Article ID: AEN-2020-01-01-023

Uses of Avermectin in Vegetable Crops

Kalyani Pradhan[1], Sandeep Rout[1*], Barsha Tripathy[2], Sitanshu Sekhar Patra[3] and Satyajeet Kar[4]

[1]Faculty of Agriculture, Sri Sri University, Cuttack, Odisha-754006, India
[2]Department of Horticulture, M. S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi, Gajapati, Odisha-761211, India
[3]Department of Meteorology and Oceanography, Andhra University, Visakhapatnam, Andhra Pradesh-530003, India
[4]Department of Forestry, JNKVV, Jabalpur, Madhya Pradesh-482004, India
Corresponding author. E-mail: sandeeprout1988@gmail.com

Emamectin is a foliar insecticide derivative of abamectin, which is isolated from fermentation of *Streptomyces avermitilis*, a naturally occurring soil actinomycete. By stimulation, it releases -aminobutyric acid which inhibits neurotransmission, as a result of which the insect becomes paralyzed within hours of ingestion, and subsequently 2–4 days later there is the death of the insect. It has registered uses in many countries on fruits, vegetables, cereals, tree nuts, oilseeds, herbs and tea.

Abamectin, ivermectin, doramectin and eprinomectin are other associated avermectins of which abamectin has been evaluated. Emamectin is the 4”-deoxy-4”-methylamino derivative of abamectin, a 16-membered macrycyclic lactone formed by the fermentation of the soil actinomycete Streptomyces avermitilis. It is generally prepared as the salt with benzoic acid, emamectin benzoate, which is a white or slightly yellow powder. Because of its chloride channel activation properties, Emamectin is extensively used in the US and Canada as an insecticide.

History

The bacterium *Streptomyces avermitilis* produces Emamectin, belongs to the avermectin family of compounds all of which show signs of toxicity for nematodes, arthropods, and a number of other pests. The benzoate salt of emamectin in particular has found prevalent use as an insecticide and is approved by the EPA for use in avoidance of emerald ash borer in ash trees. Emamectin is derivative, of avermectin B_1, also well-known as abamectin, a mixture of the natural avermectin B_1a and B_1b. It is also used in annihilation of fish lice and in fish farming.

Uses

It is commonly used in controlling lepidopterous pests in agricultural crops in India, US, Canada, Japan and recently in Taiwan. Emamectin as an insecticide has gained considerable recognition among farmers due to its low rate application of the active ingredient (6 g/acre) and its broad-spectrum application. In India and tropical Asia, the main limiting factor for vegetable production is insect pests amongst which lepidopteron pests cause a considerable amount of damage. Insect pests are the main limiting factor for vegetable production in India and tropical Asia, amongst which lepidopteron pests cause a significant amount of damage. Farmers want to protect the high value vegetable crops from any type of damage caused by insect pests which lead to the indiscriminate use of synthetic insecticides. As a result of which the insect becomes resistance to these insecticides. Some important lepidopteran pests with high reproductive capacity and capable of migrating over large distances in different vegetables are (Sojitra, 1991, Talekar and Shelton, 1990),

Diamond-back moth (DBM) in cabbage (*Plutella xylostella*), tomato fruit borer (*Helicoverpa armigera*), chilli pod borer (*Spodoptera litura*), shoot and fruit borers of brinjal (*Leucinodes orbonalis*) and okra (*Earias vitella* and *Earias insulana*). For efficient control of these lepidopteran pests recently some new pesticides have been developed having novel modes of action.
Today there is a great demand for safer and more selective insecticides affecting specifically harmful pests, while sparing beneficial insect species and other organisms. Furthermore, the fast developing resistance to conventional insecticides provides the momentum to study new alternatives and more cost-effective methods of insect control as a part of integrated pest management (IPM) programs.

Sustainable Management of Some Key Lepidopteran Insect Pests of Vegetables

The purpose of this work was to test the effectiveness of some new chemicals, microbial pesticides and insect growth regulators in controlling five important lepidopteran pests on Tomato, Brinjal, Chilli, Okra and cabbage under field condition and their safetiness to natural enemies.

