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Research Note

Effect of insecticides on some biological parameters of *Trichogramma chilonis* Ishii (Hymenoptera: Trichogrammatidae)

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ABSTRACT: Bioassay studies carried out to determine the toxicity of seven insecticides (*viz.* endosulfan 0.07%, imidacloprid 0.004%, spinosad 0.01%, triazophos 0.08%, thiodicarb 0.075%, novaluron 0.01% and azadirachtin @1ml/L) to *Trichogramma chilonis* has shown that spinosad was the most toxic in all the studies followed by triazophos. Spinosad resulted in only 17.80 per cent parasitization and 3.97 per cent adult emergence from the host eggs, *Corcyra cephalonica* Stainton treated before parasitization. Novaluron was found to be the safest resulting in 58.93 per cent parasitization and 89.72 per cent adult emergence from the host eggs treated before parasitization. The parasitization in other insecticides ranged from 20.00 to 40.47 per cent. Spinosad was also found highly toxic to all the immature stages of *T. chilonis* resulting in only 0.46, 0.66 and 0.65 per cent adult emergence when the parasitoid was treated in the egg, larval and pupal stages, respectively. Novaluron was found to be safe to all the immature stages of the parasitoid resulting in 86.75, 87.84 and 87.46 per cent adult emergence when treated in egg, larval and pupal stages, respectively. The parasitoid adult emergence in other insecticides ranged from 57.95 to 88.63 per cent when treated in egg stage, 53.97 to 87.12 per cent when treated in larval stage and 61.46 to 87.15 per cent when treated in pupal stage.

KEY WORDS: Parasitisation, adult emergence, insecticides, *Trichogramma chilonis*

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Inspite of the success of the biological control, chemical control is still being considered as an important component of Integrated Pest Management and is used in conjunction with the biological control. But, pesticides when used along with natural enemies may limit the efficacy of these biocontrol agents and have deleterious effects on parasitoids such as *Trichogramma* species. Although, all pesticides may not have a specific site of action on the beneficial organisms, they can induce sub lethal effects on reproduction and other biological functions (Junior *et al.*, 2008b). Results of augmentative releases of parasitoids have been variable and at least some of the variability has been attributed to the use of broad spectrum insecticides (Stinner *et al.,* 1974).

Integration of biological and chemical control tactics require a thorough understanding on f how pesticides affect biocontrol agents. In recent years, emphasis has been laid on the use of selective pesticides which have little or no effect on the natural enemies but effective against the target pests. Laboratory evaluation of the reduction in the beneficial capacity of the biocontrol agents due to pesticides can serve as a relevant parameter for evaluation of their safety. Therefore, necessary studies on the associated use of pesticides with parasitoids and predators are important and help in the decision making of IPM.

Several new insecticides are being developed and recommended against several pests (Anonymous, 2008; 2009). Therefore, the present studies were carried to determine the effect of some insecticides ondevelopment and survival of *T. chilonis*.

MATERIALS AND METHODS

Parasitoid material

The culture of *Trichogramma chilonis* Ishii was maintained on eggs of *Corcyra cephalonica* Stainton (Lepidoptera: Pyralidae) glued on egg cards in the laboratory. The present studies were conducted in the laboratory at an average temperature of 25±2°C and relative humidity of 55±5%.

Effect of different insecticides on host parasitization, adult emergence, female longevity and sex-ratio of *T. chilonis*

Freshly laid (0-24h old) 100 sterilized eggs of *C. cephalonica* were glued on paper cards with the help of *Acacia* gum. Fifteen egg cards thus prepared were dipped for five seconds in each of the freshly prepared insecticide solutions kept in different glass jars. The egg cards dipped in water were used as control. These treated egg cards were shade dried for 10 to 15 minutes. Thereafter, all these egg cards were placed in glass vials (7.5 X 1.0 cm) separately. Newly emerged and mated females (24h old) were isolated from culture tubes under microscope on the basis of antennal characteristics. One female was gently transferred into each of the glass vials containing treated egg cards using wet camel hair brush. After 24h, the females were removed from these tubes. Number of parasitized eggs in each replication was counted after five days as the eggs turn black and thus the per cent parasitization was calculated. When the emergence of adult parasitoids from the parasitized eggs is completed, the black eggs with exit holes were counted in all the treatments. Per cent adult emergence in each replication was thus recorded.

