EFFICACY OF NATURAL ENEMIES AGAINST *PIERIS BRASSICAE* UNDER FIELD CONDITIONS OF CAULIFLOWER

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خلاصہ

موجودہ تحقیق میں پھول گوبھی کے کھیت میں دیکھا گیا کہ دوست کیڑوں کی قدرتی طور پر افادیت کتنی ہے۔ تحقیق کے دوران 2012-2014تک گوبھی کی سنڈی کے چار(۴) دوست کیڑے Parasitoid دیکھے گئے۔ جبکہ ان دوست کیڑوں کے دو(۲) دشمن کیڑے hyper parasitoid بھی ریکارڈ کئے گئے۔ دوست کیڑوں میں ۲دوست کیڑے Cotesia glomerata اور *Diadegma pierisae* گوبھی کی سنڈی کے لاروے پر حملہ آوار ہوتے ہیں۔ جبکہ ۲دوست کیڑے Brachymeria lasus اور Pteromalus puparium اس کے پیوے پر حملہ آور ہوتے ہیں جبکہ Brachymeria lasus اور *Tatrastichus galactopus* دوست کیڑے کے دشمن hyperparsitiod ریکارڈ کئے گئے۔

قدرتی طور پر گوبھی کے کھیت میں پہلے سال میں *C. glomerata* 0.48 فی صد سے 29.03فی صد تک موثر تھا جبکہ *D.piersae* 2.63فی صد سے 18.6تک B. lasus. صفر سے 26.08فی صد اور Pteromalus puparium صفر سے 82.7فی صد جبکہ دوسرے سال *D. piersae* 2.24 سے 27.02فی صد موثر تھی جبکہ اس پر دشمن *B.* lusus کا حملہ صفر سے 17فی صد اور *T.galactopus* صفر سے 3فی صد ریکارڈ کیا گیا۔ جبکہ سب سے زیادہ موثر دوست کیڑا *P.puparium* ریکارڈ کیا گیا جو کہ 81.81فی صد تک موثر رہا۔

Abstract

In the present study, four primary parasitoids and two hyper parasitoids were collected during 2012-2014 from cauliflower genotypes under field conditions. There were two larval parasitoids (*Cotesia glomerata* and *Diadegma pierisae*), two pupal parasitoids (*Brachymeria lasus* and *Pteromalus puparium*) and two hyper parasitoids (*Brachymeria lasus* and *Tetrastichus galactopus*) collected from field grown cauliflower. Efficacy of *C. glomerata* ranged from 0.48 to 29.03%, *D. pierisae* from 2.63 to 18.6%, *B. lasus* from 0 to 26.08% and of *P. puparium* from 10 to 82.7% during 1st year. During the 2nd year of study efficacy of *D. pierisae* was 2.24 - 27.02%, but it was hyper parasitized by *B. lasus* (0 - 17%) and by *T. galactopus* (0 - 3%). Efficacy of *P. puparium* rnaged from 0 to 81.81%.

Key words: *Pieris brassicae;* cauliflower*;* larval parasitoid; pupal parasitoid; hyper-parasitoid

Introduction

Parasitoids are natural enemies play important role in agricultural ecosystems, where they regulate the population density of many of their hosts (Godfray, 1994). Accurate techniques to identify parasitoids are a prerequisite to managing host–parasitoid interactions: for example, they are needed to measure and monitor parasitism rates and host preferences of native (Agusti et al., 2005)

During our study no parasitization was recorded in the first year mid season crop might be due to excessive use of insecticides in the previous years, so to fulfill the objective of study the project was extended to late season crop, during which we collected different parasitoids in the growing season. Build up of population of natural enemies was observed in second year which might be due to avoidance of insecticides use and natural enemies conservation by keeping the mid season crop in field after harvesting the curd only.

Material and Methods

P. brassicae larvae and pupae were collected by hand from field at different intervals depending upon availability of suitable stage of *P. brassicae.* For testing efficacy of the natural enemies 4th instar *P. brassicae* were collected for *C. glomerata*, 3rd and 4th instar for *D. pierisae*, pre-pupae and pupae for *Pteromalus puparium* and pupae for *Brachymeria lasu.* The collected larvae, pre-pupa and pupae were kept in glass chimneys under laboratory conditions of 20+2°C, 50+5% RH till natural enemies emerged. The number of parasitized prey and

the number of emerged parasitoids from the infested prey were recorded and percent parasitism determined from it.

