Pheromone Traps for Navel Orangeworm - San Jose Scale

Annual Report

California Almond Board Project 81-GA1

December 18, 1981

R. E. Rice, S. A. Hoying and R. A. Jones

Department of Entomology
University of California
Davis/Parlier

81-GA1

San Jose Scale Research - 1981

DICK RICE

Project Status:

1) The periodicity of flight behaviour of the San Jose Scale in response to synthetic sex pheromones shows restricted temporal activity occurring around sunset. Further work needs to be done on environmental factors influencing this flight.

2) Male SJS trap catch was shown to be influenced by the traps height within the tree canopy.

3) Preliminary work on the flight range of male SJS has been done. The techniques used in this study need further refinement before absolute data can be obtained.

4) New techniques for monitoring SJS crawlers were developed and their feasibility tested. Further work on correlation with adult density within the tree needs to be done.

5) Experiments determining the optimum trap densities for SJS have been started. More work needs to be done before definitive conclusions can be reached.

I. Diurnal Rhythms

The periodicity of the male San Jose Scale (SJS) flight was studied in response to synthetic sex pheromone. We wanted to know if it exhibited restricted temporal activity patterns as with other insect species, and whether environmental factors could delay or inhibit their activity during these periods. We trapped SJS in March, July, and August, to determine the respective rhythms of male response during these periods.

Materials and Methods

A mechanical timing trap which segregated male catch into hourly collections was used for this experiment. The trap was installed in the eastern quadrant of a suitable Nonpareil tree so that the trapping surface and the pheromone source was 1.8 meters above the ground and close to the foliage within the tree canopy. Traps were checked, captured scale removed, and catch recorded daily.

Two locations were used for this experiment. We trapped in a mixed stone fruit block, including almonds, at the San Joaquin Valley Agricultural Research and Extension Center (KHFS) March 18-21 and August 13-26, 1981, and in a mature orchard almond block at the Tenneco West ranch near Caruthers, CA from July 17-31, 1981.

Results and Discussion

Daily recurrent temporal patterns of male SJS catch in response to the synthetic pheromone were seen for all three trapping periods (Figure 1). In every case, the onset of activity preceded sunset by at least one hour with peak activity generally occurring at sunset. Cessation of activity generally occurred shortly after sunset.

Figure 1A shows the activity pattern of male SJS from the first flight in 1981. In this flight, the major activity period precedes sunset, with a notable decrease after sunset. This is probably caused by temperatures rapidly falling below the insects' activity threshold. Figure 1B shows data collected during the third seasonal male scale flight. It is distinctive since it shows an extended period of activity, probably caused by ideal conditions for scale flight combined with higher insect density. Figure 1C shows data corresponding to the continuous flight common later in the season. Probably the inefficiency of the mechanical trap and the low densities of scale available for capture caused the brief periods of flight seen in this figure since environmental conditions for flight appeared to be ideal.

II. Trap Placement

The influence of trap height within the almond tree canopy on male SJS trap catch was investigated. This is an important factor in interpretation of trap catch.

Materials and Methods

These studies were also carried out at KHFS and the Tenneco West ranch. In each location Zoëcon SJS traps baited with 300 μg SJS-2 lures were suspended at 5 height levels (0.6, 1.8, 3.0, 4.3, and 5.5 meters) on a PVC pole. The poles were positioned on the eastern side of Nonpareil trees 3 meters from the trunk so that the poles stood vertically within and were supported by the tree canopy. Traps were checked and catch recorded daily at the Tenneco site and three times a week at the KHFS site. Traps were rotated on the pole every check day so that individual variation was minimized. The experiment was replicated 5 times at each site.

Results and Discussion

Table 1 shows the results of these experiments. Traps situated above and below the canopy at KHFS (0.6 and 5.5 m) caught significantly fewer scale than those situated within the canopy. Altogether, 95.5% of the total catch occurred within the canopy. More than 50% of the males trapped were taken at the 4.3 m level with significantly fewer at the 3.0 and 1.8 m levels. This trend was also seen at the Tenneco site where 96% of the total catch occurred within the canopy. The greatest proportion of catch occurred at the highest trapping level within the canopy (36.7%).

