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Effect of food plants on the functional response of the parasitoids

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Abstract

Effect of food plants on the functional response of parasitoid *Campoletis chlorideae*, Uchida (Hymenoptera: Ichneumonideae) is an effective bio-control agent against *Helicoverpa armigera*, Hubner (Lepidoptera: Noctuidae). an attempt has been made to find out the effect of three food plants of *H. armigera viz Cicer arietinum, Pisum sativum* and *Cajanus cajan* on functional response of *C. chlorideae*. *C. chloride* is allowed to do it functional activities like antenalen counter, stings and number of off springs emergence on three selected food plants reared host at different host densities *viz* 2,4,8,16,32 and 64 and data obtained is subjected to ANOVA. It is observed that antenalen counters, stings and no. of offspring emergence of parasitoid increase significantly with the increase of host densities reared on three food plants and found to be maximum on host reared on *C. arietinum* followed by *P. sativum* and *C. cajan*. It means this parasitoid *C. chlorideae* could play a role in the integrated control of *H. armigera*.

Keywords: food plants, parasitoids, *Campoletis chlorideae*, hymenoptera, ANOVA

Introduction

Among the many other paste of pulses, the *H. armigera* (Hubner) is the most dreaded pest in India and causes enormous losses in important pulses *viz. C. arietinum*, *P. sativum* and *C. cajan*. Generally the 2nd instar larvae is more active and sited in pod, makes the pod empty. Its adult stage is sap sucking type and in the comparison to larvae causes less damage. The most destructive form of *Helicoverpa spp.* is *H. zea (*Bodolie), *H. armigera* (Hubner) and *H. virescens* (F). In India three spp. *H. armigera* (Hubner) *H. peltigera* (Schiff) and *H. assulta* (Guenee), occur frequently, although *H. armigera* is by for the most important (Jayaraj,1982) [16]. *C. chloridae* Uchida is an effective bio-control agents against *H. armigera* (Patel & Patel, 1972; Hu *et al.*, 1985; Sathe & Nikam, 1986; Patel & Habib, 1987; Srinivas, 1989, Dai 1990; Kumar *et al.*, 1994) [24, 25, 14, 28] and parasitizes the moth's larval stages (Sathe & Nikam, 1986) [28].

A predator can respond in many ways to change the density of its prey, so parasitoid can also respond in many ways. One of the most widely investigated responses has been the consumers functional response (Soloman,1949) which is a short term behavioral phenomenon defined in terms of relationship between the numbers of host (Heliothis) parasitized by parasitoid (Campoletis).

Knowledge of the functional response is the response of individual parasitoid to changing host densities. This response is essential for clear understanding and proper approach to the modeling of host parasitoid interactions (Huffakar *et al.*, 1971; Ables & Shepard, 1974) [2]. Functional response can be useful for screening potential enemy spp. determining control potential of endogenous predators and comparing the relative effectiveness of predators in controlling the prey population. Holling (1959, 1966) [12] proposed three types of functional response. Type 1st: A linear ratio plateau; Type 2nd: A curvilinear rise to a plateau and Type 3rd: A sigmoid curve rise to a plateau. Type 2nd response is normally exhibited by arthropod predator/parasitoids but they have also been observe with entomophagous invertebrates (Hofsvang & Hagvar, 1983) [11], and is considered to be a typical functional response.

Differences in the quality of food plants and the texture of their leaves have been reported to influence the reproductive behavior of predator/parasitoids (Rabb & Bradley, 1968) [27] but little information is available on the role of food plants and their impact on the reproductive rate of parasitoid.

This type of study may throw light on selecting proper food plants for the mass rearing of host and parasitoids. Therefore in the present investigation an attempt has been made to find out the effect of three host plants of *H. armigera viz. C. arietinum*, *P. Sativum* and *C. cajan* on the functional response of *C. chlorideae*.

Materials and method

Culture of host and Parasitoids

The parasitoid *C. chlorideae* and it host *H. armigera* were reared on *C. arietinum* Linn. (Chickpea) in the laboratory at 22±4°C 70±10% RH and 10h light: 14 h dark photoperiod (Tripathi & Kumar, 1984) [1]. Laboratory cultured larva of *Helicoverpa* reared on *C. arietinum* was transferred on rest two food plants *viz P. sativu*m and *C. cajan* for rearing. 2nd instar larvae of the host (the stage most preferred by the parasitoid) (Patel & Patel, 1972; Kumar *et al.*, 1983) [24] were draw from the maintained culture and utilized as host. One day old mated and experienced (T` Hart *et al.*, 1978) [33] female parasitoid satiated (Kumar *et al.*, 1987) [1] with a 30% honey solution were used in the experiment.

