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ALMOND BOARD

1982 Almond Annual Report
Summary

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Highlights of the second full year of this project since it was continued from Dr. Clarence Davis include, 1) expansion of educational efforts for navel orangeworm, peach twig borer, and San Jose scale as part of a monitoring system, 2) initiation of a manual on 'Integrated Pest Management for Almonds', 3) development of a provisional sampling scheme for mites on almond and cooperative projects involving mites, and, 4) continuation of research on ant thresholds.

Information known about techniques for sampling and monitoring for navel orangeworm, peach twig borer, and San Jose scale were condensed into several UC and almond industry publications. Results of the 1981 and 1982 study to evaluate the efficacy of winter sanitation as part of current commercial almond production and conducted by UC Cooperative Extension Farm Advisors throughout the Sacramento and San Joaquin Valleys showed once again that low mummy levels will reduce the number of applications required by growers to keep damage levels at harvest at acceptable levels. They also indicate that if a substantial mummy load is present, some damage will occur regardless of chemical intervention. The effect of well-time treatments for the navel orangeworm is to lower the rate of increase of damage.

Barbara Peterson was hired as a scientific writer to work with the UC/IPM Manuals Group to hasten production of a manual on "Integrated Pest Management for Almond". She is working closely with UC research and extension staff to draw together existing information. As with other UC/IPM Manuals, this manual will have color photographs illustrating pests and their damage.

A presence-absence sequential sampling plan and provisional decision rules were developed in cooperating with Dr. Marjorie Hoy which provides an opportunity for the pest manager to estimate the abundance and damage potential of mites utilizing only the proportion of total leaves sampled that contain 1 or more mites. These rules can be reduced to a sampling form for practical use. The sampling plan provides a point-in-time estimate of whether a treatment is required or not. It does not provide an estimate of population growth rates or whether a treatment level will be reached at some future time. Work will continue on this next season, as will cooperation with Dr. Hoy on the release of pesticide-resistant predatory mites.

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ANNUAL REPORT - 1982

INTEGRATED PEST MANAGEMENT FOR ALMONDS

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1982 was the second full year since I continued this project from Dr. Clarence Davis. The objectives for 1982 were:

1) To expand demonstration and other educational efforts to include the utilization of phenology models for the navel orangeworm, the peach twig borer, and the San Jose scale in an IPM monitoring system.
2) To initiate production of an 'Integrated Pest Management for Almonds' manual coordinated by the UC Statewide IPM Project.
3) To work on a sampling scheme for mites in almonds.
4) To continue work on ants in relation to nut damage.

Objective 1, Sampling and Monitoring for navel orangeworm, peach twig borer and San Jose Scale in almonds -

This was the second year of conducting an educational program on monitoring statewide with cooperating UC Farm Advisors. Pheromones and NOW egg traps were purchased for the cooperators who utilized them in demonstration orchards. Heat unit (degree-day) information was provided via NOAA weather radio, broadcast and printed media, or mailed updates to give growers and pest control advisors an opportunity to compare their observations to what the Farm Advisors were seeing.

Information known about techniques for sampling and monitoring for these pests were drawn together into several UC and almond industry publications (Appendixes I, II, III, and IV).

During 1981 and 1982, UC Cooperative Extension Farm Advisors throughout the Sacramento and San Joaquin Valleys have participated in a study to evaluate the efficacy of winter sanitation as a part of current commercial almond production. Fifteen orchards were monitored in the Sacramento Valley (Butte, Colusa, Sutter, Yolo and Yuba Counties), and 18 orchards were monitored in the San Joaquin Valley (Fresno, Kern, Kings, Madera, and Merced Counties). In each orchard, mummy counts were taken in January or early February. Growers made a timely harvest, and a sample of almonds from each orchard was cracked by hand to evaluate the percent damage due to navel orangeworm. Insecticide applications were made at the discretion of the participating grower of pest control advisor. The average yield per orchard was 1334.7 lbs., with no statistical difference ($F = 1.029$; $P > 0.05$) between the orchards we monitored in the Sacramento or San Joaquin Valleys.

Of the 33 orchards monitored, 9 received one treatment, and 15 received 2 or 3 treatments. The average number of mummies in untreated orchards was 0.87 ± 1.52 ($\bar{x} \pm SD$). This was significantly ($P<0.05$) less than the average number of mummies in orchards receiving 1 treatment (28.14 ± 74.89) or 2^+ treatment (34.16 ± 40.52). These results seemed to indicate that good sanitation practices reduced the number of applications required by growers. In spite of the lack of an insecticide application, less damage was recorded on an average in the untreated orchards. The percent damage in such orchards was 1.98 ± 2.38 ($\bar{x} \pm SD$). It rose to 5.02 ± 4.44 for orchards receiving 1 navel orangeworm treatment and 7.86 ± 5.35 for orchards receiving 2 or 3 treatements. This difference was significant ($P<0.05$) when tested by 1-way ANOV ($F = 4.420$; $v = 28$), indicating that damage will occur in orchards

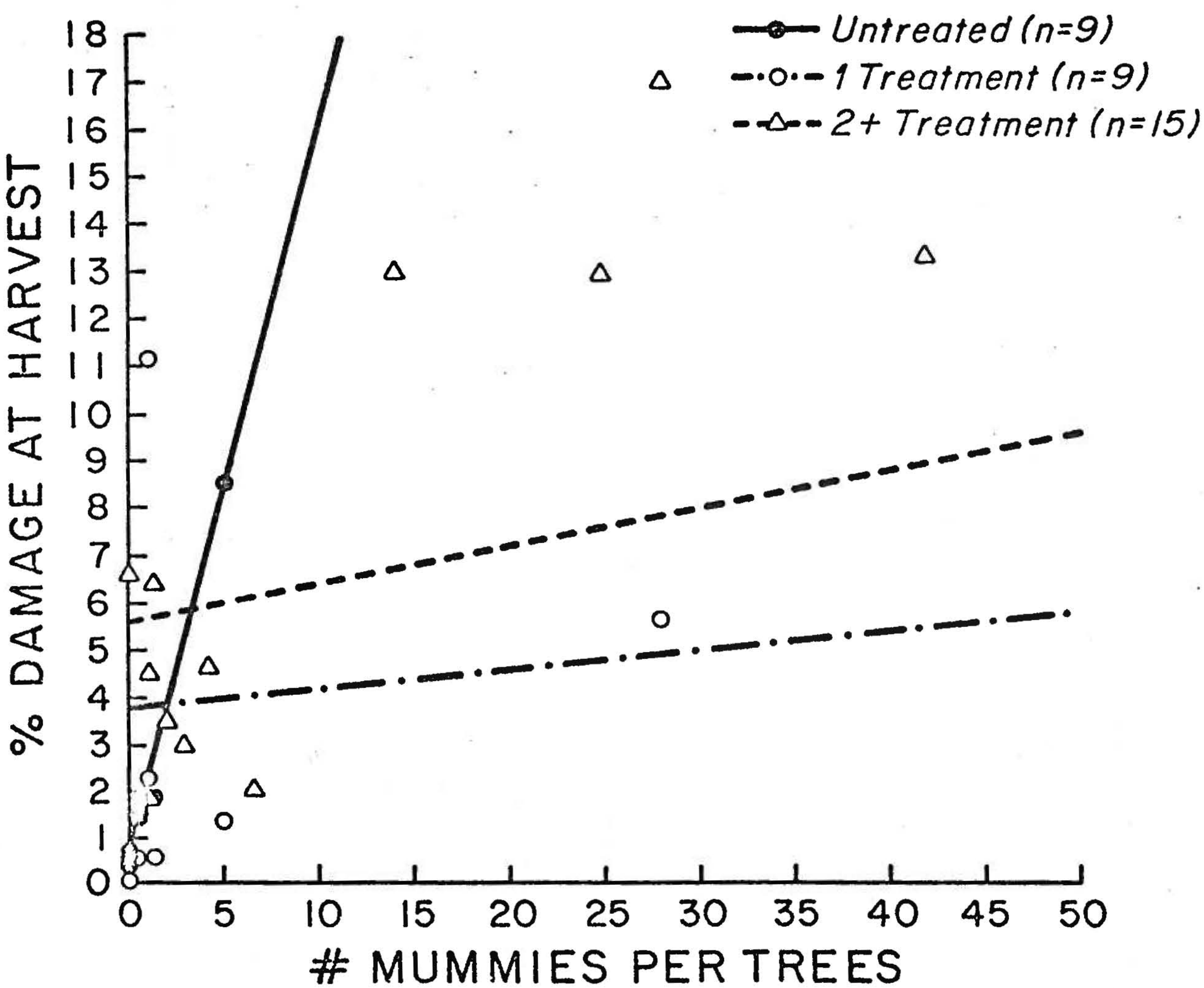

Untreated (n=9)
1 Treatment (n=9)
2+ Treatment (n=15)
% DAMAGE AT HARVEST
# MUMMIES PER TREES
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
0
5
10
15
20
25
30
35
40
45
50

