J. Plant Prot. and Path., Mansoura Univ., Vol.7 (12) ,827–830, 2016

Effect Host Plants on Parasitism Rate of the Parasitoid *Diaeretiella rapae* (M'intosh) on the Aphid *Brevicoryne brassicae* L.,

Abd – Elsamad, A. A. ; Fatma M. Saleh and Heba A. Ismail.
Plant Protection Research Institute, Agricultural Research Center, Giza, Egypt.

ABSTRACT

The experiments were carried out in laboratory at Plant Protection Institute, Sharkia branch, Sharkia Governorate during 2013-2014 seasons. The results indicate that the female of *D. rapae* accepted all stages of the cabbage aphid *B. brassicae*. The number of parasitoid adults emerged from the mummies of *B. brassicae* was significantly greater on the third and fourth instars than that obtained from the first and second instars. The highest average of parasitism was in the second instar. On the other hand, host relationship between the parasitoid *D. rapae* and *B. brassicae*, impact of males on the number of progeny of the parasitoid reared on different host plants was conducted. The results revealed that with the increase of parasitoid density the percentage of parasitism raised in cabbage followed by cauliflower and radish. The presence of males caused considerable decrease in the efficiency of the parasitoid females. This decrease reached its minimum on the three crops. The highest percentages of parasitism reached were 36.2%, 28.2% and 25.8% at eight females only/Petri dish Meanwhile; the percentages were 30.8%, 25.8% and 21.4% at 8♀+8♂ (females with males). The number of aphid offspring emerged per parasitoid female decreased with increasing of parasitoid density. The number of offspring emerged per parasitoid female was adversely affected by the presence of males.

Keywords: *Diaeretiella rapae, Brevicoryne brassicae*, Host plant, cabbage, cauliflower, radish plants.

INTRODUCTION

Aphids are considered as one of the most important pests due to their wide range of host plants in Egypt and in many parts of the world (Ibrahim and Afifi, 1994, Saleh, 2012 and 2014). *B. brassicae* aphid (Hemiptera: Aphididae) feeds on all cultivated and wild cruciferous plants. The major economic host plants include broccoli, cauliflower, head cabbage and most of the genus *Brassica* (Berry, 1998).*Diaeretiella rapae* allows its host to feed and develop after becoming parasitized. Foraging behavior, including searching, handling and oviposition, varies among and within species (Lewis *et al*., 1990; El-Naggar *et al*., 2008). Parasitoids may use chemical cues (semi-ochmeicals) and/or physical features like host size to select hosts for oviposition (Van Driesche and Bellows, 1996).

Ecological studies is to determine which attributes of parasitoids contributed to the success of biological control (Beddington *et al.*, 1978). Behavioral response of parasitoids to host density is potentially related to its success (Huffaker *et al.*, 1971; Berryman, 1999). This is described by the functional response, the relationship between host density and the attack rate of parasitoids (Solomon, 1949; Holling, 1959).

The present study was conducted to show the effect of aphid age on parasitism rate and the relationship between *D. rapae* and *B. brassicae* when reared on certain host plants.

MATERIALS AND METHODS

The present investigation was carried out at Plant Protection Research Institute, Sharkia Branch, Agricultural Research Center, and Sharkia Governorate during 2013/2014 season.

1. Effect of aphid's age on parasitism rate.

An experiment was carried out under laboratory conditions of 20.0 ± 1°C and 67.0 ± 2 % R.H to determine host stage preference of different immature stages to the parasitoid, *D. rapae*. Five mated females of *D. rapae* were exposed to 200 aphids of different ages. The experiment was replicated five times in Petri dishes.

