

SELECTIVE FIELD TOXICITY OF FOUR INSECTICIDES ON WHEAT APHID, *Schizaphis graminum* AND ITS THREE COCCINELLID PREDATORS.

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ABSTRACT

Selective toxicity of dimethoate 40% E.C. at the rates of 0.4 and 0.8 L/ha, malathion 57% E.C. at the rate of 1.0 and 1.5 L/ha, pirimiphos-methyl 50% E.C. (2.0 L/ha), and pirimicarb 50% W.P. (0.3 kg/ha) in controlling wheat aphids and their adverse effects on the coccinellid predators was carried out. The results showed that pirimiphos-methyl was the most toxic insecticide to wheat aphid, *Schizaphis graminum*, while, malathion (1 L /ha) was the least one. Pirimiphos-methyl treated plants produced significantly high levels of wheat grains followed by dimethoate (0.8 L / ha), pirimicarb (0.3 kg /ha), dimethoate (0.4 L / ha), and malathion (1.0 and 1.5 L / ha). The data indicated that malathion (1.5 L/ha) and dimethoate (0.8 L/ha) had significantly affected the food consumption of aphids by the lady predator beetles, however, pirimiphos-methyl showed low effects in this respect. Malathion (1.5 L /ha) was the most nonselective insecticide to the three types of the beneficial coccinellid beetles where it caused 100 % mortality. However, pirimiphos-methyl was relatively more selective. Generally, it can be concluded that pirimiphos-methyl was efficient in controlling the wheat aphid but relatively safe for its natural enemies coccinellid predators under field conditions.

INTRODUCTION

Aphids are the major insect pests of cereal crops world-wide where their populations have remained at economically damaging levels especially in the wheat fields. The aphid, *Schizaphis graminum* is one of the most important pests in many wheat growing areas because of its rapid spread and vast damage potential (Burton, 1988). Wheat aphid causes serious damage to cereal crops which is characterized by leaf rolling, chlorosis and plant stunting (Webster *et al*, 1987, 1991; Burd and Burton, 1992 and Burd *et al* 1993).

Beneficial insects can have an important role in reducing aphid population in wheat fields. Walton (1954) and McLeod (1989) reported that the beneficial activity is relatively limited during most of the cool winter season in which spinach is grown. Many insecticides are known to be highly effective in reducing aphid infestations. Beneficial insects such as coccinellid beetles are of major concern regarding the impact of the used insecticides. Croft (1990) indicated that beneficial arthropodes can be killed with insecticides by three routes of exposure, direct contact, consumption of prey species previously exposed to insecticides, and/or residual contact. One approach for protecting these natural enemies in IPM programs involves the use of selective insecticides, which are effective against insect pests but relatively safe for the predator (Yu, 1988). In this respect, Lee and Kim (1989) reported that the recommended concentrations of acephate, cyhalothrin, and pirimicarb showed selective toxicity between the predator beetle and the aphids. Cho *et al* (1997) studied the comparative toxicity of some insecticides to *Aphis citricola*, *Myzus malisuctus* and the predator *Harmonia axyridis* and they found that esfenvalerate which was very toxic to *A. citricola* and moderate toxic to *M. malisuctus*, was also very toxic to the aphidophagus coccinellid. However, alphamethrin that showed the lowest selectivity ratio was much safer to the predator than to the aphid.

The objective of this work was to study the selective field toxicity effect of dimethoate, malathion, pirimiphos-methyl and pirimicarb on wheat aphid and its three coccinellid predators.

MATERIALS AND METHODS

Plant Material

Wheat plants were used in aphid colony maintenance and the experiments were conducted in plot area of 1.0 x 0.5 m². Half meter distance was lefted between each plot to avoid pesticide contamination. Each plot was surrounded with cloth net to prevent aphids from escaping. Test plots were arranged in randomized complete block design with four replications in the experimental farm of King Saud University at Meleidah area.

Aphid infestation and insecticide application:

The aphid colony was established originally using *Schizocaphis graminum* collected from wheat fields of Gassim area. Wheat plants were infested with aphids using a small camel's-hair brush. Dimethoate 40% E.C. [*O,O*-Dimethyl *S*-methyl carbamoylmethyl phosphorodithioate], Malathion 57% E.C. [*S*-1,2-*bis* (Ethoxy- carbonyl) ethyl *O,O*-dimethyl phosphoro-dithioate]. Pirimiphos-methyl 50% E.C. [*O*-2-Diethylamino-6-methyl pyrimidin-4-yl *O,O*-dimethyl phosphorothioate], and pirimicarb 50% W.P. [2-dimethyl-amino- 5,6-dimethyl pyrimidin-4-yl dimethyl carbamate] were evaluated for aphid control.

