



International Journal of Horticulture and Food Science

E-ISSN: 2663-1067

P-ISSN: 2663-1075

NAAS Rating (2026): 4.74

www.hortijournal.com

IJHFS 2026; 8(7): 87-90

Received: 06-05-2026

Accepted: 10-06-2026

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Impact of intercrops on diamondback moth (*Plutella xylostella* L.) larval population on cabbage

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DOI: <https://www.doi.org/10.33545/26631067.2026.v8.i7b.800>

Abstract

The present investigation entitled “Performance of the Intercropping Systems on the Incidence of the Diamondback Moth (*Plutella xylostella* L.) and its Natural Enemies in Cabbage Ecosystem” was conducted during Rabi 2025-26 to evaluate the influence of habitat manipulation through intercropping on the incidence of diamondback moth (DBM), the abundance of its natural enemies, crop productivity, and economics in cabbage. The population of DBM larvae first appeared during the 4th Standard Meteorological Week (SMW) with a mean population of 0.68 larvae per plant and gradually increased to a peak of 1.84 larvae per plant during the 9th SMW, followed by a decline towards crop maturity. Correlation analysis revealed that DBM incidence was significantly and positively associated with maximum temperature ($r = 0.544$), minimum temperature ($r = 0.728$), sunshine hours ($r = 0.559$), and evaporation ($r = 0.501$), while morning and evening relative humidity, wind velocity, and rainfall exhibited non-significant relationships.

Among the habitat manipulation treatments, cabbage + coriander (1:1) proved to be the most effective in suppressing DBM, recording the lowest mean larval population (0.83 larvae per plant), followed by cabbage + fenugreek (2:1) (1.07 larvae per plant) and cabbage + mustard (2:2) (1.18 larvae per plant). The highest infestation (2.17 larvae per plant) was observed in the sole cabbage crop. Intercropping significantly improved crop productivity, with the highest cabbage equivalent yield (205.40 q ha⁻¹) recorded in cabbage + tomato (2:1), followed by cabbage + coriander (1:1) (204.75 q ha⁻¹) and cabbage + marigold (2:1) (201.40 q ha⁻¹). However, the highest benefit-cost ratio (4.63) was obtained with cabbage + marigold (2:1), closely followed by cabbage + coriander (1:1) (4.61), while the sole cabbage crop recorded the lowest yield (140.80 q ha⁻¹) and benefit-cost ratio (3.02).

Habitat diversification markedly enhanced the abundance of natural enemies.

Cabbage + marigold (2:1) supported the highest populations of *Coccinella septempunctata* (9.60), green lacewings (8.94), spiders (6.98), and the larval parasitoid *Cotesia plutellae* (8.94) per ten plants, with an overall mean predator population of 8.51 per ten plants. The relative abundance of natural enemies was also highest in the marigold intercropping system (21.39%), followed by mustard (16.42%) and coriander (13.78%), whereas the sole cabbage crop recorded the lowest abundance (6.48%). Laboratory studies further revealed that *C. plutellae* caused an average parasitism of 31.35%, confirming its important role in the biological regulation of DBM populations.

The study demonstrated that habitat manipulation through intercropping is an effective and eco-friendly strategy for reducing DBM infestation, enhancing natural biological control, and improving cabbage productivity and profitability. Among the evaluated systems, cabbage + marigold (2:1) emerged as the most promising treatment due to its superior economic returns and conservation of natural enemies, while cabbage + coriander (1:1) was the most effective in suppressing DBM infestation.

Keywords: *Plutella xylostella*, intercropping, cabbage, coriander, integrated pest management

1. Introduction

Cabbage (*Brassica oleracea* var. *capitata* L.) is one of the most economically important leafy vegetables cultivated widely in India due to its high nutritional value, adaptability, and market demand. It is a rich source of vitamins A, C, and K, along with essential minerals and dietary fiber. As per recent estimates, India produces over 8.5 million tonnes of cabbage from about 0.37 million hectares, making it the second-largest producer after China (NHB, 2023). In Rajasthan, cabbage cultivation is spreading gradually, covering 346 hectares with a production of approximately 7,588 tonnes, mainly in districts such as Kota, Jaipur, and Alwar (Horticulture Statistics, Govt. of Rajasthan, 2023).

The crop also plays a significant role in improving farmers' income due to its short duration and high market value.

Despite its economic importance, cabbage cultivation is heavily constrained by insect pest infestations. Among these, the Diamondback moth (DBM), *Plutella xylostella* (L.), is regarded as the most destructive and persistent pest of cruciferous crops worldwide. The larvae feed on leaf tissues, scraping the green matter and leaving behind a thin epidermal layer, which results in the characteristic "window-paning" symptoms. Severe infestation leads to skeletonization of leaves, reduced photosynthetic capacity, and ultimately significant yield loss. Reports indicate that DBM alone can cause 30-80% yield losses, and in extreme cases, even complete crop failure under favorable conditions (Kant *et al.*, 2023)^[7].