FIGURE 1

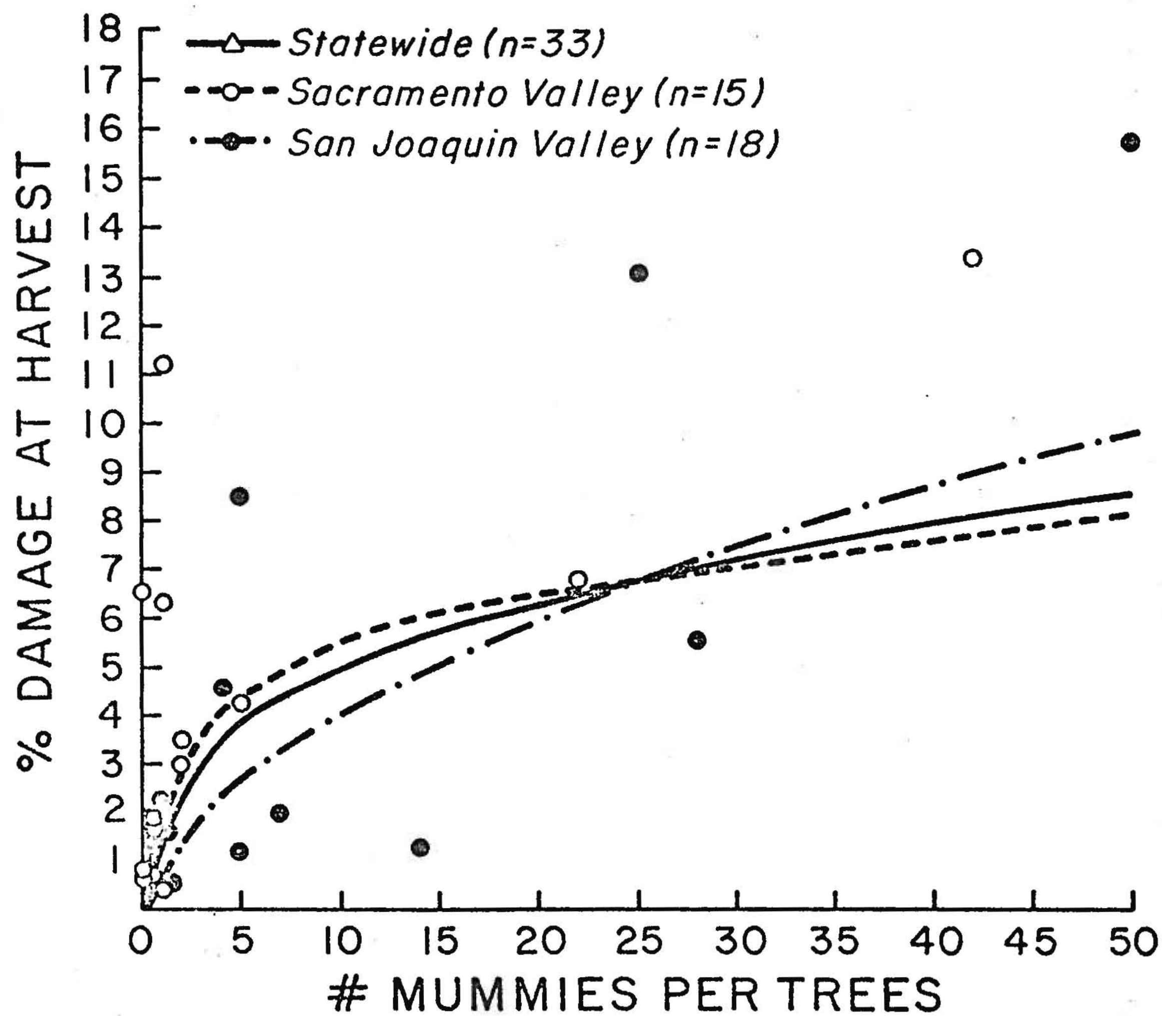

Statewide (n=33)
Sacramento Valley (n=15)
San Joaquin Valley (n=18)
% DAMAGE AT HARVEST
# MUMMIES PER TREES
0 5 10 15 20 25 30 35 40 45 50
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

FIGURE 2

where a substantial number of mummies are found regardless of chemical intervention. However, well-timed treatments for the navel orangeworm can decrease the amount of damage in orchards with higher mummy populations. Figure 1 shows that in the absence of an insecticide, damage can increase very rapidly unless adequate mummy removal is accomplished during the preceeding winter. A high level of damage may occur even when an insecticide is applied, however the amount of damage in relation to the number of mummies per tree increases at a much lower rate. These linear regression relationships are all significant (r_0 = 0.986; r_1 = 0.685; r_{2+} = 0.685) at the 5% level. Three orchards had mummy numbers in excess of 50, and were included in the analysis but not on the graph.

Figure 2 shows curvilinear regression relationships for all orchards irregardless of chemical treatment. This would likely be the amount of damage one would find in orchards that had been managed under good sanitation (the rapidly increasing portion of the curve) or under a higher mummy load with chemical intervention (the flattened portion of the curve). The regressions are significant at the 1% level.

Recommended practices for the management of navel orangeworm includes mummy nut removal, early and rapid harvest, and rapid hulling or on-farm fumigation. When chemical intervention is warranted, timing should be based on the use of egg traps with almond presscake attractant or by the initiation of hull split in the the tops of trees.

A summary of this report will appear in Almond Facts. Some of this information has already been provided to the Farm Bureau and has appeared in their Ag Alert publication (Appendix V).

Objective 2, Initiate an 'IPM for Almonds' Manual -

Barbara Peterson was hired as a scientific writer to work with Dr. Mary Louise Flint and the IPM Manuals Group to hasten production of a manual on "Integrated Pest Management for Almonds' which will be similar to the other UC/IPM manuals. Ms. Peterson was hired in July, 1982 and has worked closely with UC research and extension staff to outline the manual and draw together existing literature. Extension photographer Jack Clark has taken many of the photographs that will provide identification in the manual. Before the manual is completed, it will have undergone a rigorous review-revision process and will provide a concensus of the state of the art of pest management in almonds.

Objective 3, Sampling for Web-Spinning Mites -

Sampling for web-spinning mites -

During the summers of 1977 and 1978, Marjorie Hoy conducted a survey of almond orchards to determine the regional and within tree distribution of predatory and plant-feeding mites in almond orchards thoughout the Central Valley. Much of this data has been used in developing her pesticide resistant strains of the predator Metaseiulus occidentalis, and then conducting a field implementation program of predator introductions and mite management. Several orchards were sampled with sufficient intensity and detail as to permit an analysis of within-tree distribution and clumbing patterns of predatory and web-spinning mites. This information is readily adaptable to a presence-absence type of sequential sampling.

In 4 orchards, 25 leaves were randomly sampled from each of 10 parts of almond trees on a weekly basis. Five of the samples were from the upper portion of the tree, and five from the lower portion above the sprinkler line. Four of the five samples were taken at each compass point, with the fifth sample taken from the interior portion of the tree. An analysis of variance indicated that after mid-June, there was no significant difference in the number of mites from each of the 10 areas of the tree sampled. Prior to that time, mites were often clumped near the center of the tree. Therefore, after mid-June it appears that one can get an accurate indication of web-spinning mite abundance by randomly sampling leaves from the tree.

The data was next analyzed in terms of proportion of leaves containing web-spinning mites of all stages in relation to number of web-spinning mites per leaf. A similar comparison was made for M. occidentalis. It was observed that the relationships were different for web-spinning mites in the presence of M. occidentalis (Figure 3) than in the absence of M. occidentalis (Figures 4 & 5). The curvilinear regression in Figure 3 indicates that web-spinning mites are very clumped in the presence of M. occidentalis when compared to the regression lines in Figures 4 and 5 which represent web-spinning mites in the absence of M. occidentalis. A regression analysis was also performed for the proportion of leaves containing M. occidentalis in relation to number of M. occidentalis per leaf (Figure 6). These relationships enable accurate estimates of mite density in terms of number of mites per leaf by recording only the presence or absence of mites on a given number of leaves.

In order to use these relationships in a sampling scheme, a control action threshold is needed. Such a threshold is difficult to develop because any yield reduction resulting from feeding by web-spinning mites would likely be seen in subsequent years due to the physiological effects of nutrient deprivation on the tree resulting from the initial feeding. Such deprivation may be cumulative. Webbing due to web-spinning mites is often used as an indicator of damage potential. Heavy webbing is typically followed by defoliation. Therefore, control measures are often taken prior to the initiation of webbing.

During the summer of 1982, three orchards were monitored weekly in an effort to develop a provisional threshold based on observation. The orchards were chosed to represent the range of soil drainage conditions from sandy to clay. Each week, individual trees were observed for general appearance, webbing, web-spinning mites and predator distribution etc. A determination was made as to whether no treatment was necessary, a treatment was needed immediately, or no decision could be made. Following this observation, 50 leaves were sampled from each tree and the presence or absence of web-spinning mites and M. occidentalis was recorded. Figure 7 shows the results of the study. The mean proportion of leaves with web-spinning mites for the 'notreat' decision was 0.2637 $\pm$ 0.1642 (SD). The mean for the 'indecision' area was 0.4360 $\pm$ 0.0776. The mean for the 'treat' decision was 0.6440 $\pm$ 0.1522. The difference between these means are significant. It is interesting to note that the mean proportion of leaves infested with web-spinning mites for the 'indecision' area is at the lower end of the range for the 'treat' decision. Therefore, 0.4360 proportion infested leaves could be used as a provisional action threshold in the presence of M. occidentalis. This corresponds to 0.22 proportion infested leaves in the absence of M. occidentalis when comparing the mean number of mites per leaf of Figure 3 with Figures 4 or 5. Therefore, 0.22 proportion infested leaves could be used as a provisional action threshold in the absence of *M. occidentalis*.

The provisional thresholds can then be merged with the mean-variance relationships described in Figures 3, 4 and 5 to develop seqential sampling rules. Figures 8 and 9 are sequential sampling decision lines for web-spinning mites in the presence and absence of *M. occidentalis*. Error rates chosen for these lines were $\alpha = 0.10$ (probability of testing unnecessarily) and $\beta = 0.05$ (probability of not treating when treatment was warranted).

To use these decicion lines, leaves should be sampled randomly from portion of the tree above the sprinkler line. Each leaf should be examined for the presence of any stage of web-spinning mite. If one or more is found on the leaf, that leaf is considered infested. There is no need to count the number of mites on the leaf. When the number of infested leaves exceed the upper decision line, treatment is warranted. When the number of infested leaves is less than the lower decision line, no treatment is necessary. If no decision can be reached, more leaves should be sampled.

In developing the decision lines, the tree has been the basic sampling unit. To use this in a sampling program for mites, the number of leaves per tree should be determined to give the field person an understanding of how many leaves per tree to sample. Sample size is dependent per variance and a confidence interval about the mean which can be adjusted for time required to sample the basic unit. Lower acceptable confidence intervals require much larger sample sizes (Figure 10). By this relationship, the number of leaves that should be sampled per tree at 10% C.I. is in excess of 200, at 20% C.I. 37 leaves, and at 30% C.I. 14 leaves. Assuming it would take 12 seconds to sample a leaf and determine whether web-spinning mites were present or absent, the time required to sample a tree would be 8 minutes at 20% C.I. and 3 minutes at 30% C.I. It would be best to utilize the 20% C.I. sample if the smallest unit that could be treated were a small group of trees of a 'hot spot' in the orchard. The 30% C.I. sample would be best if a sample of the whole orchard were necessary to make a treatment decision.

Figures 11 and 12 are sampling forms that could be used when sampling web-spinning mites in almonds. Figure 11 represents a form where the basic unit is 15 leaves per tree (30% C.I.). Figure 10 represents a form where the basic unit is 40 leaves per tree (20% C.I.). Both forms utilize sampling errors of 10% α (treating when no treatment was necessary and 5% β (not treating when treatment was warranted). Provisional treatment thresholds for web-spinning mites in the presence or absence of M. occidentalis are incorporated.

To use these sampling forms, select the basic unit of the orchard on which a treatment could be applied. If the basic unit is the entire orchard, use Figure 11. In either case, start sampling from the area of the orchard that is of greatest concern. Randomly sample some leaves and look for predatory mites. If resistant predators have been released in your orchard, assume that predators are present. When it has been determined that M. occidentalis are present or absent, use the appropriate part of the form. Sample the appropriate number of leaves from each tree (15 or 40 depending on the form). Examine each leaf for the presence or absence of any life stage of web-spinning mites. Do not count the mites, just determine if they are present or absent. Record the number of leaves with web-spinning mites from 15 or 40 leaf samples, then add these together to determine the total number of leaves with web-spinning mites for all samples. Compare the latter number with the 2 columns on the sampling form labelled don't treat if $\leq$ and treat if $\geq$. If the total number of leaves with web-spinning mites to that point is less than or equal to the 'don't treat' decision line, no treatment is necessary and sampling can be terminated. If the total number of leaves with web-spinning mites is greater than or equal to the 'treat' decision line, a treatment is justified. If no decision can be reached, continue sampling until a conclusion is reached.

