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Synomonal effect of sugarcane leaf on olfactory response and parasitization of *Trichogramma chilonis* Ishii

Yeetesh Kumar, MR Singh, YK Yadu, Anupriya Chandraker and Pankaj Bhargav

Abstract
In this study, the synomonal effects of n- hexane based sugarcane leaf extract of four sugarcane varieties *viz.,* Co0238, CoJ64, CoLk8102 & CoLk94184 on parasitoid, *T. chilonis* have studied under laboratory conditions in Y- tube olfactometer and petridish bioassay. It was observed that the leaf extract of all sugarcane varieties was positively attracted the *T. chilonis* female in dual choice preference study. The attraction of parasitoid towards the extract in the dual choice study proved to be the chemical cues emanated from leaf of the sugarcane plant was responsible for foraging activity of *T. chilonis* in sugarcane crop ecosystem. The results were observed differ in petridish bioassay, the synomonal effect of leaf extracts on *Corcyra cephalonica* Stainton treated eggs have less influence on parasitoid visit, percent parasitism and adult emergence of *T. chilonis* wasp. The overall trends of higher foraging response of parasitoid were recorded on leaf extract of CoLk94184. This means that the different variety of sugarcane evolved different kind of quantitative chemical cues, which can govern for foraging behaviour of parasitoids.

Keywords: Chilo auricilius, Corcyra cephalonica, Olfactometer, Sugarcane, Synomone, Trichogramma chilonis

Introduction
Sugarcane is an important field crop of India. The large amount of sugar yield is fulfilled by sugarcane. The quality sugar yield is destroyed by various borer pests like; *Chilo Sacchariphagus indicus* Kapur, *Chilo auricilius* Dudgeon, *Scirpophaga excerptalis* Walk etc. They bore the cane by making a tunnel inside the cane and filled with excreta. Overall the borers play important role in reducing the cane yield. The females of borers are mostly laying eggs on leaves, leaf sheath and standing cane stem [1, 2, 3]. The eggs are exposed to the outer environment, which are favorable for *Trichogramma chilonis* Ishii parasitization (Figure 1). The *T. chilonis* is important egg parasitoid of sugarcane borers and has received the maximum attention in biological control.

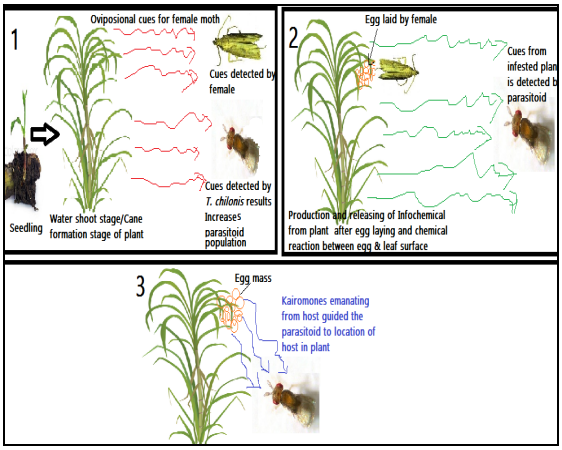

Fig 1: Tritrophic interaction between sugarcane plant, host egg and *T. chilonis* in sugarcane ecosystem.

The effective utilization of *T. Chilonis* against the sugarcane borers depends on the proper understanding of foraging strategies of parasitoid, when which kind of chemicals govern for the foraging mechanisms of parasitoid. This kind of relevant information helps the plant protection specialist to better utilization of bio-agents and increases their efficiency in field condition. The foraging strategies of parasitoid can understand by bioassay of different extracts.

In the present study, some sources of synomones such as n-hexane extracts of sugarcane leaves of four sugarcane varieties *viz.,* Co0238, CoJ64, CoLk8102 and CoLk94184 were used to study the foraging behaviour of *T. chilonis* in the laboratory through Y-tube olfactometer and petri dish bio-assay.

Materials and methods

Four sugarcane varieties *viz.,* Co 0238, CoJ64, CoLk8102 and CoLk94184 were planted at the experimental farm of ICAR-Indian Institute of Sugarcane Research Lucknow in February, 2014. A good crop was raised by giving all agronomic practices on time.

