Project Number 75-H

1975
NAVEL ORANGEWORM
ANNUAL REPORT

December 30, 1975

R. E. Rice, J. E. Dibble, L. L. Sadler

University of California

San Joaquin Valley Agricultural
Research and Extension Center
9240 South Riverbend Avenue
Parlier, California 93648

TITLE: Almond Control Board Research Project 75-H:
Navel Orangeworm Field Research: Application, Timing and Materials

PERSONNEL: Dr. R. E. Rice (Project Leader), Dr. J. E. Dibble and Lee Sadler

I. OBJECTIVES AND GOALS:

The objectives of this project were to develop methods and techniques for chemical control of navel orangeworm. Having been shown to be feasible, chemicals can be used either as a primary, or as a secondary method of control to serve as a backup system for use in conjunction with cultural controls.

II. ABSTRACT:

Chemical control of navel orangeworm was not generally considered to be feasible prior to 1973. At this time, however, it was determined that reevaluation of certain chemicals, development of new timing techniques, and evaluation of new application methods, based on testing of various types of equipment and sprayers, might prove to be useful in developing a satisfactory chemical control program for navel orangeworm in almonds.

Our approach in developing this program was to first evaluate a number of new spray rigs and types of application equipment that had become commercially available in the past 5 or 6 years to determine if these sprayers were better suited for application of chemicals in almonds than were previously available types of equipment. At the same time it was recognized that a method of timing chemical sprays to the occurrence of navel orangeworm populations in the field would be necessary if a chemical program was to be developed. At the time this program was initiated, only two chemicals, Guthion and Sevin, were available for experimental use on almonds. After reviewing the literature on navel orangeworm biology it was decided that an early season spray program would perhaps be most feasible for trying to reduce the population of insects in the orchard to a level which would provide adequate protection of the new crop almonds when they matured in the late summer, while at the same time avoiding conflicts with cultural operations, irrigation schedules, and preparation for harvest during the hull split period. In considering the two chemicals that were available for experimental use in this program it was decided that Guthion would be the most suitable chemical to use in an early season spray program, in that it generally provides a longer residue of toxicant on plant surfaces to cause mortality to developing navel orangeworm larvae in the spring.

After testing a number of sprayers and rates of application in 1973, it was determined that dilute applications of 400-500 gals. per acre, or applications of concentrate spray at the rate of 100 gals. per acre were equally effective in depositing spray material and in providing control for navel orangeworm. Results of test plots at Caruthers in 1974 showed Guthion at a rate of 2 lbs. AI/acre provided approximately 50-55% reduction of navel orangeworm damage at harvest. These sprays were applied in April and early May, 1974. The sprays were timed by use of an egg deposition or oviposition trap designed to attract navel orangeworm females and induce them to lay eggs on the surface of the trap.

Experimental procedures in 1975 were essentially the same as in 1974 and were as follows:

13-acre blocks of almonds were sprayed with an Ag-Tec Sprayall concentrate sprayer operated at 1.8 miles per hour and 24 lbs. pressure per square inch to deliver 100 gals. per acre. Guthion 50W was applied at 2 lbs. AI/acre in single sprays that were applied on either May 12 or June 3, or a double application applied on both of these dates. In addition to the chemical treatments, cultural treatments were evaluated in 1975 in which trees were completely cleaned of mummies and stick-tights and were disced under prior to moth emergence in the spring. This cultural program was conducted under two types of weather conditions, one in which the trees were wet with fog and rain, facilitating easy and complete removal of mummies, while the other weather condition was that of relatively dry trees, very little fog and very difficult removal of mummies from the trees resulting in a much greater mummy load left in the orchard after the control operations were conducted. The chemical sprays were again timed with the egg traps to the initial egg hatch of navel orangeworm moths that occurred in mid-May followed by the second application and continuing egg hatch three weeks later during the first week of June.

The results of these various chemical and cultural treatments in 1975 showed that the single early application of Guthion provided approximately 73.5% reduction in navel orangeworm damage at harvest, the single late application gave 71.6% reduction in damage, while the double application of Guthion gave 74.5% reduction in navel orangeworm damage. The cultural treatment that was conducted during wet weather conditions gave a 75.3% reduction in navel orangeworm damage while the cultural operation conducted during dry weather conditions gave only 40.4% control of navel orangeworm at harvest.

Based on these data from 1975 it was concluded that an economically feasible chemical spray program for navel orangeworm could be conducted if these sprays were properly timed with egg traps to the development of egg laying and initial egg hatch in the early spring. The use of egg traps is considered essential to the proper timing of these spray applications.

The feasibility and practical application of a chemical control program for any individual grower at this point becomes primarily an economic decision based on the growers anticipated monetary loss to navel orangeworm, and the cost for applying the insecticide controls. In situations where a grower is able to apply cultural controls to his orchard, a chemical program perhaps would not be required for additional navel orangeworm control. In other situations, however, where a grower cannot, for whatever reason, obtain good cultural cleanup during the winter period a chemical control program might prove to be a viable alternative to a cultural control program.

