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

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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. Several insect pests, including P. xylostella, attack and devour the cabbage crop (Pathak et al., 2013).

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" (Xia et al., 2013). The diamondback moth is an insect pest in India everywhere crucifers are produced, and it frequently seriously damages cole harvests (Firake et al., 2013). In many regions of Asia, the misuse and abuse of insecticides against by the diamondback moth have become severe issues. 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 and The Plutella xylostella larvae utilised in this investigation came from a cluster that was raised in a lab on cabbage plants (Jeffrey W. Lee, 2013). 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).

Fig.2. Lifecycle of Diamondback moth

Literature Review:

Shu-Jun Wei et.al 2012 explained by globally, According to estimates, the diamondback moth will cost 4 to 5 billion US dollars annually in management costs and production reductions. Whenever crucifers are not routinely cultivated in temperate climates, 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 most damaging insect pest on root plants around the world, the diamondback moth has developed resistance to different environmental insecticides 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 various insect pest combinations that widely kill Brassica vegetable crops. 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 (M. J. Furlong et al., 2013).

J.P. Correa-Cuadros et.al described Plutella xylostella mostly results in leaf defoliation and produces 80% yearly losses. "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 (M. Furlong et al., 2013).

Bin Huange et.al examined " 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 (Grigg Mcguffin, 2011).

A.b.Rai et.al explained an transition in pest status has been observed in recent decades due to modifications in cropping patterns, environments and habitats, weather, and the advent of input-intensive good dividend hybrids and cultivars. Numerous pests have widened their range of potential hosts, grown resistant to insecticides, and frequently have subsequent epidemics. Due to modifications in the ecosystems and surroundings, some insect pests of vegetable crops have grown to be serious pest and are slowly achieving this condition in various parts of the nation. Due of its prevalent incidence, farmers routinely applied insecticides. In India, from planting to harvest, cabbage and cauliflower received an average of 10 to 15 insecticide spray applications. The primary biotic barrier to the cultivation of vegetables in India is insect infestations (Chauhan et al., 2011).

Dengxia Yi et.al 2013 defined 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. The three genotypes did not significantly differ in diamondback moth larvae survival on non-Bt leaves. In light of the detrimental effects of pesticides and the difficulties in managing diamondback moth infestations, the majority of resources have been directed towards finding alternative controls for this pest. During planting to harvesting, the cole crops are plagued by diamondback moth, endangering the integrity of the profitable business model (Yi et al., 2013)(Rattan & Sharma, 2011).

Seyed Ali Asghar Fathi et.al 2011 demonstrated by For the most part, cultivators apply insecticides to combat P. xylostella infestations. According to such a moth's enhanced fertility and quicker reproduction rate, it swiftly develops a pesticide tolerance. The introduction of alternative strategies, such as resistance among host plants and biological control, has been motivated by pesticides' inability to effectively control P. xylostella and their possible negative environmental effects. One of the successful tactics used in integrated pest management programmes to diminish early P. xylostella infections and hence decrease the need for insecticide is host plant resilience (Fathi et al., 2011).

Morten E. Moldrup et.al 2012 described by On cabbage, broccoli, as well as other cruciferous vegetables, the diamondback moth is regarded as the most destructive pest in the world, with projected controlling costs. Some anthocyanins, which are occurs naturally degradation byproducts of glucosinolates, can also cause diamondback moth egg production. "Two leaf discs measuring 1 cm in diameter were placed in a 5-cm Petri dish with wet filter paper for the diamondback moth survival and performance tests on wild-type tobacco and cabbage. Two first-instar larvae were also placed in the Petri dish, and the performance was monitored for 4 days. Replacement leaf discs were made every other day"(Møldrup et al., 2012).

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 target pests' favoured hosts can be utilised. 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. No statistically significant link was found to exist between the population of P. xylostella and the weather variables of temperatures (min and max), percent relative humidity, sunlight hours, and rainfall.

References:

Adibah, N., Ishadi, M., & Mazlan, N. (n.d.). *International Journal of Sciences : Insecticide Use Impacts on Pest Resistance : An Evidence from Diamondback Moth*. 131–150.

Chakraborty, G., & Somchoudhury, A. K. (2011). *Effect of pyridalyl against Piute / la xylostella (L .) on cabbage and natural enemies*. *7*(1), 142–145.

Chauhan, J., Singh, K., Singh, V., Sci, S. K.-I. J. A., & 2011, undefined. (n.d.). Hundred years of rapeseed-mustard breeding in India: accomplishments and future strategies. *Researchgate.Net*. Retrieved November 21, 2022, from https://www.researchgate.net/profile/Kunwar-Singh-9/publication/279554671_Hundred_years_of_rapeseed-mustard_breeding_in_India_Accomplishments_and_future_strategies/links/59f70e03458515547c2338d4/Hundred-years-of-rapeseed-mustard-breeding-in-India-Accomplishments-and-future-strategies.pdf

Economics, A., & Library, D. (n.d.). *This document is discoverable and free to researchers across the globe due to the work of AgEcon Search . Help ensure our sustainability .*

