DEVELOPING MONITORING METHODS FOR ORIENTAL FRUIT MOTH IN MATING DISRUPTION ORCHARDS

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This report summarizes a project funded in 2004 to develop better damage estimates for Oriental fruit moth (OFM) in mating disruption orchards. Originally the project was designed for development of an area mating disruption program. The cost to the California Tree Fruit Agreement would have been considerable. A summary of this less intensive project follows.

METHODS AND MATERIALS

Nine orchards with a history of using OFM mating disruption were chosen for the project and were intensively monitored in 2004. Varieties included Springcrest (1 orchard), Elegant Lady (2 orchards), Summer Red (2 orchards), O' Henry (1 orchard), August Red (1 orchard), Ryan Sun (1 orchard), and August Lady (1 orchard). Harvests ranged from May through August. The mating disruptant products used were Isomate's M Rosso and the new Twin Tube (under a research authorization for limited acreage). These were applied at the manufacturers recommended rates. The Springcrest, O'Henry, August Red, Ryan Sun, and August Lady orchards were treated with M Rosso. A second application of Isomate's M 100 was applied to each of these orchards in late July. The other orchards were treated with the Twin Tube. The Twin Tube product was active for 180 days. Applications were done within the first week of March 2004.

Two OFM pheromone traps were placed in each orchard (8 ft height on north side of tree) and monitored on a weekly basis. Traps were placed on February 9 and trapping continued into October. The pheromone traps used were Trece' VI Delta Traps with Trece' L2 OFM monitoring capsules. The capsules were changed every two months and the sticky bottoms were changed if dirty. Additionally, peach twig borer was also monitored with Trece' Long Life PTB lures and Trece' VI Delta traps. The same procedures were used for PTB as with OFM.

In addition to the pheromone monitoring, terpinyl acetate bait pan traps were also employed at the beginning of each flight. The bait consisted of a mixture of terpinyl acetate (10 ml), brown sugar (4 lb), water (5 gallons), and latron CS-7 emulsifier (2 ml). A single bait pan was used in

each orchard and placed in the center of the orchard in the upper canopy on the north side of the tree. The bait pans were checked weekly during each monitoring period. OFM males and females were removed and tabulated. The mating success of females was also tabulated.

Because OFM larvae infest young terminal shoot growth prior to fruit infestation, infested shoots were also evaluated at the end of each generation. Twenty-five trees were monitored at four times during the season in each orchard. Infested shoots are called shoot strikes and serve as an indication for successful mating and potential fruit infestation. Four dates were chosen for recording: April 28, June 7, July 19, and September 13. In each block, 25 trees were chosen at random. Shoot strikes were counted at timed intervals, which consisted of 1 minute per tree. The results of the bait pan trap catches were correlated to the strike counts at the end of the first and second generation.

Five hundred fruit from each orchard were examined at harvest. The fruit was evaluated for pest infestation with particular interest in OFM infestation.

Although not in the project proposal, an insecticide efficacy trial targeting OFM was also performed. Nine treatments were evaluated for OFM management in peaches. Six replications of single-tree treatments were made. All treatments were applied on May 27 at approximately 585 dd after the first moth of the second flight. Novaluron (Diamond®) was applied at 1.6 lb per acre and 2.5 lb per acre. A third Diamond treatment (1.6 lb per acre) was made on both May 27 and July 8. The second treatment was 400 dd into the third flight. The remaining insecticides were indoxacarb (Avaunt®) at 6 oz per acre, thiacloprid (Calypso®) at 4 oz and at 6 oz per acre, spinosad (Entrust®) at 2.5 oz per acre, spinosad (Success®) at 6 oz per acre, phosmet (Imidan®) at 4 lbs per acre, a water treatment, and an untreated check. The amounts were based on the formulated product. Treatments were replicated 5 times to single trees.

Evaluation of treatment effects was based on two separate shoot infestation counts made on June 9 and July 22. A harvest evaluation of 20 fruit per tree (100 per treatment) was also done on July 15. Fruit was also examined for any signs of phytotoxicity. No fruit damage due to insecticides was seen.

RESULTS

Pheromone trapping for OFM resulted in very few moths caught. A single moth was trapped in the Summer Red orchard, 3 trapped in the August Lady orchard, and 2 trapped in the O'Henry orchard. Moths were trapped in late March and early April. No other moths were trapped during the season. Figure 1 presents the seasonal flight for OFM at the Kearney Agricultural Center where no mating disruption was done. A total of 4 generations were seen in the Crimson Lady

orchard. OFM, in this orchard, were heavily parasitized. In August, larval samples resulted in 100% parasitism.

The results of the bait pan trapping were more successful. A total of 1,576 moths were trapped in 9 weeks of trapping ranging from April 2 to July 2. Females totaled 924 (59%) and males totaled 652 (41%). Of the 924 females, 721 (78%) were mated. These were all from mating disruption orchards where pheromone traps were not catching male moths. Table 1 presents a summary of OFM trapped in bait pan traps.