III. EXPERIMENTAL PROCEDURE:

Test plots in 1975 were located at Caruthers, Fresno County, California. Chemical treatment plots were 13 acres each, reduced from an original 20 acres due to frost damage that occurred in April. Cultural control plots were 40 acres each. The untreated check area was 20 acres in size. Chemical

sprays were applied with an Ag-Tec Sprayall self-contained sprayer operated at 1.8 mph and 24 psi to deliver 100 gals. per acre. Dilute spray applications were not applied in 1975. Azinphosmethyl (Guthion) 50W at 2 lbs. AI/acre was applied on each chemical treatment date.

Nut sampling and damage evaluation procedures in the chemical and cultural control plots consisted of 10 composite sub-samples of nuts per treatment. Each of these 10 samples were taken at harvest from windrowed nuts under 2-3 trees at each of the 10 sample sites. Percent navel orangeworm damage was determined by hand shelling 250 nuts from each sub-sample.

Chemical and cultural treatments evaluated in 1975 were as follows:

a) An untreated check or control in which no cultural or chemical treatments were applied. The check was mechanically knocked on September 29 and nuts were picked up from the windrows on the same date.

b) Cultural plot A - This plot was winter knocked on January 23 under optimum weather conditions of heavy, wet fog. The mummy nuts were blown from the chemically treated berms and were disced under on February 18. This plot was knocked on September 9 but the nuts were not picked up until September 22 due to approximately 1/4 inch of rain that fell on the knocked nuts on September 10. The delay in sampling the nuts from the windrows was brought about by the necessity for letting the nuts dry prior to windrowing.

c) Cultural plot C - This plot was winter knocked on January 27 but under sub-optimum weather conditions with very little fog and relatively dry trees. Mummy nuts on the ground were blown from the berms and disced under on April 17. New crop nuts were knocked on September 25 and samples were picked up from the windrows on September 29.

d) The Guthion early chemical application received no cultural treatments in 1975. A single application of Guthion at 2 lbs. AI/acre was applied on May 12. This treatment occurred approximately 7 days after the first eggs were observed to hatch on egg traps. New crop nuts were knocked in this plot on September 22 and harvest samples were picked up from the windrows on September 26.

e) The Guthion late chemical treatment again received no cultural treatments in 1975. Guthion was applied on June 3, 3 weeks after the first application was applied in the early Guthion plot. Nuts were knocked in this plot on September 23 and nut samples were picked from the windrows on September 25.

f) Guthion 2 application chemical treatment - This plot also received no cultural treatments during 1975. Guthion at a rate of 2 lbs. AI/acre was applied on May 13 and again on June 3, 1975. New crop nuts were knocked on September 22 in this plot and harvest samples were picked up from the windrows on September 26.

In addition to the chemical and cultural control plots, a considerable amount of biological data was collected during 1975 based on observations and experiments using the navel orangeworm egg traps. These traps consisted of 25 dram plastic vials with 2 large windows cut from the sides of the vial and covered with 160 mesh nylon organdy. The bait in the egg traps was comprised of navel orangeworm laboratory rearing media.

IV. RESULTS:

The results of the chemical and cultural control experiments for navel orangeworm in 1975 are shown in Table 1. These data show that the three chemical treatments and the cultural "A" plot all produced over 70% control of navel orangeworm at harvest in September. The cultural "C" plot did not give this level of control due primarily to the excessive number of mummies left in the trees after knocking in January. In addition to the reduction of navel orangeworm damage in the chemical treatments, a reduction in peach twig borer damage to new crop almonds was observed where Guthion was applied, either as a early spray in May or as a later spray in June. Reduction of peach twig borer in the cultural plots was not attained due to the absence of chemical treatments. Damage from navel orangeworm in the untreated check plot reached a level of 27.5% in 1975 which is considered a relatively high level of loss to this insect. Table 1 shows a fairly low level of twig borer damage in the check plot. However, a considerable amount of twig borer damage was obscured on nuts attacked by both twig borer and navel orangeworm due to the extensive feeding of navel orangeworm subsequent to twig borer damage on the nut meats.

Table 2 is a hypothetical projection of grower savings or potential net returns based on the data from the chemical and cultural control treatments in 1975 and on projected yields from a growers orchard. These calculations show that in all cases, even with a relatively poor cultural program such as the cultural "C" treatment, growers with yields in excess of 1,000 lbs. per acre would have been able to realize a significant increase in net returns had chemical or cultural controls for navel orangeworm been applied to reduce damage from a level of approximately 27% in an untreated orchard.