Functional Response

To study the functional response of *C. chloridere* 1, 2, 4, 8, 16, 32 and 64 hosts (reared on *C. arietinum*) were placed separately on to moistened filter paper. Each filter paper was transferred individually to troughs (Ca 20 cm. diameter × 10 cm height) covered with glass plates. One parasitoid was introduced into each through and was allowed to attack host for 3 hours. The different activity of each parasitoid during the experiment were observed by magnifying lenses and recorded after the pattern of Kumar *et al.* 1987 [1] until emergence.

After the commencement of the experiment the larve were transferred to glass tube (10x3.25 c.m.) with fresh foliage of *C. arietinum* (Chickpea) for further development. Each tube was covered with a muslin cloth. After cocoon formation, the cocoon were collected and transferred singly by zero number camel hair brush into marked sterilized glass vials (5x1.25 c.m) with leaves of chick pea (Kumar & Tripathi, 1987, 1988) [1] to provide moisture to the developing eggs (Abidi *et al*., 1987, Kumar *et al*., 1987) [1] until emergence.

Same experiments (as above mentioned for the host reared on *C. arietinum*) were conducted with the host reared on *P. sativum* and *C. cajan* food plants.

The glass vials were kept plugged with absorbent cotton after emergence, the parasitoids were counted and data subjected to statistical analysis. The experiment was replicated five times with each food plants reared host with new experienced female parasitoid and fresh hosts (which were reared on different food plants) Because of chance of super- parasitisation (Force & Messenger, 1965) [8] or egg and larval mortality, the resulting numbers of parasitoids emerged has been taken as parameter of number of eggs laid in the present investigation.

Results

1. **Number of antennal encounter of the parasitoid *C. chlorideae* with the host *H. armigera* reared on three selected food plants *C. arietinum, P. sativum* and *C. Cajan*:** The observation shows that as the host density increases, the number of antennal encounter of the parasitoid increases significantly in all the three selected food plants reared host *H. armigera*. It was found to be maximum in host reared on *C. arietinum* ($Y = 23.511 + 1.128 \log x$, $r = 0.894$, $p < 0.01$) followed by *P. sativum* reared host ($Y = 14.787 + 0.624 \log x$, $r = 0.871$, $P < 0.01$) and *C. cajan* reared hosts ($Y = 11.489 + 0.594 \log x$, $r = 0.889$, $P < 0.01$) (Table 1, Fig 1).

ANOVA shows that the number of antennal encounter significantly influenced between the three selected food plants ($F = 16.2595$, $P < 0.01$) as well as between seven hosts density ($F = 21.2223$, $P < 0.01$) (Table 2)

Table 1: Number of antennal encounter of parasitoid *Campoletis chlorideae* at varying host density (Host: *Helicoverpa armigera* reared on three selected food plants *viz. Cicer arietinum, Pisum sativum and Cajanus cajan)* Each entry is the mean of 5 replicates (mean ± SD)

Host Density	Food Plants		
	Cicer arietinum	***Pisum sativum***	***Cajanus Cajan***
1	3.2 ± 1.483	1.8 ± 0.836	1.2 ± 0.447
2	22.6 ± 4.878	14.8 V 1.303	11.6 ± 1.140
4	30.0 ± 1.581	18.4 ± 3.577	13.8 ± 1.923
8	38.0 ± V 5.700	23.0 ± 2.121	18.4 ± 2.701
16	56.0 ± 2.738	33.2 ± 2.863	28.4 2. ±701
32	73.0 ± 2.549	43.6 ± 2.701	39.2 ± 2.280
64	85.0 ± 6.363	48.0 ± 3.674	43.2 ± 2.701
Y = a+b log x			
A	23.511	14.787	11.489
B	1.128	0.624	0.594
R	0.894	0.871	0.889
P	0.01	0.01	0.01

