

## Relative Toxicity of Some Insecticides Against Two Indigenous Parasites Associated with Lepidopteran Pests

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### Abstract

Laboratory experiment was carried out to determine the relative toxicity of different insecticides against two indigenous parasites viz. *Trichogramma chilonis* Ishii and *Bracon hebetor* Say based on median Lethal concentration (LC<sub>50</sub>). On the basis of LC<sub>50</sub> values, the order of relative safety of those insecticides to *Trichogramma chilonis* Ishii were alphacypermethrin > cypermethrin > methomyl > quinalphos > quinalphos oxon and the corresponding values to *Bracon hebetor* Say were in the order of alphacypermethrin > methomyl > cypermethrin > quinalphos > quinalphos oxon.

**Key words :** LC<sub>50</sub>, *Trichogramma chilonis* Ishii, *Bracon hebetor* Say, Comparative toxicity, Insecticides.

The Hymenoptera is the dominant order among the entomophagous insects, both in terms of the number of species and effectiveness with which they attack the insect-pests in the crop fields. Among several hymenopteran families, Braconidae and Trichogrammatidae are the most important and frequently encountered families with parasitic habit attacking some outstanding pests in many crop ecosystems. Now with the onset of Biointensive pest management programs (BIPM), there is a shift of paradigm for using biocontrol agents alone or to integrating the use of bioagents, such as *Trichogramma* spp. (egg parasitoid), *Bracon* spp. (larval parasitoid) in different crop ecosystems with other control methods without reducing the efficacy of the biocontrol agents. Above all, to get quick action and more profit, growers regularly and even indiscriminately use synthetic pesticides because of their promising attributes. The adverse effects include resistant and resurgence of pests, elevation in the status of minor pests, harmful residues and undesirable effect on natural enemies that are combating the major pests of different crops. Adverse effects of commercial pesticides on the natural enemies of pests have been recorded in numerous instances, since the advent of modern broad spectrum organic insecticides (Ripper, 1956 ; Barlett, 1964).

Number of studies has focused on the effects of pesticides on *Trichogramma* spp. (Malthi et al., 1999 ; Tiwari et al., 2002) and on *Bracon* spp. (Boongeua, 1987 ; Patil et al., 1990). However, it is urgently needed to evaluate the insecticides that are harmful to the insectpests, but equally safe to the natural enemies and human beings. In view of these, a laboratory work was conducted to formulate the relative toxicity of some insecticides towards important indigenous parasites associated with lepidopteran pests viz. *Trichogramma chilonis* Ishii and *Bracon hebetor* Say based on median lethal concentration.

### Methods

The eggs of rice meal moth, *Corcyra cephalonica* Stainton were used as host for laboratory rearing of the egg parasitoid, *Trichogramma chilonis* Ishii whereas *Bracon hebetor* Say was reared on full grown larvae (fifth instar) of *C. cephalonica*. Rearing of each parasite was done in separate Isolated chamber. Wheat flour was used as culture medium or food for rearing of *C. cephalonica*. Both the parasites were collected from the olericultural fields of Bidhan Chandra Krishi Viswavidyalaya, Kalyani (WB). Technical grades of quinalphos, quinalphos

oxon (oxygen analogue of quinalphos), methomyl, cypermethrin and alphacypermethrin were used for the purpose of study in relative toxicity on both the parasites.

#### *Mass Culture of C. cephalonica*

The nucleus culture of the rice meal moth, *Corcyra cephalonica* (laboratory host for *Trichogramma* and *Bracon*) was obtained from the Central Biological Control Station, Burdwan, West Bengal. Several glass jars (25 cm × 18 cm) were used for the mass rearing of the moth. Wheat flour of 500 g were used in each of the rearing jars. Wheat flour was sterilized at 58 C for 10 h for making it free from any contamination. Fresh *Corcyra* eggs measuring 0.1 ml and containing about 1000 eggs were placed in each rearing jar. The mouth of each jar was covered with a fine piece of muslin cloth and was kept undisturbed in rearing room at  $30 \pm 1$  C without any regulation of relative humidity for emergence of *Corcyra* adult. Immediately after emergence, the adults were collected and released for egg laying in a double mouthed black coloured glass cage (15 cm × 12 cm). One mouth of the egg laying cage was covered with a muslin cloth with a window (hole) on the cage to release *Corcyra* moth and the other mouth was covered with a wire net (30 mesh) to allow collection of *Corcyra* egg beneath. The egg laying cages were kept at  $30 \pm 1$  C temperature and  $75 \pm 5\%$  relative humidity (RH) and the eggs were collected at different intervals. Collected eggs were utilized for mass rearing of *Trichogramma* while fully mature larvae (fifth instar) were used for mass rearing of *Bracon*.