Case Study in different Vegetable crops

Brinjal

The infestation, both shoot and fruit damage were prevailed simultaneously in the field and expressed separately to explain the separate trend of shoot and fruit damage incidence. The overall mean infestation revealed the lowest fruit infestation in spinosad (12.48%) followed by flubendiamide (13.37%) treated plots, where as in untreated plot the fruit damage was 38.69%. It is manifest from the table that spinosad recorded the highest good fruit yield of 160.0 q/ha followed by flubendiamide (149.65 q/ha). Spinosad was more effective against the test insect with less damaged fruit yield, flubendiamide was the next best in order of effectiveness damaged fruits. Due to poor natural enemy complex, insecticides have been used extensively for its control. This has resulted in a progressive decrease in the effectiveness of most of the insecticides and also resulted in an outbreak of some secondary pests. Control of this pest is difficult because of its internal boring habit. In spite of its low fecundity (150 eggs per female) it has very high survival potentiality. Its entire larval period is spent within fruit/branch and it passes the whole damaging stage as true internal borer. This nature makes it afar the reach of most of the stomach poison insecticides. Among the microbial spinosad and emamectin benzoate showed better performances may be due to their contact and ovolarvicidal action that exhibited more toxic effects to eggs and neonate larvae which are the most susceptible stages of the pest. Similar results were obtained on the result of spinosad against *Leucinodes* as reported by AnandaKumar *et al*. (2002), and Thompson and Hutchins (1999).

Okra

The mean percentage of shoot and fruit infestation of three sprays revealed that all those new molecules tested were found to be considerably superior over control at 5% level. Among them spinosad recorded the lowest (4.33%) infestation followed by flubendiamide (4.83%), novaluron (5.51%) and was at par with mixed formulation of chlorpyriphos and cypermethrin (5.67%). Similarly, highest yield of okra was recorded in spinosad treated plot (72.10 q/ha) followed by flubendiamide and novaluron treated plot (66.73 and 66.0 q/ha). The high efficiency of spinosad against Okra shoot and fruit borer is also conformity with Shinde *et al*. (2007).

Tomato

In the tomato field, fruit infestation caused by *Helicoverpa armigera* was highly checked by flubendiamide, only 3.52% mean fruit damage was recorded, which was reflected on highest yield

(81.55 q/ha) also, followed by spinosad (5.21% fruit damage and yield 76.95q/ha). Other chemicals novaluron, chlorfenapyr and emamectin perform moderately to minimize the fruit infestation. Indiscriminate use of different insecticides resulted in killing of natural enemies of the borer. As nocturnal insect, its activity starts from the evening and continue till morning. This makes it more difficult to control. Flubendiamide, spinosad, emamectin benzoate and novaluron exhibited higher degree of population reduction of *Helicoverpa*. High initial larval mortality was found after application of those chemicals. *Bacillus* was less persistent than other microbial resulting in increase of population after few days of application.

Novaluron performed exceedingly well against *Helicoverpa* at all levels. Similar results were observed by Ishaaya *et al*. (1996). According to them, novaluron acts through stomach and contact actions and highly active against lepidopteran larvae producing about 100% mortality when larva feed the treated fruits. The high efficacy of flubendiamide against *Helicoverpa* is also conformity with Narayana and Rajashri (2006), and Meena *et al*. (2006).

Cabbage

All the insecticides showed a good decline of the pest population. Among them flubendiamide performs exceedingly well both in reducing DBM population (91.0%) as well as an increase in yield (24.15 ton/ha) closely followed by spinosad and novaluron. DBM (*Plutella xylostella* L.) is one of the most important insects of cabbage that quickly develops resistance in all classes of insecticides. The resistance phenomenon occurs in DBM due to its lipid characters and mixed function oxidase (MFO) system that present in liver is mainly responsible for degradation and detoxification metabolism of different toxicants after time lapse. In the present investigation flubendiamide, spinosad, novaluron and chlorfenapyr showed the best efficacy against DBM. Pramanik and Chatterjee (2004) observed that the larvae of *P. xylostella* became sluggish after novaluron treatment, followed by cessation of feeding. The larvae became changed from pale green to black. Abortive moulting was also evident in some of the larvae. Flubendiamide is a new generation insecticide having new mode of action belonging to the class of benzenedi carboxamides. The high efficacy of flubendiamide against plutella xylostella in cabbage is also proved by Ameta and Bunker (2007) and Kumar *et al*. (2007).

Chilli

In chilli field, the fruit infestation caused by Spodoptera sp. was highly checked by spinosad and novaluron. More than 90.0% reduction of fruit borer was noted with only 2.30 and 2.35% fruit infestation and more than 17.0 q/ha of Chilli yield. The rest of the other insecticides significantly reduced the pest population and increased in yield as compared to the untreated plot. Close observations in the chilli field revealed that the chemical novaluron caused moulting failure and deformity in the wide population of larva and mosaics. The new molecules with new insecticidal chemistry used in our experiment such as spinosad, emamectin benzoate have been proved well in combating this pest in cabbage. Present findings are in agreement with the work of Kumar and Devappa (2006).

