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FIELD PARASITISATION RATE OF LARVAL AND PUPAL PARASITOIDS OF DIAMONDBACK MOTH AVAILABLE AT SABOUR BIHAR INDIA

Ankit Anand, Ali Assaba Mohammed Shafi*, Nawazish Ahmad and Shriya Singh
Department of Entomology, Bihar Agricultural College,
Bihar Agricultural University Sabour, Bhagalpur, Bihar, India- 813 210
*Corresponding author email: aliassaba143@gmail.com
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ABSTRACT

Crucifer vegetables play a vital role in global nutrition, offering essential vitamins, minerals, and bioactive compounds with significant therapeutic benefits, such as anti-cancer, antibacterial, antifungal, and antioxidative properties. India is a major producer of cabbage, cauliflower, and broccoli, second only to China. However, these crops face severe pest challenges, notably from the diamondback moth (*Plutella xylostella* L.), the most destructive pest worldwide. *P. xylostella* causes extensive damage to crucifers, leading to billions of dollars in losses and costing approximately $4-5 billion annually for its management. This pest's destructive capacity is exacerbated by its resistance to insecticides and the scarcity of natural enemies. The present investigation conducted at Bihar Agricultural College Sabour aimed to evaluate the natural parasitism rates of *P. xylostella* by various larval and pupal parasitoids. Weekly collections of larvae and pupae were made, and parasitoids were reared under controlled laboratory conditions. Several larval parasitoids, including *Cotesia vestalis*, *Diadegma semiclausum, D. fenestrale, D. insulare* and *Microplitis plutellae*, were identified, with the total natural parasitism rate reaching 28.17%. Pupal parasitoids, such as *Oomyzus sokolowskii, Brachymeria exacarinata* and *Diadromus collaris*, contributed to a natural parasitism rate of 16.60%. The findings emphasize the critical role of hymenopteran parasitoids in regulating *P. xylostella* populations and reinforce the importance of biological control in integrated pest management (IPM) programs for crucifer crops. These results align with previous studies and underscore the need for continued research into sustainable pest management strategies.
***Keywords* :** Field Parasitisation, Rate of Larval and Pupal Parasitoids , Diamondback Moth

Introduction

Crucifer vegetables are crucial in providing vital nutrients like vitamins, carotenoids, flavonoids, polyphenols, minerals; promoting therapeutic values such as anti-cancerous (Francisco *et al.* 2017), antibacterial, antifungal, antioxidative (Verhoeven *et al.* 1996; Faller and Fialho 2009; Bhandari *et al.* 2015) and ensuring food security to billions of individuals all over the globe. India ranks second after China, in acreage and production in Cabbage, cauliflower and broccoli (FAOSTAT 2022).

It is attacked by numerous pests *viz.*, Cabbage Caterpillar, Diamondback moth, Cabbage Semilooper, Tobacco caterpillar, Leaf webber, Cabbage borer, Cabbage flea beetle. Minor pests include Painted bug, Aphid/Plant lice, Thrips, Bihar hairy caterpillar, Cutworms, Cabbage looper and Mustard sawfly amongst which the diamondback moth (CABI, 2020), *Plutella xylostella* L. (Plutellidae: Lepidoptera), is the most notorious and destructive one causing losses of billions of dollars all over the world. Also, it costs about $4 to $5 billion every year to deal with the management of *P. xylostella*, according to a cautious estimate by Zalucki *et al.* 2012. The menace of DBM is attributed to the dearth of natural enemies in the crop ecosystem may be due to inability of natural enemies complexes to migrate to distant new location or certainly due to use of broad spectrum insecticides. Ooi

(1979) noted that misuse of insecticides has exacerbated problems with DBM. Development of more ecologically based management strategies has been slow and difficult to implement on a large scale. Iga (1985) reported that seasonal fluctuation depended mainly on the action of natural enemies. However, microbial insecticides *Bacillus thuringiensis* Berlines (Bt) is highly toxic to certain pests, yet it has little or no adverse effects on most non target organisms, including humans. The insecticide usage becomes not only useless but also harmful when DBM develops into adult form.

Dealing with the natural enemy complex, egg parasitoid, *Trichogramma* spp.; larval parasitoids such as *Apanteles vestalis, Diadegma semiclausum, Diadegma fenestrale, Diadegma insulare,* and *Microplitis plutellae* and pupal parasitoids such as *Oomyzus sokolowskii* and *Diadromus collaris* are the most abundantly reported to be parasitizing all the development stages by many researchers and scientists.

Materials and Methods

The present investigation was conducted at the Vegetable Research Plot, Bihar Agricultural College Sabour, Bhagalpur bearing coordinates 25.23° N, 87.04° E in the fertile alluvial soil of Indo-gangetic plains of north eastern India at altitude of 75MSL falling in agroclimatic zone III-A. The region has a humid subtropical climate with around 1200 mm of annual rainfall. The monsoon season runs from June to September, often disrupting agriculture due to heavy rain and cloud cover. Summers are hot, starting in April, with May and June reaching temperatures above 40˚C. January is the coldest month, with temperatures ranging from 8˚C to 21.8˚C.