Habitat manipulation is one such promising ecological strategy that involves modifying the cropping system to enhance biodiversity, promote natural enemies, and reduce pest colonization. Practices such as intercropping cabbage with companion crops like marigold, coriander, garlic, or mustard, use of trap crops, and establishment of flowering borders can significantly influence pest behavior and natural enemy abundance. These intercrops act as repellents, attractants, or refuges for predators and parasitoids, thereby strengthening biological control (Sharma and Mahla, 2021; Jeevan, 2022; Gurr *et al.*, 2023)^[10, 6, 3].

In Rajasthan conditions, studies have shown that cabbage intercropped with marigold or coriander reduced DBM infestation by 25-40% and increased the population of key natural enemies such as *Coccinella septempunctata*, *Chrysoperla zastrowi sillemi*, and syrphid flies (*Syrphus* spp.) (Sharma *et al.*, 2021)^[10]. These natural enemies play a vital role in suppressing pest populations by predation and parasitism, contributing to sustainable pest regulation.

In addition to habitat manipulation, the use of biorational insecticides has emerged as an effective alternative to conventional chemicals. These include neem-based formulations (azadirachtin), microbial insecticides like *Bacillus thuringiensis* var. *kurstaki* (Bt), and entomopathogenic fungi such as *Lecanicillium lecanii* and *Beauveria bassiana*. These agents are target-specific, biodegradable, environmentally safe, and compatible with natural enemies, thus fitting well into IPM programs (Kant *et al.*, 2023; Singh *et al.*, 2024)^[7, 12].

Materials and Methods

Site and location of the experiment

The present investigation was carried out at the Instructional Agronomy Farm, Rajasthan College of Agriculture, Udaipur, during *Rabi* 2025. Udaipur is located at 23.40° N longitudes and 75° E latitude at an elevation of 579.5 MSL (Mean Sea Level) in the state of Rajasthan.

Climatic conditions of the study area

The zone experiences a typical sub-tropical climate characterized by cool winters and mild temperatures, with relatively low humidity during the *Rabi* season (November to April). Occasional cold waves and frost may occur during peak winter months, influencing crop growth and development. The average rainfall during the *Rabi* season is

very low (around 0- 4.8 mm), as this period mainly depends on occasional winter showers rather than the Southwest monsoon, which contributes rainfall during July to September. During winter, the temperatures may go as high as °C, while in winter it may fall to as low as 4.5°C. This region provides a safe and long growing season for most of the crops.

Field preparation and crop management

After the harvest of the previous crop, weeds and stubble were removed from the field. The experimental field was prepared first week of November by ploughing. Timely hoeing and weeding were performed as per the package of practices. Recommended doses of nitrogen and phosphorous were applied to the crop. The crop was irrigated as and when needed during the entire crop period.

Experimental design and treatment

The experiment was conducted to observe Diamond back Moth (*Plutella xylostella* L.) infestation in cabbage intercropped with different companion crops. Six crop combinations, including sole cabbage, were evaluated. The experiment was laid out in a Randomized Block Design (RBD) with three replications.

Observations recorded

Diamondback moth: The larval population of the DBM was recorded from five randomly selected plants per plot by direct visual count method. (Devi *et al.*, 2017). All the observations of DBM were recorded once in a standard week from experimental field.

Result and Discussion Larval Population Dynamics of *Plutella xylostella*

The data presented in Table 4.1 revealed that different habitat adjustment treatments significantly influenced the larval population of diamondback moth (*Plutella xylostella*) on cabbage during *Rabi* 2025-26.

The larval population first appeared during the 4th Standard Meteorological Week (SMW) with a mean population of 0.68 larvae per plant. The infestation gradually increased from the 5th SMW onwards and reached its peak (1.84 larvae per plant) during the 9th SMW. Thereafter, the population declined gradually to 1.55 larvae per plant during the 10th SMW and further to 1.20 larvae per plant during the 11th SMW.

Among the habitat manipulation treatments, cabbage intercropped with coriander

(1:1) recorded the lowest mean larval population (0.83 larvae per plant) and was significantly superior to all other treatments. This was followed by cabbage + fenugreek (2:1) with 1.07 larvae per plant, cabbage + mustard (2:2) with 1.18 larvae per plant, cabbage + marigold (2:1) with 1.25 larvae per plant, and cabbage + tomato (2:1) with 1.27 larvae per plant.

The highest larval population among the intercrops was recorded in cabbage + barley (2:1) (1.58 larvae per plant), whereas the sole cabbage crop (control) recorded the highest overall infestation (2.17 larvae per plant) throughout the observation period.

