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RESEARCH ARTICLE

Larvicidal effect of some newer insecticides on *Chrysoperla carnea* (Stephens)

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ABSTRACT

Use of Insecticides are unavoidable in pest management programmes especially when the pest crosses econimic threshold level (ETL). Nevertheless, often the plant protection products kill the natural enemy population making the pest to resurge and thus demanding more sprays. Therefore, insecticides used in IPM programmes should be selective enough to spare the beneficials. Laboratory studies were conducted to find out the toxicity of some newer insecticides against the first and third instar larvae of lacewing, *Chrysoperla carnea* (Stephens) by leaf dip method. Among the insecticides, malathion, indoxacarb, thiamethoxam, imidacloprid, diafenthiuron and spinosad evaluated for their larval mortality against 3rd instar larvae of *Chrysoperla* and were observed as 43.33, 30.00, 26.67, 23.33, 16.67 and 3.33 per cent larval mortality.

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INTRODUCTION

Biological control agents can cause substantial decrease in pest population numbers (Hassell, 1978). Green lacewing is a generalist and widely distributed predator of many soft bodies insect pests (Geetha and Swamiappan, 1998; New, 1975). Being an entomophagous predator in many crops, with wide use in biological control in glasshouse crops and its ability to be easily reared in large numbers, the common green lacewing, *Chrysoperla carnea* (Stephens) is taken as a representative of Chrysopidae (Morrison, 1985) to be used in biocontrol programme.

The impact of predacious arthropods in natural communities and agricultural crops is receiving more attention in recent years. The importance of natural enemies (parasites, predators and pathogens) as controlling agents is coming into closer focus, based on modern investigations. The concept was originally described by Stephens (1835) and was successfully used in 1868 (Zhang *et al*., 2004). The term "Biological control" was first used by Smith (1919) to signify the use of natural enemies to control insect pests. Biological control is a phase of natural control, hence, could also be termed "natural control". This broader term includes the actions of all environmental factors, both physical and biological in the regulation, determinations or governance of average population densities

The most crucial requirement for pesticides is that they must be compatible with biological control. Therefore, only those pesticides should be used that are most selective and which have no adverse effects on beneficial organisms (Hassan, 1989). In IPM, the compatibility of an insecticide with biological control agents is often examined by tests screening for mortality of natural enemies, but sub-lethal effects on beneficial insects are largely overlooked (Elzen, 1989).

The adverse impact of insecticides on natural enemies can be mitigated through choice of insecticide, dosage, or timing of insecticide application. Biological control and selective insecticides proved to be compatible tactics in Integrated Pest Management (IPM) programmes (Galvan *et al*., 2006). Integrating biological control with selective

insecticides also can minimize the likelihood of pest resurgence and possibly to reduce the number of insecticide applications (Hutchison *et al*., 2004).

Insecticides compatible to biological control agents are useful tools in an integrated pest management programme, so studying their effects on natural enemies is a necessity (Stark *et al*., 2004). The purpose of work reported here was to evaluate the effects of pesticide on larvae of *C. carnea* that could help to find tolerant predator life stage with selected insecticides and *vice versa*.

MATERIAL AND METHODS

The present investigation was carried out in the Biocontrol laboratory, Entomology section, College of Agriculture, Nagpur, Maharastra during 2012-2013. The rearing of the host insect and predator was done under controlled room temperature and relative humidity conditions ranging between 24 ± 2^0C and 60 ± 5 per cent. Details of insecticides used in the experiment are given in Table A.

Mass multiplication of Chrysopa was done in the laboratory to obtain healthy culture of the test predator. The initial culture was obtained from the already established culture of Chrysopa in Biocontrol laboratory, Entomology Section, College of Agriculture, Nagpur and was further multiplied on the factitious laboratory host, eggs of rice moth. To obtain the eggs of *Corcyra cephalonica* throughout the experimental period, rearing of rice moth was done in the laboratory and the culture was maintained on sorghum based artificial diet.

Selection of test insect :

The insects were obtained from stock culture. The uniformity in age and size of test insects were strongly observed in their selection, to minimize the chances of natural mortality in test insects.

Test design :

- Design of experiment : C.R.D.
- Number of replications : 3
- Number of treatments : 7.

