MORTALITY RESPONSES IN *BRACON HEBETOR* (SAY) (BRACONIDAE: HYMENOPTERA) AGAINST SOME NEW CHEMISTRY AND CONVENTIONAL INSECTICIDES UNDER LABORATORY CONDITIONS

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Toxicity of some new chemistry and conventional insecticides, at different dose rates recommended for field use against *Spodoptera litura*, and 10% above and below the recommended dose were determined against the adults of a larval parasitoid, *Bracon hebetor* (Say). Amongst the conventional insecticides, profenofos (Curacron 50EC), chlorpyrifos (Lorsban 40EC), methomyl (Lannate 40SP) and thiodicarb (Larvin 80DP) were selected, while from the new chemistry insecticides, lufenuron (Match 5EC), abamectin (Agrimec 1.8EC), emamectin benzoate (Proclaim 1.9EC), spinosad (Tracer 24SC), indoxacarb (Steward 15EC) and methoxyfenozide (Runner 24SC) were used. The higher dose rate of chlorpyrifos gave 100% mortality in the test insect after 24 hours of application, while at lower and recommended dose rates 100% mortality was recorded after 36 hours of application. Similarly, 100% mortality was also recorded in the adults treated with higher doses of profenofos, recommended and higher dose rate of methomyl and the higher dose rate of thiodicarb after 36hours of application. Mean while, insecticide treatments with emamectin benzoate, abamectin, spinosad, indoxacarb and methoxyfenozide, at different doses, were ranked slightly harmful to harmful after 48 hours of their application.
Keywords: *Bracon hebetor* (Say), mortality response, new chemistry insecticides, conventional insecticides

INTRODUCTION

Cotton in Pakistan is heavily sprayed with different insecticides to control its insect pests (Malik *et. al.,* 1999). It is, therefore, necessary to know the extent to which the sprayed insecticides can affect the non-target organisms especially the natural enemies of the pests, before the launch of any biological control program. Hull and Beers (1985), confirmed that with the use of more selective insecticides, that are less toxic to natural enemies, integration of biological and chemical applications may become helpful. *Bracon hebetor* (Say), a potential larval parasitoid of various Lepidopteran larvae (Magro and Parra, 2004), can easily be mass-reared in the laboratory and thus released in the field for efficient control of *Heliothis* spp. as reported elsewhere (Radhika and Chitra, 1998; Heimpel *et al.*, 1997). The contact toxicity of 3 synthetic pyrethroids, to *Bracon hebetor,* was investigated in the laboratory by Guddewar *et al*. (1992). The insecticides, viz., fenvalerate, cypermethrin and decamethrin (deltamethrin), caused 42.22, 58.33 and 73.88% mortality of the *Bracon hebetor*, respectively, after 72 hrs. Endosulfan with 23.88% mortality after 72 hours was relatively less toxic than other pyrethroids, therefore it was considered as control.

The field strains of the Braconid parasitoid, *Bracon hebetor,* collected in corn and peanut storage facilities, in Blackwille, South Carolina and Hawkinsville, Georgia, were 7.6 and 7.3 fold more resistant to malathion, respectively, than was a laboratory strain, with which they were compared. Results of the serial time response-bioassays, with a single pesticide dose, indicated that the adult males of a combined strain of *B. hebetor,* were, significantly, more sensitive to malathion than were the females, perhaps, because of their smaller size (Baker *et al.*, 1995).

Mandal and Somchoudhury (1995), tried carbaryl, phosphamidon, monocrotophos, methyl- parathion [parthion-methyl], quinalphos and endosulfan, against the adults of *Bracon hebetor* (Say.). Parthion-methyl was found to be the most toxic insecticide, followed by quinalophos, while phosphamidon was the least toxic and carbaryl, moncrotphos and endosulfan, showed a moderate toxicity. Parthion-methyl had the greatest repellent action, followed by that of quinalphos, while endosulfan had a moderate repellent action, on the ovipositing females.

