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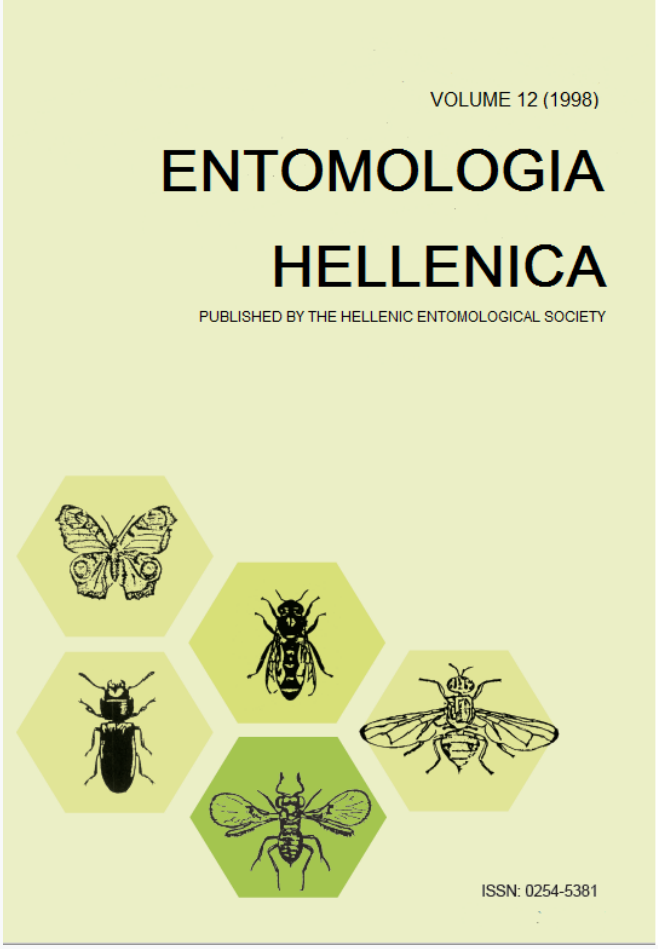

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The Use of Chemicals with Specific Mode of Action in an Integrated Control Program on Eggplant for the Greenhouse Whitefly, *Trialeurodes vaporariorum*[1]

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ABSTRACT

In the unheated plastic greenhouses of Crete, the control of the greenhouse whitefly *Trialeurodes vaporariorum* Westwood using chemicals is usually needed during winter time. The systemic insecticide Vydate when applied as soil granules at the highest dose (2g/plant), gave protection for young eggplants against whitefly for a period of 5 weeks. Experiment with different chemicals showed that the new insect growth regulator Nomolt, is fairly effective in controlling the greenhouse whitefly when used in combination with Actellic. It gave equally good results when compared with a mixture of Applaud and Actellic.

Introduction

Chemical control of the greenhouse whitefly, *Trialeurodes vaporariorum* Westwood (Homoptera: Aleyrodidae) has been used by growers for many years because it is easy, rapid and effective, but problems are numerous. Resistance, phytotoxic effects, environmental pollution and human health restrict its use. Despite these problems, chemicals are needed to supplement biological control, especially during winter when temperature is too low for effective control of whitefly by the parasite *Encarsia formosa.* Successful biological control requires low initial whitefly numbers and high temperature regimes. The use of low temperature growing conditions to produce early and profitable crops means that biological control is not always successful. The main drawback of biological control is that if sowing is early, the parasite cannot be introduced until the temperature is optimum, i.e. from February and onwards. By this time plants can be crowded with insects which makes biological control marginal or unsuccessful. The integrated control in eggplant greenhouses which is a crop of increasing importance, present special difficulties because the whitefly multiplies rapidly in this crop resulting in considerable damage, and that not much work has been done concerning eggplant. This study aimed at incorporating chemicals with specific mode of action in an integrated control program for the control of greenhouse whitefly on this important crop.

Materials and Methods

Vydate in different doses

A systemic insecticide, oxamyl (Vydate) is applied to young seedlings as soil granules to ensure plant toxicity to whitefly for a period before parasite introduction. Unless pest population can be reduced to small known numbers, parasite introductions cannot be successful. It is used early in the young seedlings and then watered in to avoid losses in the soil and to

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facilitate immediate absorption by the root systems. Counts were made every week. A second application of Vydate was made on December 4, using the same doses. During the experimental period 10 counts were made, the experiment was terminated on December 14, 1992.

Nomolt in combination with Actellic.

