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Kairomonal effect of certain organic acids on the egg parasitoid, *Trichogramma chilonis* Ishii (Hymenoptera: Trichogrammatidae)

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ABSTRACT: Chemical signals play an important role in communication between different organisms determining the ecological balance between host plants, insect pests and their natural enemies. Some organic acids present in host insects and plants influence host habitat location and host location by insect natural enemies. Kairomonal response of *Trichogramma chilonis* Ishii to seven organic acids, *viz*., triacontanoic, docosanoic, octocosanoic, tricosanoic, pentadecanoic, heptacosanoic and hexacosanoic acids, was studied by laboratory bioassay. Among the acids tested, triacontanoic acid elicited the highest response from *T. chilonis*, followed by docosanoic and octocosanoic acids. Triacantonic acid at 10 ppm concentration and docosanoic acid at 20 ppm concentration could be used successfully in IPM programmes for enhancing the activity of *T. chilonis* in different agroecosystems.

KEY WORDS: Kairomone, organic acid, *Trichogramma chilonis*

INTRODUCTION

Semiochemicals, that convey information between organisms as signaling chemicals, play a critical role in enabling insects to find food, mates and a suitable location for their progeny. Foraging female insect parasitoids use chemical cues extensively to locate, identify and exploit their hosts in different ecosystems (Beevers *et al*., 1981; King *et al*., 1985). Among the chemical cues, some organic acids present in plants and host insects are found to influence host habitat and host location by natural enemies (Hendry *et al*., 1976). Tricosane, heptanoic acid and certain other unidentified chemicals present in potato plants provided chemical signals for effective foraging of the larval parasitoid, *Orgilus lepidus* Muesebeck (Hendry *et al*., 1976). The presence of hexanoic acid, tetradecanoic acid, hexadecanoic acid and pentadecanoic acid was indicated in cotton tissues, increased the effectiveness of *Trichogramma chilonis* Ishii and *Chrysoperla scelestes* Banks. Similarly, several acids were identified in the scales of *Heliothis zea* Boddie moths. Out of these, some were found to increase the rate of parasitization of *H. zea* eggs by *Trichogramma pretiosum* Riley (Gueldner *et al*., 1984). Among the parasitoids utilized in augmentative control programmes of insect pests, *Trichogramma* has received the most attention (King *et al*., 1985). One of the native parasitoids, *T. chilonis,* is widely distributed in the Indian subcontinent (Nagarkati and Nagaraja, 1979) and known to efficiently control many lepidopteran pests (Ananthakrishnan *et al*., 1991). Detailed information on the kairomonal effect of organic acids on *Trichogramma chilonis* is lacking and hence the present study was taken up.

MATERIALS AND METHODS

Cultures of the host insect, *Corcyra cephalonica* (Stainton) and the egg parasitoid, *T. chilonis* were maintained continuously at the Biological Control Laboratory of the Division of Entomology, IARI, New Delhi. *Corcyra cephalonica* was reared on crushed and sterilized sorghum grains in a closed type rearing system (Paul and Sreekumar, 1998). The egg parasitoid was reared on UV sterilized *C. cephalonica* eggs in glass vials of 10x2.5 cm size at 25±1°C and 65±5% RH. Bioassays with the different organic acids were carried out using glass petri dishes (15cm dia.) as the experimental arena (Padmavathi and Paul, 1998). Five concentrations, 0.0001 g/10ml, 0.0002g/10 ml, 0.0003 g/10 ml, 0.0004g $10ml^{-1}$ and 0.0005 g/10 ml, were used in this study. The organic acids were subjected to two-way ANOVA of completely randomized design (CRD). In order to know the interaction between the treatments and concentrations, the data were subjected to two-factorial ANOVA. In each petri dish,

Table 1. Effect of organic acids on parasitoid activity index of *Trichogramma chilonis*