#### *Mass Culture of Trichogramma chilonis*

Eggs of *Corcyra* of less than 12 h old were sprinkled on a card (15.5 cm × 8 cm) smeared with a uniform thin layer of 2% aqueous solution of pure gum arabic. The sprinkling of eggs on the egg card was done by means of a fine sieve (30 mesh) which allowed only one egg to pass through at a time in sieve mesh so as to obtain an uniform single layer of *Corcyra* eggs on the egg card. Approximately, 20,000 (1 cc) eggs were glued on each card. One such egg card was offered to the parasite in each rearing unit. The adult parasites were fed on a 1:1 solution of honey

and distilled water drawn on the inner wall of the rearing unit with one fine brush so as to obtain fine streaks. Superparasitism was avoided by providing optimum number of host eggs to the parasitoids. The egg card was removed from the rearing unit after 24 h and a fresh card offered again for parasitisation and the process was continued till 50% of the parasites were dead, which were mostly males. After the blackening of the parasitised eggs, card was divided into small pieces and each piece was kept in separate rearing units for the emergence of adult parasite. The *Corcyra* larvae hatching from eggs that escaped parasitism were removed as they tended to be predacious on parasitized eggs.

#### *Mass Culture of Bracon hebetor*

Ten pairs of newly emerged adults of *B. hebetor* were placed in a glass jar measuring 15 × 12.5 cm and the mouth of the jar was covered with muslin cloth. Aqueous solution of 10% sugar, soaked in cotton, was offered to the adult parasites as food. Thirty full grown larvae of *C. cephalonica* collected from the laboratory culture were placed over the cloth cover and were pressed with a glass plate, to avoid the escape of larvae from cloth cover. After 24 h, the parasitized larvae were removed from the cloth cover with the help of a fine forcep and were placed in a petridish (12.5 cm in diameter), the innerside of which was covered with a filter paper. The petridish was kept at a temperature of  $30 \pm 1$  C and  $75 \pm 5\%$  RH. A new set of larvae was offered to the parasites and the process was continued till 50% of the parasites were dead, which were mostly male. After pupation of the parasite larvae, the unfed body portion of *Corcyra* larvae was removed with the help of a fine forcep and the pupae were kept in a glass jar measuring 12.5 cm × 10 cm for the emergence of adult parasites.

#### *Preparation of Stock Solution of Each Insecticide*

Primary stock solution of 1,000 ppm of each insecticide was prepared separately by diluting 99% analytical grade toxicant with ethyl acetate for quinalphos and quinalphos oxon, with methanol for methomyl and with hexane for cypermethrin and alphacypermethrin. From the primary stock solution, secondary stock solution of each toxicant was pre-

**Table 1.** Relative toxicity of different insecticides/toxicants to the pupae of *Trichogramma chilonis* Ishii.

Pesticide or toxicant	Heterogeneity df	$\chi^2$	Regression equation Y =	LC <sub>50</sub> (ppm)	Fiducial limit (ppm)	Relative toxicity	Order of relative safety
1. Quinalphos	7	20.11	2.48 + 16X (10 <sup>2</sup> )	1.466	1.827 1.175	25.06	4
2. Quinalphos Oxon	7	12.06	3.19 + 0.97X (10 <sup>2</sup> )	0.734 0.457	0.924	50.06	5
3. Methomyl	7	3.98	2.76 + 1.32X (10 <sup>2</sup> )	5.798	6.970 4.750	6.33	3
4. Alpha cypermethrin	7	6.54	0.82 + 2.67X (10 <sup>0</sup> )	36.750	39.890 33.040	1.0	1
5. Cypermethrin	7	12.10	2.37 + 1.29X (10 <sup>1</sup> )	10.832	13.750 9.270	3.39	2

pared by successive dilution. From these stock solutions, concentrations of desired strength were prepared by further dilution with respective solvents.

#### *Treatment of the Pupae of T. chilonis*

The parasitized egg cards were dipped in various concentrations of each insecticide when the parasites were in pupal stage (4 days after parasitization), then the egg cards were removed and dried under fan. The egg cards were then kept separately in glass vials to allow the emergence of the adult parasites from the insecticide treated host eggs. Similar sets were maintained where egg cards were dipped in ethylacetate, methanol and hexane to serve as control for respective treatments. After emergence of adult parasitoids, mortality of the pupae was counted on the basis of parasitised eggs which failed to show adult emergence. Each treatment was replicated thrice and there were 100 parasitized eggs in each replication.

#### *Treatment of the Adults of B. hebetor*

Insecticidal solutions at different known concentrations were applied uniformly on the filter paper strips measuring 12.5 × 5 cm at 1.5 ml/strip and these were dried under fan. The strips were then placed within glass tubes measuring 12.5 × 2.5 cm and ten numbers of newly emerged females of *B. hebetor* were released within the tube. The mouth of each glass tube was covered with cloth and the tubes were kept at 30 ± 1 C and 75 ± 5% RH placing the bottom side upward to ensure constant contact of the parasites with the in-

secticide treated filter paper. Mortality was counted after 24 h and moribund adults were treated as dead. Each treatment was replicated thrice.

