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Effect of food plant on the numerical response of *Campoletis chlorideae* uchida (Hymenoptera: ichneumonidae), a parasitoid *of Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae)

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Abstract

Effect of food plants viz. *Cicer arietinum*, *Pisum sativum* and *Cajanus cajan* on the numerical response of *Campoleris chlorideae*, Uchida, parasitoid of *Helicoverpa armigera* (Hubner) were studied in present work. It was observed that with increase of parasitoid density, the amount of parasitisation increases non – linearly. The amount of parasitisation increasing significantly with the increase of parasitoid density and it was maximum in host, *H. armigera*, reared on *C. arietinum* followed by *P. Sativum* and *Cajanus cajan* food plants. ANOVA shows that the amount of parasitisation was significantly influenced between three selected food plants (F= 81.45, P< 0.01) as well as between 4 parasitoid densities (F = 170.77, P<0.01). The rate of multiplication was maximum with one parasitoid on 50 hosts as the parasitoid density increases the rate of multiplication decreases and this decrease was maximum in host reared on *C. arietinum* followed by host reared on *P. sativum* and host reared on *C. cajan* food plants. ANOVA also revealed that amount of parasitisation is also significant between three selected food plants reared host (F= 7.02, P <0.05) and between 4 parasitoid density (F = 60.41, P< 0.01). It means this parasitoid *C. chlorideae* could play a role in the integrated control of *H. armigera*. The number of emerging offspring was maximum in *C. arietinum* reared host of 2nd instar than other food plants. *(P. sativum* and *C. cajan*) reared host. It is therefore, recommended that less number of parasitoid may be released at any recommended site for control purpose because the rate of multiplication is maximum with one parasitoid on 50 hosts.

Keywords: *campoletis chlorideae, helicoverpa armigera*, numerical response, biocontrol

Introduction

The control of pest by parasitoid depends strongly on its functional response (Riechert and Lockley, 1984; George and Hough – Goldstein, 1994). The impact of parasitoid on its host population depends upon, among other things, its ability to increase in number and to find and parasitise host (Mackauer, 1983). The rate of parasitisation, which is directly dependent on host number, is considered as an important condition for both the stability of parasitoid – host population interaction and the success of biological control (Hassell and Waage, 1984).

Natural enemies usually exhibit a functional response in terms of an increase attack rate as host density increases and a numerical response which is a change in the density of the parasitoid in response to change in host density (Holling, 1959). The numerical response is usually of vital interest because it is responsible for suppressing pest population (Huffaker et. al, 1971) and help in calculating the number of parasitoid needed to regulate the estimated host population (Knipling and Gilmore, 1971). According to Coppel and Mertins (1977), a rapid and strong numerical response characteristic is the most important attribute of a successful agent of pest mortality. Although numeric response plays a major role in decimating pest population than functional response, yet it has received less attention (Takafuji and Chant, 1976). This bias towards the functional response may lead to erroneous conclusion about their effectiveness in controlling host population (Eveleigh and Chant, 1981).

Difference in quality of food plants and the texture of their leaves have been reported to influence the reproductive behavior of the parasitoid (Rabb and Bradley, 1968; Giroux *et al*., 1995). But little information is available on the role of food plants and their impact on the reproductive rate of parasitoids. The Present investigation was aimed to find out an alter food plant on which *H. armigera* and *C. chlorideae* can successfully reared during the off-season and information regarding the exact number of parasitoids needed to regulate the estimated host population.

Materials and Methods

Culture of host and parasitoid

The parasitoid, *C. chlorideae* and its host, *H. armigera* were reared in the laboratory on the fresh leaves of *C. arietinum* Linn. (Chickpea) at 22±4^{0}C, 70 ±10% RH and 10h light: 14 Dark photoperiod (Tripathi and kumar, 1984; Kumar and Tripathi, 1985). Laboratory cultured larvae of host reared on *C. arietimum* Linn. Were transferred on *P. sativum* and *C. cajan* for rearing. 2nd instar larvae of host (The stage most preferred by the parasitoid – Patel and Patel, 1972) were drawn from maintained culture and were utilized as hosts. One day old satiated with 30% honey solution, mated and experienced female (T'hart *et al*., 1978; Kumar and Tripathi, 1985; Abidi *et al*., 1988) were used as parasitoid.

Numerical Response

To Study the numerical response of parasitoid with host reared on C. arietinum, 4 troughs (Ca 20 cm. diameter x 10 c.m. height) were arranged and numbered as 1-4. Fifty 2nd instar larvae reared on chickpea were placed separately on four moistened filter paper and were transferred individually in marked troughs.

