Pesticide tolerance in the five field strains of *Trichogrammachilonis* from northern districts of Tamil Nadu, India

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ABSTRACT

The egg parasitoid, *Trichogrammachilonis* is a potential egg parasitoid in the sugarcane, reducing early shoot borer and internode borer. The laboratory strains of *T. chilonis* was significantly inferior to the ecotypes collected from fields in their tolerance to insecticide due to continuous exposure to insecticides in the field. Hence, a study was undertaken to evaluate the laboratory reared strain of *T. chilonis* with that of other ecotypes to identify a pesticide tolerant ecotype for use in pest management by augmentative release. Five ecotypes of *T. chilonis*were collected from farmer's fields on sugarcane and citrus using sentinel egg technique by exposing egg cards of *Corcyra cephalonica*, mass reared on *C. cephalonica* for three successive generations and tested for their relative tolorenceto insecticides in comparison with the laboratory strain. Significantly higher level of parasitisation (50.59, 45.32 and 60.45 %) by Arugunam ecotype was observed on eggs sprayed with Imidacloprid 70 WS, Thiomethoxam 75 SG and Flubendamide 20% WG respectively before exposing to the parasitoid. The Amirthapuram ecotype was found next in order of tolerance to the insecticides Imidacloprid 70 WS, Thiomethoxam 75 SG and Flubendamide 20% WG (42.00, 39.46 and 56.46 respectively). The adult emergence was not found to be affected much by the insecticides sprayed before parasitisation. Varying degrees of insecticide toxicity against different ecotypes of *T. chilonis* inside host eggs was observed and Arugunam ecotype showed more tolerance to the insecticides tested with,71.28, 53.46 and 81.67 per cent adult emergence respectively from parasitised eggs sprayed with Imidacloprid 70 WS, Thiomethoxam 75 SG and Flubendamide 20% WG. Among the insecticide tested Flubendiamide was least toxic to the adult parasitoid and the parasitoid developing with in the host egg and Thiomethoxim was found to be more toxic with nearly 50 per cent reduction in the adult emergence.

Keywords: Egg parasitoid, Trichogrammachilonis, ecotype, insecticide toxicity

1. INTRODUCTION

In spite of being a powerful tactic in pest management with quick and economic suppression of pest population, insecticides are not always economically viable due to their negative effect on non-target organisms, especially on parasitoids and other beneficial insects that help in reducing the population buildup of pests. The parasitoids are highly susceptible to broad-spectrum insecticides and can quickly reduce the infestation of the target pest before reaching the economic threshold (1,2).

Utilization of *Trichogrammachilonis* in sugarcane produced most effective results in the management of borer complex. *T. chilonis*, a potential egg parasitoid, reduces stalk borer incidence by 55–60 per cent (3). Narasimha Rao et al. (4) reported that release of *T. chilonis* @ 50,000 ha-1 from 90 days after planting, results in less incidence of early shoot borer in sugarcane (0.16%) compared to the untreated plots (3.33%).

Studies showed that the laboratory strains of *T. chilonis* was significantly inferior to the ecotypes collected from fields. The ecotype collected from cotton field in Palladam recorded maximum extent of parasitism and emergence (5). Hence, the present study was undertaken to evaluate the laboratory reared strain of *T. chilonis* with that of other ecotypes to identify a pesticide tolerant ecotype for use in pest management by augmentative release.

2. MATERIAL AND METHODS

2.1. Collection of *T. chilonis* ecotypes

Five ecotypes of *T. chilonis*were collected from farmer's fields on sugarcane and citrus using sentinel egg technique by exposing egg cards of *Corcyra cephalonica* (list 1). These were mass reared on C. cephalonica for three successive generations and then tested for their relative susceptibility / resistance to insecticides in comparison with the laboratory strain.

list 1: Details of field collected trichogrammatids from Tamil Nadu

Sl. No.	Crop	Village	Latitude	Longitude	Disrict
1	Sugarcane	Chitteri	12.8752° N,	79.1193° E	Ranipet
2	Sugarcane	Rajapalayam	13.1231° N,	79.9120° E	Tiruvallur
3	Citrus	Amirthapuram	13.1231° N,	79.9120° E	Tiruvallur
4	Sugarcane	Padur	12.5107° N,	79.1268° E	Thiruvannamalai
5	Sugarcane	Arugunam	12.8185° N,	79.6947° E	Kancheepuram

2.2. Effect of insecticides before parasitism

To study the effect of insecticides on the *T. chilonis* ecotypes before parasitism, one hundred fresh, sterilized eggs of *C. cephalonica* were glued over a cardboard strip of 2.0 x 6.5 cm using diluted gum arabic, sprayed with the insecticides to the level of wetting them using a chromatography sprayer, air dried and kept in specimen tubes. A pair of female parasitoidfrom each ecotype was allowed to oviposit and the percentage of parasitism was worked out based on the blackening of eggs four days later. The adult emergence was recorded up to 10 days and the percentage emergence was worked out. The treatments were replicated five times.

