Bioefficacy study of biorational insecticide on brinjal

Aparna Kalawate* **and M. D. Dethe**

ABSTRACT

In the present study, bioefficacy of spinosad (56.25, 72 and 90 g a.i. ha^{-1}) and emamectin benzoate (5, 6.25 and 12.5 g a.i.ha^{-1}) was studied in comparison to cypermethrin (50 g a.i. ha^{-1}) and self-formulated neem seed extract (5 %). Field experiments were undertaken for two cropping seasons during *kharif* 2005 and summer 2006. From the study it was found that spinosad afforded moderate control of jassid, whitefly and aphid. However, it was found to be the most effective against BSFB. Although corresponding yield recorded in cypermethrin (check treatment) was higher (16.30 and 21.01 t ha^{-1}) it was not significantly different than that noticed in spinosad and emamectin benzoate.

Key words: *Amrasca biguttula, Bemicia tabaci, Leucinodes orbonalis,* spinosad

INTRODUCTION

Brinjal (*Solanum melongena* L.) is one of the widely used vegetable crops by most of the people and is popular in many countries *viz.*, Central, South and South East Asia, some parts of Africa and Central America (Harish *et al*., 2011). It is native of India and is grown through out the country (Choudhary, 1970; Pareet, 2006). It is an important vegetable grown in all the seasons. Due to its nutritive value, consisting of minerals like iron, phosphorous, calcium and vitamins like A, B and C, unripe fruits are used primarily as vegetable in the country. It is also used as a raw material in pickle making (Singh *et al.*, 1963) and as an excellent remedy for those suffering from liver complaints. It has been reported as Ayurvedic medicine for curing the diabetes. In addition it is used as a good appetizer, good aphrodisiac, cardiotonic, laxative and reliever of inflammation.

Though brinjal is a summer crop, it is being grown throughout the year under irrigated condition. Hence, it is subjected to attack by number of insect pests right from nursery stage till harvesting (Regupathy *et al.*, 1997). Among the insect pests infesting brinjal, the major ones are shoot and fruit borer, *Leucinodes orbonalis* (Guen.), whitefly, *Bemicia tabaci* (Genn.), leafhopper, *Amrasca biguttula biguttula* (Ishida), and non insect pest, red spider mite, *Tetranychus macfurlanei* (Baker and Pritchard). Of these, *L. orbonalis* is considered the main constraint as it damages the crop throughout the year. This pest is reported from all brinjal growing areas of the world including Germany, Burma, USA, Srilanka and India. It is known to damage shoot and fruit of brinjal in all stages of its growth. The yield loss due to the pest is to the extent of 70-92 per cent (Eswara Reddy and Srinivas, 2004; Chakraborti and Sarkar, 2011; Jagginavar *et.al* 2009). The infested fruits become unfit for consumption due to loss of quality and hence, lose their market value. It is also reported that there will be reduction in vitamin C content to an extent of 68 per cent in the infested fruits (Hemi, 1955).

Although insecticidal control is one of the common means against the fruit borer, many of the insecticides applied are not effective in the satisfactory control of this pest. Brinjal being a vegetable crop, use of chemical insecticides will leave considerable toxic residues on the fruits. Beside this, sole dependence on insecticides for the control of this pest has led to insecticidal resistance by the pest (Natekar *et al.*, 1987; Harish *et al.*, 2011). Hence, use of organic amendments, plant products and microbial origin insecticides can be the novel approaches to manage the pest. The role of microbial insecticides, in lepidopterous insect pest management has obvious advantages in terms of effectiveness, specificity and safety to nontarget organisms and other components related to biosphere. Moreover, perusal of literature indicates that limited work has been done on the efficacy of spinosad and emamectin benzoate against the brinjal pest. Hence, keeping the above point in view, present investigation was planned to evaluate the bioefficacy of spinosad and emamectin benzoate against the pest on brinjal under field condition.