2. Parasitoid - host relationship between *D.rapae* and *B. brassicae* when reared on certain host plants.

An experiment was carried out under laboratory conditions of 16.0 ± 1°C and 75.0 ± 2 % R.H. The parasitoid, *D. rapae* and its host, *B.brassicae* third and fourth nymphal instars were placed on three host plants cabbage, cauliflower and radish, respectively to study the role of host plants and the presence or absence of males on the progeny of the females parasitoids. Parasitoids were arranged in two groups. The first group contained 1,2,4 and 8 female parasitoids while the second comprised the same number of females together with equal number of males. For the experiment, 12 Petri dishes numbered 1 to 12 were divided into three sites of four each treatment. One hundred aphids were placed separately on each cabbage leaf. The Petri dishes 1-4, 5-8, and 9-12 contained aphids reared on cabbage, cauliflower and radish. In Petri dishes 1, 5, 9 and 2 , 6, 10 and 3, 7, 11 and 4, 8, 12, one, two, four and eight female parasitoids were introduced respectively and were allowed to attack hosts for six hours. The experiment of the second group of parasitoids was performed simultaneously like that of the first. Both treatments were replicated five times. The formed mummies were carefully picked out and transferred into glass tubes until emergence. Emerged as well as non-emerged adults were also counted.

RESULTS AND DISCUSSION

1. Effect of parasitism rate on aphid's age.

The parasitoid *D. rapae* accepted all stages of the cabbage aphid *B. brassicae* (Table 1).The average percentage of parasitism 3.55 ± 1.17, 26.1 ± 3.68, 21.25 ± 3.46 and 19.15 ± 2.43 in first, second, third and fourth instars, respectively. Meanwhile, the numbers of their offspring were 11.9 ± 0.72 and 27.5 ± 1.54 in 3rd and 4th instars, respectively but no adults emerged from 1st and 2nd instars. On the other hand, the total numbers of mummified aphids were 6.1 ± 0.73, 49.2 ± 2.32, 40.5 ± 2.18 and 39.3 ± 1.53.

These results are in general agreement with the work of Zhang and Hassan (2003); Abou El-Naga *et al*. (2008) and Abdul Rahman and Powell (2010) who indicated that the females of *D. rapae* attacked all stages

of the cabbage aphid *B. brassicae*. The first and second instars of cabbage aphid *B. brassicae* produced no offspring after parasitism of *D. rapae*.

Table 1. Parasitism of *B. brassicae*, a total of 200 individuals were transferred on cabbage leaves in a Petri dish and three mated females were released.

Aphid's age	Mean ± SD No. of parasitized aphids	Mean ± SD No. of emerged adults	Mean ± SD No. of non emerged adults	Mean ± SD % of adults emergence	Mean ± SD % of parasitism
First instar	6.1 c ± 0.73	0 c	6.1 d ± 0.73	0 c	3.55 c ± 1.17
Second instar	49.2 a ± 2.32	0 c	52.2 a ± 7.36	0 c	26.1 a ± 3.68
Third instar	40.5 b ± 2.18	11.9 b ± 0.72	28.6 b ± 1.56	29.17 b ± 0.83	21.25 b ± 3.46
Fourth instar	39.3 b ± 1.53	27.5a ± 1.54	11.8 c ± 1.02	69.9 a ± 2.49	19.15 b ± 2.43
F value	109.87	234.01	180.1	635.21	116.16

Means followed by the same letter in a column are not significantly different at 0.05% level of probability.

2. Parasitoid - host relationship between *D.rapae* and *B. brassicae* when reared on certain host plants.

With the increase of parasitoid density, parasitism increased in aphids reared on cabbage (*Brassica oleracea var. acephala*) followed by cauliflower (*Brassica oleracea var. botrytis*) and radish (*Raphanus sativa*).The presence of the males caused low in the efficiency of the female parasitoids. This decrease when the males were mixed with the female parasitoids, dropped to the minimum in cabbage followed by cauliflower and radish. The percentage of parasitism was influenced by the host plants as well as by the absence and presence of male parasitoids. The number of offspring emerged per female parasitoid decreases with the increase of parasitoid density. The number of offspring emerged per female parasitoid was adversely affected in the presence of the males. However, it was the maximum in cabbage followed by cauliflower and radish reared aphids.

