**Title:** Review of the Diamondback moth (Plutella xylostella), a significant cabbage pest in India, and discussion of management measures

**Abstract:**

Prevalent meteorological conditions, which vary greatly from region to region, have a big impact on how frequently diamondback moths appear. To assess the effect of meteorological circumstances on the diamondback moth's population demographics and its seasonal prevalence in cabbage crops. Plutella xylostella L. infestation levels on brassica crops, particularly cabbage, vary depending on the presence of natural predators, the location, and the varieties of plants. The diamondback moth (DBM) is one of the most insect pests that seriously harm the production of cabbage. Changing climate, the high development of plant species (vegetable and oilseed Brassica crops), and the pest's genetic adaptability, which allows it to flourish quick and easily in new environments, acquire tolerance to nearly all known herbicides, have all contributed to a rise in the incidence and consequence of P. xylostella outbreaks in recent times. P. xylostella has a wide variety of crucifer hosts, and numerous pesticides are employed to suppress it.

**Index terms:**

Cabbage, Diamondback moth (Plutella xylostella), Pest management, Weather parameters, Integrated pest management, Resistance mechanism, Pesticide use, Biopesticides.

**Introduction:**

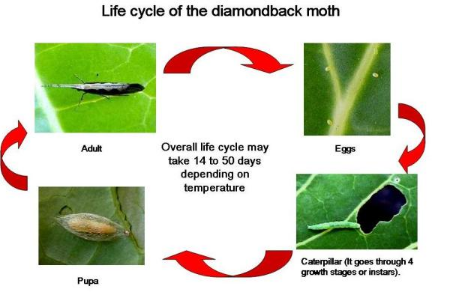
In terms of food security and agricultural productivity in India, vegetables are essential. Our nation is fortunate to have a variety of agro-climates and unique seasons, which enable the cultivation of a large range of vegetable crops. “Including an area of 2.4 lakh hectares and a total production of 56.2 lakh tonnes, India is one of the major producers of cabbage in Asia. One of the most devastating pests of farmed cruciferous vegetables worldwide is the diamondback moth, Plutella xylostella (L.)” (Gao, n.d.). The larvae of this pest, which might be varied stages, mostly cause harm to the leaflets, budding, blossoms, and seeds buds of developed cabbage plants. The larvae, despite their diminutive size, may be exceptionally numerous and completely remove the foliar tissue save for the older leaves. Diamondback moth larvae are infamous for developing resistance to new goods quickly in the past (Chakraborty & Somchoudhury, 2011).

Plutella xylostella L., also known as the diamondback moth, is a significant pest bug that damages brassica vegetables, particularly “Brassica oleracea crops including cabbage, cauliflower, broccoli, Brussels sprouts, and turnips” (Economics & Library, n.d.). Nutrients like phosphorous, potassium, calcium, sodium, iron, vitamins A, B, and C, as well as proteins, are abundant in cabbage (Sow et al., 2005). Diamondback moth is a significant pest in India because it reduces the marketable yield of cabbage by 50–80% annually. In order to apply appropriate management techniques against by the diamondback moth (Plutella xylostella (L.), and Brassica oleracea, which serves as their primary food source, present understanding of both is necessary (Keatinge & Wang, 2015).



**Fig.1**. Cabbage after Diamondback moth (Plutella xylostella) insect damaged

“On unprocessed cabbage plantings from the international scientific research farm, INPHB Yamoussoukro, Plutella xylostella larvae were recovered in July 2013” (Diabaté et al., 2014). In many regions of Asia, the misuse and abuse of insecticides against by the diamondback moth have become severe issues (Control et al., 2018). Indicator plants are species or types that are more susceptible to an infestation or diseases than the crop, as defined by integrated pest management (IPM). They draw pests and makes it easier to spot the presence of diseases and insects (Parolin et al., 2012). Additionally, a lot of work has gone into identifying the diamondback moth's natural predators, teaching farmers about the advantages of the larvae, and providing the insects through techniques distribution (Adibah et al., n.d.). P. xylostella L. larvae were acquired from a cultured that was kept under experimental conditions on a cabbage leaf (Murugan & Kovendan, 2015). To collect a range of juvenile phases of life that can be shown to predators as they evaluate their capacity to kill, diamondback moths were increased in large numbers on cabbage leaves in the lab (Miranda et al., 2011).