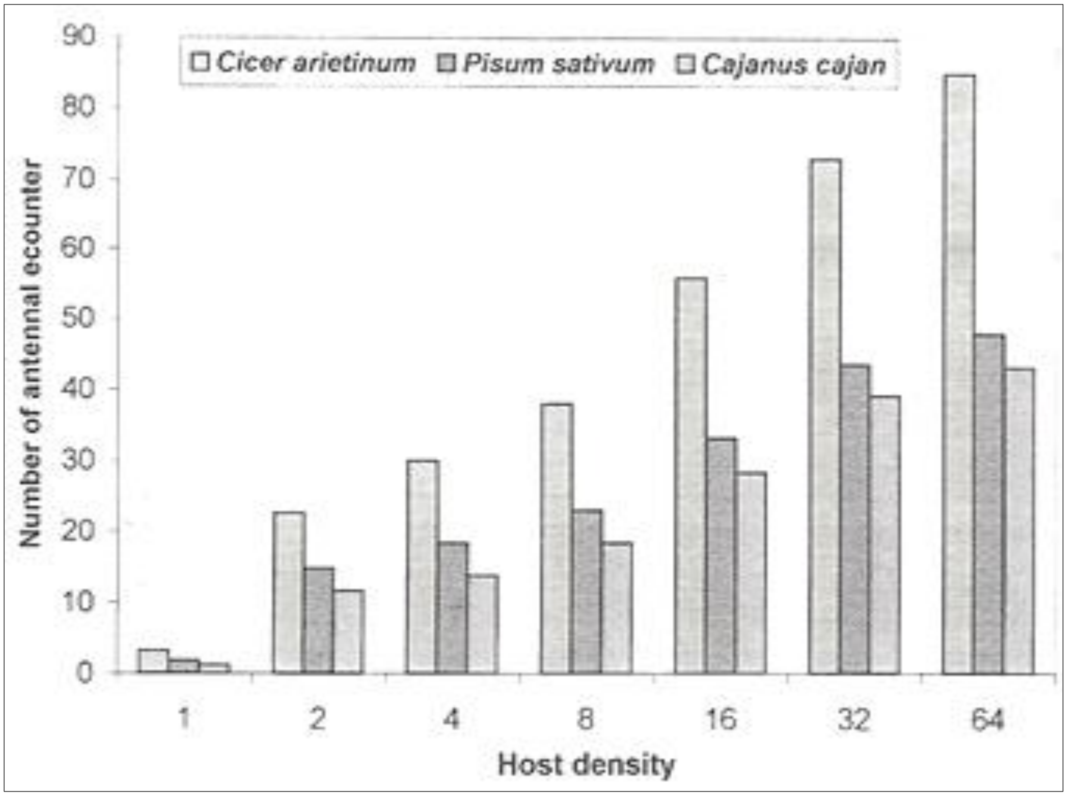

Fig 1: Number of antennal encounter of parasitoid *Campoletis chlorideae* at varying host density (Host: *Helicoverpa armigera* reared on three selected food plants *viz. Cicer arietinum, Pisum sativum* and *Cajanus cajan).*

Table 2: Summary of computation for analysis of variance of the data of Number of antennal encounter of parasitoid at varying host density reared on three selected food plants

Components	Degree of freedom	Sum of square	Variance	F- value	P
Between plants	2	1878.95	939.475	16.2595	0.01
Between density	6	7357.35	1226.225	21.2223	0.01
Interaction	12	693.37	57.7808		
Total	20	9929.67	496.4835		

2. **Number of Stings of the parasitoid *C. chlorideae* with the host *H. armigera* reared on three selected food *C. arietinum, P. sativum* and *C. cajan:*** As the host density increase, the number of stings of the parasitoids increases significantly in all the three selected food plants reared host *H. armigera*. It is maximum in host reared on *C. arietinum* (Y = 14.354 + 0.932 log x, r = 0.8535, P < 0.01) followed by *P. sativum* reared host (Y = 10.359 + 0.909 log x, r = 0.894, P < 0.01) and *C. cajan* reared host (Y = 8.089 + 0.693 log x, r = 0.898, P < 0.01) (Table 3, Fig 2). ANOVA shows that the number of strings significantly influenced between the three selected food plants (F = 10.0708, P < 0.01) as well as between seven host density (F= 72.9131, P< 0.01) (Table 4).