MATERIALS AND METHODS

Bioefficacy of spinosad against pests of brinjal was studied by planning two field experiments at the Instructional Farm of Post Graduate Institute, M.P.K.V., Rahuri. The first experiment was conducted in *kharif* season of the year 2005, whereas second field experiment was conducted during summer season of the year 2006. The field experiment was laid out in Randomised Block Design (RBD). The field was prepared with ploughing and harrowing in respect of both the experiments, however, both experiments were conducted on different plots of the same field which were earlier used for the pigeonpea crop. Good quality seeds of brinjal 'Krishna' hybrid procured from the Vegetable Research Project of MPKV, Rahuri was used for nursery sowing. About six-weeks-old healthy seedlings raised on nursery beds were used for transplanting. Before sowing, the soil of nursery beds were treated with well ground manure mixed with *Trichoderma* (biofungicide). Spacing was provided by keeping, plant to plant distance of 45 cm and row to row was 60 cm. Brinjal was raised as per recommended package of practices except insect-pest management practices.

The observations on counts of sucking pest *viz.*, aphid (nymph and wingless adult), jassid (nymph) and whitefly (nymph) were recorded on five randomly selected plants per treatment plot. On each plant, three leaves (one each from bottom, middle and top portion of the plant) were observed from lower side to note the pest count. First count was taken one day before first spray and post treatment counts were made 1, 3 and 7 days after spray. The data on surviving population were reported on per plant basis (Mean of population/three leaves). The data on counts were transformed to square root transformation ($\sqrt{n} + 0.5$) to correct heterogeneous variances and the transformed data were analysed statistically as a RBD (Gomez and Gomez, 2003). Crop damage caused by Brinjal shoot and fruit borer (BSFB) was measured on the basis of damaged shoots and fruits separately. In order to assess the per cent shoot damage, the damage shoots on five randomly selected tagged plants were counted as against total available shoots on the observed plants. Shoot damage was recorded only in respect of first spray. Fruit damage was recorded after second and third spray. Healthy and infested fruits were measured on the basis of number and weight so as to work out per cent damage. So far as yield of net plot is concerned weight of healthy fruits obtained in first six pickings was collectively considered for judging the treatment effect. The values of mean per cent damage were first transformed to their corresponding arc sine values and then statistically analysed as a RBD. Least significant difference (LSD) was determined at the probability level of 5 per cent to decide the significance of individual treatment effect.

RESULTS AND DISCUSSION

Season long performance of individual test pesticide at different rates against pests of brinjal and cumulative average fruit yield of six pickings in *Kharif* and summer is summarized in Table 1 and 2 respectively. Spinosad afforded moderate control of jassid, whitefly and aphid. However, it was found to be the most effective against BSFB. The lowest, per cent fruit infestation of 13.34 and 13.69 and 7.89 and 8.21 per cent on number and weight basis in *kharif* and summer season respectively was found in spinosad 72 gm a. i. ha^{-1} treated plots. Spinosad at 72 g a.i. ha^{-1} resulted in notable yield of healthy brinjal fruits. The marked increase in healthy fruit yield resulting due to lowest fruit damage was recorded in spinosad 72 gm a. i. ha^{-1} treatment where the maximum marketable brinjal fruit yield of 20.41 t ha^{-1} was recorded. These results are in consistent with Anil and Sharma (2010) wherein, they found that spinosad and emamectin benzoate were effective in suppressing the fruit infestation by BSFB. Dandale *et al.* (2000) reported better control of lepidopteran pests on cotton with spinosad. The efficacy of spinosad against *Heliothis* species is well

Table 1. Overall performance of pesticides on brinjal pests and fruit yield during *kharif* 2005

