ISSN (Online): 2091-2609
DOI Prefix: 10.3126/ijasbt

International Journal of Applied Sciences and Biotechnology (IJASBT)

Mini Review

Eco-Friendly Management of Diamondback Moth *(Plutella xylostella* L.) of Cabbage (*Brassica oleracea* var. *capitata*) in Nepal

Sovit Parajuli*, Sandip Paudel

Faculty of Agriculture, Agriculture and Forestry University, Rampur, Chitwan, Nepal

Article Information

Received: 19 July 2019
Revised version received: 10 September 2019
Accepted: 13 September 2019
Published: 24 September 2019

Cite this article as:
S. Parajuli and S. Paudel (2019) Int. J. Appl. Sci. Biotechnol. Vol 7(3): 304-308.
DOI: 10.3126/ijasbt.v7i3.25701

***Corresponding author**
Sovit Parajuli,
Faculty of Agriculture, Agriculture and Forestry University, Rampur, Chitwan, Nepal
Email: parajulisovit52@gmail.com

Peer reviewed under authority of IJASBT

Abstract

Cabbage is a popular cruciferous vegetable crop consumed for various purposes not only in the world, but also in Nepal. Among several pests, Diamondback moth (*Plutella xylostella*.L.) is a primary pest causing heavy loss of cabbage field each year in Nepal. Damage is caused by larvae. The trend of extensive and unscientific use of insecticide has resulted a devastating loss in cabbage production (31%-100%) and economic yield (US $4-US$5billion each year) on one hand and challenging the environment on the other hand. Thus integrated pest management practices, including botanical, biological, cultural methods and use of resistant varieties are effective. Annosom (extract of *Annona spp*.1%) and Neemix (extract of *Azadirachta indica*, 60%w/w) are effective botanical pesticides. *Diadegma spp*, among various biological control agents, is effective. Two rows of mustard for every twenty-five rows of cabbage is effective trap cropping. Yellow sticky trap is best for DBM monitoring and control. The seasonal irrigation and rain interferes the mating and oviposition and thus control of the pest. Spinosad, Indoxacarb and Emamectin benzoate are mostly used insecticides for the control of this moth. Use of specific resistant varieties like, G 9101 and G 9619 and transgenic lines are effective but in Nepalese context, least adopted by Nepalese farmers.

Keywords: *Plutella xylostella*; Integrated Pest Management; Biocontrol Agents

Introduction

Cabbage (*Brassica oleracea var. capitata*) is one of the most important vegetable crops of Nepal belonging to Brassicaceae family. The world scenario depicts that china is the top producer of cabbage (32,800,000t) followed by India (8,500,000t) and Russia (3,309,315t) (World atlas, 2017). In the context of Nepal, the total area under cabbage production is 28071.4 ha with production of 484036.8 mt and productivity 17.2 t/ha (MOAD, 2016-17). Cabbage is of potential nutritional and medicinal importance. A half cup of shredded cooked cabbage (75gm) contains 17 calories, 4 gm of carbohydrates and 1gm protein with 30-35% vitamin C (USDA National Nutrient Database). Diamond back moth (*Plutella xylostella*) is a destructive pest almost in all brassiceae vegetable crops including cabbage (Endersby, 2004). It is supposed to have originated from the Mediterranean region or Southern Africa (Talekar,

1993). Damage is caused by larval feeding. Excessive use of insecticides against DBM is one important cause as there is no circumscribed use of such insecticides in developing world or in tropics like Nepal (Mau Rlf, 2004). They cause heavy loss in the production of cabbage in Nepal (Anonymous 1997. Annual Report.,). The growth of plants is reduced and result reduction in the production and yield by 31-100% (Cardleronjj, 1986). The easy option for most of the Nepalese farmers is the application of available insecticides rather than the tedious integrated pest management practices. These insecticides create hazard to plant health and thus health of consumers, including various environmental issues. This is the first insect reported to be resistant to DDT (Ankersmit, 1953). The excessive use of insecticides has led to the modification of its physiological and genetic organization, resulting in the development of resistance. It is found that the resistance of DBM against *Bacillus thuringiensis* is due to the change in midgut receptor .The tendency of pesticide use is increasing by 10-20% every year and 90% of which is used in vegetables (Ghimire, 2018). According to a recent study, the average pesticide use in Nepal was 396gm/ha (plant protection directorate 2016, annual report) which was only 142gm/ha in 1995 (Dahal, 1995). A data on insecticide consumption given by PRMD Nepal, 2014 reveals that 113.88 mt of insecticide whose value worth 2855.56US$ was consumed. This depicts how foolhardy we, the citizens of developing countries like Nepal are. Thus integrated pest management is alternative to chemical control (DDP, 1991)