The toxicity of six insecticides against the two species of larval parasitoids, *B. hebetor* and *B. kirkpatrichki* were studied by Reddy *et al.* (1997). Results showed that endosulfan and phosalone were harmless, while monocrotophos and quinalaphos were toxic. The synthetic pyrethroid, fluvalinate, was slightly harmful to *B. kirkpatrichki,* but harmless to *B. hebetor*. Environmental friendly insecticides were screened against a laboratory strain of *Bracon hebetor* (Say), for suitability for release in an IPM of cotton by Ahmed and Ahmad (2006). Considering LC_{50}, at 24 h exposure, Lambda cyhalothrin and spinosad were the most (7 ppm) and least toxic (263 ppm), in vial, and 5 ppm and 225 ppm, in leave-dip methods, respectively, to *B. hebetor*.

The literature reviewed has neither shown a clear picture of the selectivity of insecticides to be used along with the *Bracon hebetor* nor the time of release of the parasitoid if used in an IPM program. Therefore, the present project has been carried out to determine the toxicity of commonly used insecticides against the parasitoid for their selection in the IPM program of *Spodoptera litura*.

MATERIALS AND METHODS

The research study was conducted, in the laboratory, at the Department of Agri. Entomology, University of Agriculture, Faisalabad. The experiments were laid down in Completely Randomized Design (CRD).

Stock maintenance

The larval parasitoid, *Bracon hebetor* (Say) was reared on its natural host, *Galleria mellonella* (Khan *et al.,* 2005). Therefore a good number of host insects, i.e., *Galleria mellonella* was maintained, in the Laboratory, in order to rear the parasitoid.

Rearing of *Galleria mellonella* (l.), (host)

The larvae, pupae and adults of the *G. mellonella,* were collected from the infested bee hives. The adults were released in plastic jars (dia, 5 cm and depth 30 cm) for mating and eggs collection. They were provided with 10% honey solution/folded card sheets, for feeding as well as for egg-laying. The larvae of *G. mellonella,* collected from the field as well as those hatched from the eggs laid by the adults on folded sheets were reared on a semi-natural diet comprising: 500 gms of crushed wheat grains, 100 gms of the bee-wax, 100 gms of the yeast, 100 ml of the plain/commercial glycerin. These jars, were incubated in the growth chamber, at optimum condition of 31 ± 1 °C, 75 ± 5 % R.H and 24 hours of D. The larvae, thus, reared were used in different experiments as well as for the mass-rearing of *B. hebetor*.

Rearing of *Bracon hebetor* (say.) (larval parasitoid)

The adults of the parasitoid were taken from the biological control laboratories of the Dept. of Entomology, University of Agriculture, Faisalabad. These were reared on a large scale, by using the larvae of the greater wax moth, *G. mellonella* (L.) as host, at 29 ± 1 °C, 65 ± 5% R.H and 16:8 L.D. On an average, 2 to 3 larvae of the 3rd or 4th instars of *G. mellonella,* were placed in the glass vial, with a fertilized female of the parasitoid, *B. hebetor* (Say.). The female was provided with a cotton swab, soaked in 20 % honey solution, for feeding the parasitoid. After 24 hours, the females were shifted to the other vials, with new larvae (2-3) of the host, *G. mellonella* and honey-soaked cotton swab. This process was continued upto the end of the life of the female parasitoid. The parasitized larvae of the host, *G. mellonella,* were incubated, under the optimum conditions of 29 ± 1 °C temperature and 65 ± 10 % of the relative humidity.

Insecticides

The insecticides viz., profenofos (Curacron 50EC), chlorpyrifos (Lorsban 40EC), methomyl (Lannate 40SP) and thiodicarb (Larvin 80DP) were selected, while from the new chemistry insecticides, lufenuron (Match 5EC), abamectin (Agrimec 1.8EC), emamectin benzoate (Proclaim 1.9EC), spinosad (Tracer 24SC), indoxacarb (Steward 15EC) and methoxyfenozide (Runner 24SC) were obtained in the form of their commercial formulations from the respective manufacturers. Three doses, each of the selected insecticides, i.e., the recommended dose against *S. litura* and 10% below and above the recommended dose rate, were prepared in an Analar grade Acetone. A control treatment of Acetone/ Distilled water applications was also included, for each test, to assess the natural mortality in the test insects.