To compare the efficacy of these insecticides in controlling aphid in wheat, a field trial of seven treatments with four replicates for each was carried out. The treatments were dimethoate at the rate of 0.4 and 0.8 L/ha, malathion at the rate of 1.0 and 1.5 L/ha, pirimiphos-methyl at the rate of 2.0 L/ha, pirimicarb at the rate of 0.3 kg/ha and check (unsprayed).

Wheat were sprayed with insecticides formulations aqueous dispersion or emulsion using a hand sprayer fitted with one nozzle boom. Aphid numbers were counted at 24, 48, and 72 hrs after insecticides application and the infestation reduction percentages were calculated using Henderson and Tilton equation (1955). After harvesting, the yield of wheat (g/m²) was evaluated in the different treated plots and compared with the untreated one.

Effect of the tested insecticides on predator food consumption:

Wheat plants used in this experiment were grown in pots (10 cm in diameter) in a growth chamber. Two groups of wheat plants were infested with aphids for two weeks. One pair (male & female) of each coccinellid species of *Coccinella undecimpunctata*, *Adonia variegata* or *Coccinella novemnotata* which reared on the artificial diet of drone powder according to Zaytoon (1995) and Nijima *et al* (1997), was introduced to the first group. The second group of plants was sprayed with each of the tested insecticides at the same rate and the same manner as mentioned before and then the aphids and coccinellid species were introduced. This experiment was carried out three times. The number of consumed aphids in the different two groups were recorded 24 hrs after introducing the coccinellid predators.

Effects of tested insecticides on the coccinellid predators:

A set of 10 wheat plants was infested with aphids and left for two weeks. After that, 5 pairs (male & female) of the different coccinellid species were introduced to the infested plants. This experiment was carried out three times. Insecticides were sprayed at the same rates as mentioned before. Mortality percentages of the coccinellid species were recorded 24 hrs after pesticides application.

RESULTS AND DISCUSSION

There were significant variations in the response of wheat aphid to the tested insecticides. The effects of each compound on the infestation of wheat plant with aphid were presented in Table1. Data showed that pirimiphos-methyl was the most effective pesticide on aphid at 24, 48, and 72 hrs following application. However, malathion (1L/ha) was the least one. The corresponding values of infestation reduction following pirimiphos-methyl application were 81.33 , 92.98 and 99.32 % after 24, 48, and 72 hrs, respectively , with an average of 91.21 %, whereas, those values for malathion were 35.05 , 56.25 and 74.95 %, respectively with an average of 55.42%. Several reports have recorded the high toxicity of these pesticides to parasites and predators (Bartlett 1966, Lendgren *et al* ., 1972). This greater susceptibility may result from differences in the ability to detoxify insecticides between prey and its

predator, but the exact mechanism of insecticides selectivity between prey and predator is unknown.

Table (1): Effect of different insecticides on the infestation of wheat plant with aphids.

Insecticide	Application rate /ha	Infestation reduction % $\pm$ S.D			
		24 hrs	48 hrs	72 hrs	Average
Dimethoate 40% E.C	0.4 L	48.52 $\pm$ 2.7	68.70 $\pm$ 1.7	85.67 $\pm$ 2.4	^{cd} 67.63
	0.8 L	75.7 $\pm$ 2.8	84.27 $\pm$ 4.5	92.96 $\pm$ 2.2	^{ab} 84.31
Malathion 57% E.C	1.0 L	35.05 $\pm$ 4.6	56.25 $\pm$ 3.6	74.95 $\pm$ 2.3	^c 55.42
	1.5 L	46.45 $\pm$ 2.9	64.46 $\pm$ 3.2	80.37 $\pm$ 2.4	^{dc} 63.76
Phosphamidon 50% E.C	2.0 L	81.33 $\pm$ 4.2	92.98 $\pm$ 2.6	99.32 $\pm$ 0.9	^a 91.21
Phosphamidon 50% WP	0.3 Kg	59.15 $\pm$ 4.6	76.49 $\pm$ 3.2	91.94 $\pm$ 2.7	^{bc} 75.86
L.S.D					8.63

Means followed by the same letters are not significantly different at $p < 0.05$

The yield of wheat was significantly increased following the application of all insecticides tested compared with the control treatment. Pirimiphos-methyl treated plants yielded the highest amount of wheat followed by dimethoate (0.8 L/ ha), pirimicarb (0.3 kg /ha), dimethoate (0.4 L/ha), and malathion (1.5 and 1.0 L/ha). The corresponding values of wheat yield were 205.55, 165.83, 134.4, 108.6, 92.3, and 37.68 g/ m², respectively. The control plants produced only 11.6 g/ m² (Table 2). It can be concluded that pirimiphos-methyl was the most effective pesticide against wheat aphid, *Schizaphis graminum*.

