

Appraisal of biointensive pest management strategy for managing *Myzus persicae* and *Plutella xylostella* on cabbage

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Abstract

A biointensive pest management (BIPM) module was synthesized and assessed for its effectiveness against diamond back moth (DBM) (*Plutella xylostella* L.) and green peach aphids (*Myzus persicae* Sulzer) that were infesting cabbage in Varanasi, Uttar Pradesh during the years 2023 and 2024. The BIPM module comprising sowing of Indian bold seeded mustard (*Brassica juncea* L.) Czern.) as a trap crop (25:2); installation of sex pheromone traps for DBM @ 12/acre from 30 days after translating (DAT), periodical release of *Trichogramma chilonis* @ 100000/ha; sprayings of *Bacillus thuringiensis* NBAIR BtG-4 (2×10^8 cfu/g) 1% WP @ 2 g/lit with each application occurring at 10-day intervals. Additionally, one spraying of Azadirachtin 1500 PPM @ 2 ml/lit and subsequent spraying of *Lecanicillium lecanii* NBAIR VL-8 (1×10^8 cfu/g) @ 5 g/lit of water at 10 days intervals during the onset of DBM had shown lowest DBM population (5.57/ cabbage plant) with highest percent reduction over control (60.16) than the Package of practices (32.40 PROC) and untreated control. Similarly, the incidence of polyphagous *M. persicae* was also found lowest in BIPM modules and mean population 3.31 per leaf followed by PoP (5.48 per leaf) and untreated control plots (7.86 per leaf) and thereby the BIPM practices registered highest PROC (57.89) followed by PoP (30.28 PROC).

Keywords: Biointensive pest management module, cabbage, diamond back moth, green peach aphid, natural enemies

Introduction

Cabbage (*Brassica oleracea* var. *capitata* L.), belonging to the family Brassicaceae, is a commercially significant cruciferous leafy vegetable extensively cultivated across India. It is valued for its high nutritional content, being rich in dietary fiber, vitamins, and minerals such as iron, calcium, potassium, phosphorus, iodine, and sulphur (Divekar *et al.*, 2023) ^[1], as well as phytochemicals and antioxidants (Rokayya *et al.*, 2013) ^[2], while remaining low in calories. India is the second-largest producer of cabbage in the world after China. During 2021–22, cabbage was cultivated on 412,400 hectares in India with an average productivity of 23.2 tonnes per hectare (Anonymous, 2023) ^[3], which is comparatively lower than that of many other countries. A major factor contributing to this lower productivity is the occurrence of biotic stresses, as the crop faces attacks from various insect pests throughout its growth phases.

The diamondback moth (DBM), *Plutella xylostella* (Linnaeus) (Plutellidae: Lepidoptera), is a major destructive pest of cruciferous crops, causing substantial economic losses of up to 50% and incurring an estimated cost of US \$168 million annually (Senguttuvan and Kuttalam, 2013) ^[4]. It is a primary pest of cabbage and cauliflower with rapid migratory habit and has attained global pest status (Talekar and Shelton, 1993; Halder and Rai, 2021) ^[5, 6]. The neonate DBM larvae inflict severe damage by scraping the epidermal leaf tissues and subsequently consuming the entire foliage, rendering the vegetables unfit for human consumption (Rai *et al.*, 2014) ^[7]. In cases of severe infestation during the primordial stage, both cauliflower and cabbage may develop undersized curds, with leaves that are extensively perforated, and head development may be completely inhibited. The green peach aphid, *Myzus persicae* (Sulzer) (Hemiptera: Aphididae), is a highly significant polyphagous sucking pest that affects

vegetable crops worldwide. It has been reported to utilize more than 875 secondary host plant species (Ro *et al.*, 1998) ^[8]. Aphids primarily feed on phloem sap, extracting plant nutrients through their specialized piercing–sucking mouthparts (Halder *et al.*, 2011; 2018) ^[9, 10]. In cole crops, infestation begins at the seedling stage and persists up to harvest. Their feeding activity leads to substantial reductions in both yield and market quality. In addition to sap extraction, they excrete sugar-rich honeydew onto plant surfaces, which promotes the growth of black sooty mould, thereby interfering with normal photosynthetic activity (Halder *et al.*, 2014; Halder and Soni, 2025) ^[11, 12].

