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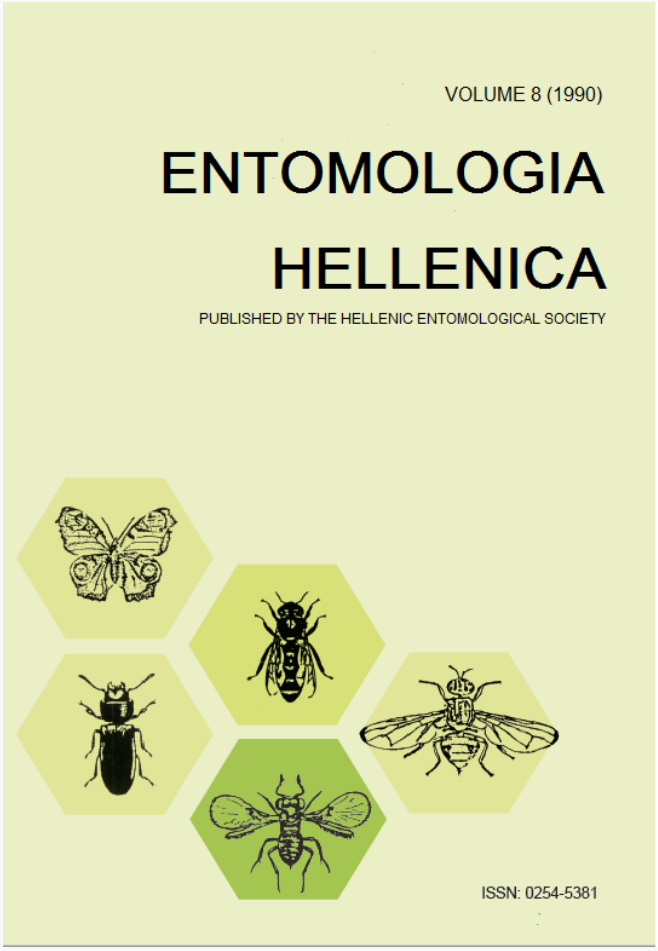

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Determination of Spray Dates for the Control of the First Generation of *Quadraspidiotus perniciosus* in Northern Greece[1]

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ABSTRACT

During 1986-1988 the relationship between catches of San José scale (SJS), *Quadraspidiotus perniciosus* (Comstock), adult males in pheromone traps and crawlers on sticky-tape traps was studied as a basis of SJS crawler control in apple orchards of Northern Greece. Spring male flight began in mid-to late April and crawler emergence occurred in mid-to late May. Crawlers were active for a period of 6-7 weeks until early July. Peak crawler emergence occurred approximately 12 days after the first emergence, or 42 days after the first males were captured on pheromone traps. Because in our 3-year study the crawler emergence occurred 29-31 days or 191-202 day-degrees (base 10.5°C) after the capture of the first male, we conclude that a consistent time-relationship exists between the two events. Two insecticide treatments, one three days after the first crawler appearance and another 10 days later (near peak crawler activity), provided the best control against the first generation of scale.

Introduction

The San José scale (SJS), *Quadraspidiotus perniciosus* (Comstock) (Homoptera: Diaspididae), is an important pest in most deciduous fruit orchards in Northern Greece. Control measures against this pest usually include dormant sprays to kill the over-wintering stages and foliar sprays against crawlers during the vegetative period. Timing of sprays against crawlers is not always successful. The effectiveness of foliar control treatments depends upon timing of sprays based on adult male flight and monitoring of crawler activity (Kozar 1977, Mague and Reissig 1983, Reissig et al. 1985). In Northern Greece, the time of male flight and crawlers emergence has been determined by pheromone trapping and sticky-tape traps, respectively (Kyparissoudas 1987). If a fixed relationship could be demonstrated between the first adult male catch on pheromone baited traps and the time of crawler appearance, this technique could be used to determine the proper timing of chemical applications against the immature stages of SJS.

The present work aimed at studying the relationship between the first SJS male catch on pheromone traps and the first catch of first generation crawlers on sticky-tape traps in apple orchards of Northern Greece. In addition, the efficacy of chemical control was assessed using this relationship to time different applications.

