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KAIROMONAL EFFECT OF SCALES FROM *EARIAS VITELLA* F. AND *CORCYRA CHEPHALONICA* STAINTON ON BIOLOGY OF *TRICHOGRAMMA CHILONIS* (ISHII)

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ABSTRACT

The hexane extracts of scales of male and females of *Earias vitella* F. and *Corcyra chephalonica* Stainton were evaluated along with standard octacosane on the performance of *Trichogramma chilonis* under laboratory conditions and potted plants. Results revealed that eggs of *C. cephalonica* treated with hexane extract of female *E. vitella* and *C. cephalonica* scales at 10000 ppm resulted in maximum parasitism of 81.99% and 75.99% by *T. chilonis,* respectively, as against 40.66% in untreated (only hexane). Maximum emergence of 71.03% was observed in eggs treated with female extracts of *C. cephalonica* female followed by *E. vitella* (70.08%). Similar was the trend with fecundity and longevity with extract of female *C. cephalonica*. The effect of kairomones on parasitism evaluated with potted plants revealed significantly more parasitism when stapled egg cards of *C. cephalonica* on cotton and pigeonpea were treated with extract of female *E. vitella* scales (66.66 and 70.05%, respectively).

Key words: Kairomone, *Trichogramma chilonis*, *Earias vitella*, *Corcyra cephalonica*, scales, hexane extracts, octacosane, parasitism, emergence, potted plants, egg cards

Kairomone is an interspecific semiochemical or a mixture of semiochemicals, produced by one species which induces responses advantageous to an individual of a different species perceiving the signal (Dicke and Sabelis, 1988). Herbivores in natural ecosystems are limited, not so much by food supply, but rather by natural enemies (Hairston et al., 1960). Chemical cues play a major role in the process of host selection by parasitoids (Milonas et al., 2009). Chemicals released from hosts, their secretions and by-products and associated organisms influence the behaviour of natural enemies. Foraging female insect parasitoids use these chemical cues extensively to locate, identify and exploit their hosts (Alhmedi et al., 2010; Penaflor et al., 2011). Among the insect parasitoids, the egg parasitoid *Trichogramma chilonis* Ishii is widely distributed in the Indian subcontinent, and used against lepidopterans. It is extensively used to manage bollworm complex viz., *Helicoverpa armigera* (Hubner), *E. vitella*, *E. insulana* F., *S. litura* F. and *Pectinophora gossypiella* Saunders (Kumar et al., 2009; Fant et al., 2013). The rice meal moth *Corcyra cephalonica* Stainton is an important factitious host utilised in many biocontrol laboratories in India for the mass production of *T. chilonis*. Spotted bollworms *Earias vitella* F. is one of the major destructive pests of okra, cotton and hollyhock, and a serious pest of okra causing 52.33- 70.75% damage (Choudhury et al., 2021). The present study examined the effect of kairomones from host insects on biological parameters *viz*., parasitism, adult emergence, fecundity, adult longevity and sex ratio of *T. chilonis* on hosts, *C. cephalonica* and *E. vitella* under laboratory and potted plant conditions.

MATERIALS AND METHODS

Trichogramma chilonis and *C. cephalonica* culture were maintained in the Biocontrol Laboratory, Department of Entomology, Dr PDKV Akola Experiments were conducted during 2018-19 using freshly laid, cleaned, UV irradiated *Corcyra* eggs glued on a strip of card sheet (6 x 2 cm) in a single layer using gum. These cards were exposed to *T. chilonis* for maintenance of the culture. Fine streaks of honey and water (1:1) were provided as adult food. After 24 hr, the parasitized egg cards were transferred to fresh glass tubes (15x 2.5 cm). The parasitoids that emerged from the cards were used. The larvae *E. vitella* were collected from okra at the research farm of Department of Entomology Dr PDKV, Akola. These were reared on the fruits of okra under laboratory condition, with 10% honey provided as adult diet. The rearing was carried out at 25± 2°C and 65± 5% RH. Healthy pupae of *E. vitella* were selected and sexed at pupal stage (Mahapatro and Gupta, 1999). Pupae were collected separately in petriplate (10 cm dia) and transferred to rearing cages

(30 cm^3) separately for adult emergence. The male and female moths were used for kairomone extraction. The culture of *C. cepholonica* required for multiplication of *T. chilonis* was maintained under laboratory condition using standard procedure on grains of sorghum. Healthy adults of *C. cephalonica* were selected and sexed using labial palpi (Rajasekhar et al., 2016).