Integrated Pest Management

Integrated Pest Control is a holistic approach that attempts to integrate all the necessary and scientific aspects of crop management with minimum insect pest infestation so as to bring the damage to a minimum economic threshold level. Highlighting the initiation of integrated pest management practices in Nepal, the Nepal government accepted IPM as a part of plant protection program but due to the lack of trained manpower and budget, it was not launched in farm level till 1998. Nepal adopted the community IPM (CIPM) in 1997 and its first project was implemented as Farmers Field School in rice in the year 1998 (Westendorp, 2002). The first district to adopt IPM practices was Chitwan. At present, Nepal government, Ministry of Agriculture and Livestock has prioritized and promoted the use of IPM techniques in most of the districts (Baker, 1994)

Botanical Control

The use of various botanical plants in their crude form can be used effectively in controlling the infestation of DBM. These botanical plant extracts are non-toxic to mammals including human and non-target pest and are inexpensive compared to chemical pesticides (Prakash, 1997) (Schmutterer, 1995). The plants from family Meliaceae like neem tree, *Azadirachta indica* and syringe tree, *Melia azadirach* are found to be very effective in controlling DBM (Isman, 1999). Nicotene, rotenone and pyrethrum were popular among the botanical insecticides (Schmutterer, 1981). These plants possess properties like repellency, anti- feeding, fast knock down, flushing action, bio-degradability and broad spectrum activity for resistance reduction (Mochiah *et al*., 2011). According to a research conducted in the premise of our university, Agriculture and Forestry University (AFU), the control over DBM was 100% effective using chemicals(chloropyrifos 16% A.I. and Alphacypermethrin 1% E.C) but considering yield, pest control, B.C. ratio, market price, environmental factors etc., cattle urine was best followed by Annosom(extract of *Annona spp.* 1%) and Neemix(Neem oil 60% w/w, Azadirachtin content <300ppm) (Bhattarai, 2015).Thus, the easily available and less expensive botanical plants in Nepalese surroundings like Neem*(Azatirachta indica*), Bakaino(*Melia azadirach*),Asuro(*Justicia adhatoda*), marijuana(*Cannabis sativa*) etc. can be effectively converted into botanical insecticides to minimize the suffer of marketable yield loss of cabbage.

Biological Control

Considerable efforts have been made for DBM control using biological control agents, primarily micro-organisms, predators and parasitoids. The predators like spider, coccinellid beetles, pentatomid bugs, phytoseiulus mites, chrysopids and ophionea beetles were reported to attack DBM larvas in later stage of cabbage development, thus causing 70% prey mortality (Vu, 1988). It has been reported that the vespid wasp *Ropalidia sumatrae* attack DBM larvae in lowland crucifers (Yasumatsu, 1981). According to a research (Nemoto, 1985), the higher number of DBM even in insecticide treated field was due to lower predator number. This depicts the resistance development in one hand while in other hand it emphasizes on the scope of biocontrol agents by the replacement of chemicals. The effective viruses for DBM control includes nuclear poly-hedrosis virus, called *Autographa californica* (AcNPV) and *Galleria mellonella*(GmNPV) (Kadir and Payne, 1989). In the south east Asian countries like Nepal, Thailand, the mass release of egg parasitoids of *Trichogramma confusum* @ 375,000 parasitoids/ha resulted parasitoid population to increase upto 65.5% (Vattanatangum, 1988). *Diadegma* sp is the principle regulator of DBM (Marsh, 1917). In New Zealand, use of *Cotesia plutellae*, *Diadromus collaris* and *Oomyzus sokolowski* has reduced DBM infestation by 80% (Yaseen, 1978). A nematode, *Steinernema carpocapsae* controlled DBM by 41% (Baur *et al*., 1998). Several species of entomopathogenic fungus such as *Beuveria bassiana*, *Zoophthora radicans*, *Metarhizium anisopliae* are used successfully (Rana and Sarfraz, 2005). Use of such agents have saved US$ 365,000 per year and also have reduced environmental hazards. Presently, various evidences show that parasitoid plays dominant role in population dynamics of DBM (Lim, 1986). Thus use of biocontrol agents as IPM

tools and attendant reduction in chemical pesticides should be given prime importance (Ooi, 1989).

