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POPULATION DENSITY OF PREDATORS OF DIAMONDBACK MOTH (*PLUTELLA XYLOSTELLA* L.) AT SABOUR BIHAR INDIA

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ABSTRACT

The diamondback moth (*Plutella xylostella* L.) has emerged as the most destructive pest for Brassica vegetables globally, incurring billions in losses due to insecticide resistance and insufficient natural enemy activity. This study highlights the dynamic interactions between *P. xylostella* and its predators, which include members of Syrphidae, Hemerobiidae, Chrysopidae, Staphylinidae, Coccinellidae, and Formicidae families. Field investigations at the Vegetable Research Plot, Bihar Agricultural College, Sabour, Bihar, identified key predators such as *Allograpta* (hover fly), *Micromus* (brown lacewing), *Chrysoperla carnea* (green lacewing), *Paederus* (rove beetle), *Harmonia axyridis* (Asian lady beetle), *Pheidole megacephala* (big-headed ant), and *Tetramorium* spp. Predators exhibited significant temporal fluctuations in abundance across crop growth stages. During plant establishment stage (46th–47th SMW), *H. axyridis* (3.9 individuals) and *Paederus* (3.7) were predominant. At the head initiation stage (48th–51st SMW), *Paederus* (19.9) and *H. axyridis* (18.0) were most abundant, alongside *C. carnea* (11.7), *Tetramorium* (11.4), *P. megacephala* (10.9), and *Allograpta* (19.2). In the head development stage (52nd–3rd SMW), *Paederus* peaked at 41.6, followed by *P. megacephala* (31.2), with *Micromus* (3.7) being least abundant. Surprisingly, during the harvesting stage (4th–8th SMW), *Tetramorium* (91.1) and *P. megacephala* (79.5) were dominant, while *Allograpta* (35.7) and *Micromus* (35.4) remained less prevalent. Overall, predator populations peaked at 102.6 individuals per 20 plants in the 8th SMW, demonstrating their critical role in natural pest suppression. These findings underscore the potential of leveraging predator dynamics for integrated pest management in Brassica cropping systems.

***Key words*:** Diamondback moth, predators, *Chrysoperla*, Syrphidae, Coccinellidae

Introduction

Cole crops are well-known for their health benefits, thanks to their abundance of essential nutrients and phytochemicals, which have been linked to protection against certain diseases, including cancers (Francisco *et al.*, 2017) and heart conditions (Cartea *et al.*, 2011a). These beneficial bio-molecules include polyphenols, vitamins, flavonoids, carotenoids, minerals, and unique compounds known as glucosinolates (Cartea *et al.*, 2011b). Studies have shown that glucosinolates and their derivatives offer various health advantages, such as anticancer, antibacterial, antifungal, antioxidative, and allelopathic properties (Verhoeven *et al.*, 1996; Faller and Fialho 2009; Bhandari *et al.*, 2015).

The diamondback moth (CABI 2020), *Plutella xylostella* L. (Plutellidae: Lepidoptera), has emerged as the most devastating insect pest affecting Brassica vegetables, including *Brassica oleracea* L., on a global scale accounting for billions of dollar loss. The damage inflicted by *P. xylostella* follows a pattern where first-instar larvae mine into leaf tissue, whereas later instars scrap leaf tissue from the undersides, creating irregular patches and often leaving the top epidermal layer and leaf veins with a window-like appearance. The severity of its infestation is largely due to a shortage of effective natural enemies and the development of resistance to insecticides, which contribute to its widespread outbreaks. 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.

A wide range of parasitoids and predators target all developmental stages of *P. xylostella*. General predators, including birds and spiders, often prey on adult moths. Over 90 species of parasitoids have been documented globally (Goodwin 1979) attacking all life stages of *P. xylostella*. Among these, the most prominent and effective predators belong to family Syrphidae, Hemerobiidae, Chrysopidae, Staphylinidae, Coccinellidae and Formicidae. Thus, this paper helps finding the insights about the abundance of predators of diamondback moth at Sabour.

Material and Methods

The experiment was conducted both in the field and in the laboratory. Field work took place at the Vegetable Research Plot, Bihar Agricultural College Farm, while laboratory work occurred in the Department of Entomology at Bihar Agricultural College, Sabour, Bhagalpur, Bihar. Cole crops observed during the study were cabbage, cauliflower, broccoli and red cabbage. The plot featured fertile, well-drained sandy loam soil with a pH of 7.2 and access to bore-well irrigation. The laboratory, equipped for detailed studies. Sabour, located in the Indo-gangetic plains of northeastern India at an altitude of 41 meters above sea level, lies within agro-climatic zone III-A, with coordinates from 24.47° to 26.56° N latitude and 82.12° to 83.98° E longitude. The region has a humid subtropical climate, receiving around 1200 mm of annual rainfall, mostly during the monsoon season from June to September, which often brings heavy rainfall and cloud cover impacting agriculture. Summers, from April to June, are hot, with temperatures exceeding 40°C in May and June, while January is the coldest month with temperatures ranging from 8.0°C to 21.8°C.