Treatment	Mean number/plant			Mean Fruit borer infestation (%)		*Mean yield (t/ha)
	Jassids	Whiteflies	Aphids	Number basis	Weight basis	
Spinosad 56.25 g a.i./ha	26.77	2.94	16.26	13.58	13.94	15.31
Spinosad 72 g a.i./ha	25.68	2.78	16.05	13.34	13.69	15.68
Spinosad 90 g a.i./ha	28.80	3.02	16.42	13.69	14.15	15.19
Emamectin benzoate 5 g a.i./ha	12.11	2.28	3.61	13.89	14.41	14.95
Emamectin benzoate 6.25 g a.i./ha	11.70	2.20	3.45	13.74	14.31	15.14
Emamectin benzoate 12.5 g a.i./ha	13.24	2.41	3.84	13.98	14.66	14.46
Cypermethrin 50 g a.i./ha	9.60	2.15	2.95	13.10	13.40	16.30
NSE 5 % crude extract 500 L/ha	40.76	4.94	20.65	20.36	22.52	13.57
Untreated control	44.00	5.73	26.57	27.62	29.77	12.96
S.E. ±	0.310	0.040	0.040	0.395	0.259	0.163
CD at 5 %	0.912**	0.121**	0.121**	1.287**	0.845**	0.489**

* Fruit yield of only six pickings, ** Significant at 5% level

documented (Kharbotli *et al.*, 1999; Brickle *et al.*, 2000; Johnson *et al.*, 2000; Mansoor-ul-Hasan *et al.*, 2001, Vadodaria *et al.*, 2001; Gowda *et al.*, 2006). It has also been found very effective against diamondback moth (Walunj *et al.*, 2001; Tambe and Mote, 2003). Emamectin benzoate, 6.25 g a.i. ha^{-1} proved most effective against jassid, whitefly and aphid with low levels of infestation. In summer season, although the magnitude of jassid population was low, emamectin benzoate at all three rates recorded significantly lower number of jassids in contrast to 20.28 jassids per plant in untreated control. In summer again it resulted as the best treatments in controlling whiteflies and aphids (1.97 to 2.43 and 2.95 to 3.55, respectively). Shoot and fruit borer infestation was comparatively less in emamectin benzoate treated plants and averaged 8.31 to 8.60 and 8.56 to 8.92 per cent fruit damage on number and weight basis, respectively, in *kharif* and 13.74 to 13.98 and 14.31 to 14.66 per cent fruit damage on number and weight basis, respectively in summer. Such results were obtained by Prasad and Devappa (2006), wherein emamectin benzoate at 10 g a.i. ha^{-1} was found to be effective in reducing the dead hearts and fruit damage in brinjal. Nevertheless, the dose of emamectin benzoate used by these workers was higher than 6.25 g a.i. ha^{-1} which showed better control in this study. Emamectin benzoate treatments provided yield to the tune of 14.46 to 15.14 and 19.22 to 19.95 t ha^{-1} in *kharif* and summer respectively. Although, the reports on efficacy of this pesticide are not found on brinjal jassids, most related compound avermectin provided moderate control of jassids on brinjal in West Bengal by Ghosh *et al.* (2004).

NSE (5%) crude extract gave poor control of jassid, whitefly and aphid in both the seasons. Comparatively low yield was recorded in NSE treated plots than other pesticide treatments. Inferior performance of neem based product noticed in the present study was also reported by Mote and Shivu Bhavikatti (2003) in field experiment on brinjal for comparing the efficacy of chemical and non-chemical pesticides against pests of brinjal.

Control of jassid, whitefly and aphid obtained in cypermethrin treated plots was relatively more than that noticed in test pesticides. Cypermethrin resulted as the most effective treatment against BSFB recording 13.10 and 13.40 and 7.70 and 7.97 per cent fruit damage on number and weight basis, in *kharif* and summer respectively. Obviously, high yield was obtained in cypermethrin treated plots when compared with spinosad and other treatments. Such results were also reported in experiments on brinjal conducted by several workers (Agnihotri *et al.*, 1990; Umapathy and Baskaran, 1991; Borad *et al.*, 2002; Duara *et al.*, 2003).

