Numerical Response of *Campoletis chloridae* Uchida (Hymenoptera: Ichneumonidae), a parasitoid of *Heliothis armigera* (Hubner) (Lepidoptera : Noctuidae)

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ABSTRACT

With the increase of parasitoid density the number of emerging offspring increases upto four parasitoids, then shows a tendency towards stabilisation. The rate of multiplication is maximum with one parasitoid on 50 hosts. The rate of multiplication has an inverse relationship with the parasitoid density. This is the most significant trend exhibited during this study. The fact that more parasitoids have a lower rate of multiplication shows the existence of intraspecific competition amongst the parasitoid.

Keywords: Parasitoid density, intraspecific competition

INTRODUCTION

The impact of a parasitoid on its host population depends upon, among other things, its ability to increase in numbers and to find and parasitise hosts (Mackauer, 1983; Tangkawanit *et al.,* 2018). 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 & Waage, 1984; Sule *et al.* 2014).

Natural enemies usually exhibit a "*functional response*" in terms of an increased 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 (Soloman, 1949; Holling, 1959). The numerical response is usually of vital interest because it is responsible for suppressing pest population (Huffaker *et al.*, 1971) and helps in calculating the number of parasitoids 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 numerical response plays a major role in decimating pest population than functional response, yet, it has received less attention (Huffaker *et al.*, 1970; Takafuji & Chant, 1976). This bias towards the functional response may lead to erroneous conclusions about their

effectiveness in controlling host-population (Eveleigh & Chant, 1981). Apparently, meagre attempt has been made to investigate the numerical response of *C. chloridae*. The present work is in this direction.

MATERIALS AND METHODS

The parasitoid, *C. chloridae* and its host, *H. armigera* were reared on *Cicer arietinum* Linn. (chickpea) in the laboratory at 22 ± 4°C, $70 \pm 10\%$ RH and 10 h light : 14 h dark photoperiod (Tripathi & Kumar, 1984; Kumar & Tripathi, 1985). Second instar larvae of the host (the stage most preferred by the parasitoid – Patel & Patel, 1972) were drawn from the maintained culture and were utilised as hosts. One day old, satiated with 30% honey solution, mated and experienced female ('T Hart *et al*., 1978; Kumar & Tripathi, 1985; Abidi *et al.,* 1988) were used as parasitoids.

To study the numerical response of the parasitoids, 4 troughs (ca 20 cm. diameter x 10 cm. height) were arranged and numbered as 1-4. 50 second instar larvae 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 parasitoids were introduced in 1st, 2nd, 3rd, and 4th trough respectively and were allowed to attack hosts for 3 hrs. The experiment was replicated ten times with new experienced

female parasitoids and fresh hosts. After parasitisation, the larvae were transferred in the glass tubes (10 x 3.25 cm.) having fresh foliage of *C. arietinum* (chickpea) for further development. The tubes were covered with muslin cloth. After cocoon formation, the cocoons were collected and transferred singly into marked sterilised glass vials (5 x 1.25 cm.) with leaf cuttings of the host plants (Kumar & Tripathi, 1985, 1987) (to provide moisture to the developing eggs) until emergence. The glass vials were kept plugged with absorbent cotton. The parasitoids when egressed out from the cocoons were counted and the data so obtained was subjected to the regression analysis for better understanding of their interactions.

RESULTS AND DISCUSSION

Table 1 and Fig. 1 illustrate that as the parasitoid density increases, the amount of parasitisation increases non-linearly ($Y= 23.90 \pm 16.20$ Log X) with a significant correlation ($r^2 = 0.903$, P < 0.001). However with the increase of parasitoid density the rate of multiplication (Table 1, Fig, 2) (= parasitoids egressed/parasitoids put in) decreases non-linearly ($Y = 21.55 - 19.55$ Log X) with negative correlation ($r^2 = - 0.980$, P < 0.001) and is maximum with one parasitoid on 50 hosts (Fig. 2).

With the increase of parasitoid density the number of emerging offspring increases upto four parasitoids, then shows a tendency towards stabilisation. This indicates that in order to achieve a considerable number of parasitoids, more parasitoids might be required (Tripathi & Kumar, 1984; Pandey *et al*. 1986; Kumar *et al*. 1988; Abidi *et al*., 1989; Hagvar & Hofsvang, 1990). Table 1 and Fig 1 show that when double the number of parasitoids were put in for parasitisation, a doubling of parasitisation ratio in any case was not observed which might be due to limited oviposition time (Cloutier, 1984; Tripathi & Kumar, 1984; Kumar & Tripathi, 1985, 1987; Pandey *et al*., 1986; Kumar *et al*., 1988; Abidi *et al*., 1989) and the reduction of individual's efficiency because of mutual interference (Lawrence, 1981; Avilla & Albajes, 1983; Kumar & Tripathi, 1985; Kumar *et al*., 1988). Under field conditions a strong mutual interference might be taking place due to an increase in the parasitoid density which may result in the dispersal of the parasitoid (Tripathi & Kumar, 1984; Abidi *et al*., 1989).