The pure stock culture of egg parasitoid *T. chilonis* were maintained in the Biological Control, Division of Crop Protection, ICAR-IISR, Lucknow and further were multiplied in rice moth, *Corcyra cephalonica* Stainton host eggs and used for study. Culture of *C. cephalonica* was maintained in the laboratory on broken grains of sorghum fortified with pulses as per the method described by Paul and Sreekumar [4].

Preparation of extracts

Cut sets of all four sugarcane varieties *viz.,* Co0238, CoLk8102, CoJ64 and CoLk94184 were planted in plots measuring 6m x 4.5 m at IISR, Research Farm in the month of February, 2015. Before the extraction of synomones, 5 month old healthy sugarcane plants (5 of each variety) were cut and brought to the laboratory. From top 4th to 6th leaves were cut for extraction process because these leaves actively release a good quantity of long range volatile organic compounds and info-chemicals. Leaves were washed thoroughly in distilled water and socked excess water was wiped out with tissue paper. After the cleaning the leaves were cut in to small pieces (1.5 cm^2) separately in sterilized petridishes.

Ten gram of cut pieces of leaf samples were taken in one conical flask (500 ml) containing 130 ml n-hexane (99% AR) and kept for overnight. In next day the extract was filtered through Whatman No. 1 filter paper in clean and sterilized conical flask (250 ml). These extract are stored in deep freezer at -20 ºC for bio-assay study.

Development of Y- Tube Olfactometer

The Y- tube olfactometer has been devised to study the attraction of parasitoids, *T. chilonis* towards extracts under dual choice set of experiments. Y-tube olfactometer is used for testing the single semiochemical source/samples for choice and no choice experiments. A 'Y'-tube olfactometer was devised in Biological Control Laboratory, IISR, Lucknow for behaviour study of insects with the suitable modification in Y-tube air flow olfactometer developed by Potting *et al*. [5].

Y- Tube Olfactometer Bioassay for *T. chilonis* Olfactory Orientation Behaviour Study

Bioassay studies of synomonal extracts were carried out under laboratory conditions at 26 ± 1°C and 65 ± 5% R.H. in Y-tube olfactometer. n-hexane based filtrates of all types of extracts were taken as a 100 % concentration. Two strips measuring 2cm x 1cm were cut from Whatman No. 1 filter paper. One strip was treated with 50 µl filtrate as treatment and one other strip treated with 50 µl n-hexane as a control. One of each treated strip was placed in arm marked as "T" (treatment) and "C" (control). The arms were connected by a twist connector of the air delivery system of olfactometer. Individual 0-24 hours old well fed female wasps of *T. chilonis* were released to stem of Y tube and open end of the stem was plugged with n-hexane treated cotton and movement of insect was watched. In one set of experiment, 10 insects were released and observed and two sets of the same experiment were maintained in one replication. Each "Y" tube olfactometer bioassay were replicated for 05 times. To avoid any asymmetrical bias in the set of experiment the strip treated with odor source and treated with n-hexane were exchanged after the release of five wasps. The procedure adopted here is described by Potting *et al*. [5] with suitable modifications.

Responds of *T. chilonis* to treatment/treated control was recorded by counting the number of wasps visited the target. If the test female walked towards an odor source and crossed the 'choice line' (2 cm after the division of the base tube) and stayed there for more than 10 seconds, it was taken as a choice from the odor source in that arm.