These data indicate that most of the SJS activity occurs in the upper portion and within the canopy.

III. Male SJS Flight Range

San Jose Scale is believed to be an extremely weak flier based on its body size, wing structure, and musculature. Evidence exists that suggest males may be capable of limited upwind directed flight as well as downwind undirected random dispersal. An experiment was designed to determine the distance and direction of male SJS flight.

Materials and Methods

This experiment was conducted in an open field bounded by experimental alfalfa and grape plots at KHFS. Using weather data records from KHFS, prevailing wind data was used to determine upwind/downwind directions at the study site. Prevailing winds were found to come from 291°. A trapping grid pattern of 32 traps baited with pheromone was set up surrounding a central release table. Traps were hung from 1.5 m steel fence posts 15.25 m from the release table at 21°, 111°, 201°, and 291° (magnetic compass headings), then at 30.5 m intervals until the furthest traps were 137 m from the central release table. Additional traps were placed at 66°, 156°, 246°, and 336° starting at 30.5 m from the release table, then at 30.5 m intervals to 91.5 m. Laboratory reared SJS colonies producing male scale were dusted with yellow flourescent powder and placed on the release table at least one hour before sunset. This insured large numbers of marked male scale available for recapture. All traps were returned to the lab the following morning and examined using a UV light to determine marked scale collected.

Results and Discussion

Traps were set up and checked 7 times during 1981 (8/28, 8/29, 9/9, 9/10, 9/14, 9/15, and 9/16). Only one male was recaptured in a trap 91.5 m 111° from the central release station. Large numbers of males were thought to have been released since active males were observed just prior to release before each experiment. Small scale laboratory tests conducted after the first failures in the field showed that marked males could be caught in baited pheromone traps and that the marking powder did not totally inhibit flight as was thought possible. Failure of the field experiments could have been caused by a number of factors including i) field temperature range at the time of release causing mortality, ii) a change in behaviour of the lab colony when introduced to field conditions, iii) an overestimation of flight distances thought possible by SJS based on data from the California Red Scale, iv) and interference of long distance flight caused by the marking powder.

IV. Dormant Control

Four dormant treatments for San Jose Scale were evaluated for seasonal control.

Materials and Methods

Treatments consisted of 1) 6 gallons of superior oil in 100 gallons of water per acre, 2) 6 gallons of oil and 2.5 lbs. Diazinon ai/acre, 3) 6 gallons of superior oil and 1 lb. Lorsban 4EC ai/acre, and 4) 2 lbs. Supracide 2E ai/acre. The materials were applied to 10 acre test plots at the Tenneco West ranch near Caruthers, CA December 22 and 29, 1980 by ranch personnel. A Turbomist low volume sprayer operating at 130 psi was used. A Navel Orangeworm spray (Guthion 50WP at 2 lbs. ai/acre) was added on May 9, 1981 to all treatments except the oil alone.

Ten twigs, each 25 cms in length, were randomly selected from each of 5 Nonpareil trees within each treatment. Using a polepruner, samples were taken from the upper portion of the tree, and returned to the lab where they were examined with a binocular microscope. All scale covers were lifted with a dissecting needle to assess the scale life stage and rate of parasitization.

Results and Discussion

Table 2 shows the results of the SJS harvest evaluation. The Supracide treatment provided excellent seasonal control of San Jose Scale compared to the other treatments. There was little difference between the other three treatments in terms of actual scale numbers present per twig. A greater proportion of twigs were infested in the oil alone treatment and there was evidence of parasitization not seen in any other treatment. The lack of parasitization in treatments 2, 3, and 4 can probably be attributed to the Navel Orangeworm treatment in May.

V. SJS Crawler Monitoring and Population Estimation

The crawler stage is the only dispersive stage of San Jose Scale. Large numbers of crawlers (up to 450/female) are produced and can possibly provide us with an easy and efficient means to predict the magnitude and precise onset of damaging scale activity. A new method was used in 1981 to monitor crawler activity.