For observing longevity of the adult parasitoids, the emerged adults from all the 15 replications in each treatment were placed in separate test tubes where a streak of honey is provided as food on paper strips. Observations on the surviving adults were taken at an interval of 24h in each test tube till their death. The per cent females in the progeny in each treatment were noted by counting the number of male and female adults after their death in each treatment.

Susceptibility of immature stages of *T. chilonis* to various insecticides

Freshly laid sterilized eggs of *C. cephalonica* were glued uniformly on paper strips with *Acacia* gum. These egg cards were exposed to adults of *T. chilonis* for 24h in the ratio of 1:6 of parasitized and unparasitized eggs to obtain adequate parasitization. Pieces of egg cards containing about 100 eggs (assuming a minimum of 50-60 eggs as parasitized) were prepared and dipped in each freshly prepared insecticide solution for five seconds using a pair of forceps after 1, 3, and 7 days of parasitization i.e. presuming egg, larval and pupal stages of the parasitoid within the host eggs, respectively. The treated egg cards were allowed to dry in shade for 10-15 minutes and later each was transferred into a separate glass vial (7.5 x 1.0 cm). Each treatment was replicated 10 times. The number of eggs turning black was recorded in all the treatments In each treatment, emergence of adult parasitoids was recorded by counting the black eggs with exit holes and per cent adult emergence was calculated. Parasitized eggs dipped in tap water were used as control.

Statistical Analysis

The data generated in all the experiments were analysed in completely randomized design (CRD). The observations in percentages were angularly transformed and then analysed using the statistical software, OPSTAT developed by CCS Haryana Agricultural University, Hisar.

RESULTS AND DISCUSSION

Effect of different insecticides on host parasitization, adult emergence, female longevity and sex-ratio of *T. chilonis*

Per cent parasitization

The data on effect of different insecticide treated eggs of *C. cephalonica* on parasitization by *T. chilonis* shows that among all the treatments highest per cent parasitization was observed in control (58.87%) while all the insecticides except novaluron (at par with control) recorded significantly less parasitism over control (Table 1). Among the insecticides, highest parasitization was observed in novaluron (58.93%) while it was lowest in spinosad (17.80%) followed by triazophos (20.00%), azadirachtin (33.80%), endosulfan (34.20%), imidacloprid (35.53%) and thiodicarb (40.47%). From the above results, spinosad and triazophos seems to be the most toxic insecticides to the adult parasitoid inhibiting the parasitisation efficiency whereas novaluron, the safest with no effect on the parasitisation efficiency.

Bastos *et al.* (2006) and Goulart *et al.* (2008) also reported that endosulfan significantly reduced the parasitisation efficiency. Singh and Sharma (2008) reported triazophos to be more toxic than endosulfan which was similar to our findings. Several workers have reported that novaluron was safe to the parasitoid and did not affect the ability of parasitoid to parasitize the treated eggs (Bastos *et al*., 2006; Junior *et al*., 2008a). Spinosad was found to be very toxic inhibiting the parasitisation efficiency (Mason *et al*., 2002; Giolo *et al*., 2007; Junior *et al*, 2008a) which is similar to our findings. Ramesh and Manickvasagam (2006) reported Nimbecidine to cause significantly lower parasitism than control which is in tune with current results.