Petridish Bioassay for Parasitoid Activity Study in Synomonal Extracts

Bioassay of different extracts for egg parasitoid activity was carried out in borosil make petri dish (150 x 15 mm). The Petridishes were placed on the top of working table in the laboratory under a 40 W overhead fluorescent tube as a source of light. The procedure described by Lewis *et al.* [6] has been adopted with suitable modifications. Cleaned and healthy 0-24 hr old eggs of *C. cephalonica* were washed twice in n-hexane (99% AR) to remove any traces of scales or kairomones present on the surface of the eggs. n-hexane washed eggs were treated with UV light (15W) in the UV chamber for 45 min at 15 cm distance. A total of 30 eggs was glued on a 4 cm^2 whatman No.1 filter paper piece and six egg cards were prepared for each replication. Egg cards were treated with serial dilutions of different extracts *viz;* C_1 – 1% (120 µl of 100 % concentrated extracts/11.880 ml n-hexane), C_2 -0.1%, C_3 – 0.01%, C_4 – 0.001% and C_5-0.0001% equivalent to 10000 ppm, 1000 ppm, 100 ppm, 10 ppm and 1 ppm, respectively @ 50 µl /card. In one replication, 5 cards treated with different dilution of extracts and one card treated with n-hexane was taken in one petridish and such five petri dishes were maintained for each treatment. Thus there were five replications in each treatment. The cards were arranged equi-distantly in the experimental arena, which consisted of a 150 mm diameter. The 0-24 hours old 10 gravid female wasps of *T. chilonis* was released in to center of arena. After a few minutes, parasitoids start to move towards the egg cards treated with different extracts. The parasitoids were allowed to search in the experimental arena for a total period of 45 minutes from the time of settlement of parasitoids on the strips. Number of parasitoids that visited the cards was counted at 5 minutes interval (referred to as Parasitoid Activity Index). After 45 min. the parasitoids were removed carefully from such egg card with the help of camel soft brush (zero number) and these cards were kept individually in sterilized glass vials at 26º ± 1°C and 65 ± 5% R.H. Parasitism was recorded after 03-04 days at blackening of eggs (referred to as Percent Parasitization Index) and emergence of wasp was recorded (referred to as an Adult

Emergence Index).

Statistical Analysis

The data obtained in different experiments were subjected to statistical analysis as described by Gomez and Gomez [7]. The data on parasitoid activity index were subjected to square root transformation, whereas the data on percent parasitisation were subjected to Arc Sin transformation and data on adult emergence were subjected to square root transformation. In order to know the interaction between treatments and concentrations, data from petridish bioassay were subjected to two- factorial CRD analysis in SAS 9.2 [8] and the means were tabulated. Treatment means were differentiated with the help of least significant difference (LSD = CD) value taken at 5%. For comparing the various treatments, the means of the original data were used.

Data obtained from Y tube olfactometer bioassay were analyzed by the Chi square test of independence (α = 0. 05) in SWAU [9] turner faculty online mathematics analysis.

Results and Discussion

Response of *T. chilonis* to leaf extract of four sugarcane variety in "Y" tube Olfactometer bioassay

This study aims to define the behavioural activity of *T. chilonis* on sugarcane leaf extracts. The hundred female wasps of *T. chilonis* were released to stem of the Y tube olfactometer and movement of the wasp was recorded. The experiment was done with all four sugarcane varieties separately. It was observed that the number of parasites preferred the odor of leaf extracts of all four sugarcane varieties or choice was significantly higher over untreated control or no choice but among the sugarcane varieties, the difference in the number of parasitoid preferred the choice and no choice were not significant ($\chi^2 = 2.977$, df = 3; $p < 0.05$). The highest number of individuals of parasitoid (70) was observed in the leaf extract of CoLk94184 (Figure 2) followed by CoJ64 leaf extract (64), CoLk8102 (61) and Co0238 (59). Data indicates that the leaf extract of Co0238 was less preferred by the parasite as compared to other sugarcane varieties (Figure 2).

It is evident data that the hypothesis is correct and there is no difference between observed frequency and expected frequency and the association between leaf extracts of all varieties and dual choice preference by *T. chilonis* was independent. On the basis of chi square interpretation, the dual choice preferences by *T. chilonis* in relation to four varietal leaf extracts was independent. The results of preference may be governed by own effect of responsible leaf extract of individual sugarcane variety. The bioassays of leaf extract were proved that the leaf has a responsible component for attraction of parasitoid toward the host plant. The result observed by Geetha [10] supports the present findings, in her experiment on no-choice and two- choice with hexane washings of a number of crop plants including sugarcane to *T. chilonis,* the higher number of individuals of wasps were attracted to hexane based extract of all the plant including sugarcane. Fatouros *et al.* [11], Rani *et al.* [12], Penaflor *et al.* [13], Bhagat *et al.* [14], Huang *et al*. [2] were also reported that the leaves of plant release ovipositional chemical cues to attract the female moths for oviposition. These long range cues are also used by parasitoids to locate plants with host eggs.