Table 2. Overall performance of pesticides on brinjal pests and fruit yield during summer 2006

Treatment	Mean number/plant			Mean Fruit borer infestation (%)		*Mean yield (t/ha)
	Jassids	Whiteflies	Aphids	Number basis	Weight basis	
Spinosad 56.25 g a.i./ha	14.41	5.32	16.01	8.01	8.24	19.71
Spinosad 72 g a.i./ha	13.97	5.19	15.17	7.89	8.21	20.41
Spinosad 90 g a.i./ha	14.97	5.53	16.38	8.13	8.34	19.09
Emamectin benzoate 5 g a.i./ha	7.20	2.26	3.11	8.41	8.70	19.48
Emamectin benzoate 6.25 g a.i./ha	6.97	1.97	2.95	8.31	8.56	19.95
Emamectin benzoate 12.5 g a.i./ha	7.51	2.43	3.55	8.60	8.92	19.22
Cypermethrin 50 g a.i./ha	6.74	1.84	2.57	7.70	7.97	21.01
NSE 5 % crude extract 500 L/ha	17.01	16.10	18.73	15.51	17.09	16.64
Untreated control	20.28	21.00	25.61	19.67	20.82	14.92
S.E. $\pm$	0.254	0.068	0.317	0.390	0.742	0.388
CD at 5 %	0.762**	0.203**	0.950**	1.271**	2.421**	1.162**

* Fruit yield of only six pickings, ** Significant at 5% level

Lower rates applied to crop may result in better control and longer time periods of protection and also low risk of residues. Judicious use of insecticides during flowering or fruiting stage provides fruits that are acceptable for markets. Feeding damage makes the fruit unacceptable or fruits containing larvae are unfit for export markets. Pesticides may effectively keep fruits free from damage but the requirement of markets for fruits with residues within MRLs had led to have pesticides with short pesticidal persistence and effective at low use rates. The combination of pesticides with short residue persistence, continual infestation throughout the harvest and ability of pest to bore into fruits and feed internally in protected conditions lead to re-infestation of tender fruits. This necessitates further insecticide treatments; therefore, management may need to go beyond foliar sprays. Integration of control measures with biological and chemical control measures is essential to suppress pest populations and simultaneously conserve beneficial organisms. In the present study, spinosad and emamectin benzoate was found to be very effective in controlling the pest of brinjal. Though cypermethrin treated plots recorded maximum yield but was at par with the test compounds i.e. spinosad and emamectin benzoate. Moreover, both the test pesticide has low mammalian toxicity. Spinosad is a naturally derived insecticide produced by fermentation of the bacterium, *Saccharopolyspora spinosa*, it is a rare actinomycete collected from the soil in the Caribbean Island in 1982. Spinosad was characterized in 1988 and consists of a mixture of related spinosyn toxins, principally spinosyn A and D. It has very good contact and stomach activity. It shows no effects on the predatory insects such as lady bird beetles, lacewings, big eyed bugs and shows reduced activity against parasitic wasps and flies. Because of low applicator's risks, it is recommended as an IPM tool (Nowak *et al.*, 2000). Emamectin benzoate is a second generation avermectins. Avermectins represent a novel class of macrocyclic lactones. They are a mixture of natural products produced by a soil actinomycete, *Streptomyces avermitilis*. Emamectin benzoate is a semi-fermented and semi-synthesized pesticides derived from the metabolites produced by *S. avermitilis*. It is a mixture of two homologues viz., emamectin B1a and B1b. Although it is not systemic, possess translaminar movement when applied on crop. From the results, it can be concluded that spinosad and Emamectin benzoate can be included in the IPM on brinjal. Moreover, Seasons long use of a single pesticide is discouraged in most resistance management tactics. Instead, alternating compounds with different modes of action is advocated to delay the resistance in target species. Both test compounds have novel, different modes of action. They fit very well in the IPM strategy of brinjal crop due to their low toxicity to mammals and natural enemies of pests. Spinosad alternated with emamectin benzoate needs to be studied as IPM tool for managing major brinjal pests (jassid, aphid, whitefly and BSFB). Both test pesticides can be considered as an alternative to synthetic pyrethroids on brinjal crop more particularly in the situation where development of resistance to pyrethorids and resurgence of sucking pests was experienced.