Materials and Methods

SJS male flight and crawler emergence was charted for three years (1986-1988) in two untreated apple orchards infested by the scale at Naoussa and

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Macrohori, in the Imathia area of Central Macedonia (Northern Greece). Adult males were monitored using the standard SJS pheromone traps (Zoecon, Palo Alto, California) baited with dispensers loaded with 300 μg of SJS-2 pheromone (Gieselmann et al. 1979). In each experimental orchard, four pheromone traps were placed in early April, 1.8-2.0 m high, in the north side of the trees and spaced 50 m apart. Trap observations in both orchards were made daily until the first appearance of males. In the Naoussa orchard after the onset of male flight, the traps were checked three times per week until mid-June.

Crawler emergence was detected with sticky-tape traps (Mague and Reissig 1983, Kyparissoudas et al. 1987). In both orchards, approximately 25 days after the onset of male flight, a crawler trap was placed on each of four branches in each of four trees. The traps were checked daily until the first appearance of the crawlers. In the Naoussa orchard, after the first crawler appearance the traps were checked weekly during 1986 and 1987 and three times per week in 1988, until early July. In all cases, the crawlers on the traps were counted using a dissecting microscope in the laboratory. Counts were expressed as number/cm^2 of tape.

Day-degree (DD) estimates were derived by averaging the daily maximum and minimum temperatures and subtracting the lower developmental threshold of 10.5°C for this species (Baskerville and Emin 1969). Temperature data were collected from a meteorological station near the orchards.

In 1988, in a third apple orchard, located between Naoussa and Macrohori, a test was conducted in order to confirm the efficacy of control sprays based on the relationship between male catch and crawler emergence. The orchard was divided into four plots and each treatment was applied to four single-tree replicates in a complete randomized block design. An unsprayed buffer tree was left between two sprayed trees (Asquith et al. 1977). Seasonal crawler activity was measured on tape traps in the unsprayed check trees. The traps were checked two or three times per week (Fig. 3). Sprays of quinalphos (Ekalux 25 EC, Sandoz, Switzerland) were applied at three different time regimes. The first treatment included two sprays, which were made on 18 and 28 May; the second and third treatments included one spray each on 18 and 28 May, respectively (Table 2). On 30 June, 100 random fruits were picked from each tree and percent infested fruit was determined.

Results and Discussion

The flight of the overwintering generation males began in mid-to late April and continued for 3-4 weeks (Fig. 1A), while the emergence of the crawlers occurred in mid-to late May and continued for 6-7 weeks, until early July (Fig. 1B). The first crawlers emerged 29-31 days (approximately 196 DDs) after the first male captures (Table 1), as reported by Kozar (1977), Rice et at. (1982), and Kyparissoudas (1987). Peak crawler emergence occurred in the second week (Fig. 1B), approximately 12 days after their emergence (Fig. 2), and 41-43 days after the first males had been captured on pheromone traps (Table 1, Fig. 2). The time of appearance of the males and crawlers is in agreement with observations made using different methods by Paloukis (1983) and Katsoyannos and Argyriou (1985) under similar conditions. Based on this information, it is possible to forecast the appearance of crawlers without having to observe them in the field.

In the 1988 chemical spray trials, these criteria were used as a basis for the control of first generation SJS crawlers by comparing the effect of different spray times on fruit quality (Table 2). It can be seen that single sprays applied either three days after crawler emergence or near peak crawler activity did not adequately protect fruits (14.50% and 8.75% fruit infes-

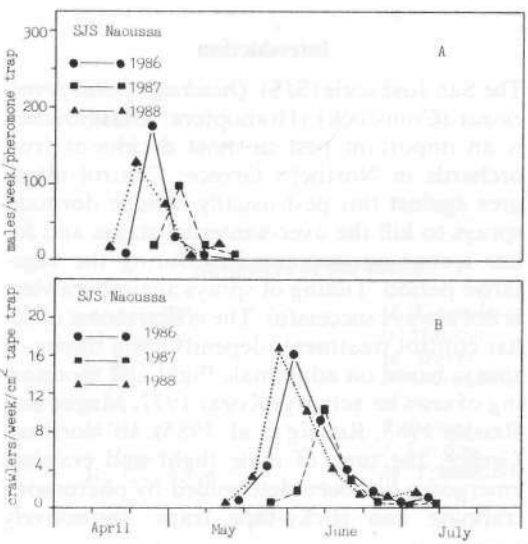

FIG. 1. 1A, San José scale adult male flight activity, 1986-1988; 1B, San Jose scale crawler appearance, 1986-1988; Naoussa, Northern Greece.