Figures 1 through 6 show navel orangeworm moth flights based on pheromone trap data and navel orangeworm egg laying patterns based on oviposition trap data. Comparisons are also made between eggs from female moths and male moths collected in pheromone traps in untreated plots, in cultural plots, and in plots receiving applications of Guthion. Comments regarding the data in each figure are included on each page with the respective figures.

V. DISCUSSION:

Our conclusions based on the data from the 1974 and 1975 seasons are that chemical controls, properly applied, for navel orangeworm would be economical in many grower operations. It should be recognized that the potential for creating biological upsets of other pests, particularly phytophagous mites such as European red mite and two-spotted mite, exist wherever chemicals such as Guthion are used. For this reason it could be argued that the cultural control approach, particularly where it can be

done as successfully as was shown in the 1975 cultural "A" treatment, would be the control program of choice for navel orangeworm. However, it should also be recognized that some growers may be unable to achieve this level of orchard cleanup, especially in years when rainfall and fog are extremely light such as is now occurring in the winter of 1975-76. Under these circumstances a chemical control program, properly applied and timed to the occurrence of egg deposition and initial larval hatch in the springtime, would then prove to be the control program of choice by growers. In summary, then, researchers are now able to offer or suggest to growers either a chemical or cultural control program for navel orangeworm, either of which should prove to be equally successful if the programs are properly carried out.

It would appear at this time that the initial goals and objectives of this particular project have essentially been achieved, in that a chemical control program which can serve as an alternative to cultural control programs has been demonstrated to be effective.

Recommendations for future work under this project would be to first evaluate the feasibility of combining a winter cultural program and single sprays of Guthion or some other suitable, registered material which would be applied either in the early season, such as in May or June against the first moth flight, or a chemical spray applied during the second period of oviposition that appears to occur in late June and early July. It might be that this later spray in July would provide even greater protection of the new crop nuts as they split, but it would be necessary to apply this last spray prior to the 60 day legal cut-off date before harvest.

Table 1. Chemical and cultural control of Navel Orangeworm, 1975.
R. E. Rice, L. L. Sadler.

Treatment	Sprayed or disced	Knock and harvest	% NOW[1/]	% NOW reduction	% PTB	NOW & PTB total
Guthion, 2X	5-13-75 6-3-75	9-22 9-26	7.0 a[2/]	74.5	0.6	7.6
Guthion, early	5-12-75	9-22 9-26	7.3 a	73.5	0.4	7.7
Guthion, late	6-3-75	9-23 9-25	7.8 a	71.6	0.3	8.1
Cultural A	2-18-75	9-9 9-22	6.8 a	75.3	1.3	8.1
Cultural C	4-17-75	9-25 9-29	16.4 b	40.4	0.6	17.0
Untreated	-	9-29 9-29	27.5 c	-	0.3	27.8

1/ Calculated from ten 250-nut sub-samples taken from each treatment.

2/ Values in columns followed by the same letter are not statistically different at the 5% level.

Table 2. Evaluation of navel orangeworm control trials, Caruthers, Fresno County, 1975.

Treatment	% NOW Damage[1/]	% NOW Reduction	Analysis of NOW controls based on yield/acre[2/] 1200 lbs. Cost	1200 lbs. Net	1500 lbs. Cost	1500 lbs. Net	1800 lbs. Cost	1800 lbs. Net
Check	27.5	-	$321.00	$ -	$401.25	$ -	$481.50	$ -
Guthion: 5/13 6/3	7.0	74.5	120.00	201.00	138.75	262.50	157.50	324.00
Guthion: 5/13	7.3	73.5	101.10	219.90	120.75	280.50	140.40	341.10
Guthion: 6/3	7.8	71.6	107.10	213.90	128.25	273.00	149.40	332.10
Cultural A	6.8	75.3	87.60	233.40	105.75	295.50	123.90	357.60
Cultural C	16.4	40.4	202.80	118.20	249.75	151.50	296.70	184.80

1/ Average from ten 250-nut samples per treatment.

2/ Calculated on nut meat value of $0.75/lb. plus 1/4¢/lb. assessment for each % NOW damage over 3%; $22.50/acre cost per spray application, or $15.00/acre for post-harvest orchard clean-up.

