). Both trials used fixed wing aircraft fitted with micronair rotary atomizers instead of conventional nozzles. The plane flew about 20 feet over the tree canopy in both cases. Spray deposition was evaluated in all parts of the tree canopy in the Colusa County trial, and twig strike counts and damage at harvest was evaluated at both sites. The description and most results that follow are from the Colusa Co. trial.

The Colusa Co. orchard was 16 years old (cultivars Price, Mission and Nonpareil). Trees were spaced on 7.5 m centers and tree height averaged 7 to 8 m. For this study, the orchard was divided into 4 adjacent blocks, each situated adjacent to one another in an east to west direction, with tree rows running north/south. Each treatment block consisted of 15 rows of trees about 320 m long, and each control block consisted of 20 rows. Blocks were alternately selected as unsprayed control block or treatment block. Minimum block size selection was a result of recommendations based on forestry research on spray drift and canopy penetration. Applications were initiated on February 25 at 12:40 hour and on March 3 at 13:28 hour and lasted approximately 10 minutes in each case. These dates coincided with popcorn and petal fall flowering stages, respectively. Basic weather data were observed and recorded at the orchard (Table 19). Wind direction on the first date was from the southwest, and on the second date from the southeast. The spray system was calibrated prior to the study and consisted of 6 Micronair AU 5000 atomizers set at 50^{o} blade angle, each applying 3.4 liters of spray per minute. The Ag-Cat applied the spray from south to north and north to south over every other tree middle for a total of 8 swath widths were flown per block.

Prior to each application, substrates for measuring droplet deposition were placed in one tree in the southern half of every other tree row in all blocks. They were also placed on one tree in the northern half of every other row in one of two treatment blocks and adjacent control blocks. Kromekote cards measuring 8 x 11 cm, and polyethylene soda straws measuring 0.48 cm in diameter and 20 cm in length were attached horizontally to a PVC pole that was extended upright into the outer canopy of each tree. Cards and straws were positioned at a height of 3.3 m and 6.7 m on the middle and top of the east and west sides of each tree monitored. In addition, cards were placed on the ground on the east and west sides of the tree. Cards and straws were removed immediately following each application. Droplet marks were counted on a 4 cm^2 area on each card, and on a 5 cm length of each straw. Bt deposition was also measured following the first treatment by determining colony forming units on twigs. Immediately after treatment, 4 twigs were removed from the upper canopy of each tree that contained cards and straws. These were taken to the lab at Entotech Inc. and rinsed with water. The rinsate was plated onto a growth medium and cultured. The number of colony forming units was then counted. Larval activity was assessed on April 8 by counting the number of peach twig borer shoot strikes. Nut damage was assessed at harvest.

Deposition patterns in treated and untreated blocks indicated that relatively little drift occurred, even though the ULV application was applied at a height of approximately 4 m above the tree canopy, and with a cross-wind up to 3.9 m per second during the second application (Figures 1a and 1b). This is important both in terms of drift to nontarget sites during commercial applications and also for designing future research. For example, the size of plots could be reduced, permitting greater replication when orchard size or amount of substance to be applied is a limiting factor. Considerable differences of within tree droplet distribution were noted. During the first application, significantly more droplets occurred on cards located in the top eastern region of each tree than in any other location monitored (Table 20). Droplet counts in the second application were also significantly higher in this portion compared to all other locations with the exception of the top west portion (Table 20). This difference could not be attributed to wind direction, as the wind came from different directions in the two applications. Mean densities (mean = 10 per cm2) of spray droplets were very consistent between application periods on mid-canopy cards during both application periods, and did not vary between cards on the east and west sides of the tree.

Droplet densities on cards were closely correlated with those on straws (Fig. 2). In fact, the absolute densities on card versus straw samplers compared closely in most instances (Tables 20 and 21). Based on average droplet densities for all in-tree sample zones, droplet densities were 22% lower on card samplers and 30% lower on straw samplers from the first to second application period. Perhaps this was due to an increased leaf surface area from the first to second period. It is also valuable to note that droplet densities on ground samplers were considerably reduced during the second application. These results are likely to have been due to the presence of more foliage during the second application occurring at petal fall, compared with only leaf tips emerging from buds during the first application at popcorn stage. It is possible that somewhat different application parameters used during these two treatment timings could improve spray coverage and efficacy. It is important that more droplets deposition occurs on upper canopy locations, as significantly more peach twig borer feeding occurs in this area of the tree. It might be expected that increased deposition in the upper canopy would improve efficacy of insecticides for control. To further evaluate the dynamics of droplet density variability, droplet densities on east cards were correlated with those of west cards on the same tree. The correlation between card pairs was low ($r=0.41$) during the first application and increased during the second application ($r=0.62$).

In assessing the spray treatment efficacy against peach twig borer, shoot strike counts were lower in treated (mean = 3.8, SE = 0.88) compared to control (mean = 8.9, SE = 1.25) plots ($p<0.07$, df = 1). We believe that the actual level of damage, particularly in the control plots was probably greater than our estimates. Published studies which evaluate efficacy using shoot strikes have been conducted in two to four year old orchards where the flagged shoot tips can easily be seen and counted. Older trees are taller, have a greater number of twigs and shoots, and have less vigorous shoot growth which make the shoot strikes less apparent. By removing branches and counting the total number of shoot strikes on a portion of one tree versus the number counted on that portion of the tree from the ground, we estimate that less than 20% of shoot strikes were actually counted in our samples. Harvest was conducted during the month of August. No peach twig borer damaged nuts were detected in the treated plots, and only 0.3% nuts showed damage in the check blocks at harvest (Table 22). Total worm damage (mostly navel orangeworm) was lower in the *Bt* treated part of the Colusa County orchard, however. Although dormant or bloom time insecticide sprays do not control navel orangeworm, it is possible that navel orangeworm selectively invades nuts previously damaged (for example by peach twig borer), and this might have been the case in our trial.

We did not attempt to establish a quantitative relationship between mean shoot strikes per tree in a row versus average number of droplets deposited on cards or straws, however, a generalized relationship can be seen in Figure 3 where mean shoot strikes in the control plots (where low deposition occurred) was usually greater than that of the treated plots. These data should be used with caution because confidence intervals of individual treatment means are large.

No attempt was made to characterize deposition in the Fresno County orchard, however, both shoot strike counts and damage at harvest was assessed as an indicator of treatment efficacy. Two formulations of Dipel were used in the trial, and application techniques approximated that of the Colusa Co. trial. Shoot strike counts taken in late March indicated that both formulations of Dipel significantly reduced the number of peach twig borer twig strikes relative to the untreated control (Table 23), and gave comparable results to that of the conventional diazinon and oil dormant treatment which was applied by ground. No difference in damage at harvest was indicated by any of the treatments, however.

This study was the first attempt to use a commercial scale ULV application of *Bt* on an orchard in California. The Colusa Co. trial in particular compared different methods used to sample deposition of *Bt* on almond twigs from the bloom time applications. Developing a representative sampling methodology to assess aerial deposition and efficacy of *Bt* in an orchard situation is critical to evaluating the quality of application and for improving aerial application methods. These quantification's are needed to implement *Bt* as a control alternative to ground application methods when weather, ground conditions or orchard size preclude ground application.

<u>Objective 3</u>. Walt Bentley and Mario Viveros conducted trials in both 1990 and 1991 to determine the potential of excluding mites from trees by banding trees in February with duck tape covered with Tanglefoot. This year trials were conducted to confirm their findings (which were variable in 1991 when spider mite populations were relatively low), and to learn more about the migration of the mites on the trees. In addition to the trunk banding, a scaffold banding treatment was added. This new treatment consisted of bands placed on the secondary scaffolds at approximately 5 feet in height. In addition, soil movement of spider mites was also traced through the spring and again in the late summer.

Preliminary analysis of this year's data seems to indicate that tree bands will reduce spider mite migration into trees early in the season, delaying the rapid buildup of spider mites typically observed in orchards. In the first (Bidart) orchard, both the trunk and scaffold bands significantly reduced early mite movement and peak populations of mites (Fig. 4a, 4b and 4c). The scaffold banding appeared to give the best results. In the second orchard (Weins), trunk banding was not as successful but the scaffold banding somewhat reduced the peak mite population (Fig. 5a, 5b and 5c). Unlike prior years, mites were not completely excluded from trees in either orchard with the banding treatment. Banding does not seem to seriously impact the predator mite populations (Figure 6a, 6b, 6c, 7a, 7b, 7c). This technique could help balance predator and spider mite populations early in the season improving biological control. More importantly it may help explain why in some years high numbers of spider mites overwhelm the predator populations.