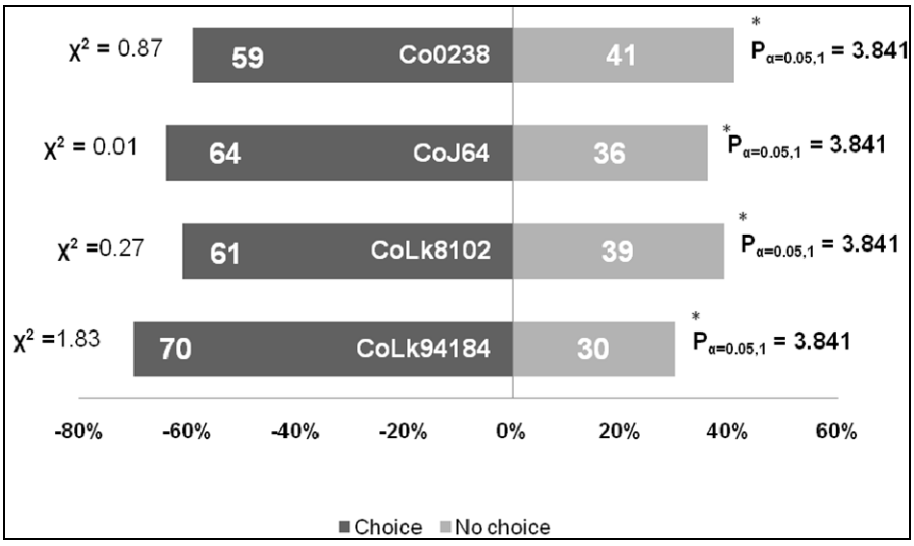

Fig 2: Synomonal effect of uninfested sugarcane plant leaf extract of four varieties on behavior of *T. chilonis* in dual choice Y- tube Olfactometer experiment. Asterisks indicate the dual choice preferences within the test is independent (chi-square, P<0.05).

In sugarcane based agro-ecosystem, the tritrophic relationships between the plant, insect host and parasitoids (Figure 1), the eggs are laid by females of borers like; sugarcane stalk borer, *C. auricilius* on the lower surface of sugarcane leaves means eggs are exposed to open environment are not easily visualized by the parasitoid. The volatiles of the sugarcane plant attract *C. auricilius* female for oviposition [2], these synomonal volatiles are attract the egg parasitoids simultaneously [10], after the oviposition by pest might initiate the release of plant volatiles functioning as host finding cues for egg parasitoids [13]. In this process of host location and selection, several cues associated with the host are playing a major role, the plant-parasitoid interactions were studied where the plant surface chemicals act as info-chemicals that attract or arrest the parasitoids for egg parasitization and strategically help in preventing the pest infestation [12]. Efficacy of parasitoids can be enhanced by having the idea of the relationship among the host plants, pests and parasitoids (tritrophic relationship) that is influenced by some volatile chemicals emanated from the surface of plant leaves and insect pests (Semiochemicals) [15]. Communication between the parasitoid and plants for attracting them is done through the exchange of information between signaler (plant) and receivers (parasitoids) are guided

by a type of semiochemical, synomones. While the communication among the animals signaler (host insect stages and their byproducts) and receiver (parasitoid) is guided by kairomone [16]. These chemicals are also used for enhancing the parasitoid activity and effectiveness of biological agents.

Synomonal effect of uninfested sugarcane plant leaf extract on visit of *T. chilonis* in petri dish bioassay

This study also defines the foraging behaviour of *T. chilonis* near the host eggs laid on plant to identify the chemicals responsible for enhancing the activity of parasitoid and parasitization rate. In this bioassay the untreated and treated clutch of eggs treated with different concentration of synomonal extracts were tested.