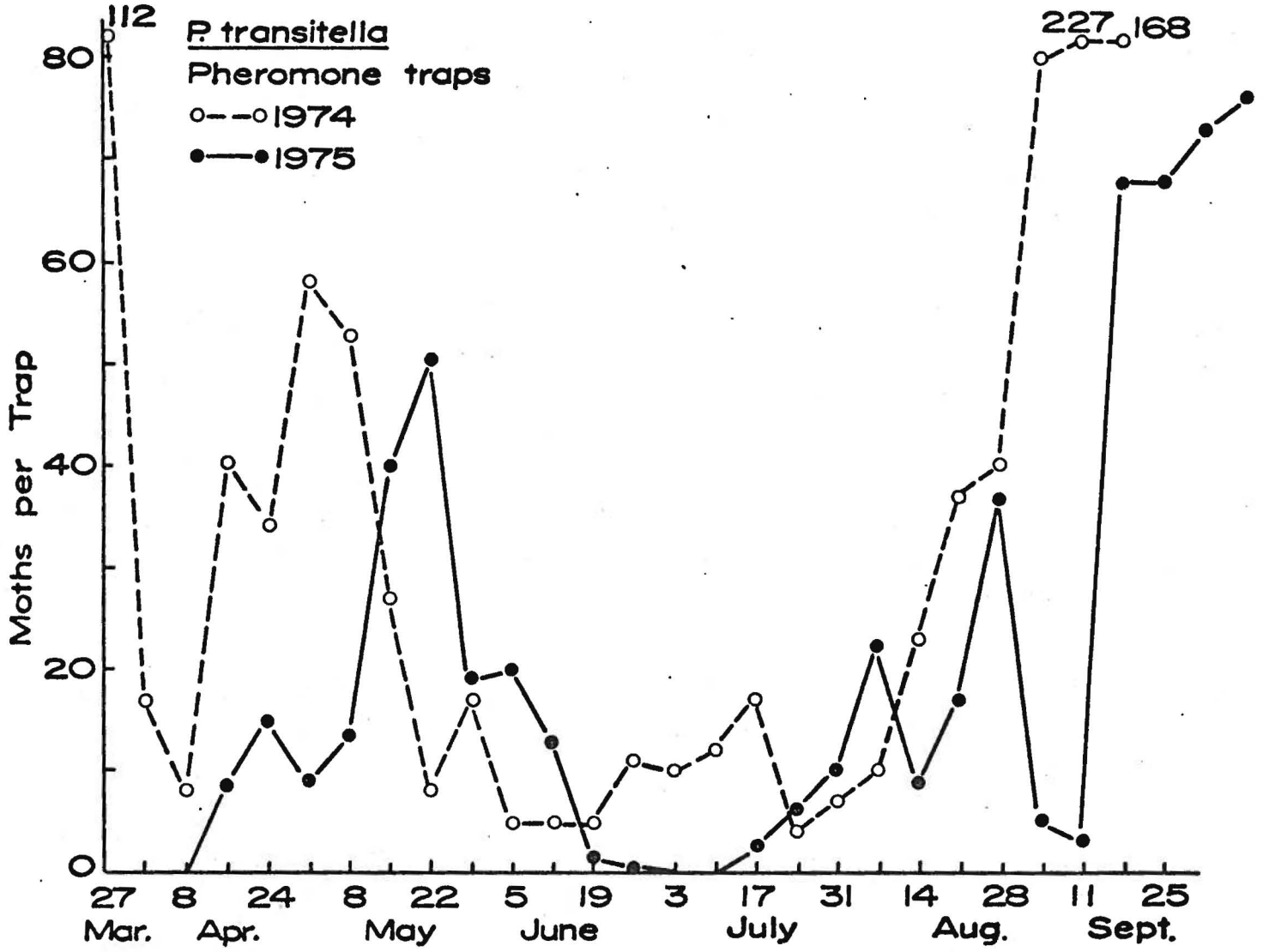

FIG. 1. Pheromone trap records of male NOW moth collections show the types of seasonal variations that can occur in insect populations, particularly in spring emergence of overwintered populations. Delayed development of subsequent generations was evident, but moth flight still coincided closely with hull split