There was a substantial difference in the percentage of mated females in the orchard with the highest bait pan trap (August Lady, 180 females and 84% mated) and those with the lowest bait pan trap catches (Springcrest, 27 females and 59% mated; O'Henry 26 females and 62% mated). The August Lady orchard (approximately 12 acres) is adjacent to an untreated almond orchard and an untreated plum orchard. The Springcrest orchard is surrounded by other orchards under mating disruption programs. The O' Henry orchard, with the exception of a grafted peach planting to the west, is also bordered by mating disruption orchards. Figures 2, 3, and 4 represent the number of female moths trapped and the number mated for the August Lady, Springcrest, and O'Henry orchards respectively.

Shoot strikes caused by OFM increased through the season for each of the orchards. On April 28, the average shoot strikes per tree ranged from 0 (August Red and Summer Red orchard) to 3.56 in the August Lady orchard. The August Lady orchard was the only orchard that averaged over 1 strike per tree (See figure 5). The general guide for an OFM spray is an average of 3 strikes per tree.

On June 7, after the second flight of OFM, shoot strikes ranged from .2 per tree (August Red orchard) to 4.04 (August Lady orchard). The August Red, Springcrest and Summer Red P orchard averaged the fewest shoot strikes. Clearly the August Lady orchard was going to require an insecticide application. Figure 6 presents the average strike count for each orchard on June 7.

The third count of strikes due to OFM occurred on July 19. The counts ranged form 13.56 for the Elegant Lady orchard C to 1.24 in the O'Henry orchard. Both Elegant Lady orchards had been harvested at this time. In examining shoots for worms, in the Elegant Lady orchard, the majority of strikes were due to peach twig borer. The August Lady orchard had received two sprays aimed at OFM a treatment was made on May 28 (during the second flight) and another on June 30 (during the third flight). Spinosad (Success®) was applied at the rate of 6 ounces per acre for each application. The August Lady orchard still had the seconds highest strike counts with an average of 8.64 per tree. Figure 7 presents the average strike count for each orchard on

July 19. At this date, strike counts from OFM and PTB become increasingly difficult to separate.

The fourth count of OFM occurred on September 13. The average number of strikes per tree ranged from 1.5 per tree (Summer Red) to 15.84 per tree (August Red). All fruit had been harvested by September 13. Figure 8 presents the average number of strikes per tree from each orchard. These figures should give and indication of the development of OFM late in the season and the population in 2004.

A regression analysis was done that related the number of mated females for the season to the average number of strikes per tree for each orchard. A significant and direct relationship was found with the April and June strike counts. The Correlation Coefficient for the June strike counts and the number of mated females was 0.79 and significant at the 0.014 level. The Correlation Coefficient for the April strike counts and mated females was 0.71 and significant at the 0.032 level. Both figures can be used to predict the need for treatment.

Fruit infestation due to OFM was low in all cases. The following varieties were harvested on the dates indicated: Springcrest, May 6; O'Henry, July 22; Ryan Sun, July 27; August Red, August 9; Summer Red, August 2; and August Lady, August 6. Figure 9 presents the results of insect infestation due to four key pests. The greatest amount of OFM damage occurred in the first harvest of O'Henry peach. Three fruit from a 500 fruit sample were infested with OFM. Four of the orchards had no damage from OFM, four had 1 fruit in 500 infested, and two orchards had 2 fruit damaged. Forktailed bush katydid caused the most damage, but was still very low. The Summer Red C orchard had 1% katydid damage (5 fruit in 500 sampled). Two orchards had no katydid damage, two had 1 fruit damaged, four had 2 fruit damaged, one orchard had 3 fruit damaged and one had 4 fruit damaged. Thrips, omnivorous leafroller and San Jose scale were of minor concern.

Only the June strike evaluation OFM produced a difference based on insecticide treatment effects in the experimental trial (Table 2). The June 9 evaluation resulted in the Avaunt, 4 oz. Calypso, 2.5 lb. Diamond and the 4 lb. Imidan treatments performing best. Of these pesticides, Avaunt and the highest rate of Diamond were the only two significantly different ($P< 0.05$, Fisher's Protected LSD) than both the untreated and the water treatment. The following figures represent the average number of shoot strikes per tree on June 9: Avaunt, 0.2; Diamond at 2.5 lb, 0.4; Calypso at 4 oz, 0.6; Imidan at 4 lb, 0.6; Success, 1; Calypso at 6 oz, 1.4; Diamond at 1.6 (1 spray), 1.6; Entrust at 2.5 oz, 2.2; Untreated 2.4, Diamond at 1.6 (first of 2 sprays), 2.8; and water treatment 3.0. Numerically, the Avaunt application performed best but was not significantly different ($P<0.05$ Fisher's Protected LSD) than either Calypso spray, the single Diamond spray at 1.6 lb, the single Diamond spray at 2.5 lb, the Imidan spray, or the Success spray. The 2.5 lb rate of Diamond was no different from the above materials plus the Entrust.

The July 22 shoot strike evaluations did not result in a statistical difference among any of the treatments. Only a single fruit (water treatment) was found infested with OFM at harvest on July 15. Table 2 presents this information.

CONCLUSION

Management of OFM with mating disruption was successful in each of the orchards monitored in 2004. Only two orchards applied supplemental sprays in early June for OFM. These were the Ryan Sun and August Lady varieties. The August Lady orchard was also treated in July with spinosad. Each of these varieties had infestation problems in the past. The August Lady treatments were based on strike counts observed in April and June. The Ryan Sun treatment was not warranted based on strike counts in April and June, but because of the history of damage. A single spinosad spray was applied in early June.