Percent parasitism and percent parasitoid mortality was calculated by following formulae:

$$\% \text{ Parasitism} = \frac{\text{No. of parasitized host}}{\text{Total No. of hosts collected}} \times 100$$

$$\% \text{ Parasitoid Mortality} = \frac{\text{No. of parasitoid failed to emerge}}{\text{Total No. of parasitoid pupa}} \times 100$$

Results and Discussion

There were 2 larval parasitoids *Cotesia glomerata* and *Diadegma pierisae*, 2 pupal parasitoids *Brachymeria lasus* and *Pteromalus puparium* and 2 hyper parasitoids *Brachymeria lasus* and *Tetrastichus galactopus* collected during 2012-2014 from cauliflower field. The samples were send to CABI Islamabad, Pakistan for identification.

Table 1 revealed that parasitism of *P. brassicae* by *Cotesia glomerata* was maximum of 29.03% on 7 May and minimum of 0.48% on 22 April, 14. Mean no. of parasitoid pupae formed were a maximum of 33 on 17 April and minimum of 27.1 on 7 May, 14. Mean no. of hyper parasitoid (*Tetrastichus galactopus*) emerged from *Cotesia glomerata* per-pupa were a maximum of 2.4 on 7 May and minimum no. of 1.8 on 17 April, 14.

Brachymeria lasus parasitism of *P. brassicae* pupa was a maximum of 26.08% on 11 March and nil each on 28 March and 4 April, 14 (Table 2). Mean no. of *B. lasus* parasitoid emerged was a maximum no. of 12 on 5 March and nil each on 28 March and 4 April, 14.

Table 1. Parasitism of *P. brassicae* larvae by *C. glomerata* during April - May, 2013.

Date of collection	No. of *P. brassicae* larvae	No. of *P. brassicae* parasitized larvae	% Parasitism	Mean no. of *Cotesia glomerata* pupa formed	Mean No. of *T. galactopus* emerged per *C. glomerata* pupa
17-4-2013	10	2	20	33	1.8
22-4-2013	615	3	0.48	28	-
07-5-2013	31	9	29.03	27.1	2.4

Table 2. *B. lasus* parasitism of *P. brassicae* pupa during March, 2013.

Date of collection	No. of *P. brassicae* pupa collected	No. of *P. brassicae* parasitized pupae	% Parasitism	Mean No. of *Brachymeria lasus* emerged
05-3-2013	139	12	8.63	12
11-3-2013	26	6	26.08	6
28-3-2013	6	0	0	0
04-4-2013	12	0	0	0
17-4-2013	10	1	10	1
07-5-2013	29	1	3.44	1

D. pierisae parasitism of *P. brassicae* larvae was maximum of 18.6% on 5 March and minimum of 2.63% on 23 March, 2014 (Table 3). Mean no. of parasitoid emerged were a maximum of 17 on 5 March and minimum no. of 1 each on 14 and 23 March. Female to male sex ratio was a maximum of 3.25:1 on 5 March and minimum of 1:0 and 0:1 on 14 March and 23 March, respectively. Mortality of the parasitoid was maximum of 66.66% on 14 March and nil on 23 March, 2013.

D. pierisae (Ichneumonide wasp) parasitization of *P. brassicae* larvae was maximum of 36.89% on 23 Feb. and minimum of 2.25% on 21 April, 2014 (Table 4). Mean no. of emerged parasitoid were a maximum no. of 154 on 9 April and minimum no. of 3 on 21 April. The female to male sex ratio was a maximum of 3:0 on 21 April and minimum of 1:1 on 14 Feb. Mortality of the *D. pierisae* was a maximum of 28 on 9 April and nil on 20 Feb and 21 April. Mean no. of *B. lasus* (Chalcid wasp) emerged from *D. pierisae* pupa were maximum of 17 on 9 April. Mean no. of hyper parasitized *D. pierisae* pupa and hyper parasite *T. galactopus* emerged were 3 and 22 on 9 April, respectively. These values were nil on all the remaining dates of observation.

P. puparium parasitism was maximum of 82.7% on 7 May and minimum of 10% on 23 April, 2013 (Table 5). Mean no. of parasitoid emerged was maximum of 27.31 on 11 March and minimum no. of 10 on 23 April. The no. of emerging holes were in high range of 1-8 on 11 March and lower range on 1-2 on 28 March, 2013.

Table 3. *D. pierisae* parasitism of *P. brassicae* larvae during March, 2013.