Table 1. Effect of different insecticides on host parasitization, adult emergence, female longevity and sex-ratio of *Trichogramma chilonis*

Treatment	Parasitization (%)	Adult emergence (%)	Female adult longevity (Days)	Females in the progeny (%)
Endosulfan (0.07%)	34.20 (35.51)[b]	77.44 (61.75)[c]	14.03[d]	75.93 (60.75)[bc]
Imidacloprid (0.004%)	35.53 (36.51)[bc]	81.05 (64.33)[c]	14.24[d]	76.46 (61.06)[bc]
Spinosad (0.01%)	17.80 (23.70)[a]	3.97 (7.76)[a]	0.1[a]	0.10 (1.81)[a]
Thiodicarb (0.075%)	40.47 (39.43)[c]	79.70 (63.28)[c]	11.03[c]	98.82 (85.44)[d]
Triazophos (0.08%)	20.00 (26.41)[a]	40.67 (39.57)[b]	6.56[b]	77.42 (63.83)[c]
Novaluron (0.01%)	58.93 (50.15)[d]	89.72 (71.40)[d]	18.56[f]	75.73 (60.59)[bc]
Azadirachtin(1 ml/l)	33.80 (35.49)[b]	78.95 (62.78)[c]	17.77[e]	73.99 (59.42)[b]
Control(water only)	58.87 (50.10)[d]	93.64 (75.65)[e]	19.75[g]	74.09 (59.47)[b]
SE (m)	(1.23)	(1.12)	0.18	(1.44)
CD ($P = 0.05$)	(3.44)	(3.14)	0.52	(4.03)

Figures in parentheses are angular transformed values

Adult emergence

Among the treatments highest per cent adult emergence from the parasitized eggs treated before parasitization was observed in control (93.64%) while all the insecticides recorded significantly less emergence over control (Table 1). Among the insecticides, highest adult emergence was observed in novaluron (89.72%) while it was lowest in spinosad (3.97%) followed by triazophos (40.67%), endosulfan (77.44%), azadirachtin (78.95%), thiodicarb (79.70%) and imidacloprid (81.05%). From these results it can be concluded that spinosad and triazophos greatly affected the adult emergence and are thus toxic to the parasitoid while all other insecticides seemed to be relatively safe showing no drastic effect on adult emergence.

The present findings are in accordance with those of Ramesh and Manickavasagam (2006) who have also reported that nimbecidine though significantly affected the egg parasitization did not show negative effect on the adult emergence of *T. chilonis*. Singh and Sharma (2008) reported endosulfan and imidacloprid to be comparatively safe having less effect on the adult emergence. Spinosad caused higher parasitoid mortality in the parasitized eggs (Mason *et al.*, 2002) which is in tune with the present findings.

Female longevity

Among all the treatments highest female longevity was observed in control i.e. 19.75 days (Table 1). Among the insecticides, highest female longevity was observed in novaluron (18.56 days) while it was lowest in triazophos (6.56 days) followed by thiodicarb (11.03 days), endosulfan (14.03 days), imidacloprid (14.24 days) and azadirachtin (17.77 days). There was no emergence of *T. chilonis* adults from spinosad treated eggs. Similar findings were also reported by Ramesh and Manickavasagam (2006).

Proportion of females in the progeny

Significantly high proportion of females in the progeny of *T. chilonis* was recorded in eggs treated with thiodicarb (98.82%) and triazophos (77.42%) as compared to control (74.09%) (Table 1). The proportion of females in the progeny of imidacloprid (76.46%), endosulfan (75.93%), novaluron (75.73%) and azadirachtin (73.99%) were found to be on par with control.

The present findings are in line with those of Ramesh and Manickavasagam (2006) who reported that irrespective of the treatments *viz*. Nimbecidine and endosulfan, the per cent females are on par with control.

Susceptibility of immature stages of *T. chilonis* to various insecticides

The adult emergence was found to significantly vary between different treatments in all the immature stages tested (Table 2). The insecticides showed different degrees of toxicity to the egg, larval and pupal stages of the parasitoid. Among the insecticides tested only novaluron was found to be completely safe as it had not affected the adult emergence from any of the immature stage treated.