Soil monitoring also indicated most mite movement occurred in late February (Fig. 8). It is possible that during this time some cultural manipulation of the soil could be used to reduce or stop mite movement to the trees.

Table 1. COMPARISON OF REGISTERED *Bt* PRODUCTS APPLIED AT POPCORN & PETAL FALL. JOHN EDSTROM COLUSA CO., 1992 (n=5)

Treatment [1]	Mean Shoot Strikes [2]
Untreated	8.0 a
Diazinon 50WP (3 lb.) + Oil	0.4 b
Javelin WG (1 lb.)	1.0 b
Biobit WP (1 lb.)	1.4 b
Dipel 2X (1 lb)	1.8 b

[1] 300 gallons/acre
[2] ANOVA, $p < 0.006$; means followed by the same letter do not differ ($p < 0.05$) by Waller-Duncan MRT.

Table 2. COMPARISON OF REGISTERED *Bt* PRODUCTS APPLIED AT POPCORN & PETAL FALL. JOHN EDSTROM, COLUSA CO., 1992 (n=5)

Treatment [1]	Shoot Strikes [2]
Untreated	13.0 a
Diazinon 50WP (3 lb.) + Oil	0.4 b
Javelin WG (1 lb.)	2.8 b
Biobit WP (1 lb.)	2.6 b
Dipel 2X (1 lb)	4.6 b

[1] 300 gallons/acre
[2] ANOVA, $p < 0.004$; means followed by the same letter do not differ ($p < 0.05$) by Waller-Duncan MRT.

Table 3. *Bt* (Javelin WG) WITH OIL, NO OIL & ROVRAL + OIL APPLIED IN DORMANT SEASON. COLUSA CO., 1992 (n=5)

Treatment [1]	Shoot Strikes [2]
Untreated	13.0 a
Diazinon 50WP (3 lb.) + Oil	0.4 b
Javelin (1 lb.)	2.8 b
Javelin (1 lb.) + Oil (4.5 gal.)	0.8 b
Javelin (1 lb) + Rovral + Oil	0.8 b

[1] 300 gallons/acre
[2] ANOVA, $p < 0.001$; means followed by the same letter do not differ ($p < 0.05$) by Waller-Duncan MRT.

Table 4. CONFIRMATION OF *Bt* (Biobit HP WP) TREATMENT TIMING. JOHN EDSTROM, COLUSA CO., 1992 (n=5)

Treatment [1]	Shoot Strikes [2]
Untreated	8.0 a
Diazinon 50WP (3 lb.) + Oil	0.4 b
Bt @ Popcorn & Petal Fall	2.2 b
Bt @ Popcorn, Petal Fall & Petal Fall + 2 Weeks	0.4 b
Bt @ Full Bloom	4.2 bc

[1] Biobit applied at 0.5 lb. in 300 gallons/acre.

[2] ANOVA, $p < 0.01$; means followed by the same letter do not differ ($p < 0.05$) by Waller-Duncan MRT.

Table 5. CONFIRMATION OF *Bt* (Javelin WG) TREATMENT TIMING. JOHN EDSTROM, COLUSA CO., 1992 (n=5)

Treatment [1]	Shoot Strikes [2]
Untreated	13.0 a
Diazinon 50WP (3 lb.) + Oil	0.4 b
Bt @ Popcorn & Petal Fall	0.8 b
Bt @ Full Bloom	2.4 b

[1] Javelin applied at 1.0 lb. in 300 gallons/acre. All treatments with 4.5 gal. oil applied during dormant season.

[2] ANOVA, $p < 0.002$; means followed by the same letter do not differ ($p < 0.05$) by Waller-Duncan MRT.

Table 6. *Bt* APPLIED AT DIFFERENT DILUTIONS AT POPCORN AND PETAL FALL. JOHN EDSTROM, COLUSA CO., 1992 (n=4)

Treatment [1]	Shoot Strikes [2]
Untreated	14.75 a
Supracide 2E (3 pts.) + Oil	1.25 b
Bt in 40 gallons/acre water	7.50 b
Bt in 80 gallons/acre water	3.25 b
Bt in 350 gallons/acre water [3]	11.75 b

1 Biobit and Javelin applied at 0.5 lb (40 gal.) . & 0.25 lb. (80 and 350 gal.) (equivalent units), respectively.

2 ANOVA, $p < 0.03$; means followed by the same letter are not different ($p < 0.05$) by Waller-Duncan MRT.

3 All treatments applied by airblast except for 350 gal. rate which was applied by handgun.

Table 7. *Bt* (Javelin WG) APPLIED AT DIFFERENT RATES AND DILUTIONS AT POPCORN AND PETAL FALL. JOHN EDSTROM, COLUSA CO., 1992 (n=4)

Treatment [1]	Shoot Strikes [2]
Untreated	14.75 a
Supracide 2E (3 pts.) + Oil	1.25 b
Bt @ 0.25 lb. in 80 gal/acre water	3.25 ab
Bt @ 0.25 lb. in 350 gallons/acre water	11.75 ab
Bt @ 0.5 lb. in 80 gal/acre water	4.75 ab
Bt @ 0.5 lb. in 350 gallons/acre water	7.25 ab

1 Oil applied to Bt plots during dormant season at 4.5 gal. per acre; 80 gal. rate applied by airblast and 350 gal. rate applied by handgun.

2 ANOVA, $p < 0.011$ (not significant); means followed by the same letter are not different ($p < 0.05$) by Waller-Duncan MRT.

Table 8. *Bt* (Biobit WG) APPLIED AT SIMILAR RATES, BUT WITH REDUCED VOLUME AT POPCORN AND PETAL FALL. JOHN EDSTROM, COLUSA CO., 1992 (n=4)

Treatment [1]	Shoot Strikes [2]
Untreated	14.75 a
Supracide 2E (3 pts.) + Oil	1.25 b
Bt @ 1.0 lb. in 80 galllons/acre water	3.50 b
Bt @ 0.5 lb. in 40 gallons/acre water	7.50 ab
Bt @ 0.1 lb. in 10 gallons/acre water	14.75 a
Bt @ 0.2 lb. in 10 gallons/acre water	8.25 ab

[1] Oil applied to Bt plots during dormant season at 4.5 gal. per acre; 40 and 80 gal. rate applied by airblast and 10 gal. by handgun with micronaire atomizer.

[2] ANOVA, $p < 0.02$; means followed by the same letter are not different ($p < 0.05$) by Waller-Duncan MRT.

Table 9. EFFICACY OF NONREGISTERED *Bt* PRODUCTS APPLIED AT POPCORN AND PETAL FALL. JOHN EDSTROM, COLUSA CO., 1992 (n=5)

Treatment [1]	Shoot Strikes [2]
Untreated	13.0 a
Diazinon 50WP (3 lb.) + Oil	0.4 b
Javelin WG @ 1.0 lb.	0.8 b
Cutlass WP @ 1.5 lb.	0.4 b
Cutlass WP @ 2.0 lb.	1.2 b
Condor OF @ 1 qt.	2.6 b
Condor OF @ 1.25 qt.	2.4 b
MVP @ 2.0 qt.	2.8 b

[1] All materials applied in 300 gallons/acre. All treatments with 4.5 gal. oil applied during dormant season. Javelin WG is registered and was applied as a treated *Bt* control.

[2] ANOVA, $p < 0.001$; means followed by the same letter do not differ ($p < 0.05$) by Waller-Duncan MRT.

Table 10. COMPARISON OF TREATMENT TIMINGS FOR CARBARYL APPLIED AS A DORMANT OR DELAYED DORMANT TREATMENT. JOHN EDSTROM, COLUSA CO., 1992 (n=5)

Treatment [1]	Shoot Strikes [2]
Untreated	13.0 a
Diazinon 50WP (3 lb.)	0.4 b
Javelin WG (1 lb.)	2.8 b
Sevin XLR (1 gal.) mid January	0.8 b
Sevin XLR (1 gal.) late January	3.0 b
Sevin XLR (1 gal.) early pink bud	6.8 b

[1] Applied at 300 gallons/acre; All treatments with oil applied during dormant season at 4.5 gal.
[2] ANOVA, $p < 0.008$; means followed by the same letter do not differ ($p < 0.05$) by Waller-Duncan MRT.