Table 3: Number of stings of parasitoid *Campoletis chlorideae* at varying host density (Host: *Helicoverpa armigera* reared on three selected food plants *viz. Cicer arietinum*, *Pisum sativum* and *Cajanus cajan*. Each entry is the mean of 5 replicates. (Mean ±SD)

Host Density	Food Plants		
	Cicer arietimum	***Pisum sativum***	***Cajanus cajan***
1	0.8 ± 0.400	0.4 ± 0.047	0.2 ± 0.047
2	3.0 ± 0.707	2.6± 0.894	2.2 ± 0.447
4	18.0 ± 0.707	13.0 ± 2.000	9.0 ± 0.707
8	32.0 ± 5.385	28.0 ± 1.221	22.0 ±1.581
16	45.0± 1.870	31.0 ± 4.123	27.0 ± 1.225
32	57.0 ± 1.581	54.0 ± 3.535	38.0 ± 1.224
64	63.0 ± 7.035	59.0 ± 1.000	46.0 ± 3.464
Y = a+b log x			
A	14.354	10.359	8.049
B	0.932	0.9.9	0.693
R	0.854	0.894	8.898
P	0.01	0.01	0.01

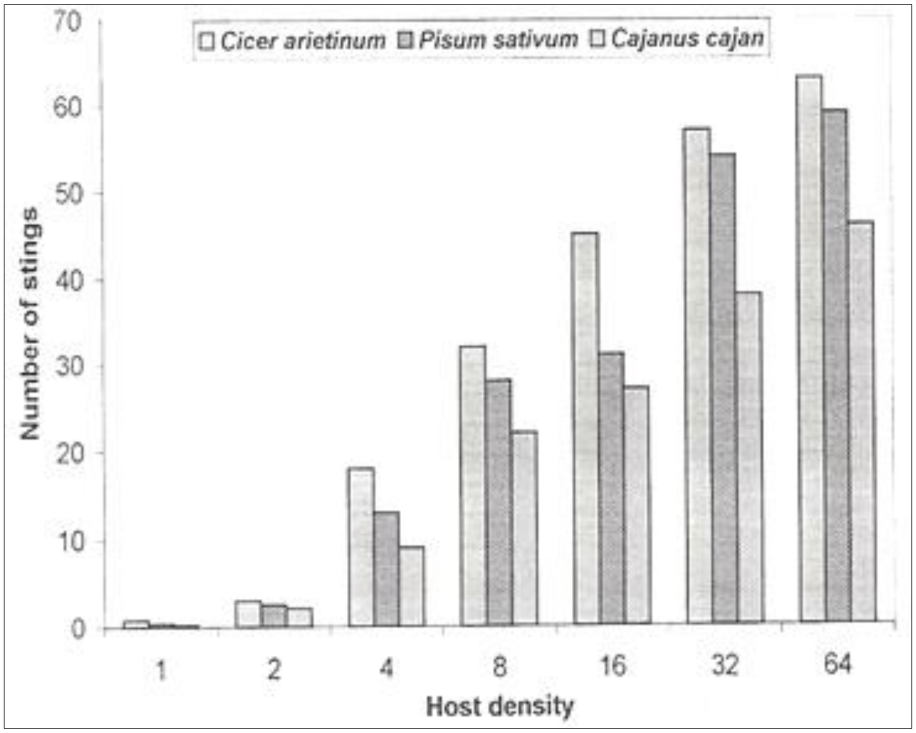

Fig 2: Number of stings of *Campoletis chlorideae* at varying host density (Host: *Helicoverpa armigera* reared on three selected food plants *viz. Cicer arietinum, Pisum sativum* and *Cajanus cajan*).

Table 4: Analysis of variance of Number of stings of parasitoid *Campoletis chlorideae* at varying host density reared on three selected food plants

Components	Degree of freedom	Sum of square	Vaiance	F- value	P
Between plants	2	399.29	199.65	10.0708	0.01
Between density	6	8672.58	1445.43	72.9131	0.01
Interation	12	237.89	19.82		
Total	20	9309.76	465.49		

3. **Number of offspring emerged of the parasitoid *C. chlorideae* with the host *H. armigera* reared on three selected food plants *C. arietinum, P. sativum* and *C. cajan:*** The relationship between the number of parasitoid emerged and host density resemble to that of antennal encounter and parasitoid's stung i.e. the number of parasitoid emerged increased slowly at first, then rapidly to gain a maximum value. As the host density increases, the number of offspring emerged of the parasitoids increases significantly in all three selected food plants reared host *H. armigera*. It was found to be maximum in host reared on *C. arietinum* (Y = 0.851+0.352 log x, r= 0.936, P < 0.01) followed by the hosts reared on *P. sativum* (Y = 0.355+ 0.313 log x, r = 0.952, P <0.01) and host reared on *C. cajan* (Y = - 0.28+0.225 log x, r= 0.954, P < 0.01) (Table 5. Fig 3). ANOVA shows that the number of emerging offspring significantly influenced between the three selected food plants (F= 6.3554, P< 0.025) as well as between seven host density (F= 54.7895, P<0.01) (Table 6).