Troughs were covered with glass plates; one, two, four and eight parasitoid were introduced in 1st, 2nd, 3rd and 4th trough, respectively and were allowed to attack hosts for three hours. The experiment was replicated five times with new experienced female parasitoid and fresh hosts reared on *C. arietinum*.

Same experiment as above mentioned, were conducted with the hosts reared on *P. sativum* and *C. cajan* food plants. After parasitisation, the larvae were transferred in the glass tubes (10 x 3.25 c.m.) having fresh foliage of *C. arietinum*, *P. sativum* and *C. cajan* for further development. The tubes were covered with muslin cloths.

After cocoon formation, the cocoon were collected and transferred singly into marked sterilized glass vials (5x1.25c.m.) with leaves cuttings of the food plants to provide moisture to developing eggs, until emergence. The glass vials were kept plugged with absorbent cotton. The parasitoids when emerged out from the cocoon were counted and the data so obtained were subjected to the regression analysis. F-test and two- way analysis of variance test are also calculate for better understanding of their interactions.

Results and Discussion

Amount of Multiplication

The experiments reported herein were intended to evaluate the relationship between the effect of food plants of the hosts and the amount of parasitisation at varying parasitoid densities. It was observed that with increase of parasitoid density, the amount of parasitisation increases non – linearly (Table 1, Fig 1). The amount of parasitisation increasing significantly with the increase of parasitoid density and it was maximum in host, *H. armigera*, reared on *C. arietinum* ($Y= 24.565+1.783 \log x$; $r= 0.829$) followed by host, *H. armigera*, reared on *P. Sativum* ($Y= 20.173+ 1.687 \log x$; $r= 0.843$) and host, *Helicoverpa armigera*, reared on *C. cajan* food plant ($Y= 16.130+ 1.965 \log x$; $r= 0.887$, $P< 0.05$) (Table 1, Fig 1).

ANOVA (Analysis of variance) shows that the amount of parasitisation was significantly influenced between three selected food plants ($F= 81.45$, $P< 0.01$) as well as between 4 parasitoid densities ($F = 170.77$, $P<0.01$) (Table 2).

The food plants significantly affect the number of parasitisation at varied parasitoid densities. The endolarval parasitoid *C. chlorideae* parasitize the different food plant reared host *H. armigera*. The female parasitoid when comes near the host is attracted towards it. This attraction of the parasitoid to the host is mainly due to odor of the host (Nordlund and Lewis, 1976; Vet and Groenewold, 1991). Having reached the region in which the host is located, the female parasitoid tries to find out the exact spot by vibrating its antennae. When once the parasitoid is within the reach of the host, it probably gives to final stimulus to oviposit (Sathe and Santhakumar, 1988).

With the increase of parasitoid density the number of emerging offspring increases up to four parasitoids, then shows a tendency towards stabilization. This indicates that in order to achieve a considerable number of parasitoid, more parasitoid might be required (Hagvar and Hofsvang, 1990; Leon and Erazo, 1993). Table 1 and Fig 1 show that when double the number of parasitoid were put in for parasitisation, a doubling of parasitisation ratio in any case was not observed which might be due to limited oviposition time (Abidi *et al*., 1989; Brower and Press, 1990) and the reduction of individual’s efficiency because of mutual interference (Avilla sand Albajes, 1983; Kumar *et al*., 1988; Youm and Gilstrap, 1993; Jervis *et al*., 1994). Under field conditions, a strong mutual interference might be taking place due to an increase in the parasitoid density, which may results in the dispersal of the parasitoid (Nikam and Pawar, 1993).

The amount of parasitisation increase significantly with increase of parasitoid density in the entire three food plants reared host and is maximum in *C. arietinum* reared host followed by *P. sativum* reared host and the *C. cajan* food plant reared host due to the varying amount of allomones as well as a chemical stimuli (kairomones) and the other different factors. 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; Ananthkrishnan *et al*., 1991). The Parasitoid *C. chlorideae* preferred the *C. arietinum* reared 2nd instar larvae of the host *H. armigera* (Kumar *et al*., 1994; 2000) quality of food resources kairomones, emanates, emanates more host – seeking stimulant.