Predators of diamondback moth dwelling in the niche of these Cole crops were identified and counted *in-situ* or brought to the laboratory of Department of Entomology, BAC Sabour for identification under the supervision of experts based on entomological keys. The population density of each predator was worked out per 20 plants for each different predator of DBM starting from 46th to 13th every Standard Meteorological Week (SMW).

Growth and development of Cole crops occurred in stages namely, transplanting to plant establishment stage (46th to 47th SMW); head initiation stage (48th to 51st SMW); head initiation to development stage (52nd to 3rd SMW) and harvesting stage (4th to 8th SMW). For

Table 1: Mean population (per 20 plants) of predators of *P. xylostella* in Cole crops grown at Vegetable Research Plot, BAC Farm, Sabour.

SMW	*Allograpta*	*Micromus*	*Chrysoperla carnea*	*Paederus*	*Harmonia axyridis*	*Pheidole megacephala*	*Tetramorium*	Total mean population
46	0.0	0.0	0.0	1.2	0.3	0.8	0.6	2.90
47	0.0	0.0	0.6	2.5	3.6	2.1	1.7	10.50
48	0.8	0.2	1.6	3.7	3.2	2.5	2.3	14.30
49	1.1	0.2	4.9	4.2	3.7	1.6	3.9	19.60
50	1.7	0.4	3.7	5.2	4.9	2.6	4.6	23.10
51	2.2	0.6	1.5	6.8	6.2	4.2	0.6	22.10
52	2.9	0.9	1.6	7.7	7.7	5.1	2.5	28.40
1	4.2	0.3	2.7	9.1	8.9	6.5	4.9	36.60
2	5.8	0.7	3.6	10.5	2.6	7.9	8.3	39.40
3	6.3	1.8	3.5	14.3	4.7	11.7	9.9	52.20
4	6.7	3.3	3.6	16.8	5.6	14.2	12.8	63.00
5	11.6	4.5	8.7	16.9	7.4	14.3	16.1	79.50
6	7.4	7.6	14.1	10.1	10	15.8	17.3	82.30
7	6.3	8.9	15.6	11.3	12.6	17	20.6	92.30
8	3.7	11.1	16.3	12.5	16.5	18.2	24.3	102.60
9	3.2	8.2	14	9	13.7	14.7	24.5	87.30
10	2.8	6.1	12.9	6.6	9.6	12.3	22.4	72.70
11	2.1	1.3	6.1	2.9	3.7	8.6	16.9	41.60
12	1.6	4.4	2.3	7.6	1.4	5	13.6	35.90
13	0.9	2.3	1.9	4.8	6.2	2.2	8.4	26.70

research purpose, the crops were left unharvested in the field until senescence (9th to 13th SMW).

Results and Discussion

Predators like *Allograpta* (hover fly) (Syrphidae: Diptera), *Micromus* (brown lacewing) (Hemerobiidae: Neuroptera), *Chrysoperla carnea* (green lacewing) (Chrysopidae: Neuroptera), *Paederus* (rove beetle) (Staphylinidae: Coleoptera), *Harmonia axyridis* (Asian lady beetle) (Coccinellidae: Coleoptera), *Pheidole megacephala* (the bigheaded ant) (Formicidae: Hymenoptera) and *Tetramorium* (Formicidae: Hymenoptera) ants were found in the crops.

Allograpta was seen hovering over the red cabbage crop, while the eggs of brown lacewings were discovered on the underside of cabbage leaves, often near infestation sites. Unlike green lacewing eggs, these eggs were not stalked. Grubs of *Chrysoperla carnea* were found on broccoli leaves, feeding on the early instars of DBM. Adult *Paederus* were observed climbing the cauliflower foliage, both adults and grubs being predatory and thriving in fallen leaves, soil, and decaying matter. *Harmonia axyridis*, a coccinellid, was spotted undergoing metamorphosis, transitioning from grub to adult lady beetle. These adults exhibited various color patterns, ranging from solid orange to orange with black spots or red with black spots, and could easily be mistaken for other ladybird species like the seven-spotted lady beetle (*Coccinella septempunctata*). Big-headed ants were found devouring DBM larvae, with worker ants ranging in color from yellowish-brown or reddish-brown to nearly black, similar to *Tetramorium* ants, which were also feeding on DBM larvae.