Table 5: Number of offspring emergence of parasitoid *Campoletis chlorideae* at varying host density (Host. *Helicoverpa armigera* reared on three selected food plants *viz. Cicer arietinum*, *Pisum sativum* and *Cajanus cajan*. Each entry is the mean of 5 replicates (mean ± SD)

Host Density	Food plants		
	Cicer arietinum	***Pisum sativum***	***Cajanus cajan***
1	0.2 ± 0.040	0.0 ± 0.000	0.0 ± 0.000
2	0.6 ± 0.570	0.4 ± 0.040	0.2 ± 0.040
4	1.0 0.700	0.8 ± 0.030	0.4 ± 0.040
8	2.0±0.700	1.8 ± 1.780	0.6± 0.540
16	8.6 ± 4.820	6.0 ± 1.580	3.8± 1.780
32	18.0±1.000	15.2 ± 2.280	10.6± 1.510
64	20.2 ± 2.380	18.0± 1.580	12.8 ±2.380
Y = a+b log x			
a	0.8508	0.3551	-0.0275
b	0.3515	0.3127	0.2251
r	0.9356	0.9519	0.9535
p	0.01	0.01	0.01

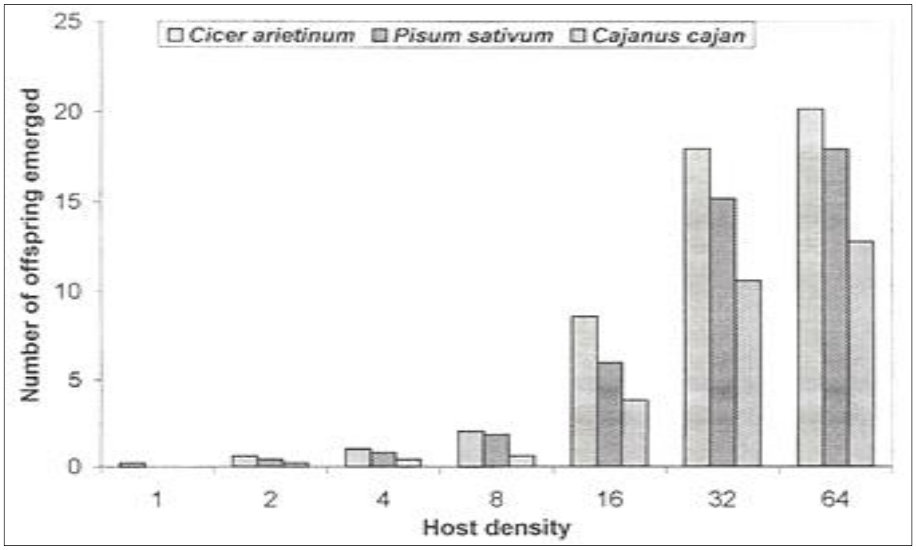

Fig 3: Number of offspring emergence of *Parasitoid Campoletis chlorideae* at varying host density (Host: *Hellicoverpa armigera* reared on three selected food plants *viz. Cicer arietinum, Pisum sativum and Cajanus cajan*).

Table 6: Analysis of variance of Number of offspring emergence of parasitoid *Campoletis chlorideae* at varying host density reared on three selected food plants

Components	Degree of freedom	Sum of square	Variance	F- value	P
Between plants	2	35.89	17.94	6.3554	0.025
Between density	6	928.39	154.73	54.7895	0.01
Interaction	12	33.88	2.82		
Total	20	998.18	49.90		

Discussion

It was observed that when a female parasitoid *C. chlorideae* becomes active, being to vibrate her antennae up and down and side to side when she approach the vicinity of host. In doing so first she touches the substratum and finally the hosts. The hosts are encountered by the antennae of the parasitoid and are examined for provisional acceptance or rejection. If the host is acceptable then the parasitisation follows. The number of antennal encounters of the parasitoid was increased significantly by the increase in host density in all three selected food plants reared host. With the increase of host density, the number of pricking's by the parasitoid in to the hosts body increases significantly in all three selected food plants reared hosts and maximum in *C. arietinum* reared host followed by *P. sativum* and *C. cajan* reared host.