REFERENCES

Agnihotri, N. P., Sinha, S. N., Jain, H. K. and Chakraborti, A. K. 1990. Bioefficacy of some synthetic pyrethroids against *Leucinodes orbonalis* and their residues on brinjal. *Indian Journal of Entomology*, **52**(3) : 373-378.

Anil and Sharma, P. C. 2010. Bioefficacy of insecticides against *Leucinodes orbonalis* on brinjal. *Journal of Environmental Biology*, **31:** 399-402.

Borad, P. K., Patel, H. M., Chavda, A. J. and Patel, J. R. 2002. Bioefficacy of endosulfan and cypermethrin mixture against insect pests of brinjal (*Solanum melongena*). *Indian Journal of Agricultural Science*, **72**(11): 685-688.

Brickle, D. S., Tunipseed, S. G. and Sullivan M. J. 2000. Comparison of different chemistries and rates against bollworm in *Bt* and conventional cotton. In: *Proceedings Beltwide Cott. Conf. Nat. Cott. Coun. Memphis*, USA. **2**: 971-975 **PP**.

Chakraborti Sudarshan and Sarkar Pijush Kanti. 2011. Management of *Leucinodes orbonalis* Gunee on eggplants during the rainy season in India. *Journal of Plant Protection Research*, **51** (4): 325-328.

Choudhary, B. 1970. Vegetables. National Book Trust, India, 25-50 **PP**.

Dandale, H. G., Rao, N. G. V., Tikar, S. N. and Nimbalkar, S.A. 2000. Efficacy of spinosad against cotton bollworms in comparison with some synthetic pyrethroids. *Pestology*, **24**(11): 6-10.

Duara, B., Deka, S. C., Baruah, A. A. L. H. and Barman, N. 2003. Bioefficacy of synthetic pyrethroids against brinjal shoot and fruit borer. *Leucinodes orbaonalis* (Guen.). *Pesticide Residues Journal*, **15**(2): 155-156.

Eshwara Reddy and Srinivasa, S. G. 2004. Management of shoot and fruit borer, *Leucindoes orbonalis* (Guen.) in brinjal using botanicals/oils. *Pestology,* **28**: 50-52.

Ghosh, S. K., Laskar, N., Basak, S. N. and Senapati, S. K. 2004. Seasonal fluctuation of *Bemisia tabaci* Genn. on brinjal and field evaluation of some pesticides against *Bemisia tabaci* under terai region of West Bengal. *Environmental Ecology*, **22**(4): 758-762.

Gomez, K. A. and Gomez, A. A. 1984. Statistical Procedures for agricultural Research (2nd edn.), Wiley Interscience Pub. John Wiley and Sons, New York. 680 **P**.

Gowda Sidde, D. K., Yelshetty Suhas, Patil, B.V. and Gopali, J. B. 2006. Field evaluation of newer insecticides against gram pod borer *H. armigera* (Hubner). *Pestology,* **30**(4): 27-29.

Harish D. K., Agasimani, A. K., Imamsaheb S. J. and Patil Satish S. 2011. Growth and yield parameters in brinjal as influenced by organic nutrient management and plant protection conditions. *Research Journal of Agricultural Sciences,* **2**(2): 221-225.

Hemi, M. A. 1955. Effect of borer attach on the vitamin 'C' content of brinjal. *Pakistan Journal of Health,* **4**: 223-224.

Jagginavar S. B., Sunitha N. D., Biradon A. P. 2009. Bioefficacy of flubendiamide 480SC against brinjal fruit and shoot borer, *Leucindoes orbonalis* Guen. *Karnataka Journal of Agricultural Scences,* **22**(3): 712-713.