The capture of a substantial number of moths in bait pan traps, while none were trapped in pheromone traps, indicates that significant mating does continue in mating disruption orchards. While most research entomologists are aware of this, most commercial farmers may be surprised with this information. The lowest level of mating success was during the first and second flights where mating success was below 70%. During the third flight, mating success was 73 to 75%. During the fourth flight mating approached 90%. The orchards with the lowest number of moths trapped (Springcrest and O' Henry) also had the lowest mating throughout the season. Each of these orchards had been under mating disruption for a number of years and, based on the shoot strikes, OFM populations were the lowest of any orchards. The close relationship found between mated moths and shoot strikes indicates that counting strikes, particularly during the first two flights, is a good indication of damage potential. Also strikes found in the early generations can be used to as indicators for the most optimum control of OFM. This timing is 500 dd into the second flight. An average of three strikes per tree at the end of the first and second flights appears to be an indicator of need to spray for varieties harvested in late July and August.

Overall, no orchard had more than .5% OFM damage at harvest. Four of the 9 orchards had no OFM infestation. No peach twig borer infestation was detected. Only two orchards had San Jose scale infestation, both less than 0.2%. Damage from forktailed bush katydid was the most common type of damage, but and averaged 0.4%.

The results of the OFM insecticide trial are encouraging. Two reduced risk materials, Avaunt and Diamond performed equally to the most common organophosphate, Imidan. Pressure in the trial block is low and a similar treatment will be done in 2005 to validate these trials. Avaunt is not currently registered but is effective on katydid as well as OFM.

With the availability of OFM mating disruption products that last for 180 days or more the peach and nectarine farmers are in a better position to develop long term mating disruption. University of California recommendations are for complete disruption through September. Integrating these

longer lasting products with late season sprayable products should make this approach more feasible. Also, the availability of effective insecticides for OFM management, particularly August harvested varieties, makes it possible to gradually reduce the level of organophosphate and pyrethroid materials that are being regulated.

ACKNOWLEDGEMENTS

We wish to thank cooperating growers Bill Chandler, Ty Parkinson, and Rick Schellenberg for their assistance in this project. We also thank the California Tree Fruit Agreement for financial support. Pacific BioControl made generous donations as well.

Table 1. Summary of Oriental fruit moth bait pan catches in 2004.

Date	Total Moths	Total Females	Mated Females	Non	Percent Mated	Total Males
4/3	129	**64**	**43**	**21**	67.19%	**65**
4/10	460	193	126	67	65.28%	267
4/17	85	48	35	13	72.92%	37
4/24	68	33	21	12	63.64%	35
6/5	81	53	37	16	69.81%	28
6/15	65	38	28	10	73.68%	27
6/19	17	8	6	2	75.00%	9
6/26	151	112	90	22	80.36%	39
7/3	520	375	335	40	89.33%	145
Season Total	**1576**	**924**	**721**	**203**	**78.03%**	**652**

Table 2. Affect of various insecticide application (May 27, 2004)

Pesticide	**Rate/Acre**	**Strikes/tree 6/9**	**Strikes/tree 7/22**	**Infested Fruit**
Avaunt	6 oz	0.2 (± .2) a	31.4 (± 5.8)	0
Calypso	4 oz	0.6 (± .4) abc	36.2 (± 5.8)	0
Calypso	6 oz	1.4 (± .4) abcd	32.4 (± 4.6)	0
Diamond (2 apps)	1.6 lb	2.8 (± .58) cde	23.2 (± 3.2)	0
Diamond	1.6 lb	1.6 (± .51) abcde	30.0 (± 1.7)	0
Diamond	2.5 lb	0.4 (± .25) ab	20.8 (± 3.6)	0
Entrust	2.5 lb	2.2 (± .58) bcde	35.2 (± 5.5)	0
Imidan	4 lb	0.6 (± .40) abc	32.4 (± 4.2)	0
Success	8 oz	1.0 (± .63) abcd	23.0 (± 3.6)	0
Water		2.4 (± 1.12) cde	34.8 (± 6.6)	1
Untreated		3.0 (± 1.45) e	25.8 (± 3.5)	0