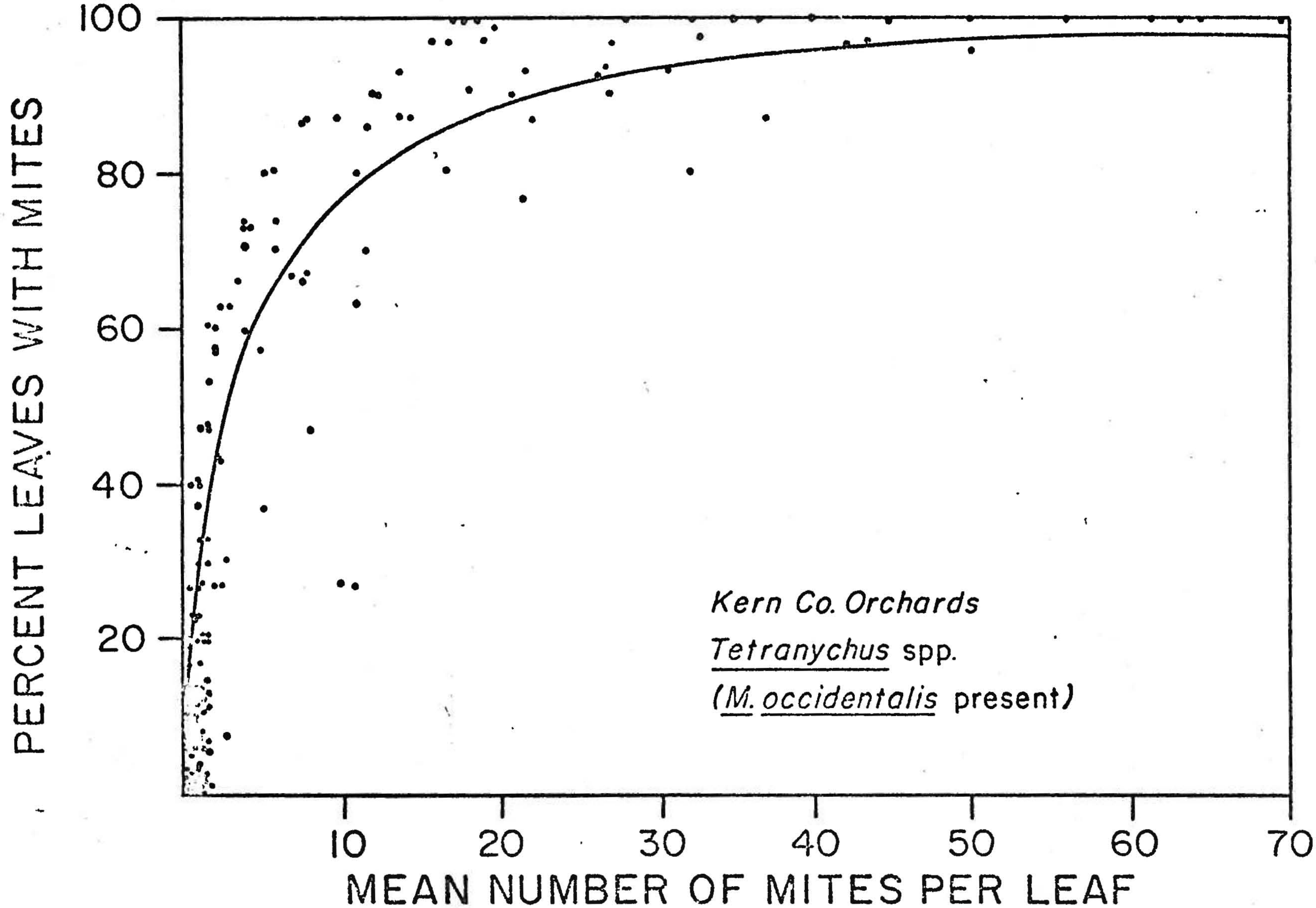
This sampling scheme provides a point-in-time estimate of whether a treatment is required or not. It does not provide an estimate of population growth rates or whether a treatment level will be reached at some future time. It is most valuable when you are not sure of whether to apply an acaricide or not at some point in the season beyond mid-June. For example, a sample could be taken prior to a hull split treatment for navel orangeworm to determine if an acaricide should be applied as well.

When using an acaricide, the presence or absence of _M. occidentalis_ is a limiting factor. If _M. occidentalis_ are present, lower rates of acaricide might be justified as these predators will help to control web-spinning mites naturally when they are allowed to survive and have a sufficient food source (the web-spinning mites).

More work will be conducted to validate this sampling scheme, and to provide a physiological estimate of threshold rather than the provisional threshold incorporated at this time. Cooperators will continue to include Dr. Hoy and Dr. Barnes.

Objective 4, Ant Damage -

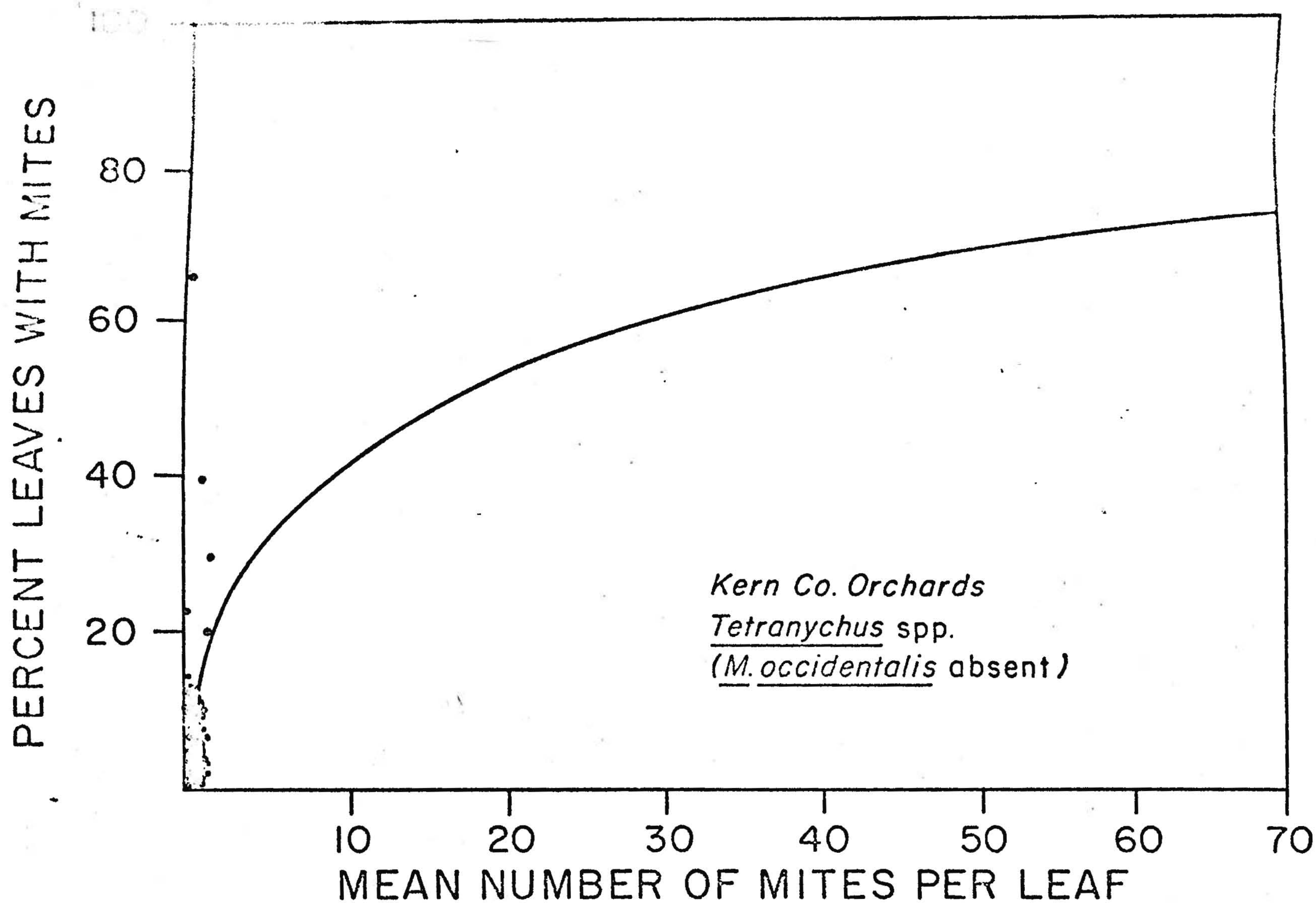
During 1980 and 1981, Wilbur Reil conducted basic work on ant damage to almonds. This work was summarized in a 1982 California Agriculture article (Appendix VI). Work was initiated in 1982 to help define the treatment thresholds for ants in a Kern County orchard. This work will continue in 1983.



PERCENT LEAVES WITH MITES
100
80
60
40
20
10
20
30
40
50
60
70
MEAN NUMBER OF MITES PER LEAF
Kern Co. Orchards
Tetranychus spp.
(M. occidentalis present)