Date of collection	No. of *P. brassicae* larvae collected	No. of parasitized *P. brassicae* larvae	% Parasitism	Mean no. of *D. pierisae* emerged	Female:Male Sex ratio	Mortality (%) of *D. pierisae* pupa
05-3-13	129	24	18.6	17	3.25:1	29.1
14-3-13	28	3	10.71	1	1:0	66.66
23-3-13	38	1	2.63	1	0:1	0
01-4-13	357	40	11.20	14	2:1.5	55

Table 4. *D. pierisae* parasitism of *P. brassicae* and *B. lasus* and *B. galactopus* hyperparasitism of *D. pierisae* during February- April, 2014.

Date of collection	No. of *P. brassicae* larvae collected	No. of parasitized *P. brassicae* larvae	% Parasitism	Mean No. of *D. pierisae* emerged	Female:Male Sex ratio	% Mortality of *D. pierisae* pupa	Mean no. of *B. lasus* from *D. pierisae* pupa	Mean No. of *D. pierisae* pupa hyperparasitized by *T. galactopus*	Mean no of *T. galactopus* emerged from *D. pierisae* pupa
14-2-14	91	20	21.97	18	1:1	2	0	0	0
20-2-14	37	10	27.02	10	1 :1.5	0	0	0	0
23-2-14	103	38	36.89	27	0 :27	11	0	0	0
25-2-14	88	8	9.09	6	6:0	2	0	0	0
28-2-14	72	5	6.94	5	1 :1.5	0	0	0	0
23-3-14	349	55	15.75	36	1 :1.7	11	6	0	0
09-4-14	877	202	23.03	154	1 :1.9	28	17	3	22
17-4-14	161	34	21.18	20	1 :2.3	14	0	0	0
21-4-14	133	3	2.25	3	3:0	0	0	0	0

Table 5. *P. puparium* parasitism of *P. brassicae* pupae during March, 2013.

Date of collection	No. of *P. brassicae* pupae collected	No. of parasitized *P. brassicae* pupa	% Parasitism	Mean No. of *P. puparium* emerged per pupa	Emerging holes
05-3-2013	155	105	67.74	26.19	50 pupae 1 hole 29 pupae 2 hole 20 pupae 3 hole 4 pupae 4 hole 1 pupae 5 hole 1 pupae 7 hole
11-3-2013	56	41	73.21	27.31	19 pupae 1 hole 12 pupae 2 hole 1 pupae 3 hole 6 pupae 4 hole 2 pupae 5 hole 1 pupae 8 hole
28-3-2013	6	3	50	15	1 pupae 1 hole 2 pupae 2 hole
23-4-2013	10	1	10	10	1 pupae 1 hole
07-5-2013	29	24	82.7	10.4	10 pupae 1 hole 7 pupae 2 hole 2 pupae 3 hole 3 pupae 4 hole 1 pupae 5 hole

Table 6. *P. puparium* parasitism of *P. brassicae* pupae during November, 2013 to April, 2014.

Date of collection	No. of *P. brassicae* pupa collected	No. of parasitized *P. brassicae* pupa	% Parasitism	Mean No. of *P. puparium* emerged per pupa	No. of holes	% Mortality of parasitized pupa
27-11-13	7	2	28.5	39	2 pupae 1 hole	0
19-12-13	76	23	30.2	74.82	20 pupae 1 hole 30 pupae 2 hole	6.57
23-12-13	66	31	46.96	79.6	22 pupae 1 hole 9 pupae 2 hole	10.6
30-12-13	60	18	30	73.77	16 pupae 1 hole 2 pupae 2 hole	18.33
02-01-14	5	0	0	0	0	0
20-01-14	8	0	0	0	0	0
29-01-14	7	0	0	0	0	0
10-02-14	51	18	35.29	84.72	13 pupae 1 hole 3 pupae 2 hole 2 pupae 3 hole 1 pupae 6 hole	13.72
24-02-14	50	29	58	84.27	10 pupae 1 hole 15 pupae 2 hole 5 pupae 3 hole	0
26-02-14	33	27	81.81	46.81	6 pupae 1 hole 11pupae 2 hole 9 pupae 3 hole 1 pupae 4 hol	0
28-02-14	57	26	45.6	51	8 pupae 1 hole 9 pupae 2 hole 3 pupae 3 hole 4 pupae 4 hole	0
03-03-14	36	26	72.2	68.61	12 pupae 1 hole 5 pupae 2 hole 4 pupae 3 hole 2 pupae 4 hole 2 pupae 5 hole 1 pupae 6 hole	0
04-04-14	57	28	49.12	70	5 pupae 1 hole 12 pupae 2 hole 2 pupae 3 hole 5 pupae 4 hole	14.4
09-04-14	92	49	53.26	72.05	17 pupae 1 hole 5 pupae 2 hole 6 pupae 3 hole 3 pupae 4 hole 1 pupae 5 hole 2 pupae 6 hole 1 pupae 11 hole	28.57
17-04-14	60	7	11.66	42.85	3 pupae 1 hole 1 pupae 2 hole 3 pupae 4 hole	0