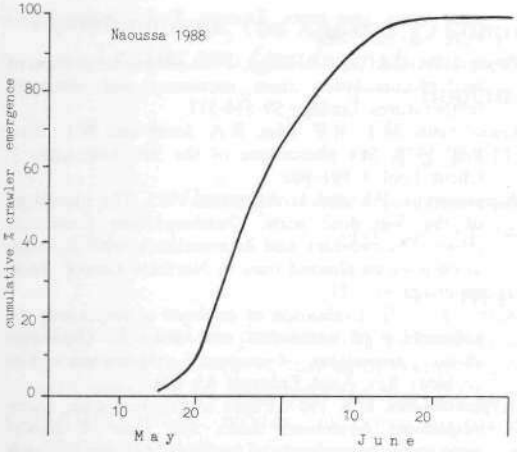

FIG. 2. San José scale crawler captures on sticky-tape traps; Naoussa, 1988.

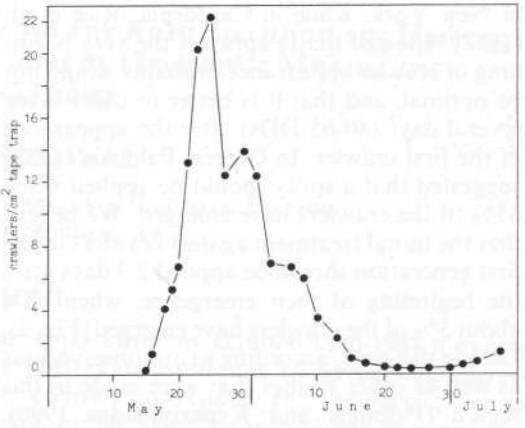

FIG. 3. San José scale crawler catches on sticky-tape traps in apple orchard located between Naoussa and Macrohori, 1988.

tations, respectively) in severely infested trees. The most effective control (0.50% infestation) was obtained by applying two sprays, the first 3 days after emergence and another 10 days later, near peak crawler activity (Fig. 3).

Current recommendations for the timing of sprays against crawlers vary considerably in different countries. In the USA, Reissig et al. (1985) suggested one treatment at the beginning of crawler activity and a second 10-14 days later

TABLE 1. Catch dates, accumulated day-degrees and elapsed time from first male flight to first crawler emergence, 1986-1988.

	Catch date		Period from 1st male to 1st crawler	
Area	1st male	1st crawler	Day-degrees (base 10.5°C)	Days
Naoussa	19 April 86	19 May 86	198	29
	26 April 87	27 May 87	194	30
	15 April 88	15 May 88	193	29
Macrohori	17 April 86	19 May 86	202	31
	27 April 87	29 May 87	199	31
	17 April 88	18 May 88	191	30
Average			196	30

TABLE 2. Effect on fruit damage of different spraying regimes with Ekalux 25 EC (Quinalphos) in 1988.

		Dates of spray		
Treatment	1 (f.p.)/ 100 litres	3 days after first crawler emergence (18 May)	Peak crawler emergence (28 May)	% SJS-infested fruit (30 June)
Ekalux 25 EC	125	×	×	0.50 a
Ekalux 25 EC	125	×	–	14.50 c
Ekalux 25 EC	125	–	×	8.75 b
Unsprayed		–	–	32.00 d

In the column, means followed by the same letter are not significantly different ($P > 0.05$, Duncan's multiple range test).

in New York, while in California, Rice et al. (1982) reported that a spray at the very beginning of crawler appearance probably would not be optimal, and that it is better to delay it for several days (40-65 DDs) after the appearance of the first crawler. In Greece, Paloukis (1986) suggested that a spray should be applied when 65% of the crawlers have emerged. We believe that the initial treatment against crawlers of the first generation should be applied 2-3 days after the beginning of their emergence, when only about 5% of the crawlers have emerged (Fig. 2). During this time, according to our observations as well as other studies that were made in this region (Paloukis and Kyparissoudas 1990), there are only immatures present (crawler and white cap stages), which are the most sensitive to insecticides (Rice et al. 1982, Paloukis 1983). Also, relatively early sprays are justified because fruits become infested within the first week of the crawlers' emergence (Mague and Reissig 1983). Then, because crawler emergence lasts for approximately 45 days (Figs. 1B, 2) a second treatment would likely cover the entire period of crawler activity, assuming that residual activity of the conventional insecticides continues for 10-14 days.

