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Effectiveness of three insecticides against mustard aphid, *Lipaphis erysimi* kalt. and their safety to the predator, *Coccinella septempunctata* L.

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Abstract

Three insecticides - Metasystox-R 25EC, Dimethion 40EC and Fentro 50EC were sprayed on mustard aphid to evaluate their effectiveness on *Lipaphis erysimi* and safety to the predator *Coccinella septempunctata* in the field. Metasystox-R was found as the most effective insecticide against mustard aphid. Fentro was highly toxic to *C. septempunctata*. Dimethion at the concentration of 0.025% proved to be soft to the predator. The insecticides influenced different growth parameters and yield attributing character of mustard and lead to higher seed yield. The response of Metasystox–R at 0.05% concentration was comparatively better for growth parameters and yield of mustard giving maximum cost benefit ratio (CBR) followed by Dimethion and Fentro at comparable doses. Metasystox-R was evaluated as the most suitable insecticide for controlling mustard aphid.

Introduction

Mustard crop suffers heavy losses every year due to the attack of mustard aphid, *Lipaphis erysimi* Kalt (Hemiptera: Aphididae). The pest attacks mustard and many cruciferous vegetable crops (Kim et al. , 1986 and Bekhetia, 1986). Both the adult and nymphs cause damage to mustard plant from seedling to maturity. The predator *Coccinella septempunctata* L. (Coleoptera: Coccinellidae) a lady bird beetle may play a vital role in lowering the population of mustard aphid in the field. Use of insecticide sometimes becomes essential when the natural enemies fail to reduce the rapid increasing aphid population. Different insecticides have been tested against the pest in different parts of the world and the frequent use of the insecticides at higher concentration has shown several adverse effects in the agro-ecosystem. Judicious use of pesticide is of prime importance now in successful implementation of integrated pest management program. Although several insecticides are used by the farmers in controlling mustard aphid but the information about the effectiveness of many common insecticides are yet to be determined against the pest in Bangladesh. The insecticides such as Metasystox, Dimethoate and Fenitrithion are reported as effective against sucking pest (Pedigo, 1996; Gupta, 1999 and Roy, 2002). Reports on the use of these insecticides against mustard aphid and its adverse effect to common ladybird beetle, *Coccinella septempunctata* in Bangladesh are not available. The present experiment was undertaken to determine the effectiveness of three insecticides to *L. erysimi* pest and their safety to the coccinellid predator.

MATERIALS AND METHODS

The experiment was conducted in the field laboratory of Entomology Division of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh during November 2001 to February 2002. Mustard variety BINA Sarisha-4, of *Brassica napus* L. was used as test crop. The experiment was conducted in

a randomized complete block design with three replications. The unit plot size was 5m x 4m. The spacing between block to block, plots to plot was 1 m and 0.5 m. Application of fertilizer was made as recommended. Necessary intercultural operations were made as required. The crop was monitored to check the natural infestation of the aphid. The mustard plants were sprayed with the selected insecticides using a Knapsack sprayer when the inflorescences, leaves and shoots of mustard plants had a considerable level of aphid infestation and presence of the coccinellid. Three insecticides namely Metasystox-R 25EC, Dimethion 4OEC and Fentro 50EC with the doses of 0.05% and 0.025% for each were applied to determine the effectiveness against mustard aphid, *L. erysimi* and their harmful effects on the predator, *C. septempunctata*. Untreated plots were not sprayed. Data were recorded on level of mustard aphid and the predator at 1, 4 and 7 days after application of insecticides. Total numbers of infested and uninfested plants were collected from five randomly selected rows of each plot to calculate the infestation percentage of mustard plants by mustard aphid. The percent of plant infestation was also converted into percent reduction of aphid infested plant.

Effect of insecticides on mustard aphid and the predator

The 10 cm apical twigs of the selected mustard plants were cut and brought to the laboratory in polythene bags separately. The aphids were removed from the plants with the help of a soft brush and placed on a piece of white paper. Then the number was counted with the help of a magnifying glass and hand tally counter. Infested twigs and inflorescence were checked carefully, so that not a single aphid could escape at the time of counting. Ten randomly selected plants from each plot were selected for counting the population of the predator, *C. septempunctata*.