Materials and Methods

10 X 10 cm plexiglas plates coated with silicone grease were placed under the almond tree canopy approximately 1 meter from the tree trunk on 1 m vertical stakes situated horizontally and sticky side up. There were 4 plates placed at the primary cardinal directions (N, S, E, and W) under the five trees monitored at the Tenneco West ranch. The plates were replaced and counted at weekly intervals from July 21 - October 22, 1981.

Twig samples were taken concurrently to estimate absolute density changes in San Jose Scale populations in 1981. Samples consisted of 10 twigs, each 25 cm in length, randomly selected from the upper portion of each of the 5 Nonpareil trees used for crawler trapping. Samples were taken to the lab where they were examined for scale stage and parasitization rates.

Results

Figure 2 shows crawler catch on the sticky plates compared to the number of adult female SJS found on the twig samples and the percent infested twigs. Crawler catch declined steadily throughout the trapping period from a high of 9.75 crawlers/trap on July 28 to a low of 0.3 crawlers/trap on the final sample date of October 22. Similarly adult female SJS numbers on twigs appeared to decline over the same period as did the percent of infested twigs. The fluctuating adult counts are believed to be a product of insufficient sample size. Although the correlation between crawler catch and adult numbers was poor (r = .43 Spearman's Coefficient of Rank Correlation), this experiment suggests that by increasing the sample size correlations could be made. Traps that were made of double stick tape and used in other stone fruits to monitor SJS appear to be more sensitive and may also improve these correlations when used in the future.

VI. Evaluation of Navel Orangeworm Chemical Treatments (Table 3)

This project is funded primarily for research on the bionomics of San Jose Scale on almonds. However, the scope of research activities in almonds includes several other pests, therefore data on navel orangeworm and peach twig borer is also included in this report.

Nut samples were obtained at harvest from four chemical spray plots applied for the control of navel orangeworm in almonds in Fresno County. Ten 200 nut sub-samples were taken from each treatment, which consisted of single 10 acre blocks of mature Nonpareil, Neplus and Milow almonds. The chemical treatments consisted of: 1) a single dormant spray of copper and oil applied in December, 1980; 2) a dormant application of copper, oil and Diazinon in December, and a May spray of Guthion; 3) a dormant application of copper, oil and Diazinon, plus a May spray of Guthion and a hull-split application of Pounce in mid July, and 4) a dormant treatment of copper, oil and Diazinon, plus a May spray of Guthion and a hull-split application of Pounce. Nuts were harvested from these plots on September 2, 1981 and were hand cracked and examined for navel orangeworm and peach twig borer damage. The results of these evaluations are shown in Table 1.

The use of only the dormant treatment of copper and oil resulted in a relatively high level of navel orangeworm infestation (8.1%). When Diazinon was added to the dormant spray, along with the Guthion treatment in May, navel orangeworm damage dropped to 1.9%. When the full dormant spray plus the hull-split application of Pounce was used, navel orangeworm damage increased to 3.3%. When all three chemical timings were used, navel orangeworm damage again dropped to a low level (1.7%). In relation to peach twig borer, it was expected that the absence of Diazinon in the dormant spray would result in a relatively high level of twig borer damage in nut meats. When Diazinon was added to the dormant spray (treatments 2, 3, and 4) twig borer damage dropped to a relatively insignificant level. It was observed that the combination of dormant treatments plus the May Guthion sprays gave better overall twig borer control than did the dormant Diazinon treatment plus the hull-split treatment of Pounce.

The data from these plots agree with previous years' observations from similar trials. Dormant sprays without the use of an organophosphate insecticide generally lead to high levels of twig borer damage, and some increase in navel orangeworm damage as well. The combination of a full dormant spray plus a May spray of Guthion generally results in acceptable levels of both navel orangeworm and twig borer control. The application of a hull-split treatment using a pyrethroid insecticide resulted in somewhat higher levels of both navel orangeworm and twig borer in 1981 compared to the full dormant and May sprays with Guthion. However, it was noted that the treatment with Pounce applied at hull-split (treatment 3) generally had fewer pin hole attacks in the nuts than the treatment using Guthion in May (treatment 2). The implications from these data are that if late harvest is anticipated, the hull-split application of Pounce may allow fewer infested nuts than the May sprays using Guthion.