Petri dish bioassay was carried out with different concentrations (10000 ppm, 1000 ppm, 100 ppm, 10 ppm and 1ppm) of leaf extracts of uninfested sugarcane plants of all four sugarcane varieties. In the case of Co0238, the mean visit of parasitoid (Parasitoid Activity Index, PAI) (in parenthesis) (Table 1) was lower in all the concentration than control (n-hexane) (22.80). While within the concentrations the PAI was higher (13.40) in 1000 ppm followed by 100 ppm (11.40), 10000 ppm (11.0), 1 ppm (10.60) and 10 ppm (10.40) (Table 1). In the case of CoJ64, the visit of parasitoid (PAI) was low in all the concentration than control (n-hexane) (19.40) (Table 1). While within the concentrations the PAI was higher (7.80) in 10000 ppm followed by 1ppm (5.60), 1000 ppm (5.20), 100 ppm (3.60) and 10 ppm (3.40) (Table 1). In the case of CoLk8102, PAI was higher (27.80) in untreated control over treatments but in 1 ppm PAI was 24.20 and it was at par with untreated control (Table 1). PAI in other treatments was 13.80 (1000 ppm), 13.20 (100 ppm), 10.60 (10000 ppm) and 7.80 (10 ppm). Trend in CoLk94184 was same as in the case of CoLk8102 except 10000 ppm and 10 ppm (Table 1). It is evident from data presented in table 1 that the 10 ppm concentration was least preferred in three sugarcane varieties except CoLk94184. Among the different varieties, the PAI was highest (16.70) in CoLk94184 followed by CoLk8102 (16.23), Co0238 (13.27) and CoJ64 (7.50) (Table 1). This finding indicates that varieties play an important role in attraction of parasitoids. No more work has been done on these aspects except Madhu *et al.* [17]. The results found by Madhu *et al.* [17] were similar in bioassay of eight plants including sugarcane aqueous extracts in petridishes by using Trichogramatids and they were found that *Trichogramma brasiliense* (Ashmead) and *T. japonicum* (Ashmead) represent variant activity in egg cards treated with different extracts and the lowest activity of parasitoids were recorded in egg cards treated with sugarcane leaf extract. In different cultivar of rice ecosystem the *Trichogramma japonicum* and *T. chilonis* represents significant variations in parasitoid activity and parasitization rate [14].

Table 1: Synomonal effect of uninfected sugarcane plant leaf extract of four varieties on visit of *T. chilonis* in petri dish bioassay

Concentration (C)	Means of variety (T) × Concentration (C) interactions				Mean
	Co0238	CoJ64	CoLK8102	CoLK94184	
C_1	11.00 (3.28)	7.80 (2.30)	10.60 (3.19)	8.00 (2.43)	9.35^{bc} (2.80)
C_2	13.40 (3.06)	5.20 (1.65)	13.80 (3.68)	18.60 (4.13)	12.75^{bc} (3.13)
C_3	11.40 (2.96)	3.60 (1.60)	13.20 (3.23)	17.60 (4.16)	11.45^{bc} (2.99)
C_4	10.40 (2.87)	3.40 (1.40)	7.80 (2.47)	14.20 (3.70)	9.00^{c} (2.61)
C_5	10.60 (2.96)	5.60 (2.27)	24.20 (4.81)	20.40 (4.39)	15.20^{b} (3.61)
Control (Hexane)	22.80 (4.45)	19.40 (4.26)	27.80 (5.25)	21.40 (4.57)	22.85^{a} (4.63)
Mean	13.27^{a} (3.26)	7.50^{b} (2.25)	16.23^{a} (3.77)	16.70^{a} (3.90)	
Factors		S.E(m)±	C.D. at 5%		
Treatment (T)		0.24	0.69		
Concentration (C)		0.24	0.69		
Treatment × Concentration (T×C)		0.61	1.70		

Figures in parenthesis are square root transformed values.
Means of five observation.
C_1= 1% (10000 ppm), C_2 = 0.1% (1000 ppm), C_3 = 0.0 1% (100 ppm),
C_4 = 0.001% (10 ppm), C_5= 0.0001% (1 ppm), Control (Hexane) = n- Hexane (99%)

Synomonal effect of uninfested sugarcane plant leaf extract on parasitism by *T. chilonis* in petri dish bioassay

The data of mean percent parasitization (in parenthesis) of *C. cephalonica* eggs by *T. chilonis* when egg clutch treated with different concentrations of leaf extract of all sugarcane varieties were exposed to study the parasitoid activity index in petri dish bioassay are presented in table 2.