Table 11. EFFICACY OF 2 FORMULATIONS OF CARBARYL APPLIED AS A DORMANT TREATMENT IN LATE JANUARY. JOHN EDSTROM, COLUSA CO., 1992 (n=5)

Treatment [1]	Shoot Strikes [2]
Untreated	13.0 a
Diazinon 50WP (3 lb.) + oil	0.4 b
Javelin WG (1 lb.)	2.8 b
Sevin XLR (1 gal.) + oil	3.0 b
Sevin 80S (5 lb.) + oil	2.2 b

[1] Applied at 300 gallons/acre; All treatments with oil applied during dormant season at 4.5 gal.
[2] ANOVA, $p < 0.02$; means followed by the same letter do not differ ($p < 0.05$) by Waller-Duncan MRT.

Table 12. EFFICACY OF REGISTERED PYRETHROIDS USED AS DORMANT TREATMENTS AGAINST PEACH TWIG BORER. JOHN EDSTROM, COLUSA CO., 1992 (n=5)

Treatment [1]	Shoot Strikes [2]
Untreated	8.0 a
Diazinon 50WP (3 lb.) + Oil	0.4 b
Bt (Javelin WG) 1.0 lb @ Popcorn & Petal Fall	1.0 b
Asana XL @ 10 oz. + Oil	0.0 b
Pounce 2E @ 6 oz. + Oil	0.2 b

[1] All sprays applied in 300 gallons/acre with oil at 4.5 gal.
[2] ANOVA, $p < 0.0003$; means followed by the same letter do not differ ($p < 0.05$) by Waller-Duncan MRT.

Table 13. 1992 BLOOM AND DORMANT TREATMENTS FOR PEACH TWIG BORER (SHOOT STRIKES)

COUNTY	TREATMENT	OVERWINTER GENERATION
BUTTE	Bt + OIL	0.6 (25%)
	DORMANT	--
	CHECK	0.8 (0%)
FRESNO	Bt + OIL	1.6 (--%)
	BT + DORMANT	0.0 (--%)
	DORMANT	0.6 (--%)
	CHECK	--
GLENN	Bt + OIL	2.3 (82%)
	DORMANT	5.7 (56%)
	CHECK	12.9 (0%)
KINGS	Bt + OIL	1.4 (--%)
	DORMANT	1.1 (--%)
	CHECK	--
MADERA	Bt + OIL	0.2 (80%)
	DORMANT	0.1 (90%)
	CHECK	1.0 (0%)

Table 14. 1992 PEACH TWIG BORER SHOOT STRIKES (MEAN $\pm$ (SE)) FOR ALL ORCHARDS COMBINED.

TREATMENT	Number	Percentage of Control
Bt + OIL	1.03 (0.64)	62.33 (18.68)
DORMANT	2.90 (2.80)	73.00 (17.00)
CONTROL	4.90 (4.00)	0.00 (0.00)

Table 15. 1992 BLOOM AND DORMANT TREATMENTS FOR PEACH TWIG BORER (PERCENTAGE DAMAGE AT HARVEST)

		DAMAGED MEATS		LARVAE IN HULLS		
COUNTY	TREATMENT	PTB	NOW	PTB	NOW	TOTAL
BUTTE	Bt (Biobit)+ OIL	0.2	0.8	0.8	0.1	0.9
	Bt (Dipel) + OIL	0.3	0.3	0.9	0.2	1.7
	Bt + DORMANT	0.1	1.0	1.2	0.5	2.8
	DORMANT	0.4	0.2	0.7	0.1	1.4
	CHECK	0.1	0.9	0.9	0.3	2.2
COLUSA	Bt (Biobit) + OIL	0.3	10.2	6.8	0.2	17.5
	DORMANT	0.5	7.3	7.8	4.9	20.5
	CHECK	0.2	5.2	5.1	0.4	10.9
FRESNO	Bt (Dipel) + OIL	0.0	0.3	8.4	0.4	9.1
	Bt + DORMANT	0.0	0.7	9.6	0.7	11.0
	DORMANT	0.0	0.1	8.6	0.4	9.1
	CHECK	--	--	--	--	--
GLENN	Bt (Dipel) + OIL	0.0	0.3	0.7	0.1	1.1
	DORMANT	0.1	0.1	3.2	0.4	3.8
	CHECK	0.0	0.5	5.4	0.2	6.1
KINGS	Bt (Biobit)+ OIL	2.7	1.2	25.7	0.2	29.8
	DORMANT	2.9	0.0	28.8	0.5	32.2
	CHECK	--	--	--	--	--
MADERA	Bt (Dipel) + OIL	0.1	0.6	3.8	0.1	4.6
	DORMANT	0.0	0.6	5.1	0.1	5.8
	CHECK	0.1	0.4	4.2	0.1	4.8
YOLO	Bt (Javelin)+ OIL	0.9	4.8	4.0		9.7
	DORMANT	0.8	3.6	6.3		10.7
	CHECK	0.5	3.4	10.7		14.6

Table 16. 1992 PEACH TWIG BORER DAMAGE AT HARVEST FOR ALL ORCHARDS COMBINED

TREATMENT	MEAN (SE) DAMAGE PTB	NOW	TOTAL
Bt + OIL	2.82 (1.21)	3.40 (1.93)	6.84 (3.09)
DORMANT	4.45 (1.52)	3.43 (2.93)	8.44 (3.38)
CONTROL	3.30 (1.06)	2.00 (1.21)	7.72 (2.23)

Table 17. 1992 PEACH TWIG BORER BLOOM TRIALS, PERCENT REDUCTION IN DAMAGE FOR ALL ORCHARDS COMBINED

TREATMENT	PERCENT (SE) OF CONTROL PTB	NOW	TOTAL
Bt + OIL	24.1 (21.1) a	21.3 (12.3) a	32.2 (14.8) a
DORMAN	9.7 (9.7) ab	25.9 (17.7) a	20.2 (8.5) a
CONTROL	0.0 (0.0) b	0.0 (0.0) b	0.0 (0.0) b

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

Table 18. BLOOM AND DORMANT TREATMENTS FOR PEACH TWIG BORER. PERCENTAGE INFESTED NUTS AT HARVEST. WILBUR REIL, YOLO CO. 1992.

TREATMENT	PTB	NOW	HULLS	TOTAL
Javelin	0.89 (.23)	2.5 (0.3)	3.9 (0.9)	7.5 (0.8)
Javelin + OIL	0.88 (.68)	4.8 (2.1)	4.0 (0.2)	8.0 (0.4)
Sevin XLR	1.25 (.48)	3.7 (0.6)	3.8 (0.7)	9.2 (1.6)
Sevin + OI	0.52 (.27)	3.9 (0.4)	4.7 (1.4)	9.0 (1.3)
Diazinon 50W	0.81 (.13)	4.3 (0.7)	2.5 (1.0)	7.3 (1.8)
Diazinon + OIL	0.84 (.49)	5.2 (1.3)	3.9 (1.2)	10.2 (2.3)
OIL	0.59 (.32)	3.6 (0.2)	5.3 (0.8)	9.4 (1.0)
Untreated	0.51 (.29)	3.5 (0.5)	4.5 (0.7)	9.4 (0.7)

Table 19. WEATHER DATA FOR THE AERIAL APPLICATION OF *Bacillus thuringiensis* IN THE COLUSA CO. ORCHARD, 1992.

			Wind		
February 25	Temp. ^{o}C	RH %	Direction	Speed	Precip.
12:00 hr	18	65	210	1.3	0
13:00 hr	20	58	245	1.1	0
March 3					
13:00 hr	18	60	165	3.7	0
14:00 hr	18	59	164	3.9	0

Table 20. MEAN DENSITY OF SPRAY DROPS MONITORED BY USING CARDS LOCATED IN UPPER- AND MID-CANOPY AND AT GROUND LEVEL, COLUSA CO., 1992, (MEAN DROPS PER CM^2).

	mean drops	± CI	mean drops	± CI
First Application				
Top	21.8	4.2	14.0	8.0
Middle	10.5	4.8	11.4	1.2
Ground	18.6	3.6	16.2	3.0
Second Application				
Top	14.0	2.8	11.2	0.3
Middle	10.4	3.8	9.0	3.2
Ground	8.8	3.2	9.6	0.5

Table 21. MEAN DENSITY OF SPRAY DROPS MONITORED BY USING STRAWS POSITIONED IN THE UPPER- AND MID-CANOPY LOCATIONS, COLUSA CO., 1992, (MEAN DROPS PER CM^2).

	mean drops	± CI	mean drops	± CI
First Application				
Top	6.4	4.3	7.8	4.2
Middle	6.0	3.5	4.2	1.6
Second Application				
Top	6.4	2.0	4.0	1.0
Middle	4.0	1.8	3.2	0.8

Table 22. ULTRA LOW VOLUME (ULV) AERIAL *Bt* TRIAL, COLUSA CO. 1992. APPLICATIONS MADE AT POPCORN AND PETAL FALL (PERCENTAGE OF NUTS AT HARVEST)

