ESTIMATION OF PREDATOR POPULATIONS IN A SQUASH FIELD UNDER CHEMICAL SPRAYING CONDITIONS AGAINST APHID INFESTATION

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Abstract

In a field experiment carried out in 1993 and 1994 seasons for evaluating the abundance of predators under chemical spraying applied on Nili squash. The most harmful insecticide was Malathion which reduced total numbers of aphidophagous nymphs and larvae during spraying (3.27 individuals/leaf vs 9.03/leaf for the control and 2.05 individuals/leaf vs 15.96 individuals/leaf for the control during 1993 and 1994 seasons, respectively). Supermisrona (mineral oil) was the safer compound and Sumicidin (fenvalerate) was intermediately affecting predator community. In a laboratory test, the mortality percentage of Euseius scutalis and Phaenobrimia aphidivora treated by Supermisrona were 18.75 and 13.62%, respectively, with insignificant differences from the control.

INTRODUCTION

In Egypt squash plantation, is subject to aphids which affect the foliage and reduce the yield by sucking plant sap (downward curled leaves) and by transmitting many virus diseases (malformed leaves within stunted plants). Insecticides applied are selected to inhibit the spread of virus diseases by different modes of action on the pest. For this purpose, high mortality due to the insecticides application took place by blocking the respiration (mineral oil), by acting on the nervous system (organophosphorous compounds) or by exerting a rapid knockdown on the pest (synthetic pyrethroids). However the chemical application is not considered the main target that would be extended to the prevention of virus disease transmission. Chemical spraying would be stopped at the beginning of the flowering stage because fruits rapidly set are consumed as vegetable food. After a period of 20-25 days, plants are kept without any protection against new attacks of winged aphids. Such circumstances obligate researchers to evaluate the effect of insecticides on beneficial insects. Predators offering a high voracity to aphids , would be protected for checking pest populations . Studies on several chemical groups of insecticides and their effect on natural enemies guide workers to propose integrated programs . Petts and Pieters (1982) , Poehling *et al.* (1985 a,b) and Gravena *et al.* (1988) studied the field abundance of some predators influenced by insecticide applications which caused the pest resurgences. Terry *et al.* (1993) found that application induced outbreaks of secondary pests. Aveling (1981) reportd the causes of predator mortality by systemic insecticides (fumigant effect, direct feeding or contact action). Lingren and Ridgway (1967), Tanigosh and Fargerlund (1984), Yokohama *et al.* (1984) and Thistelwood *et al.* (1992) evaluated the mortality by pesticides in the laboratory. Sublethal effects on predators (Larval survivorship, adult emergence, fecundity predation efficiency) were determined by Shour and Growder (1980), Grafton-Cardwell and Hoy (1985) and Roger *et al* (1994). Wilkinson *et al* (1979) studied the survival coefficient of four entomophagous species resulting from contact toxicity of synthetic pyrethriods. Selectivity of some insecticides was reported by Rock (1979), Chaudhuri and Ghosh (1982), Rajakulendran and Plapp (1982 a,b) and Mizell and Sconyers (1992).

The present study was carried out to evaluate the effect of a mineral oil, an organophosphorous compound and a synthetic pyrethriod on aphid predators in a squash field as well as the mortality effect of these insecticides on predators in the laboratory.

MATERIALS AND METHODS

Field experiments

The present study was conducted at the experimental farm of Horticulture Research Station, El Kanater, Qalyobia Governorate, in the autumn of 1993 and repeated in 1994 season. Squash Cucurbita pepo L var. eskandarani was cultivated in a randomized complete block design with four replicates / treatment. Each plot (16 m2) consisted of four rows of five meters each, 0.8 m wide with plants spaced 0.5

m apart within rows and 40 plants/plot. Plants were seeded as Nili plantation on September 28 of the 1993 growing season and in August 17 of the following season and the usual agricultural practices were followed to the crop.