This protection method offers some advantages. Because spraying to control SJS is nearly always necessary (insect quarantine plant in Greece), it is not necessary to know the relationship between pheromone catches and population densities of males, nor between densities of males or crawlers and damage to fruit, in order to determine the time of spraying. It is necessary only to know a) the date flight period starts, b) the time period of crawler activity (peaks, gaps, etc) and c) the daily temperature readings between the first male appearance and the first crawler emergence.

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KEY WORDS: *Quadraspidiotus perniciosus*, Pheromone traps, Sticky-tape traps, Day-degrees (DD)

Προσδιορισμός του Χρόνου Ψεκασμών για την Καταπολέμηση της Πρώτης Γενεάς του *Quadraspidiotus perniciosus* σε Οπωρώνες Μηλιάς της Βόρειας Ελλάδας

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ΠΕΡΙΛΗΨΗ

Σε οπωρώνες μηλιάς στην περιοχή Ημαθίας μελετήθηκε κατά την περίοδο 1986-1988 η σχέση ανάμεσα στις συλλήψεις των αρσενικών της διαχειμάζουσας γενεάς του *Quadraspidiotus perniciosus* Comstock σε φερομονικές παγίδες και των κινητών προνυμφών της 1ης γενεάς του σε κολλητικές ταινίες-παγίδες, ως βάση για τον προσδιορισμό, χωρίς παρατηρήσεις στον οπωρώνα, του κατάλληλου χρόνου εφαρμογής των χημικών επεμβάσεων για την καταπολέμηση του κοκκοειδούς. Η έναρξη της πτήσης των αρσενικών συνέβη κατά τη διάρκεια του β΄ δεκαπενθημέρου του Απριλίου, ενώ οι πρώτες κινητές προνύμφες (έρπουσες) εμφανίστηκαν στο β΄ δεκαπενθήμερο του Μαΐου, με ένα εύρος 6-7 εβδομάδων (τέλος Ιουνίου-αρχές Ιουλίου). Το μέγιστο της εμφάνισης των κινητών προνυμφών παρατηρήθηκε 12 ημέρες μετά τις πρώτες συλλήψεις τους στις κολλητικές ταινίες-παγίδες ή κατά μ.ο. 42 μέρες μετά τη σύλληψη των πρώτων αρσενικών στις φερομονικές παγίδες. Η χρονική διάρκεια μεταξύ σύλληψης των πρώτων αρσενικών στις φερομονικές παγίδες και της παρουσίας των πρώτων κινητών στις κολλητικές-ταινίες παγίδες ήταν κατά μ.ο. 30 ημέρες ή 196 ημεροβαθμοί. Δεδομένου ότι οι κινητές προνύμφες στα τρία χρόνια αυτής της μελέτης εμφανίστηκαν 30 περίπου μέρες (ή 196 ημεροβαθμοί) μετά τη σύλληψη των πρώτων ενηλίκων, συμπεραίνεται ότι υπάρχει μία συνεπής χρονική σχέση μεταξύ των δύο αυτών γεγονότων. Δύο ψεκασμοί με το εντομοκτόνο Ekalux 25 EC, ένας τρεις μέρες μετά την εμφάνιση των κινητών προνυμφών και ο δεύτερος 10 μέρες αργότερα (στο μέγιστο περίπου της εμφάνισης των κινητών), έδωσαν τα καλύτερα αποτελέσματα συγκριτικά με ένα μόνο ψεκασμό που έγινε με το ίδιο εντομοκτόνο τρείς μέρες από την εμφάνιση των κινητών ή στο μέγιστο της εμφάνισής τους.