Pheromone traps for Oriental fruit moth in all of these treatments showed extremely high levels of OFM activity throughout the 1981 year. However, no evidence of Oriental fruit moth feeding damage was observed in any of the nut samples examined from the NOW chemical control plots in 1981.

VII. Peach Twig Borer

Work continued on the validation of the peach twig borer phenology model and development of optimum timing for control of late April or early May twig borer larval populations. Peach twig borer moths were monitored with pheromone traps in a fourth leaf almond orchard near Caruthers in Fresno County. The first twig borer moths were collected in traps on April 7, 1981. This first flight of twig borer moths continued well into late May before the overwintering population had completely emerged.

Following the first moth collections on April 7, the model predicted that first egg hatch should occur at 220 D^{o} after first moths were collected; these D^{o} had accumulated by April 24 (Figure 3). Following egg hatch, insecticide applications of Diazinon at 2 lbs. a.i. per acre were applied to different parts of the orchard at 300, 400, 500 and 600 degree intervals after first moth collections. Three hundred D^{o} had accumulated by April 30, which was approximately 2 days before the peak of the moth flight. First twig strikes were observed in almond terminals on May 4, followed by the 400 D^{o} accumulation on May 5. The 500 D^{o} accumulation occurred on May 11, and the 600 D^{o} accumulation had occurred on May 17. The results (Table 4) of the chemical treatments at the 100 degree intervals, beginning at 300 degrees after first moth flight were as follows: 300 D^{o} treatment - 19 strikes; 400 D^{o} treatment - 5 strikes; 500 D^{o} treatment - 4 strikes; and 600 D^{o} treatment - 27 strikes. These results indicate that optimum timing for twig borer treatments in May is somewhere between 400 and 500 D^o following first moth collections. These data also agree with our 1980 projections that optimum timing should be somewhere near or after 400 degrees had accumulated, based on egg and first-instar larval development.

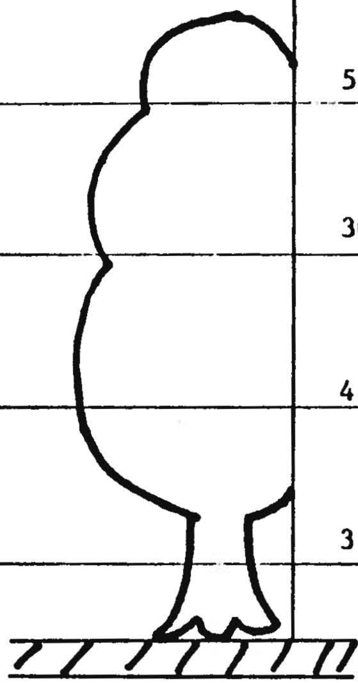
It is also interesting to note that the 400 D^o accumulation, when superimposed on the moth flight curve, occurs about 4 days after the peak of the moth flight and only 1 day after the first strikes were observed in terminals. You will recall that many of the older recommendations for twig borer control were related either to chemical applications 5 to 10 days after first strikes were observed, or within 1 week after the peak of the moth flight. The use of the D^o phenology model for twig borer now gives us a 3rd technique or option in timing these twig borer treatments. However, it would seem that the phenology model would be the simpler or easier of the three techniques to use, since it would involve less work and time to know when optimum timing for these treatments would occur in the field.

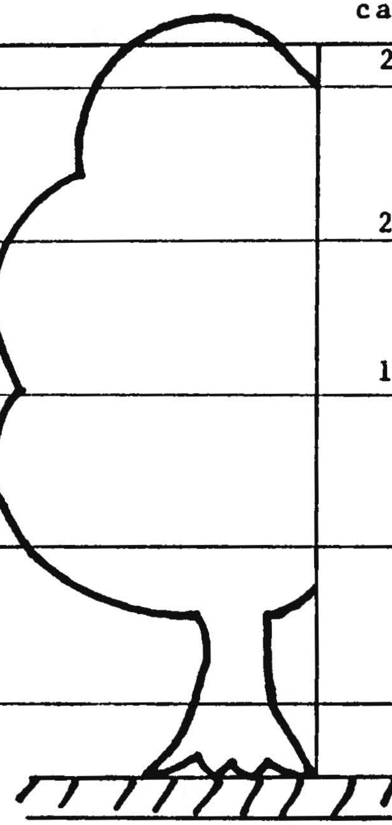
VIII. Longevity of Almond Press Cake in NOW Egg Traps

Navel orangeworm egg collections on egg traps using powdered almond press cake changed weekly were compared to traps using press cake that was not changed. Results of these comparisons showed that trap loads of ground-up or powdered almond press cake could be used for up to 8 weeks without changing the cake, provided the press cake remained dry and powdery. Press cake that gets wet or lumpy and moldy should be replaced as soon as possible.