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**Fig.2.** Lifecycle of Diamondback moth

**Literature Review:**

Shu-Jun Wei et.al 2013 explained by globally, According to estimates, the diamondback moth will cost 4 to 5 billion US dollars annually in management costs and production reductions. In temperate regions where crucifers are not consistently grown, the diamondback moth could indeed successfully survive the winter months according to biological research and field research. The migrations of the diamondback moth have previously been investigated using techniques for genetic variation. The diamondback moth has evolved a resistance to several pesticides in the environment and the most dangerous insect pest on root vegetables in the world, can occasionally cause yield loss of more than 90% (Wei et al., 2013)(Srinivasan, 2012).

G. Sow et.al 2013 documented by “Cabbage diamondback moth (DBM), Plutella xylostella, is a cost-effective pest”. Therefore, it is anticipated that the alternating of Neem and B. thuringiensis will be a successful technique for the controlling of DBM in cabbage. DBM larvae obstruct physiological activities like respiration and photosynthetic activity as they grow on cabbage leaves. The plant responds by producing additional leaves to get around the stress. This in mind, efforts have been made to create a cabbage rejuvenation and transformation strategy that is effective against diamondback moth (Sow et al., 2013)(Peirce, 2007).

Michael J. Furlong et.al 2013 demonstrated by over the past 20 years, farming practices and improved efficiency of the DBM has gained more notoriety as a pest because of brassica vegetables and oilseed crops. Despite these advancements, DBM is still the most harmful component of the several insect pest combos that destroy Brassica vegetable crops globally. Here, a bioclimatic model for DBM was created and verified to forecast its fundamental occurrence, including areas where it can be a seasonally pest as well as those where it survives year-round. Not standing the enormous effort put forth to create integrated DBM management strategies. DBM is under attack from a range of natural enemies, comprising bacteria, viruses, pathogenic fungus, microsporidia, parasites, and arthropod predators (Furlong et al., 2013).

Sadia Munir et.al 2014 described by the most dangerous pest to brassicaceous agricultural crops is Plutella xylostella, but it is also one of the most challenging to control. “The four life stages of Plutella xylostella are egg, larva, pupa, and adult”. During the initial 24 to 48 hours following mating, ovulation primarily takes place at night and eventually decreases. Plutella xylostella has a strong ability to move across large distances in a short amount of time. Migration patterns and population seasonality of Plutella xylostella are well known. Plutella xylostella is unable to endure harsh winters and can live on a variety of ecological hosts (Munir et al., 2015).

Bin Huange et.al 2014 examined by “ the jumping behaviour and fertility of females in no-choice and free-choice laboratory contexts were compared via video recordings of host selection by P. xylostella in order to ascertain the causes of the population decline in the mixed cropping field”. In order to maximise their potential fitness, P. xylostella must find the preferred host plant species. Different behavioural responses were displayed by P. xylostella to the selected vegetable species. Researchers' ability to find migratory diamondback moths and anticipate the appearance of populations hotspot should improve with more appealing surveillance devices (Huang et al., 2014)(Miluch et al., 2014).

M Chandrashekharaiah et.al 2015 explained by the Plutella xylostella (Linnaeus), is a severe pest of Brassicaceae crops that severely reduces crop yields across the globe. Farmers frequently sprayed insecticides as a result of its frequent occurrence. In India, growers primarily rely on insecticides to regulate P. xylostella. In India, from planting to harvest, cabbage and cauliflower received an average of 10 to 15 insecticide spray applications. The population of P. xylostella became resistant to insecticides as a result of this improper method of applying pesticides (Chandrashekharaiah, 2015).