The scale extracts from *E. vitella* and *C. cephalonica* adults were prepared following Ananthakrishnan et al. (1991). Freshly emerged, healthy, 0-24 hr old male and female moths were collected and kept in a deep freezer at -20^{0}C for 15 min for immobilization. Ten grams of moths were weighed and soaked in 100 ml distilled hexane for 24 hrs and shaked in water bath (Haake, SWB 20) at 28^{o}C for two hours and later held at 50^{o}C for 20 min. It was filtered through Whatman No.1 filter paper (Yasuda 1997). Anhydrous sodium sulphate was added @ 1g/10g and kept for 1 hour for dehydration. The extract was again filtered through Whatman No. 1 filter paper. The extract was distilled at 60-70^{o}C in water bath and the residues left at the bottom of the round bottom flask were collected by rinsing with small quantity of HPLC grade distilled hexane in small tube. The tube was kept in water bath for evaporation and the resultant extract was diluted to the required concentration by using HPLC grade hexane and the volume was made up in a 5ml volumetric flask. The extracts were stored at -20^{0}C in deep freezer for further studies.

One % (10000 ppm) of each extract was prepared with hexane (diluent) and was used for the experimentation (100 mg/10 ml of hexane). Clean, healthy and 0-24 hr old eggs of *C. cephalonica* sterilized with 4 w UV light (45 min) were washed twice in hexane to remove the traces of scales or natural kairomones present on the surface of eggs and shade dried. These eggs were pasted with white gum on trichocards, at the rate of 30 eggs (*C. cephalonica*) piece (egg card) per replication. Kairomonal extracts (10000 ppm) of host insects were used to treat the egg cards by micropipette (50 µl/card) separately and shade dried (Baskarn et al., 2018). Laboratory studies of moth scale extract of host insects on parasitization by *T. chilonis* was carried out at ambient conditions. The procedure adopted was similar to the one described by Ananthakrishnan et al. (1991). The treated egg cards were arranged in a circular fashion at equidistance in a Petri-dish (150x 15 mm dia.) and the parasitoids were released at the centre at 6:1 ratio. After 24 hr exposure, egg cards were kept in glass tube and incubated at 25± 2 ºC and 65± 5% RH. The parasitization was observed on 6th day after exposure. Choice tests were conducted separately for each extract. Laboratory experiment was conducted at 25± 2°C, 65± 5% RH. Each treatment was replicated five times, with one egg card considered as one replication.

Cotton and pigeon pea plants were grown in pots in a nethouse. These potted plants were arranged at equidistant from the point of release and covered with a net. These potted plants were stapled with trichocards containing *Corcyra* eggs. Kairomonal extracts of various host insects were used to treat the egg cards (50 µl/ card) and shade dried. The *T. chionis* adults were released from a distance of 3 feet to study the preference of *T. chilonis* for parasitization considering the attraction by different kairomones. Release of adults were done during morning hours only i.e. before 11 a.m. Egg cards were collected after 24 h and kept in vials for development at an ambient temperature. After 4 days, parasitisation was recorded on the basis of black colouration of eggs (Ananthakrishnan et al., 1991). 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 was completed, the black eggs with exit holes were counted in all the treatments. Per cent adult emergence in each replication was thus recorded. In order to determine the fecundity, newly emerged, mated female parasitoid was released in a separate glass vial (4.3 cm diameter and 5.5 cm length) containing 20, one-day old *C. cephalonica* eggs, on egg card (rectangular 5 cm x 1.5 cm). Undiluted honey was placed inside the lid of each vial as a drop and the vial was closed. After every 24 hours, egg card was replaced with new egg card, which has 20 *Corcyra* eggs. This procedure was done till all the females in the glass vial died. For observing longevity of the adult parasitoids, the emerged adults from all the 5 replications in each treatment were placed in separate test tubes where a streak of honey provided as food on paper strips. 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. Appropriate transformations were followed and all the transformed data were analysed using CRD (Completely Randomized Design) for ANOVA (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Effect of hexane extracts of host insects on performance of *T. chilonis* evaluated under laboratory

conditions depicted in Table 1 reveal differences indicating that the hexane extracts significantly influence the parasitization by *T. chilonis*. Significantly maximum parasitism (81.99%) was observed in hexane extract of female *E. vitella* which was significantly superior. The hexane extract of male *C. cephalonica* (67.99%) and octacosane kairomone dust (64.74%) were the next best, both being at par. The data regarding the effect of host insect kairomones on % adult emergence of *T. chilonis* from treated eggs of *C. cephalonica* was in the range of 52.77 to 71.03%. Application of hexane extract of female *C. cephalonica* showed significantly maximum emergence (71.03%) which was followed by hexane extract of female *E. vitella* (70.08%), male *C. cephalonica* (69.55%) and male *E. vitella* (67.57 %). These results are in line with those of Singh et al. (2002) on the female body wash of *C. cephalonica* and *H. armigera* on adult emergence in *T. chilonis* and *Trichogramma exiguum* Pinto and Platner. Maruthadurai et al. (2011) observed maximum adult emergence in egg cards treated with whole body wash of male *S. litura* followed by female *E. vitella* by *T. brasiliensis* and *T. chilonis*. In the present study, whole body wash of female *C. cephalonica* followed by female of *E. vittella* recorded higher emergence by the egg parasitoid *T. chilonis*. Parthiban et al. (2015) reported similar observations with *T. chilonis*. Significantly maximum fecundity of *T. chilonis* was observed with hexane extract of female *C. cephalonica* i.e. 73.2 eggs/ female, followed by hexane extract of female *E. vitella* and hexane extract of male *C. cephalonica*; maximum longevity of female was 9.8 days when egg cards were treated with hexane extract of female *C. cephalonica*, which was at par with hexane extracts of female and male *C. cephalonica*.