In the case of Co0238, the parasitisation of *C. cephalonica* eggs were higher (51.99%) in control (n-hexane) over all the treatments (Table 2). Among the concentrations, the parasitisation were higher (35.33%) in 100 ppm (Table 2) followed by 10000 ppm (29.99%), 10 ppm (26.66%), 1 ppm (22.66%) and 1000 ppm (22.00%). In the case of CoJ64, the parasitisation of *C. cephalonica* eggs were higher (63.33%) in control (n-hexane) over all the treatments. Among the concentrations, the parasitisation was higher (11.33%) in 1 ppm (Table 2) followed by 10000 ppm (10.00%), 10 ppm (6.66%), 1000 ppm (5.33%) and 100 ppm (2.00%).

Table 2: Synomonal effect of uninfested sugarcane plant leaf extract of four varieties on per cent parasitisation by *T. chilonis* in petri dish bioassay.

Concentration	Means of variety (T) × Concentration (C) interactions				Mean
	Co0238	CoJ64	CoLk8102	CoLk94184	
C_1	29.99 (32.54)	10.00 (14.07)	59.33 (51.88)	43.33 (40.67)	35.66^{bc} (34.79)
C_2	22.00 (24.32)	5.33 (10.07)	52.66 (46.70)	80.00 (65.28)	40.00^{bc} (36.59)
C_3	35.33 (32.46)	2.00 (3.68)	35.99 (33.53)	76.00 (60.74)	37.33^{bc} (32.60)
C_4	26.66 (25.04)	6.66 (9.59)	41.33 (36.75)	69.33 (57.06)	36.00^{c} (32.11)
C_5	22.66 (24.33)	11.33 (19.10)	84.66 (69.45)	73.33 (62.51)	48.00^{ab} (43.85)
Control (Hexane)	51.99 (43.57)	63.33 (54.63)	60.00 (51.08)	86.66 (71.51)	65.50^{a} (55.20)
Mean	31.44^{c} (30.38)	16.44^{d} (18.52)	55.66^{b} (48.23)	71.44^{a} (59.63)	
Factors		S.E(m)±		C.D. at 5%	
Treatment (T)		3.34		9.38	
Concentration (C)		4.09		11.49	
Treatment × Concentration (T×C)		8.18		22.98	

Figures in parenthesis are Arc sin transformed values.

Means of five observation.

C_1 = 1% (10000 ppm), C_2 = 0.1% (1000 ppm), C_3 = 0.0 1% (100 ppm), C_4 = 0.001% (10 ppm), C_5= 0.0001% (1 ppm), Control (Hexane) = n- Hexane (99%)

In the case of CoLk8102 the parasitisation of *C. cephalonica* eggs were higher (84.66%) in the 1 ppm concentration of the extract and it was significantly higher over other concentrations including control (n-hexane) (Table 2). It was 60.00 per cent in untreated control. In 10000 ppm, parasitisation was 59.33 per cent followed by 1000 ppm and 10 ppm with 52.66 percent and 41.33 percent parasitisation, respectively. The lowest parasitisation (35.99%) of eggs were recorded in 100 ppm. In the case of CoLk94184, the parasitisation of *C. cephalonica* eggs were higher (86.66%) in control (n-hexane) over all the treatments (Table 2). Among the concentrations, the parasitisation was higher (80.00%) in 1000 ppm (Table 2) followed by 100 ppm (76.00%), 1 ppm (73.33%), 10 ppm (69.33%), and 10000 ppm (43.33%). On variety basis, the higher mean percent parasitisation was recorded in the leaf extract of CoLk94184 (71.44%) (Table 2) followed by CoLk8102 (55.66%), Co0238 (31.44%) and low parasitisation was recorded in CoJ64 (16.44%). It is also observed that the PAI has less influence on parasitisation. It has been observed that sugarcane variety behaves independently in respect of parasitoid's visit and prasitisation. Present findings is corroborate with the findings of Madhu *et al.*[17], they bioassayed aqueous extracts of eight plants including sugarcane in petri dishes to observe their synomonal effect on parasitism by *Trichogramma brasiliense* (Ashmead) and *T. japonicum* (Ashmead) and found low response of parasitoids to maize and sugarcane extracts.

Adult emergence of *T. chilonis* when eggs treated with different concentrations of leaf extracts of uninfested plants of four sugarcane varieties

The data of mean *T. chilonis* adult emergence (in parenthesis) from parasitized eggs of *C. cephalonica* when egg clutch treated with different concentrations of leaf extract of uninfested sugarcane plant of four varieties were exposed to parasitoid to study the parasitoid activity index in petri dish bioassay are presented in table 3.