Typically, growers resort to prophylactic and scheduled applications of insecticides to manage this nefarious oligophagous pest in India (Senguttuvan and Kuttalam, 2013) ^[4]. However, the negative effects associated with environment, the resurgence of other sucking pests, and the development of resistance to pesticides, as well as adverse effects on non-target organisms and beneficial fauna, cannot be overlooked (Halder *et al.*, 2021; Kodandaram *et al.*, 2017(a)(b); Roy *et al.*, 2017) ^[13, 14, 15, 16]. It is not unusual for the cabbage growers to give 10–12 rounds of chemical sprays in a crop season, often unnecessary and unjustified, furthermore, without any appreciable increase in the yield. Thus there is an urgent need for the development of suitable and eco-friendly biointensive pest management (BIPM) combining trap crop, pheromone trap, botanicals and entomopathogens to ensure sustainable cabbage production. Furthermore, information regarding the development of such protocols for the holistic management of pests for cabbage is also very scanty. Keeping this in view, synthesis and evaluation of multifaceted, and improved biointensive pest management (BIPM) technology in cabbage was conducted to reduce the over dependence and the excessive reliance on chemical pesticides and to safeguard the ecosystem as a whole.

Materials and Methods

The field experiments were carried out at the experimental farm of the Indian Council of Agricultural Research-Indian Institute Vegetable Research (ICAR-IIVR), Varanasi (82°52' E longitude and 25°12' N latitude), Uttar Pradesh, India during *rabi* season (January to May) of 2023 and 2024. The experimental site comes under the alluvial zone of Gangetic plains having soils silt loam in texture and low in organic carbon (0.43%) and available nitrogen (185 kg/ha).

Raising of the crops

Cabbage seeds (cv. Golden Acre) were sown in the fine-tilth nursery bed during the second fortnight of December. After 35 days, the seedlings were transplanted in to the main field at a spacing of 60 x 60 cm (row to row and plant to plant) in a plot size of 5x4 m². A total of twenty four such plots were maintained. The recommended doses of N, P, K fertilizers (100:80:60) and FYM 15-20 t/ha were applied. N, P and K were supplied through urea, di-ammonium phosphate and muriate of potash, respectively. Half of the nitrogen was applied as a basal dose at the time of transplanting with the remaining half was applied 30 days after transplanting. The full doses of both phosphorus and potassium were given during transplanting. Hand weeding and irrigations were provided as required and usual crop husbandry measures were undertaken except any plant protection measures.

The biointensive pest management module (BIPM)

The Bio-intensive insect pest management module (BIPM) for major insect pests of cabbage comprised sowing of Indian bold seeded mustard (*Brassica juncea* (L.) Czern.) as a trap crop (25:2); installation of Religion pheromone traps for DBM @ 12/acre from 30 days after translating (DAT), periodical release of *Trichogramma chilonis* @ 100000/ha; need based sprayings of *Bacillus thuringiensis* NBAIR BtG-4 (2x10⁸ cfu/g) 1% WP @ 2 g/lit and each spraying was done at 10 days intervals during the initiation of DBM and one spraying of Azadirachtin 1500 PPM @ 2 ml/lit and subsequent spraying of *Lecanicillium lecanii* NBAIR VL-8 (1x10⁸ cfu/g) @ 5 g/lit of water at 10 days intervals. In addition botanical management/ package of practices comprising spraying neem seed kernel extract (NSKE) @ 5% along with stickers (0.1%) and an untreated control plots (120 sq meter) separated from the main field (~100 meter apart) were also maintained.

Data recording

The population of *P. xylostella* (larvae as well as pupae) was counted from the each cabbage head at periodical intervals. Twenty cabbage head per plots were counted and expressed as number of diamond back moth/plant. Similarly, cabbage aphids (both nymphs and adults) populations were calculated by counting the insects per leaf per plant. As such 20 plants were taken from each plot and expressed as number of sucking pests per leaf/plant. Then the per cent reduction over control (PROC) were computed for each pest using the following formula:

$$\text{Per cent reduction over control} = \frac{(\text{Pest population in treatment} - \text{Pest population in control}) \times 100}{\text{Pest population in control}}$$

In case of predator population, number of predators *i.e.* number of spiders and lady bird beetles (grubs/pupae/adults) were counted per plant during February–March of each experimental year.