Present study indicated that kairomonal compounds from *C. cephalonica and E. vitella* female whole body wash increased the fecundity. Nordlund et al. (1976) observed kairomonal response of *Heliothis zea* treated host scale on *Trichogramma pretiosum* Riley. Zaborski et al. (1987) observed more fecundity when eggs of spruce budworm were treated with such a hexane extract and Angoumois grain moth scales by *Trichogramma minutum* Riley. Nordlund et al. (1976) observed that *T. pretiosum* showed a longevity of 12.2 days when there was constant exposure to the kairomones found in the scales of *H. zea*. TuncbIlek and Ayvaz (2003) reported significant effect of 50% honey+50% host egg extracts of *Ephestia kuehniella* and *Sitotroga cerealella* on longevity of *Trichogramma evanescens* Westwood. No significant differences were observed in the number of males and females in the progenies after rearing the *T. chilonis* with treatments; maximum male: female ratio of 1:1.03 was observed in hexane extract of scales of female *E. vitella;* thus, different moth scales extracts do not influence the sex ratio. Nordlund et al. (1976) observed sex ratio (male: female) on scale extract of *H. zea* to be 0.93.

Parasitism by *T. chilonis* was significantly higher

Table 1. *T. chilonis* on eggs of *C. cephalonica*, as influenced by hexane extracts of host insects, and parasitism by *T. chilonis* on hexane extracts of host insect scales treated *C. cephalonica* eggs stapled on cotton and pigeonpea

Treatments	% parasitism	% Emergence	Fecundity (Eggs/ female)	Female longevity (Days)	Sex ratio (M: F)	Cotton	Pigeonpea
C. cephalonica (male)	67.99 (55.58)	69.55 (56.56)	69.6 (56.63)	8.4 (16.85)	1:1.00	53.33 (46.91)	62.11 (52.03)
C. cephalonica (Female)	75.99 (60.79)	71.03 (57.68)	73.2 (58.86)	9.2 (17.66)	1:0.90	57.26 (49.18)	54.05 (47.35)
E. vitella (male)	71.99 (58.09)	67.57 (55.32)	66.4 (54.62)	8.0 (16.43)	1:0.84	54.66 (47.68)	57.99 (49.63)
E. vitella (Female)	81.99 (68.58)	70.08 (56.86)	71.8 (57.94)	9.8 (18.24)	1:1.03	66.66 (54.90)	70.05 (56.89)
Octacosane Dust	64.72 (53.59)	60.81 (51.21)	63.0 (52.55)	7.8 (16.22)	1:0.91	51.33 (45.76)	55.39 (48.16)
Control (Hexane)	40.66 (39.61)	52.77 (46.60)	42.2 (40.51)	7.0 (15.34)	1:0.81	40.664 (39.61)	38.66 (38.43)
SE(m)±	1.17	1.05	1.8	0.02		1.33	1.87
CD (p = 0.05)	3.42	3.09	5.25	0.06		3.89	5.84

*Mean of seven replications; Figures in parentheses arc sin transformed values

when stapled egg cards of *C. cephalonica* on cotton plants were treated with hexane extract of *E. vitella* female scales (66.66 %). On pigeonpea *T. chilonis* release is not recommended, hence, performance was evaluated under greenhouse on potted plants. *Corcyra* egg cards with kairomones from host insect scales were used and the results revealed significant differences (Table 1; hexane extract of female *E.vitella* scales was found to be the most effective (70.05 %). These results corroborate with the earlier ones- Lewis et al., 1975; Elzen et al., 1984; Nordlund et al., 1984; Nordlund 1987 and Shu et al., 1990. Paul et al. (1997) also observed that the cards treated with whole body washings of female *C. cephalonica* registered maximum parasitization by *T. brasiliensis* and *T. japonicum* Ashmead. Ananthakrishnan et al. (1991) reported 83.4% parasitism on whole body wash of *H.armigera* treated eggs and 68.5% parasitism on whole body wash of *C. cephalonica* treated eggs. Rani et al. (2007) also observed that mean parasitism of *T. japonicum* increased with hexane extract of yellow stem borer adult body, frass extract, larval extract and control under field and potted plant conditions. Parthiban et al. (2015) observed significantly more parasitism on eggs of *Spodoptera litura* (F.) when egg cards were treated by whole body wash of female and male, and larval extract of *C. cephalonica*, with *T. chilonis*.

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