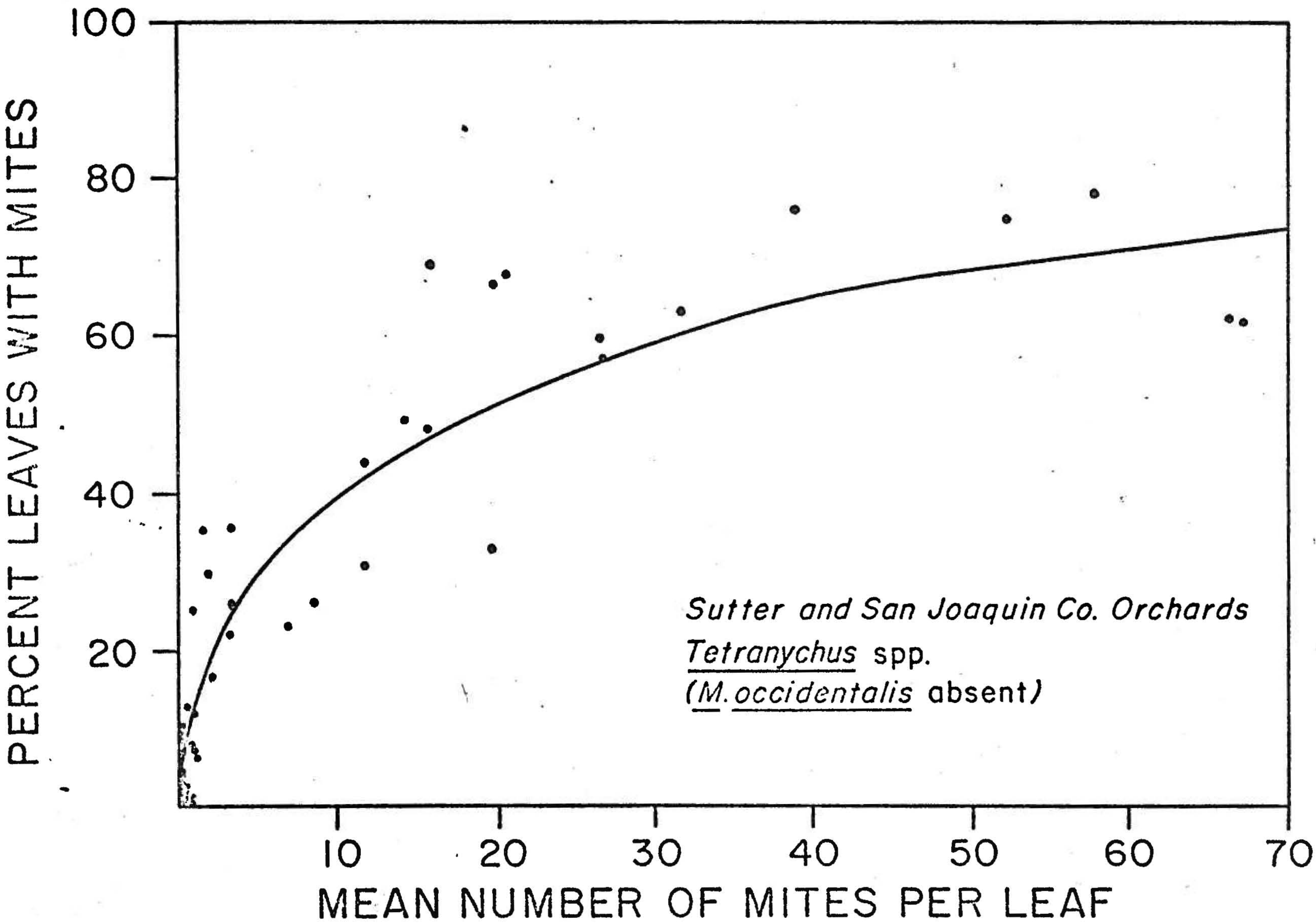
Figure 3

Figure 4



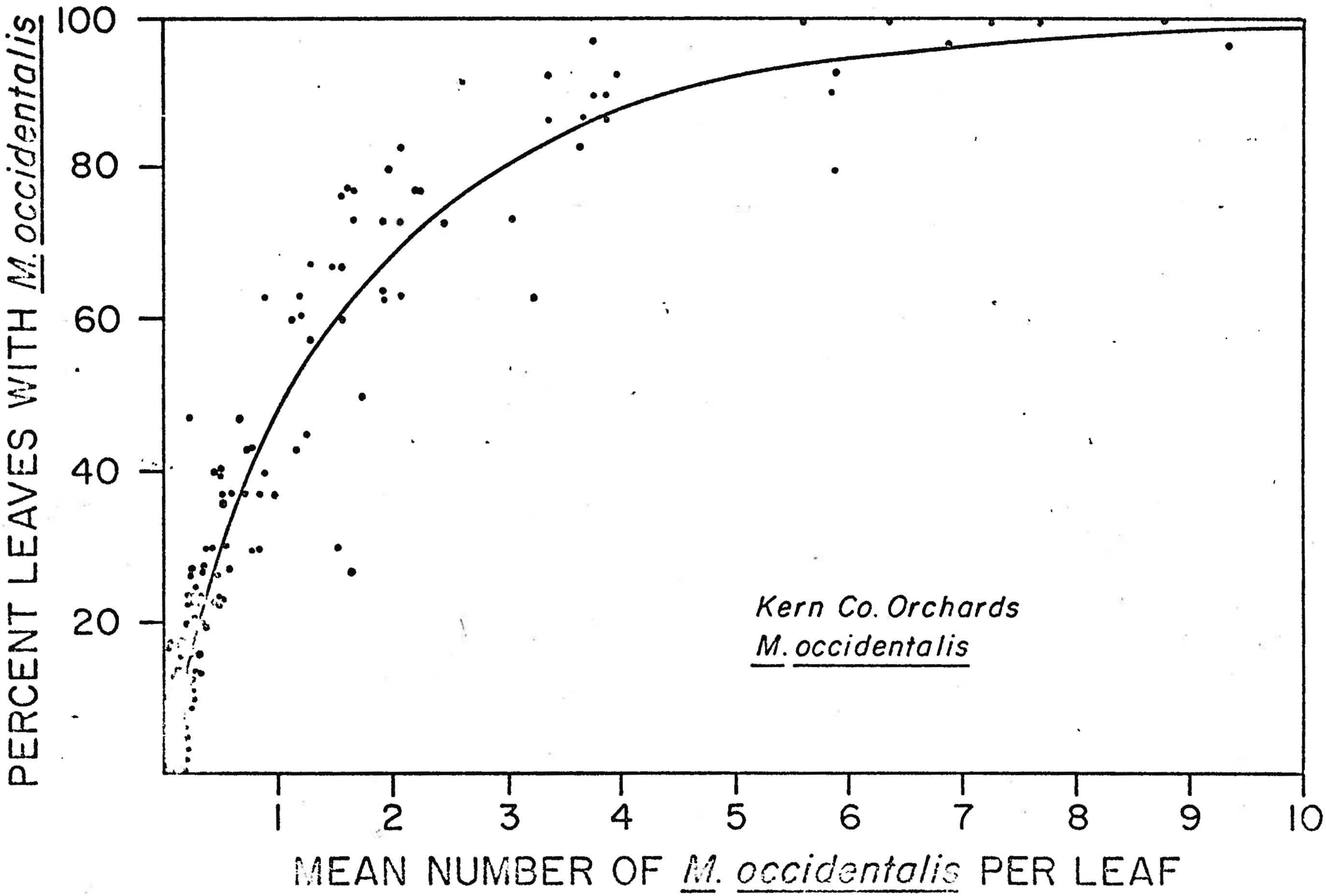
PERCENT LEAVES WITH MITES
80
60
40
20
Kern Co. Orchards
Tetranychus spp.
(M. occidentalis absent)
10
20
30
40
50
60
70
MEAN NUMBER OF MITES PER LEAF

Figure 5



100
80
60
40
20
PERCENT LEAVES WITH MITES
10
20
30
40
50
60
70
MEAN NUMBER OF MITES PER LEAF
Sutter and San Joaquin Co. Orchards
Tetranychus spp.
(M. occidentalis absent)

Figure 6



PERCENT LEAVES WITH M. occidentalis
100
80
60
40
20
1
2
3
4
5
6
7
8
9
10
MEAN NUMBER OF M. occidentalis PER LEAF
Kern Co. Orchards
M. occidentalis

Figure 7

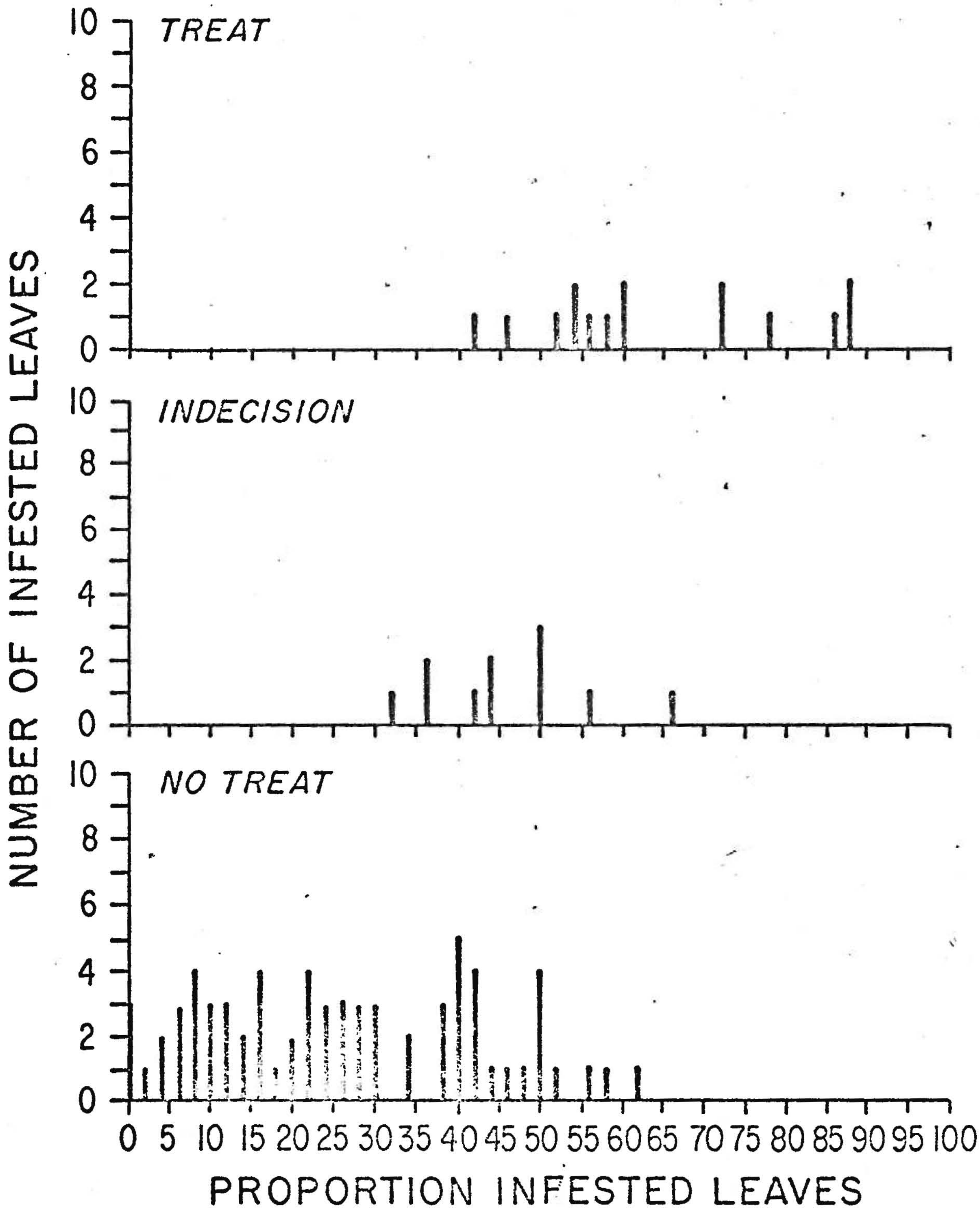

TREAT
INDECISION
NO TREAT
NUMBER OF INFESTED LEAVES
0 2 4 6 8 10
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
PROPORTION INFESTED LEAVES