A growth regulator which effects chitin synthesis in a number of insects, has recently been introduced. Nomolt, a trade name for teflubenzuron, is an insecticide developed by Celamerck GMBH and Co. KG, Ingelheim, Germany. Nomolt affects chitin synthesis in the larvae of Lepidoptera, Coleoptera and Diptera. It also has an ovicidal effect or prevents adults from laying viable eggs in a number of pests. Adult insects and most sucking species are not affected. Nomolt does not act immediately; larvae remain alive for some days but they soon stop feeding and die within a short time at moulting or pupation. Beneficial insects (except predatory bugs and bumble bees) are generally not harmed, so that Nomolt is compatible with integrated pest management programs. Sixteen eggplants were grown in peat-perlite mixture in pots under cylindrical frames covered with white nets to form cages for the plants. A window was constructed in each net to permit irrigation, treatment application and counting. The experimental design was a completely randomized design with 4 treatments including the control. Treatments tested were: Nomolt + Actellic, Applaud + Actellic, Vydate granules (2g/plant) and the control. Applaud acts on the immature stages while actellic acts against adults. Nomolt was combined with Actellic because it acts on early stages only. Adult whiteflies, 18-20/plant were transferred to the cages before assigning treatments to establish a homogenous population. The first count was made on April 2, 1992 and accordingly treatments were assigned. Counts were made weekly, followed by treatments except for Vydate which was applied only once at the beginning of the experiment. To differentiate between treatments and compare the effectiveness of treatments, mean separation was by Duncan's multiple range test at the 5% level of significance for Vydate doses and Nomolt and Applaud in combination with Actellic (Table 1 and Table 2 respectively). The experiment lasted 40 days and 7 counts were made.

Results and discussion

Vydate in different doses

The different doses of Vydate reduced whitefly numbers on eggplant to a satisfactory low level (Table 1). At the first count (before treatment), the population density was more or less the same in all treatments, ranging from 10.6 to 13.2 adults per plant. One week after the application of the treatments, significant differences were observed, with the lowest whitefly numbers on plots that received the highest dose (2.0g/plant): the higher the dose, the lower the population density. These differences continued until the end of the third week, after which there was no significant difference between the 4 Vydate tretments. By the end of the 5th week, whitefly numbers started to increase and reached the same level of the initial density. The last count on December 14 indicated no significant differences between the controls and the treated plots indicating the termination of the systemic action. The second dose, applied on December 4, led to marginal reductions indicated in the count on December 9, because at that time eggplants were big and Vydate effectiveness was for a short period and only on young eggplants.

Following population changes over time, the control plots showed the highest numbers until the end of the experiment, reaching 34.2 adults/plant. There was a sharp decrease in week 2, approximately the same as in all treated plots, with the highest dose having the lowest numbers. The lowest population numbers were observed on November 14, followed by a sharp increase until December 4, where the second application of Vydate was made resulting in a reduction by

TABLE 1. Population means of whitefly under different doses of Vydate.

Date	2g/plant	1.5g/plant	1g/plant	0.5g/plant	Control
30.X	11.50 a	13.20 a	12.00 a	11.20 a	10.60 a
4.XI	2.00 d	2.35 cd	3.50 bc	4.50 ab	12.35 a
9.XI	2.80 c	2.80 c	3.40 bc	4.25 b	13.65 a
14.XI	1.20 d	1.70 cd	2.15 c	3.10 b	16.95 a
19.XI	3.60 b	3.85 b	4.30 b	4.45 b	18.85 a
24.XI	3.35 b	3.70 b	3.70 b	3.25 b	21.60 a
29.XI	12.75 b	12.10 b	11.20 b	12.40 b	22.20 a
4.XII	17.35 b	16.50 b	19.00 b	17.15 b	27.80 a
9.XII	13.30 b	13.80 b	13.90 b	15.15 b	33.30 a
14.XII	31.50 a	26.55 a	29.10 a	26.75 a	34.20 a

Means followed by the same letter in the same line are not significantly different at the 5% level of significance. (Duncan's multiple range test).

December 9, then the whitefly numbers started to increase towards the end of the experiment on December 14. No phytotoxic symptoms were observed as a result of Vydate aplication.

Vydate protected eggplant for a period of 5 weeks, in agreement with both Michelakis (1987) and Boukadida (1991), but Hocart (1981) and Kassis (1989) reported that Vydate effectiveness lasted for 3 weeks on greenhouse tomatoes. The absence of yellowing on the lower leaves after Vydate treatment indicated that no phytotoxic symptoms occurred with the observations of Michelakis (1978) on tomato plants. However Hocart (1981), Kassis (1989) and Boukadida (1991) observed phytotoxicity on tomato plants following Vydate application. The second application of the chemical resulted in lower whitefly numbers for one week, after which they increased again, as also seen by Kassis (1989) following a second dose application on greenhouse tomatoes. Vydate is useful for integrated programs to control the greenhouse whitefly on eggplant. The fact that it acts only on young eggplants resticts its use before parasite introduction to maintain healthy, whitefly — free plants and to ensure successful introduction of the parasite, which depends on the initial whitefly density. Vydate treatment cannot ensure completely whitefly — free eggplant, but reduces the population considerably. For eggplant, the standard dose should be 2.0 g/plant instead of 1.0 g/plant as in tomato, since good protection resulted without phytotoxic symptoms. Vydate at the highest dose (2 g/plant) should therefore be used in an integrated program for the control of the greenhouse whitefly on eggplant.