The percentage of parasitism in cabbage increases in absence of the males and the maximum percentage of parasitism was 36.2 for *D. rapae*. Meanwhile, the percentage of parasitism on cabbage decreases in the presence of males and the maximum percentage of parasitism was 30.8 for *D. rapae*. A significant influence on the rate of parasitism and the number of aphid parasitoids *D. rapae* occurred between all densities of parasitoid (Table 2). The maximum number of adults emerged in laboratory in absence of the males was 27 for *D. rapae* at 8♀ only and 22 individuals in presence males at 8♀ + 8♂ (Fig. 1), But , the minimum was 12.8 at 1♀ only and 7.6 individuals at 1 ♀ + 1 ♂ on cabbage (Fig. 1)

The percentage of parasitism in cauliflower increases in absence of males and the maximum percentage of parasitism was 28.2 for *D. rapae*. The parasitism decreases in presence of males and the maximum percentage was 25.8 for *D. rapae*. A significant influence on the rate of parasitism and the number of aphid parasitoid of *B. brassicae* by *D. rapae* occurred between all densities of the parasitoid (Table 3). The maximum number of adults emerged in laboratory in absence of the males was 21.2 for *D. rapae* at 8 ♀ only and 18.4 individuals in presence males at 8 ♀ + 8 ♂ on cauliflowers. Mean while, the minimum was 9.8 for *D. rapae* at 1 ♀ only and 5.6 individuals at 1 ♀ + 1 ♂ (Fig. 2)

Table 2. Effect of parasitoid number on the number of aphid parasitized, adult parasitoids emerged, number of adults non emerged , percentage of adults' emergence and percentage of parasitism reared on cabbage under 16.0 ± 1°C and 75.0 ± 2 % R.H.

Parasitoid density	Mean ± SD No. of aphids parasitized	Mean ± SD Percentage of adults emergence	Mean ± SD Percentage of parasitism
1♀	15.6 C ± 1.02	82.04 A ± 0.63	15.6 C ± 1.02
2♀	22.6 B ± 2.88	81.48 A ± 2.08	22.6 B ± 2.88
4♀	30.6 A ± 1.2	77.876 AB ± 1.19	30.6 A ± 1.2
8♀	36.2 A ± 2.03	74.05 B ± 2.47	36.2 A ± 2.03
1♀ + 1♂	9.4 C ± 1.07	80.68 A ± 1.54	9.4 C ± 1.07
2♀ + 2♂	13.6 C ± 1.39	71.942 BC ± 1.17	13.6 C ± 1.39
4♀ + 4♂	25.2 B ± 1.15	77 AB ± 1.01	25.2 B ± 1.15
8♀ + 8♂	30.8 A ± 2.41	70.68 C ± 2.59	30.8 A ± 2.41

Means followed by the same letter in a column are not significantly different at 0.05% level of probability.

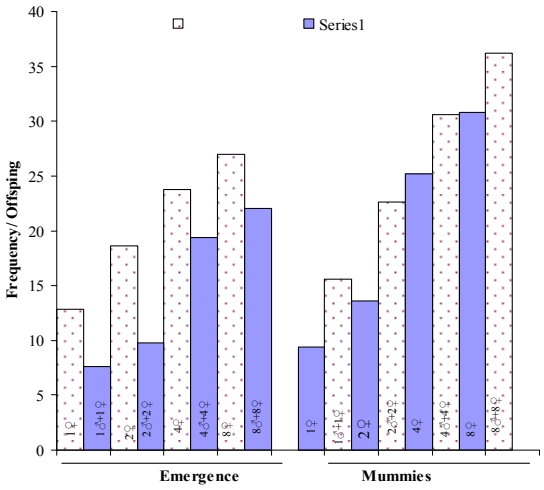

Fig. 1. Fecundity of the parasitoid of by *D. rapae* against *B. brassicae* infesting cabbage plant at its different density under laboratory conditions.

Table 3. Effect of parasitoid number on the number of aphid parasitized, adult parasitoids emerged , number of adults non emerged , percentage of adults' emergence and percentage of parasitism reared on cauliflower under 16.0 ± 1°C and 75.0 ± 2 % R.H.