Table 1: Effect of different parasitoids on DBM mortality rate

Parasitoids	**% DBM mortality**
Diadegma insulare	46.5
Microplitis plutellae	7
Oozymus sokolowskii	2
Diadegma subtilicornis	0.4

Source: (Shelton, 2002)

Cultural Practices

Time of planting, crop rotation, intercropping/mixed cropping, proper irrigation including other scientific agronomic practices come under this heading. It has been found that sowing cabbage during wetter period prevents DBM infestation (Lim, 1982). It has also been experienced at our university horticultural farm that during damp and wet period, there is less appearance of this pest whose population increases with dryness. Crop rotation of cabbage with beans and cucurbits is also abundant in south Asian countries including Nepal which has been found effective. Two rotations, cabbage-peas-turnip or cabbage-luffa, and tomato-cabbage-squash or cucumber is effective (Vu, 1988). Two rows of mustard as trap crop for every twenty-five cabbage rows is effective. In Malaysia and Philippines, tomato intercropped with cabbage resulted DBM larvae to reduce gradually (Buranday, 1975) possibly due to repellent property. This study reveals that such healthy practices cause least damage to environment with better production and yield. However some inconsistent result (Magallona, 1977) suggest for further investigation.

Resistant varieties

Use of resistant varieties against DBM is not much practiced by Nepalese farmers due to insufficiency of proper scientific researches. The available evidences show that the cabbage lines, G 9101 and G 9619 with dark green foliage exhibited DBM resistance due to mortality of 1st instar larvae. Also, in field tests, G 8329, mature Chinese cabbages and pak choi were least damaged. (Lin *et al*., 1983). Transgenic head cabbage, developed through *Agrobacterium tumifaciens*- mediated gene transformation with a synthetic Bt gene, cry1Ab3, were also found resistant to DBM larvae. However, the economic and modern scientific constraints make such transgenic production limited in developing countries like Nepal and thus a lot of delving in this field is required.

Monitoring

There is difficulty in monitoring DBM larvae because of their smaller size and propensity to be concealed in the heart leaves. Thus various monitoring tools have been assessed over the pest control. Pheromones have been used for initial detection of the pest, their magnitude and first occurrence (Mitchell, 1981).Pheromone is released by female moth to attract male. The development of synthetic pheromones is effective in attracting male moths. The traps should be set in the cabbage field during the last week of April or first week of May or early of the season. According to a research (Sivapragasam and Saito, 1986), among the various vinylchloride plated traps (yellow, clear,blue and red), more adult moth were collected on yellow coloured plate showing Yellow Sticky Trap to be effective. Various trap crops can be used for controlling the pest infestation. Among various trap crops under consideration (glossy and waxy collards, Brassica oleracea L var. acephala; Indian mustard, Brassica juncea (L) Czern; and yellow rocket, Barbarea vulgaris (R.Br.) var.arcuata , yellow rocket was the best trap crop (Francisco and Badenes-Perez, 2004).

Irrigation

Regulated sprinkle irrigation has been found in the substantial reduction of DBM infestation (Telekar, 1986). In Nepalese context, sprinkle irrigation doesn't hold best option till now as most farmers are marginalized, un-aware and with low economy and access. Thus the seasonal irrigation and rain interferes the mating, oviposition and clears minute larvae resulting lower pest population.

Chemical Control

Spinosad, Indoxacarb and Emamectin benzoate are mostly used insecticides for control of this moth (Zhao, 2002). Spinosad is the first member of naturalyte insecticide with high level of activity with low human and environmental risk (Thompson, 2000). A research suggests cartap as best insecticide in Japan (Sakai, 1985) so used over 30% crucifer growing areas resulting resistant. On a research conducted in U.S and Mexico, among the three group of insecticides (Spinosad, indoxacarb and emamectin benzoate), indoxacarb was found to be resistant to some extent (Zhao, 2006). A research conducted on our university horticulture farm depicted that maximum mortality of DBM larvae were recorded on Anthsuper (Chloropyrifos 16% A.I.+ Alpha-cypermethrin 1% EC) treated plots (Bhattarai, 2015).