Table 1: Number of offspring emerged at different initial number of *Campoletis chlorideae* (host reared on three selected food plants viz. *Cicer arietinum*, *Pisum sativum* and *Cajanus cajan*) put with 50 hosts (*Helicoverpa armigera*) Each entry is the mean of replicates (mean ±SD)

Parasitoid density	**Host (reared on different food plants)**		
	Cicer arietinum	***Pisum sativum***	***Cajanus cajan***
1	22.0 ± 2.92	18.0± 2.00	15.0 ± 2.83
2	31.0 ± 0.71	26.0±1.05	21.0 ±1.22
3	35.0 ± 1.41	30.0 ±1.00	28.0 ±1.58
4	35.0 ± 1.41	30.0 ± 1.00	28.0 ± 1.58
8	37.0 ± 1.58	32.0 ±2.12	30.0 ± 3.54
Y = a+b log x			
A	24.565	20.174	16.130
B	1.783	1.687	1.975
R	0.829	0.843	0.887
P	NS	NS	0.05

Table 2: Summary of computation for analysis of variance of the data of Table 1

Components	**Degree of freedom**	**Sum of square**	**Variance**	**F-value**	**P**
Between plants	2	122.17	61.09	81.45	0.01
Between density	3	384.25	128.08	170.77	0.01
Interaction	6	4.5	0.75		
Total	11	510.92	46.44		

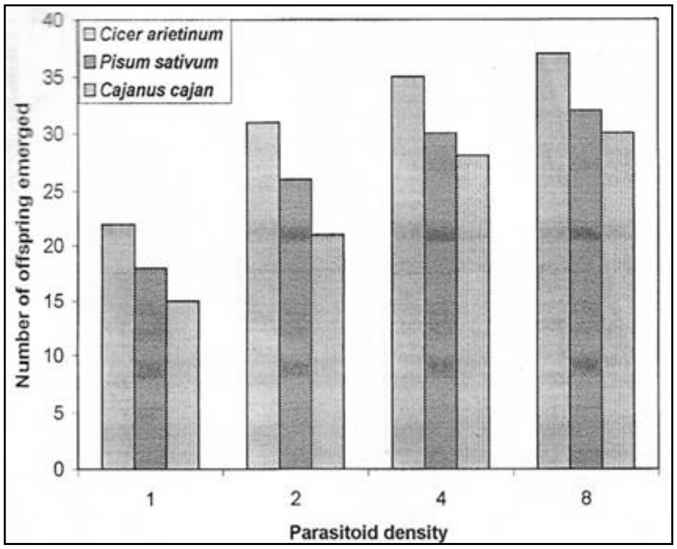

Fig 1: Number of offspring emerged at different initial number of *C. chlorideae* (host reared on three selected food plants viz. *C. arietinum* , *P. sativum* and *C. cajan*) put with 50 hosts (*H. armigera*).

Rate of Multiplication

The rate of multiplication (Number of parasitoid emerged/ Number of parasitoid put in for parasitisation) was maximum with one parasitoid on 50 hosts (Table 3). As the parasitoid density increases the rate of multiplication decreases and this decrease was maximum in host reared on *C. arietinum* (Y= 21.174 - 2.273 log x, r= -0.925, P<0.05) followed by host reared on *P. sativum* (Y= 17.587 – 1.857 log x, r= 0.934, P<0.05) and host reared on *C. cajan* food plant (Y= 14.517 – 1.451 log x, r = - 0.935, P<0.05) (Table 3, Fig 2).

ANOVA (Analysis of variance) also revealed that amount of parasitisation is also significant between three selected food plants reared host (F= 7.02, P <0.05) and between 4 parasitoid density (F = 60.41, P< 0.01) (Table 4).

The rate of multiplication has an inverse relationship with the parasitoid density. This is the most significant trend exhibited during this study. More parasitoid has a lower rate of multiplication, which shows the intra-specific competition amongst the parasitoid (Hassell, 1982; Leon and Erazo, 1993; Zaki *et al*., 1994.) The number of offspring emerged per parasitoid (Table 3, Fig 2) was maximum in 1 parasitoid density and then decreases to 8 parasitoid density. The number of offspring was maximum in *C. arietinum* reared host followed by *Pisum sativum* reared host and *C. cajan* food plant reared host *H. armigera.*