M. Zurina et.al 2015 evaluated by the majority of the cabbage grown is usually consumed and is primarily shipped to Singapore. Furthermore, a widespread issue of heavy pest and diseases, primarily by insect pests known scientifically as Plutella xylostella, threatens the expansion of cabbage production. Insecticides are used by the majority of cabbage farmers and the majority of the nation's primary producers of cabbage to control P. xylostella. For more than 40 years, the main method of controlling insecticides has been used to control P. xylostella. The three genotypes did not significantly differ in diamondback moth larvae survival on non-Bt leaves (Zurina, 2015)(Yi et al., 2013).

**Damage Symptom of diamondback moth, Plutella xylostella**

The formation of caverns in the head, similar to those found in brussel sprouts and cabbage, causes a lot of damage. Additionally, plants in the crucifier field grown on ridges are typically the first to show signs of crop loss. With over 90% of crop failure can be caused by a big P. xylostella infestation, and instead just some few final phase larvae on a cabbage can make it impossible to sell.

**Control Strategies Used:**

Combinations of insecticides can also be helpful. For illustration, to suppress the diamondback moth, combining the use of entomopathogens and nematode is an effective solution. One such persuasive strategy that is popular in contemporary agriculture is organic farming. To control crop pests, organic farmers in India utilise mixtures that include plant extracts, animal urine, cow dung, and other regional ingredients.

**Integrated management of diamondback moth, Plutella xylostella:**

**Cultural Practices:**

**Pre-season cleanup:**

Clear the greenhouse of all weeds and plant waste. Numerous pests also affect broad - leaved or even other vegetables. This is why it's crucial to keep other crops away from the greenhouse and to avoid dense weed growths along the outside margins of the greenhouse.

**Balanced use of fertilizer**

Implementing fertilisation regimens depending on the appropriate use of nutrients is advised. Only provide nitrogen when absolutely necessary for healthy growth. Periodic heavy treatments create nitrogen surpluses that promote excessive growth and the aphid and other insect population expansion. It has been discovered that applying potassium at the right quantities lowers the prevalence of insect pests.

**Pinching and Pruning**

With order to stop pests from spreading throughout the greenhouse, it can be quite beneficial to pinch off damaged plant parts, blooms, and leaves as well as those that have spots or leaf tissue covered in insect larvae or egg deposits. Before being disposed of, the plant detritus should be put right away in sealed containers. The populations of all the pests that are being targeted may be decreased with this method.

**Trap crop**

For early identification and pest control, several of the preferred hosts of the target pests can be used. To stop the spread of the diamondback moth, marigolds are grown as a trap crop.

“It is not unexpected that crucifer crops with overhead sprinkle irrigation tend to have fewer diamondback moth larvae than drip or a furrow-irrigated crop since rainfall has been found as a significant determinant in death for young larvae”. It has been noted that interplanting tomato with cabbage inhibits or reduces DBM egg-laying.

**Genetic Control of diamondback moth, Plutella xylostella**

There is still untapped potential for establishing varietal resistance in brassicas against DBM. It has also been unsuccessful to change the biochemical and morphological properties of plants. Thus, the creation of resistant varieties remains a major obstacle for biochemists and plant breeders in South Africa, considering its possibilities as a different non-chemical DBM control technique.

**Conclusion:**

The diamondback moth P. xylostella was the initial insect pest to evolve resilience to diamides, and it is also the organism in which the fundamental causes of the resistance have received the most attention. Constant and excessive use of pesticides causes the diamondback moth to acquire resilience, rendering the product ineffective when new and efficient insecticide becomes introduced. Although their efficiency and recognised role in biocontrol agents, supplementary plants have not yet been utilised to their full capacity in integrated pest management strategies. The diamondback moth has long been regarded as Asia's most harmful pest of crucifers. It was determined that there was no statistically significant connection between both the population of P. xylostella and the weather variables of temperatures (min and max), percent relative humidity, sunlight hours, and rainfall.

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