Yield

The mustard crop was harvested when they were fully mature. The yield of seeds per plot was recorded and expressed as kg per hectare. Plant height, number of branch per plant, total numbers of pods per plant, pod length, number of seeds per pod were also recorded. Plant height and pod length was measured by meter scale.

Economic evaluation of insecticides on the yield of mustard

Economic evaluation of insecticides on seed yield of mustard was made for each treatment based on the Cost Benefit Ratio (CBR). Cost benefit ratio was calculated as follows:

$$CBR = \frac{\text{Net profit over control}}{\text{Cost of treatment}}$$

Where, Cost of treatment = Price of insecticides + Labour charge

Statistical analyses

Results obtained from different parameters were statistically analyzed using one factor Randomized Complete Block Design (RCBD). The means were separated using Duncan's Multiple Range Test (DMRT).

Results and Discussion

Effect of insecticides on aphid infested plant

The results on percent reduction of aphid-infested plants of different treatments are presented in Table 1. At 1 DAT highest percentage of reduction of aphid-infested plant were observed from Metasystox-R treated plants both at high and low doses after different time intervals.

Table 1. Effect of three insecticides on the reduction of aphid infested plant

Name of insecticide	Dose (%)	% Reduction of aphid infested plant		
		1 DAT	4 DAT	7 DAT
Metasystox-R 25EC	0.05	71.36 [a]	80.40 [a]	67.67 [a]
	0.025	68.00 [ab]	74.40 [ab]	60.20 [ab]
Dimethion 40EC	0.05	60.03 [bc]	71.27 [abc]	53.76 [abc]
	0.025	55.13 [cd]	68.23 [bc]	49.17 [bc]
Fentro 50EC	0.05	51.03 [de]	64.87 [bc]	45.17 [bc]
	0.025	46.20 [e]	60.50 [c]	40.00 [c]
LSD value at 5%		8.52	10.25	14.55

- Means in a column followed by the same letter(s) are not significantly different.
- DAT = Days after treatment.

The lowest reduction of aphid infested plant was observed with Fentro at low dose. At 4 DAT, the highest percent reduction of aphid infested plant (80.40%) was observed at the high dose of Metasystox-R which was identical to its low dose and high dose of Dimethion.

Effect of insecticides on aphid population

The percent reduction of aphid population varied significantly among the treatments (Table 2). The reduction of aphid population ranged from 68.78 to 91.22% at 1 DAT, 75.20 to 99.44% at 4 DAT, 28.67% to 86.26% at 7 DAT. The highest reduction of aphid population was observed in plants treated with high dose of Metasystox-R and the lowest was with Fentro at low dose. In all the treatments percent reductions of aphid population were significantly different in high and low doses. Nagia and Sharma. (1989) reported that Oxydemeton methyl (0.03%) was effective against *L. erysimi*. Thomas and Phadke (1992) found that Oxydemeton methyl (0.025%) reduced 90.48, 92.71, 88.70% aphid population at 1, 3 and 5 days after spraying. Upadhyay and Agrawal (1993) reported that Oxdemeton methyl (0.025%) was the most toxic to mustard aphid. Nirmala *et al.* (2001) recommended Metasystox (0.025%) for the control of mustard aphid. All the findings are in conferment with the findings of the present study. A few variations were found which might be due to the variation of doses of insecticides and experimental location.

Table 2. Effect of three insecticides on the reduction of aphid population

Name of insecticide	Dose (%)	% Reduction of aphid population		
		1 DAT	4 DAT	7 DAT
Metasystox-R 25EC	0.05	91.22 [a]	99.44 [a]	86.26 [a]
	0.025	86.63 [b]	97.61 [a]	81.45 [b]
Dimethion 40EC	0.05	82.37 [b]	92.37 [b]	73.77 [c]
	0.025	82.37 [b]	90.35 [b]	63.45 [d]
Fentro 50EC	0.05	71.81 [c]	85.50 [c]	45.65 [e]
	0.025	68.78 [c]	75.20 [d]	28.65 [f]
LSD value at 5%		43.34	27.04	33.44

- Means in a column followed by the same letter are not significantly different.
- DAT = Days after treatment.