During the experiments, different types of interferences amongst the parasitoid were recorded: (1) Direct interference amongst the parasitoid (mutual interference or intra-specific competition). Interference may ensure due to intra-specific or due to physical or chemical nature of the food plant (Nordlund and Lewis, 1985) on which the hosts are found in their attempt to approach the host or in trying to overcome the obstacle in approaching the host many encounters amongst them occur. This is a probable course of interference. Direct interference might be in the form of heads on (antennal, encounter), or head of one and tail of other (Cephalo – Caudal encounter) or in the form of rubbing of the sides when one is trying to overtake the other during movement (lateral encounter), or even only the caudal ends of the parasitoid may be touch each other (Caudal encounter). This type of interference decreases their searching efficiency (Hassell, 1971). (II) Avoidance of contaminated hosts and (III) Loss of parasitoid egg due to mutilation (Abdulrahman, 1974). These factors might be acting singly or in conjunction. At higher densities the ovipositing female were brought in close proximity to each other because of less oviposition area and as a result, they probe in the location on the sting unit (Ashley and Chambers, 1979). Mutual interference can also cause eggs to be laid (Kumar and Tripathi, 1987) and increase the production of male progeny (Mackauer and Kambhampati, 1984; Abidi *et al*., 1988).

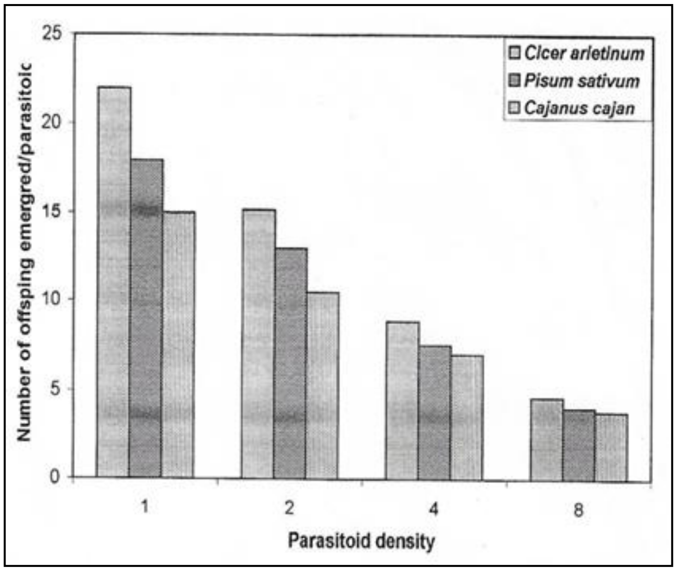

Fig 2: Number of offspring emerged per parasitoid at different initial number of *C. chlorideae* (host reared on three selected food plants viz. *C. arietinum*, *P. sativum* and *C. cajan*) put with 50 hosts (*H. armigera).*

Table 3: Number of offspring emerged per parasitoid at different initial number of *Campoletis chlorideae* (host reared on three selected food plants viz. *Cicer arietinum*, *Pisum sativum* and *Cajanus cajan*) put with 50 hosts (*Helicoverpa armigera*). Each entry is the mean of 5 replicates (mean ± SD)

Parasitoid density	Host (reared on different food plants)		
	Cicer arietinum	***Pisum sativum***	***Cajanus cajan***
1	22.0± 2.92	18.0 ± 2.00	15.0 ± 2.83
2	15.2 ± 0.35	13.0 ± 0.53	10.5 ± 0.61
3	8.8 ± 0.35	7.5 ± 0.25	7.0 ± 0.31
4	8.8 ± 0.35	7.5 ± 0.25	7.0 ± 0.31

8	4.6 ± 0.19	4.0 ± 0.27	3.8± 0.44
y = a+b log x			
A	21.173	17.587	14.517
B	-2.273	-1.857	-1.451
R	-0.925	-0.934	-0.935
P	0.05	0.05	0.05

Table 4: Summary of computation for analysis of variance of the data of Table 2

Components	Degree of freedom	Sum of square	Variance	F – value	P
Between plants	2	26.45	13.225	7.02	0.05
Between density	3	341.23	113.743	60.41	0.01
Interaction	6	11.3	1.833		
Total	11	378.98	34.452		

Summary

The results obtained show that as the parasitoid density increases, the mutual interference increases, which cause a reduction in an individual's searching efficiency. The present investigation furnished an insight into the number of parasitoid needed to regulate the estimated host population. The results discussed so for reveal that *C. chlorideae* is a potential bio control agent against *H. armigera*. The number of emerging offspring was maximum in *C. arietinum* reared host of 2nd instar than other food plants. *(P. sativum* and *C. cajan*) reared host. It is therefore, recommended that less number of parasitoid may be released at any recommended site for control purpose because the rate of multiplication is maximum with one parasitoid on 50 hosts.

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