TREATMENT	DAMAGED MEATS PTB	DAMAGED MEATS NOW	LARVAE IN HULLS	TOTAL LARVAE
Bt Plot 1	0.0	13.1	2.9	16.0
Bt Plot 2	0.0	19.3	5.9	25.2
Dormant	0.2	14.1	2.8	17.1
Check 1	0.6	23.2	8.3	32.1
Check 2	0.3	24.1	5.1	29.5

Table 23. ULTRA LOW VOLUME (ULV) AERIAL *Bt* TRIAL, FRESNO CO. 1992, APPLIED BY BILL BARNETT AND RICH COVIELLO. APPLICATIONS MADE AT POPCORN AND PETAL FALL. (SHOOT STRIKES PER TREE ON MARCH 31)

TREATMENT	Mean $\pm$ SE
Dipel AF	2.57 ± 1.00
Dipel ES	2.33 ± 0.99
Diazinon + Oil	1.80 ± 1.32
Untreated Control	12.93 ± 1.32

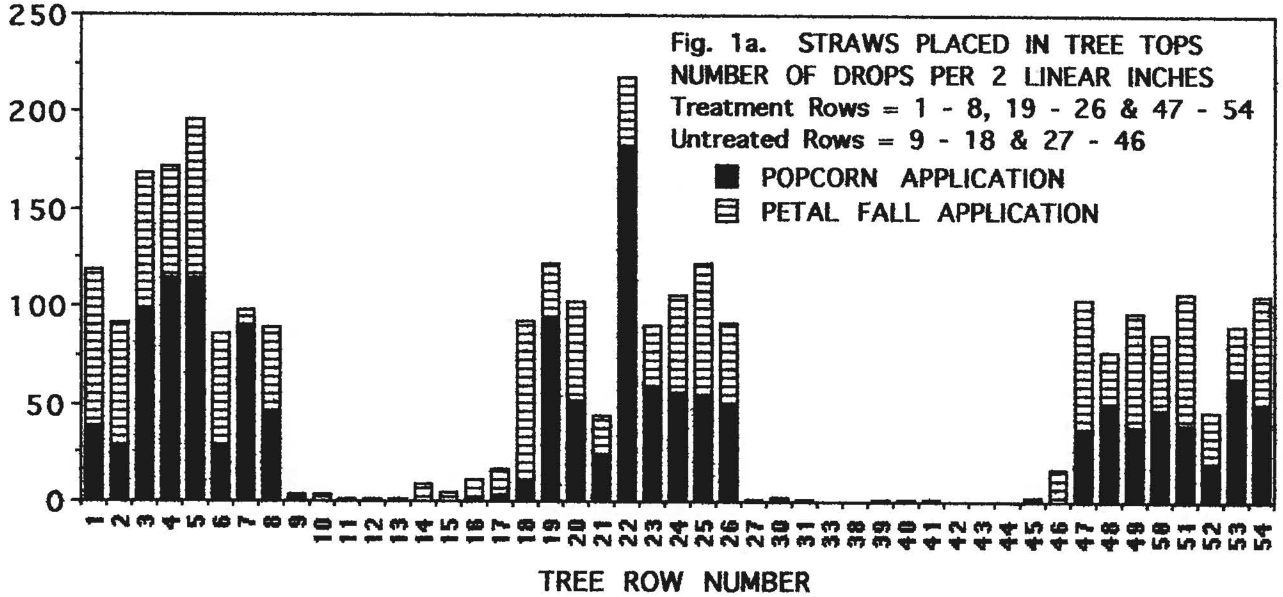

Fig. 1a. STRAWS PLACED IN TREE TOPS
NUMBER OF DROPS PER 2 LINEAR INCHES
Treatment Rows = 1 - 8, 19 - 26 & 47 - 54
Untreated Rows = 9 - 18 & 27 - 46

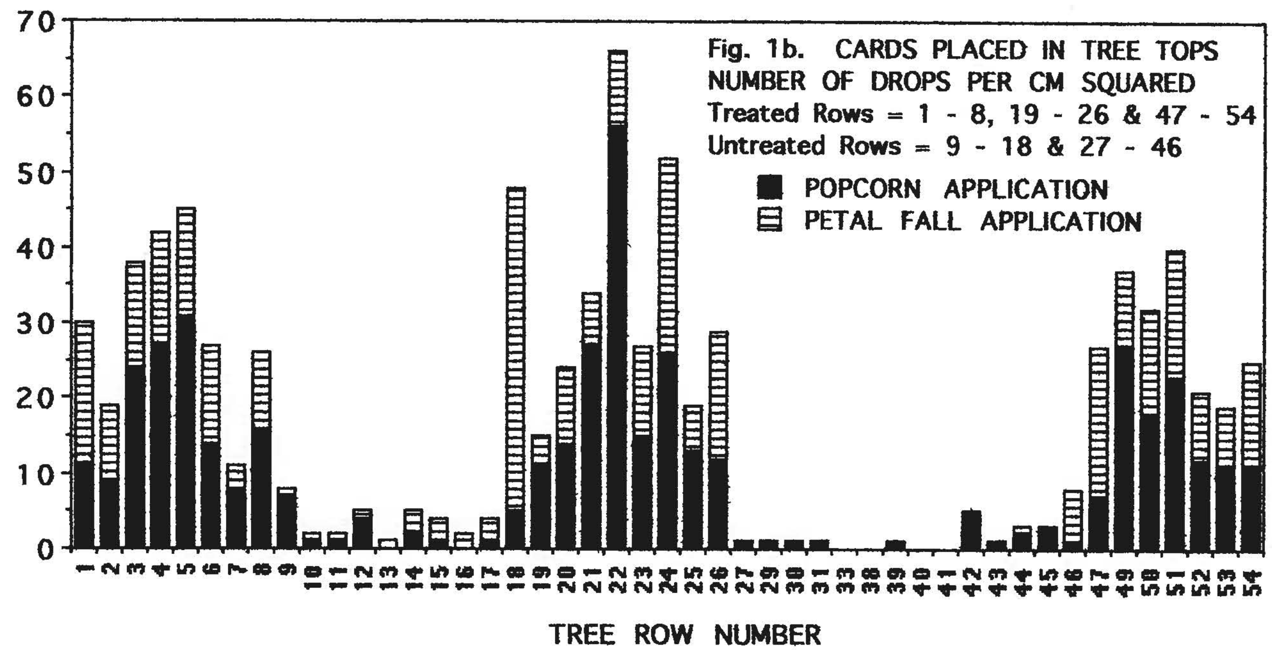

Fig. 1b. CARDS PLACED IN TREE TOPS
NUMBER OF DROPS PER CM SQUARED
Treated Rows = 1 - 8, 19 - 26 & 47 - 54
Untreated Rows = 9 - 18 & 27 - 46

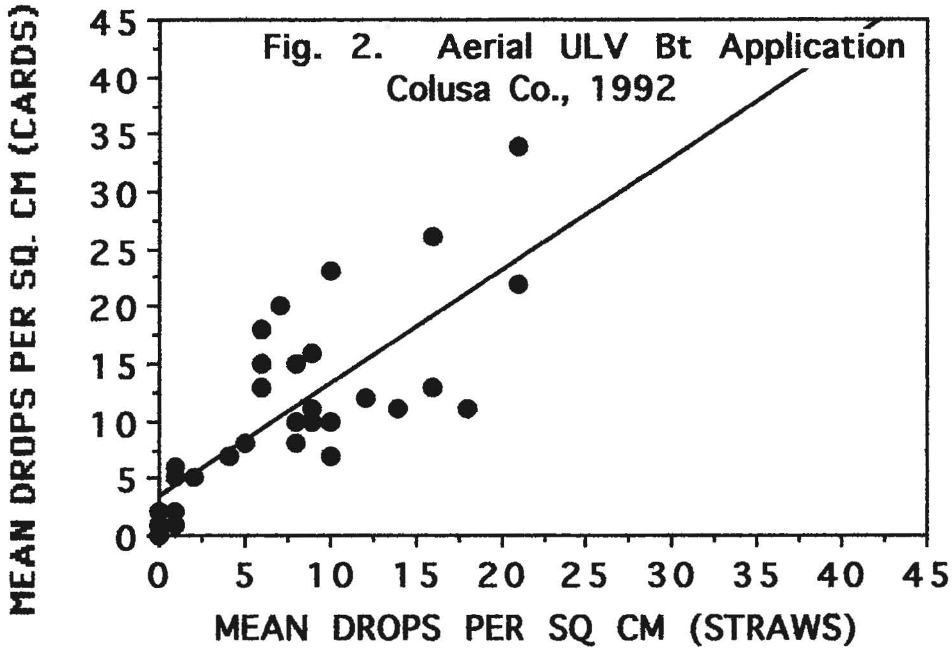
Fig. 2. Aerial ULV Bt Application
Colusa Co., 1992
MEAN DROPS PER SQ. CM (CARDS)
MEAN DROPS PER SQ CM (STRAWS)
0
5
10
15
20
25
30
35
40
45

