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Research Paper

Observations on comparative efficacy of insecticides against *Carcella illota* and *Bacillus thuringiensis*

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Abstract

A recent study was carried out to determine the relative toxicity of nine commonly used insecticides viz. cypermethrin 25%EC, endosulfan 35% EC, carbaryl 5%DP, cyhalothrin 5% EC, phosalone 35%EC, deltamethrin 2.8%EC, monocrotophos 36%SL, thiodicarb 75%WP, and chlorpyriphos 50%EC, to the natural enemies Carcella illota and Bacillus thuringiensis, under the laboratory conditions. Insecticides were tested at field recommended dose according to the standard method for testing side effects of insecticides on natural enemies of insect pests. In the laboratory initial toxicity test phosalone, thiodicarb and endosulfan were found to be harmless to Carcella illota and Bacillus thuringiensis. Cypermethrin and monocrotophos were slightly harmful to Carcella illota but harmless to Bacillus thuringiensis. The results obtained in the present study showed that all the nine insecticides were not equally effective to both the bio-agents. Carbaryl and cyhalothrin were found to be most toxic to both the natural enemies.

Key words: Bio-agent, *Bacillus thuringiensis*, *Carcella illota*, natural enemies, insecticide

Introduction

Insecticides are major agents used to control agricultural pests. In India, insecticides have been widely used for controlling insect pests, with the exception of those in which organic forming is practiced. Intensive and extensive use of insecticide, however, has caused several problems: development of insecticide resistance in pest insects, environmental pollution and side effects on non-target organisms including the natural enemies of the target pests [1]. Naturally occurring pathogens and parasitoids (natural enemies) are important in regulating populations of *Heliothis*. Conservation of beneficial arthropods is a fundamental principle of the integrated pest management (IPM) concept. Conserving natural enemies can provide economic benefit to growers, as natural enemies help to reduce pest populations. Studies on natural enemies of insect pests of chickpea have identified key species and outlined the role played by them in pest population dynamics [2]. However, their full potentiality to provide the control of pests in nature needs to be exploited particularly when integrated with the use of limited need based insecticidal applications.

The use of some insecticidal applications may be unavoidable, considering the increased demand for pulses, cotton, oil seeds, and cereals in the country, but the insecticides to be used should be selected with care so that they do minimal harm to pathogens and parasitoid. Testing of insecticides on natural enemies is important before field application and their selectivity depending upon the abundance or inundative release of natural enemies is imperative for conserving bio-agents and for maintaining a healthy agro-eco system [3]. Most of the insecticides (about 44%) are used against Lepidoptera. Among the larval parasitoids *Carcella illota* is very common. Several arthropod pathogens including *Bacillus thuringiensis* have been observed to feed on eggs and early stage larvae of *Heliothis* [4]. Divakar et al. 1982, 1983 [5, 6] also reported the efficacy of natural enemies in biocontrol of crop pests in India. A major problem with insecticides, even modern selective bio-insecticides, is that they can cause disruptions to the natural enemy complex by removing the food/host resource required by parasitoids and pathogens. Information on the relative toxicity of different insecticides against a range of natural enemies is available from a variety of sources including the long- term International Organization for Biological and Integrated Control- West Palaearctic Regional Section (IOBC-WPRS) working group research programme. The increasing indiscriminate use of insecticides adversely affects such potential natural enemies [7]. Therefore, selectivity of insecticides is important in Integrated Pest Management. To manage the pest effectively research efforts have been made during last two decades under All India Coordinated Pulses Improvement Project (AICPIP). This research was conducted to evaluate the toxicity of the nine insecticides on the predominant species of natural enemies (noted above) in laboratory.

Materials and Methods

This study was carried out during 2011 and 2012, at Research Station, Bilaspur Chhattisgarh, India to evaluate the comparative efficacy of insecticides against natural enemies *Carcella illota* and *Bacillus thuringiensis.* The nine technical grade insecticides were used in laboratory initial toxicity test: cypermethrin 25%EC, endosulfan 35% EC, carbaryl 5%DP, cyhalothrin 5% EC, phosalone 35%EC, deltamethrin 2.8%EC, monocrotophos 36%SL, thiodicarb 75%WP, and chlorpyriphos 50%EC. *H. armigera* insects were collected from all chickpea growing areas of Bilaspur, Chhattisgarh and were used in present study**.** The larval parasitoid *Carcella illota* and the larval pathogen *Bacillus thuringiensis* were regularly reared in the laboratory using the pod borer *Heliothis armigera* as host.