Bioassay

The treatments were applied as inner lining to glass vials. A sample containing 2 ml of each treatment was put in the vials with the help of dropper. The vials were rolled with hands, and then air dried because acetone evaporates rapidly in air. When the insecticide deposits became dry, these vials were used, as a testing arena. Thirty test insects of *Bracon hebetor* (Say) that included ‘adults’ of uniform age, were put in the treated vials and the data were recorded after 12, 24, 36 and 48 hours on mortality levels. The insecticides were categorized as; Harmless (<50 % mortality); Slightly harmful (50-79 % mortality); Moderately harmful (80-89 % mortality) and as Harmful (>90 % mortality).

RESULTS AND DISCUSSION

The data on percentage mortality of newly emerged adults of *Bracon hebetor* were noted after 12, 24, 36 and 48 hours of treatment application with different insecticides at different dose rates. The data have been analyzed statistically, and presented in Table-1.

Table 1. Percentage mortality in *Bracon hebetor* after different time intervals of the insecticide applications, under laboratory conditions

Treat.	Insecticides	Dose/acre (gm or ml)	Mean Mortality (%) After 12 hrs of treatment application	Mean Mortality (%) After 24 hrs of treatment application	Mean Mortality (%) After 36 hrs of treatment application	Mean Mortality (%) After 48 hrs of treatment application
T1	Profenofos (Curacron 50EC)	450	59.167±2.097 ij	67.500±0.833 hi	85.833±0.833 efg	94.167±0.833 c
T2	Profenofos (Curacron 50EC)	500	66.667±1.361 gh	74.167±0.833 fg	92.500±0.833 bcd	100.000±0.000 a
T3	Profenofos (Curacron 50EC)	550	70.833±1.596 efg	81.667±0.962 cde	100.000±0.000 a	100.000±0.000 a
T4	Chlorpyrifos (Lorsban 40EC)	900	77.500±1.596 de	84.167±0.833 cd	100.000±0.000 a	100.000±0.000 a
T5	Chlorpyrifos (Lorsban 40EC)	1000	85.833±0.833 bc	94.167±0.833 ab	100.000±0.000 a	100.000±0.000 a
T6	Chlorpyrifos (Lorsban 40EC)	1100	94.167±0.833 a	100.000±0.000 a	100.000±0.000 a	100.000±0.000 a
T7	Methomyl (Lennate 40SP)	360	69.167±1.596 fg	84.167±0.833 cd	93.333±1.361 bc	99.167±0.833 ab
T8	Methomyl (Lennate 40SP)	400	81.667±0.962 cd	93.333±1.361 b	100.000±0.000 a	100.000±0.000 a
T9	Methomyl (Lennate 40SP)	440	91.667±0.962 ab	96.667±1.361 ab	100.000±0.000 a	100.000±0.000 a
T10	Thiodicarb (Larvin 80DP)	360	65.000±0.962 ghi	78.333±0.962 def	90.000±1.361cde	98.333±0.962 abc
T11	Thiodicarb (Larvin 80DP)	400	75.000±0.962 def	85.833±0.833 c	95.833±0.833 ab	100.000±0.000 a
T12	Thiodicarb (Larvin 80DP)	440	81.667±0.962 cd	93.333±1.361 b	100.000±0.000 a	100.000±0.000 a
T13	Lufenuron (Match 5EC)	45	50.833±1.596 klm	62.500±1.596 ijk	72.500±0.833 kl	86.667±1.361 de
T14	Lufenuron (Match 5EC)	50	60.833±0.833 hij	64.167±1.596 ij	82.500±0.833 fgh	94.167±0.833 c
T15	Lufenuron (Match 5EC)	55	69.167±1.596 fg	77.500±1.596 ef	90.833±0.833 bcde	100.000±0.000 a
T16	Abamectin (Agrimec 1.8EC)	180	50.000±1.925 klm	62.500±0.833 ijk	79.167±0.833 hij	88.333±0.962 d
T17	Abamectin (Agrimec 1.8EC)	200	59.167±0.833ij	70.833±1.596 gh	85.833±0.833 efg	95.000±0.962 bc
T18	Abamectin (Agrimec 1.8EC)	220	66.667±1.361 gh	79.167±0.833 def	92.500±0.833 bcd	99.167±0.833 ab
T19	Emamectin benzoate (Proclaim 1.9EC)	90	37.500±1.596 p	43.333±1.925 n	61.667±1.667 no	72.500±0.833 hi
T20	Emamectin benzoate (Proclaim 1.9EC)	100	41.667±1.667 op	55.000±1.667 lm	74.167±0.833 jkl	84.167±0.833 def
T21	Emamectin benzoate (Proclaim 1.9EC)	110	50.000±1.361 klm	60.833±0.833 jkl	80.833±0.833 ghi	94.167±0.833 c
T22	Spinosad (Tracer 24SC)	36	39.167±0.833 p	47.500±0.833 n	60.000±1.361 o	72.500±0.833 hi
T23	Spinosad (Tracer 24SC)	40	49.167±1.596 lmn	56.667±1.361 klm	65.833±0.833 mn	80.833±0.833 fg
T24	Spinosad (Tracer 24SC)	44	55.833±1.596 jkl	65.000±0.962 hij	74.167±0.833 jkl	85.000±0.962 def
T25	Indoxacarb (Steward 15SC)	90	36.667±1.925 p	46.667±1.361 n	60.000±1.361 no	69.167±0.833 i
T26	Indoxacarb (Steward 15SC)	100	42.500±0.833 nop	54.167±0.833 m	69.167±1.596 lm	76.667±1.361 gh
T27	Indoxacarb (Steward 15SC)	110	47.500±0.833 mno	59.167±0.833 jklm	75.833±1.596 ijk	82.500±1.596 ef
T28	Methoxyfenozide (Runner 24SC)	90	47.500±0.833 mno	55.833±1.596 lm	65.833±2.097 mn	76.667±1.361 gh
T29	Methoxyfenozide (Runner 24SC)	100	56.667±1.925 jkl	64.167±0.833 ij	77.500±1.596 hijk	85.833±0.833 de
T30	Methoxyfenozide (Runner 24SC)	110	70.000±1.361 fg	80.000±1.361 cdef	87.500±0.833 def	98.333±1.667 abc
T31	Control		0.000±0.000 q	0.000±0.000 o	0.000±0.000 p	0.000±0.000 j