Table 2. Susceptibility of immature stages of *Trichogramma chilonis* to various insecticides

Treatment	Adult emergence (%)		
	Egg stage	Larval stage	Pupal Stage
Endosulfan (0.07%)	63.02 (52.55)[b]	56.20 (48.56)[c]	65.00 (53.74)[bc]
Imidacloprid (0.004%)	85.73 (68.78)[d]	84.33 (66.72)[d]	82.84 (65.67)[d]
Spinosad (0.01%)	0.46 (1.73)[a]	0.66 (2.53)[a]	0.65 (2.50)[a]
Thiodicarb (0.075%)	88.63 (70.50)[d]	87.12 (69.20)[de]	87.15 (69.20)[de]
Triazophos (0.08%)	57.95 (49.59)[b]	53.97 (47.28)[c]	61.46 (51.85)[b]
Novaluron (0.01%)	86.75 (68.90)[d]	87.84 (69.82)[e]	87.46 (69.64)[e]
Azadirachtin (1 ml/l)	79.74 (64.16)[c]	9.47 (17.79)[b]	69.45 (56.48)[c]
Control (water only)	94.18 (76.43)[e]	95.13 (77.79)[f]	92.08 (74.02)[f]
SE (m)	(1.63)	(1.09)	(1.38)
CD ($P = 0.05$)	(4.60)	(3.09)	(3.89)

Figures in parentheses are angular transformed values

It resulted in an emergence of 86.75, 87.84 and 87.46 per cent from the egg, larval and pupal stages, respectively; while in control the emergence was 94.18, 95.13 and 92.08 per cent from egg, larval and pupal stages, respectively.

Spinosad was found to be the most toxic resulting in practically no emergence from any of the parasitoid stage treated, and hence should not be recommended to be used in conjunction with inundative releases of *T. chilonis*.

Endosulfan showed some toxicity to both egg and larval stages but was found relatively safe to the pupal stage of the parasitoid resulting in adult emergence of 63.02, 56.20 and 65.00 per cent from egg, larval and pupal stages, respectively. More or less similar results were observed in case of triazophos which resulted in 57.95, 53.97 and 61.46 per cent adult emergence from egg, larval and pupal stages of the parasitoid, respectively.

Both imidacloprid and thiodicarb were found to be safe to all the stages of the parasitoid resulting in the emergence of 85.73, 84.33 and 82.84 per cent and 88.63, 87.12 and 87.15 per cent, respectively, from egg, larval and pupal stages. Azadirachtin was found to be relatively safe to egg and pupal stages of the parasitoid with adult emergence of 79.74 and 69.45 per cent but toxic to the larval stage with only 9.47 per cent adult emergence.

Spinosad was reported to be toxic to all the immature stages by many workers (Consoli *et al*., 2001; Nevarez *et al*., 2009; Ksentini *et al*., 2010). Basappa (2007) reported imidacloprid to be relatively safe to all the developmental stage of the parasitoid. Bastos *et al*. (2006) reported endosulfan to significantly decrease adult emergence which is in tune to the present findings. Srinivasan *et al.* (2001) reported nimbecidine to be safe to all the developmental stages of the parasitoid whereas the present findings show nimbecidine to be toxic to the larval stage which is supported by Jalali and Singh (2003) and Saber *et al*. (2004).

Thus it can be concluded that when the parasitoid, *T. chilonis* was exposed to treated eggs for parasitisation, all the insecticides except novaluron caused significantly less parasitism. Spinosad and triazophos were the most toxic among the tested insecticides as these significantly reduced the parasitism, adult emergence and female longevity and hence should not be recommended to be used in conjunction with the inundative releases of parasitoids in IPM programmes. Novaluron is found to be the safest insecticide as it had not affected any of the biological parameter tested and hence can be safely integrated in the IPM programmes.

Imidacloprid, thiodicarb and novaluron are safe to all the immature stages of *T. chilonis*. Endosulfan and triazophos were found to be moderately toxic to all the immature stages of the parasitoid with larval stage being the most susceptible. Azadirachtin though found to be safe to the egg and pupal stages was found to be highly toxic to the larval stage. In general it was found that larval stage was the most susceptible to insecticides, this might be because the larval stage is the feeding stage of the parasitoid and has every possibility to accumulate much quantity of insecticide than the egg and pupal stages. The pupal stage was found to be relatively safe irrespective of the treatment, this might be because it is the non feeding stage and the adults emerged on the very next day of treatment thus the exposure time to the insecticide was very less.

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