The data were subjected to Analysis of Variance (ANOVA) with least significant difference ($p=0.05$) as test criterion using SAS software (version 9.3).

Results and Discussion

The effect of biointensive pest management module on two major pests of cabbage *viz.*, cabbage aphids (*Myzus persicae*) and diamond back moth (*Plutella xylostella*) are illustrated in table 1. During the first year *i.e.*, 2023, the BIPM module exhibited the lowest population of DBM (6.67 per plant) while the corresponding values from botanical management and untreated control plots were 10.82 and 15.39 per plant, respectively. This trend was also observed in the following year, 2024, with diamond back moth populations per plant recorded at 4.87, 8.08 and 12.56 for BIPM, botanical management and untreated control plots, respectively. The mean data over the two years revealed that the BIPM module had harboured the significantly lowest DBM population (5.57/ cabbage plant) with highest percent reduction over control (60.16) than the botanical management (32.40 PROC) and untreated control. Likewise, the incidence of polyphagous aphids *M. persicae* was also found lowest in BIPM modules and the corresponding values were 2.65 and 3.96 per leaf during the year 2023 and 2024, respectively (Table 1), with mean population 3.31 per leaf which was significantly superior to

the botanical management (4.97, 5.98 and 5.48 per leaf for the year 2023, 2024 and mean value) and untreated control plots (7.04, 8.67 and 7.86 per leaf, respectively). The BIPM practices also registered highest (57.89) PROC followed by botanical management (30.28 PROC).

The population of two associated predatory fauna *i.e.*, predatory lady bird beetles (*Coccinella septempunctata*, *Cheilomenes sexmaculata*) and spiders (Lynx and Wolf spiders) were counted (Table 2). The populations of predatory lady bird beetles in BIPM module were 2.69 and 3.13 per plant during the year 2023 and 2024 which were statistically at par with botanical management (2.78 and 2.78 per plant). Similarly, the mean populations of spiders in BIPM and botanical management were 2.22 and 2.44 per plant, respectively. However, the untreated control plots harboured the highest number of predatory fauna during both the years (Table 2).

The incidence of cabbage aphids (*Myzus persicae*) and diamond back moth (*Plutella xylostella*) on cabbage initiated during the first week of February coinciding with the onset of spring in the Varanasi region. From the tables 1 and 2 it is evident that BIPM module was effective in managing DBM and aphids in cabbage.

Bio-intensive insect pest management module comprised different ecofriendly components such as sowing of Indian bold seeded mustard (*Brassica juncea* (L.) Czern.) as a trap crop; installation of sex pheromone traps for DBM; periodical inoculative release of *Trichogramma chilonis*; need based sprayings of *Bacillus thuringiensis*; Azadirachtin 1500 PPM and subsequent spraying of

Lecanicillium lecanii were found promising against these duo nefarious pests of cabbage in the region. Indian mustard is a potential trap crop against DBM. Srinivasan and Krishna Moorthy (1991) [17] documented that cabbage grown alone supported significantly higher larval populations of diamondback moth, *Plutella xylostella* (Linnaeus) and cabbage leaf webber, *Crociodolomia binotalis* Zeller as compared to mustard intercropped cabbages, and resulted in loss of marketability. They also inferred that a planting pattern of 15 rows cabbage followed by mustard rows was found to be the most promising for successful management of both pests. The egg parasitoid *Trichogramma chilonis* was released periodically for the management of DBM. According to Jidung *et al.*, 2023 [18], *T. chilonis* is a very efficient parasitoid in suppression of cabbage DBM (*Plutella xylostella*) under Manipur, India condition and can be explored as a potential bio control agent against Lepidopterous insect pests of agricultural importance. The entomopathogenic bacterium, *Bacillus thuringiensis* was incorporated in the BIPM module for the management of DBM infesting cabbage. Several authors mentioned the bioefficacy of *B. thuringiensis* against several lepidopteran insects including *Plutella xylostella*, *Helicoverpa armigera* (Hübner), *Leucinodes orbonalis* (Guenée) etc. (Halder *et al.*, 2016; Gemmeda *et al.*, 2024; Kalia *et al.*, 2013) [19, 20, 21]. The white halo fungus, *Lecanicillium (Verticillium) lecanii* is highly effective entomopathogenic fungus that targets all life stages of sucking pests like aphids, whiteflies, scale insects, thrips and mealy bugs (Nikhade *et al.*, 2024) [22]. According to Ganassi *et al.*, 2010 [23], *L. lecanii* affected the survival of the aphids (*Schizaphis graminum* (Rondani) (Hemiptera: Aphididae)) and the lethal time values being lower for alate compared to apterous morphs and nymphs. Further, histological analysis revealed that the fungal hyphae

