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# Comparative Efficacy of Bio-Agents and Botanicals on the Management of Diamondback Moth (*Plutella xylostella* Linn.) on Cabbage under Allahabad Agroclimatic Conditions

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**A B S T R A C T**

In order to determine the comparative efficacy of some bio-agent (*Bacillus thuringiensis* and *Beauveria bassiana*) and botanicals (neem oil, NSKE, Neem leaf, tobacco, dhatura and *Lantana camera*) along with an untreated control against *Plutella xylostella*. Field trial was conducted during rabi season 2016-2017. Each insecticide was sprayed twice at 15 days interval. The larval count per plant was taken day before and 3, 7 and 14 days after each spray. All the insecticides tested significantly reduced the pest population compared to control. The highest percent reduction of diamondback moth larvae against control was observed in *Bacillus thuringiensis* (61.22%). The mean crop yield ranged between 211 q/ha to 371 q/ha in the insecticidal treatment, the highest being *Bacillus thuringiensis* (371 q/ha) followed by Neem oil (331 q/ha). The cost benefit ratio varied from 1:3.1 to 1:6.9 in different insecticidal treatments, the highest in NSKE (1:6.9) followed by Neem oil (1:6.8).

## Introduction

Cabbage is one of the most popular cole vegetables grown in India. It is commonly used fresh as boiled vegetables, cooked in curries and process, salad, etc. It is known to posses medicinal properties and its enlarged terminal buds is a rich source of Ca, P, Na, K, S, Vitamin A, Vitamin C and dietary fibre. India is the second largest producer of cabbage after China. India is producing about 8534.5 million tonnes in an area of 372.24 ha with a productivity of 22.9 MT/ha. In Uttar Pradesh cabbage is grown in an area of about 0.72 million ha producing 5.7 million tonnes.

The brassica crop has a multiple insect pest complex. The important insect pest species are Diamondback moth (*Plutella xylostella* L), Cabbage caterpillar (*Pieris brassicae* Linnaeus), Cabbage semi-looper (*Thysanoplusia orichalcea* Fabricius) and (*Autographa nigrisigna* Walker), Tobacco caterpillar (*Spodoptera litura* Fabricius), Cabbage leaf webber (*Crocodolomia binotalis* Zeller), Cabbage borer (*Hellula undalis* Fabricius) and Cabbage aphid (*Brevicoryne brassicae* W). Among the insect pests, diamondback moth, *Plutella xylostella* L.

(Plutellidae: Lepidoptera) is the most destructive pest (Mahla *et al.*, 2005). In India, Krishnamoorthy (2004) reported a 52% yield loss on cabbage due to diamondback moth. Diamondback moth has developed resistant to almost all the group of chemical pesticides. This has necessitated the used of ecofriendly insecticides to sustain the management of diamondback moth. The efficacy of neem products and microbial insecticides like *Bacillus thuringiensis* has been reported by several workers (Nethravathi and Hugar, 2010; Raut and Simon, 2010 and Meena *et al.*, 2011). Due to their efficacy in controlling the target pests without adversely affecting their natural enemies, bio-agents and botanicals ensures effectiveness, safety and acceptability to mankind. Hence the present study was undertaken for assessment of the efficacy of bio-agents and botanicals for managing Diamondback moth on cabbage and to study cost benefit ratio.

## Materials and Methods

The investigation was conducted at the Central Research Field, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh during rabi season of 2016-2017. Experiment was laid out in randomized block design (RBD) with 9 treatments including untreated control and replicated three times. One month old cabbage (cv Magic ball) seedlings were transplanted in the plot of 2 $m^2$ area with 45cm x 30 cm spacing. All the recommended agronomic management practices were followed for raising the crop except the insecticidal spray. The field efficacy of selected bio-agents and botanicals viz., *Bacillus thuringiensis* (Dipel), *Beauveria bassiana* (Yash Beauveria) and Dhatura leaf extract, Tobacco leaf extract, *Lantana camera* leaf extract, Neem leaf extract, NSKE and Neem oil was compared with untreated control. Applications of the treatments were started as soon as the pest level crossed the ETL *i.e.*, 2-3 larvae per plant the second spray was given after 15 days respectively. The population count of diamondback moth larvae was recorded by randomly selecting five plants from each plot. The population count of Diamondback moth larvae was recorded one day before every spray which served as pre-treatment observation and the subsequent counts were taken on $3^{rd}$, $7^{th}$ and $14^{th}$ days after each spray (Post-treatment). Observation on the larval population were recorded during morning hours. In order to evaluate the effect of the treatments on the yield, the weight of cabbage heads were recorded. After attaining a desirable size the cabbage head were pluck. The weights of harvested heads in the plot of each treatment were sum-up to the total yield and computed on hectare basis by using hectare factor.