Concentration	Acids							
C1	Doco-sanoic	Pentada-cosanoic	Trico-sanoic	Octo-sanoic	Hexaco-sanoic	Heptaco-sanoic	Tria-cantonoic	Mean
C2	5.63 (1.92)	6.63 (2.41)	7.25 (2.47)	4.25 (1.76)	6.00 (2.14)	1.25 (1.15)	14.0 (3.47)	6.43 (2.19)
C3	11.63 (3.35)	6.25 (2.45)	3.00 (1.57)	4.13 (1.84)	2.50 (1.27)	3.88 (1.69)	8.75 (2.51)	5.73 (2.10)
C4	12.63 (3.51)	0.75 (1.01)	7.00 (2.36)	15.13 (3.65)	3.88 (1.76)	3.63 (1.64)	7.38 (2.43)	7.20 (2.34)
C5	5.25 (2.09)	4.38 (2.08)	5.63 (2.11)	6.38 (2.37)	1.13 (1.05)	12.38 (3.14)	5.63 (2.16)	5.83 (2.14)
Control (Hexane)	3.88 (1.77)	2.38 (1.42)	6.38 (2.42)	4.50 (1.97)	2.63 (1.45)	4.88 (1.88)	3.50 (1.60)	4.02 (1.79)
Mean	7.73 (2.51)	4.02 (1.87)	5.98 (2.21)	6.69 (2.30)	3.48 (1.57)	4.44 (1.74)	7.98 (2.48)	

	SEM	CD at 5%
Treatment	0.19	0.52
Concentration	0.17	0.48
Interaction (T x C)	0.45	1.26

Figures in parentheses are square root transformed values; C_1 = 10 ppm, C_2 = 20 ppm, C_3 = 30 ppm, C_4 = 40 ppm, C_5 = 50 ppm

Table 1. Effect of organic acids on parasitoid activity index of *Trichogramma chilonis*

Concentration	Acids							
	Doco-sanoic	Pentada-cosanoic	Trico-sanoic	Octo-sanoic	Hexaco-sanoic	Heptaco-sanoic	Tria-cantonoic	Mean
C1	27.08 (25.37)	48.75 (41.75)	45.83 (38.84)	24.17 (22.64)	21.67 (23.03)	12.50 (14.29)	65.42 (55.68)	35.06 (31.66)
C2	62.08 (53.29)	15.83 (18.90)	24.17 (22.66)	20.0 (22.17)	6.67 (9.41)	23.75 (23.82)	48.75 (42.08)	28.75 (27.48)
C3	37.08 (33.51)	37.08 (34.52)	41.67 (36.55)	19.17 (22.13)	20.38 (21.21)	3.33 (7.43)	45.42 (41.18)	29.16 (28.08)
C4	61.25 (51.24)	2.08 (7.22)	39.59 (35.53)	55.42 (48.53)	22.08 (22.68)	22.92 (23.50)	47.92 (41.78)	35.89 (32.93)
C5	18.75 (20.14)	37.50 (34.86)	30.0 (28.73)	32.50 (31.25)	0.42 (4.86)	47.09 (40.33)	30.0 (28.71)	28.04 (26.98)
Control (Hexane)	24.17 (23.80)	15.83 (17.67)	19.58 (22.27)	22.50 (23.65)	16.67 (18.03)	15.83 (18.87)	8.75 (12.11)	17.62 (19.49)
Mean	38.40 (34.56)	26.18 (25.82)	33.47 (30.76)	28.96 (28.40)	14.65 (30.07)	20.90 (21.37)	41.04 (36.92)	

	SEM	CD at 5%
Treatment	3.85	10.72
Concentration	3.05	8.48
Interaction (TxC)	8.61	23.98

Figures in parentheses are angular transformed values; C_1 = 10 ppm, C_2 = 20 ppm, C3 = 30 ppm, C4 = 40 ppm, C_5 = 50 ppm ten healthy, 0-24 h old, anaesthetized and fast reviving females of *T. chilonis* were released at the centre. Each petri dish was considered as a replication and eight such replications were maintained. The parasitoids were allowed to search in the experimental arena for a period of 45 minutes from the time of recovery. The number of parasitoids that visited the cards was counted at five minutes interval and the total number visiting each card was referred to as 'parasitoid activity index' (PAI). After 45 minutes, the parasitoids were removed carefully from each egg card and these cards were kept individually in homeopathic vials for development at 26±1°C and 65±5% RH. Based on the number of blackened eggs, per cent parasitism was calculated and the data were subjected to analysis of variance (Gomez and Gomez, 1986).