Figure 8

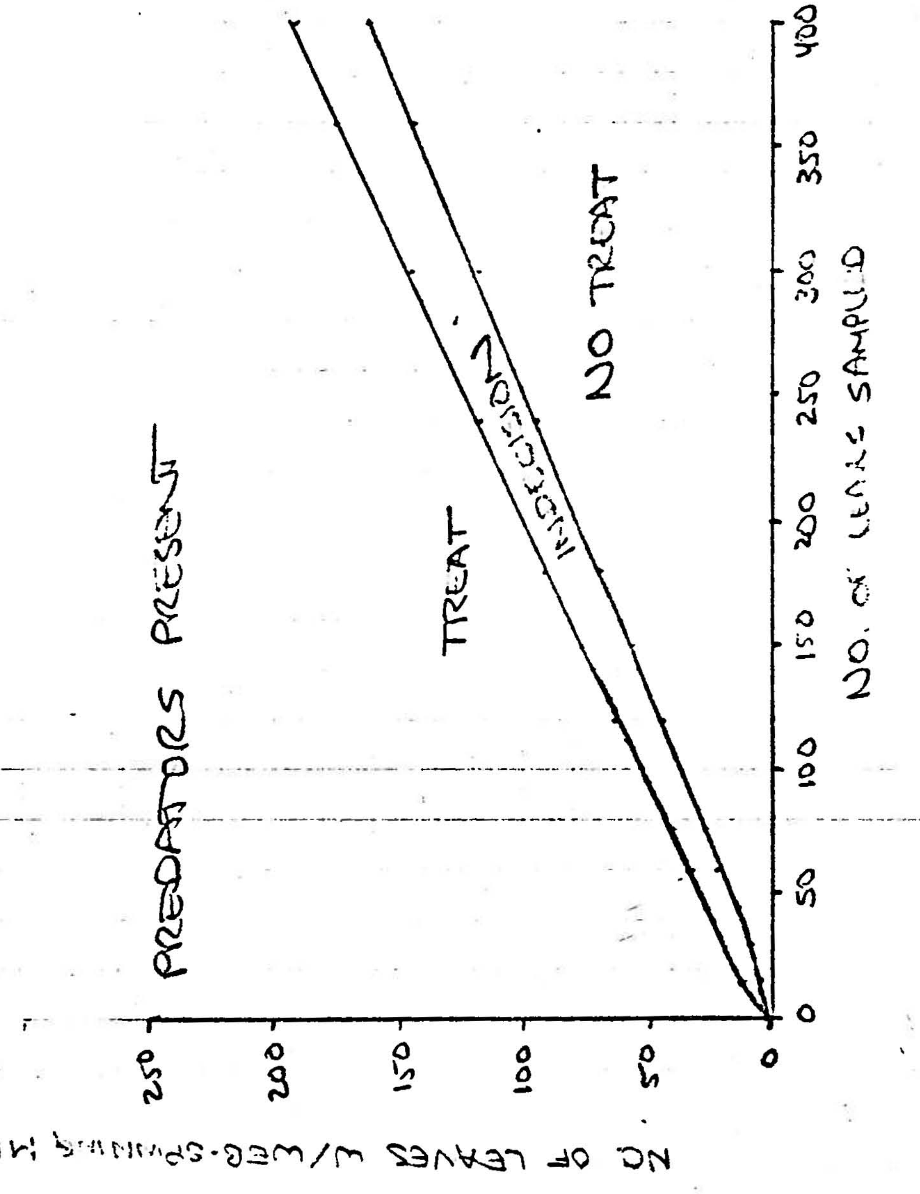

PREDATORS PRESENT
TREAT
INDECISION
NO TREAT
NO. OF LEAVES SAMPLED
NO. OF LEAVES W/WEB-SPINNING MITES
0
50
100
150
200
250
300
350
400

Figure 9

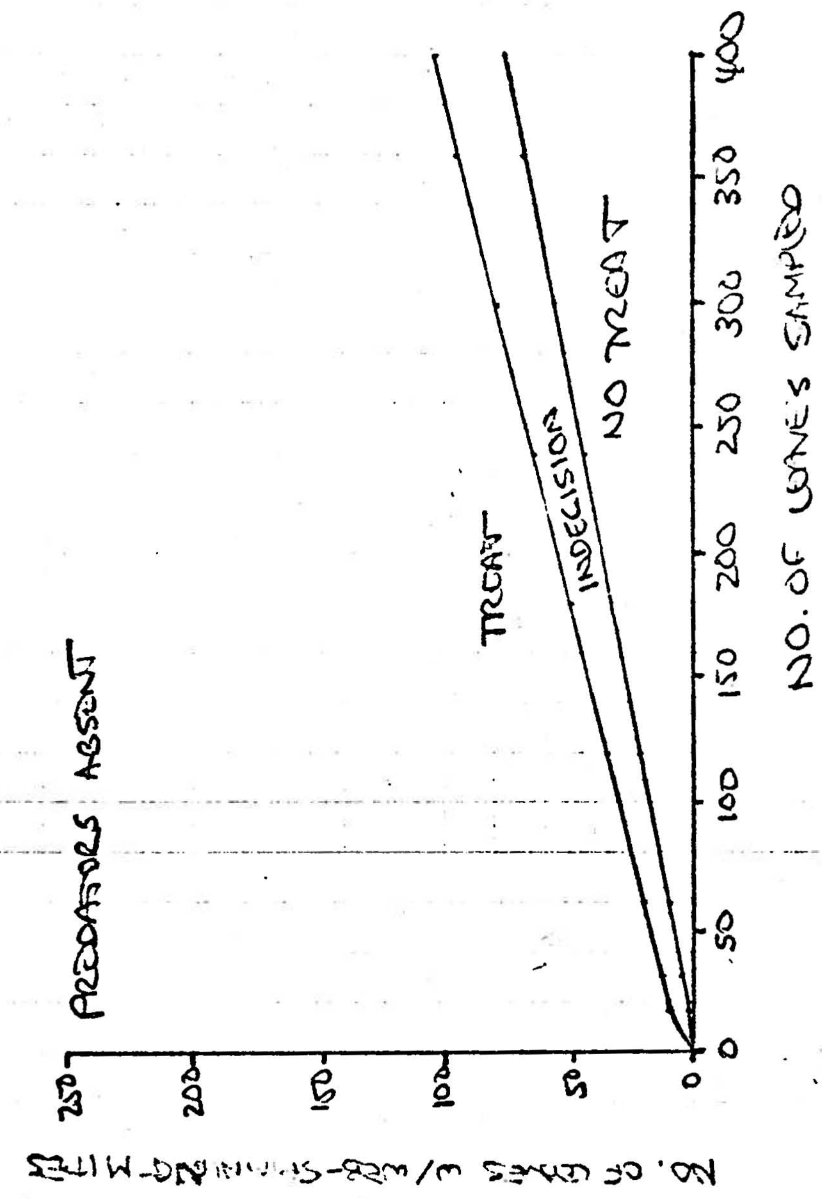

PREDATORS ABSENT
TREAT
INDECISION
NO TREAT
0
50
100
150
200
250
300
350
400
NO. OF LEAVES SAMPLED
NO. OF LEAVES W/ WEB-SPINNING MITES

Figure 10

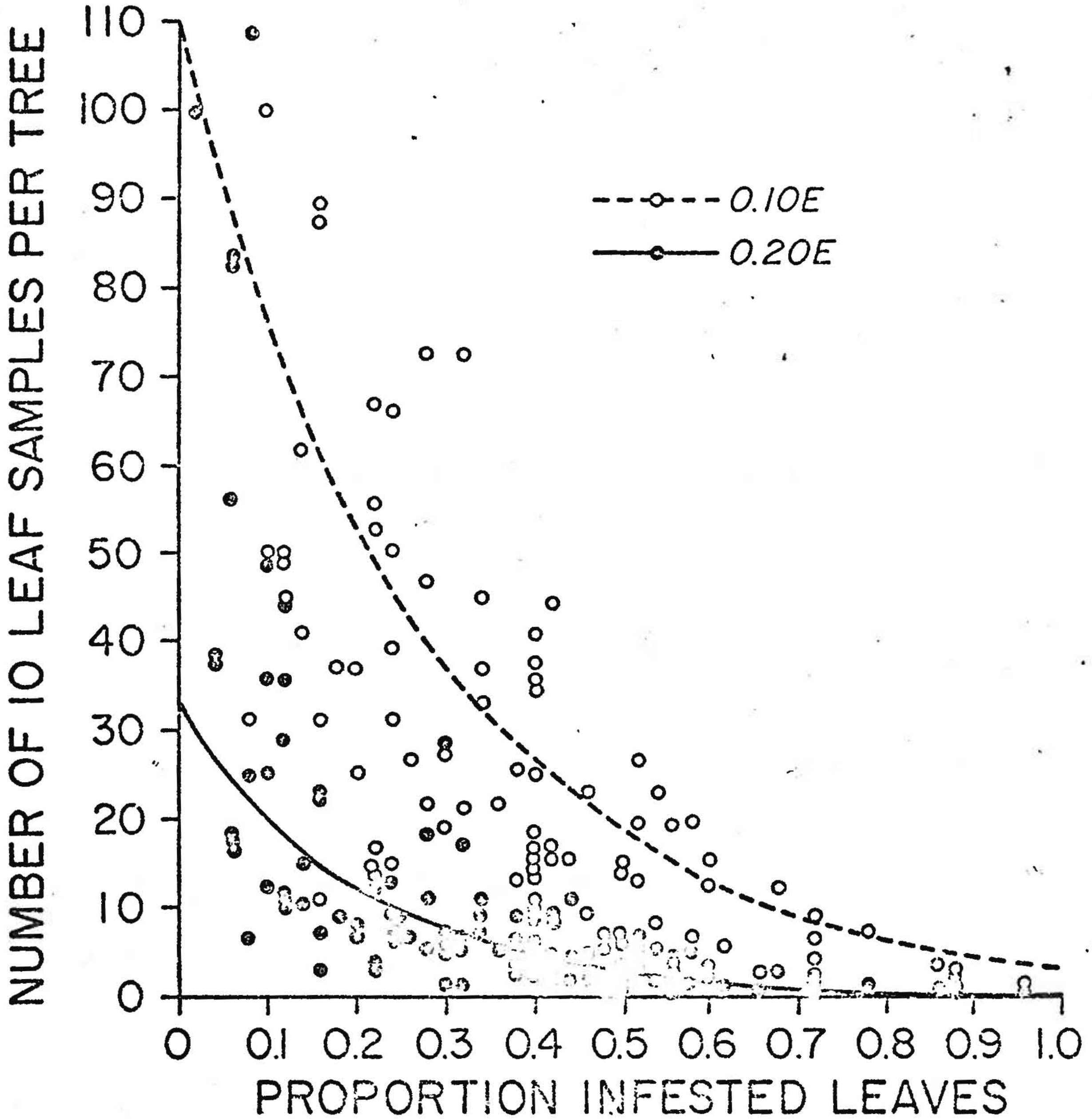

NUMBER OF 10 LEAF SAMPLES PER TREE
0.10E
0.20E
0
10
20
30
40
50
60
70
80
90
100
110
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
PROPORTION INFESTED LEAVES