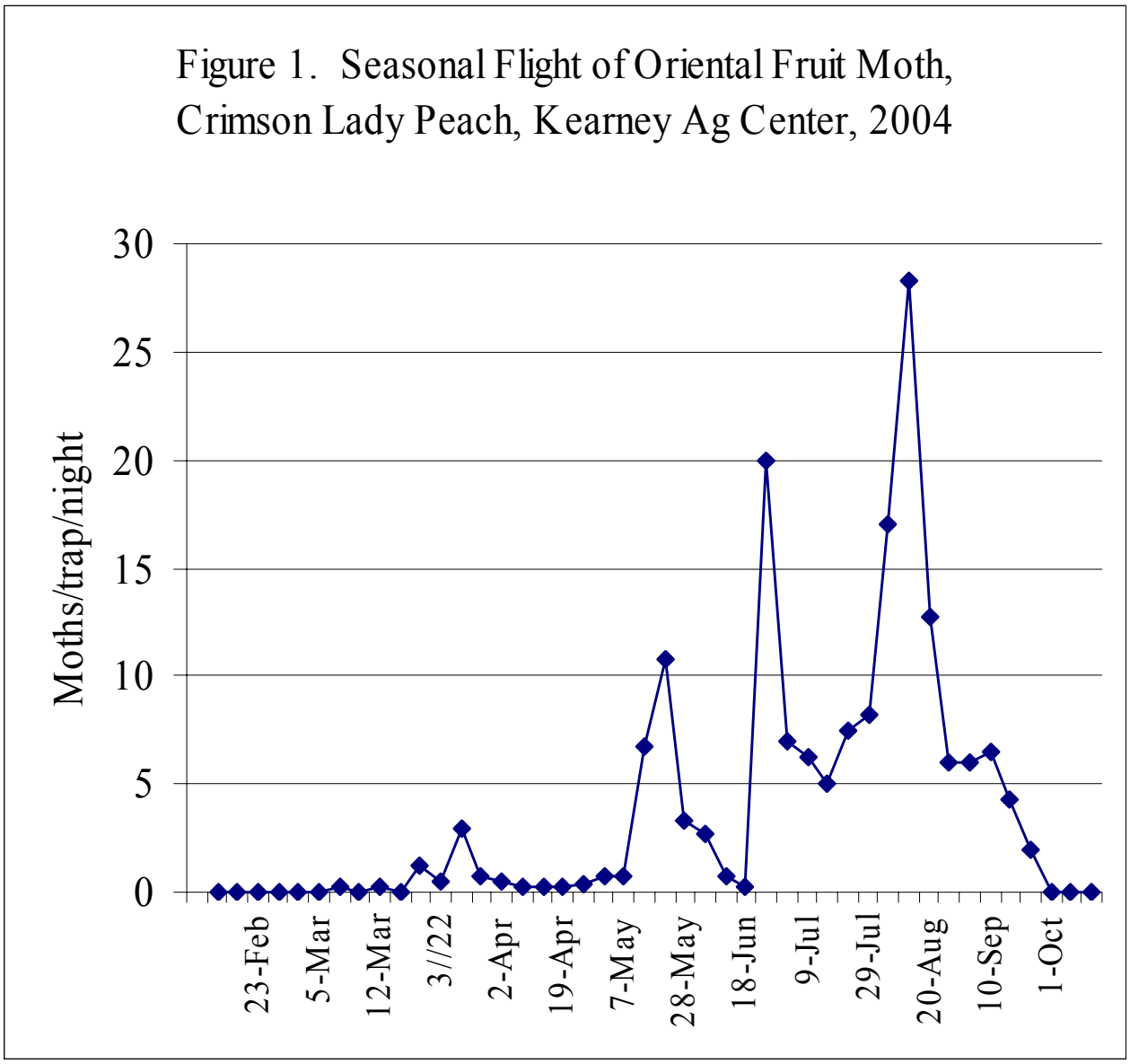
Figure 1. Seasonal Flight of Oriental Fruit Moth,
Crimson Lady Peach, Kearney Ag Center, 2004
Moths/trap/night
30
25
20
15
10
5
0
23-Feb
5-Mar
12-Mar
3//22
2-Apr
19-Apr
7-May
28-May
18-Jun
9-Jul
29-Jul
20-Aug
10-Sep
1-Oct