RESULTS AND DISCUSSION

Triacantonoic acid elicited maximum response by way of mean PAI (7.98), followed by docosanoic acid (7.73) irrespective of the concentration, whereas the least mean PAI (3.48) was found with hexacosanoic acid. Comparative analysis of the data showed that the response of the parasitoid as revealed by mean PAI was on par with each other in the case of docosanoic, triacantonoic, octasanoic and tricosanoic acids (Table 1).

Among the different acids triacantonoic acid showed maximum mean parasitism followed by docosanoic acid, irrespective of the concentration. Hexacosanoic acid showed the least mean parasitisation. Triacantonoic acid was found to show highest parasitisation (65.42) at the lowest concentration C_1, considering all the acids assayed at different concentrations. It was followed by docosanoic acid at C_2 (62.08). The lowest mean parasitisation was observed in hexacosanoic acid at the highest concentration C_5 (0.42). Interaction analysis between different organic acids and concentrations revealed that triacantonoic acid showed highest mean parasitisation at C_1 and C_3, with a value of 19.63 and 13.63, respectively (Table 2).

Docosanoic acid showed the highest mean parasitisation at C_2 and C_4 (18.63 and 18.38, respectively). Heptacosanoic acid showed maximum mean parasitisation (14.13) at the highest concentration C_5. At the lowest concentration C_1 and medium concentration C_3, lowest mean parasitisation (3.75) was observed in heptacosanoic acid. In C_2 and C_5, hexacosanoic acid showed the lowest mean parasitisation. At C_4, Pentadcosanoic acid showed minimum mean parasitisation (Table 2).

Kairomonal response of *T. chilonis* to triacontanoic acid, docosanoic acid, octosanoic acid, tricosanoic acid, pentadecanoic acid, heptanoic acid and hexacosanoic acid was studied by bioassays. Triacontanoic acid was found to have significantly higher kairomonal activity followed by docosanoic and octosanoic acids, whereas hexacosanoic acid was found to be the least preferred. Tricosane, heptacosanoic acid, and other unidentified host finding chemicals present in potato plants provided chemical signals for the larval parasitoid *Orgilus lepidus* (Hendry *et al*., 1976). The importance of several chemical cues from plants and herbivores has been emphasized (Lewis *et al*., 1975) and compounds such as hexatriacontane, hexanoic acid, tetradecanoic acid and hexadeconoic acid, mostly from plant origin, improve the activity of entomophagous insects. The presence of hexanoic acid, tetradecanoic acid, hexadacanoic acid and pentadacanoic acid in cotton tissues was reported to increase the effectiveness of entomophagous insects (Ananthakrishnan, 1992). Studies with cotton cultivars indicated that the presence of kairomonal compounds such as eicosane, pentacosane and dodecanoic acid in the plant source would increase the activity of natural enemies (Annadurai *et al*., 1990). Similarly, several acids were identified in the scales of *H. zea* moths (Gueldner *et al*., 1984) and their possible role as kairomones was suggested. The acids identified in the scales of adults of *H. zea* were hexanoic, heptanoic, octanoic, nonanoic, 2 or 3 furancarboxylic phenyl acetic, benzoic, sorbic and 4-hydroxybenzoic acids which were found to be responsible for such activity. Kairomonal response observed to triacontanoic acid, docosanoic acid, and octosanoic acid in the present investigation corroborates these findings. These organic acids at appropriate concentrations could be used as kairomonal sprays successfully in IPM programmes to enhance the activity and effectiveness of trichogrammatids because of their positive kairomonal effect on them.

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