Table (2): Effect of different Insecticides on the yield of wheat.

Insecticide	Application rate (ha)	Yield (g/m ²)
Pirimiphos-methyl	2.0 L	^a 205.55 ± 8.2
Dimethoate	0.4 L	^d 108.6 ± 3.6
	0.8 L	^b 165.85 ± 4.1
Malathion	1.0 L	^f 37.68 ± 2.9
	1.5 L	^e 92.3 ± 7.5
Pirimicarb	0.3 Kg	^c 134.4 ± 2.3
Control	---	^g 11.60 ± 1.2
L.S.D		8.95

Means followed by the same letters are not significantly different at p<0.0

Table (3): Effect of insecticides on food consumption of aphids by Lady Beetles.

Types of coccinellid beetles	Food consumption %	Average
	Before pesticide application	
<i>Coccinella novemnotata</i>	64.82 ± 1.43	^a 67.99 ± 4.7
<i>Coccinella undecimpunctata</i>	74.0 ± 1.45	
<i>Adonia variegata</i>	65.15 ± 2.0	
	Pirimiphos-methyl 2.0L/ha	
<i>Coccinella novemnotata</i>	9.95 ± 1.2	^b 17.76 ± 8.4
<i>Coccinella undecimpunctata</i>	28.25 ± 2.1	
<i>Adonia variegata</i>	15.09 ± 2.6	
	Malathion 1.0L/ha	
<i>Coccinella novemnotata</i>	7.85 ± 3.1	^d 7.18 ± 2.8
<i>Coccinella undecimpunctata</i>	9.11 ± 1.9	
<i>Adonia variegata</i>	4.59 ± 1.3	
	Malathion 1.5L/ha	
<i>Coccinella novemnotata</i>	1.31 ± 0.8	^c 3.21 ± 2.6
<i>Coccinella undecimpunctata</i>	6.00 ± 2.7	
<i>Adonia variegata</i>	2.32 ± 1.34	
	Dimethoate 0.4L/ha	
<i>Coccinella novemnotata</i>	13.35 ± 0.8	^c 14.35 ± 3.3
<i>Coccinella undecimpunctata</i>	17.36 ± 3.6	
<i>Adonia variegata</i>	12.34 ± 2.9	
	Dimethoate 0.8L/ha	
<i>Coccinella novemnotata</i>	4.33 ± 1.1	^c 4.48 ± 2.4
<i>Coccinella undecimpunctata</i>	6.95 ± 2.1	
<i>Adonia variegata</i>	2.14 ± 0.9	
	Pirimicarb 0.3Kg/ha	
<i>Coccinella novemnotata</i>	8.35 ± 1.8	^c 14.48 ± 5.2
<i>Coccinella undecimpunctata</i>	19.19 ± 2.6	
<i>Adonia variegata</i>	15.91 ± 2.7	
L.S.D		1.98

Means followed by the same letters are not significantly different at $p < 0.05$

Table (4): Effect of different insecticides on the number of coccinellid beetles

Insecticide	Types of Coccinilid Beetles	Mortality% ± S.D	Average % mortality
Dimethoate 40% E.C, 0.4L/ha	<i>Coccenella novemnotata</i>	83.43 ± 2.9	^d 83.84 ± 6.6
	<i>Coccenella undecimpunctata</i>	76.75 ± 1.4	
	<i>Adonia variegata</i>	91.34 ± 1.5	
Dimethoate 40% E.C, 0.8L/ha	<i>Coccenella novemnotata</i>	98.14 ± 1.1	^b 97.21 ± 3.1
	<i>Coccenella undecimpunctata</i>	93.48 ± 1.6	
	<i>Adonia variegata</i>	100.0 ± 0.0	
Malathion 57% E.C, 1.0L/ha	<i>Coccenella novemnotata</i>	95.13 ± 1.1	^c 92.58 ± 4.7
	<i>Coccenella undecimpunctata</i>	86.54 ± 1.4	
	<i>Adonia variegata</i>	96.08 ± 2.0	
Malathion 57% E.C, 1.5L/ha	<i>Coccenella novemnotata</i>	100.0 ± 0.0	^a 100.0 ± 0.0
	<i>Coccenella undecimpunctata</i>	100.0 ± 0.0	
	<i>Adonia variegata</i>	100.0 ± 0.0	
Pirimiphos- methyl 50% E.C, 2.0L/ha	<i>Coccenella novemnotata</i>	66.25 ± 2.4	^c 68.03 ± 11.3
	<i>Coccenella undecimpunctata</i>	56.10 ± 1.4	
	<i>Adonia variegata</i>	81.73 ± 2.1	
Pirimicarb 50% WP, 0.3Kg	<i>Coccenella novemnotata</i>	93.52 ± 2.2	^d 83.34 ± 8.1
	<i>Coccenella undecimpunctata</i>	76.15 ± 2.7	
	<i>Adonia variegata</i>	80.35 ± 2.0	
L.S.D			1.61