Conclusion

Though eco-friendly management of Diamondback moth suggests minimum use of insecticides, almost all the farmers of Nepal are seen to adopt chemical control measures. The ease of availability, medium low cost (compared to equivalent biological, botanical or cultural control measures), low labor cost and less tedious job (compared to IPM practices) are probably the most common reasons for the excessive chemical use. Such excessive use of chemicals that is shortening the life of ours and on contrary, increasing pest lives should be discouraged. Adoption of IPM practices should be emphasized for a

healthy and ecofriendly management of DBM in cabbage so that the next generation has to suffer less by its impact.

Author's Contribution

Sovit Parajuli designed the research plan; Sandip Paudel performed experimental works & collected the required data. Both authors analysed the data, prepared the manuscript and finalized the manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest with present publication.

References

Ankersmit G (1953) DDT-Resistance in Plutella maculipennis(L.) in Java. *Bulletin of Entomological Research* **44**(3): 421-425.

Anonymous (1997) Annual Report.,. Lalitpur, Nepal: Regional Plant Protection LaBoratory.

Baker SA (1994) Promoting proper pesticide use in Nepal. Kathmandu, Nepal: Policy analysis in agriculture and related resource management research report 28, Ministry of Agriculture and Winrock International.

Baur ME, Kaya HK, Tabashnik BE, Chilcutt CF. (1998) Suppression of diamondback moth (Lepidoptera: Plutellidae) with an entomopathogenic nematode (Rhabditida: Steinernematidae) and Bacillus thuringiensis Berliner. *Journal of Economic Entomology* **91**(5):1089-1095. DOI: 10.1093/jee/91.5.1089

Bhattarai SR (2015) Eco-Friendly Management of Diamond Back Moth (Plutella xylostella) of Cabbage (Brassica oleracea Var.capitata) in Chitwan Nepal. Agriculture and Forestry University, 119-124.

Buranday RA (1975). Effects of cabbage tomato intercropping on the incidence and oviposition of the diamondback moth, Plutella xylostella L.). *Phillipp Entomol* **69**: 374.

Cardleronjj H (1986). Control of Diamondback Moth in South East Asia by Profenofos. *Proceeding of The First International Workshop, Asian Vegetable Research and Development Centre. Taiwan*.

Dahal L (1995) Study on pesticide pollution in Nepal. National Conservation Strategy Implementation Project, National Planning Commission, HMG Nepal, in collaboration with IUCN-The World Conservation Union.

DDP (1991) Biological Control of Insect Pest and Weeds. Reinhold.

Endersby NM (2004). Proceedings of The Fourth International Workshop on The Management of Diamondback Moth and Other Crucifers Pest.

Francisco R and Badenes-Perez AM (2004) Evaluating Trap Crops for Diamondback Moth, Plutella xylostella(Lepidoptera: Plutellidae). *Journal of Economic Entomology*. 1365-1372. DOI: 10.1093/jee/97.4.1365

Ghimire DR (2018) Pesticide Poisoning, Ways to Deal with It. *The Himalayan Times*, August 07, 2018

Isman MH (1999) *Neem and related natural products; Methods in Biotechnology*. Humana Press Inc., 139-153. DOI: 10.1093/10.1385/0-89603-515-8:139

Kadir HA and Payne CC. (1989) Relationship of a Plutella xylostella nuclear polyhedrosis virus (NPV) to NPV of Galleria mellonella. *Journal of Invertebrate Pathology* **53**(1): 113-115. DOI: 10.1016/0022-2011(89)90081-5

Lim GT (1982) The biology and effects of parasites on the diamondback moth, Plutella xylostella (l). Ph.D thesis, 317.

Lim GT (1986). Biological control of diamondback moth. preceedings of the First International Workshop.

Lin J, Eckenrode CJ and Dickson MH (1983) Variation in Brassica oleracea resistance to diamondback moth (Lepidoptera: Plutellidae). *Journal of Economic Entomology* **76**(6):1423-1427. DOI: 10.1093/jee/76.6.1423

Magallona E (1977) Studies for the control of insect pess of cruciferous vegetables with emphasis on Plutella xylostella(L.). (p. 35). Annual report (1976-77).

Marsh H (1917) Life history of Plutella maculipennis, the diamondback moth. *Journal of Agricultural Research* 1-10.

Mau Rlf GM (2004). Diamondback Moth, Plutella Xulostella (L.) Resistance Management in Hawaii. 307-311.

Mitchell E (1981) Management of insect pests with semiochemicals: concept and practices. Plenum Press, 514.DOI: 10.1007/978-1-4613-3216-9

MOAD (2016-17) Statistical Information On Nepalese Agriculture, Agribusiness Promotion and Statistic Division. Kathmandu, Nepal.