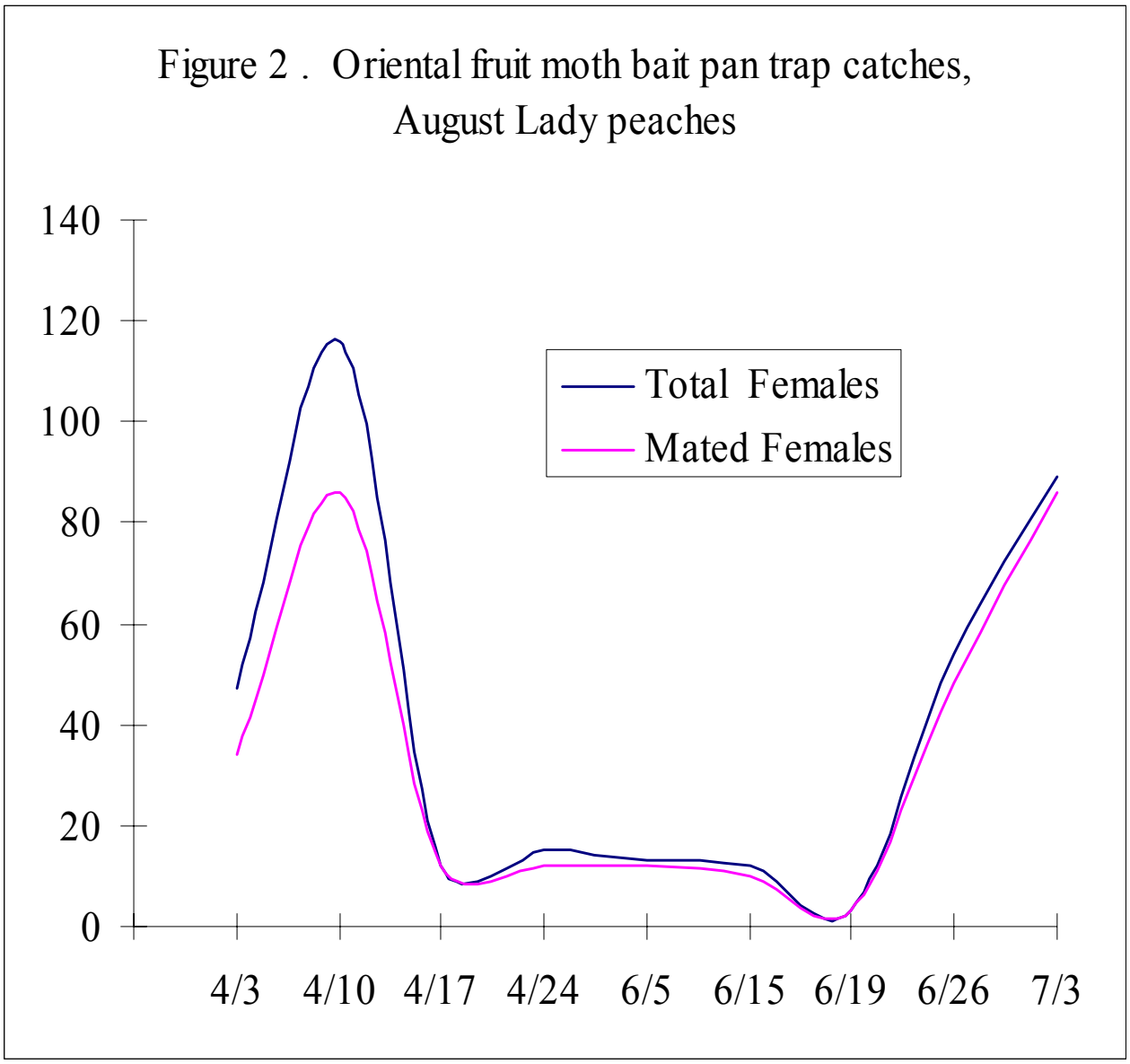
Figure 2 . Oriental fruit moth bait pan trap catches,
August Lady peaches
140
120
100
80
60
40
20
0
Total Females
Mated Females
4/3
4/10
4/17
4/24
6/5
6/15
6/19
6/26
7/3