Means sharing similar letters, do not differ significantly, at 0.05 probability level according to text.

All the treatments with different dose rates of insecticides gave significant mortality of adult parasitoids after different time intervals as compared to untreated check. The conventional insecticides, proved to be highly toxic in the present studies than the new chemistry insecticides. It is observed, from the data, that the higher doses (10% above the recommended dose rate) of chlorpyrifos and methomyl, ranked as highly toxic or harmful, with mortality more than 90% in these treatments; where as the same insecticides, at their recommended doses, and thiodicarb at a higher dose proved to be moderately harmful with mortality between 80-90%, after 12 hours of treatment. The higher dose rate of chlorpyrifos gave 100% mortality in the test insect after 24 hours of application, where as its lower and recommended dose rates killed 100% population after 36 hours of application. These results are in confirmation with those of Baker *et al.* (1995), who compared the field strains of *Bracon hebetor* and reported that the laboratory strains were more susceptible to the insecticides, belonging to organophosphate group. The complete mortality (100%) was observed in the adults treated with higher dose rate of profenofos, recommended and higher dose rate of methomyl and the higher dose rate of thiodicarb after 36hours of application. All the conventional insecticides proved to be highly toxic for the test insects after 48 hours of their application. These results are also in confirmation with those obtained by Reddy *et al,* (1997), who reported that monocrotophos and quinalphos were toxic to *Bracon hebetor*. Mandal and Somchoudhury (1995), also evaluated some conventional insecticides against *Bracon hebetor*, and reported that organophosphates were toxic for the parasitoid.

Amongst new chemistry insecticides, complete mortality (100%), was observed in the adults treated with the high dose rate of lufenuron i.e., 55ml/Acre, after 48 hours of application. The higher dose-rates (10% above the recommended) of methoxyfenozide (110 ml/acre), leufenuron (55 ml/acre) and abamectin (220 ml/acre), proved to be slightly harmful, as the percentage mortality, in the adults, of *B. hebetor* treated with these dose rates ranged between 50-79%, after 12 hours of interval. The insecticides, like, abamectin (200 ml/acre) and methoxyfenozide (100 ml/acre) were also slightly harmful, at their recommended dose rates.