The rate of multiplication has an inverse relationship with the parasitoid density. This is the most significant trend exhibited during this study. More parasitoids have a lower rate of multiplication which shows the intraspecific competition amongst the parasitoids (Ashley & Chambers, 1979; Lawrence, 1981; Hassel, 1982; Hofsvang & Hagvar, 1983; Tripathi & Kumar, 1984; Vet *et al*., 1984). During the experiment four types of interference have been recorded

viz. antennal encounter, lateral encounter, cephalocaudal encounter and caudal encounter. At higher densities the ovipositing females were brought in close proximity to each other because of less oviposition care (Abidi *et al*. 1987) and as a result they attempted to either parasitise the same host or probe in the same location on the sting unit (Ashley & Chambers, 1979). Mutual interference can also cause fewer eggs to be laid (Tripathi & Kumar, 1984; Kumar & Tripathi, 1987; Abidi *et al*., 1989) and increase the proportion of male progeny (Mackauer & Kambhapati, 1984; Avilla & Albajes, 1984; Lin & Carver, 1985; Kumar & Tripathi, 1987; Abidi *et al*., 1988, 1989). The results obtained show that as the parasitoid density increases, mutual interference increases, which cause a reduction in an individual's searching efficiency (Hassel, 1982; Chua & Dyck, 1982; Eveleigh & Chant, 1982; Kumar &

Tripathi, 1985; Abidi *et al*., 1987; Kumar *et al*., 1988). The effect of this interference on the stability of host-parasitoid interactions have been explored theoretically by Hassell & May (1973), Rogers & Hassell (1974) and Beddington (1975). They demonstrated that the greater the value of mutual interference constant, the greater is the tendency for the interaction to become stable. However, Stinner, (1976), Stinner & Lucas (1976) and Yeargan & Latheef (1976) consider that no such interference exists and the decrease in the area of discovery with the increase in parasitoid number is result of a non-poisson distribution of its eggs.

The results discussed so far reveal that *C. chloridae* is a potential biocontrol agent against *H. armigera*. It is, therefore recommended that less number of parasitoids may be released at any recommended site for control purposes because the rate of multiplication is maximum with one parasitoid on 50 hosts.
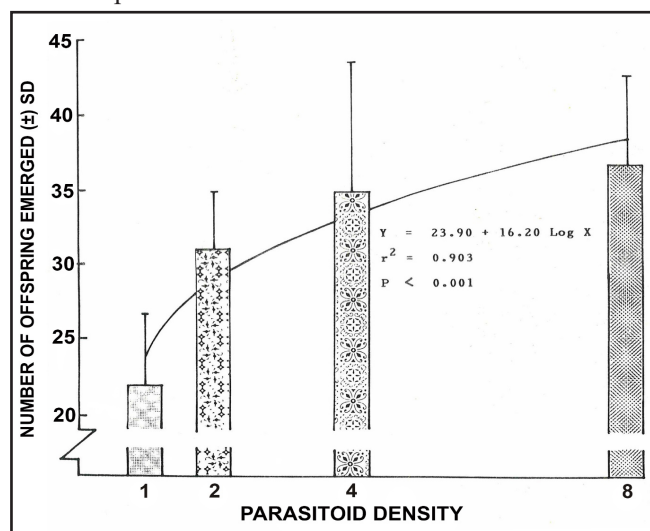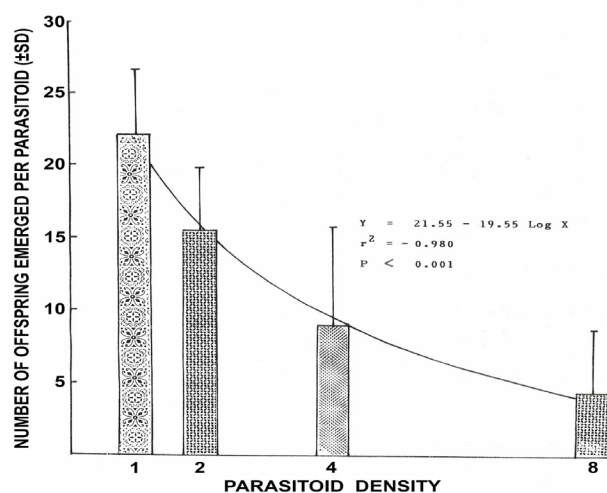

Fig 1.

Fig. 2

Legend of the Illustrations

Fig 1 Graphic representation of number of offspring emerged at different initial number of *C. chloridae* (mean ± SD).

Fig 2 Graphic representation of rate of multiplication of the parasitoid *C. chloridae* (mean ± SD).

Table 1 : Number of offspring emerged at different initial number of *C. chloridae* and offspring emerged per parasitoid put with 50 hosts (*H. armigera*). Each entry is the mean of 5 replicates.

Initial number of parasitoids	Number of offspring emerged	Number of offspring emerged per parasitoid
1	22	22
2	31	15.50
4	35.0	8.75
8	37.0	4.62
Pooled S.E.	2.98	2.54

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