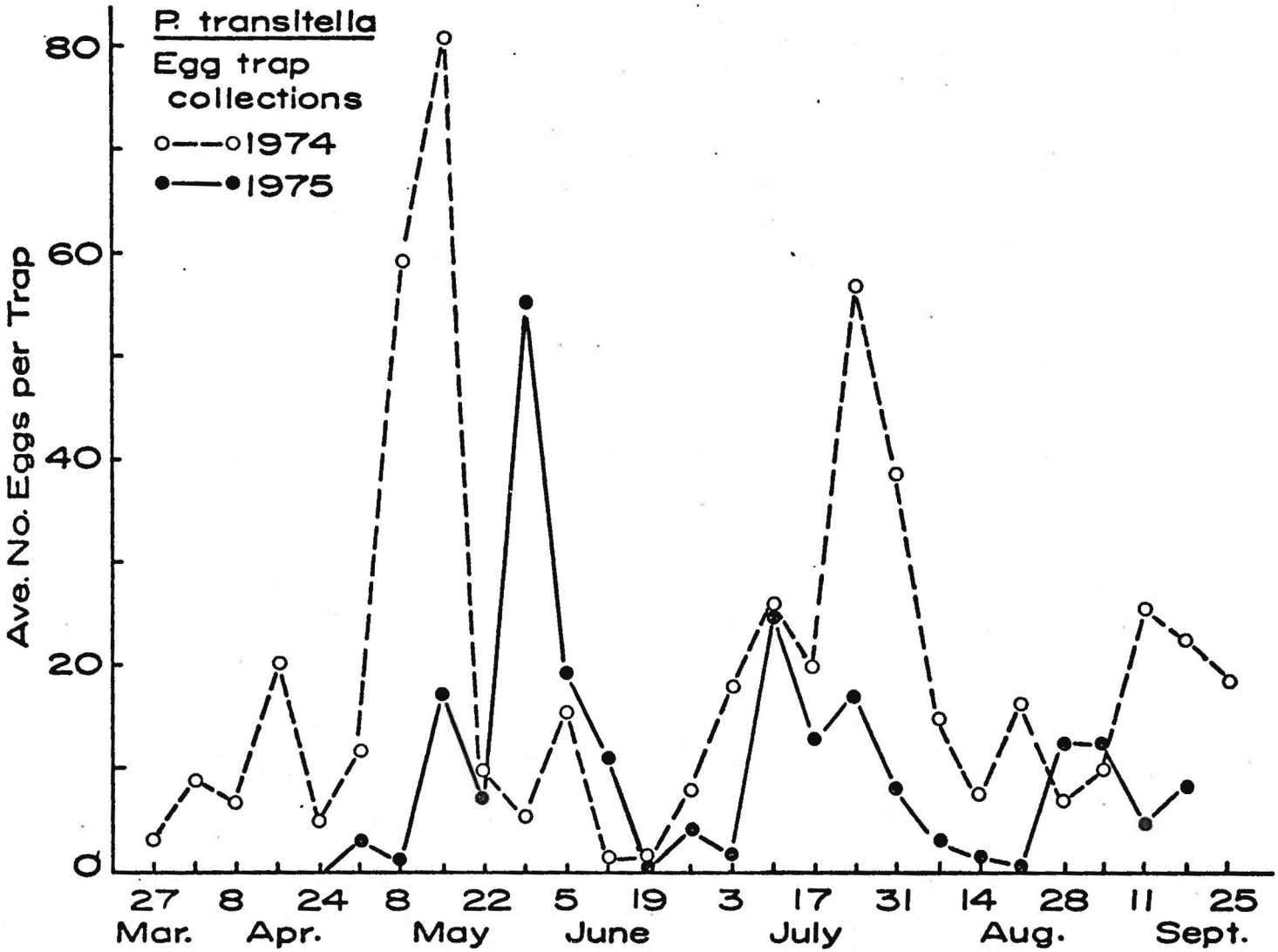

FIG. 2. Egg traps also reflect late emergence of female moths and egg laying in 1975 compared to 1974. The first treatment of Guthion was applied on May 12, 1975, compared to April 10, 1974. Note late June-early July egg laying in both years.

