Evaluating Insecticides for the Control of Narcissus Flies under Field Conditions in Israel

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In Israel, narcissus bulb flies (Diptera: Syrphidae) are serious pests of cultivated flower bulbs of the families Liliaceae and Amaryllidaceae. The large narcissus fly (*Merodon eques*) is the major pest, whereas the small narcissus fly (a new species in the genus *Eumerus*, yet to be described) is only a secondary pest. The large narcissus fly is also considered a quarantine pest by the U.S.A. authorities. Narcissus bulbs, *Narcissus tazetta* (var. 'Ziva'), were planted in an experimental field at Bizzaron during November 1995 and harvested during June 1996. Currently aldicarb (Temik) is recommended for the control of narcissus fly larvae. We compared the control efficacy of imidacloprid (Confidor) and isazofos (Miral) with that of aldicarb. These latter insecticides were applied to the soil in February, in April, or on both dates. The mean level of damaged bulbs in the untreated plots was 32%. Two applications of aldicarb, one in February and one in April, reduced the damage to the lowest level of 0.5%. A single application of aldicarb in February, and two applications of imidacloprid – one in February and one in April – reduced the damage to 5–10%. Treatments with imidacloprid in February or in April, reduced the damage to 12–13%. Neither one application of aldicarb in April, nor any of the treatments with isazofos, was effective. In all treatments, larvae of the large narcissus fly were found in only approximately one-third of the damaged bulbs. The level of infestation with the small narcissus fly in the untreated bulbs was only approximately 2%. The effects of the insecticide treatments on the small narcissus fly were similar to those recorded for the large narcissus fly .
KEY WORDS: Syrphidae; *Merodon eques*; *Eumerus* spp.; larva; chemical control; imidacloprid (Confidor); isazofos (Miral); aldicarb (Temik).

INTRODUCTION

In temperate and Mediterranean regions, narcissus bulb flies (Diptera: Syrphidae) are serious pests of cultivated flower bulbs of the families Liliaceae and Amaryllidaceae (6). The large narcissus flies (*Merodon* spp.) are the major pests. The larva of the large narcissus fly tunnels into the bulb as it develops (typically, only one larva is found in each bulb). The common species in Israel has been identified recently as *M. eques* (9). This species is considered a quarantine pest by the U.S.A. authorities. According to Brosh and Hadar (3) the large narcissus fly has two generations a year in Israel. Adult flies of the autumn generation are active during October and November, and those of the spring generation during April and May. The small narcissus fly (a new species in the genus *Eumerus*, yet to be described) is a secondary pest, which attacks only diseased or damaged

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bulbs. The maggots of the small narcissus fly are gregarious and usually cause a soft decay of the entire bulb. According to Nestel *et al.* (9) the small narcissus fly can produce three to four generations between April and October. In Israel, narcissus bulbs are usually planted during the autumn or early winter and are harvested early in the following summer.

The recommended control procedure for narcissus flies is to apply insecticides to the foliage during periods of adult activity, and to incorporate insecticides into the soil during periods of larval development (8). In most countries the persistent chlorinated hydrocarbon insecticides, such as chlordane and heptachlor, are no longer permitted for use against soil pests. Therefore, alternative insecticides are now being sought to control larvae of the narcissus flies. Brosh *et al.* (4) found that a spring application of the carbamate insecticide aldicarb (Temik) effectively controlled larvae of the large narcissus fly. Similar results were obtained in Poland (2). Based on these reports, it has been recommended in Israel that aldicarb should be applied twice (November and April) to control larvae of the large narcissus fly (8). In recent years, growers who followed this recommendation often complained of unsatisfactory control.

In this study we compared the efficacy of two alternative soil insecticides – imidacloprid and isazofos – to aldicarb. Imidacloprid (Confidor) is a relatively new systemic insecticide of the chloronicotinyl group (5,7). It has proved especially effective against insect pests when absorbed through the roots. The organophosphate insecticide isazofos (Miral) is extremely effective against certain soil pests such as the grubs of scarab beetles (1,12). We studied also the effect of the time of application on the efficacy of these insecticides.

MATERIALS AND METHODS

Insecticides used

The following registered insecticides were used [the first name in parentheses is the manufacturer, and the second name is the Israeli distributor]: Confidor – 34% imidacloprid EC (Bayer AG, Germany; Lidorr Chemicals Ltd., Ramat haSharon); Miral – 2% isazofos G (Ciba-Geigy AG, Switzerland; C.T.S. Ltd., Chemicals & Technical Supplies, Tel Aviv); and Temik – 15% aldicarb G (Rhône-Poulenc, France; Agan, Chemical Manufacturers Ltd., Ashdod).

Field study

Narcissus bulbs, *Narcissus tazetta* (var. 'Ziva', size 15), were planted during November 1995, in an experimental field at Bizzaron. To increase the likelihood of infestation, the experimental field was located adjacent to narcissus plants remaining from a crop grown in the previous year which had been heavily infested with the large narcissus fly. Planting, fertilization, weed control and irrigation followed commercial practice. There were ten treatments (described in Table 1) and four blocks. Plot size was 10×2 m, and a randomized block design was used. An additional untreated plot (30×2 m) was used to follow the dynamics of larval infestation throughout the course of the study. After planting, 50 bulbs were lifted from this plot at monthly intervals. The rate of infestation of these bulbs and the size of the maggots were determined. At harvest time (mid June 1996), 300–400 bulbs were lifted from the central region of each plot. The number of bulbs damaged by narcissus flies and the number of bulbs infested with maggots were recorded for each plot.