Table 1: Impact of habitat adjustment on population density of diamondback moth, *Plutella xylostella* on cabbage during Rabi, 2025-26

Tr. No.	Treatment details	Mean population of larvae/plant at different Standard Meteorological Weeks								
		04 SMW	05 SM W	06 SM W	07 SM W	08 SM W	09 SM W	10 SM W	11 SM W	Mean
T ₁	Cabbage + Coriander (1:1)	0.33 (0.91) *	0.60 (1.05)	0.87 (1.17)	0.87 (1.16)	1.07 (1.25)	1.27 (1.32)	1.00 (1.22)	0.60 (1.04)	0.83 (1.15)
T ₂	Cabbage + Mustard (2:2)	0.53 (1.02)	0.73 (1.11)	1.20 (1.30)	1.27 (1.32)	1.47 (1.40)	1.67 (1.47)	1.40 (1.37)	1.13 (1.27)	1.18 (1.29)
T ₃	Cabbage + Tomato (2:1)	0.27 (0.87)	0.93 (1.19)	1.33 (1.35)	1.47 (1.39)	1.60 (1.44)	1.80 (1.51)	1.53 (1.42)	1.20 (1.29)	1.27 (1.33)
T ₄	Cabbage + Fenugreek (2:1)	0.40 (0.94)	0.60 (1.05)	1.07 (1.25)	1.20 (1.29)	1.40 (1.38)	1.60 (1.44)	1.27 (1.32)	1.00 (1.21)	1.07 (1.25)
T ₅	Cabbage + Marigold (2:1)	0.73 (1.10)	0.93 (1.19)	1.27 (1.33)	1.33 (1.35)	1.53 (1.42)	1.73 (1.49)	1.40 (1.37)	1.07 (1.25)	1.25 (1.32)
T ₆	Cabbage + Barley (2:1)	0.87 (1.16)	1.07 (1.25)	1.53 (1.42)	1.73 (1.49)	1.93 (1.56)	2.13 (1.62)	1.87 (1.54)	1.47 (1.40)	1.58 (1.44)
T ₇	Control (Cabbage as sole crop)	1.60 (1.45)	1.80 (1.52)	2.20 (1.64)	2.27 (1.66)	2.47 (1.72)	2.67 (1.77)	2.40 (1.70)	1.93 (1.55)	2.17 (1.63)
Mean		0.68	0.95	1.35	1.45	1.64	1.84	1.55	1.20	-
SE(m) ±		0.02	0.03	0.02	0.03	0.03	0.02	0.03	0.03	0.02
CD		0.07	0.09	0.05	0.08	0.10	0.08	0.08	0.10	0.08

*Figures in parentheses are square root transformed values, SMW= Standard Meteorological Week

Conclusion

The present investigation entitled “Performance of the Intercropping Systems on the Incidence of the Diamondback Moth (*Plutella xylostella* L.) and its Natural Enemies in Cabbage Ecosystem” during Rabi 2025-26 clearly demonstrated that habitat manipulation through intercropping significantly influenced the incidence of diamondback moth (DBM), crop productivity and the abundance of natural enemies.

The population of DBM larvae first appeared during the 4th Standard Meteorological

Week (SMW) with an average population of 0.68 larvae per plant. The infestation gradually increased throughout the season and reached its peak (1.84 larvae per plant) during the 9th SMW, after which the population declined towards crop maturity. Correlation analysis indicated that DBM incidence exhibited a significant positive association with maximum temperature ($r = 0.544$), minimum temperature ($r = 0.728$), sunshine hours ($r = 0.559$), and evaporation ($r = 0.501$), whereas morning relative humidity, evening relative humidity, wind velocity, and rainfall showed non-significant relationships with pest incidence.

Among the different habitat adjustment treatments, cabbage intercropped with coriander (1:1) proved to be the most effective in suppressing DBM infestation, recording the lowest mean larval population (0.83 larvae per plant) throughout the cropping season. This was followed by cabbage + fenugreek (1.07 larvae per plant) and cabbage + mustard (1.18 larvae per plant). The highest infestation (2.17 larvae per plant) was observed in the sole cabbage crop (control), confirming that monocropping favoured greater pest multiplication.

Intercropping also had a significant influence on crop productivity. The highest cabbage equivalent yield (205.40 q ha⁻¹) was obtained from cabbage + tomato (2:1), closely followed by cabbage + coriander (204.75 q ha⁻¹) and cabbage + marigold (201.40 q ha⁻¹). Although tomato intercropping produced the highest equivalent yield, the highest benefit-cost ratio (4.63) was recorded in cabbage + marigold (2:1), followed by cabbage + coriander (4.61), indicating superior economic returns from these habitat

manipulation practices. The lowest yield (140.80 q ha⁻¹) and benefit-cost ratio (3.02) were recorded under the sole cabbage crop.

Habitat diversification considerably enhanced the abundance of natural enemies of DBM. Among the intercrops, cabbage + marigold supported the highest populations of predators, recording 9.60 *Coccinella septempunctata*, 8.94 green lacewings and 6.98 spiders per ten plants, with an overall mean predator population of 8.51 per ten plants. The same treatment also recorded the highest population of the larval parasitoid *Cotesia plutellae* (8.94 parasitoids per ten plants). Likewise, the relative abundance of natural enemies was highest in the marigold intercropping system (21.39%), followed by mustard (16.42%) and coriander (13.78%), whereas the lowest abundance was observed in the sole cabbage crop (6.48%).

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