



BIOTIC POTENTIAL OF APHID PARASITOID, *DIAERETIELLA RAPAE* (HYMENOPTERA: BRACONIDAE: APHIDIINAE) FEEDING AGAINST CABBAGE APHID, *BREVICORYNE BRASSICAE* (HEMIPTERA: APHIDIDAE)

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ABSTRACT

Many aphid species are attacked by parasitoid *Diaeretiella rapae* (M'Intosh). Though, it is specialized in feeding on crucifer aphid's mostly cabbage aphid, *Brevicoryne brassicae*. The potential of biological agent (parasitoid) is depend upon its density due to distribution of restricted resources in some cases. The current study was laid out under laboratory conditions (at 25 ± 2 °C temperature, 65-70 % R.H. and 16L:8D photoperiod) to checked the biotic potential of *D. rapae* at its changed densities (one, two, four, eight and ten pairs) on fixed number of cabbage aphid (100 in number) as a host. Various parameters for parasitoid (e.g. % parasitism, adult emergence and longevity of parasitoid adult and per pair parasitism rate) were assessed to check its biotic potential. According to the results highest parasitism (43.09 % \pm 0.63) was observed in maximum density (10 pairs) and lowest percent parasitism (16.59 % \pm 1.28) in minimum density (1 pair) of parasitoid. Adult emergence was maximum (80.31 % \pm 1.33) at highest density (10 pairs) and minimum adult emergence (45.99 % \pm 1.27) was noted at lowest density (1 pair) of parasitoid. In case of adult longevity, maximum (8.2 days \pm 0.38) and minimum (6 days \pm 0.32) longevity was noted in lowest density level (1 pair) and highest density level (10 pairs) of parasitoid respectively. However, per pair parasitism rate reduced with the increase in parasitoid densities due to intra-specific competition developed between the parasitoids for parasitism. Positive relationship was observed between % parasitism and in emergence of adults. Increased in parasitoid densities increased the % parasitism and adult emergence of parasitoid. Results of the study will be helpful in implementing the use of parasitoids as biological control agents in IPM.

Keywords: *Diaeretiella rapae*, Parasitoid densities, Percent parasitism, Adult emergence

INTRODUCTION

Control of insect pests by bio-control agents is defined as the action of these agents that maintain a pest population at a lower level. *Diaeretiella rapae* (M'Intosh) (Hymenoptera: Braconidae) is the most common bio-control agent of *Brevicoryne brassicae* (L.) (Hemiptera: Aphididae) (Saleh, 2008; Maghraby, 2012) and can also be used for managing other aphid species (Pike *et al.*, 1999; Maghraby, 2012).

Different studies have been evaluated the parasitism, influence on growth, egg laying and population growth of the host aphid (Tsai and Wang, 2002; Lin and Ives, 2003; He *et al.*, 2005). Host and parasitoid interactions have been of extensive awareness in ecology for many years. Mortality of host at field level due to parasitoid attack may have three relationships with density,

1. Directly density dependent when the parasitism increased with host density
2. Indirectly density dependent when parasitism decrease with increase host density and
3. Density independent when mortality occurs at intermediate densities (Lessells, 1985; Stiling, 1987; Walde and Murdoch 1988).

These modes of attacks affect the stability of host parasitoid interaction is not fully resolved (Pacala and Hassell, 1991; Godfray and Pacala 1992; Rohani *et al.*, 1994; Getz and Mills, 1996).

Parasitism of aphid has been shown to be density dependent (Sinha and Singh, 1979). The percentage of parasitism increased with the increase of number of parasitoids.

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According to the Herakly (1970) *D. rapae* played the major role in suppressing the population of *B. brassicae* if the parasitoid densities increase the fecundity of parasitoid as number of mummies and emerged adults also increased. According to Levie *et al.* (2000) that increased in parasitoid densities for the controlling the cereal aphids, results showed that *A. rhopalosiphii* seemed to be a good control when densities increased. Intra-specific competition is developing among individual of parasitoid in high density when host density increases which leads to decrease parasitoid parasitism (Ralec *et al.* and Zahra *et al.* 2011).