Treatments applied were : 1- spraying with a mineral oil Supermisrona at 3-day intervals until flowering (26-28 days after emergence) using seven and nine oil applications for the 1993 and 1994 seasons, respectively at the rate of 15 ml/liter of water. 2- A phosphorous compound Malathion as a non-systemic insecticide weekly applied at the rate of 2.5 ml/liter of water and plants received three and five applications for 1993 and 1994 seasons, respectively. 3-A synthetic pyrethriod fenvalerate (Sumicidin) as a weekly application for the 1994 season using five applications at the rate of 2.5 ml/liter of water. Treatments were started at the second true-leaf stage on 12 October 1993 and at the cotyledonary stage in 23 August 1994.

Predators estimated in the experiment were : *Euseius scutalis* (Athias-Henrior) (Acarina : Phytoseiidae), Chrysoperla carnea Steph (Neuroptera : Chrysopidae), *Coccinella undecimpunctata* L. (Coleoptera : Coccinellidae), *Orius albidipennis* Reut. (Hemiptera : Anthocoridae), *Phaenobrimia aphidivora* Rub. (Diptera : Cecidomyiidae) *Syrphus corollae* F. (Diptera : Syrphidae). Predators were counted on ten squash leaves as numbers of moving stages of E.scutalis, nymphs and adults for O.albidipennis and larvae of the other predators. Eggs were counted for C.carnea and C.undecimpunctata to avoid a misestimation of the effect of insecticides because the larvae of these predators may prey on their own eggs at the low prey densities (personal observation), also inspections of leaves were made in situ for larvae of these two predators and then leaves were transferred to the laboratory for the inspection under a stereomicroscope. Inspections were carried out at four dates: the first as a pretreatment inspection, the second coincided with the day of spray termination, the third and the fourth as a 15-day and 30-day posttreatment of the last spraying, in 1993 season. The same inspections were accomplished for 1994 season except the first was a mid-treatment inspection. Analysis of variance was used and separation of means was determined by LSD test at 5% level.

Laboratory tests:

The two most abundant predators on squash E.scutalis and P.aphidivora were tested for the toxicity of the three insecticides used in the field treatments : Supermisrona, Malathion and Sumicidin. Cotton and squash seedlings were planted in pots to obtain cultures of aphids (*Aphis gossypii* Glover) and mites *Tetranychus urticae* Koch as preys for the predators. Other seedlings were kept free of insects and mites. Excised leaves from these seedlings were dipped into solutions of insecticides at the field rates as follows : Supermisrona (15 ml/liter) Malathion and Sumiciden (2.5 ml/liter) and an untreated control (as leaves dipped in water) for 10 seconds and allowed to dry. Moving stages of *E.scutalis* and 4th-instar larvae of *P.aphidivora* were collected in the field 3h before. In the laboratory the predators were confined in a Petri dish on treated squash leaves lower surface upwards, with each insecticide. They were kept on wet cotton wool and provided with portions of cotton or squash leaves infested with a sufficient amount of preys and petri dishes were covered with lids. Each treatment was replicated four times. Mortality was recorded after 48 h at $25^{o}C \pm 2^{o}C$ and corrected by Abbott's formula (1925). Data were analyzed and means were separated by the LSD at 1% level.

RESULTS AND DISCUSSION

Data in Tables 1 and 2 show numbers of predators associated with four insecticides exerting their effect on these beneficial arthropods. In Table 1 (1993 season), the 1st inspection in October 12 (pretreatment estimation) indicated that predators were nearly similar in abunance in all plots, with higher numbers of *E.scutalis* and *C.carnea* than other predators. On October 26 when plants received two applications of Malathion, they harboured the least numbers of each of the predators and of the total number of aphidophagous species (3.47 individuals/leaf versus 9.03 individuals for the control). Oil -sprayed plants were harboured by an intermediate level of abundance of different predators.