Table 1. The influence of trap height on SJS male trap catch.

Trap Height Level	KHFS[1)] catch[3)]	KHFS[1)] percent[4)]	CARUTHERS[2)] catch[3)]	CARUTHERS[2)] percent[4)]
A - 5.5 meters	0.72	0.8 c	263	36.7 a
B - 4.3 m	51.1	52.3 a	215.8	32.7 a
C - 3.0 m	30.9	37.1 b	126.6	20.1 b
D - 1.8 m	4.7	6.1 c	51.0	6.8 c
E - 0.6 m	3.1	3.5 c	21.2	3.3 c





1) Trapping period: 8/6/81 - 9/4/81
2) Trapping period: 7/22/81- 8/6/81
3) No. ♂ SJS trapped/trap/interval: 5 traps/level
4) Preportion caught at each height level

Table 2.

SAN JOSE SCALE

Treatment[1)2)]	Harvest Evaluation[3)] 9-10-81 Adult[4)]	Immatures[4)]	% infested twigs
1. 6 gallons oil 10 lbs. Cu	0.52 (0.06 parasitized)	1.68 (0.14 parasitized)	52
2. 2.5lbs. Diazinon 40WP 6 gallons oil 10 lbs. Cu	0.50	1.26	28
3. 1 lb. Lorsban 4EC 6 gallons oil 10 lbs. Cu	0.96	1.12	30
4. 1 lb. Supracide 2E	0.0	0.0	0

1) Treatment dates: Trt 1. 12-22-80, Trt 2.3.4. 12-29-80.
2) All rates are ai/acre.
3) Nonpareil
4) Individuals/twig, 50 twigs/treatment.

Table 3. Chemical treatments for NOW and PTB-1981.

Treatment	% Worm damaged nuts 1/ NOW	PTB	Comb. NOW/PTB	Total
1. Dormant - Cu+Oil 2/	8.1	2.9	2.0	13.0
2. Dormant - Cu, oil, diazinon May - Guthion	1.9	0.0	0.0	1.9
3. Dormant - Cu, oil, diazinon Hullsplit - Pounce	3.3	0.9	0.8	5.0
4. Dormant - Cu, oil, diazinon May - Guthion Hullsplit - Pounce	1.7	0.05	0.2	2.0

1/ Totals from ten 200-nut subsamples harvested Sept. 2, 1981.

2/ Commercial applications to 10.0 acre blocks @ 100 gpa. Supreme oil @ 6.0 gal/acre; copper @ 10.0 lbs/100; Diazinon 40W @ 6.25 lbs/acre; Guthion 50W @ 4.0 lbs/acre; Pounce @ 1/2 pt/acre. Dormant treatment Dec. 22-24, 1980. May treatment May 6-9; Hullsplit treatment July 15, 1981.

Table 4. Timing of Peach Twig Borer (PTB) chemical controls - 1981.

Treatment[1/]	No. Strikes	% Control
300 D^o, April 30	19	75.6
400 D^o, May 5	5	93.6
500 D^o, May 11	4	94.9
600 D^o, May 17	27	65.4
Untreated Check	78	--

1/ Fourth-leaf almonds, Fresno County. Diazinon 50W @ 2.0 lbs per acre; strikes counted June 3, 1981.