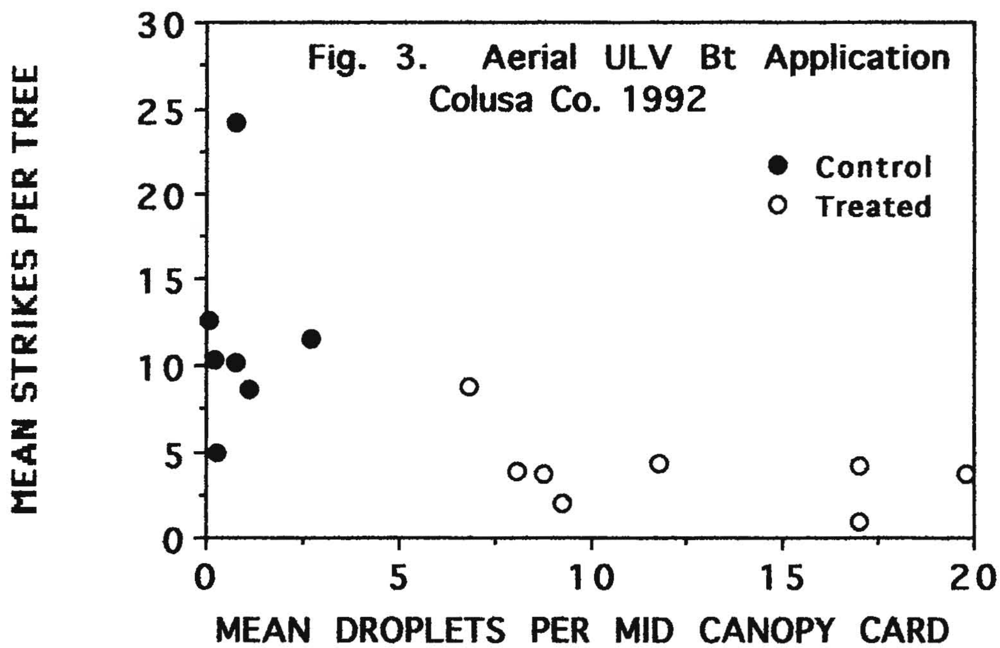
Fig. 3. Aerial ULV Bt Application
Colusa Co. 1992
Control
Treated
MEAN STRIKES PER TREE
MEAN DROPLETS PER MID CANOPY CARD
0
5
10
15
20
25
30