P. puparium parasitism of *P. brassicae* pupae was maximum of 81.81% on 26.2.14 and minimum on 2, 20 and 29 Jan, 2014 (Table 6). Mean no. of parasitoid emerged were maximum no. of 84.72 on 10 Feb and nil on 2, 20 and 29 Jan, 2014. The mean no. of emerging holes were in high range of 1-11 holes on 9 April and nil on 2, 20 and 29

Jan, 2014. Percent mortality of the parasitoid pupae was maximum of 28.57% on 9 April and nil on 27 Nov, 2013, and 2, 20 and 29 Jan, 14, 24, 26 and 28 Feb, 3 March and 17 April, 2014.

There were 2 larval parasitoids *C. glomerata* and *D. pierisae*, 2 pupal parasitoids *B. lasus* and *P. puparium* and 2 hyper parasitoids *B. lasus* and *T. galactopus* collected during 2012-2014 from cauliflower fields. Gabriela (2001) recorded 5 primary parasitoids (*Hyposoter ebeninus, Cotesia rubecula, Cotesia glomerata, Trichogramma evanescens* and *Compsilura Concinnata*) and 2 secondary parasitoid (*Trichomalopsis submarginatus* and *T. galactopus*) from *P. brassicae.* Mehdi *et al* (2011a) also recorded ten species of primary parasitoids *C. glomerata*, *Brachymeria femorata* Panzer, *Aprostocetus taxi* Graham, *Agrothereutes adustus* Grav., *Blapsidotes vicinus* Grav., *Hyposoter clauses* Brischke, *Pteromalus puparum , Exorista larvarum* (L.), *Exorista segregata* Rondan and *Phryxe vulgaris* Fallén.

Parasitoids play an important role in reducing *P. brassicae* population density. Eggs and larvae of *P. brassicae* are also attacked by generalist predators such as carabids, spiders, staphylinids and chrysopids (Pfiffner *et al*., 2009). But no parasitoid or predator was collected from *P. brassicae* eggs in Pakistan (Mushtaque and Mohyuddin, 1984). Parasitoids cause *P. brassicae* mortality ranging from 15.3% to 18.56% in cultivated crop, and 41.31% to 45.19% in wild hosts (Mehdi *et al.*, 2011 a). They further reported that parasitoids of *P. brassicae* belonged to the families: Eulophidae, Ichneumonidae, Chalcididae, Tachinidae, Braconidae and Pteromalidae, which caused 0.56, 1.41, 1.97, 3.66, 44.51 and 47.89% parasitization in two years.

Parasitism of *P. brassicae* by *C. glomerata* was maximum of 29.03% on 7 May. Mean no. of parasitoid pupae formed were a maximum of 33 on 17 April. Mean no. of hyper parasitoid *T. galactopus* emerged from *C. glomerata* per-pupa were a maximum of 2.4 on 7 May. *Brachymeria lasus* parasitism of *P. brassicae* pupa was a maximum of 26.08% on 11 March. In our study *C. glomerata* showed 0.48 - 29.03% parasitization in 1st year but no parasitization was recorded in 2nd year. *T. galactopus* hyper parasitoid was also collected from *C. glomerata* pupa. Hyperparasitization ranged from 1.8% - 2.4%. Gu *et al*. (2003) reported that superparasitism is common in *C. glomerata*. Gabriela (2001) stated that hyper parasitoids has negative effect on primary parasitoids efficiency. Mehdi *et al*. (2011a) found that *C. glomerata* was the second most effective parasitoid which caused 43.45% and 45.57% parasitism in two consecutive years. Sato and Ohsaki (2004) reported that *P. brassicae* larvae were parasitized by *C. glomerata*, but the parasitism rate of *P. brassicae* larvae was lower than that of *P. rapae*.