Figure II

Date: ____________________

Orchard: ________________

Predators Present

Tree Number	No.Leaves Sampled	No.Leaves w/ Web-spinng Mites in Each Sample	Total No. of Leaves w/Web-spinning Mites For All Samples	Don't Treat if ≤	Treat if ≥
1	15	____	____	4	10
2	30	____	____	9	18
3	45	____	____	15	26
4	60	____	____	21	33
5	75	____	____	27	40
6	90	____	____	33	48
7	105	____	____	39	55
8	120	____	____	45	62
9	135	____	____	51	69
10	150	____	____	57	76
11	165	____	____	63	83
12	180	____	____	70	90
13	195	____	____	76	97
14	210	____	____	82	104
15	225	____	____	88	111
16	240	____	____	94	118
17	255	____	____	101	125
18	270	____	____	107	132
19	285	____	____	113	139
20	300	____	____	119	146

****Stop Sampling***

Predators Absent

Tree Number	No.Leaves Sampled	No.Leaves w/ Web-spinning Mites in Each Sample	Total No. Leaves w/ Web-spinning Mites For All Samples	Don't Treat if ≤	Treat if ≥
1	15	____	____	1	7
2	30	____	____	4	12
3	45	____	____	6	16
4	60	____	____	9	20
5	75	____	____	12	24
6	90	____	____	15	28
7	105	____	____	18	31
8	120	____	____	21	35
9	135	____	____	23	39
10	150	____	____	26	43
11	165	____	____	29	46
12	180	____	____	32	50
13	195	____	____	35	54
14	210	____	____	38	57
15	225	____	____	41	61
16	240	____	____	45	65
17	255	____	____	48	68
18	270	____	____	51	72
19	285	____	____	54	75
20	300	____	____	57	79

****Stop Sampling***

1982

Figure 12

Date: ____________________

Orchard: ____________________

Predators Present

Tree Number	No. Leaves Sampled	No. Leaves w/ Web-Spinning Mites In Each Sample	Total No. of Leaves w/Web-Spinning Mites For All Samples	Don't Treat if ≤	Treat if ≥
1	40	____	____	13	23
2	80	____	____	29	43
3	120	____	____	45	62
4	160	____	____	61	81
5	200	____	____	78	99
6	240	____	____	94	118
7	280	____	____	111	136
8	320	____	____	128	155
9	360	____	____	145	173
10	400	____	____	161	191
11	440	____	____	178	210
12	480	____	____	195	228
13	520	____	____	212	246
14	560	____	____	229	264
15	600	____	____	246	282

****Stop Sampling***

Predators Absent

Tree Number	No. Leaves Sampled	No. Leaves w/ Web-Spinning Mites In Each Sample	Total No. of Leaves w/Web-Spinning Mites For All Samples	Don't Treat if ≤	Treat if ≥
1	40	____	____	5	14
2	80	____	____	13	25
3	120	____	____	21	35
4	160	____	____	28	45
5	200	____	____	36	55
6	240	____	____	45	65
7	280	____	____	53	74
8	320	____	____	61	84
9	360	____	____	69	93
10	400	____	____	77	103
11	440	____	____	86	112
12	480	____	____	94	122
13	520	____	____	102	131
14	560	____	____	111	141
15	600	____	____	119	150

****Stop Sampling***

1982

APPENDIX I

DEGREE-DAYS IN RELATION TO AN INTEGRATED PEST MANAGEMENT PROGRAM

The authors are Frank Zalom, Integrated Pest Management Specialist, University of California, Davis, and Ted Wilson, Assistant Professor, Entomology, University of California, Davis.

Temperature controls the developmental rate of many organisms. Plants and invertebrate animals, including insects and nematodes, require a certain amount of heat to develop from one point in their life cycles to another. The developmental rate is based on the accumulation of heat units and is therefore measured in terms of physiological time instead of calendar time.

It is well known that little growth occurs below a minimum developmental threshold or above a maximum developmental threshold. These thresholds vary with different species. In general, an organism's development is faster at higher temperatures that are below the maximum threshold (Figure 1). Less development occurs at temperatures nearer the minimum threshold. Minimum and maximum developmental thresholds have been determined for certain plants and pests through carefully controlled laboratory and field experiments. The total amount of heat above the minimum threshold and below the maximum threshold required for the organism to develop from one point to another in its life cycle is calculated in units called degree-days (°D).

Degree-days are the accumulated product of time and temperature among the developmental thresholds for each day (Figure 2). One °D is one day (24 hours) with the temperature above the minimum developmental threshold by 1 degree. For example, if the minimum developmental threshold for an organism is 50° F and the temperature remains 51° F (or 1° F above the minimum developmental threshold) for 24 hours, 1 °D is accumulated.

Several methods have been used to calculate °D. All are approximations of the actual number of °D accumulated for a given set of temperatures and thresholds, and therefore rarely provide the exact °D values. However, most are adequate with respect to the types of weather instrumentation generally used and the accuracy required for pest management decisions. The methods vary somewhat in complexity and in accuracy seasonally or with different climatic regions. Whichever method is utilized, it is important that it is the same method that was used in developing the organism's biological growth relationships.

Calculations of °D can be made by utilizing programmable hand calculators, computers or precalculated tables. Degree-day tables are typically produced using a computer. They may be produced for organisms with known minimum developmental thresholds or known minimum and maximum thresholds. Different tables must be used for organisms with different thresholds.

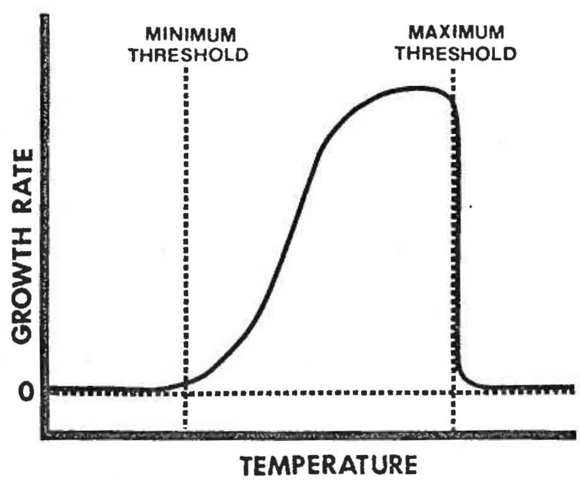


Figure 1. An organism's rate or growth and development is faster at higher temperatures below a given maximum threshold.

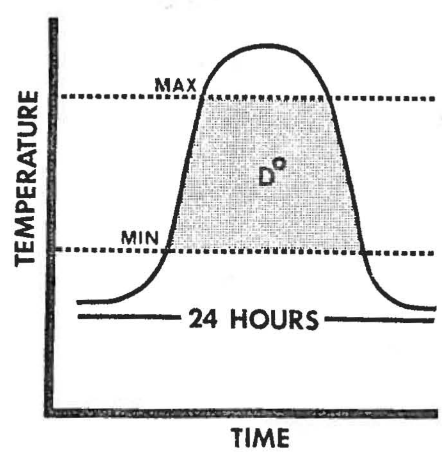


Figure 2. Degree-days are the accumulated product of time and temperature between a given maximum and minimum temperature for 24 hours.

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UNIVERSITY OF CALIFORNIA

LEAFLET 21301

MAX TEMP	MINIMUM TEMPERATURE 30	32	34	36	38	40	42	44	46
118	20	21	21	21	22	22	23	23	24
116	20	20	21	21	22	22	23	23	24
114	20	20	21	21	21	22	22	23	23
112	20	20	20	21	21	22	22	22	23
110	19	20	20	20	21	21	22	22	23
108	19	19	20	20	20	21	21	22	22
106	19	19	19	20	20	21	21	22	22
104	18	19	19	19	20	20	21	21	22
102	18	18	19	19	19	20	20	21	21
100	18	18	18	19	19	19	20	20	21
98	17	17	18	18	19	19	19	20	21
96	17	17	17	18	18	19	19	20	20
94	16	16	17	17	18	18	18	19	20
92	16	16	16	17	17	17	18	18	19
90	15	15	16	16	16	17	17	18	18
88	14	14	15	15	16	16	16	17	18

Figure 3. A portion of a degree-day table indicating the number of degree-days (19) that had accumulated on a day when the maximum temperature was 94 and the minimum temperature was 44.

On these tables, the low temperature for the day is charted along the top of the page and the high temperature for the day along the side of the page. To find the °D for one day, locate the low and high temperature for that day and follow the column and row to where they intersect (Figure 3). This number represents the total °D for that day.

The total heat unit requirement (or number of °D) necessary for an organism to complete a generation is a constant for each species. It will not change regardless of how heat is applied to an organism or the individual's location. Accumulation of °D is initiated at a specific point in time known as a biofix. This time varies with the organism involved and is based on a specific biological event such as planting date or trap catch. To accumulate °D using a table, simply add together the °D values obtained each day beginning with the date the biofix event occurred for the organism of interest. Again, the °D value for each date is based upon the daily maximum and minimum temperatures. Accumulation of °D should be done in a timely manner, especially when a control action decision is near. This will help to forecast when a control action should be made. In general, °D accumulate more slowly early in the season than later in the season.

Some developmental relationships have been determined that require use of degree-hours. Accurate calculation of degree-hours requires a record of hourly temperatures rather than daily minimum and maximum temperatures which are utilized in calculating °D. This sort of weather instrumentation is often unavailable to the user. In this case, simple approximation of degree-hours can be made by multiplying the number of °D for a given period of time by 24.

Degree-day models can be used as tools in making certain pest management decisions during the season. Where the necessary biological information is known, °D can be used to predict the development of specific pests. This knowledge is useful in adjusting cultural operations to minimize problems associated with pest control operations, in timing pesticide applications to make them more efficient, and in advising the crop consultant or grower of the status of development in the life cycle of a particular pest so that more efficient monitoring schedules are established.

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3m–6/82–HS/VG

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APPENDIX 11

MONITORING PEACH TWIG BORER DEVELOPMENT WITH DEGREE-DAYS

The authors are Richard E. Rice, Entomologist, San Joaquin Valley Agricultural Research and Extension Center; Frank G. Zalom, Integrated Pest Management Specialist, University of California, Davis; and Jay F. Brunner, Assistant Professor, Entomology, Washington State University.

The development of the peach twig borer *Anarsia lineattela* Zeller can be monitored using pheromone traps and local temperature. The relationship between climate and the insect's biology above a minimum developmental threshold and below a maximum threshold is measured in degree-days. Degree-days (°D) are heat units that drive the insect from one point in its life cycle to another. More information on the calculation and use of degree-days are available in leaflet 21301, *Degree-Days in Relation to an Integrated Pest Management Program.*

BIOLOGY

The peach twig borer is a major pest of almonds and stonefruits. It also attacks other treefruits, but it has not been reported as a major pest on hosts other than *Prunus* species.

Peach twig borer overwinters as a first or second instar larva in cells (hibernaculae) under the thin bark in limb crotches or in bark cracks. The presence of hibernaculae on trees can be determined by observing the small "chimneys" of frass and wood chips constructed on the bark surfaces by feeding larvae. During bloom and petal fall, overwintered twig borer larvae emerge from their hibernaculae and migrate up the small limbs and twigs to begin feeding on young leaves and buds. A single larva may attack and damage several buds or small terminals. As terminal growth develops, maturing larvae will establish themselves in a single shoot, causing a wilting or "flagging" of several terminal leaves. Upon maturity, these larvae will leave the mined shoot and seek a protected place, normally on the tree, for pupation.