Insecticides, like, emamectin benzoate, indoxacarb and spinosad were harmless, after 12 hours of their application, at all the three dose rates. The higher dose rates (10% above the recommended dose rate) of abamectin, leufenuron and spinosad proved to be slightly harmful as the percentage mortality in the adults of *B. hebetor,* treated with these dose rates ranged between 50-79%, after 24 hours of interval. Insecticides, like, emamectin benzoate, indoxacarb and spinosad were harmless, after 24 hours of their application, at lower dose rates (10% below the recommended dose rate). However, minimum mortality (43.333 ± 1.925) was found in emamectin benzoate @ 90 ml/acre, followed by indoxacarb (46.667 ± 1.361) @ 90 ml/acre and that in spinosad (47.500 ± 0.833) @ 110 ml/acre. The insecticide treatments of emamectin benzoate, abamectin, spinosad, indoxacarb and methoxyfenozide, at different doses, were ranked slightly harmful to harmful after 48 hours of their application. Same kind of experiment was done by Ahmed and Ahmad (2006). They examined insecticides, that included some environmentally safe insecticide, like, lambda-cyhalothrin and spinosad for their toxicity against *B. hebetor*. According to them, spinosad was least toxic to the adults of *Bracon hebetor* and these results are in coordination with our results, stating least mortality with spinosad. However, Kovalankov (2002) reported that spinosad exhibited marginal to excellent selectivity but was highly toxic to *Bracon mellitor*. Finally, minimum toxicity (0.000 ± 0.000) to *Bracon hebetor* was, however, found in the untreated control.

REFERENCES

Ahmed, S. and M. Ahmad. 2006. Toxicity of some insecticides on *Bracon hebetor* under laboratory conditions. Phytoparasitica 34: 401-404.

Baker, J.E., D.K. Weaver, J.E. Throne and J.L. Zettler. 1995. Resistance to protectantinsecticides in two field strains of the stored-products insect parasitoid, *Bracon hebetor* (Hymenoptera: Braconidae). J. Econ. Entomol., 88: 512-519.

Guddewar, M.B., A. Shukla and M.L. Saini. 1992. Relative toxicity of synthetic pyrethroids to adults of *Bracon hebetor* Say (Braconidae: Hymenoptera). Pl. Protect. Bull. Faridabad 44: 16-17.

Hull, L.A. and E.H. Beers. 1985. Ecological Sensitivity modifying chemical control practices to preserve natural enemies. In: Biological pest Control in Agricultural Ecosystem. Acad. Press, Orlando, Fla., pp. 103-121.

Heimpel, G. E., M. F. Antolin, R. A. Franqui, and M. R. Strand, 1997. Reproductive isolation and genetic variation between two "strains" of *Bracon hebetor* (Hymenoptera: Braconidae). Bio. Contr., 9: 149-156.

Khan, R.R., M. Ashfaq and S.A. Rana. 2005. Some studies on the toxicity of conventional and new chemistry insecticides against *Bracon hebetor* (Say) (Hymenoptera: Braconidae) under laboratory conditions. Pak. Entomol. 27: 19-21.

Kovalankov, V.G. 2002. A biomethod for condition of arthropods resistances to insecticides. *Zahista-i-Karantin-Res-Tenni*. 5: 18-19.

Magro, R.S and J.R.P. Parra. 2004. Comparison of artificial diets for rearing *Bracon hebetor* Say (Hymenoptera: Braconidae). Bio. Cont. 29: 341–347.

Malik, A.K., S. Mansoor, N.A. Saeed, S. Asad, Y. Zafar, J. Stanley and P. Markham. 1999. Development of CLCV resistance cotton varieties through genetic engineering. Mongr. Directorate Agric. Inform. Pb., Pakistan. p.3.

Mandal, S.K.and A. K. Somchoudhury, 1995. Bioefficacy of commercial formulation of insecticides against *Bracon hebetor* (Say). Ind. J. Entomol. 57: 50-54.

Radhika, P. and K.C. Chitra. 1998. Correlation between life expectancy and adult emergence in *Bracon hebetor* (Say) as influenced by host level nutrition. Indian J. Plant Prot. 26(1): 68-71.

Reddy, G.R.S., Sreelatha and B.J. Divakar. 1997. Toxicity of six insecticides to two species of *Bracon*. Ind. J. Plant Prot. 25: 135-136.