2.3. Effect of Insecticides after parasitism

To study the effect of spraying after parasitism, one hundred, four-day-old eggs parasitized by *T. chilonis* were glued over a cardboard strip as described earlier and sprayed with insecticides to the level of wetting them using a chromatography sprayer. The emergence of adult parasitoid was observed up to 7 days after spraying, sexed and the percentage emergence and sex ratio were worked out. The treatments were replicated five times.

3. RESULTS AND DISCUSSION

3.1. Effect of insecticides on the development of *T. chilonis* sprayed on host egg before parasatisation

All the insecticides tested significantly reduced the parasitisation by *T. chilonis* when the eggs were sprayed before exposure to the parasitoid. However, the field collected ecotypes performed better compared to the laboratory population. Parasitisation by Arugunam ecotype was significantly higher (50.59, 45.32 and 60.45 %) on eggs sprayed with Imidacloprid 70 WS, Thiomethoxam 75 SG and Flubendamide 20% WG respectively (Table 1,2,3). The Amirthapuram ecotype was found next in order of tolerance to the insecticides Imidacloprid 70 WS, Thiomethoxam 75 SG and Flubendamide 20% WG (42.00, 39.46 and 56.46 respectively). The insecticide Flubendiamide was found to be least toxic with more than 50 per cent parasitisation in all the ecotypes including laboratory population. Shahid et al. (6) observed that Flubendiamide was the most selective and safest insecticide and did not affect the development, survival and egg laying capacity of *T. chilonis*. Hussain et al., (7) also reported that Flubendiamide 480 SC was safer compared to Chlorantraniliprole against *T. chilonis* which is in accordance to the present findings.

Table.1. Effect of Imidacloprid 70% WS on the development of *Trichogrammachilonis* sprayed before Parasitisation of host eggs

Ecotype	Parasitisation (%)	Adult emergence (%)	Male (%)	Female (%)	Sex ratio (♂:♀)
Arugunam	50.59 (41.47)^{a}	83.45 (73.86)^{a}	41.61 (32.65)^{e}	58.39 (44.56)^{a}	1:1.40
Amirthapuram	42.00 (32.59)^{c}	81.00 (70.35)^{c}	43.75 (33.89)^{c}	56.25 (46.61)^{c}	1:1.28
Rajapalayam	40.10 (31.65) ^{d}	80.20 (69.36)^{d}	45.27 (35.45)^{b}	54.73 (43.67)^{d}	1:1.20
Padur	38.45 (29.56) ^{e}	79.78 (68.34)^{e}	46.65 (36.72)^{a}	53.35 (41.86)^{e}	1:1.14
Chitteri	45.33 (35.45)^{b}	82.25 (72.56)^{b}	42.66 (31.55)^{d}	57.34 (45.45)^{b}	1:1.34
Laboratory population	35.45 (23.24) ^{f}	78.00 (68.56)^{f}	46.35 (36.10)^{a}	53.65 (41.89)^{f}	1:1.16

Mean of five replications
Figures in parenthesis are Arcsine transformed values
Means followed by same letters within columns are not significantly different by Tukey's HSD test (*P* = 0.05)

Table.2. Effect of Thiomethoxam 75% SG on the development of *Trichogrammachilonis* sprayed before Parasitisation of host eggs

Ecotype	Parasitisation (%)	Adult emergence (%)	Male (%)	Female (%)	Sex ratio (♂:♀)
Arugunam	45.32 (36.84)^{a}	75.60 (66.75)^{a}	40.39 (32.21)^{f}	59.61 (49.56)^{a}	1:1.47
Amirthapuram	39.46 (29.43)^{c}	72.23 (62.65)^{c}	43.39 (34.36)^{d}	56.61 (45.56)^{c}	1:1.30
Rajapalayam	30.10 (21.22)^{d}	71.40 (61.56)^{d}	44.27 (33.45)^{c}	55.73 (46.67)^{d}	1:1.26
Padur	28.00 (20.56)^{e}	70.78 (61.34)^{e}	45.56 (36.78)^{b}	54.44 (45.87)^{e}	1:1.19

Chitteri	41.23 (32.78)^{b}	73.25 (64.56)^{b}	42.44 (32.56)^{e}	57.56 (46.35)^{b}	1:1.35
Laboratory population	25.60 (17.50)^{f}	69.10 (59.51)^{f}	45.98 (36.89)^{a}	54.02 (44.91)^{f}	1:1.17