Johnson, D. R., Lorenz, G. M., Hopkins, J. D. and Page, L. M. 2000. Summary of Tracer performance for bollworm (*Helicoverpa zea*) and tobacco budworm (*Heliothis virescens*) control in Arkansas Cotton 1998-1999. *Special Report Arkansas Agricultural Experimental Station*, No. **198**: 240-244 **PP**.

Kharboutli, M. S., Allen, C. T., Capps, C. Jr., Earnest, L. and Oosterhuis, D. M. 1999. Bollworm and Tobacco budworm control studies. In: *Proceedings of the 1999 Cotton Research Meeting and summaries of cotton research in progress.* Arkansas Agricultural Experiment Station, Arkansas 72701 USA, 209-213 **PP.**

Mansoor, U. L. Hasan, Waqas Wakil and Ahsan Rasool. 2001. Comparative efficacy of some traditional and newly introduced insecticides against *Helicoverpa armigera* on cotton. *Pakistan Journal of Agricultural Sciences,* **38**(3-4): 47-48.

Mote, U. N. and Bhavikatti Shivu. 2003. Efficacy of chemical and non-chemical insecticides against major pests of brinjal in kharif season. *Journal* *of Applied Zoological Researchers*, **14**(1): 54-56.

Natekar, M. G., Samarjit Rai and Agnihotri, N. P. 1987, Bioefficacy of synthetic pyrethroids and their residues in brinjal fruit. *Pestology,* **11:**18-22.

Nowak, J. T., Feltig, C. J., McCravy, K. W. and Berisford, C. W. 2000. Efficacy tests and determination of optimal spray timing value to control Nantucket Pine tip moth. (Lepidoptera: Tortricidae) infestation. *Journal of Economic Entomology,* **93**(6): 1708-1713.

Pareet D. Jyoti. 2006. Biorational approaches for the management of brinjal shoot and fruit borer. *M.Sc. (Agri.) Thesis*, University of Agricultural Sciences, Dharwad, Karnataka, India.

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

Regupathy, A., Palanisamy, S., Chandramohan, N. and Gunathilagaraj, K. 1997. A guide on crop pests. Sooriya Desk Top Publishers, Coimbatore, 264 **P**.

Singh, S., Krishnakumar, S. and Katyal, S. L. 1963, Fruit culture in India. *Indian Council of Agricultural Research,* New Delhi, 412 **P**.

Tambe, A. B. and Mote, U. N. 2003. Effectiveness of new molecules, spinosad 2.5 SC against diamondback moth *Plutella xylostella* L. on cabbage. *Journal of Applied Zoological Researchers,* **14**(1): 44-45.

Umapathy, G. and Baskaran, P. 1991. Bio efficacy of certain synthetic pyrethorids against major pests of brinjal. *Madras agricultural Journal,* **78**(14): 8-10.

Vadodaria, M. P., Patel, U. G., Maisuria, I. M., Patel, C. J. and Patel, R. B. 2001. Bioefficacy of a new insecticide spinosad against bollworm of cotton. *Pestology,* **25**(9): 24-28.

Walunj, A. R., Pawar, S. A. and. Darekar, K. S. 2001. Evaluation of a new molecule spinosad for the control of DBM (*Plutella xylostella* L.) on cabbage. *Pestology*, **25**(9): 56-57.

Aparna Kalawate1[1] and M.D.Dethe[2]

[1]Indian Plywood Industries Research and Training Institute (IPIRTI), P.B.No. 2273, Tumkur Road, Yashwantpur, Bangalore-560022, India.
Phone: 080-30534015; Fax: 080-28396361,
E-mail: aparna_ent@yahoo.co.in
[2]Department of Entomology, MPKV, Rahuri-413 722, Dist. Ahmednagar (Maharashtra). India.

Manuscript history

Received : 07.01.2012

Revised : 07.05.2012

Accepted : 19.05.2012