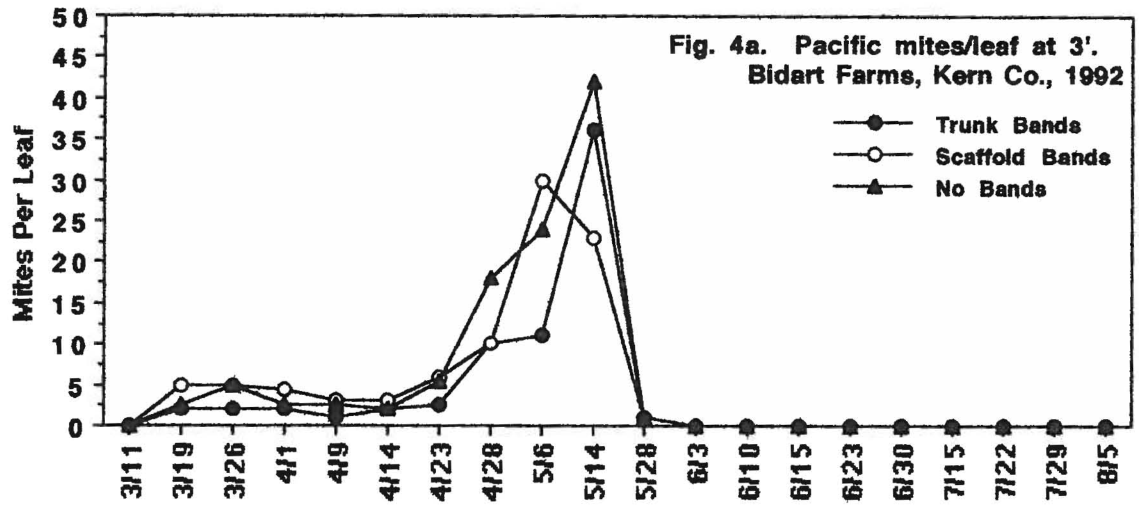

Fig. 4a. Pacific mites/leaf at 3'. Bidart Farms, Kern Co., 1992

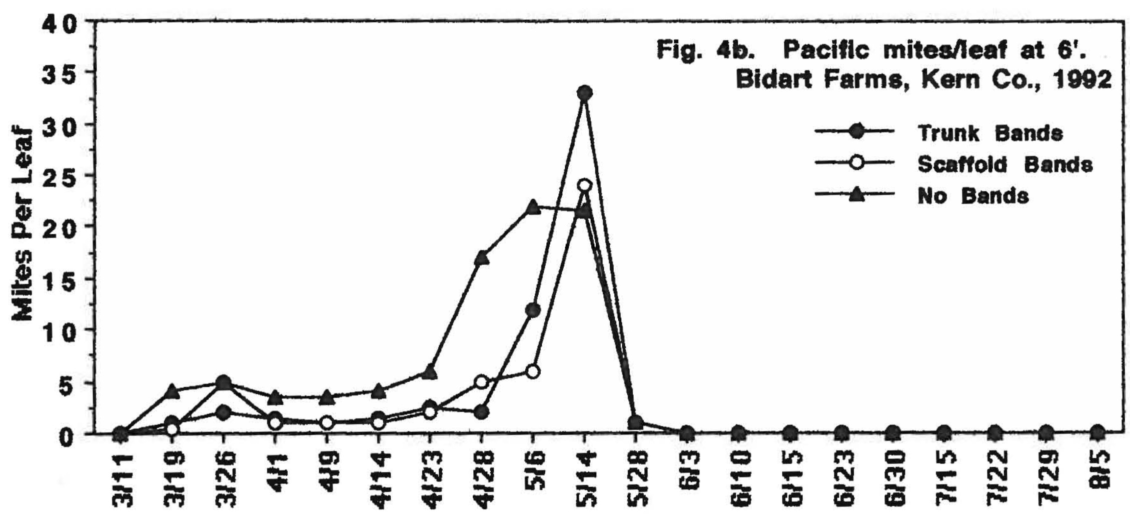

Fig. 4b. Pacific mites/leaf at 6'. Bidart Farms, Kern Co., 1992

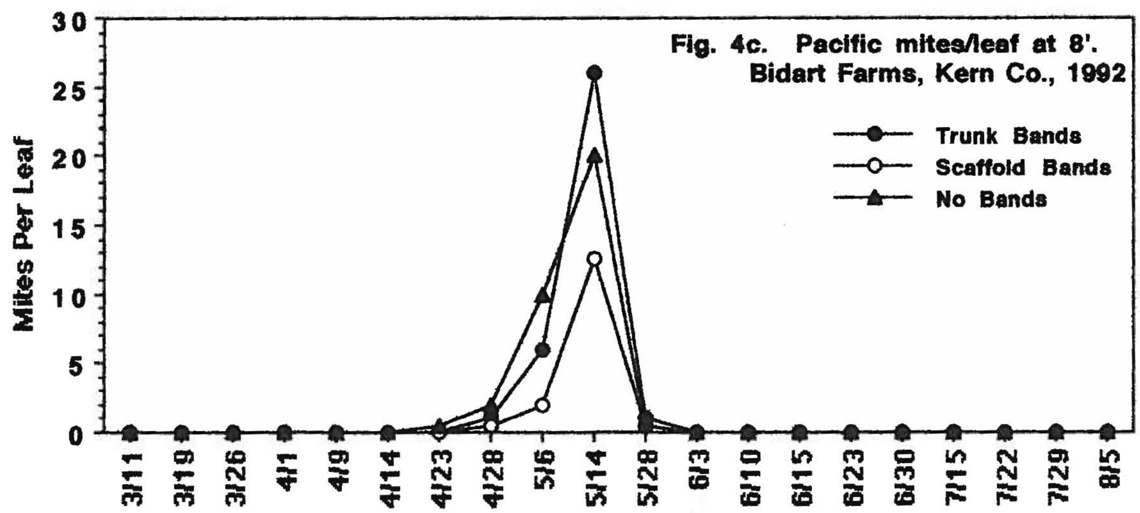

Fig. 4c. Pacific mites/leaf at 8'. Bidart Farms, Kern Co., 1992

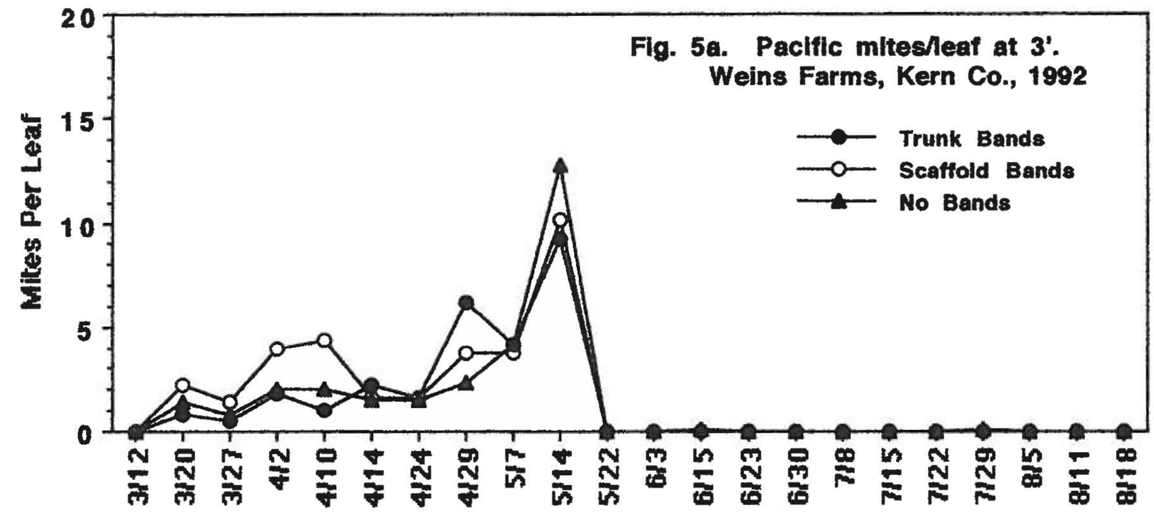
Fig. 5a. Pacific mites/leaf at 3'.
Weins Farms, Kern Co., 1992
Trunk Bands
Scaffold Bands
No Bands
Mites Per Leaf
0
5
10
15
20
3/12
3/20
3/27
4/2
4/10
4/14
4/24
4/29
5/7
5/14
5/22
6/3
6/15
6/23
6/30
7/8
7/15
7/22
7/29
8/5
8/11
8/18

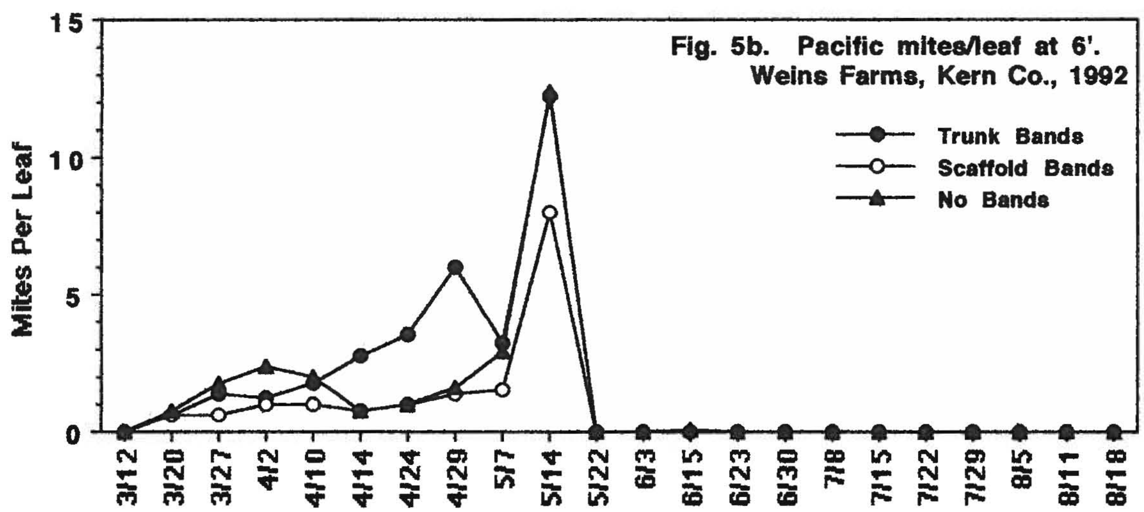
Fig. 5b. Pacific mites/leaf at 6'.
Weins Farms, Kern Co., 1992
Trunk Bands
Scaffold Bands
No Bands
Mites Per Leaf
0
5
10
15
3/12
3/20
3/27
4/2
4/10
4/14
4/24
4/29
5/7
5/14
5/22
6/3
6/15
6/23
6/30
7/8
7/15
7/22
7/29
8/5
8/11
8/18

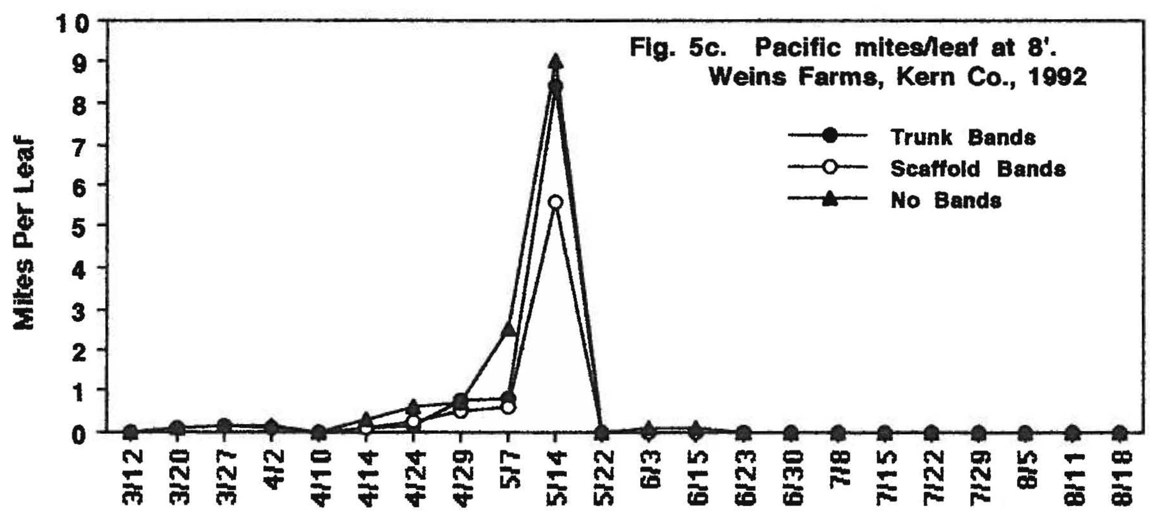
Fig. 5c. Pacific mites/leaf at 8'.
Weins Farms, Kern Co., 1992
Trunk Bands
Scaffold Bands
No Bands
Mites Per Leaf
0
1
2
3
4
5
6
7
8
9
10
3/12
3/20
3/27
4/2
4/10
4/14
4/24
4/29
5/7
5/14
5/22
6/3
6/15
6/23
6/30
7/8
7/15
7/22
7/29
8/5
8/11
8/18