On November 9, insecticide applications have been stopped 15 days before, and subsequent numbers of predators raised in all treated and untreated plots, probably when aphids increased (41.75 aphids/leaf for the control) by the favourable climatic factors. Numbers of each predator remained the lowest in plots receiving Malathion spray. The total number of entomophagous species was the highest for the control (20.04 individuals/leaf) while the oil-treated plots harboured high numbers (14.89 individuals/leaf) due to the high number of aphids (27.00 aphids/leaf) and a relatively high number of *P.aphidivora* associated with preys. On November 23, plants left without chemical spraying for a month, harboured the least number of *E.scutalis* and *C.carnea* in all plots. On the other hand, oil-treated plants harboured

Tables 1. Mean number of prdators* and aphids per leaf on squash sprayed by Supermisrona and Malathion in El Kanater, Qalyobia Governorate, Hort. Res. Station during, 1993 Nili season.

Treatment / Inspection dates / Predators	Supermisrona 15 ml/liter					Malathion 2.5 ml/liter					Control						
	12 Oct	26 Oct	9 Nov	23 Nov	Total number	12 Oct	26 Oct	9 Nov	23 Nov	Total number	12 Oct	26 Oct	9 Nov	23 Nov	Total number	F	LSD
E.scutalis	3.72	1.47	3.00	1.85	10.05	3.90	1.32	2.42	1.22	8.66	3.50	3.20	2.85	1.35	10.90	2.95	
C.carnea	3.87	2.35	2.87	1.47	10.57	3.77	1.05	2.77	0.72	8.32	3.80	2.77	4.00	1.07	11.65	22.13	1.24
C.undecimpunctata	(4.20)	(2.42)	(2.72)	(1.87)	(10.97)	(4.20)	(1.77)	(2.72)	(1.50)	(10.32)	(5.30)	(4.22)	(3.30)	(3.30)	(16.12)	65.14	1.35
O.albidipennis	0.77	1.72	2.55	2.52	7.57	0.00	0.57	1.92	1.97	4.47	0.95	1.37	3.85	2.77	8.15	61.79	1.005
P.aphidivora	(1.30)	10.57	(3.72)	(10.70)	(16.17)	(1.05)	(1.57)	(2.02)	(4.72)	(9.37)	(1.02)	(3.52)	4.90	(7.82)	(17.27)	32.54	8.14
S.corollae	0.00	0.00	1.50	3.50	5.00	0.00	0.00	0.97	1.67	2.70	0.00	0.00	3.87	3.15	7.02	41.62	1.15
Total of aphidophagous	2.45	2.95	6.12	10.55	22.07	2.12	0.75	5.35	9.87	18.10	2.42	3.17	5.87	10.75	22.22	10.08	2.54
nymphs, larvae	1.05	1.62	1.85	2.92	7.45	0.90	0.90	1.60	2.02	5.42	0.82	1.72	2.45	4.20	9.20	75.10	0.75
Aphids	8.14	8.64	14.89	11.69		6.79	3.27	12.61	15.45		7.99	9.03	20.04	21.94			
	0.25	0.00	27.00	22.00		0.25	2.25	13.00	12.00		2.25	3.00	41.75	15.00			

* Predators are evaluated as larvae, eggs are presented in parentheses.

Tables 2. Mean number of predators and aphids per leaf on squash sprayed by Supermisrona, Malathion and Sumicidin in El Kanater, Qalyobia Governorate, Hort. Res. Station during 1994 Nili season.