The behavior of an insect parasitoid, when searching for a suitable host, is guided by a single general principle. The attempt to parasitise as many hosts as possible and thereby achieves maximum reproductive success (Cook & Hubbard, 1977) [6]. We observed that, after stinging, the hosts crawled away from the parasitoid. When there is antennal contact with the host the parasitoid probably receives additional cues, which stimulate oviposition. As the host density increase the number of offspring emerged increased significantly in all three food plants reared host. The relationship between the number of parasitoid emerged and host density showed that parasitoid emergence increases slowly at first, as host density increased, parasitoid emergence increased most rapidly and there after established. The number of emerging offspring is maximum in *C. arietimum* food plant reared hosts followed by *P. sativum* food plant reared hosts and *C. cajan* food plant reared hosts.

These all phenomenon (activity) associated with the functional response increases significantly with the increase of host density, possibly due to the presence of volatile chemicals (Allomones) in varying quantities on the food plants and increased kairomonal concentration which activates the parasitoid (Nordlund & Lewis, 1976, Ananthakrishnan *et al.*, 1991) [22, 3]. The kairomones stimulate the host seeking response of the parasitoid, thus play a significant role in host location and host acceptance by the parasitoid (Arthur, 1981) Kairomones affect the behavior of parasitoid in at least three different ways (1) By the activation of searching for hosts, (2) Through retention of the parasitoid in the target area and (3) By improving the egg distribution of the parasitoid (Singh & Srivastava, 1990) [29].

The role of increased surface area of contact of the host at higher host densities may play a significant role in increasing of antennal encounter (Hassell & Rogers, 1972, Pandey *et al.*, 1984, Abidi *et al.* 1987) [10, 23, 1]. The number of antennal encounters might also have increased at higher host densities because the parasitoid spent significantly more time for stinging and parasition (Kumar *et al.* 1988, 1994) Since large number of healthy hosts found by them as she could identify the previously parasitised hosts (Hofsvag & Hagvar, 1983) [11]. Results also indicate that it was host density, which influenced the attack pattern of the parasitoid. Similar observation has been reported by 'T' Hart *et al.* (1978) [33] and Podoler & Major (1981) [26]. It has also been observed that not one sting preclude ovipositions at all host densities (Hamilton, 1974 ; abidi *et al.*, 1987; Kumar *et al.*,1994) [1] irrespective of three selected food plant reared host *H. armigera*. These false attacks depends upon the host size, stage of development, immediate availability of eggs in the oviduct of female parasitoid, nutrition of the parasitoid during its development and the co-presence of males along with females (Abidi *et al.*, 1987; Tripathi & Singh, 1991) [1, 30].

The analysis of variance show that number of offspring significantly influenced between three food plants as well as seven host densities. Parasitoid encounters a series of challenges before ovipositing her eggs into host, she has to locate host`s habitat and the host, assess the host and decide whether to oviposit or not (Singh *et al.*, 2001) [30]. The oviposition trend of *C. chlorideae* was sigmoid in nature and resembled the type III curve of Holling (1959) [12]. The sigmoid functional responses are density dependent up to some threshold of host density and many contribute to stability if the average host density falls below this the maximum egg laying capacity of parasitoid under the describe experimental conditions even in presence of large number of healthy hosts. This type of density responsive behaviour of the parasitoid is considered to be the most stabilizing relationship (Holling, 1966; Lawrence, 1981; Abidi *et al.*, 1987; Kumar *et al.*, 1994) [13, 1].

At lower host densities the parasitoid did not find hosts as frequently, reducing the number of eggs laid at these densities. At higher host densities the parasitoid got activated possibly due to increased kairompnal concentration, which stimulates this behaviour (Chiri & Legner, 1982; wen *et al.*, 1991) [5, 37]. The change of the parasitoid successfully locating a suitable host were increased as there was a larger host surface area for the parasitoid to contact, thereby resulting in higher levels of parasitisation (Van Lenteren and Bakker, 1976) [36].