Parasitoid density	Mean ± SD No. of aphids parasitized	Mean ± SD Percentage of adults emergence	Mean ± SD Percentage of parasitism
1♀	12.6 C ± 0.5	78.244 A ± 1.13	12.6 C ± 0.5
2♀	20.8 B ± 1.74	80.846 A ± 1.22	20.8 B ± 1.74
4♀	25.6AB± 1.9	75.284 A ± 1.59	25.6AB± 1.9
8♀	28.2 A ± 1.93	75.098 A ± 2.03	28.2 A ± 1.93
1♀ + 1♂	7.2 D ± 0.96	79.498 A ± 3.33	7.2 D ± 0.96
2♀ + 2♂	14.2 C ± 0.37	74 A ± 4.25	14.2 C ± 0.37
4♀ + 4♂	18.8 B ± 1.49	73.72 A ± 2.97	18.8 B ± 1.49
8♀ + 8♂	25.8 A ± 1.39	72.158 A ± 1.08	25.8 A ± 1.39

Means followed by the same letter in a column are not significantly different at 0.05% level of probability.

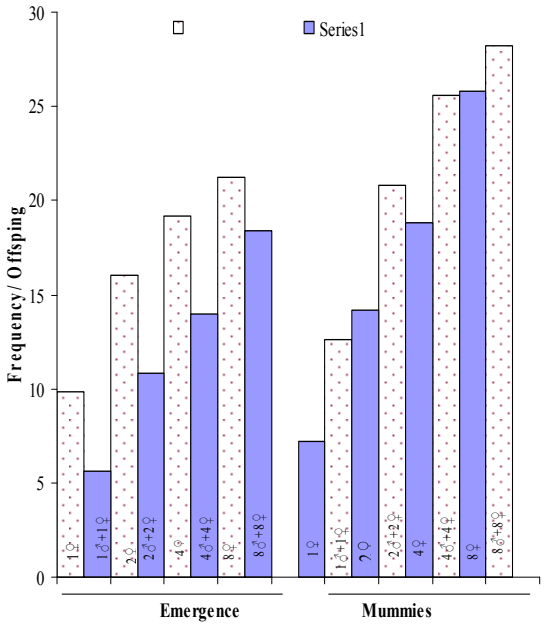

Fig. 2. Fecundity of the parasitoid of by *D. rapae* against *B. brassicae* infesting cauliflower plant at its different density under laboratory conditions.

Parasitism percentage of in radish increases in absence of the males and the maximum percentage of parasitism was 21.4 for *D. rapae* (Table 4). A significant influence on the rate of parasitism and the number of aphid parasitoid of *B. brassicae* by *D. rapae* was also noticed between all densities of parasitoid. The number of parasitized aphid and percentage of parasitism of *B. brassicae* differ significantly on the three different host plants: cabbage plants, cauliflower and radish, (Table, 4). The maximum number of adults emergwd in laboratory in absence of the males was 18.6 for *D. rapae* at 8 ♀ only and 13.8 individuals in presence males at 8 ♀ + 8 ♂ on radish, Mean while, the minimum was 6.6 for *D. rapae* at 1 ♀ only and 4.8 individuals at 1 ♀ + 1 ♂ (Fig. 3). Chau and Mackauer (2001) showed that preference of certain host species has been demonstrated in laboratory studies where parasitoids more of ten ovipositor in some species than in on there, when both the host species are offered separately or simultaneously. On the other hand, Gently and Barbosa (2006) reported that leaf epicuticular was plays an important role on the movement, foraging behavior and attack efficiency of *D. rapae* . However, Abdul- Rehman and Powell (2010) mentioned that parasitoids have potential as biological control agents but their efficiency in dependent upon their presence in the right place at the right time and right host parasitoid ratio. Understanding parasitoid behavior, together with identification of physical and chemical signals regulating the behavior, parasitoids introduced through inundative releases in the filed.

Table 4. Effect of parasitoid number on the number of aphid parasitized, adult parasitoids emerged , number of adults non emerged , percentage of adults'emergence and percentage of parasitism reared on radish under 16.0 ± 1°C and 75.0 ± 2 % R.H.