Treatments / Inspection dates / Predators	Supermisrona 25 ml/liter					Malathion 2.5 ml/liter					Sumicidin 2.5 ml/liter					Control					F	LSD
	6 Sep.	20 Sep.	4 Oct	18 Oct	Total number	6 Sep.	20 Sep.	4 Oct	18 Oct	Total number	6 Sep.	20 Sep.	4 Oct	18 Oct	Total number	6 Sep.	20 Sep.	4 Oct	18 Oct	Total number		
E.scutalis	3.65	3.77	4.22	3.62	15.32	2.15	2.10	5.20	4.90	14.90	1.50	1.67	3.00	3.37	9.55	7.10	7.75	3.85	3.37	22.30	3.86	1.57
C.carnea	0.70	3.02	3.17	3.25	(10.52)	0.00	0.50	2.55	1.97	5.02	0.00	0.95	2.75	3.60	7.30	0.00	2.72	3.42	3.60	9.45	36.91	1.21
C.undecimpunctata	(2.22)	(1.02)	(4.25)	(3.02)	9.40	(0.00)	(0.77)	(3.72)	(2.40)	(5.27	(0.52)	(0.87)	(3.20)	(2.92)	(7.52)	(2.00)	(1.32)	(3.95)	(2.92)	10.97	41.65	1.02
O.albidipennis	0.00	0.00	2.37	7.02	(12.72)	0.00	0.00	1.70	3.57	(10.42)	0.00	0.00	2.57	5.82	8.40	0.00	0.00	2.70	5.82	7.35	34.61	0.95
P.aphidivora	(0.00)	(0.00)	(1.22)	(11.45)	9.30	(0.00)	(0.00)	(4.65)	(5.73)	6.37	(0.00)	(0.00)	(2.65)	(7.10)	(9.75)	(0.00)	(0.00)	(10.80)	(7.10)	(49.7)	7.11	1.75
S.corollae	2.77	1.95	2.30	2.27	14.70	0.82	0.85	2.40	2.30	11.97	0.87	0.92	2.52	2.55	6.87	2.42	2.62	2.25	2.55	9.30	16.72	1.21
Total of aphidophagous	0.00	0.90	4.75	9.05	7.37	0.00	0.70	3.70	7.57	6.70	0.00	1.35	3.95	7.85	13.17	0.00	2.87	6.00	7.85	16.87	29.3	1.24
nymphs, larvae	0.00	0.00	2.87	4.50		0.00	0.00	2.62	4.07		0.00	0.00	2.97	4.25	7.22	0.00	0.00	3.87	4.25	8.40	50.4	1.01
Aphids	3.47	5.87	15.46	26.09		0.82	2.05	12.97	19.97		0.87	3.22	14.76	24.07		2.42	15.96	18.24	24.07			
	2.00	0.00	0.50	9.00		0.22	0.00	5.75	3.00		3.25	3.00	0.00	3.00		15.00	4.25	8.00	3.00			

* Predators were evaluated as larvae, eggs were presented in parentheses.

more predators than Malathion-treated plants and the total number (11.96 individuals/leaf) of aphidophagous species declined in these plots keeping aphid lower numbers under stress (22.00 aphids/leaf). In Malathion-treated plots and untreated ones the total number of predators increased and seemed to reduce aphids by a high rate of predation. Treatments were significantly different in the total of predators evaluated by the end of the season.

In 1994 season the first inspection was carried out on September 6 (Table 2), when plants were sprayed for two weeks, showed a lower number of *E.scutalis* (3.65, 2.15 and 1.5 individuals/leaf) than the control (7.10 individuals/leaf). Other predators showed nearly a similar trend in all plots and generally scarce because of a low prey density due to the insecticide application or the high temperature and humidity resulting from the earlier plantation of the 1994 season than the 1993 one. On September 20, most of chemical treatments were applied, Malathion and Sumicidin highly reduced predator numbers while oil-treated plots remained intermediatly harboured by the predators, with no coccinellieds or syrphids observed in all plots. Sumicidin-treated plots harboured the highest number of P.aphidivora among the other treatments. Predator numbers highly increased in plots on October 4 (two weeks after treatment termination) and oil-treated plots harboured the highest total number of aphidophagous predators (15.46 individuals/leaf versus 12.97 and 14.76 individuals/leaf for Malathion and Sumicidin - treated plots, respectively) and preys were kept under a lower density in different treatments than the control. The last inspection (18 October, a month after treatments termination) showed the highest numbers of predators on plants sprayed with oil (26.09 individuals/leaf) with a relatively high number of aphids (9.00 aphids/leaf). The three treatments differed significantly in the total number of each predator by the end of the season.