The results discussed so for reveal that *C. chlorideae* is a potential bio – control agent against *H. armigera* because it has a sigmoid functional response resembling the type III curve of Holling (1959) [12], considered to be the most stabilizing relationship. The functional response and its associated behavioral activities are maximum in *C. arrietinum* food plant reared host than other food plants *(P. sativum and C. cajan*) reared host. The results suggest that parasitoid *C. chlordeae* could play a role in integrated control of *H. armigera.*

Reference

1. Abidi AZ, Kumar A, Tripathi CPM. Impact of male on the functional response of *Diaeretiella rapae* M' Intosh Hymenoptera: Aphidiidae, a parasitoid of *Lipaphis erysimi* Kalt. Homoptera: *Aphidae* - J. Appl. Ent, 1987; 103:304-312.
2. Ables JR, Shepard M. Responses and competition of the parasitoids *Spalangia endius and Muscidifurax raptor* Hymenoptera: Pteromalidae at different densities of house fly pupae. Can. Ent, 1974; 106: 825-830.
3. Ananthakrishnan TN, Senrayan R, Murugesan S, Annadurai. Kairomones of *Heliothis armigera* and *Corcyra cephalonica* and their influence on the parasitic potential of *Trichogramma chilonis* – J. Biol. Sci. 1991; 16:117-119.
4. Arthur AP. Host acceptance by parasitoids. In: D.A. Nordland, R.L. Jones, & W.J. Lewis, eds. Semi chemicals: Their role in pest control, John Willey & Sons, New York. 1981; 97-120.
5. Chiri AA, Lengner EF. Host - searching Kairomones alter behavior of *Chelonus sp. Nr. Curvimaculatus*, a hymenopterous parasite of the pink bollworm, *Pectinophora gossypiella* Saunders - Environ. Entomol, 1982; 2:452-455.
6. Cook RM, Hubbard SF. Adaptive searching strategies in insect parasites, J. Anim. Ecol, 1977; 46:115-125.
7. Dai XF. Biology of *Campoletis chlorideae* Hymenoptera: Ichneumonidae and its Control of cotton boll worm in the field. Ch. J. Bio. Cont. 1990; 6:153-156.
8. Force DC, Messenger PS. Laboratory studies on competition among three parasite on the spotted alfa alfa aphid *Theriophis* maculate Buckton. Ecology, 1965; 64:853-859.