Treatment of larvae :

Leaf dip assay was used to treat the larvae, as it more closely approximates the field exposure. Fresh, medium size and unsprayed leaves of cotton (*Gossypium hirsutum*) variety PkvHY-4 were collected from 60 days old plants. Leaves were cut into same diameter of Petriplates. Leaf discs were dipped for 5 seconds into insecticide solutions and in water for control. All treated and control discs were allowed to air dry and placed in Petriplates (1.25 cm dia. and 0.75 cm deep). Water moistened filter paper was then placed underneath of each leaf disc. The larvae of 1st and 3rd instars were placed in Petriplates separately. Irradiated eggs of *Corcyra cephalonica* were sprinkled in each Petriplate as a food for larvae. The larvae were considered dead if they no longer moved or twitched when being touched 2-3 times with a brush.

Observations :

Ten larvae that were placed in the treated Petriplate in each replication were observed and the larvae were considered to be dead if they no longer moved or twitched when being touched 2-3 times with a brush. Mortality data were recorded at 24h, 48h and 72h after exposure and calculated the per cent mortality in each treatment.

The mean per cent mortality of larvae in different treatments was calculated by the following formula :

$$\text{Mean per cent mortality} = \frac{\text{Number of larvea dead}}{\text{Number of larvea released}} \times 100$$

Statistical analysis :

The per cent mortality in laboratory studies was corrected using Abbot's formula (Abbot, 1925) given below. The corrected per cent mortalities were transformed to arcsine percentage and subjencted to statistical analysis adopting Completely Randomized Design.

$$P = \frac{P1 - C}{100 - C} \times 100$$

where,

P = the corrected per cent mortality

P1 = the observed per cent mortality in treatment

C = the per cent mortality in control.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Table A : Various insecticides selected for the treatment of larvae of *Chrysoperla carnea*

Sr. No	Common name	Trade name	Group	Dose/ha.	Dose/lit.
1.	Diafenthiuron 50 WP	Pegasus	Thiourea	300 g a.i.	1.2 g
2.	Imidacloprid 17.8 SL	Confidor	Chloronicotinyl	25 g a.i.	0.28 ml
3.	Indoxacarb 15.8 EC	Steward	Oxadiazine	75 g a.i.	0.94 ml
4.	Spinosad 45 SC	Tracer	Spinosyn	75 g a.i.	0.3 ml
5.	Thiamethoxam 25 WG	Actara	Thia-nicotinyl	25 g a.i.	0.2 g
6.	Malathion 50 EC	Hilthion	Organophosphate	500 g a.i.	2 ml

Effect of different insecticides on per cent mortality of first instar chrysopa larvae :

The figures contained in Table 1 clearly exhibited that the toxicity of different insecticides against first instar Chrysopa larvae varied significantly after different time intervals and increased significantly with the increase in exposure period from 24h to 72 h.

The cumulative mortality data showed that the safest insecticide was spinosad 45 SC @ 0.3 ml/l which killed only 13.33 per cent larvae of Chrysopa and differed significantly with control.

It is also clear from data of table that maximum mortality of first instar Chrysopa was obtained with malathion 50 EC @ 2 ml/l (86.67 %) followed by indoxacarb 15.8 EC @ 0.94 ml/l, thiamethoxam 25 WG @ 0.2 g/l, imidacloprid 17.8 SL @ 0.28 ml/l, diafenthiuron50 WP @ 1.2 g/l, spinosad 45 SC @ 0.3ml/l with 80.00, 76.67, 43.33, 26.67 and 13.33 per cent larval mortality, respectively up to 72 h exposure period.

Similar results were also reported by Mishra *et al*. (2012) who tested malathion 50 EC on 1st instar of *Chrysoperla carnea* and observed that it caused 94.3 per cent larval mortality and also Ribeiro (1988) and Cordeiro *et al*. (2010) assessed that malathion, which led to 100 per cent mortality of the newly hatched lacewing larvae.

Muzammil Sattar *et al*. (2010) and Raguraman and Uthamasamy (2005) observed less toxicity of spinosad and was safe to *C. carnea*.

Miles (2006) noticed that Spinosad was shown to be compatible with the use of Neuroptera (*Chrysoperla carnea* and *Chrysoperla rufibularis*) and Diptera (*Aphidoletes aphidimyza*) as toxic effects were short-lived due to the low persistence of spinosad.

Effects of various insecticides on per cent mortality of third instar Chrysopa larvae :

The data contained in Table 2 revealed that the mortality of third instar Chrysopa larvae increased significantly with the increase in exposure period from 24 h to 72 h.