### Preparation of neem seed kernel and neem leaf extraction

Neem kernel and neem leaf were collected from nearby locality of SHUATS, Allahabad. Kernels and neem leaf were crushed in to fine powder using grinder, and sieved using wire mesh. The extraction was made by mixing the powder with water in plastic container at the rate of 50g powder per liter of water. After mixing the solution was stirrer carefully until all the powder mixed completely with the water. These solutions were left overnight. The following morning the extract were filter into the sprayer using plastic mesh sieve for field used.

### Preparation of dhatura leaf extraction

Dhatura leaves were collected from nearby locality of SHUATS, Allahabad. Collected leaves were dried well and ground it to powder. 50 g dhatura powder was mixed with one liter of water. After mixing the solution was stirrer carefully until all the powder

mixed completely with the water. The solution was left overnight. The following morning the extract were filter into the sprayer using plastic mesh sieve for field used.

## Preparation of tobacco leaf extraction

Tobacco leaves were collected from local market, Allahabad. Collected tobacco leaves were dried well and ground it to powder. 125g tobacco leaf powder was mixed with 2.0 L of water and boiled for 30 minutes. The mixture was cooled and filtered through muslin cloths and then 15g detergent 8 L of water were added as a pickling agent. Finally this product was ready for spraying.

## Preparation of *L. camera* leaf extraction

1 kg of young fresh lantana leaf was collected and crushed into small pieces using knife, then the chopped leaf was ground using grinder with 250 ml of water to make paste. The paste was strain through muslin cloth and kept for 24 h. At the time of application the aqueous extract was diluted in 9.75 L water.

The data collected on percent reduction in population of Diamondback moth (*Plutella xylostella*) were subjected to statistical analysis for testing the level of significance. Similarly, the replication wise data of each treatment on yield of cabbage head were also subjected to analysis of variance.

## Results and Discussion

The mean data on percent reduction of population of diamondback moth obtain at three, seven and fourteen days after first spray. Table 2 revealed that all the treatments significantly differed from the untreated control after first spray and reduction in the larval population of *P. xylostella* was observed in the all insecticidal treatments. The maximum percentage of larval reduction was observed in *Bacillus thuringiensis* (58.14%) followed by neem oil (50.09%) whereas, control plot (16.75%), showed least effectiveness. The overall mean of first spray shows that the treatment T2 Tobacco leaf extract (28.23%) and T7 *B. bassiana* (30.12%) are statistically non-significant with each other; treatment T4 neem leaf (38.12%) and T5 NSKE (40.28%) are also at par with each other. Similarly, after second spray the highest percentage reduction in larval population of *P. xylostella* was observed in *Bacillus thuringiensis* (64.29%) followed by Neem oil (57.01%) when compared to control (16.75%). Among all the treatment, treatment T1 dhatura leaf extract (29.25%) and T3 *L. camera* leaf extract (27.66%) are also statistically non-significant with each other (Table 1).

The overall highest mean per cent reduction of *P. xylostella* in cabbage was observed in *Bacillus thuringiensis* (61.21%) and Neem oil (53.57%). All the treatments showed significant increase in yield over untreated control. Highest mean yield of cabbage was recorded in *Bacillus thuringiensis* (07.43 kg/plot) followed by Neem oil (06.61 kg/plot) and NSKE (06.37 kg/plot), whereas the lowest yield was observed in untreated control (03.28 kg/plot). Among the treatments T6 Neem oil (06.61 kg/plot) and T5 Neem leaf extract (06.36 kg/plot) are at par with each other, treatment T4 Neem leaf extract (06.13 kg/plot) and T7 *B. bassiana* (06.05 kg/plot) are at par with each other, T7 B. bassiana (06.05 kg/plot) and T2 Tobacco leaf extract (05.35 kg/plot) are also at par with each other and again T2 Tobacco leaf extract (05.35 kg/plot) and T1 Dhatura leaf extract (04.49 kg/plot) were found statistically at par with each other. T1 Dhatura leaf extract (04.49 kg/plot) and T3 L. camera (04.23 kg/plot) were also at par with each other. Thus, *B. thuringiensis* is highly effective