Adults from the overwintered larval generation usually begin emerging in April. Moths of this generation lay eggs primarily on terminals or young leaves, but in some instances they may also lay eggs on green fruit. Twig borer larvae can develop equally well in green shoots or immature fruit. The first generation larvae develop during May and June and give rise to the next moth flight in late June and early July. During this flight and during the one following in August, many moths lay eggs on maturing fruit.

Some of the larvae that are produced from the moth flight in August and September go into hibernaculae for overwintering; others continue to develop on fruit or twigs and give rise to a generation of moths in October. These moths lay eggs that produce larvae for the overwintering (fourth) generation that emerge as moths the following spring.

MONITORING

Adult twig borer populations can be monitored with pheromone traps. The wing-style traps and pheromone dispensers are available commercially. Instructions for their use are provided with the traps from the manufacturers. Traps should be placed in orchards from about March 15 in the south to April 10 in the north to detect moth emergence, and should be positioned in the northern or eastern quadrant of the tree at a height of 6 to 7 feet. Traps should be serviced and moths counted at least once—or preferably twice—per week, particularly during peak flight periods. Trap bottoms should be replaced whenever they become obviously dirty, or when about 250 moths have been collected and removed from a trap. Pheromone dispensers should be replaced every 4 to 6 weeks.

Developmental thresholds are 50° F minimum and 88° F maximum. Accurate use of degree-days to monitor peach twig borer is initiated with the collection in a pheromone trap of the first male moths that emerge each year. Approximately 220 °D accumulate from first moth catch to egg hatch in the next generation. Larval development requires an additional 507 °D. Approximately 1060 °D are required for completion of a generation. Preliminary studies suggest that optimum timing for first generation larval treatments ("May" sprays) should be between 400 ° and 500 °D after first moth collections in spring.

You may use the table on the back of this page to calculate peach twig borer degree-days from weather data. To find the total degree-days for a day, locate the low and high temperature for the day and follow the column and row to where they intersect. To accumulate degree-days, add together the degree-days for each date beginning with the first moth catch.

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LEAFLET 21302

DEGREE-DAY TABLE FOR THE PEACH TWIG BORER

LOWER THRESHOLD: 50.00 F UPPER THRESHOLD: 88.00 F

MINIMUM TEMPERATURES

MAX TEMPS	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90
118	21	22	22	23	23	24	24	25	26	27	28	28	29	30	31	32	32	33	34	35	35	36	36	37	37	38	38	38
116	21	22	22	23	23	24	24	25	26	27	27	28	29	30	31	31	32	33	34	34	35	36	36	37	37	38	38	38
114	21	21	22	22	23	23	24	25	26	26	27	28	29	30	31	31	32	33	34	34	35	36	36	37	37	38	38	38
112	21	21	22	22	22	23	24	24	25	26	27	28	29	30	30	31	32	33	34	34	35	36	36	37	37	38	38	38
110	20	21	21	22	22	23	23	24	25	26	27	28	28	29	30	31	32	33	33	34	35	36	36	37	37	38	38	38
108	20	20	21	21	22	22	23	24	25	26	27	27	28	29	30	31	32	32	33	34	35	35	36	37	37	38	38	38
106	20	20	21	21	22	22	23	24	24	25	26	27	28	29	30	31	31	32	33	34	35	35	36	37	37	38	38	38
104	19	20	20	21	21	22	22	23	24	25	26	27	28	29	30	30	31	32	33	34	34	35	36	37	37	38	38	38
102	19	19	20	20	21	21	22	23	24	25	26	27	27	28	29	30	31	32	33	34	34	35	36	37	37	38	38	38
100	19	19	19	20	20	21	22	22	23	24	25	26	27	28	29	30	31	32	32	33	34	35	36	36	37	38	38	38
98	18	19	19	19	20	21	21	22	23	24	25	26	27	28	29	30	30	31	32	33	34	35	36	36	37	38	38	38
96	18	18	19	19	20	20	21	22	23	23	24	25	26	27	28	29	30	31	32	33	34	35	35	36	37	38	38	38
94	17	18	18	18	19	20	20	21	22	23	24	25	26	27	28	29	30	31	32	33	33	34	35	36	37	38	38	38
92	17	17	17	18	18	19	20	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	37	38	38
90	16	16	17	17	18	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	36	37	38	38
88	15	16	16	16	17	18	18	19	20	21	22	23	24	25	26	27	28-	29	30	31	32	33	34	35	36	37	38	
86	14	15	15	15	16	17	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		
84	13	14	14	15	15	16	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34			
82	12	13	13	14	14	15	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32				
80	11	12	12	13	13	14	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30					
78	11	11	11	12	12	13	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28						
76	10	10	10	11	11	12	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26							
74	9	9	9	10	10	11	11	12	13	14	15	16	17	18	19	20	21	22	23	24								
72	8	8	8	9	9	10	10	11	12	13	14	15	16	17	18	19	20	21	22									
70	7	7	8	8	8	9	9	10	11	12	13	14	15	16	17	18	19	20										
68	6	6	7	7	7	8	8	9	10	11	12	13	14	15	16	17	18											
66	5	6	6	6	6	7	7	8	9	10	11	12	13	14	15	16												
64	4	5	5	5	5	6	6	7	8	9	10	11	12	13	14													
62	4	4	4	4	5	5	5	6	7	8	9	10	11	12														
60	3	3	3	3	4	4	4	5	6	7	8	9	10															
58	2	2	2	3	3	3	3	4	5	6	7	8																
56	1	2	2	2	2	2	2	3	4	5	6																	
54	1	1	1	1	1	1	2	2	3	4																		
52	0	0	0	0	0	1	1	1	2																			
50	0	0	0	0	0	0	0	0																				
48	0	0	0	0	0	0	0																					

1-5/82-HS/VG

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PRINTED MAY 1982

APPENDIX III

Monitoring San Jose Scale Development with Degree-Days

Development of the San Jose scale *Quadraspidiotus perniciosus* (Comst.) can be measured using pheromone traps and local temperatures. The relationship between climate and the insect's biology above a minimum developmental threshold and below a maximum threshold is measured in degree-days. Degree-days (°D) are heat units that drive the insect from one point in its life cycle to another. More information on the calculation and use of degree-days is available in leaflet 21301, *Degree-Days in Relation to an Integrated Pest Management Program.*

Biology

San Jose scale is a severe pest of deciduous trees throughout the world. Its host range includes more than 700 plant species including many stonefruits and nuts in California. Scale populations on the tree can develop to the point of killing fruit wood and reducing yields. They may also occur directly on fruit or leaves in exceptionally heavy infestations.

The adult female scale cover is grey, circular, slightly raised, and may have a ringed appearance that results from the molting process. Females may reach 2 mm in diameter. The developing scale's body is under the waxy cover and is yellow to light orange in color. San Jose scale bodies are similar in color to walnut scale and these two species are difficult to separate. Olive scale and Italian pear scale covers are also grey, but the scale bodies are pink or purple.

Crawlers emerge from under the female scale's cover and move to a feeding site within 8 hours. Scales are exceptionally vulnerable to control at this stage. Crawlers are very small (0.3 mm long) and yellow in color. Scales continue to feed and grow at the site of initial settling, constantly adding to their cover as they molt and increase in size. Females molt twice; the fifth instar is the mature male which has wings and is capable of mating immediately after emerging from under its cover.

The scale overwinters primarily as a late first instar nymph called a "blackcap". In temperate climates, such as California's, up to 20 percent of the overwintering population may be comprised of mature mated females. The overwintering scales give rise to mature females and winged males in March or April.

Crawlers of the first generation begin emerging in late April or May and give rise to the first generation male flight in June. Additional flights typically follow in July or August and again in September or October. Crawlers emerging in October and November produce the overwintering (fourth) generation flight the following spring.

Monitoring

Adult male scales respond to a sex pheromone and their seasonal flights can be monitored with pheromone traps. The tent-style traps and pheromone dispensers are available commercially. Instructions for their use are provided with the traps by the manufacturers. Traps should be placed in orchards by February 25 in the south and by March 15 in the north to detect male emergence, and should be positioned in the northern or eastern quadrant of the tree at a height of 6 to 7 feet. Traps should be serviced and male scales counted at least once and preferably twice per week during critical flight periods. Traps should be replaced whenever they become obviously dirty and when males are hard to detect. Pheromone dispensers should be replaced every 4 to 6 weeks.

Although a dormant spray is preferred when treatment is warranted, the best alternate time for a scale spray is during crawler emergence in May. Late fall or postharvest treatments are not as effective as dormant or May sprays. Accurate use of degree-days to monitor San Jose scale is initiated with the collection in a pheromone trap of the first male scales that emerge each year, usually in March. Crawler emergence begins about 405 °D after first male flight. Approximately 1050 °D are required for completion of a generation.

The optimum timing for 'May' crawler treatment is about 600 to 700 °D after the first male scale is collected in March.

You may use the table on the back of this page to calculate San Jose scale degree-days from weather data. To find the total degree-days for a day, locate the low and high temperature for the day and follow the column and row to where they intersect. To accumulate degree-days, add together the degree-days for each date beginning with the first moth catch.