After 72 h exposure period, the results revealed that malathion50 EC @ 2 ml/l was still toxic with 43.33 per cent larval mortality and was followed by toxicity of indoxacarb 15.8 EC @ 0.94 ml/l, thiamethoxam 25 WG @ 0.2 g/l, imidacloprid 17.8 SL @ 0.28 ml/l with 30.00, 26.67 and 23.33 per cent, respectively third instar larval mortality after 72 h exposure.

Table 1 : Effect of various insecticides on per cent mortality of first instar larvae of Chrysopa

Tr. No.	Treatments	Dose/l.	1st instar larval mortality (%)		
			24 h	48 h	72 h
T_1	Diafenthiuron 50 WP	1.2 g	13.33 (21.14)	16.67 (23.86)	26.67 (31.00)
T_2	Imidacloprid 17.8 SL	0.28 ml	26.67 (31.00)	36.67 (37.22)	43.33 (41.15)
T_3	Indoxacarb 15.8 EC	0.94 ml	46.67 (43.08)	73.33 (59.00)	80.00 (63.43)
T_4	Spinosad 45 SC	0.3 ml	10.00 (18.43)	13.33 (21.14)	13.33 (21.14)
T_5	Thiamethoxam 25 WG	0.2 g	46.67 (43.08)	63.33 (52.78)	76.67 (61.22)
T_6	Malathion 50 EC	2 ml	50.00 (45.00)	80.00 (63.93)	86.67 (68.86)
T_7	Control	Water	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
	'F' test		Sig.	Sig.	Sig.
	SE (m) ±		2.09	2.56	2.01
	C.D. (P=0.05)		6.36	7.76	6.09

Values in the parenthesis are arcsine transformed

Table 2 : Effect of various insecticides on per cent mortality of third instar Chrysopa larvae

Tr. No.	Treatments	Dose/lit.	3rd instar larval mortality (%)		
			24 h	48 h	72 h
T_1	Diafenthiuron 50 WP	1.2 g	10.00 (18.43)	10.00 (18.43)	16.67 (23.86)
T_2	Imidacloprid 17.8 SL	0.28 ml	16.67 (23.86)	20.00 (26.67)	23.33 (28.78)
T_3	Indoxacarb 15.8 EC	0.94 ml	20.00 (26.57)	26.67 (31.00)	30.00 (33.21)
T_4	Spinosad 45 SC	0.3 ml	3.33 (6.14)	3.33 (6.14)	3.33 (6.14)
T_5	Thiamethoxam 25 WG	0.2 g	20.00 (26.56)	23.33 (28.78)	26.67 (31.00)
T_6	Malathion 50 EC	2 ml	30.00 (33.21)	36.67 (37.22)	43.33 (41.15)
T_7	Control	Water	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
	'F' test		Sig.	Sig.	Sig.
	SE (m) ±		2.54	2.88	2.87
	CD at 5%		7.70	8.73	8.71

Values in the parenthesis are arcsine transformed

Amongst these, the toxicity of indoxacarb 15.8 EC @ 0.94 ml/l was at par with malathion 50 EC @ 2 ml/l. Per cent mortality by diafenthiuron 50 WP @ 1.2 g/l was found to be increased to 16.67 per cent which earlier was 10.00 per cent at 24 h and 48 h. Mortality by spinosad 45 SC @ 0.3ml/l was found least *i.e.* 3.33 per cent and followed to have same trend of toxicity throughout the exposure periods. Thus, data presented in Table 3 showed that as the larvae became larger in size from first to third instar, their tolerance to insecticides also increased.

These findings are in line with those of Mishra *et al*. (2012) who tested malathion 50 EC for larvicidal effect on 3rd instar of *Chrysoperla carnea* and observed that malathion caused 40.6 per centlarval mortality. Reddy and Divakar (1998) and Chaturvedi. (2004) reported that malathion was found harmful to *C. carnea*.

Hussain *et al.* (2012) reported that spinosad was less toxic and proved safer to 3rd instar larvae of *C. carnea* at all post treatment intervals. Reddy and Divakar (1998) found that spinosad caused significantly higher mortality than controls but this effect was less immediate, lasted longer and was less intense than effects with conventional insecticides.

As per the safety norms, diafenthiuron can be declared as a harmless insecticide to *C. carnea*. It was also reported that low and recommended dose of diafenthiuron was harmless to *C. carnea* and higher dose was slightly harmful (Nasreen *et al*., 2005).

Muzammil Sattar (2010) observed that third instar *C. carnea* larvae were more tolerant to insecticides tested (spinosad, imidacloprid, indoxacarb) than the first two instars.

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