Figure 3. Oriental fruit moth bait pan trap catches, Springcrest peaches

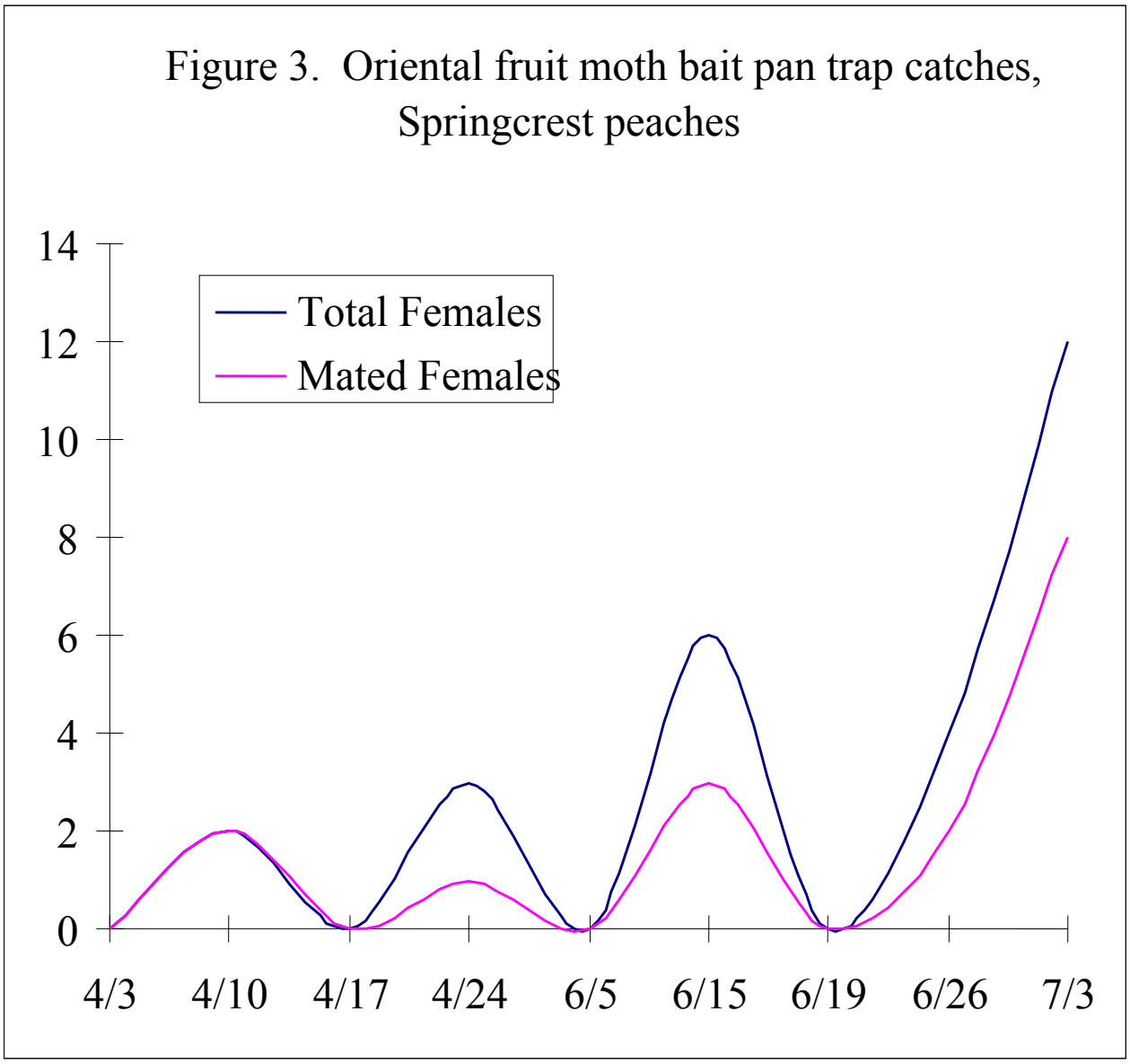

Figure 4. Oriental fruit moth bait pan trap catches, O'Henry peach.

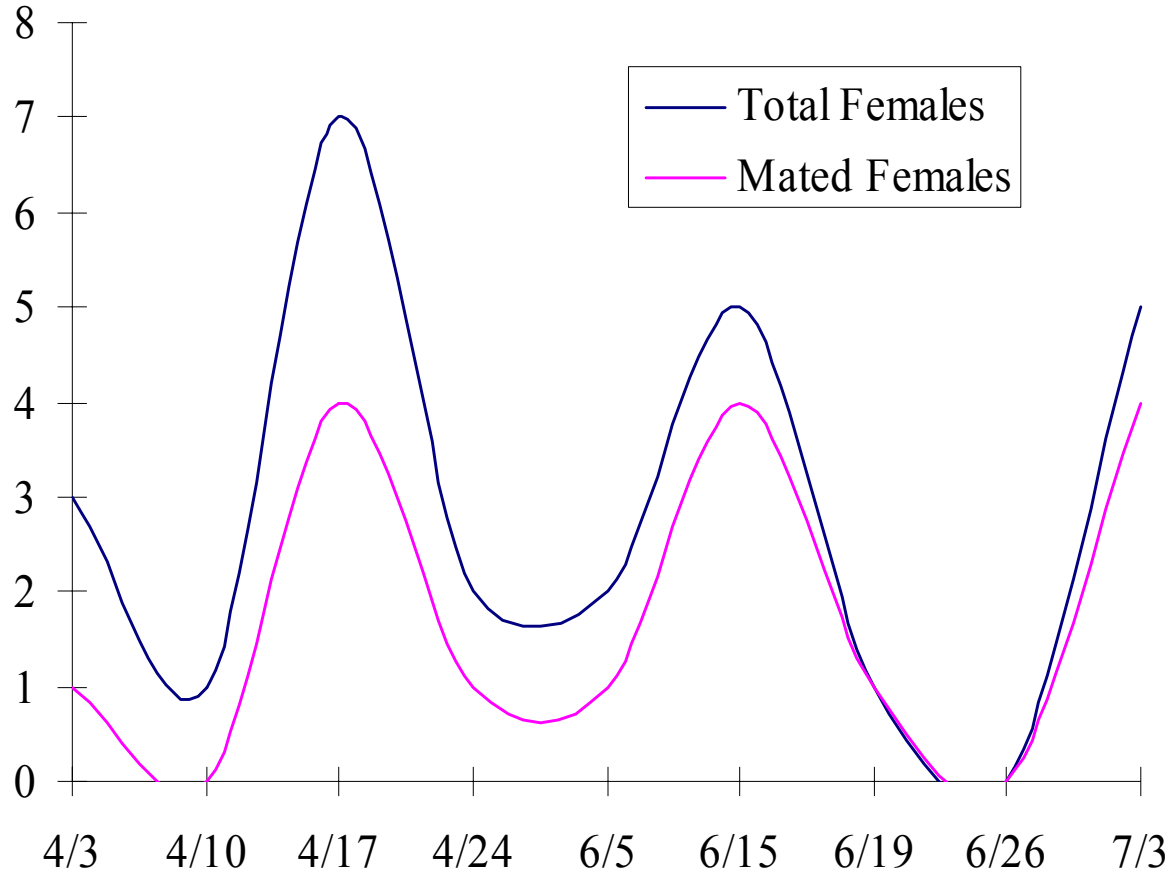

Figure 5. Oriental fruit moth average shoot strikes per tree, April 28.