Means followed by the same letters are not significantly different at $p < 0.05$

The effect of the tested insecticides on the food consumption of aphids by coccinellid predators was demonstrated in Table 3. Data showed that food consumption percentage by *Coccinella novemnotata*, *Coccinella undecimpunctata*, and *Adonia variegata* were 64.82, 74.0 and 65.15%, respectively, with an average of 67.99% before using insecticides. This average value was significantly declined to 17.76, 14.48, 14.35, 7.18, 4.48 and 3.21 after application of pirimiphos-methyl (2.0 L/ha), pirimicarb (0.3 kg/ha), dimethoate (0.4 L/ha), malation (1.0 L/ha), dimethoate (0.8 L/ha) and malathion (1.5 L/ha), respectively. These data indicated that malathion (1.5 L/ha) and dimethoate (0.8 L/ha) were significantly affected the food consumption, however, pirimiphos - methyl showed low effects on the coccinellid predators. The comparative toxicity of these insecticides to the three types of coccinellid beetles, was indicated in Table (4). The data indicated that malathion (1.5 L/ha) was the most toxic insecticide to the three types of the coccinellid beetles where it caused 100% mortality. On the other hand, pirimiphos - methyl was relatively less toxic to all species used of the predators.

Generally, our results concluded that pirimiphos - methyl 50% E.C. at the rate of 2.0 L/ha was the most toxic insecticide to the aphid but relatively safe for its natural enemies coccinellid predators.

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الملخص العربي

دراسة السمية الاختيارية لأربعة مبيدات حشرية
على المن وخنافس أبو العيد في حقول القمح

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تم دراسة السمية الاختيارية في حقول القمح لأربعة مبيدات حشرية على المن وثلاثة أنواع من خنافس أبو العيد والتي تعتبر أهم المفترسات الطبيعية لحشرة المن . وكانت المبيدات المختبرة هي: دايمثويت ٤٠ % مركز قابل للاستحلاب بمعدل ٠.٤ ، ٠.٨ ، ١ لتر/ هكتار ، ملاثيون ٥٧ % مركز قابل للاستحلاب بمعدل ١٠ ، ٢٠ ، ٤٠ لتر/ هكتار ، ميتل - بريميفوس ٥٠ % مركز قابل للاستحلاب بمعدل ٢٠ ، ٤٠ لتر/ هكتار ، بريميكارب ٥٠ % مسحوق قابل للبلل بمعدل ٣٠٠ جم / هكتار .

وقد أوضحت الدراسة أن مبيد ميتل - بريميفوس بالمعدل المستخدم كان أكثر المبيدات المختبرة سمية على حشرة المن بينما كان مبيد الملاثيون أقلها تأثيرا عند استخدامه بمعدل ١ لتر للهكتار وكذلك أوضحت النتائج أن القطع المعاملة بمبيد ميتل - بريميفوس أعطت أعلى إنتاجية لحبوب القمح بالمقارنة بالمبيدات الأخرى يليه بعد ذلك القطع المعاملة بمبيد دايمثويت بمعدل ٠.٨ لتر للهكتار ثم القطع المعاملة بمبيد بريميكارب بمعدل ٣٠٠ جراما للهكتار ثم القطع المعاملة بمبيد دايمثويت بمعدل ٠.٤ لتر للهكتار ثم القطع المعاملة بمبيد ملاثيون بمعدل ١ لتر للهكتار وأخيرا القطع المعاملة بمبيد ملاثيون بمعدل ١ لتر للهكتار . أما بالنسبة لتأثير المبيدات المختبرة على المعدل الاستهلاكي لحشرة المن بواسطة خنافس أبو العيد فقد أظهرت الدراسة أن مبيد الملاثيون بمعدل ١ لتر للهكتار أو مبيد دايمثويت بمعدل ٠.٨ لتر/هكتار يؤثر تأثيرا معنويا على معدل استهلاك حشرة المن بواسطة خنافس أبو العيد الثلاثة. بينما كان مبيد ميتل - بريميفوس أقل المبيدات المستخدمة تأثيرا. ويمكننا القول على ضوء هذه الدراسة أن مبيد ميتل - بريميفوس بالمعدل المذكور يعتبر أكثر المبيدات المختبرة تأثيرا على المن في حقول القمح وفي نفس الوقت يعتبر أكثرهم أمانا على خنافس أبو العيد التي تعتبر لها دورا هاما في مكافحة حشرة المن جنبا الى جنب مع المبيدات الحشرية.