Crops like cabbage, cauliflower, broccoli, radish, mustard and red cabbage were grown at the plot during the time period of the experiment. Every week, starting from 46th SMW, 2023 till 13th SMW, 2024, 50 suspected silken cocoons and 150 sluggish and lethargic larvae of the diamondback moth were collected and brought to the Bio-control facility laboratory of the Department of Entomology. The larvae were reared in the glass rearing cage by feeding fresh cabbage leaves and the cocoons were kept until the emergence of the adult stage of larval and pupal parasitoids, respectively. Parasitoids were identified based by the experts based on taxonomic keys. Later on, their natural field parasitization rates were calculated.

The glass rearing cage was maintained at abiotic conditions of 25 ± 5^{o}C, RH 65 ± 10%, and 12 hr photoperiod (Mondédji *et al*., 2015) in the incubator. For convenience, larval-pupal, prepupal-pupal and pupal parasitoids were considered in one category as pupal parasitoids

Results

Several larval parasitoids were identified from diamondback moth caterpillars collected from crop fields. These included *Cotesia (=Apanteles) vestalis* (Braconidae), *Diadegma semiclausum, Diadegma fenestrale, Diadegma insulare* (Ichneumonidae), and *Microplitis plutellae* (Braconidae). Their parasitization natural field parasitization rates are shown in Table 1.

During each SMW, 150 larvae were examined. In the 13th SMW, 2024, 45 (30%) larvae were parasitized by *Apanteles vestalis*, and 18 (12%) by *Diadegma semiclausum*. Additionally, 85 larvae (56.67%) were parasitized by *Diadegma fenestrale*, 11 (7.33%) by *Diadegma insulare*, and 13 (8.67%) by *Microplitis plutellae*. Overall, parasitism was highest in the 12th SMW, 2024, with 146 larvae (97.33%) parasitized out of 150 suspected larvae.

Across the study, the average parasitism rates for *Apanteles vestalis, Diadegma semiclausum, Diadegma fenestrale, Diadegma insulare,* and *Microplitis plutellae* were 9.77%, 2.93%, 10.73%, 1.87%, and 2.87%, respectively, out of 3000 larvae. The total parasitism rate for all larval parasitoids was 28.17%.

Three pupal parasitoid species *Oomyzus sokolowskii* (Eulophidae), *Diadromus collaris* (Ichneumonidae), and *Brachymeria exacarinata* (Chalcididae) were identified from the suspected diamondback moth pupae gathered in the field. Their parasitism percentages are provided in Table 2.

Oomyzus sokolowskii was first recorded during the 49th SMW, 2023 reaching its highest count of 8 in the 13th SMW, 2024. Out of 1000 collected pupae, *Diadromus collaris* parasitized 56 (5.60%), and *Brachymeria exacarinata* parasitized 50 (5.00%). In total, all pupal parasitoids accounted for 16.60% parasitism, with 166 parasitized pupae from 1000 collected.

Discussion

Contribution of *Cotesia plutellae, Diadegma semiclausum, D. fenestrale, D. insulare* and *Microplitis plutellae* in total parasitism were 34.67, 10.41, 38.11, 6.63 and 10.18 per cent respectively. Familiar results were sighted by Bhat and Bhagat (2008) where maximum parasitization percentage due to *Cotesia plutellae* and *Diadegma fenestrale* were 29.4 and 57.3 per cent. Highest parasitization of 12.00 per cent due to *Diadegma semiclausum* was in agreement to the findings of Afiunizadeh and Karimzadeh (2015). These both findings of present study are also in corroboration with observations of Debbarma *et al*. (2018) *i.e.,* maximum parasitization by *C. plutellae* and *D. semiclausum* were 32.85 and 12.36 per cent. The dominance of hymenopteran parasitoids like *Diadegma fenestralis* Holm., *Diadromus collaris* Gravenhorst, and *Cotesia* spp. was in accordance with the investigations of Chauhan *et al*. (1997) and Devi *et al*. (2004).

Also, no parasitism due to *Diadegma* spp. was reported at temperature near or below 15°C, as similar to reports of Monnerat *et al*. (2002).

Similarly, for pupal parasitoids *Oomyzus sokolowskii, Diadromus collaris* and *Brachymeria exacarinata,* their contribution in total parasitism were 36.14, 33.73 and 30.1 per cent. Availability of *Oomyzus sokolowskii, Diadromus collaris* and *Brachymeria exacarinata* as pupal parasitoids of *P. xylostella* in present study was similar to findings of Waladde *et al*. (2001), Sarfraz *et al*. (2005), Gathu *et al*. (2009) and Kahuthia (2011).