Mean of five replications
Figures in parenthesis are Arcsine transformed values
Means followed by same letters within columns are not significantly different by Tukey's HSD test (*P* = 0.05)

Table.3. Effect of Flubendamide 20% WG on the development of *Trichogrammachilonis* sprayed before Parasitisation of host eggs

Ecotype	Parasitisation (%)	Adult emergence (%)	Male (%)	Female (%)	Sex ratio (♂:♀)
Arugunam	60.45 (50.87)^{a}	90.81 (81.14)^{a}	40.12 (31.63)^{f}	59.88 (48.56)^{a}	1:1.49
Amirthapuram	56.46 (48.43)^{b}	87.30 (76.56) ^{b}	43.66 (33.55)^{d}	56.34 (45.45)^{c}	1:1.29
Rajapalayam	54.56 (45.56)^{c}	85.56 (75.33) ^{c}	45.75 (34.89)^{c}	54.25 (43.61)^{d}	1:1.18
Padur	51.00 (42.26)^{d}	83.40 (74.66) ^{d}	47.27 (38.45)^{b}	52.73 (43.67)^{e}	1:1.11
Chitteri	58.23 (47.78)^{e}	88.00 (78.45)^{b}	41.66 (32.65)^{e}	58.34 (48.56)^{b}	1:1.40
Laboratory population	42.33 (31.33)^{f}	81.77 (71.26) ^{e}	48.65 (39.72)^{a}	51.35 (42.86)^{f}	1:1.05

Mean of five replications
Figures in parenthesis are Arcsine transformed values
Means followed by same letters within columns are not significantly different by Tukey's HSD test (*P* = 0.05)

The adult emergence was not found to be affected much by the insecticides sprayed before parasitisation. Adult emergence was found to be more (83.45, 75.60 and 90.81 % respectively in Imidacloprid 70 WS, Thiomethoxam 75 SG and Flubendamide 20% WG respectively) in Arugunam ecotype (Table 1,2 and 3). However, all the three insecticides were found to be more toxic to laboratory population with reduced adult emergence. More percentage of females emerged from the Arugunam ecotype irrespective of the pesticide tested compared to the other ecotypes. The sex ratio of *T. chilonis* ecotypes including the laboratory population was not found to be influenced by the insecticides tested with a near 1:1 ratio in the laboratory population and near 1: 1.5 ratio in the Arugunam ecotype which was found to be more tolerant to the insecticides tested.

3.2 Effect of insecticides sprayed on parasitised host egg on the development of *Trichogrammachilonis*

The results showed varying degrees of insecticide toxicity against different ecotypes of T. chilonis inside host eggs. Arugunam ecotype showed more tolerance to the insecticides tested with,71.28, 53.46 and 81.67 per cent adult emergence respectively from parasitised eggs sprayed with Imidacloprid 70 WS, Thiomethoxam 75 SG and Flubendamide 20% WG. All the other four ecotypes also recorded more adult emergence compared to the laboratory population (Table 4,5 and 6). Nasreen et al., (8) observed that Imidacloprid had little impact on the egg parasitoid, *T. chilonis* and recorded 90.67 per cent adult emergence at recommended dose.

Table.4. Effect of Imidacloprid 70% WS on the development of *Trichogrammachilonis* sprayed on parasitised host eggs

Ecotype	Adult emergence (%)	Male (%)	Female (%)	Sex ratio (♂:♀)
Arugunam	71.28 (62.14)[a]	42.39 (32.36)[e]	57.61 (47.56)[a]	1:1.35
Amirthapuram	67.30 (58.56)[c]	45.75 (33.89)[c]	54.25 (44.91)[c]	1:1.18
Rajapalayam	65.56 (55.33)[d]	46.27 (37.45)[b]	53.73 (43.67)[d]	1:1.16
Padur	63.40 (53.66)[e]	47.58 (38.69)[a]	52.42 (41.89)[e]	1:1.10
Chitteri	69.30 (59.45)[b]	44.44 (33.56)[d]	55.56 (45.35)[b]	1:1.25
Laboratory population	61.70 (52.26)[f]	47.91 (38.78)[a]	52.09 (43.87)[f]	1:1.08

Mean of five replications
Figures in parenthesis are Arcsine transformed values
Means followed by same letters within columns are not significantly different by Tukey's HSD test (*P* = 0.05)

Table.5. Effect of Thiomethoxam 75% SG on the development of *Trichogrammachilonis* sprayed on parasitised host eggs