Fathi, S. A. A., Bozorg-Amirkalaee, M., & Sarfaraz, R. M. (2011). Preference and performance of Plutella xylostella (L.) (Lepidoptera: Plutellidae) on canola cultivars. *Journal of Pest Science*, *84*(1), 41–47. https://doi.org/10.1007/s10340-010-0324-3

Firake, D., Lytan, D., Entomology, G. B.-M., & 2013, undefined. (n.d.). Bio-diversity and seasonal activity of arthropod fauna in brassicaceous crop ecosystems of Meghalaya, North East India. *Emtoscipublisher.Com*. Retrieved November 21, 2022, from https://emtoscipublisher.com/index.php/me/article/html/559/policy

Furlong, M. J., Wright, D. J., & Dosdall, L. M. (2013). Diamondback moth ecology and management: Problems, progress, and prospects. *Annual Review of Entomology*, *58*, 517–541. https://doi.org/10.1146/annurev-ento-120811-153605

Furlong, M., Wright, D., Entomol, L. D.-Annu. Rev., & 2013, undefined. (n.d.). Diamondback moth ecology and management: problems, progress, and prospects. *Researchgate.Net*. Retrieved November 21, 2022, from https://www.researchgate.net/file.PostFileLoader.html?id=5241800ad4c1189817f25d20&assetKey=AS%3A272142548045824%401441895247799

Gao, X. (n.d.). *DIVERSITY OF TWO GENES FROM CHEWING PEST PLUTELLA XYLOSTELLA (L .) POPULATIONS NATIVE TO DIFFERENT GEOGRAPHICAL R ...*

Grigg Mcguffin, K. N. (2011). *Susceptibility of codling moth in southwestern Ontario apple orchards to currently recommended insecticides*. https://atrium.lib.uoguelph.ca/xmlui/handle/10214/20939

Jeffrey W. Lee. (2013). 小综述：小菜蛾(Plutella xylostella)分子档案. 昆虫分子生物学研究, *5*(1), 62–70. https://doi.org/10.5376/imbr.cn.2013.02.0001

Miranda, F., Bylund, H., Grönberg, L., Larsson, L., & Björkman, C. (2011). Population density and killing capacity by predators of eggs and larvae of the diamondback moth in nicaragua. *Environmental Entomology*, *40*(2), 333–341. https://doi.org/10.1603/EN10277

Møldrup, M. E., Geu-Flores, F., de Vos, M., Olsen, C. E., Sun, J., Jander, G., & Halkier, B. A. (2012). Engineering of benzylglucosinolate in tobacco provides proof-of-concept for dead-end trap crops genetically modified to attract Plutella xylostella (diamondback moth). *Plant Biotechnology Journal*, *10*(4), 435–442. https://doi.org/10.1111/j.1467-7652.2011.00680.x

Parolin, P., Desneux, N., & Bout, A. (2012). *Secondary plants used in biological control : A review*. *April*. https://doi.org/10.1080/09670874.2012.659229

Pathak, R., Borad, C. K., & Parasharya, B. M. (2013). Community Structure of Insectivorous Birds of Cabbage Fields. *Journal of Biological Control*, *27*(2), 135–138.

Peirce, S. (2007). Poie t ic C r. *Drug and Alcohol Findings*, *43*(1), 27599.

Rattan, R. S., & Sharma, A. (2011). *Review Article Plant Secondary Metabolites in the Sustainable Diamondback Moth (Plutella xylostella l .) Management*. *1*(3), 295–309.

Sow, G., Diarra, K., & Keddie, A. (2005). *The relationship between the diamondback moth , climatic factors , cabbage crops and natural enemies in a tropical ... July*. https://doi.org/10.2478/fhort-2013-0001

Sow, G., Niassy, S., Arvanitakis, L., Bordat, D., & Diarra, K. (2013). *Effect of timely application of alternated treatments of Bacillus thuringiensis and neem on agronomical particulars of cabbage*. *8*(48), 6164–6170. https://doi.org/10.5897/AJAR12.510

Srinivasan, R. (2012). Integrating biopesticides in pest management strategies for tropical vegetable production. *Journal of Biopesticides*, *5*(SUPPL.), 36–45.

Wei, S. J., Shi, B. C., Gong, Y. J., Jin, G. H., Chen, X. X., & Meng, X. F. (2013). Genetic Structure and Demographic History Reveal Migration of the Diamondback Moth Plutella xylostella (Lepidoptera: Plutellidae) from the Southern to Northern Regions of China. *PLoS ONE*, *8*(4). https://doi.org/10.1371/journal.pone.0059654

Xia, J., Huang, Z., Entomology, Q. H.-A. in, & 2013, undefined. (n.d.). Histopathological study of Plutella xylostella infected by three entomopathogenic fungal species. *Scirp.Org*. Retrieved November 21, 2022, from https://www.scirp.org/html/3-1270009_37362.htm

Yi, D., Cui, S., Yang, L., Fang, Z., Liu, Y., Zhuang, M., & Zhang, Y. (2013). Influences of Cry1Ac broccoli on larval survival and oviposition of diamondback moth. *Journal of Insect Science*, *15*(30), 1–5. https://doi.org/10.1093/jisesa/ieu054