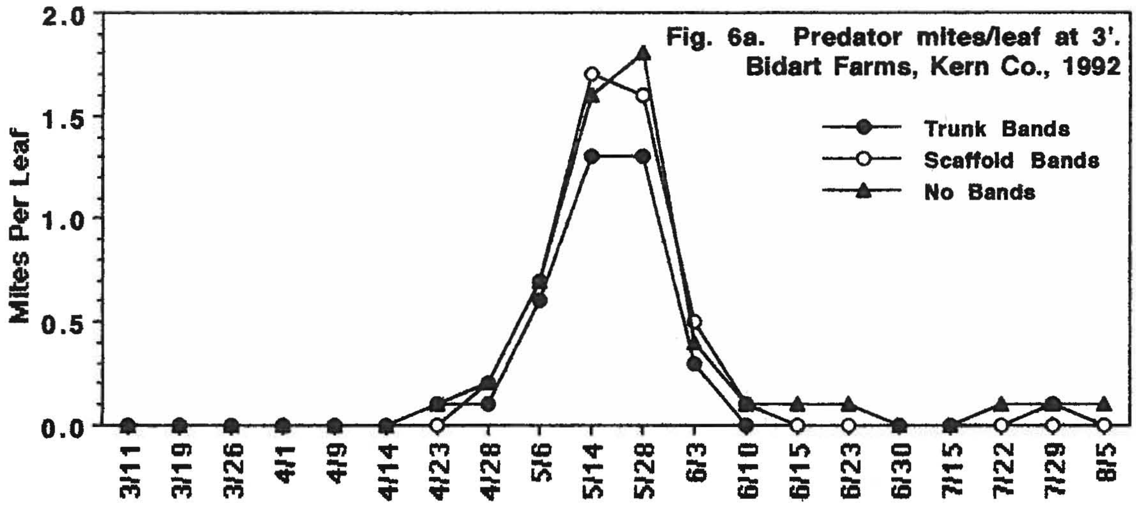
Fig. 6a. Predator mites/leaf at 3'.
Bidart Farms, Kern Co., 1992
Trunk Bands
Scaffold Bands
No Bands
Mites Per Leaf
2.0
1.5
1.0
0.5
0.0
3/11
3/19
3/26
4/1
4/9
4/14
4/23
4/28
5/6
5/14
5/28
6/3
6/10
6/15
6/23
6/30
7/15
7/22
7/29
8/5

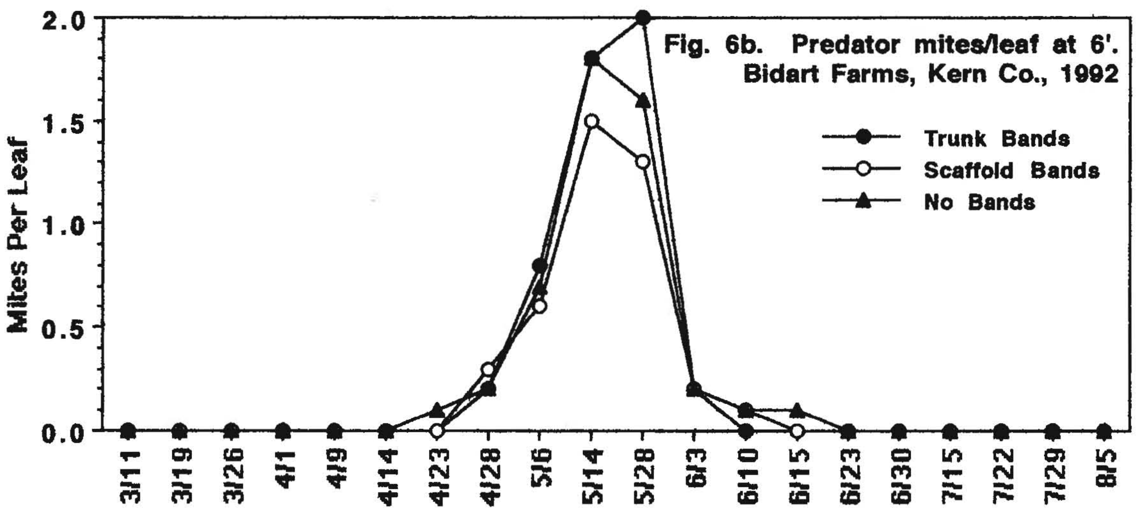
Fig. 6b. Predator mites/leaf at 6'.
Bidart Farms, Kern Co., 1992
Trunk Bands
Scaffold Bands
No Bands
Mites Per Leaf
2.0
1.5
1.0
0.5
0.0
3/11
3/19
3/26
4/1
4/9
4/14
4/23
4/28
5/6
5/14
5/28
6/3
6/10
6/15
6/23
6/30
7/15
7/22
7/29
8/5

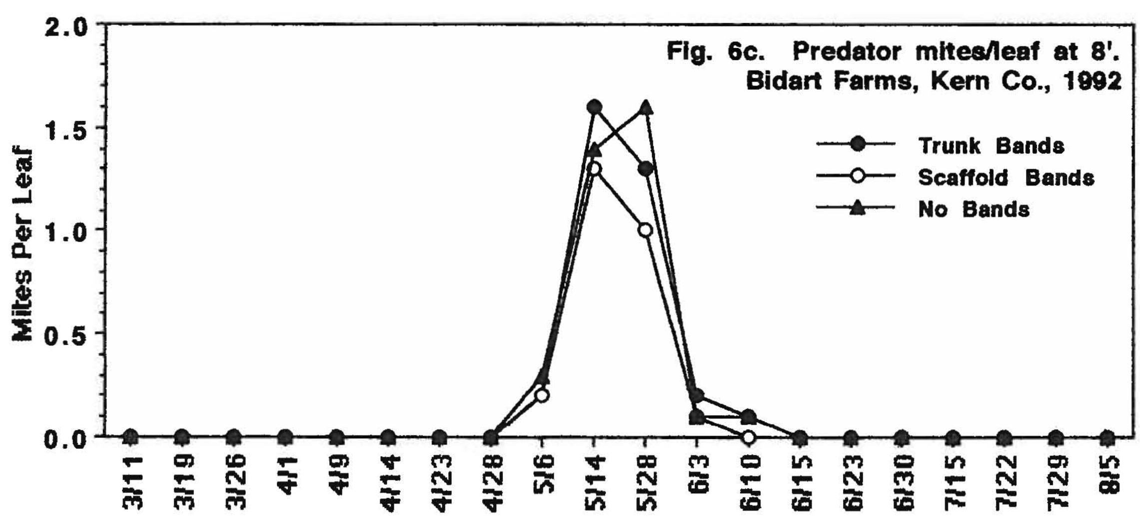
Fig. 6c. Predator mites/leaf at 8'.
Bidart Farms, Kern Co., 1992
Trunk Bands
Scaffold Bands
No Bands
Mites Per Leaf
2.0
1.5
1.0
0.5
0.0
3/11
3/19
3/26
4/1
4/9
4/14
4/23
4/28
5/6
5/14
5/28
6/3
6/10
6/15
6/23
6/30
7/15
7/22
7/29
8/5

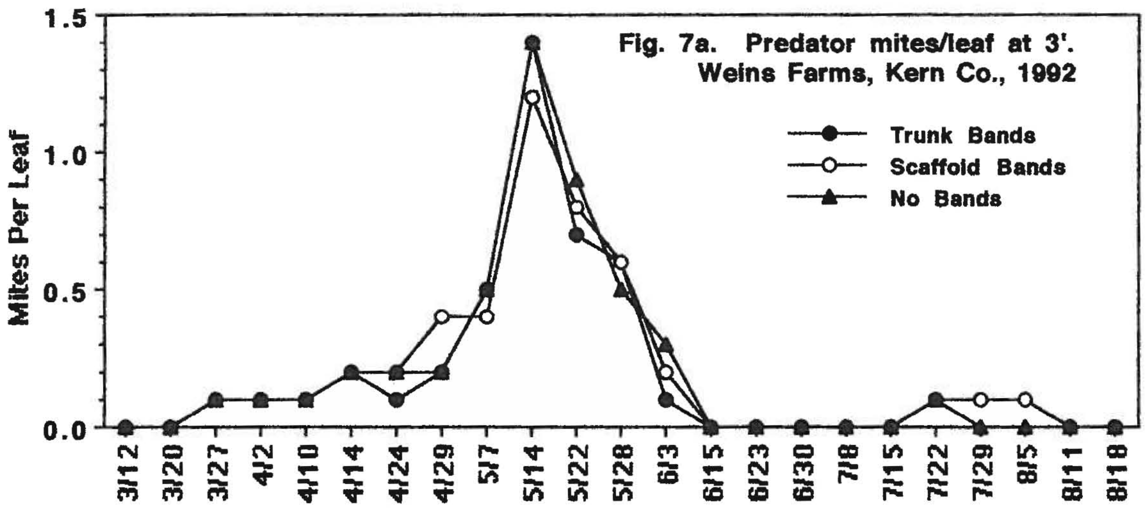
Fig. 7a. Predator mites/leaf at 3'.
Weins Farms, Kern Co., 1992
Trunk Bands
Scaffold Bands
No Bands
Mites Per Leaf
1.5
1.0
0.5
0.0
3/12
3/20
3/27
4/2
4/10
4/14
4/24
4/29
5/7
5/14
5/22
5/28
6/3
6/15
6/23
6/30
7/8
7/15
7/22
7/29
8/5
8/11
8/18