Effect of insecticides on the predator *C. septempunctata*

Percent reduction of *C. septempunctata* after spraying varied significantly among the treatments (Table 3). Percent reduction of the predator ranged from 60.92 to 85.74% at 1 DAT, 49.27 to 86.72% at 4 DAT and 29.81 to 76.28% at 7 DAT. At 1 DAT, the highest percent reduction (85.74%) was observed from high dose of Fentro which was statistically identical to its low dose. The lowest percent reduction (60.92%) was observed from low dose of Dimethion, which was statistically similar to its high dose (62.41%). Both doses of Metasystox-R had similar results. At 4 DAT, highest percent reduction of the *C. septempunctata* was observed from Fentro treated plants with high dose (86.72%) followed by its low dose and high dose of Metasystox-R (79.03 and 79.00%, respectively). The minimum reduction was found at the low dose of Dimethion (49.27%) and which was statistically dissimilar to other treatments.

Table 3. Effect of three insecticides on the reduction of the predator, *C. septempunctata*

Name of insecticide	Dose (%)	% Reduction of *C. septempunctata*		
		1 DAT	4 DAT	7 DAT
Metasystox-R 25EC	0.05	78.15[b]	79.00[b]	65.39[b]
	0.025	76.80[b]	72.28[c]	51.29[c]
Dimethion 40EC	0.05	62.41[c]	54.64[d]	47.44[c]
	0.025	60.92[c]	49.27[e]	29.81[d]
Fentro 50EC	0.05	85.74[a]	86.72[a]	76.28[a]
	0.025	83.33[a]	79.03[b]	73.72[a]
LSD value at 5%		4.12	3.93	3.98

- Means in a column followed by the same letter are not significantly different.
- DAT = Days after treatment.

At 7 DAT, the highest percent reduction of the predator was obtained from high dose of Fentro treated plants, which was 76.28% and was identical to its low dose (73.28%). The lowest percent reduction was found from the low dose of Dimethion treated plants which was 29.81% and was significantly different from other treatments. Olszak (1982) and, Sharma and Adlakha (1986) found that Fenitrothion was most toxic to the predator. Rajgopal and Kareen (1984) and Tripathi *et al.* (1988) reported that Demethion was safe to the predator. These findings are in conformity with the findings of the present study. A few variations were found which might be due to the variation in dose of insecticides and existing environmental conditions.

Effect of insecticides on the growth parameters and yield of mustard

The effect of three insecticides on different growth parameters and yield of mustard crop were measured and compared with control (without insecticides). The treatment-wise mean crop characters and yield are presented in the Table 4.

Plant height and number of branches

The highest plant height (92.73 cm) of mustard was observed from high dose Metasystox-M treated plants while minimum plant height was recorded from the unsprayed plants (53.63 cm). Low dose of Fentro showed the least plant height (69.50 cm). As regard the response of insecticides on the number of branches, all the treated plants significantly produced more branches than unsprayed ones. Spraying with high dose of Metasystox-M produced maximum branches (5 branches) as compared to unsprayed crop (1.66 branches).

Length and number of pod and seed yield

A significantly highest length of pod (5.60 cm) was found in mustard plants treated with high concentration of Metasystox-M followed by its low dose and high dose of Dimethion (5.33 cm) (Table 4). Higher number of pods was observed at high dose of Metasystox-R treated plants (122.7) and lowest in unsprayed plants. Formation of pods due to the effect of low dose of Metasystox (110.3), high and low dose of Dimethion (100.7 and 96.67, respectively) and Fentro at high and low doses (17.67 and 17.67, respectively) were second, third, fourth and fifth in order. The insecticide treatments in mustard plants increased the pod number significantly over the control. Maximum number of seeds per pod was observed at high dose of Metasystox-R treated plants (23.33) followed by its low dose and high dose of Dimethion (19.00 and 19.33 seeds, respectively) whereas the plants treated with low dose of Dimethion and both doses of Fentro produced 19.67, 17.67 and 15.6 seeds per pod, respectively. No significant difference was found among the treatments of low dose of Dimethion, high and low doses of Fentro in respect of number of seeds per pod. The lowest number of seeds per pod was observed in untreated crop (12.67). It is clearly evident that the insecticide spraying significantly increased number of seeds per pod over the control which might be due to the reduction of pest population.