against *P. xylostella*, which is the most important and destructive pest of cruciferous crop. The present findings are in conformity with the results of Vanlaldiki *et al.*, (2013) who reported that *B. thuringiensis* gave the minimum larval population after (3, 7 and 10 DAA) against DBM *P. xylostella.* Similarly the superior of *B. thuringiensis* formulation for the control of DBM population has also been consistently found by other researchers (Leibee and Sevage, 1992; Seal, 1995 and Asokan *et al.*, 1996.). Sontakke *et al.*, (2014) also reported that a product of *B. thuringiensis* (Lipel and Xen tari) was found to be most effective against was *P. xylostella.* Malathi and Sriramulu (2000) also mentioned about the effectiveness of *Bt* against lepidopterous pests. Although the yield of the plot treated with *B. thuringiensis* and neem oil were higher than NSKE, due to their higher cost of treatment they failed to show higher B: C ratio and higher cost benefit ratio was obtained from NSKE (1:6.9) treated plot. Saxena and Kidiavai (1970) also reported that highest (1:24.06) incremental cost benefit ratio (ICBR) was observed in NSKE because of its low cost, the treatment of neem oil ranked next to NSKE, but failed to show higher ICBR because of its higher cost and this result was supported by the finding of Karkar *et al.*, (2014). Rahman *et al.*, (2014) also observed higher MBCR (2.99) from NSKE treated fruits.

**Table.1** Efficacy of bio-agents and botanicals on the management of DBM larva and on yield in cabbage

| Treatment No. | Treatment (per L of water) | Percent reduction in larval population of Diamondback moth | | Yield (kg/plot) |
|---|---|---|---|---|
| | | First Spray | Second Spray | |
| | | Mean | Mean | |
| T1 | Dhatura leaf @ 50g/L | 24.56$^{e}$ | 29.25$^{g}$ | 4.49$^{f}$ |
| T2 | Tobacco leaf @ 12.5g/L | 28.23$^{d}$ | 38.71$^{f}$ | 5.35$^{e}$ |
| T3 | *Lantana camera* @ 100g/L | 21.95$^{f}$ | 27.66$^{g}$ | 4.23$^{f}$ |
| T4 | Neem leaf @ 50g/L | 38.12$^{c}$ | 48.29$^{d}$ | 6.13$^{cd}$ |
| T5 | NSKE @ 50g/L | 40.28$^{c}$ | 51.05$^{c}$ | 6.37$^{bc}$ |
| T6 | Neem oil@ 3ml/L | 50.09$^{b}$ | 57.01$^{b}$ | 6.61$^{b}$ |
| T7 | *B. bassiana* @ 1g/L | 30.12$^{d}$ | 45.11$^{e}$ | 6.01$^{d}$ |
| T8 | *Bacillus thuringiensis* @ 4g/L | 58.14$^{a}$ | 64.29$^{a}$ | 7.43$^{a}$ |
| T0 | Control | 16.75$^{g}$ | 16.75$^{g}$ | 3.28$^{g}$ |
| | S.Ed(±) | 1.20 | 0.92 | 0.13 |
| | C.D.(P= 0.05) | 2.549 | 1.946 | 0.28 |

**Table.2** Economics of cultivation

| S No. | Treatment | Yield (q/ha) | Cost of yield Rs/q | Total cost of yield (Rs) | Common cost (Rs) | Treatment cost (Rs) | Total cost (Rs) | Net returns (Rs) | B:C ratio |
|---|---|---|---|---|---|---|---|---|---|
| T1 | Dhatura leaf | 224.50 | 700 | 157150 | 27513 | 600 | 28113 | 129037 | 1:4.5 |
| T2 | Tobacco leaf | 267.50 | 700 | 187250 | 27513 | 4050 | 31563 | 155687 | 1:4.9 |
| T3 | *Lantana camera* | 211.50 | 700 | 148050 | 27513 | 600 | 28113 | 119937 | 1:4.2 |
| T4 | Neem leaf | 306.50 | 700 | 214550 | 27513 | 600 | 28113 | 186437 | 1:6.6 |
| T5 | NSKE | 318.50 | 700 | 222950 | 27513 | 600 | 28113 | 194837 | 1:6.9 |
| T6 | Neem oil | 331.00 | 700 | 231700 | 27513 | 2112 | 29625 | 202075 | 1:6.8 |
| T7 | *Beauveria bassiana* | 300.80 | 700 | 210583 | 27513 | 780 | 28293 | 182290 | 1:6.4 |
| T8 | *B. thuringiensis* | 371.50 | 700 | 260050 | 27513 | 9240 | 36753 | 223297 | 1:6.07 |
| | Control | 164.00 | 700 | 114800 | 27513 | --------- | 27513 | 87287 | 1:3.1 |

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