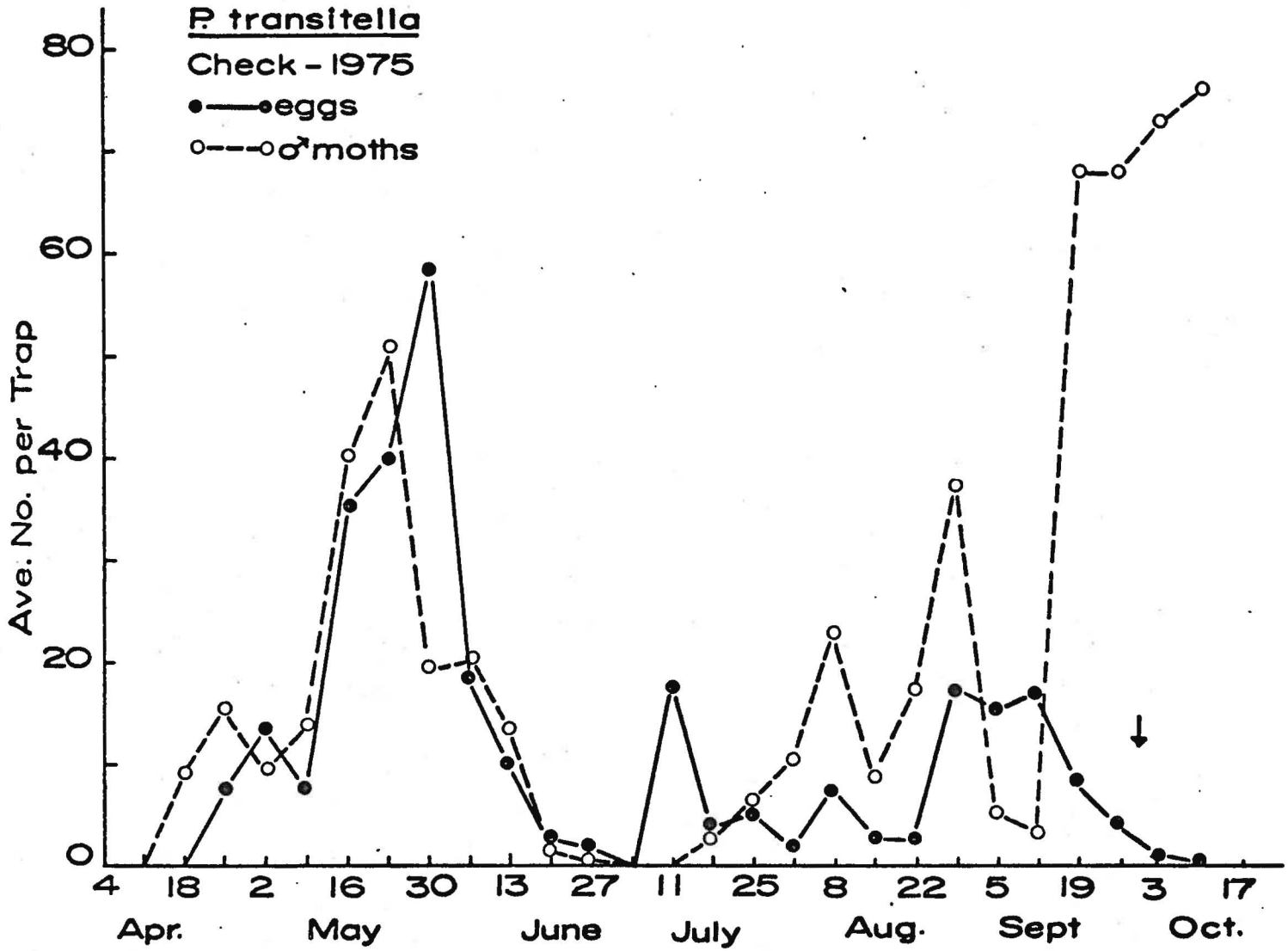

FIG.3. NOW oviposition started within one week after the first male moths were collected in pheromone traps. Note similarity of moth and egg trends during spring emergence and flight. A period of female activity and egg laying occurred in mid-July that was not indicated by male response to the pheromone traps. July - Sept. response to egg traps by female moths declined due to competition from splitting hulls.