Table 1 : Natural parasitism percentage of different larval parasitoids of *P. xylostella*

S M W	Suspected DBM Larvae collected	*Apanteles vestalis*		*Diadegma semiclausam*		*Diadegma fenestrale*		*Diadegma insulare*		*Microplitis plutallae*		Total parasitism amongst suspected larvae collected	
		NPL	Per cent	NPL	Per cent	NPL	Per cent	NPL	Per cent	NPL	Per cent	TPL	Per cent
46	150	1	0.67	0	0.00	0	0.00	0	0.00	1	0.67	2	1.33
47	150	1	0.67	0	0.00	1	0.67	0	0.00	0	0.00	2	1.33
48	150	3	2.00	1	0.67	0	0.00	0	0.00	0	0.00	4	2.67
49	150	2	1.33	2	1.33	0	0.00	2	1.33	2	1.33	8	5.33
50	150	4	2.67	1	0.67	1	0.67	1	0.67	3	2.00	10	6.67
51	150	3	2.00	0	0.00	2	1.33	0	0.00	2	1.33	7	4.67
52	150	3	2.00	1	0.67	1	0.67	2	1.33	3	2.00	10	6.67
1	150	4	2.67	0	0.00	0	0.00	0	0.00	4	2.67	8	5.33
2	150	7	4.67	0	0.00	0	0.00	0	0.00	2	1.33	9	6.00
3	150	13	8.67	0	0.00	0	0.00	0	0.00	1	0.67	14	9.33
4	150	15	10.00	0	0.00	4	2.67	0	0.00	4	2.67	23	15.33
5	150	16	10.67	4	2.67	8	5.33	3	2.00	3	2.00	34	22.67
6	150	17	11.33	5	3.33	12	8.00	2	1.33	3	2.00	39	26.00
7	150	19	12.67	4	2.67	17	11.33	1	0.67	4	2.67	45	30.00
8	150	20	13.33	6	4.00	24	16.00	4	2.67	7	4.67	61	40.67
9	150	22	14.67	8	5.33	30	20.00	6	4.00	8	5.33	74	49.33
10	150	28	18.67	11	7.33	39	26.00	7	4.67	12	8.00	97	64.67
11	150	34	22.67	14	9.33	45	30.00	9	6.00	10	6.67	112	74.67
12	150	36	24.00	13	8.67	85	56.67	8	5.33	4	2.67	146	97.33
13	150	45	30.00	18	12.00	53	35.33	11	7.33	13	8.67	140	93.33
G.T	3000	293	9.77	88	2.93	322	10.73	56	1.87	86	2.87	845	28.17

NPL - number of parasitized larvae out of total collection of suspected diamondback moth larvae in particular SMW
TPL - total parasitized larvae of DBM in particular SMW
G.T - Grand total (during entire study period)

Table 2 : Natural parasitism percentage of different pupal parasitoids of *P. xylostella*

SMW	Suspected DBM pupae collected	*Oomyzus sokolowaskii*		*Diadromus collaris*		*Brachymeria exacarinata*		Total parasitism amongst suspected pupae collected	
		NPP	Per cent	NPP	Per cent	NPP	Per cent	TPP	Per cent
46	50	0	0.00	0	0.00	0	0.00	0	0.00
47	50	0	0.00	0	0.00	1	2.00	1	2.00
48	50	0	0.00	1	2.00	0	0.00	1	2.00
49	50	1	2.00	2	4.00	0	0.00	3	6.00
50	50	1	2.00	1	2.00	1	2.00	3	6.00
51	50	0	0.00	0	0.00	2	4.00	2	4.00
52	50	1	2.00	1	2.00	1	2.00	3	6.00
1	50	1	2.00	2	4.00	1	2.00	4	8.00
2	50	2	4.00	0	0.00	2	4.00	4	8.00
3	50	2	4.00	2	4.00	0	0.00	4	8.00
4	50	3	6.00	2	4.00	3	6.00	8	16.00
5	50	3	6.00	3	6.00	3	6.00	9	18.00
6	50	4	8.00	4	8.00	4	8.00	12	24.00
7	50	4	8.00	3	6.00	4	8.00	11	22.00
8	50	5	10.00	4	8.00	3	6.00	12	24.00
9	50	5	10.00	5	10.00	4	8.00	14	28.00
10	50	6	12.00	6	12.00	5	10.00	17	34.00
11	50	7	14.00	7	14.00	5	10.00	19	38.00
12	50	7	14.00	6	12.00	6	12.00	19	38.00
13	50	8	16.00	7	14.00	5	10.00	20	40.00
G.T	1000	60	6.00	56	5.60	50	5.00	166.00	16.6

NPP - number of parasitized pupae out of suspected diamondback moth pupae collected in particular SMW
TPP - total parasitized pupae of DBM in particular SMW
G.T - Grand total (during entire study period)

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Competing Interests

Authors have declared that no competing interests exist.

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