In many cases, there was an optimum release level that formed effective management of a pest species. This was specifically right when natural enemies were used as a biological control agent. Increasing the release rate above the top rate did not increase control of the pest and thus would be economically opposed (Van Driesche *et al.*, 2001, 2002; Collier and van Steenwyk, 2004; Crowder, 2007).

The determination of current study was to evaluate the impact of different parasitoid densities on parasitism of *B. brassicae* under laboratory conditions. Different densities of parasitoids were used to check parasitism rate on *B. brassicae*. Aphid and parasitoid population were selected from reared culture.

MATERIAL AND METHOD

Experimental procedure

Canola cultivar (Punjab sarsoon) was sown in plastics pots under laboratory conditions (25±2 °C; 65-70% R.H. and 16L: 8D photoperiod). After three weeks of germination, these potted plants were put into plastic cages (35×25×25 cm). Total 100 aphids (third instars) and different parasitoid densities (1, 2, 4, 8 and 10 pairs) were released on each pot. Five replications were made for each parasitoid density. All parasitoid densities were offered aphid population for 24 hours stinging period (Saleh, 2014). After one day of stinging period parasitoids were removed from cages with the help of aspirator. The aphids were kept under laboratory condition until the formation of mummies.

Study Parameters

Percent parasitism

After mummies formation, percent parasitism was recorded by using by this formula,

$$\text{Percent parasitism} = \frac{\text{No. of mummies}}{\text{Total number of aphids}} \times 100$$

Percent emergence

For percent emergence of adult parasitoid, each mummy was put into Eppendorf tube. When mummies change into dark brown (near to emergence), a cotton soaked honey solution (9:1) was kept into tube (Wang *et al.*, 2010). Percent emergence was recorded by using this formula,

$$\text{Percent emergence} = \frac{\text{No. of adult emerged}}{\text{Total number of mummies}} \times 100$$

Adult longevity

To calculate adult longevity of *D. rapae* from each aphid density, emerged parasitoids were transferred into clean Eppendorf tube. Parasitoids were fed by 10 % honey solution. Daily observation was done to check the longevity until they died.

Per pair parasitism rate was also determined by total percent parasitism divided by pair of parasitoid used.

Statistical analysis

Data on percent parasitism, adult emergence and adult longevity of parasitoid were analyzed using completely randomized design (CRD) to check the effect of different parasitoid densities on host and means were separated by Tukey's HSD all pair-wise comparison test.

RESULTS

Analysis of variance for percent parasitism and percent emergence of adult *Diaeretiella rapae* with different densities on *Brevicoryne brassicae*

The analysis of variance regarding percent parasitism and adult emergence is shown in (Table 1). The result showed that all the treatments (*D. rapae* densities) had highly significant impact on percent parasitism and percent adult emergence.

Percent parasitism of *Diaeretiella rapae* with different densities on *Brevicoryne brassicae*

Percent parasitism of *D. rapae* with different densities on *B. brassicae* is shown in (Fig. 1). The result showed that increased in parasitoid densities leads to increase the percent parasitism. In this graph the maximum percent parasitism (43.09 %) was observed at highest density (10 pairs) and minimum percent parasitism (16.59 %) was observed in the lowest density (1 pair) of *D. rapae*. Other parasitoid densities, 2 pairs, 4 pairs and 8 pairs of *D. rapae* showed 25.91 %, 30.21 % and 41.29 % percent parasitism respectively.