In the case of Co0238, the number of *T. chilonis* adults emerged from *C. cephalonica* eggs was higher (14.40) in control (n-hexane) over all the treatments (Table 3). Among the concentrations, adult emergence was higher (6.20) in 10000 ppm & 100 ppm (Table 3) followed by 10 ppm (6.00), 1000 ppm (5.00) and 1 ppm (4.40). In the case of CoJ 64, the adult emergence was higher (15.20) in control (n-hexane) over all the treatments (Table 3). Among the concentrations, the adult emergence was higher (2.40) in 1 ppm (Table 3) followed by 10000 ppm (2.00), 10 ppm (1.00), 100 ppm (0.60) and 1000 ppm (0.40). In the case of CoLk8102 the adult emergence was higher (20.00) in the 1 ppm concentration of the extract and it was significantly higher over other concentrations including control (n-hexane) (Table 3). It was 14.20 in untreated control (n-hexane). In 10000 ppm, adult emergence was 12.60 followed by 1000 ppm (12.40) and 10 ppm (7.40). The least adult emergence (7.20) was recorded in 100 ppm (Table 3). In the case of CoLk94184, the adult emergence was higher (23.60) in the 1000 ppm concentration of the extract (Table 3) and it was significantly higher over other concentrations including control (n-hexane). It was 20.60 in untreated controls. In 1 ppm, adult emergence was 20.40 followed by 100 ppm (20.20) and 10 ppm (16.60). The least adult emergence (11.80) was recorded in 10000 ppm. On the variety basis, the higher adult emergence was recorded in the leaf extract of CoLk94184 (18.87) followed by CoLk8102 (12.30) and Co0238 (7.03) (Table 3). The least adult emergence was recorded in CoJ64 (3.60). It is also observed that the PAI and percent parasitization has less influence on adult emergence. It has been observed that the sugarcane variety behaves independently in respect of parasitoids visit, parasitization and adult emergence.

Table 3: Adult emergence of *T. chilonis* when eggs treated with different concentrations of leaf extracts of uninfested plants of four sugarcane varieties in petri dish bioassay

Concentration (C)	Means of variety (T) × Concentration (C) interactions				Mean
	Co0238	CoJ64	CoLK8102	CoLK94184	
C_1	6.20 (2.39)	2.00 (0.84)	12.60 (3.46)	11.80 (2.93)	8.15^{bc} (2.40)
C_2	5.00 (1.83)	0.40 (0.28)	12.40 (3.38)	23.60 (4.80)	10.35^{bc} (2.57)
C_3	6.20 (2.04)	0.60 (0.34)	7.20 (2.32)	20.20 (4.49)	8.55^{bc} (2.30)
C_4	6.00 (1.86)	1.00 (0.62)	7.40 (2.32)	16.60 (3.63)	7.75^{c} (2.11)
C_5	4.40 (1.74)	2.40 (1.31)	20.00 (4.45)	20.40 (4.42)	11.80^{b} (2.98)
Control (Hexane)	14.40 (3.36)	15.20 (3.61)	14.20 (3.71)	20.60 (4.51)	16.10^{a} (3.80)
Mean	7.03^{c} (2.20)	3.60^{d} (1.17)	12.30^{b} (3.27)	18.87^{a} (4.13)	

Factors	S.E(m)±	C.D. at 5%
Treatment (T)	0.23	0.65
Concentration (C)	0.28	0.79
Treatment × Concentration (T×C)	0.56	1.59

Figures in parenthesis are square root transformed values. Means of five observation C_1= 1% (10000 ppm), C_2 = 0.1% (1000 ppm), C_3 = 0.0 1% (100 ppm), C_4 = 0.001% (10 ppm), C_5= 0.0001% (1 ppm), Control (Hexane) = n- Hexane (99%)

Conclusion

The leaf extracts of all sugarcane variety is responsible for synomonal activity by attracting, guiding the parasitoid toward the host. The chemical cues emanated from leaf of sugarcane plant were responsible for foraging activity of *T. chilonis* in sugarcane crop ecosystem. The influence of extracts on parasitoid visit, percent parasitism and adult emergence of *T. chilonis* wasp is very less when the extracts are applied on the host eggs.

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