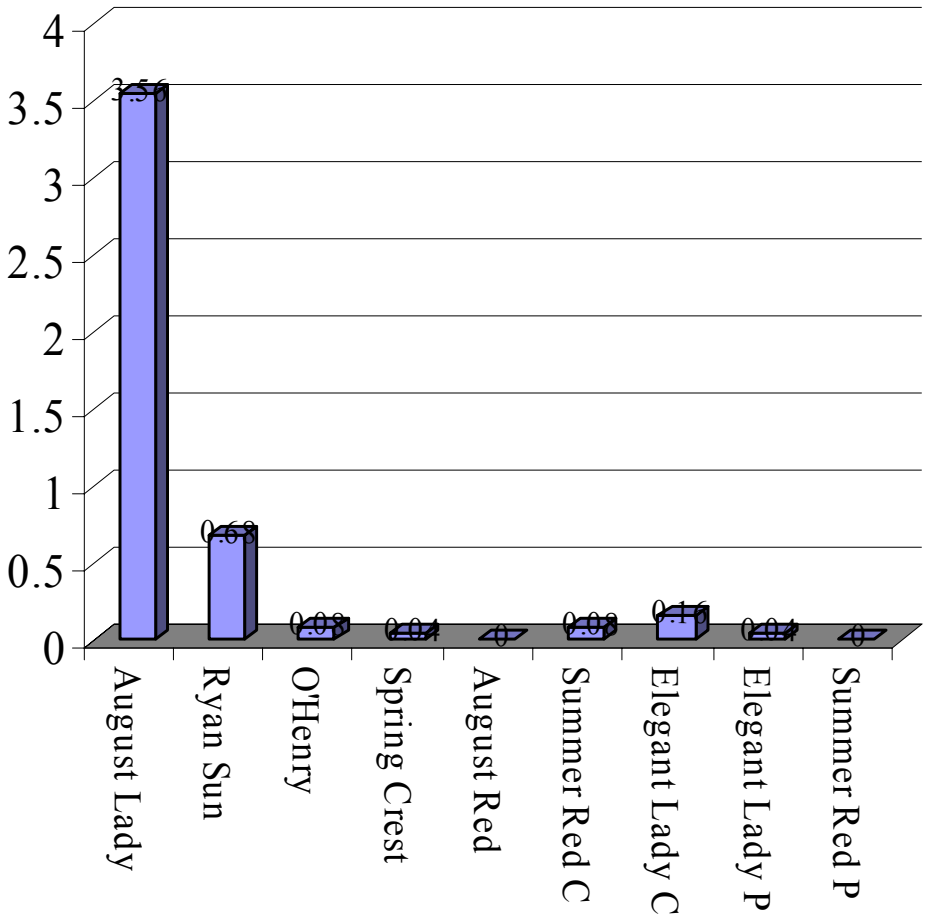

Figure 6. Oriental fruit moth average shoot strikes per tree, June 7.