Percent adult emergence of *D. rapae* with different densities on *B. brassicae*

Adult emergence of *D. rapae* is shown in (Fig. 2) which showed that with the increased in parasitoid densities the adult emergence of parasitoid increased. Maximum percent emergence (80.31 %) was recorded at highest density (10 pairs) and minimum adult emergence (45.99 %) was observed in 2 pairs of parasitoid density. Other density level of parasitoid such as 1 pair, 4 pairs and 8 pairs showed 52.81 %, 59.07 % and 70.88 % parasitoid emergence respectively.

Relationship of different densities of *D. rapae* with percent parasitism and its adult emergence

The linear trend lines showed the relationship of parasitoid densities with percent parasitism and its adult emergence (Fig. 3). The result showed that positive but close relationship is present between both of them. Increased the parasitoid densities also increases the percent parasitism as well as its adult emergence.

Per pair parasitism rate of *D. rapae*

Percent parasitism of *D. rapae* increased with the increased in parasitoid densities. But per pair parasitism rate decrease with

the increase in parasitoid densities is shown in (Fig. 4). Many reasons are present behind this such as intra-specific competition develops between parasitoids for parasitism. In this graphical representation the trend line showed that there is negative but strong relationship present between the *D. rapae* densities and per pair parasitism rate. The result showed per parasitism rate decreased simultaneously with increase in densities.

Adult longevity of *Diaeretiella rapae* at its different densities

The adult longevity of parasitoid at its different densities described Fig. 5. The results showed that with the increased in parasitoid densities, total longevity of adult parasitoids decreased. The maximum adult longevity (8.2 days) was observed at its low density (1 pair) and minimum adult longevity (6 days) of parasitoid was observed at its highest density (10 pairs) followed by 2 pairs, 4 pairs and 8 pairs the adult longevity were 7.6, 7.4 and 6.6 days respectively.

Table:1

Analysis of variance for percent parasitism and percent emergence of adult *D. rapae* with different densities on *B. brassicae*.

SOV	DF	SS	MS	F-value	P-value
Percent parasitism					
Treatment	4	2426.84	606.711	1.06	<0.001
Error	20	114.94	5.747		
Total	24	2541.79			
Treatment	4	3815.85	953.961	8.26	<0.001
Error	20	2309.18	115.459		
Total	24	6125.03			

Highly Significant (P < 0.001)

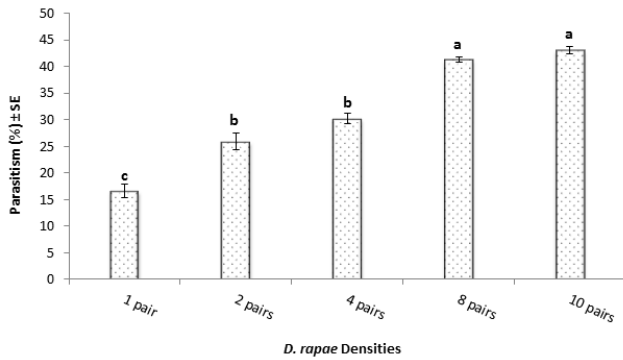


Fig. 1

Percent parasitism of *D. rapae* with different densities on *B. brassicae* (Mean ± SE) mean followed by same letters is not significantly different for each temperature regime (Tukey HSD, P<0.05).

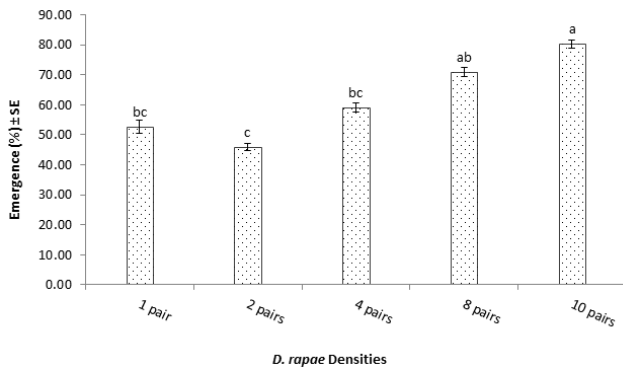


Fig. 2

Percent adult emergence of *D. rapae* with different densities on *B. brassicae* (Mean ± SE) mean followed by same letters is not significantly different for each temperature regime (Tukey HSD, P<0.05)