Mochiah MB, Banful B, Fening KN, Amoabeng BW, Ekyem S, Braimah H and Owusu-Akyaw M (2011) Botanicals for the management of insect pests in organic vegetable production. *Journal of Entomology and Nematology* **3**(6): 85-97.

Nemoto HS (1985) Application of an immunological method for the identification of predators of the diamondback moth, plutella xylostella L.(lepidoptera:Yponomeutidae) in cabbage fields. *Japanese Journal of Entomology and Zoology*. 61-66. DOI: 10.1303/jjaez.29.61

Ooi PA (1989) Introduction of exotic parasitoids to control the Diamondback moth in Malaysia. Plant protection Tropics, 103-111.

Prakash AR (1997) Botanical Pesticides Against Nematodes.Botanical Pestcides in Agriculture. CRC Lewis Publishers, Boca Raton. DOI: 10.1201/9781315138572-2

Rana M and Sarfraz BA (2005) Biological control of the diamondback moth, Plutella xylostella: A review. *Biocontrol Science and Technology*. 763-789. DOI: 10.1080/09583150500136956

Sakai M (1985). Chemical Control of Diamondback Moth in Japan with Special Reference to Cartap. Agricultural Chemical Division. DOI: 10.1271/nogeikagaku1924.59.756

Schmutterer H (1981) Ten years of neem research in Federal Republic of Germany: in natural pesticide from neem tree (Eds). 21-32.

Schmutterer H (1995) The Neem Tree. Wiley. DOI: 10.1002/3527603980

Shelton AW (2002). Parasitoids of Cabbage Lepidoptera in Central New York. *Journal of Entomological Science* 270-271. DOI: 10.18474/0749-8004-37.3.270

Sivapragasam A and Saito TA (1986) yellow sticky trap for the diamondback moth Plutella xylostella (L.)(Lepidoptera: Yponomeutidae). *Applied entomology and zoology*. **21**(2): 328-33. DOI: 10.1303/aez.21.328

Talekar NA (1993) Biology, Ecology and Management of Diamondback moth. *Annual Review of Entomology*. 275-301. DOI: 10.1146/annurev.en.38.010193.001423

Telekar NL (1986). Intercropping and modification of irrigation for the control of diamondback moth. Proceedings of the first international workshop (pp. 145-155). Taiwan: Asian Vegetable Research and Development Centre.

Thompson GR (2000). Spinosad- a case study: an example from a natural product discovery programme. *Pest Management Science*, 596-702. DOI: 10.1002/1526-4998(200008)56:8%3C696::aid-ps182%3E3.0.co;2-5

Vattanatangum (1988). Informal expert consultation on IPM in major vegetables in Asia. Country Review Paper, RAPA (FAO).

Vu V (1988) Informal Expert Consultation on IPM in Major Vegetable Crops in Asia. Country Review Paper, 11.

Westendorp AA (2002) Strengthening social capital in agriculture and natural resources innovation. Community IPM Farmers Field Schools (FFSs) in Nepal.

World atlas (2017) The world leader in cabbage production. Retrieved from worldatlas.com: https://www.worldatlas.com/articles/the-world-leaders-in-cabbage-production.html

Yaseen M (1978). The establishment of two parasites of the diamondback moth Plutella xylostella(Lepi: Plutellidae) in Trinidad, W.I. *Entomophaga* 111-114. DOI: 10.1007/bf02371716

Yasumatsu KT (1981) An effective hunter of the larvae of Plutella xylostella (Linne). MAPPS NEWSL

Zalucki MA (2012). Estimating the Economic Cost of One of the World's Major Insect Pests, Plutella xylostella (Lepidoptera: Plutellidae): Just How long is a Piece of String? *Journal of Economic Entomology* 1115-1129. DOI: 10.1603/ec12107

Zhao JYM (2002). Monitoring and Characterisation of Diamondback Moth (Lepidoptera: Plutellidae) Resistance to spinosad. *Journal of Economic Entomology*, 430-436. DOI: 10.1603/0022-0493-95.2.430

Zhao JC (2006) Monitoring of Diamondback Moth (Lepidoptera: Plutellidae) Resistance to Spinosad, Indoxacarb, and Emamectin benzoate. *Journal of Economic Entomology*, **19**(1): 176-181. DOI: 10.1603/0022-0493(2006)099[0176:modmlp]2.0.co;2