A series of concentrations (in water) for each insecticide was prepared on the active ingredient (a.i.) based on ppm by diluting the commercial formulation. Leaves were dipped in each concentration for 30 s and then left to dry for one hour. The 2nd and 4th instar larvae were confined with treated leaves in glass jars for 48 hours. Test also included a non-treated control in which leaves were dipped in water (as a check). Treated leaves were then removed and fresh untreated leaves were provided for three days. Four replications were tested for each concentration. Experiment was run under controlled laboratory conditions at 28 ± 2ºC and 65 ± 2% R.H (Relative humidity) with a long day photoperiod (LD, 16·h:8·h L:D). Insecticides were tested at field recommended dose according to the standard method for testing side effects of insecticides on natural enemies suggested by [8].While mortality of the parasitoid 48 hrs after treatment was considered for grading the insecticides. The data were subjected to Analysis of variance (ANOVA) and LSD (Least Significant Difference) tests.

Results and Discussion

During 2012, the incidence of bollworm was generally low compared to previous season but the trend in results was strikingly similar to that of previous season. The insecticides exhibited a range of toxicity to the natural enemies screened after 48 hrs of exposure (Table 1 & Table 2). Results presented in Table 1 & Table 2 indicated that endosulfan, thiodicarb and phosalone are least toxic to both the natural enemies. Phosalone, thiodicarb and endosulfan had very little toxicity to both of the species tested, indicating that these products could likely be used with very little impact on natural enemy populations in the field. The present observations on the effect of phosalone and endosulfan are in agreement with those of [9] on *Microplitis croceipes*. [10] Have also reported that thiodicarb and endosulfan not only were better for controlling *Helicoverpa armigera* but also were safer to enemies in cotton field. Phosalone is harmless to natural enemies and is therefore suitable for use in integrated control programs. Endosulfan is frequently considered to be safe to natural enemies. In earlier evaluations endosulfan was found to be safe to *B. hebetor* and *B. brovicornis* [11] but was reported to be toxic to *B. kirkpatricki* [12].

It is apparent from the Table 1 & Table 2 that insecticides viz deltamethrin and chlorpyriphos**,** were found to be slightly harmful to the parasitoid as well as to the pathogen in the present study. Cypermethrin and monocrotophos were slightly harmful to *Carcella illota* but harmless to *Bacillus thuringiensis*. Carbaryl and cyhalothrin were found to be most toxic to both the natural enemies. These results are in agreement with earlier finding of [13] who also reported highly toxicity of Carbaryl to *Chrysoperla carnea*. Previous laboratory and field research studies have shown that major lepidopteran pests are currently being controlled by the application of broad-spectrum insecticides such as monocrotophos or carbaryl four times at weekly intervals during the growing season. However, these broad-spectrum materials are highly toxic to insect natural enemies [14]. The activity of natural enemies is often hampered by the high insecticidal pressure throughout the crop growth and indiscriminate use of insecticides adversely affects such potential natural enemies [15]. Insecticides because of their selectivity are well suited to being key components in an agro-ecosystem, because they lack direct activity on natural enemies [16].

Table 1 A: Relative toxicity of nine insecticides to *Carcella illota* during 2011

S. No.	Insecticides Trade name and Formulation	Concentration Active Ingredient Mortality%	Effect on Larval Parasitoid Evaluation	*Carcella illota* category
1	Cypermethrin	25% EC	61.7	2
2	Endosulfan	35% EC	23.5	1
3	Carbaryl	5% DP	100	4
4	Cyhalothrin	5% EC	100	4
5	Phosalone	35% EC	22.1	1
6	Deltamethrin	2.8% EC	59.9	2
7	Monocrotophos	36% SL	55.2	2
8	Thiodicarb	75% WP	24.1	1
9	Chlorpyriphos	50% EC	61.9	2

*Evaluation category: 1=Harmless (less than 50%) 2= Slightly harmful (50-79%). 3=Moderately harmful (80-99%). 4=Harmful (above 99%).