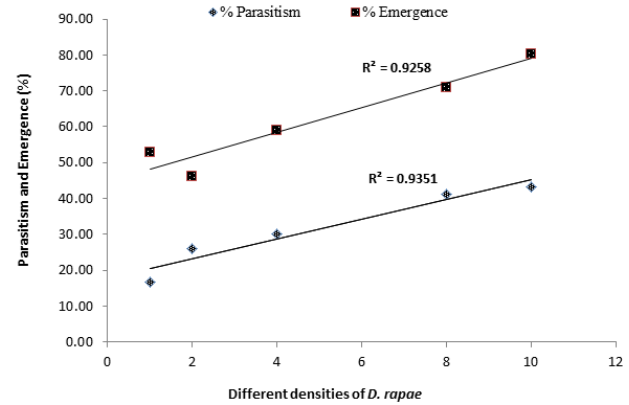


Fig. 3

Relationship of different densities of *D. rapae* with percent parasitism and its adult emergence.

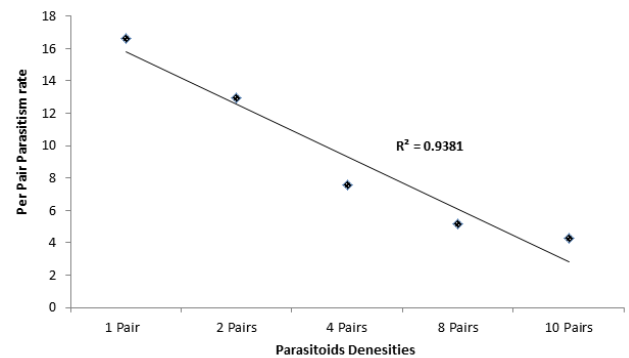


Fig. 4

Per pair parasitism rate of *D. rapae*

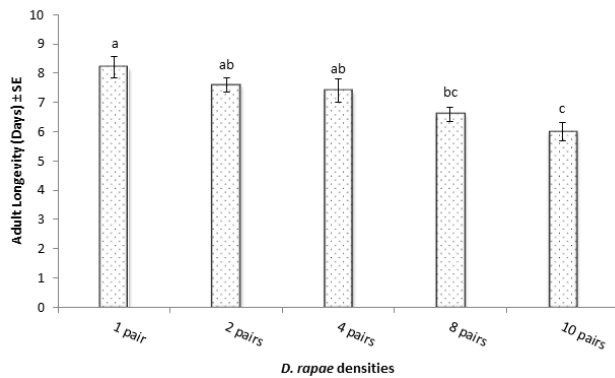


Fig. 5

Adult longevity of *Diaeretiella rapae* at its different densities (Mean \pm SE) mean followed by same letters is not significantly different for each temperature regime (Tukey HSD, $P \leq 0.05$).

DISCUSSION

Diaeretiella rapae is the most important natural enemy which suppressed the population of *Brevicoryne brassicae* under field and laboratory condition. The present study was conducted under laboratory conditions. The result presented that highest percent parasitism (43.09 %) was noted at maximum density level (10 pairs) and lowest percent parasitism (16.59 %) in the minimum density (1 pairs) of parasitoid. The present findings are also resulted that with the increased in parasitoid densities, also increased the adult emergence of parasitoid. The maximum percent emergence (80.31 %) was recorded at highest density of parasitoid and minimum adult emergence (45.99 %) observed at 2 pairs of parasitoid density. My findings are correlating with Saleh (2014) who observed the same results as in present study. He reported that percentage of parasitism increased with the increased in parasitoid densities. This percentage reaches at 35 %, 29 % and 25 % for *D. rapae* at 11 parasitoids per 200 aphids. Percent emergence also increased with the increased in parasitoid densities.