9. Hamilton PA. The biology of *Monoctnus Pseudoplatani*, *Trioxys cirssi* and Dyscritulus planicept, with the notes on their effectiveness as parasites of the Sycamore aphid, *Drepanosiphum platanoides* - Ann. Soc, Ent. Er. N.S. 1974; 10:821-840.
10. Hassell MP, Rogers DJ. Insect parasite responses in the development of population models – J. Anim. Ecol, 1972; 41:661-676.
11. Hofsvang T, Hagvar EB. Functional responses to prey density of *Ephedrus Cerasicola* Hymenoptera: Aphidiidae, An Aphidiid parasitoid of *Myzus persicae*, Homoptera: Aphididae. Entomophaga, 1983; 28:307-324.
12. Holling CS. Some characteristics of simple types of predation and parasitism. *Can. Ent*. 1959; 91:385-398.
13. Holling CS. The functional response of Invertebrates predators to prey density. Mem. Ento. Soc. Can. 1966; 48:1-86.
14. Hu AL, Zheng MS, Cheng HK, Li LC. Biology of *Campoletis Chloridae* Hym: Ichneumonidae, A natural enemy of *Heliothis armigera* Lep: Noctuidae. *Natural enemies of Insects*. 1985; 7:143-146.
15. Huffaker CB, messenger PS, De Bach P. The natural enemy component in natural control and their biological control. In biological Control *ed.* Huffaker, C.B. Plenum press. 1971; 16-67
16. Jayaraj S. Biological and Agricultural studies. In proceedings of the International work shop on *Heliothis* management. 1982; 17-28.
17. Kumar N, Kumar A, Tripathi CPM. Functional response of Campoletis chloridae Hymenopetra: Ichneumonidae, a parasitoid of Heliothis armigera Hubner Lepidopetera: Noctuidae in an enclosed experimental system. – Biol. Agric. and Horic, 1994; 10:287-295.
18. Kumar A, Tripathi CPM, Singh R, Pandey RK. Binomics of *Trioxys* Binodoxys indicus an aphidiid parasitoid of Aphis craccivora 17. Effect of host plant on the activitiesof the parasitoid. *Z.ang. Ent*, 1983; 96:304-307.
19. Kumar A, Tripathi CPM. Parasitoid host relationship between *Trioxys Binodoxys indicus* Subba Rao and Sharma Hymenoptera: Aphididae. IV. Effect of host plants on the sex ratio of the parasitoid. *Entomon*, 1987; 12:96-97.
20. Kumar A, Shanker S, Pandey KP, Sinha TB, Tripathi CPM. Parasitoid host relationship between *Trioxys* Binodoxys *indicus* Subba Rao and Sharma Hymenoptera: Aphididae and Aphis craccivora Koch, Hemiptera: Aphidiidae. VI. Impact of male on the number of progeny of the parasitoid reared on certain host plant. *J. Appl. Ent*. 1988; 105: 476-482.
21. Lawrence PO. Interference competition and optimal host selection in the parasitic wasp, *Biosteres longicaudatus*. - Ann. ENT. *Soc. Amer*, 1981; (74):540-544.
22. Nordlund DA, Lewis WJ. Terminology of chemical releasing stimuli in ultra-specific and interspecific interaction - *J.Chem. Ecol*, 1976; 2:211-220.
23. Pandey KP, Singh R, Tripathi CPM. Functional response of *Diaeretiella rapae* M' Intosh Hymenoptera: Aphidiidae, a parasitoid of the mustard aphid *Lipaphis erysimi* Kalt Homoptera: Aphididae. *Z. ang. Ent*, 1984; 98:321-327.
24. Patel BP, Patel RE. Biology of *Campoletetis perdistinctus* viereck a larval parasite of *Heliothis armigera* HB - *J. Anim. Morphol*, *Physiol*, 1972; 19:123-134.
25. Patel PN, Habib MEM. Biological studies on *Campoletis flavicincta* Ashmead, 1890 Hymenoptera: Ichneumonidae an endoparasite of the fall army worm, *Spodoptera frugiperda* abbot & Smit, 1797 Lepidoptera: Noctuidae. *J. Appl. Ent.*, 1987; 104: 28-35.
26. Podoler H, Mazor M. *Dirhinus giffardii* Silvestri Hymenoptera: Chalcididae as a parasite of the Mediterranean fruit fly *Ceratitis capitata* Wiedmann Diptera: Tephritidae. I some Biological studies – *Acta Oecologica Oecol. Applic*, 1981; 2:255-265.
27. Rabb RI, Bradley JR. The influence of host plant on the parasitism of eggs of the tobacco hornworm – *J. Econ. Entromol*, 1968; 61:1249-1252.
28. Sathe TV, Nikam PK. Courtship behaviour, oviposition and adult emergence of *Campoletis chloridae*, a parasitoid of *Heliothis armigera* Hübner. *Sci. Cult.*, 1986; 52: 67-68.
29. Singh R, Srivastava M. Effects of host extract on the life table of the parasitoid *Trioxys indicus* Subba Rao and Sharma Hymenoptera: Aphidiidae *J. Aphidol*. 1990; 4:93-97.
30. Singh R, Singh K, Prasad M. Thermal influence on the development, reproduction and progeny sex ratio of *Lipolexis scutellaris* Mackauer Hymenoptera: Braconidae, aphidiinae - *Proc, Nat. Acad. Sci.*, 2001; 70(B)-267-278.
31. Soloman ME. The natural control of animal populations. *J. Anim. Ecol.*, 1949; 18:1-35.
32. Srinivas PR. Extent of parasitism of gram pod borer *Heliothis armigera by* Ichneumonid larval parasites. *Indian J. of Agric. Sci.,* 1989; 59(6):377-378.
33. T' Hart J; Jonge J de, Colle M, Dicke Lenteren JC Van, Ramakers P. Host selection, host discrimination and functional response of *Aphidius matricariac Haliday* Hymenopetra: Braconidae a parasite of the green peach aphid, *Myzus persical* Sulz - Med. Fac. Landbouww. *Rijksuniv*. *Gent*, 1978; 43:441-453.
34. Tripathi CPM, Kumar A. Effect of host plants on the numerical *response of Trioxy* Binodoxys indicus Subba Rao and Sharma Hymenopetra: Aphidiidae, a parasitoid of *Aphis craccivora* Koch, Hemiptera: Aphididae - *Z. Ang. Ent*., 1984; 97:101-107.
35. Tripathi RN, Singh R. Aspects of life table studies and functional response of an aphidiid parasitoid Lysiphlebia mirzai – *Ent. Exp. Appl*. 1991; 59:279-287.
36. Van Lenteren JC, Bakker K. Functional responses in invertebrates. Netherlands Journal of Zoology, 1976; 26:567-572.
37. Wen S, Xie Y, Xie Z. Influence of host factors on the oviposition of Bracon greeni Hym; Braconidae. *Chin. J. Biol. Cont*. 1991: 7:105-107.