Ecotype	Adult emergence (%)	Male (%)	Female (%)	Sex ratio (♂:♀)
Arugunam	53.46 (45.75)[a]	41.12 (31.63)[f]	58.88 (49.12)[a]	1:1.43
Amirthapuram	46.22 (35.51)[c]	42.56 (32.45)[c]	57.44 (46.45)[c]	1:1.34
Rajapalayam	44.83 (34.65)[d]	43.75 (34.89)[c]	56.25 (45.61)[d]	1:1.28
Padur	42.40 (32.86)[e]	45.27 (36.45)[b]	54.73 (45.67)[e]	1:1.20
Chitteri	47.78 (38.34)[b]	41.61 (31.65)[d]	58.39 (48.56)[b]	1:1.40
Laboratory population	41.10 (32.34)[f]	46.65 (38.72)[a]	53.35 (44.86)[f]	1:1.14

Mean of five replications
Figures in parenthesis are Arcsine transformed values
Means followed by same letters within columns are not significantly different by Tukey's HSD test (*P* = 0.05)

Table.6. Effect of Flubendamide 20% WG on the development of *Trichogrammachilonis* sprayed on parasitised host eggs

Ecotype	Adult emergence (%)	Male (%)	Female (%)	Sex ratio (♂:♀)
Arugunam	81.67 (71.86)^{a}	42.67 (33.63)^{e}	57.33 (47.56)^{b}	1:1.34
Amirthapuram	78.25 (67.56)^{c}	43.66 (34.55)^{c}	56.34 (46.45)^{c}	1:1.29
Rajapalayam	76.60 (66.35)^{d}	43.71 (33.88)^{c}	56.29 (46.61)^{c}	1:1.28
Padur	74.20 (64.36)^{e}	45.47 (36.45)^{b}	54.53 (44.67)^{d}	1:1.20
Chitteri	80.78 (71.34)^{b}	43.39 (34.36)^{d}	56.61 (45.56)^{c}	1:1.30
Laboratory population	72.33 (62.56)^{f}	46.66 (36.72)^{a}	53.34 (43.86)^{a}	1:1.14

Mean of five replications
Figures in parenthesis are Arcsine transformed values
Means followed by same letters within columns are not significantly different by Tukey's HSD test (P = 0.05)

Among the insecticide tested Flubendiamide was least toxic to the parasitoid developing with in the host egg and Thiomethoxim was found to be more toxic with nearly 50 per cent reduction in the adult emergence. Earlier, William and Price (9) reported thiamethoxam as toxic to *T. pretiosum* adults. Studies on the residual toxicity of 3 neonicotinoid compound thiamethoxam, chlorantraniliprole, clothianidin to *T. chilonis* revealed thiamethoxam as the most toxic compound to the adults whereas chlorantraniliprole was harmless and clothianidin was slight to moderately harmful (10). Uma et al (11) reported*T. japonicum* adult mortality of 21.25 and 40.00 per cent in chlorantraniliprole and thiamethoxam respectively. However imidacloprid and thiamethoxam were found moderately toxic, recording intermediate parasatisation (12). Suganthy (13) also observed that there was no significant adverse effect on *T. chilonis* by imidacloprid. Similar effect on the sex ratio was observed when the parasitised host eggs were sprayed after parasitisation also. The sex ratio of *T. chilonis* ecotypes including the laboratory population was not found to be influenced by the insecticides tested with a near 1:1 ratio in the laboratory population and near 1: 1.5 ratio in the Arugunam ecotype which was found to be more tolerant to the insecticides tested (Table 4,5 and 6).

All the ecotypes tested showed more tolerance to the three insecticides tested compared to the laboratory population with Arugunam ecotype showing high degree of tolerance. The variation in the field collected ecotypes in their parasatisation potential and pesticide tolerance were reported earlier (14). All the six ecotypes collected from Gudimangalam, Pongalur, Udumalpet, Palladam, Mettupalayam and chingleput were able to tolerate the commonly used insecticides viz., Quinalphos (0.05 %), Monocrotophos (0.05 %), Deltamethrin (0.002%) and Endosulfan (0.07 %) with increased LT 50 value compared to the laboratory population (5). One of the reason for the increased tolerance of the field collected ecotype may be the development of resistance to their continuous exposure to insecticides in the field. Lian-Cheng Xie et al.(15) observed highest resistance rate of T. japonicum to imidacloprid (17.8-folds) after 10 successive treatments and experienced 2.5, 4.72, and 7.41-fold increases in tolerance to thiamethoxam, buprofezin, and nitenpyram, respectively.

4. CONCLUSION

This study suggests that the field collected ecotypes of egg parasitoid, *Trichogrammachilonis* were comparatively tolerant to the insecticides Imidacloprid,70 WS, Thiomethoxam 75 SG and Flubendiamide 20WG. Among the three insecticides, Flubendiamide was found safer to the parasitoid and it could be considered for inclusion in IPM programmes that depend on *T. chilonis*.

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