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LEAFLET 21312

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DEGREE-DAY TABLE JR SAN JOSE SCALE

LOWER THRESHOLD: 51.00 F UPPER THRESHOLD: 90.00 F

MINIMUM TEMPERATURES

MAX TEMPS	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90
118	21	22	22	22	23	23	24	24	25	26	27	28	28	29	30	31	32	32	33	34	35	35	36	37	37	38	38	39	39
116	21	21	22	22	23	23	24	24	25	26	27	27	28	29	30	31	32	32	33	34	35	35	36	37	37	38	38	39	39
114	21	21	21	22	22	23	23	24	25	25	26	27	28	29	30	31	31	32	33	34	35	35	36	37	37	38	38	39	39
112	20	21	21	22	22	22	23	24	24	25	26	27	28	29	29	30	31	32	33	34	34	35	36	37	37	38	38	39	39
110	20	20	21	21	22	22	23	23	24	25	26	27	28	28	29	30	31	32	33	33	34	35	36	36	37	38	38	39	39
108	20	20	20	21	21	22	22	23	24	25	25	26	27	28	29	30	31	32	32	33	34	35	36	36	37	38	38	39	39
106	19	20	20	21	21	21	22	23	23	24	25	26	27	28	29	30	31	31	32	33	34	35	35	36	37	38	38	39	39
104	19	19	20	20	21	21	22	22	23	24	25	26	27	28	28	29	30	31	32	33	34	35	35	36	37	38	38	39	39
102	19	19	19	20	20	21	21	22	23	23	24	25	26	27	28	29	30	31	32	33	33	34	35	36	37	37	38	39	39
100	18	18	19	19	20	20	21	21	22	23	24	25	26	27	28	29	30	31	31	32	33	34	35	36	37	37	38	39	39
98	18	18	18	19	19	20	20	21	22	23	24	24	25	26	27	28	29	30	31	32	33	34	35	36	36	37	38	39	39
96	17	17	18	18	19	19	20	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	34	35	36	37	38	39	39
94	17	17	17	18	18	19	19	20	21	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	38	39
92	16	16	17	17	17	18	19	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	37	38	39
90	15	15	16	16	17	17	18	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
88	14	15	15	15	16	16	17	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
86	13	14	14	14	15	15	16	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35		
84	12	13	13	13	14	14	15	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33			
82	11	12	12	12	13	13	14	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31				
80	11	11	11	12	12	12	13	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29					
78	10	10	10	11	11	11	12	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27						
76	9	9	9	10	10	10	11	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25							
74	8	8	8	9	9	9	10	10	11	12	13	14	15	16	17	18	19	20	21	22	23								
72	7	7	8	8	8	9	9	9	10	11	12	13	14	15	16	17	18	19	20	21									
70	6	6	7	7	7	8	8	8	9	10	11	12	13	14	15	16	17	18	19										
68	5	6	6	6	6	7	7	8	8	9	10	11	12	13	14	15	16	17											
66	5	5	5	5	5	6	6	7	7	8	9	10	11	12	13	14	15												
64	4	4	4	4	5	5	5	6	6	7	8	9	10	11	12	13													
62	3	3	3	4	4	4	4	5	5	6	7	8	9	10	11														
60	2	2	3	3	3	3	3	4	4	5	6	7	8	9															
58	2	2	2	2	2	2	2	3	3	4	5	6	7																
56	1	1	1	1	1	1	2	2	2	3	4	5																	
54	1	1	1	1	1	1	1	1	1	2	3																		
52	0	0	0	0	0	0	0	0	0	1																			
50	0	0	0	0	0	0	0	0	0																				
48	0	0	0	0	0	0	0	0																					

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Using Degree-Days In A Peach Twig Borer Monitoring Program

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Biology

The peach twig borer, *Anarsia lineatella* Zeller, is a major pest of almonds. It also attacks other treefruits, but has not been reported as a major pest on hosts other than *Prunus* species. It is reported from Europe and the Mediterranean area, and was first reported as a pest in California in the 1880's.

Adults of peach twig borer are nocturnal moths 8 to 11 mm long, with steel-gray mottled forewings. Adults may live up to 5 weeks in captivity. Eggs are yellow-white to orange, and are bluntly oval with surface reticulations. They are laid on fruit surfaces, on twig terminals, or on the undersides of leaves next to veins or the mid-rib. Females have been observed to lay over 100 eggs each, with an average number per female of 80 to 90. Eggs hatch in 4 to 18 days, depending upon temperature.

Larvae of peach twig borer have a dark chocolate-brown head and prothorax with distinctive alternating dark and light brown bands or rings around the abdomen. Larvae have 4 or 5 instars. Mature larvae may reach 12 cm in length. Pupae are usually 6 to 10 mm long, smooth, brown, and without a cocoon. Twig borer pupae are not usually found in the fruit.

Peach twig borer overwinters as a 1st or 2nd instar larva in cells (hibernaculae) under the thin bark in limb crotches or in bark cracks. The presence of hibernaculae on trees can be determined by observing the small "chimneys" of frass and wood chips constructed on the bark surfaces by feeding larvae. During the bloom and petal fall period, overwintered twig borer larvae emerge from their hibernaculae and migrate up the small limbs and twigs and begin feeding on young leaves and buds. A single larva may attack and damage several buds or small terminals. As terminal growth develops, maturing larvae will establish themselves in a single shoot or terminal and may mine the interior of the shoot, causing a wilting or "flagging" of several terminal leaves. Upon maturity, these larvae will leave the mined shoot and

PEACH TWIG BORER
LOWER THRESHOLD: 50.00 F UPPER THRESHOLD: 88.00 F
MINIMUM TEMPERATURES

MAX TEMPS	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88
118	20	21	21	21	22	22	23	23	24	24	25	26	27	28	28	29	30	31	32	32	33	34	35	35	36	36	37	37	38	38
116	20	20	21	21	22	22	23	23	24	24	25	26	27	27	28	29	30	31	31	32	33	34	34	35	36	36	37	37	38	38
114	20	20	21	21	21	22	22	23	23	24	25	26	26	27	28	29	30	31	31	32	33	34	34	35	36	36	37	37	38	38
112	20	20	20	21	21	22	22	22	23	24	24	25	26	27	28	29	30	30	31	32	33	34	34	35	36	36	37	37	38	38
110	19	20	20	20	21	21	22	22	23	23	24	25	26	27	28	28	29	30	31	32	33	33	34	35	36	36	37	37	38	38
108	19	19	20	20	20	21	21	22	22	23	24	25	26	27	27	28	29	30	31	32	32	33	34	35	35	36	37	37	38	38
106	19	19	19	20	20	21	21	22	22	23	24	24	25	26	27	28	29	30	31	31	32	33	34	35	35	36	37	37	38	38
104	18	19	19	19	20	20	21	21	22	22	23	24	25	26	27	28	29	30	30	31	32	33	34	34	35	36	37	37	38	38
102	18	18	19	19	19	20	20	21	21	22	23	24	25	26	27	27	28	29	30	31	32	33	34	34	35	36	37	37	38	38
100	18	18	18	19	19	19	20	20	21	22	22	23	24	25	26	27	28	29	30	31	32	32	33	34	35	36	36	37	38	38
98	17	17	18	18	19	19	19	20	21	21	22	23	24	25	26	27	28	29	30	30	31	32	33	34	35	36	36	37	38	38
96	17	17	17	18	18	19	19	20	20	21	22	23	23	24	25	26	27	28	29	30	31	32	33	34	35	35	36	37	38	38
94	16	16	17	17	18	18	18	19	20	20	21	22	23	24	25	26	27	28	29	30	31	32	33	33	34	35	36	37	38	38
92	16	16	16	17	17	17	18	18	19	20	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	37	38
90	15	15	16	16	16	17	17	18	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	37	38
88	14	14	15	15	16	16	16	17	18	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
86	13	14	14	14	15	15	15	16	17	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
84	12	13	13	13	14	14	15	15	16	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34		
82	11	12	12	12	13	13	14	14	15	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32			
80	11	11	11	11	12	12	13	13	14	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30				
78	10	10	10	11	11	11	12	12	13	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28					
76	9	9	9	10	10	10	11	11	12	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26						
74	8	8	8	9	9	9	10	10	11	11	12	13	14	15	16	17	18	19	20	21	22	23	24							
72	7	7	8	8	8	8	9	9	10	10	11	12	13	14	15	16	17	18	19	20	21	22								
70	6	7	7	7	7	8	8	8	9	9	10	11	12	13	14	15	16	17	18	19	20									
68	6	6	6	6	6	7	7	7	8	8	9	10	11	12	13	14	15	16	17	18										
66	5	5	5	5	6	6	6	6	7	7	8	9	10	11	12	13	14	15	16											
64	4	4	4	4	5	5	5	5	6	6	7	8	9	10	11	12	13	14												
62	3	3	4	4	4	4	4	5	5	5	6	7	8	9	10	11	12													
60	3	3	3	3	3	3	3	4	4	4	5	6	7	8	9	10														
58	2	2	2	2	2	2	3	3	3	3	4	5	6	7	8															
56	1	1	1	1	2	2	2	2	2	2	3	4	5	6																
54	1	1	1	1	1	1	1	1	1	2	2	3	4																	
52	0	0	0	0	0	0	0	0	1	1	1	2																		
50	0	0	0	0	0	0	0	0	0	0	0																			
48	0	0	0	0	0	0	0	0	0	0																				
46	0	0	0	0	0	0	0	0	0																					
44	0	0	0	0	0	0	0	0																						
42	0	0	0	0	0	0	0																							
40	0	0	0	0	0	0																								

seed a protected place, normally on the tree, for pupation.

Adults from the overwintered larval generation usually begin emerging in April. Moths of this generation lay eggs primarily on terminals or young leaves, but in some instances they may also lay eggs on green fruit. Twig borer larvae can develop equally well in green shoots or immature fruit. The 1st-generation larvae develop during May and June, and give rise to the next moth flight in late June and early July. During this flight and the one following in August, many moths lay eggs on maturing fruit.

Some of the larvae that are produced from the moth flight in August and September go into hibernaculae for overwintering; others continue to develop on fruit or twigs and give rise to a 3rd generation of moths in October. These moths lay eggs that produce larvae for the overwintering (4th) generation that emerge as moths the following spring.

Table 1. Developmental thresholds and degree-day requirements.

PTB Phenology Model	
Lower Threshold:	50°F
Upper Threshold:	88°F
1st Moth to Egg Hatch:	220 D°
Larval Development:	507 D°
Pupal Development:	333 D°
D° Per Generation:	1060 D°

Monitoring

Adult twig borer populations can be monitored with sex pheromone traps. The wing-style trap and pheromone dispensers are available commercially. Traps should be placed in orchards by March 15 (south) to April 10 (north) to detect initial moth emergence, and should be positioned in the N or E quadrant of the tree at a height of 6-7 feet. Traps should be serviced and moths counted at least once, or preferably twice per week, particularly during critical flight periods. Trap bottoms should be replaced whenever they become obviously dirty, or when 250 moths have been collected and removed from a trap.

Accurate use of the predictive phenology model for peach twig borer (Table 1) relies upon collection of the first male moths that emerge in April each year. Approximately 1060 degree-days (D°) are required for completion of a generation. Preliminary data suggests that optimum timing for 1st generation larval treatments ("May" sprays) should be between 400 and 500 D° after 1st moth collections in April.

Determining the number of D° that have accumulated following the 1st moth catch is relatively simple using the accompanying degree-day table for peach twig borer. The low-temperatures for day is charted along the top of the page and the high temperature for a day along the side of the page. To find the D° for a given day, locate the low and high temperature from your orchard for the day and follow the column and row to where they intersect. Degree-days should be calculated from the day the first moth was trapped.

To accumulate D° simply add together the D° values obtained each day based on the daily maximum and minimum temperatures.

Control of peach twig borer is most effective during the winter or when directed at first generation larvae. It is easier to kill young larvae than other developmental stages. Sprays should be avoided at bloomtime when bees are present in the orchard.

Veteran broker Frank Glueck dies

Frank C. Glueck, owner of Frank C. Glueck and Company in Cincinnati, Ohio, died February 17.

Glueck represented Blue Diamond® brand almond products since 1938 making his firm one of the oldest in the Exchange brokerage network. The Exchange was also his first account.

"Frank had many friends at the Exchange and throughout our domestic broker network," said Pat Brandon, Regional Sales Manager. "Many of us have had the privilege of knowing and working with Frank over the years. We'll all miss him."

Glueck retired recently and was working on a consulting basis for his son Gerald (Jerry) Glueck who will continued as owner/operator of the brokerage firm.