Table 4. Effect of three insecticides on the growth parameters and yield of mustard when applied for controlling *L. erysimi*

Name of insecticide	Dose (%)	Plant height (cm)	No. of branches plant^{-1}	No. of Pods plant^{-1}	Pod length (cm)	No. of seeds pod^{-1}	Seed yield kg/ha
Metasystox-R 25EC	0.05	92.73 ^{a}	5.00 ^{a}	122.7 ^{a}	5.60 ^{a}	23.33 ^{a}	1750^{a}
	0.025	84.50 ^{b}	3.33 ^{b}	110.36 ^{b}	5.12 ^{ab}	19.00 ^{ab}	1200^{b}
Dimethion 40EC	0.05	81.90 ^{bc}	3.00 ^{c}	100.7 ^{c}	5.35 ^{ab}	19.33 ^{ab}	1200^{b}
	0.025	74.30 ^{d}	2.66 ^{c}	96.67 ^{c}	4.43 ^{bc}	17.67 ^{bc}	950^{c}
Fentro 50EC	0.05	79.10 ^{c}	3.00 ^{d}	87.67 ^{d}	4.48 ^{bc}	17.67 ^{bc}	980^{c}
	0.025	69.50 ^{e}	2.66 ^{e}	71.67 ^{e}	4.08 ^{c}	15.67 ^{bc}	700^{d}
Control		53.63 ^{f}	1.66 ^{f}	64.67 ^{f}	3.03 ^{d}	12.67 ^{c}	500^{e}
LSD value		4.47	1.50	4.55	0.86	5.155	104.5
Probability		0.01	0.05	0.01	0.05	0.05	0.05

- Means in column followed by same letter (s) are not significantly different.

Table 4 clearly indicates that high dose Metasystox-R treated plants produced highest amount of seeds (1750 kg ha^{-1}). Lowest yield was found from untreated plot (500 kg ha^{-1}). Low dose of Metasystox-R and high dose of Dimethion treated plots computed second (1200 kg ha^{-1}), low dose of Dimethion and high dose of Fentro (950 kg ha^{-1} and 980 kg ha^{-1}, respectively) third and low dose of Fentro (800 kg ha^{-1}) fourth in order of seed yield respectively. All of the treated plants showed a significant increase of seed yield over the control. Hossain (1993) reported a similar finding that application of insecticides has positive response to the growth and yield of mustard. In an experiment with mustard (Ramkishore and Phadke, 1988) reported yield increase in mustard with Oxydemeton methyl. From the above results it was evident that all the growth parameters viz. plant height, number of branch per plant, number of pod per plant, pod length, number of seeds per pod and seed yield were significantly increased over control with the application of insecticides. The over all growth in insecticides treated plants might be due to the control of mustard aphid, which led to a healthy growth of the mustard plant.

Cost benefit ratio of the insecticide application

Economic evaluation of the three insecticides based on the yield of mustard has been presented in Table 5. At high dose (0.05%), the highest benefit was obtained from Metasystox-R treated plants, which gave the highest cost benefit ratio (CBR) (8.65). The lowest was observed from Fentro, which were 5.4 at high dose. At low dose (0.025%), the highest CBR (7.98) was also observed from Metasystox-R. The lowest CBR was observed from Fentro, which was 4.92 at low dose.

Malik *et al.* (1988) received maximum CBR from Metasystox-R treated crop. In the present study as Metasystox-R showed highest CBR, this insecticide could be considered as most effective insecticide in controlling the mustard aphid, *L. erysimi*.

Table 5. Cost benefit ratio (CBR) of three insecticides in controlling mustard aphid, *L. erysimi*

Name of insecticide	Dose (%)	Amount of insecticide (Litre ha^{-1})	Cost in Tk.	Return		Gross benefit (Tk ha^{-1})	Benefit over control (Tk ha^{-1})	Cost benefit ratio (CBR)
				Seed yield (Kg ha^{-1})	Price of seed (Tk ha^{-1})			
Metasystox-R 25EC	0.05	1.25	2200	1750	29750	27550	19050	8.65
	0.025	0.625	1325	1200	20400	19075	10575	7.98
Dimethion 40EC	0.05	0.78	1542	1200	20400	18858	10350	6.71
	0.025	0.39	996	950	16150	15154	6654	6.68
Fentro 50EC	0.05	0.625	1275	980	16660	15385	6885	5.40
	0.025	0.3125	862.5	800	13600	12747.5	4247.5	4.92
Control				500	8500			

- Price of insecticides + Tk 450.00 Labour charge

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