

# Integrated Pest Management Strategies for Controlling Diamondback Moth (DBM) in Cruciferous Vegetables

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Cruciferous vegetables are vegetables of the family Brassicaceae (also called Cruciferae) which include economically important crops of different genus like cabbage, cauliflower, broccoli, radish, kale, mustard etc. They contain sulphur containing secondary metabolites, called glucosinolates, which have a wide range of beneficial effects. The major cruciferous vegetables grown in India are cabbage and cauliflower, and they are mostly grown during the winter (*Rabi*) season. The major pests that are associated with crucifers are diamond back moth (*Plutella xylostella*), cut worm (*Spodoptera litura*), cabbage butterfly (*Pieris brassicae*) etc. Among these, the lepidopteran pest, diamondback moth is found to be the most destructive of all.

Diamondback moth, *Plutella xylostella* L. (Lepidoptera: Plutellidae), is the most destructive pest of crucifers around the world causing about 90% economic loss in these crops. The young larvae feed voraciously on the tender parts of the leaves, decreasing the appeal and market value of the produce. Though it is a major key pest of crucifers, particularly in cabbage and cauliflower crops in India, the control of diamondback moth is difficult through chemicals as the pest has developed resistance to a majority of pesticides including DDT and synthetic parathion, and also to about 82 compounds belonging to different classes of insecticides over 17 countries. In addition, use of chemical pesticides results in environmental pollution and their persistence in the crops can cause serious health damage.

## Morphology and lifecycle

The female moth lays its eggs singly or in groups of 2 to 10 on the underside of the leaves of the host plant. The most suitable host plants for laying eggs are cabbage and cauliflower. The females prefer the tough lower leaves of the plant for this purpose. The freshly laid eggs are pale yellow with a greenish

tinge and oval in shape. The larvae initially, after hatching, are pale white in colour with a dark brown head. These first instar larvae often tunnel through the leaves and eventually undergo three moultings to form the final fourth instar larvae. The fourth instar larvae are green in colour and their body is covered with short spiny hairs. The entire larval period lasts for 7 to 11 days. The larvae finally make a beautiful transparent web-like cocoon which remains attached to the foliage. The pupal period varies from 3-5 days. The adults that emerge are small greyish brown in colour. Forewings have three white triangular spots along the inner-margin and when adult folds the wings the spots from opposite wings meet to form diamond shape. The incidence of the pest varied from season to season owing to difference in the climatic conditions.



Fig. 1a: Eggs



Fig. 1b: Larvae



Fig. 1c: Pupa



Fig. 1d: Adult

Plate 1: Lifecycle of diamondback moth (DBM)

## Nature of damage

The insect lays eggs preferably on the fibrous lower leaves, but the larvae upon hatching move upwards to feed on the young soft upper leaves of the

plant. The larvae colonise the areas around the growing buds, in the loose spaces between leaves and on the underside of the wrapper leaves. The larvae scrape the leaf epidermis often leaving whitish patches on the leaf surface. They may also bore into the growing buds causing disfigurement and destruction of the commercially important structures like the curd of cauliflower. This reduces the market value of the produce significantly, causing economic loss to the producers.



Fig. 2: Cauliflower curd damaged by DBM

Fig. 3: Cabbage plant damaged by DBM larvae

The older larvae bites into the leaves causing tiny feeding “windows” on the leaf surface. In case of heavy infestation, the larvae completely skeletonise the leaf, leaving only the leaf veins behind. It also eats the curd, thereby hampering its development.



Fig. 4: Heavy infestation of DBM larvae

Fig. 5: Completely skeletonised cauliflower plant

## Integrated pest management strategies

### Cultural practices

- Practising clean cultivation by removal and destruction of plant debris and residues after harvest.
- Pinching and pruning of affected plant parts to lower the pest population.
- Removal and destruction of weeds which may act as alternate host of the pest.
- Balanced application of fertilisers. Excessive application of nitrogenous fertilisers makes the plant more succulent and hence, more prone to pest attacks.
- Trap cropping by growing two rows of mustard after every 25 rows of cabbage reduces 80 to 90% of DBM population and other pests. One row of mustard is sown 15

days before transplanting of cabbage and the other row 25 days before. The first and last rows of the patch are also mustard. The mustard crops are sprayed with Dichlorovos 0.1% soon after germination. The DBM are attracted to the mustard crop and the cabbage crop is less affected.

- Inter cropping with tomato plants with one row of tomato between two rows of cabbage helps to bring down the pest population as the tomato plant acts as a repellent. The tomato intercrop is planted two weeks before transplanting of the main crop.
- The population of DBM decreases considerably during the rainy season as the eggs get washed away. The similar effect can be created by installation of sprinkler irrigation methods to reduce the pest population.
- Installation of pheromone traps @ 12 per hectare for mass trapping and monitoring.
- Growing of resistant cultivars, e.g., Pusa Drumhead and Golden Acre of cabbage, or moderately resistant cultivars, like Pusa Samandh, Pride of India and Selection-51.

### Biological methods

- Spraying with Azadirachtin 0.3% EC @ 20 ml per 20 L water is effective in reducing the pest damage.
- Foliar application of Bio-Power® WP (*Beauveria bassiana* 1.15% at  $1.0 \times 10^8$  CFUs/g) @ 100 g per 20 L water.
- Foliar application of DiPel® DF (*Bacillus thuringiensis* subsp. *kurstaki*, Strain ABTS-351, 54% w/w) @ 20 g per 20 L water.
- Use of botanical pesticides like chilli extracts and seaweed extracts helps in controlling the pest population. Chilli possesses insecticidal properties that effectively repel the pest. Seaweed extract, on the other hand, is absorbed by the plant through assimilation and the biostimulants present along with micronutrients enhance the physiological resistance of the plant.



Fig. 6: Installation of pheromone trap in cabbage field



Fig. 7: *Cotesia plutellae* wasp attacking a DBM larva

- Use of *Zingiber officinale* extracts @ 25% w/v serves a better alternative to chemical pesticides in controlling the DBM larvae. The larval population often shows resurgence after chemical application, but the extracts of *Z. officinale* brings down their population significantly.
- Release of natural predators, like *Chrysoperla carnea* (Chrysopidae: Neuroptera), which attack the egg and larval stages; parasitoids, like *Trichogramma chilonis* Ishii (Trichogrammatidae : Hymenoptera), which is an egg parasitoid; *Cotesia plutellae* (Braconidae : Hymenoptera), which is a larval parasitoid; to control the pest population significantly.

#### Chemical insecticides:

- Spinosad 45% SC, Indoxacarb 14.5% SC and Emamectin benzoate 5% SG are the most effective treatments against DBM larval population
- Spinosad 45% SC is the best insecticide against DBM and also improves the production by having higher benefit-cost ratio.

#### Conclusion

Cruciferous crops like cabbage and cauliflower form an important part of the Indian vegetable market. So, effective control measure should be taken up to reduce losses and bring higher productivity. The lepidopteran pest diamondback moth, which has assumed status of an important pest, needs to be controlled with strategies that are economical to the farmers and sustainable to the environment.

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