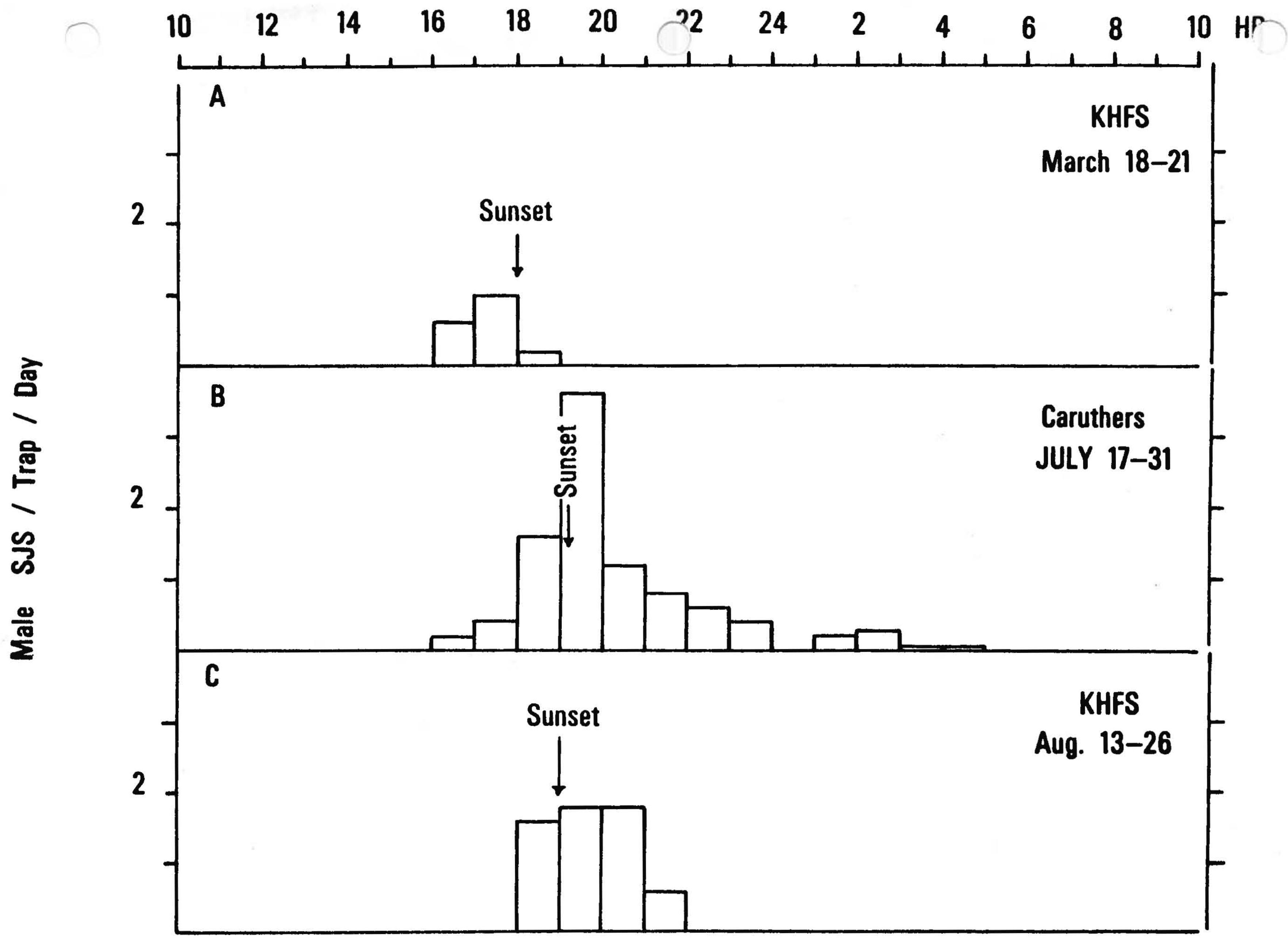
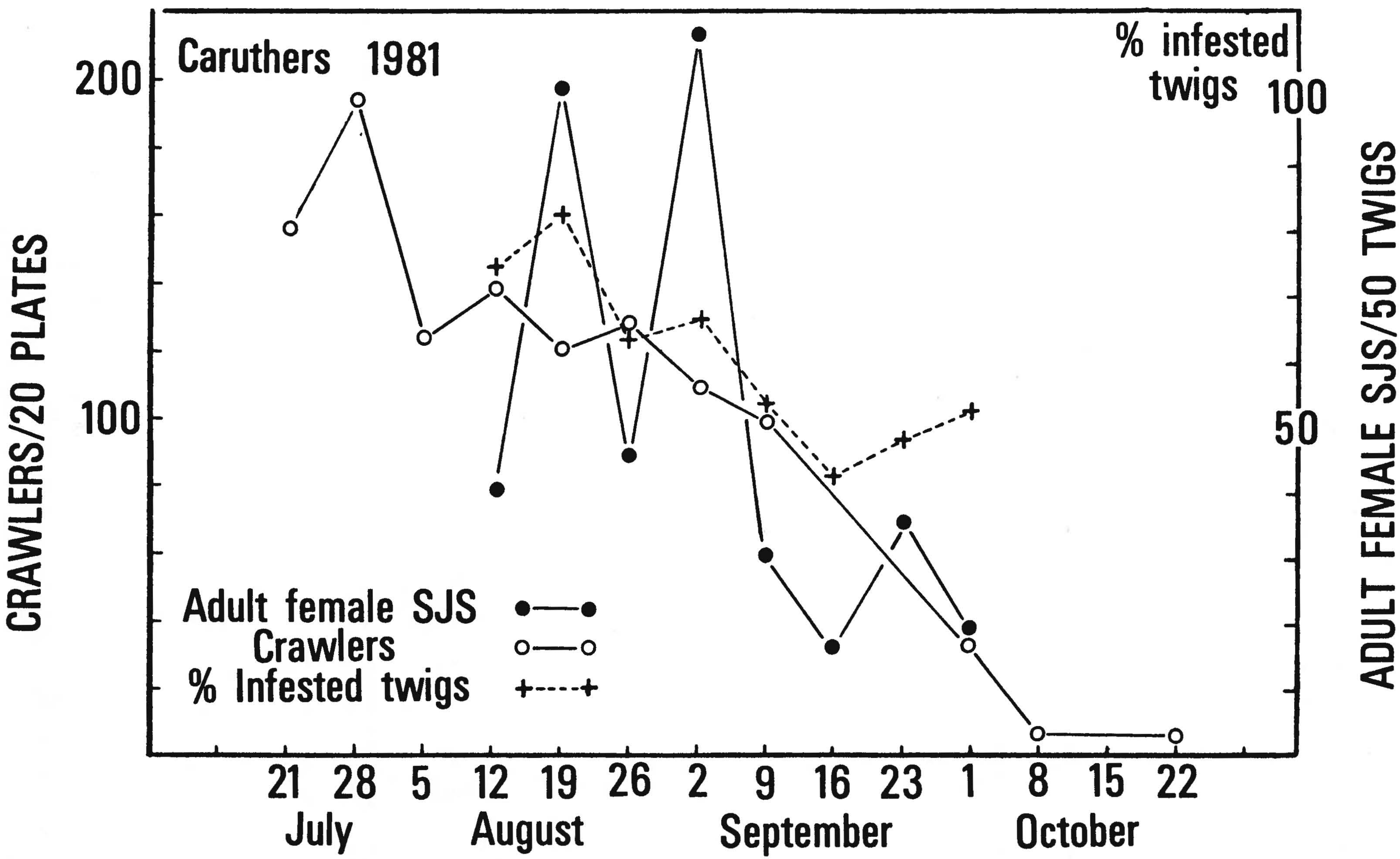
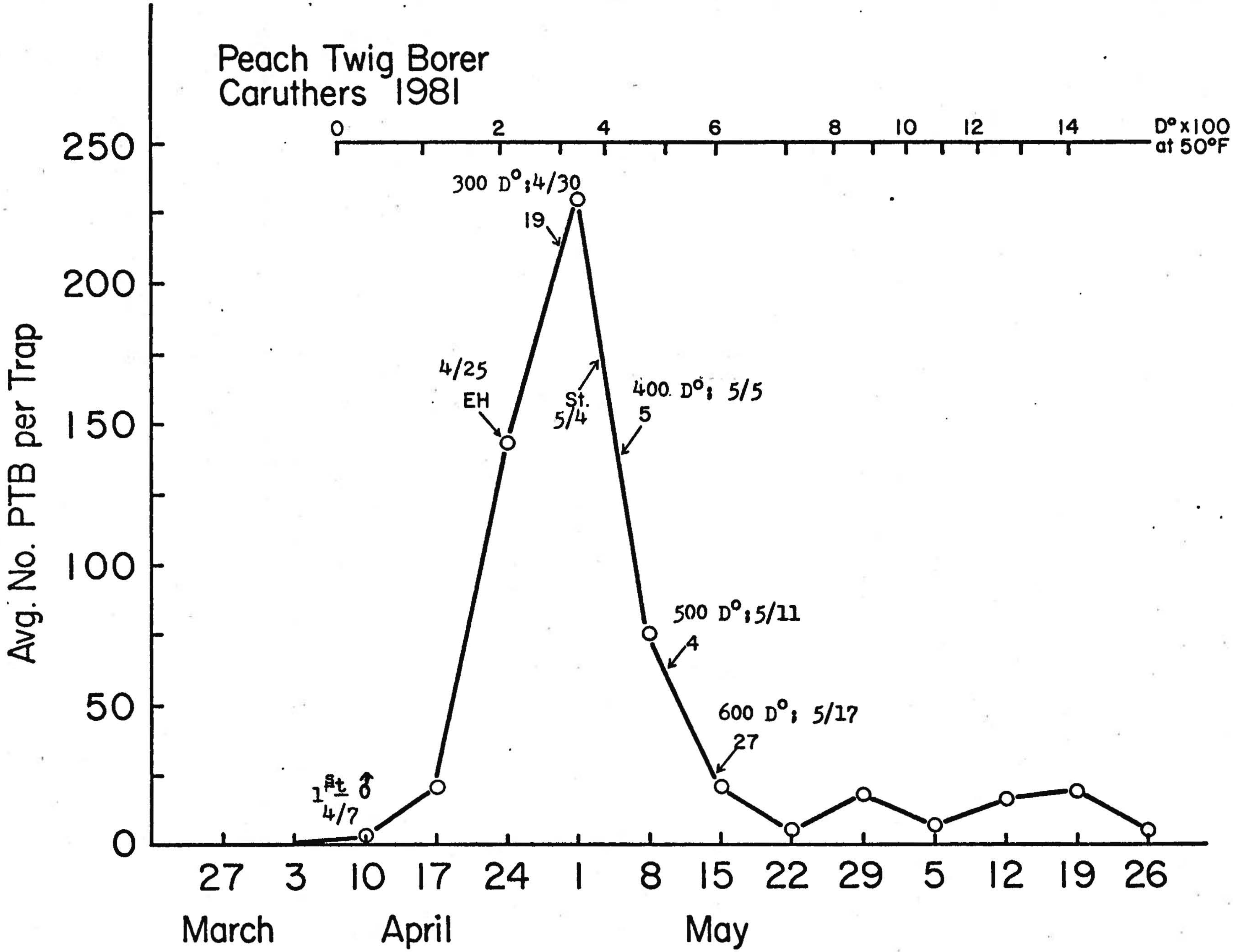

10 12 14 16 18 20 22 24 2 4 6 8 10 HR
Male SJS / Trap / Day
A
KHFS
March 18–21
Sunset
2
B
Caruthers
JULY 17–31
Sunset
2
C
KHFS
Aug. 13–26
Sunset
2

Figure 1.

Figure 2.


Caruthers 1981
% infested
twigs
200
100
100
50
CRAWLERS/20 PLATES
ADULT FEMALE SJS/50 TWIGS
Adult female SJS
Crawlers
% Infested twigs
21
28
5
12
19
26
2
9
16
23
1
8
15
22
July
August
September
October



Peach Twig Borer
Caruthers 1981
0
2
4
6
8
10
12
14
D°x100
at 50°F
250
200
150
100
50
0
Avg. No. PTB per Trap
300 D°;4/30
19
4/25
EH
St.
5/4
400 D°; 5/5
5
500 D°;5/11
4
600 D°; 5/17
27
1st ♂
4/7
27
3
10
17
24
1
8
15
22
29
5
12
19
26
March
April
May

Figure 3.