invaded the host hemocoel of a limited number of alate and apterous morphs as the fungus entered through the spiracles. In botanical management where botanical pesticides like neem seed kernel extracts (NSKE) 5% were sprayed and some pest management were achieved. Neem, recognized biopesticide, it is extensively utilized in agriculture due to its insecticidal properties enabling it to manage a wide range of insect pests (Halder *et al.*, 2012, 2018; Devi and Gogoi, 2023) [24, 25, 26].

Azadirachtin, a complex tetranortriterpenoid, is considered as the main constituent and commercial neem formulations, available on the world market for insect control in organic farming (Benuzzi and Ladurner, 2018) [27]. Presence of the Azadirachtin and other related compounds in NSKE is responsible for the management of major insect pests of cabbage in the current study.

Conclusions

The diamondback moth (*Plutella xylostella*) and green peach aphid (*Myzus persicae*) are recognized as major insect pests of cabbage in the region. To manage these pests in an environmentally sustainable manner a bio-intensive pest management (BIPM) module has been developed. This module includes the use of Indian mustard as a trap crop, deployment of sex pheromone traps, inoculative release of the egg parasitoid *Trichogramma*, and need-based application of entomopathogens such as *Bacillus thuringiensis* and *Lecanicillium lecanii*, along with botanicals like Azadirachtin, has shown considerable effectiveness against these destructive pests. Nevertheless, a comprehensive understanding of crop phenology, prevailing weather conditions, seasonal pest dynamics, and regular pest surveillance, coupled with the timely implementation of various BIPM components, is crucial for effective and successful pest management.

Table 1: Evaluation of BIPM practices for the cabbage Aphids and Diamond back moth during 2023 and 2024

Treatments	DBM/ Plant				Aphid/Leaf			
	2023	2024	Average	PROC*	2023	2024	Average	PROC
T1: BIPM practices	6.67 ^c	4.87 ^c	5.57 ^{cc}	60.16	2.65 ^c	3.96 ^b	3.31 ^c	57.89
T2: Botanical management	10.82 ^b	8.08 ^b	9.45 ^b	32.40	4.97 ^b	5.98 ^b	5.48 ^b	30.28
T3: Untreated control	15.39 ^a	12.56 ^a	13.98 ^a	--	7.04 ^a	8.67 ^a	7.86 ^a	--
CD (5%)	2.89	2.73	2.26	--	2.67	2.41	2.11	--

*PROC = $\frac{\text{Pest population in treatment} - \text{Pest population in control}}{\text{Pest population in control}} \times 100$

Table 2: Effect of BIPM practices against beneficial fauna (lady bird beetles and spiders) in cabbage during 2023 and 2024

Treatments	Predatory Lady bird beetle /plant			Spiders/ plant		
	2023	2024	Average	2023	2024	Average
T1: BIPM practices	2.69 ^a	3.13 ^{ab}	2.91 ^{ab}	2.07 ^a	2.36 ^a	2.22
T2: Botanical management	2.78 ^{ab}	2.78 ^a	2.78 ^a	2.19 ^a	2.68 ^a	2.44
T3: Untreated control	3.17 ^b	3.62 ^b	3.40 ^b	2.54 ^a	3.11 ^b	2.83
CD (5%)	0.46	0.41	0.43	0.44	0.39	--

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