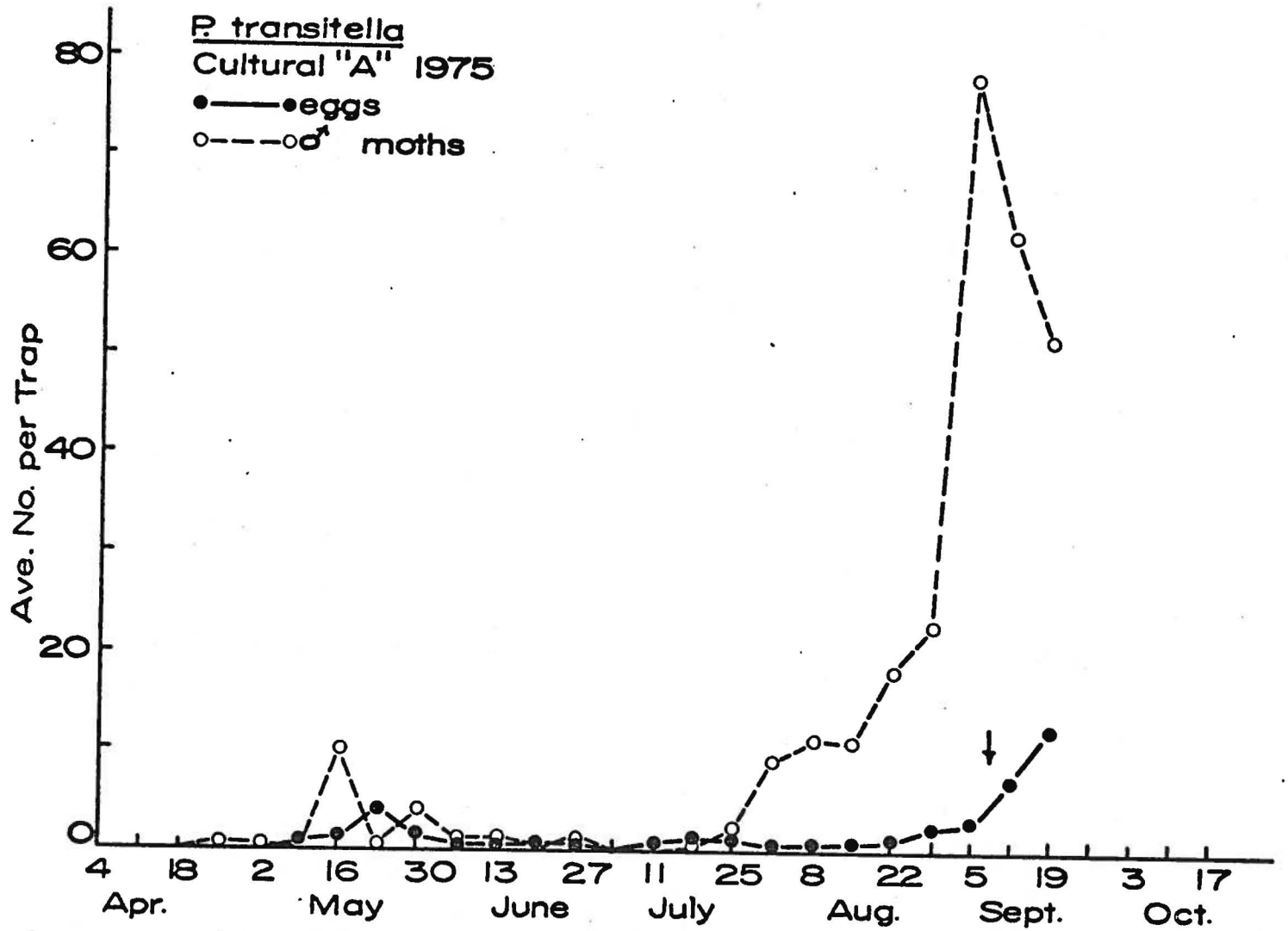

FIG. 4. Effect of winter cultural operations on NOW populations is obvious when compared to the untreated check. Increase in moths starting in August is believed due to re-infestation of cultural "A" plot by moths from adjacent uncleaned areas of orchard.

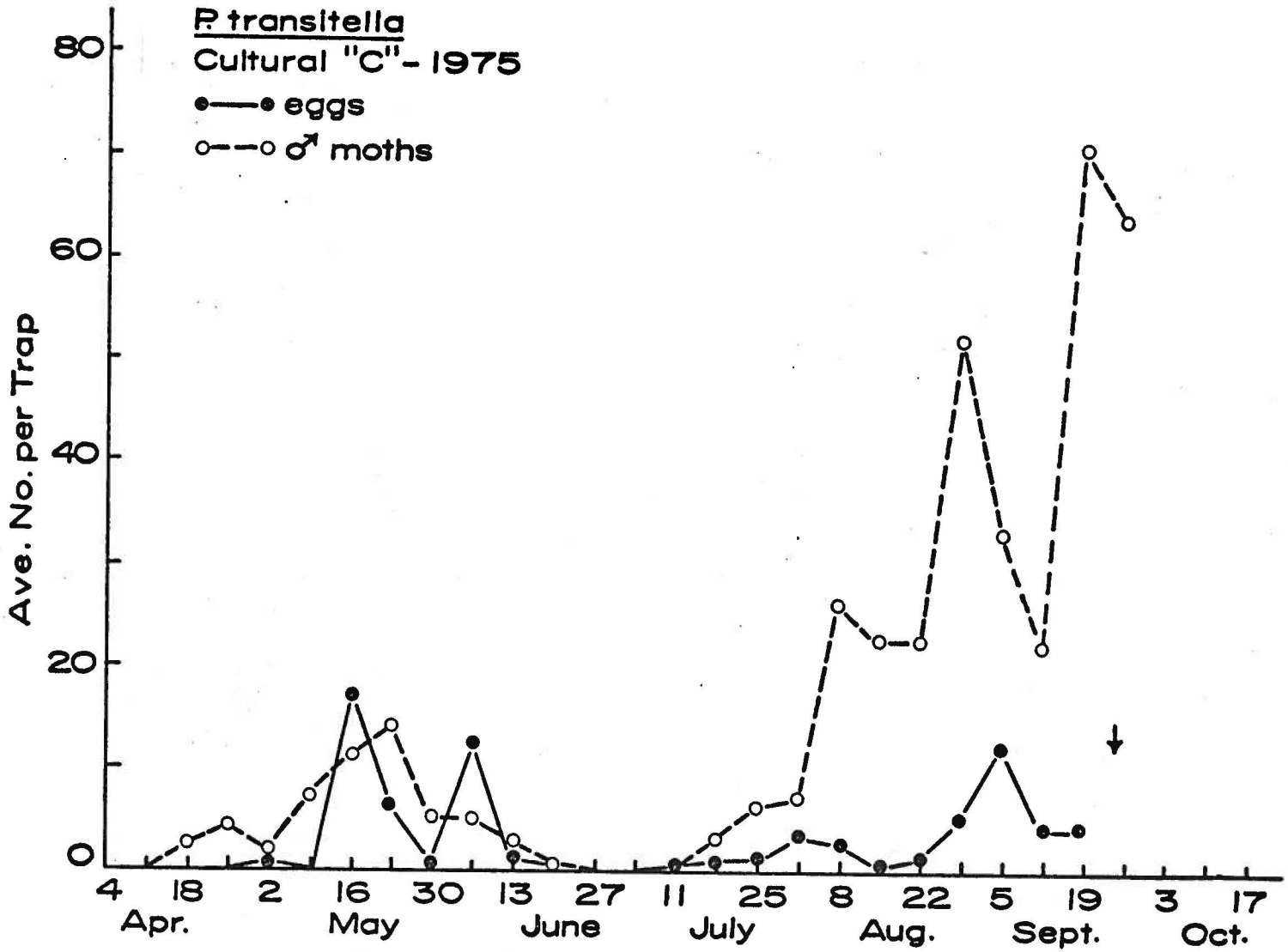

FIG. 5. Moth and egg populations in cultural "C" plot were higher than in cultural "A" plot, but not as high as in the untreated check. Overwintering NOW survival in this plot was primarily in tree mummies, since ground mummies had been destroyed as in "A" plot, but trees in cultural "C" were not cleaned nearly as well due to less favorable weather at the time of winter knocking.