The previous findings were closely related to those of the laboratory test (Table 3). Sumicidin was highly toxic to *E.scutalis* and *P.aphidivora* while a low percentage of mortality was observed by the mineral oil (13.62%) for the Phaenobrimia larvae. Malathion and Sumicidin treatments were significantly different from the control while Supermisrona treatment did not differ. For the Sumcidin treatment it was observed that larvae of Phaenobrimia moved slowly within the 1st 24 h then a high percentage of mortality occurred after 48 h (68.17 %) which highly increased within 72 h.

Data previously presented indicated that predator number were similar when squash plots were treated or untreated during the pretreatment inspection. Since applying several sprays to the plant, predator populations were more numberous in the check plots than the treated ones but the least reduction in predators was observed in oil-treated plots. It seemed that Malathion was the most detrimental to the benificial tested species. Anthocorids (1993 season), coccinellids and syrphids (1994 season) appeared after spray termination in relatively small numbers in all plots while no individuals inhabited plants from seedling emergence. Predator populations were rebounded after sprays had been stopped (3rd inspection). Numbers of some predators declined over the time at the 4th inspection (phytoseiids, chrysopids and coccinellids) while others increased (anthocorids, cecidomyiids). During this inspection the body remnants of the preyed aphids were observed on squash leaves. It could be concluded that the mineral oil was the safer compound for the beneficial arthropods evaluated in the field and this was in agreement with the findinges of Gravena *et al* (1988) who reported that mineral oil was more selective than dimethoate for coccinellids and chrysopids. Fenvalarate was less harmful to the predators, however it reduced their numbers on squash, thus it was safer than Malathion. Its survival coefficient for predators was extended to 82% compared with OP compounds (14-29%). (Wilkinson *et al.*, 1979), Rajakulendran and Plapp (1982 a,b) reported that fenvalerate was less toxic to C.carnea based on its selectivity ratio indicating that synthetic pyrethroids having valeric acid in their molecules (fenvalerate) are safer than others having cyclopropane- carboxylic acid. Fenvalerate caused hyperactivity to predators followed by slightly smaller trap catches (Poehling *et al.*, 1985 a).

Table 3. Percentage mortality of moving stages of *E.scutalis* and last-instar larvae of *P.aphidivora* fed on aphids exposed to squash leaves treated with a field rate of Supermisrona, Malathion, Sumicidn, in the laboratory

Insecticides Predators	Supermisrona 15 ml/liter	Malathion 2.5 ml/liter	Sumicidin 2.5 ml/liter	Control	F	LSD
E.scutalis	18.75	59.08	68.17	8.33	12.15	39.34
P.aphidivora	13.62	45.45	68.17	8.33	15.92	32.54

Fenvalerate, exerting the knockdown (females of C.carnea fell to the soil, twitching, failed to walk or oviposit), had little effect on mortality after recovery from these symptoms (Grafton - Cardwell and Hoy, 1985). Malathion (OP) was the most dangerous to predators in the previous experiment by probably affecting locomotion, feeding and searching of coccinellid as reported by Roger *et al.* (1994). He also reported that Malathion reduced the numbers of aphids consumed by predators by a temporary inactivation (diminution of the predation efficiency). However, Tanigoshi and Fargerlund (1984) indicated that Malathion was moderately toxic to *Euseius hibisci* (Chant) compared with other OP compounds. In our field experiment, during the spray application, little numbers of aphids were observed (1993 and 1994 seasons) indicating the success of the chemical treatment. In the same time, less numbers of aphidophagous insects might participate in regulating the aphids increasing the searching capacity in low prey densities conditions or enhancing self-predation on their own eggs (chrysopids and coccinellids). However, egg predation may be beneficial by prolonging the survival of these larvae if aphids become scarce (Aveling, 1981). After spray termination, relatively larger numbers of aphids developed on plants (1993 season) but that coincided with the fruiting stage and feeding or transmission of diseases by aphids did not probably affect the fruit set. In 1994 season the predation effeciency in this period was more pronounced (low numbers of aphids) possibly due to the effect of the higher temperatures and numbers aphids) possibly due to the effect of the higher temperatures and humdities of the earlier plantation on preys and predators than 1993 season. Survival of small populations of aphids (with no economic effect on crop yield) provided an important food source for the maintenance of the aphidophagous species (Poehling *et al.*, 1985 b). In general, a gradual recolonization was observed by the tested species of predators, 2-4 weeks after treatment as demonstrated by (Terry *et al.*, 1993) to regulate aphids to prevent outbreaks.