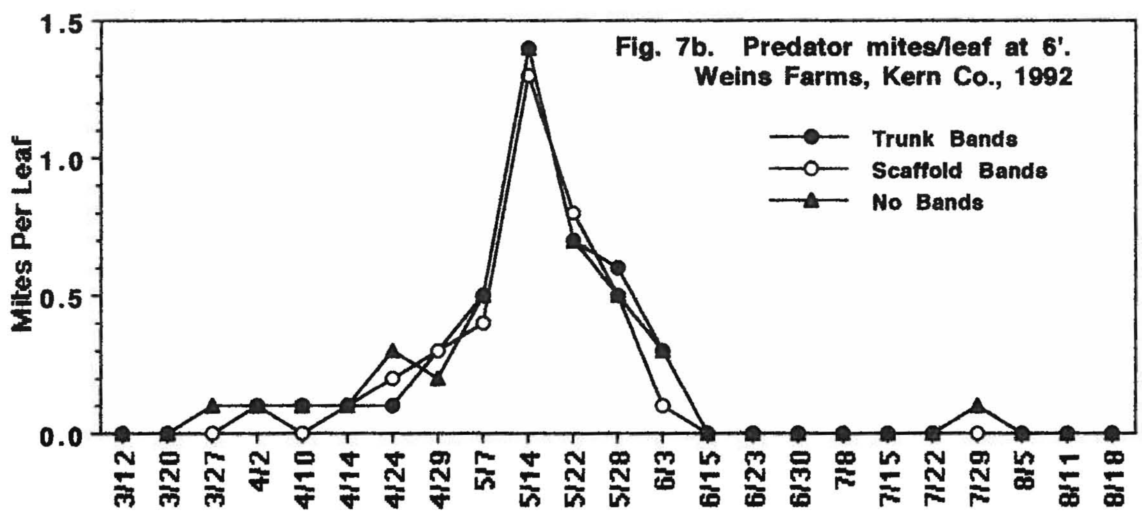
Fig. 7b. Predator mites/leaf at 6'.
Weins Farms, Kern Co., 1992
Trunk Bands
Scaffold Bands
No Bands
Mites Per Leaf
1.5
1.0
0.5
0.0
3/12
3/20
3/27
4/2
4/10
4/14
4/24
4/29
5/7
5/14
5/22
5/28
6/3
6/15
6/23
6/30
7/8
7/15
7/22
7/29
8/5
8/11
8/18

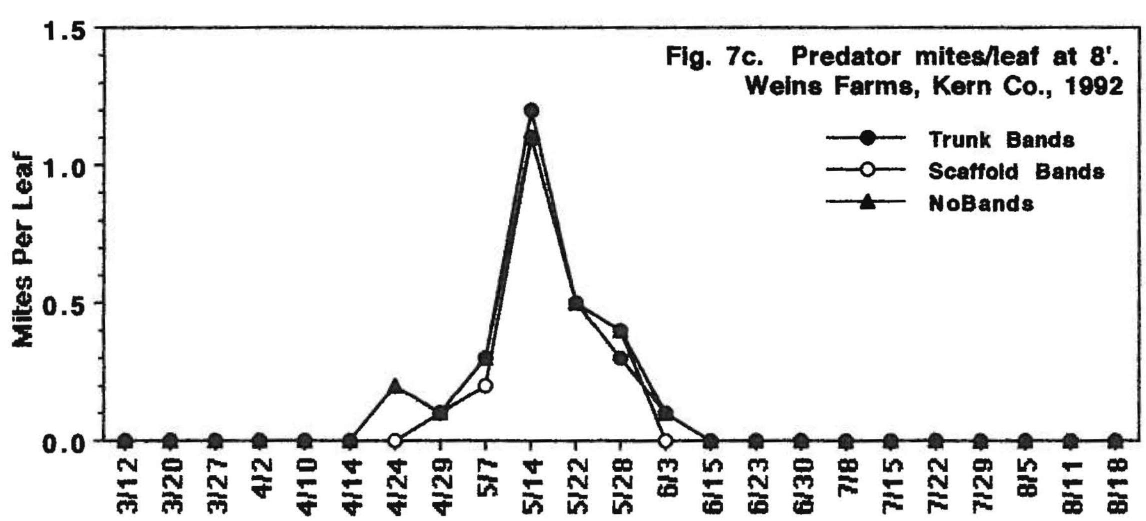
Fig. 7c. Predator mites/leaf at 8'.
Weins Farms, Kern Co., 1992
Trunk Bands
Scaffold Bands
NoBands
Mites Per Leaf
1.5
1.0
0.5
0.0
3/12
3/20
3/27
4/2
4/10
4/14
4/24
4/29
5/7
5/14
5/22
5/28
6/3
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6/30
7/8
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7/29
8/5
8/11
8/18

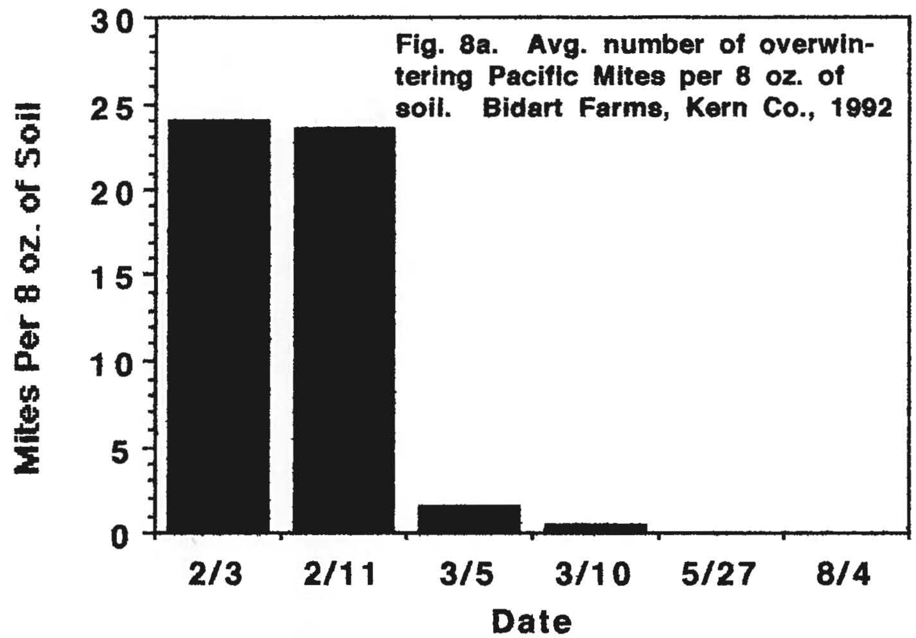

Fig. 8a. Avg. number of overwintering Pacific Mites per 8 oz. of soil. Bidart Farms, Kern Co., 1992

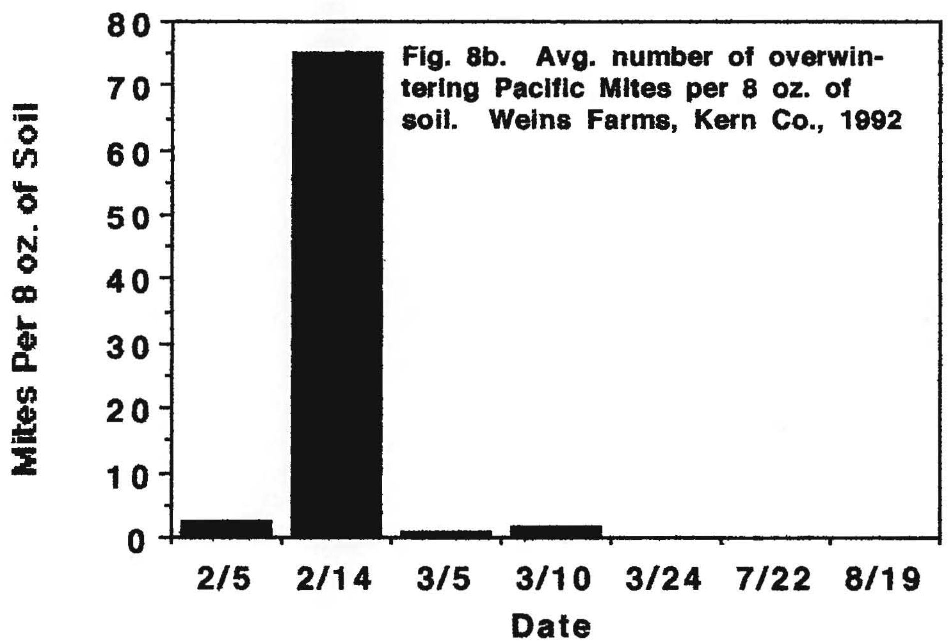

Fig. 8b. Avg. number of overwintering Pacific Mites per 8 oz. of soil. Weins Farms, Kern Co., 1992