Per pair parasitism rate decreased with the increased in parasitoid densities. The results showed per parasitism rate decreased simultaneously with increase of parasitoid densities. These results are also similar with Ralec *et al.* (2011) and Zahra *et al.* (2011) who observed that host density increase lead to minimize host parasitized by parasitoid, because intra specific competition develop between parasitoids especially in females. The results are also correlated with Jones *et al.* (2003) who observed that increased in parasitoid densities the male progeny of parasitoid increased because male require less food as compared to female parasitoids. These findings also similar to Abidi *et al.* (1989) who revealed that number of offspring produced by per female of *D. rapae* show negative relation with the parasitoid densities. My results are also same as the Panday *et al.* (1986) who found that per pair rate of parasitism reduced with the increased in densities of parasitoid.

Present findings are also similar to Herakly and El-Ezz (1970); Ragab and Ghaniy (1997) and El-Naggar *et al.* (2008) they founds that increased in parasitoid densities lead

to increase in percent parasitism, percent emergence and fecundity rate increased. So, parasitoids at higher density give effective control to suppress the population of aphids. The present study results are also somewhat similar to Gowling and Van-Emden (1994) who observed that percent parasitism differences by parasitoid *D. rapae* occurs due to the many factors such as nutritional quantity of host plant. The characteristics and nutritional value of plants also influence the parasitism, adult longevity, development period of parasitoid (Fernandez and Nentwig 1997).

The results of present findings are that increased *D. rapae* densities also increase % parasitism and adult emergence of parasitoid. The R^2 values for percent parasitism and percent adult emergence from mummies made by parasitoid is 0.9351 and 0.9258 respectively. This showed that positive relation of parasitoid densities with the percent parasitism and adult emergence. These results are similar to Shukla *et al.* (1997) who revealed those parasitoids at 1, 2, 4 and 8 parasitoid densities the percent emergence had significant positive correlation with increasing in density of *D. rapae*. The multiplication rate of *D. rapae* decreased with the increased of its densities because due to mutual interference between the species.

Present findings are also accordance with the findings of Levie *et al.* (2000) who observed that at low density of parasitoid the control of aphid is low and parasitoid densities increase the parasitism rate also increased which suppressed the aphid population. Our results are correlate with the results of Stilmant (1994), he released different parasitoid densities of about, 6, 13, 26 parasitoids for 70 aphids per density. The result showed that at lower density of host the parasitoid showed maximum reduction in aphid population and these result also similar with the Holler and Haardt (1993) who observed that level of parasitism *S. avenue* by *A. abdominalis* is high in laboratory is high as compared to field.

Strong positive relation was present between percentage parasitism and adult emergence with parasitoids densities. The increase in densities of parasitoid increases the parasitism rate and adult emergence of parasitoid from host mummies increased and vice versa. In case of per pair parasitism rate of *D. rapae* the relationship is negative but its show strong relation with parasitoid densities. per pair parasitism rate decreased when parasitoid densities increased due to many factors such as, due to increase in density of parasitoid and when host density was constant, the competition among parasitoids increased and parasitoid female parasitized the host more time.

CONCLUSION

Strong positive relation was present between percentage parasitism and adult emergence with parasitoids densities. The increase in densities of parasitoid increases the percent (%) parasitism and adult emergence from host mummies increased and vice versa. In case of per pair parasitism rate of *D. rapae* the relationship is negative but its show strong relation with parasitoid densities. Per pair parasitism rate decreased when parasitoid densities increased due to many factors such as, due to increase in density of parasitoid and when host density was constant, the competition among parasitoids increased and parasitoid female parasitized the host more time.

Authors' contributions

MAA conceived and designed the experiment; MJH performed the experiment; ABMR & MJH analyzed the data; MAA & ABMR contributed materials/ analysis/ tools; and MJH wrote the paper. All authors read and approved the final manuscript.

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