The laboratory test showed that the highest toxicity was reported for Sumicidin followed by Malathion and the percentage of mortality was not significantly different for the oil-treated species than the control. The pesticide, affecting predators, probably by penetration through the cuticle (contact) or by feeding insecticide-killed preys, were more realistic predictors of predator survivals in the field when estimated by residual method (leaf disc-diptechnique) as reported by Yokohama *et al.* 1984, Thistlewood, *et al.*, 1992).

The mortality observed within the first 48 h was the most correct and stable for Malathion as suggested by Roger *et al.* (1994) that it caused a rapid mortality, 78% mortality within 15 min after treatent and 100% after 2 hr. On the contrast, fenvalerate (Sumicidin) effects might be extended to paralyzed or failed to pupate individuals within 72 h (Shour and Crowder, 1980) or reduced numbers of eggs of

C.carnea (Grafton-Cardwell and Hoy, 1985). Our laboratory test might present an attenuate effect of pesticide toxicity and did not resemble the field effect where preys and predators were evenly sprayed in some periods. By contrast fenvalerate which caused the rapid knockdown, permitted females normal oviposition rates after recovery and many adults of C.carnea should be able to escape treated plants after the initial contact and knockdown, thus, reducing the impact of fenvalerate (Grafton-Cardwell and Hoy, 1985).

It could be recommended that a safer compound such as a mineral oil that would protect beneficial arthropods, keeping low numbers of preys and maintains this entomophagous community (aphid-predators). Chemical sprays would be accomplished at intervals that do not coincide with aphid peaks because little numbers of aphid survivals existing with more dead predators lead to outbreaks. Systemic aphicides are required in an integrated pest management .

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تقييم أعداد المفترسات على الكوسة تحت ظروف الرش الكيماوى لمكافحة إصابة المن

مجدا انيس بشتلى ، رجاء عزيز سدراك

معهد بحوث وقاية النباتات - مركز البحوث الزراعيه - الجيزه - مصر .

فى تجربة حقلية اجريت لتقدير وفرة تعداد المفترسات تحت ظروف المعاملات الكيماوية للكوسة النيلية فى موسمى ١٩٩٣ و ١٩٩٤ كان الملاثيون هو الأكثر ضررا حيث قلل تعداد الحوريات واليرقات مفترسة المن أثناء فترة الرش (٣,٢٧ فرد / ورقة مقابل ٩,٠٣ / ورقة لمعاملة المقارنة و ٢,٠٥ فرد/ ورقة مقابل ١٥,٩٦ فرد / ورقة لمعاملة المقارنة أثناء موسمى ١٩٩٣ و ١٩٩٤ على التوالى) . سوبرمصرونا (الزيت المعدنى) كان الأكثر أمانا والسوميسيدين كان ذو تأثير متوسط على تعداد المفترسات . أما فى الإختبار المعملى فكانت النسبة المئوية للموت لكل من P.aphidivora, E.scutalis المعاملة بالزيت المعدنى ١٨,٧٥٪ ، ١٣,٦٢ ٪ على التوالى بدون فروق معنوية بينهم وبين معاملة المقارنة.