Table 1 B: Relative toxicity of nine insecticides to *Carcella illota* during 2012

S. No.	Insecticides Trade name and Formulation	Concentration Active Ingredient Mortality%	Effect on Larval Parasitoid Evaluation	*Carcella illota* category
1	Cypermethrin	25% EC	65.7	2
2	Endosulfan	35% EC	29.5	1
3	Carbaryl	5% DP	100	4
4	Cyhalothrin	5% EC	100	4
5	Phosalone	35% EC	21.3	1
6	Deltamethrin	2.8% EC	61.9	2
7	Monocrotophos	36% SL	59.2	2
8	Thiodicarb	75% WP	24.1	1
9	Chlorpyriphos	50% EC	57.9	2

*Evaluation category: 1=Harmless (less than 50%) 2=Slightly harmful (50-79%). 3=Moderately harmful (80-99%). 4=Harmful (above 99%).

Table 2 A: Relative toxicity of nine insecticides to *Bacillus thuringiensi* during 2011

S. No.	Insecticides Trade name and Formulation	Concentration Active Ingredient Mortality%	Effect on Larval Parasitoid Evaluation	*Carcella illota* category
1	Cypermethrin	25% EC	31.7	1
2	Endosulfan	35% EC	27.5	1
3	Carbaryl	5% DP	100	4
4	Cyhalothrin	5% EC	100	4
5	Phosalone	35% EC	32.3	1
6	Deltamethrin	2.8% EC	64.9	2
7	Monocrotophos	36% SL	35.2	1
8	Thiodicarb	75% WP	23.1	1
9	Chlorpyriphos	50% EC	54.9	2

*Evaluation category: 1=Harmless (less than 50%) 2=Slightly harmful (50-79%). 3=Moderately harmful (80-99%). 4=Harmful (above 99%).

Table 2 B: Relative toxicity of nine insecticides to *Bacillus thuringiensi* during 2012

S. No.	Insecticides Trade name and Formulation	Concentration Active Ingredient Mortality%	Effect on Larval Parasitoid Evaluation	*Carcella illota* category
1	Cypermethrin	25% EC	35.7	1
2	Endosulfan	35% EC	22.5	1
3	Carbaryl	5% DP	100	4
4	Cyhalothrin	5% EC	100	4
5	Phosalone	35% EC	27.3	1
6	Deltamethrin	2.8% EC	61.9	2
7	Monocrotophos	36% SL	39.2	1
8	Thiodicarb	75% WP	20.1	1
9	Chlorpyriphos	50% EC	57.9	2

*Evaluation category: 1=Harmless (less than 50%) 2=Slightly harmful (50-79%). 3=Moderately harmful (80-99%). 4=Harmful (above 99%).

The results obtained in the present study showed that all the nine insecticides were not equally effective to both the bio-agents. Reduction in pest population and increase in yield following inundative release of *Clubiona sp.* has been reported [17]. A major problem with insecticides, even modern selective bio-insecticides, is that they can cause disruptions to the natural enemy complex by removing the food/host resource required by parasitoids and pathogens. Scientists have suggested that sub-lethal or slow-killing doses could potentially provide immediate control of crop damage by a pest while stimulating the buildup of its natural enemies. The availability of insecticides that are less toxic to insect natural enemies will permit growers to conserve natural enemies and limit problems with secondary pests. [18] Demonstrated the impact of a presumably selective insecticide, on natural enemy populations, and the role of these natural enemies in suppressing *Heliolhis* sp populations. Others have also shown the detrimental effect of insecticides on natural enemy populations. Some insecticides have disrupted natural enemy complexes and induced are a resurgence of the target pests or non-target minor pests [19]. In contrast, use of selective insecticides that are less toxic to natural enemies than to pests should conserve natural enemy populations, and the surviving natural enemies may suppress the pest populations, which in turn will reduce the rate of insecticide application.

To effectively utilize the natural enemies as biological control agents, we should acquire information about the effects of insecticides on them based on the above observations, it may be concluded that the endosulfan, thiodicarb and phosalone are not harmful to both the bio-agents tested in the present evaluation. Extensive screening of insecticides readily available in India should be under taken with the objective of utilizing only those that have a demonstrably higher degree of safety to natural enemies. Unless this is done and recommendations of insecticidal applications are based on such studies, it would be meaningless to consider augmenting natural enemy populations. We should analyze data to interpret the effects of insecticides on natural enemies. Further, to select appropriate insecticides and establish an optimal method of insecticide use, we need to quantify the role of natural enemies in pest control.

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