The population of *Allograpta* was first observed in the 48th SMW at 0.8 per 20 plants, peaking at 11.6 individuals per 20 plants in the 5th SMW, and then declining as the temperature increased. Both *Micromus* and *Chrysoperla carnea* reached peaks of 11.1 and 16.3 individuals in the 8th SMW, respectively. *Paederus* started at a mean of 1.2 in the 46th SMW and became most abundant in the 5th SMW with 16.9 individuals. *Harmonia axyridis* and *Pheidole megacephala* reached their highest populations of 16.5 and 18.2 in the 8th SMW, respectively. *Tetramorium* ants peaked at 24.5 in the 9th SMW and dropped to 8.4 in the 13th SMW. Overall, the maximum predator abundance was 102.6 per 20 plants in the 8th SMW, which declined to 26.7 by the end of the season in the 13th SMW represented in Table 1.

Considering different growth stages of the crop from economic point of view (Fig. 1), present study highlighted that amongst predators, *Harmonia axyridis* was most abundant with mean of 3.9 individuals followed by *Paederus* (3.7) during plant establishment stage (46th to 47th SMW). In head initiation stage (48th to 51st SMW), *Paederus* (19.9) was most abundant followed by *Harmonia axyridis* (18.0), *Chrysoperla carnea* (11.7), *Tetramorium* (11.4), *Pheidole megacephala* (10.9), *Allograpta* (19.2). Further in head initiation to development stage (52nd to 3rd SMW), again, *Paederus* (41.6) was most abundant with *Pheidole megacephala* (31.2) trailing behind. *Micromus* (3.7) was least abundant. But surprisingly during, harvesting stage (4th to 8th SMW), *Tetramorium* (91.1) became most abundant followed by *Pheidole megacephala* (79.5). Whereas, *Allograpta* (35.7) and *Micromus* (35.4) were least abundant in the eco-system of crops.

These findings are similar as reported in previous studies by Hosseini *et al.*, 2012 and Miranda *et al.*, 2011. Alam (1992) identified coccinellids (lady beetles), chrysopids (lacewings), syrphids, and staphylinids as the most common predator groups in cabbage fields. These predators targeted different stages of pest development, with coccinellids feeding on eggs and young larvae, chrysopids on larvae, syrphids on young larvae, and staphylinids on larvae and pupae. These observations are consistent with the findings of the present study, which highlights the role of these predator groups in regulating pest populations. Similarly, Lim (1992) reported that coccinellid beetles, chrysopids, and carabid beetles' prey on *P. xylostella* which corroborates the current study's emphasis on the diverse range of natural enemies thriving in the crop ecosystem. Staphylinid beetles, as noted by Sunderland (2002) and Szwejda (2004), are recognized as significant generalist predators in many agro-ecosystems and play a crucial role in controlling

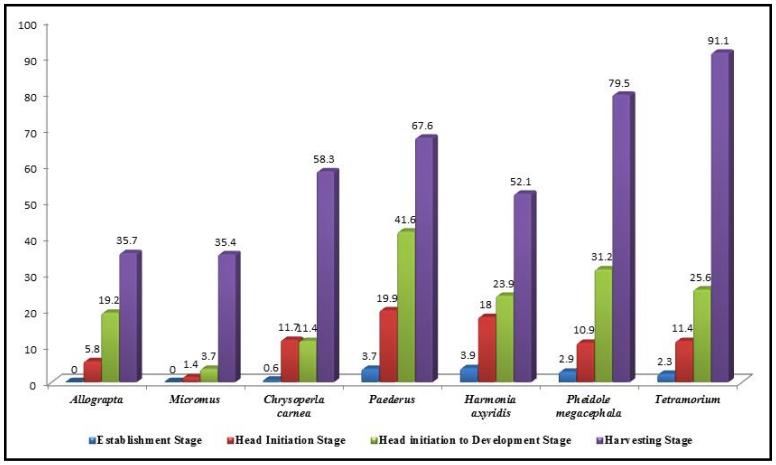

Fig. 1: Population density of predators of DBM at different stages of crop growth.

P. xylostella, further supporting the findings of this study.

However, the present study underscores the importance of *Paederus* as part of the predator complex influencing *P. xylostella* populations. Additionally, predatory lacewing larvae (*Chrysoperla* spp.) have been recognized as potential biological control agents for the diamondback moth (Eigenbrode and Kabalo 1999; Reddy *et al.*, 2002). The findings from this study align with these reports, reinforcing the role of lacewing larvae in pest suppression.