Mean no. of *B. lasus* parasitoid emerged was a maximum no. of 12 on 5 March. *D. pierisae* parasitism of *P. brassicae* larvae was maximum of 18.6% on 5 March. Mean no. of parasitoid emerged were a maximum of 17 on 5 March. Female to male sex ratio was a maximum of 3.25:1 on 5 March. Mortality of the parasitoid was maximum of 66.66% on 14 March. In the present study *B. lasus* caused 0% - 26.08% parasitization of *P. brassicae* pupae. Mehdi *et al*. (2011a) reported that the third most effective parasitic species of *P. brassicae* is *B. femorata*, which reduced pest numbers by 2.43% - 4.89% in two years. *Brachymeria* few species are solitary primary parasitoids of lepidopteran pupae and *B. femorata* was reported from *P. brassicae, Euphydryas aurinia, E. desfontainii, Melitaea didyma, M. deione, Maniola jurtina* and *B. tibialis* (Shaw *et al*., 2009).

D. pierisae (Ichneumonide wasp) parasitization of *P. brassicae* larvae was maximum of 36.89% on 23 Feb. Mean no. of emerged parasitoid were a maximum no. of 154 on 9 April. The female to male sex ratio was a maximum of 3:0 on 21 April. Mortality of the *D. pierisae* was a maximum of 28 on 9 April. In current study parasitism of *P. brassicae* larvae by *D. pierisae* was 2.63% - 18.6% and 2.25% -36.89% during 2012-13 and 2013-14, respectively. The percent mortality of *D. pierisae* pupae was 0% - 66.66 % and 0% - 28% during 2012-13 and 2013-14, respectively. During 2nd year of study *D. pierisae* was hyper parasitized by *B. lasus* and *T. galactopus* 0% - 17% and 0% - 3%, respectively. Mushtaque and Mohyuddin (1984) reported that *D. pierisae* and *A. glomaratus* are important larval parasitoids of *P. brassicae* in Pakistan.

Mean no. of *B. lasus* (Chalcid wasp) emerged from *D. pierisae* pupa were maximum of 17 on 9 April. Mean no. of hyper parasitized *D. pierisae* pupa and hyper parasite *T. galactopus* emerged were 3 and 22 on 9 April, respectively. Shaw *et al*. (2009) reported that a few chalcidids (including species of *Brachymeria*) arise as pseudo hyper parasitoids on Ichneumonoidea cocoons.

P. puparium parasitism of *P. puparium* was maximum of 82.7% on 7 May. Mean no. of parasitoid emerged was maximum of 27.31 on 11 March. The no. of emerging holes were in high range of 1-8 on 11 March. *P. puparium* parasitism of *P. brassicae* pupae was maximum of 81.81% on 26.2.14. Mean no. of parasitoid emerged were maximum no. of 84.72 on 10 Feb. The mean no. of emerging holes were in high range of 1-11 holes on 9 April. Percent mortality of the parasitoid pupae was maximum of 28.57% on 17 April.

During current study parasitism of *P. brassicae* pupae by *P. puparium* was 10% - 82.7% and 0% - 81.81% during 2012-13 and 2013-14, respectively. Mean no. of parasitoid emerged was 10.00 - 27.31 and 0 – 84.72 per pupae of *P. brassicae* during 2012-13 and 2013-14, respectively. Mean no. of emerging holes were in range of 1-8 and 1-11 during 2012-13 and 2013-14, respectively which might be due to super parasitism. *P. puparum* is a

gregarious pupal parasitoid, which has a wide host range, including species of Pieridae and Nympahlidae. *Pteromalus* regulate the population of *Papilio xuthus* at low density (Takagi, 1985). This wasp is a predominant pupal endoparasitoid of *Pieris rapae* (Zhu *et al*., 2008) and is considered to be an important biological control agent of *P. brassicae* (Harvey *et al*., 2007). Mushtaque and Mohyuddin (1984) reported that *P. puparum* is most abundant and widely distributed in Pakistan and it can parasitization up to 100% of *P. brassicae* pupae. Mehdi *et al.*, (2011a) reported that *P. puparium* reduced the *P. brassicae* by 49.65% and 46.13% in two consecutive years. And number of *P. puparum* parasitoid emerged from *P. brassicae* pupa was 42.36 ± 2.42, but more than 200 parasitoids produced per *P. brassicae* pupae, when more than one female attacked a single host. They further reported that *P. puparum* along with *C. glomerata* may play an important role in the biological control of *P. brassicae.* But, Jalali and Leeuwen (2009) stated that biological control alone may not be sufficient to manage insect pest populations and supplementary insecticide treatments may be needed in IPM program.

Conclusion

The study shows that in studied area different species of parasitoids were recorded showing good control of pest *P. brassicae*. But they need synchronization with minimal use of insecticides for conservation of these natural enemies.

Acknowledgement

Higher Education Commission, Islamabad is highly acknowledged for sponsoring this part of PhD Dissertation and CABI Islamabad Pakistan for identification of insects.

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