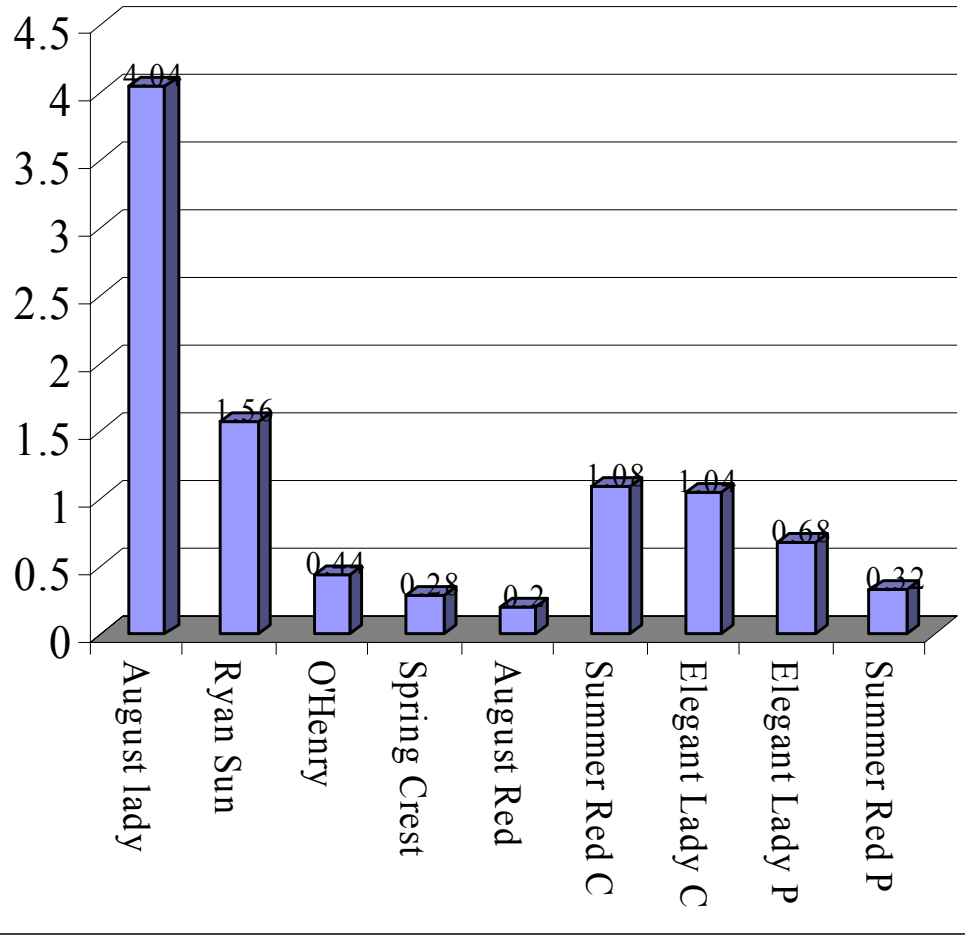

Figure 7. Oriental fruit moth average shoot strikes per tree, July 19

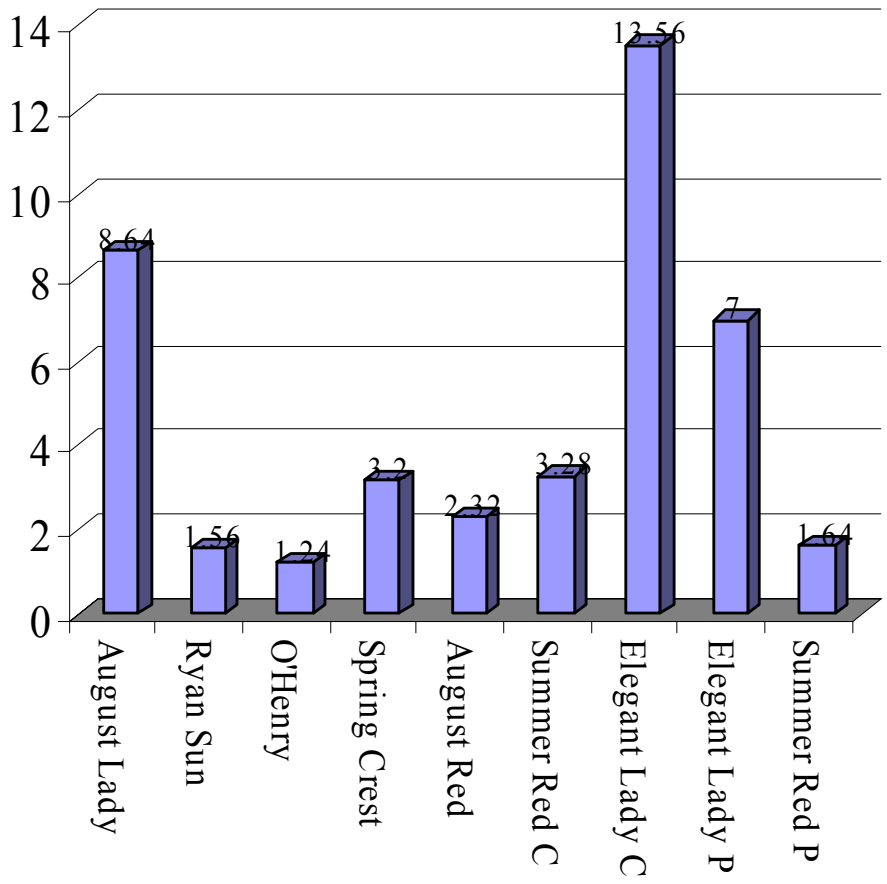

Figure 8. Oriental fruit moth average shoot strikes per tree, Sept 13

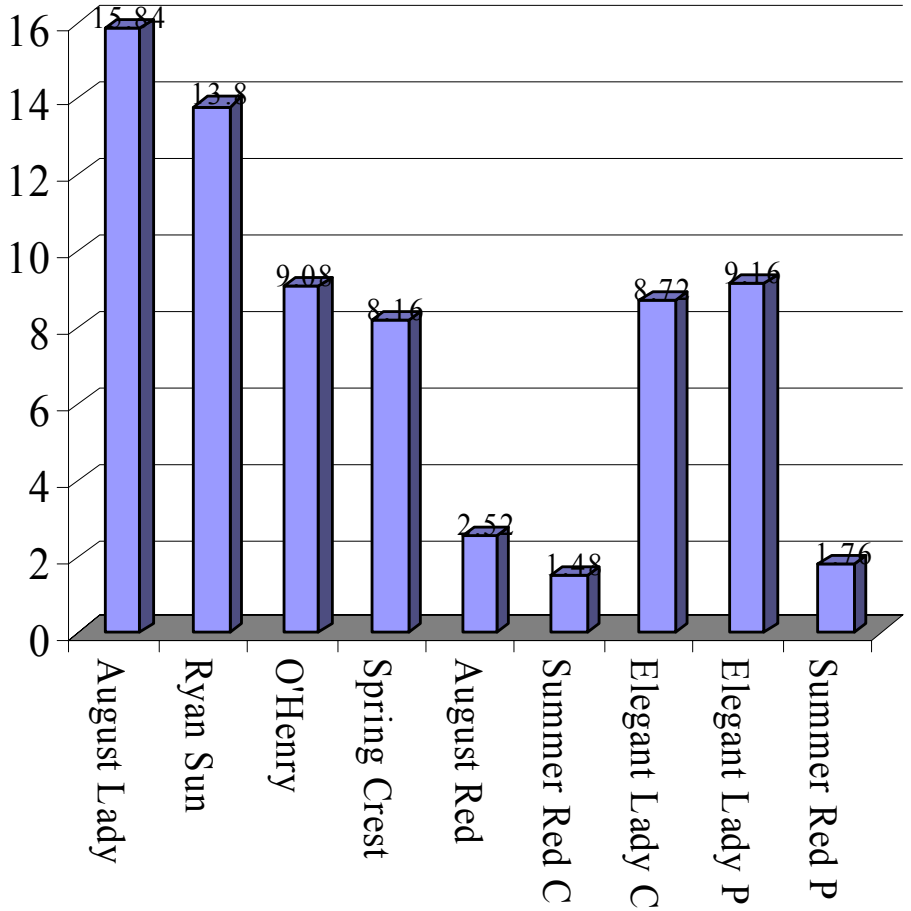

Figure 9. Insect damage due to various pests in the 2004 pest management program.