Nomolt in combination with Actellic

Up to 10 of April, there were no significant differences between treatments, but, from 17 of April onwards, significant differences were detected (Table 2). In the control plots, whitefly numbers were high, while in treated plots they decreased. Treatment with Vydate, was significantly different from treatment with Nomolt + Actellic and Applaud + Actellic, having the lowest population density until May 8. The last counting on May 15 indicated a sudden increase in whitefly numbers in the Vydate treated plants due to the fact that activity was lost and the whitefly population started to build again.

Following the population changes overtime, we see that for the first week, whitefly numbers were approximately the same due to the homogenous infestasion, varying from 18.25 to 19.25 adults/plant. The whitefly numbers started to increase from the second week in the control plots, while in the treated plots, they decreased. Plots treated with Nomolt + Actellic and Applaud + Actellic followed approximately the same pattern. After May 8, whitefly numbers on Vydate treated plants increased to 16 adults/plant, in comparison with 2.75 and 3.0 adults/plant in plots treated with Nomolt + Actellic and Applaud + Actellic respectively. Therewere no significant differnces between plots treated with Nomolt + Actellic and those treated with Applaud + Actellic. Both combinations reduced pest populations to same levels. Vydate showed more effective control than either combination, maintaining adults at lower numbers. Vydate is a promising systemic insecticide when used for young seedlings, maintaining its activity for 3-5 weeks. In this experiment the duration was 4-5 weeks confirming the results of Michelakis (1987) and Boukadida (1991). Applaud and Actellic were tested by Boukadida (1991) on tomatoes who found them effective in reducing whitefly numbers. There are no report on the combined effect of Actellic and Nomolt? in this study they reduced the population similarly to the combined effect of Applaud and Actellic. Alhtough the mode of action of Nomolt differs from that of Applaud, their effectiveness is more or less the same. Nomolt therefore can be used in

TABLE 2. Whitefly adults per eggplant under different treatments.

Date	App. + Act.	Nomolt + Act.	Vyd. 2 g/plant	Control
April 3	19.25 a	19.25 a	19.25 a	18.25 a
April 10	19.50 a	20.25 a	18.25 a	19.75 a
April 17	15.50 b	15.50 b	9.00 c	23.25 a
April 24	13.75 b	10.75 b	5.50 d	26.50 a
May 1	9.25 b	8.75 b	3.50 c	31.50 a
May 8	7.25 b	6.50 b	3.75 c	36.00 a
May 15	3.00 b	2.75 b	16.00 c	39.50 a

App. = Applaud, Act. = Actellic, Vyd. = Vydate.
Means followed by the same letter in the same line are not significantly fifferent at the 5% level of significance (Duncan's multiple range test).

an integrated program for the control of the greenhouse whitefly on eggplant in combination with Actellic, by reducing the insect pest population and by introducing later the beneficial insects. This was better observed on the use of Vydate. Danne and Donavan (1997) found that two Vydate applications in Ireland reduced excessive whitefly numbers to a sufficiently low level for subsequent biological control to be established with an April introduction of parasites. They stated that the integration of Vydate and *Encarsia* ensures successful biological control. This is also in accordance with Helyer et al. (1984) who found that oxamyl treatment killed all stages of whitefly, but plants remained phytotoxic for only 20 days and an introduction of beneficials could therefore occur later.

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KEY-WORDS: Chemical control, Oxamyl, Vydate, Nomolt, Applaud, Actellic, Greenhouse whitefly, *Trialeurodes vaporariorum.*

Η χρησιμοποίηση εντομοκτόνων με ειδικό τρόπο δράσης σε ένα πρόγραμμα Ολοκληρωμένης αντιμετώπισης του αλευρώδη των θερμοκηπίων (*Trialeurodes vaporatiorum* West) σε μελιτζάνα

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ΠΕΡΙΛΗΨΗ

Στα μη θερμαινόμενα πλαστικά θερμοκήπια της Κρήτης συνήθως υπάρχει ανάγκη χρησιμοποίησης χημικών εντομοκτόνων για την αντιμετώπιση του αλευρώδη των θερμοκηπίων (*T. vaporariorum)* κατά τη χημερινή περίοδο.

Το διασυστηματικό εντομοκτόνο Vydate όταν εφαρμόζεται στην κοκκώδη μορφή και στην υψηλότερη δόση των 2 gr/φυτό έδωσε καλή προστασία από τον αλευρώδη στα μικρά φυτά μελιτζάνας για μια περίοδο πέντε (5) εβδομάδων. Πειράματα με διάφορα χημικά εντομοκτόνα έδειξαν ότι ο νέος ρυθμιστής της ανάπτυξης των εντόμων (Momolt) είναι αρκετά αποτελεσματικός στην αντιμετώπιση του αλευρώδη των θερμοκηπίων όταν χρησιμοποιήθηκε σε συνδυασμό με Acteric. Σε σύγκριση με το συνδυασμό Applaud και Actellic έδωσε εξ ίσου καλά αποτελέσματα.