Parasitoid density	Mean ± SD No. of aphids parasitized	Mean ± SD Percentage of adults emergence	Mean ± SD Percentage of parasitism
1♀	9 C ± 0.7	74.02 A ± 3.2	9 C ± 0.7
2♀	14.6 B ± 1.96	76.25 A ± 2.78	14.6 B ± 1.96
4♀	24 A ± 0.7	69.21 A ± 2.72	24 A ± 0.7
8♀	25.8 A ± 1.59	72.1 A ± 2.37	25.8 A ± 1.59
1♀ + 1♂	6.2 D ± 0.79	76.83 A ± 3.41	6.2 D ± 0.79
2♀ + 2♂	10.4 D ± 1.16	68.67 A ± 2.85	10.4 D ± 1.16
4♀ + 4♂	16.8 B ± 1.15	65.76 A ± 1.58	16.8 B ± 1.15
8♀ + 8♂	21.4 A ± 1.36	65.14 A ± 3.95	21.4 A ± 1.36

Means followed by the same letter in a column are not significantly different at 0.05% level of probability.

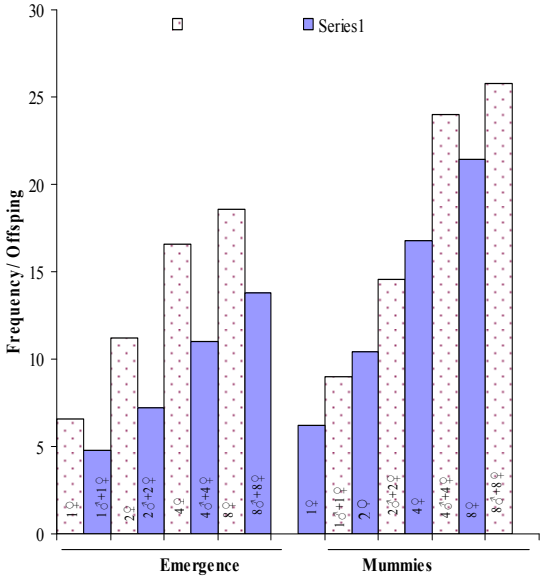

Fig. 3. Fecundity of the parasitoid of by *D. rapae* against *B. brassicae* infesting radish plant at its different density under laboratory conditions.

REFERENCES

Abo El-Naga, A.M., M. E. El-Naggar, A. A. Ghanim and A. A. Saleh (2008): Host relationship between the parasitoid *Diaeretiella rapae* and the cabbage aphid, *Brevicoryne brassicae*. Egypt J. Agric. Res., 86(2):637.

Abdul Rahman and W. Powell (2010): Host selection behavior of aphid parasitoids (Aphidiidae: Hymenoptera). Journal of Plant Breeding and Crop Science 2(10): 299-311.

Beddington, J.R., C.A. Free and J.H., Lawton (1978): Characteristics of successful natural enemies in models of biological control of insect pests. Nature, 273: 513-519

Berryman, A.A. (1999): The theoretical foundations of biological control. In: Hawkins, B.A., Cornaell, H.V. (Eds.): Theoretical Approaches to Biological Control. Cambridge University Press, Cambridge, 3-21.

Berry, R.E. (1998): Insects and mites of economic importance in the Pacific Northwest, 2nd Ed. OSU Bookstore, Inc. Corvallis, OR, USA. 221pp.

Chau, A. and M. Mackauer (2001): Preference of the aphid parasitoid *Monoctonus paulensis* (Hymenoptera : Braconidae) for different aphid species female choice and offspring survival. Bio. Control. 20(1): 30 – 38.

El-Naggar, E. M.; A. M. Abou El-Naga; A. A. Ghanim and A. A., Saleh (2008): Mass production and field application of some aphid natural enemies. Egypt J. Agric. Res., 86 (2):623-624.

Gently, G.L. and P. Barbosa (2006): Effect of leaf epicuticuar wax on the movement, foraging behavior, and attack efficacy of *Diaeretiella rapae*. Entomol., Exp. P. Appl., 121: 115 – 122.