Data analysis

The numbers of damaged and infested bulbs were converted to percentage, transformed to arcsine $\sqrt{\%}$ to homogenize the variances, and analyzed by ANOVA followed by Duncan's multiple range test at a significance level of 5% (10). A factorial analysis (11) was used to determine the overall differences between the insecticides and the application dates, as well as the interactions between them.

RESULTS

Maggots of the large narcissus fly were first noted in the bulbs in April. These maggots were small (2–4 mm) and penetrated the bulbs from the top. Infestation in April was approximately 12% and it remained at this level until harvest time. The size of the maggots reached 6–13 mm by harvest time. Maggots of the small narcissus fly were first noted in the bulbs only in June.

TABLE 1. Effect of different insecticides on the percent of damaged bulbs and percent of bulbs infested with larvae of narcissus flies at harvest (Bizzaron, 1996)

Insecticide	kg a.i./ha	Application date	% Damaged bulbs	% Bulbs infested with maggots of the large fly	% Bulbs infested with maggots of the small fly
Untreated	–	–	32.0 ab[y]	12.3 ab	1.7 abc
Confidor[z] (imidacloprid) 34% a.i., EC	0.34	February 24	12.8 cd	2.5 cde	1.0 abcd
		April 22	12.0 cd	3.6 cd	1.1 abc
		February + April	9.4 d	2.0 cd	0.6 bcd
Miral (isazofos) 2% a.i., G	2.00	February 24	42.9 a	16.4 a	3.7 a
		April 22	36.4 ab	9.7 ab	2.7 ab
		February + April	37.5 ab	15.7 a	3.0 ab
Temik (aldicarb) 15% a.i., G	4.50	February 24	5.4 d	0.7 de	0.6 cd
		April 22	24.5 bc	5.7 bc	0.5 bcd
		February + April	0.5 e	0.2 e	0.0 cd

[z] Confidor solution was applied at the rate of 10^3 *l*/ha, followed by irrigation at the rate of 100^3 *l*/ha.
[y] Within columns, means followed by a common letter do not differ significantly ($P<0.05$; ANOVA followed by Duncan's multiple range test).

The mean level of damaged bulbs in the untreated plots was 32% (Table 1). Two applications of aldicarb, one in February and one in April, reduced the damage to the lowest level recorded, 0.5%. One application of aldicarb in February, and two applications of imidacloprid – one in February and one in April – reduced the damage to 5–10%. Treatments with imidacloprid in February or in April reduced the damage to 12–13%. One application of aldicarb in April, and all the treatments with isazofos, were ineffective.

In all treatments live larvae were found in only approximately one-third of the damaged bulbs. The mean level of infestation with the large narcissus fly in the untreated plots was 12% (Table 1). Two applications of aldicarb, one in February and one in April, reduced this figure 60-fold. One application of aldicarb in February reduced the level 15-fold. All treatments with imidacloprid reduced the level approximately fivefold. One application of aldicarb in April, and the treatments with isazofos, did not differ significantly from the untreated control. The mean level of infestation with the small narcissus fly in the untreated plots was approximately 2% (Table 1). Although the effect of the treatments had a trend similar to that of the large narcissus fly, due to the small numbers no significant reduction was noted for any of them.

The factorial analysis revealed that overall there were no significant differences between the February and April applications. Two applications of insecticides were significantly better than one application in reducing the level of damage, but not of infestation. Overall, there was no significant difference between aldicarb and imidacloprid, both of which gave significantly better control than isazofos. Significant interactions between application dates and insecticides were found for both the level of damage and the level of infestation with the large narcissus fly.

DISCUSSION

In this study bulbs were planted in mid November and therefore were at risk of infestation by the late autumn and spring generations of the large narcissus fly (3). From our study of the population dynamics of the fly, it appears that most of the infestation was by flies of the spring generation that had probably developed in the adjacent narcissus plants remaining from a crop grown in the previous year. It was interesting to note that the infestation rates remained unchanged from April to June. This may indicate that egg-laying activity was concentrated mostly in March, which would be 1–2 months earlier than suggested by Brosh and Hadar (3). Another possible explanation is the high rate of natural mortality of young maggots; no maggots were found in two-thirds of the untreated damaged bulbs. Movement of maggots between bulbs may also explain their absence. Studying the size of the larvae revealed that medium to large maggots, which probably cause most of the damage, were present only during May and June.

Overall, there were no differences between the February and the April applications in reducing the rate of damage, and two applications usually gave better control than one. Nor was there any difference in effectiveness between aldicarb and imidacloprid, both of which gave significantly better control than isazofos. Application of aldicarb in February reduced damage fivefold more than application in April. This may indicate that aldicarb is more effective against eggs and newly hatched maggots than against older maggots. Alternatively, bulbs may absorb aldicarb more effectively before they are damaged, or while they are growing rapidly during the winter. Applications of isazofos did not reduce damage significantly in comparison with the untreated bulbs. This insecticide is known to be effective against insects in the soil (1,12) but lacks systemic activity in plants. In this study we noted that maggots of the large narcissus fly penetrated the bulbs from the top, and thus had little chance of coming into contact with isazofos in the soil.

Control of the small narcissus fly maggots followed the same trend as that for the large narcissus fly. The former flies infested the bulbs late in the growing season and attacked only bulbs that were already damaged.

This study confirmed the findings of Brosh *et al.* (4) that spring application of aldicarb provides effective control of the large narcissus fly maggots. A single application of this insecticide, in late February, gave the most cost-effective control. Imidacloprid was found to be a good alternative insecticide for the control of narcissus flies. The rate and method of application of imidacloprid need to be studied further in an attempt to improve its efficacy.

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