While the role of predators in agro ecosystems is well established (Symondson *et al.*, 2002), few studies have quantitatively assessed their impact on *P. xylostella* populations due to methodological challenges. This study provides further evidence of the potential of generalist predators to effectively suppress *P. xylostella* populations, supporting and building upon these earlier observations.

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References

Alam, M.M. (1992). Diamondback moth and its natural enemies in Jamaica and some other Caribbean Islands, 233-243. *In* N. S. Talekar, Proceedings: Diamondback moth and other crucifer pests: the Second International Workshop, 10-14 December 1990, Tainan, Taiwan. Asian Vegetable Research and Development Center, Shanhua, Taiwan.

Bhandari, S.R., Jo J.S. and Lee J.G. (2015). Comparison of glucosinolate profiles in different tissues of nine brassica crops. *Molecules*, **20(9)**, 15827-15841. doi:10.3390/molecules200915827

CABI (2020) *Plutella xylostella* (diamondback moth). Retrieved from https://www.cabi.org/isc/datasheet/42318 (15.07.2020)

Cartea, M.E., Francisco M., Soengas P. and Velasco P. (2011a). Phenolic compounds in Brassica vegetables. *Molecules*, **16(1)**, 251-280.

Cartea, M.E., Lema M., Francisco M. and Velasco P. (2011b). Basic information on vegetable Brassica crops. In CK Jan Sadowski (Ed.), *Genetics, genomics and breeding of vegetable Brassicas*, 1-33. Taylor & Francis Group: CRC Press.

Eigenbrode, S.D. and Kabalo N. (1999). Effect of *Brassica oleracea* waxblooms on predations and attachment by *Hippodamia convergens. Entomol. Exp. Appl.*, **91**, 125-130.

Faller, A. and Fialho E. (2009). The antioxidant capacity and polyphenol content of organic and conventional retail vegetables after domestic cooking. *Food Research International*, **42(1)**, 210-215.

Francisco, M., Tortosa M., Martínez-Ballesta Md. C., Velasco P., García-Viguera C. and Moreno D.A. (2017). Nutritional and phytochemical value of Brassica crops from the agri-food perspective. *Annals of Applied Biology*, **170(2)**, 273-285. doi:10.1111/aab.12318

Goodwin, S. (1979). Changes in the number of parasitoid complex associated with the diamondback moth, *Plutella xylostella* (L.) (Lep.). *Victoria. Aust. J. Zool.*, **27**, 981-989.

Hosseini, R., Schmidt O. and Keller M.A. (2012). Detection of predators within Brassica crops: A search for predators of diamondback moth (*Plutella xylostella*) and other important pests. *African Journal of Agricultural Research*. **7**, 3473-3484.

Iga, M. (1985). The seasonal prevalence of occurrence and the life-table of the diamondback moth, *Plutella xylostella* (*Linnaeus*) (*Lepidoptera: Plutellidae*). *Japanese Journal of Applied Entomology and Zoology*, **29**, 119-125.

Lim, G.S. (1992). Integrated pest management of diamondback moth, 565-576. *In* N. S. Talekar, Diamondback Moth and Other Crucifer Pests: Proceedings of the Second International Workshop. Tainan, Taiwan, 10-14 December 1990. Asian Vegetable Research and Development Center, Shanhua, Taiwan.

Miranda, F., Bylund H., Grönberg L., Larsson L., Björkman C. (2011). Population density and killing capacity by predators of eggs and larvae of the diamondback moth in Nicaragua. *Environmental Entomology*, **40**, 333-341.

Ooi, P.A.C. (1979). The natural enemies of *Plutella xylostella* (L.) in Cameron Highlands, Malaysia. *Malaysian Agric. J.*, **52**, 77-84.

Reddy, G.V.P., Holopainen J.K. and Guerrero A. (2002). Olfactory responses of *Plutella xylostella* natural enemies to host pheromone, larval frass, and green leaf cabbage volatiles. *J. Chem. Ecol.*, **28**, 131-143.

Symondson, W.O.C., Sunderland K.D. and Greenstone M.H. (2002). Can generalist predators be effective biocontrol agents? *Annu. Rev. Entomol.*, **47**, 561-594.

Szwejda, J. (2004). Review of pests and natural enemies actually occurring on cabbages in Poland. *Nowosci warzywnicze*., **39**, 97-104.

Verhoeven, D.T., Goldbohm R.A., van Poppel G., Verhagen H., van den and Brandt P.A. (1996). Epidemiological studies on brassica vegetables and cancer risk. *Cancer Epidemiology and Prevention Biomarkers*, **5(9)**, 733-748.