Holling, C.S. (1959): Some characteristics of simple types of predation and parasitism. Canadian Entomologist, 91: 385-398.

Huffaker, C.B., P.S. Messenger and P. De Bach (1971). The natural enemy component in natural control and the theory of biological control. In: Huffaker, C.B. (Ed.). Biological Control. Academic Press, New York, 16-67.

Ibrahim, A.M.A. and A.I. Afifi (1994): *Aphidiius colemani* Viereck and *Aphidius picipes* (Ness) as a parasitoid on the mealy plum aphid, *Hyalopterus pruni* (Geoffroy) on peach in Egypt. Egypt. J. Biol. Pest Control., 4(1): 45-56.

Lewis, W.J., L.E. Vet, J.H. Tumlinson, J.C. Van Lenteren and D.R. Papaj (1990): Variations in parasitoid foraging behavior: Essential element of a sound biological control theory. Environ. Entomol., 19: 1183-1193.

Saleh, A. A. A. (2012): Evaluation of release of *Diaeretiella rapae* (M´Intosh) for controlling the cruciferous aphid *Brevicoryne brassicae* L. on cauliflower plants at Sharkia Governorate, Egypt. J. plant prot. and path., Mansora Univ., 3(3): 307-318.

Saleh, A.A.A. (2014): Efficacy of the aphid parasitoid *Diaeretiella rapae* (M'Intosh) to control *Brevicoryne Brassicae* L., *Aphis Craccivora* (Koch) and *Aphis Nerii boyer* at Sharkia governorate, Egypt. J. Agric. Res., 92(1): 21-31.

Solomon, J.E. (1949): The natural control of animal populations. Journal of Animal Ecology, 18: 1-35.

Van Driesche, R.G. and T.S Bellows (1996): Biological Control. Springer Science and Business Media, London, ISBN: 9780412028618, Page: 539.

Zhang, W. Q and S.A. Hassan (2003): Use of the parasitoid *Diaeretialla rapae* (M'Intosh) to control the cabbage aphid *Brevicoryne brassicae* (L) China. J. Appl. Ent., 127: 522-526.

تأثير العوائل النباتية على معدل التطفل للطفيل *D. rapae* على من الصلبيات *Brevicoryne brassicae* فى غياب أو وجود الذكور

عبدالله على عبدالصمد ، فاطمه محمد صالح و هبه عبدالله أسماعيل

معهد بحوث وقاية النباتات – مركز البحوث الزراعية- الجيزة , مصر.

اجريت التجارب المعملية فى معهد بحوث وقاية النباتات فرع الشرقية خلال موسمى ٢٠١٣ – ٢٠١٤ و أظهرت النتائج أن الطفيل *D. rapae* يهاجم كل الاطوار و لكن لايخرج نسل إلا فى الطور الثالث و الرابع للحوريات و كانت أعلى نسبة تطفل ٢٦.١ ±٣.٦٨ فى الطور الثانى للحوريات على من الصلبيات *Brevicoryne brassicae* و أوضحت النتائج الدراسة العلاقة بين الطفيل *Diaeretilla rapae* و من الصلبيات *Brevicoryne brassicae* فى وجود أو غياب الذكور على العوائل النباتية الكرنب و القرنبيط و الفجل على التوالى. و أظهرت النتائج انه بزيادة كثافة الطفيل تزداد نسبة التطفل على نباتات الكرنب و القرنبيط و الفجل و يؤدى وجود الذكور الى خفض كفاءة التطفل و بالتالى تقل نسبة التطفل على الثلاث محاصيل. وكانت أعلى نسبة تطفل ٣٦.٢ – ٢٨.٢ – ٢٥.٨ % على الكثافة العددية للطفيل ٨ إناث لكل طبق بينما كانت ٣٠.٨ – ٢٥.٨١ - ٢٥.٨ % على الكثافة العددية ٨ إناث الى ٨ ذكور لكل طبق بترى. و اوضحت النتائج قلة نسل الإناث مع زيادة كثافة الطفيل و يصل ادناه على نباتات الفجل ويليه نباتات القرنبيط ثم نباتات الكرنب.