Effect on Natural enemies

All the chemicals except mixed formulation of chlorpyriphos + cypermethrin are comparatively safer to natural enemies – spider, Menochillus, Chrysoprla and Cotesia on brinjal, tomato, chilli and cabbage. It was observed that among the chemicals (except mixed formulation) chlorfenapyr has some little effect on the population of natural enemy. In case of tomato where number of spiders per 10 plants was observed, only the mixed formulation of chlorpyriphos & cypermethrin was the toxic chemical which spares the natural enemies. In chilli, no any natural enemies were observed in the plot treated with mixed formulation of chlorpyriphos & cypermethrin. In cabbage, the diamond back moth larvae parasitized with *Cotesia plutellae* were collected from the treated plots and reared in the laboratory and observed the percentage of emergence. It was revealed from the observations that only two chemicals, mixed formulation of chlorpyriphos and cypermethrin and chlorfenapyr were significantly reduced parasitism at 5% level. So except those two chemicals all the chemicals were proved safe to the parasite *Cotesia plutellae*.

Conclusions

The new eco-friendly and selective insecticides are based on new receptors of insect nervous and endocrine systems as well as different metabolic pathways of the different insecticides. Flubendiamide is one of the important insecticides that have excellent action on insects with unusual symptoms such as body contractions and feeding cessation. It caused a gradual contraction of the insect body thickening and shortening without convulsions and activates the ryanodine receptor, a calcium release channel which is involved in muscle contraction. Spinosad, chlorfenapyr, emamectin benzoate and novaluron are very much potent insecticides than others and their effect persisted for 5-15 days. Conventional insecticide – chlorpyriphos + cypermethrin was also very much effective against all lepidopteran pests but at the same time, it reduced all the natural enemies in all crops.

References

Ameta, O.P. and Bunker, G.K. (2007). Efficacy of NNI 001 (Flubendiamide) 480 SC against diamondback moth, *Plutella xylostella* (Linn.) in cabbage and its effects on natural enemies under field conditions. *Pestology*. 31 (6): 21-24.

Anandkumar, V., Nagangoud, A. and Patil, B.V. (2002). Management of Brinjal shoot and fruit borer, *Leucinodes orbonalis* (Guen.) Proceedings on National seminar on “Integrated pest Management in the current century” held at B.C.K.V., India p. 238-248.

Ishaaya, I., Yablonski, S., Mendelson, Z., Mansour, Y. and Horowitz, A.R. (1996). No-valuron (MCW-275), a novel benzoylphenyl urea, suppressing developing stages of lepidopteran, whitefly and leafminer pests. Proceedings of the Brighton Crop Protection Conference. Pests and Diseases. 3:1013-1020.

Kumar, P. and Devappa, V.(2006). Bioefficacy of emamectin benzoate 5% udar.SG (Proclaim) against brinjal shoot and fruit borer. Pestology. 30(3): 17-19.

Lakshmi Narayana, S. and Rajasri, M. (2006). Flubendiamide 20 WDG (RIL-038)-A new molecule for the management of American bollworm. *Helicoverpa armigera* on cotton. *Pestology*. 30 (11): 16-18.

Meena, R.S., Srivastava, C.P. and Joshi, N. (2006). Bioefficacy of some newer insecticides against the major insect pests of short duration pigeonpea. *Pestology*. 30 (9): 13-16.

Pramanik,P. and Chatterjee, M.L.(2004). Effects of novaluron on the population of *Plutella xylostella* and *Spodoptera litura* on cabbage. *Annals of Plant Protection Sciences*. 12 (1): 204-205.

Shinde, B.D. Sarkate, M.B. More, S.A and Sable, Y.R. (2007). Evaluation of different pesticides for safetyness to predators on Okra. *Pestology*. 31 (5): 25-28.

Sojitra, J.R. (1991). Estimation of avoidable losses due to pests of various bhendi varieties. M. Sc. (Agri.) thesis submitted to Gujrat Agricultural University. S.K. Nagar, P. 93.

Talekar, N.S. and Shelton, A.M. (1990). Biology, ecology and management of diamondback moth. *Annual Review of Entomology*. 38: 275-301.

Thompson, G. and Hutchins, S. (1999). Spinosad. *Pesticide outlook*. 10 (2): 78-81.

Vinoth K. B., Srinivasan, T., Kumaran, N. and Kuttalam, S. (2007). Evaluation of flubendiamide 480 SC against diamond back moth (*Plutella xylostella* L.) in cabbage. *Pestology*. 31 (11): 48-51.