#### *Corrected Mortality Calculation*

From mortality percentage, corrected percentage mortality was calculated by applying Abbott's formula (Abbott 1925).

$$\text{Corrected mortality (\%)} = \frac{(\% \text{ kill in treatment} - \% \text{ kill in control})}{(100 - \% \text{ kill in control})}$$

#### *Calculation of Relative Toxicity*

Regression equation of each insecticide for both *T. chilonis* and *B. hebetor* devised by probit analysis (Finney 1971) and curve was drawn in each case. The calculation was based upon the transformed log concentration on X-axis and probit kill on Y-axis. After working out the regression equations, media lethal concentration values (LC<sub>50</sub>) were calculated. Relative toxicity of different toxicants was also calculated on the basis of LC<sub>50</sub> values with respect of unity, being the least effective insecticide to each parasite.

## **Results and Discussion**

### *T. chilonis*

The relative toxicity of different insecticides, viz., quinalphos, quinalphos oxon, methomyl, alphacypermethrin and cypermethrin as contact poisons were determined on the basis of the median

**Table 2.** Relative toxicity of different insecticides to the adults of *Bracon hebetor*.

Pesticide or toxicant	Heterogeneity df	$\chi^2$	Regression equation Y =	LC <sub>50</sub> (ppm)	Fiducial limit (ppm)	Relative toxicity	Order of relative safety
1. Quinalphos	7	0.87	2.64 + 1.53X (10 <sup>2</sup> )	0.034	0.046 0.025	4.76	4
2. Quinalphos Oxon	7	3.44	2.92 + 1.58X (10 <sup>3</sup> )	0.020	0.027 0.015	8.1	5
3. Methomyl	7	4.11	3.51 + 1.55X (10 <sup>2</sup> )	0.091	0.123 0.067	1.78	2
4. Alpha cypermethrin	7	4.44	3.72 + 1.05X (10 <sup>2</sup> )	0.162	0.267 0.098	1.0	1
5. Cypermethrin	7	3.53	4.67 + 0.19X (10 <sup>3</sup> )	0.048	0.511 0.004	3.37	3

lethal concentration (LC<sub>50</sub>) value of each insecticide tested towards *Trichogramma*. The LC<sub>50</sub> values and relative toxicity of the insecticides are presented in Table 1 along with heterogeneity, regression equation and fiducial limits. Table 1 shows that amongst the insecticides tested, quinalphos oxon showed lowest LC<sub>50</sub> value (0.734) and therefore, it was the most toxic insecticide. Alphacypermethrin exhibited highest LC<sub>50</sub> value (36.75) and obviously it was the least toxic. On the basis of LC<sub>50</sub> values quinalphos oxon, quinalphos, methomyl and cypermethrin were found to be about 50.06, 25.06, 6.33 and 3.39 times, as toxic as alphacypermethrin. Evidently quinalphos and its oxygen analogue were extremely toxic to the pupal stage of *Trichogramma* whereas alphacypermethrin was least toxic. Methomyl and cypermethrin were moderately toxic to *T. chitonis*.

From safety/selectivity data towards natural enemies based on the order of relative safety (ORS) of different insecticides were alphacypermethrin > cypermethrin > methomyl > quinalphos > quinalphos oxon (Table 1). The findings of the present investigation on the high toxic nature of quinalphos to *Trichogramma* confirmed the earlier observation of Fijem and Schulton (1981), Santharam and Kumarswami (1985) and Verma and Singh (1987). The relatively low toxicity of methomyl recorded by the present authors was in conformity with the findings of Bull and Coleman (1985). The selectivity exhibited by the two synthetic pyrethroids viz., cypermethrin and alphacypermethrin during the present investigation was in line with the findings recorded by Broglio (1991). Moreover, least toxicity of alphacypermethrin might be attributed to the presence of only cis

isomers as compared to cypermethrin which was an admixture of two isomers i.e. cis and trans at 1: 1 ratio. Oxygen analogue of quinalphos was found to be more toxic than quinalphos might be due to activated nature of the compound.

#### *B. hebetor*

The LC<sub>50</sub> values, relative toxicity and order of relative safety provided by each insecticide to *Bracon* adults along with regression equation (Table 2) revealed that amongst the insecticides tested, quinalphos oxon showed lowest LC<sub>50</sub> value (0.020) and therefore, it was most toxic to the parasitoid. Alphacypermethrin on the other hand, exhibited highest LC<sub>50</sub> value (0.162) being least toxic to the test parasitoid. Considering the LC<sub>50</sub> value of alphacypermethrin as unity, quinalphos oxon, quinalphos, cypermethrin and methomyl were 8.1, 4.76, 3.78 and 1.78 times as toxic as alphacypermethrin respectively. Based on ORS of different insecticides in descending order were found to be alphacypermethrin > methomyl > cypermethrin > quinalphos > quinalphos oxon (Table 2). Valarmathi and Sundararajan (1986) observed methomyl to be the moderately toxic and synthetic pyrethroids to be the less to *Bracon* and these observations lent further support to the findings of the present investigation.

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