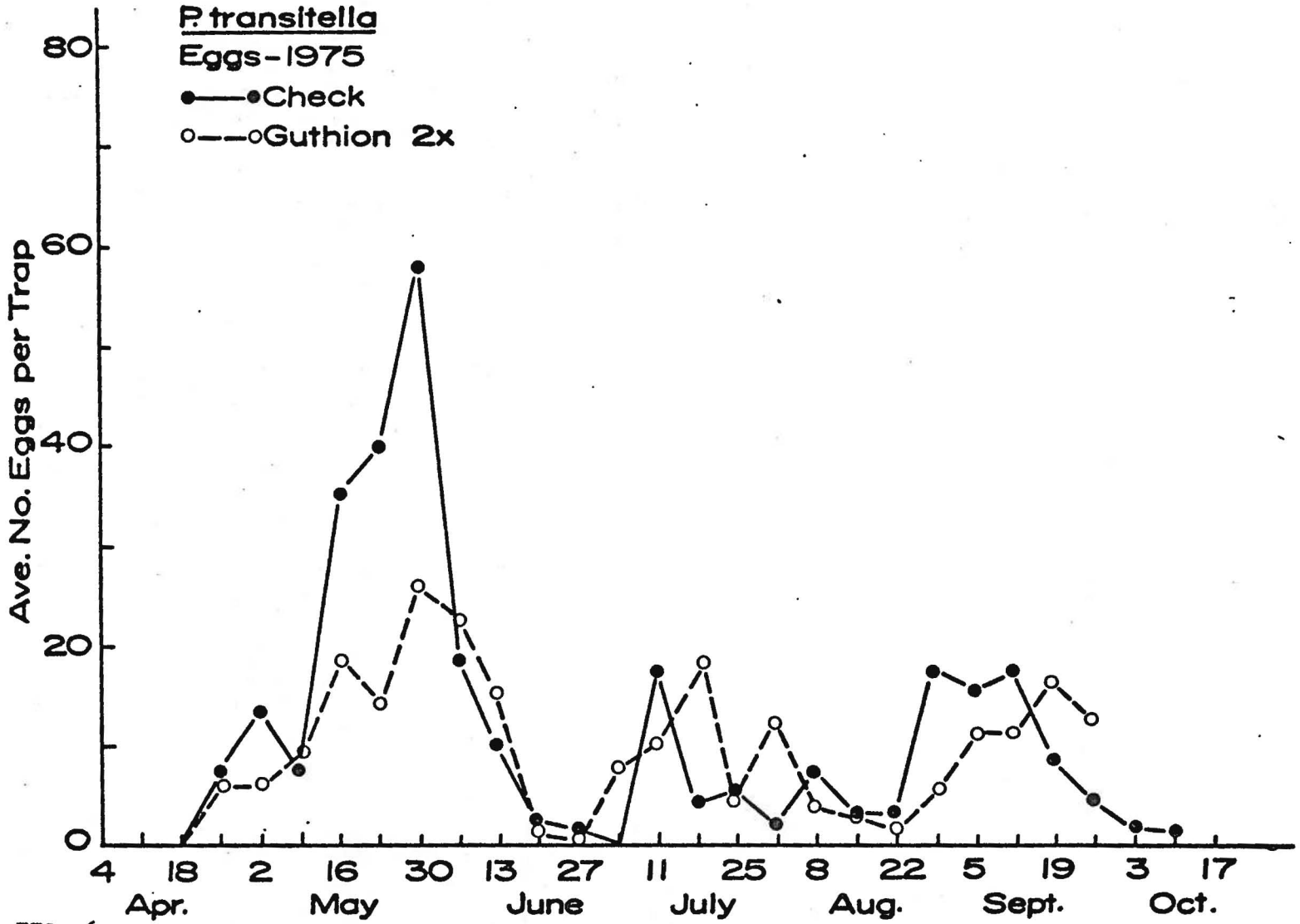

FIG. 6. Comparisions of egg deposition curves in untreated check and Guthion 2X treatment show some suppression of egg laying during spring spray period (5/13 - 6/3/75), probably due to moth kill. However, this suppressive effect did not carry over to the July - August hullsplit period.