Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(3): 686-689

Received: 07-03-2017
Accepted: 08-04-2017

AM Parihar
Department of Entomology,
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola,
Maharashtra, India

DB Undirwade
Department of Entomology,
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola,
Maharashtra, India

RM Wadaskar
Department of Entomology,
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola,
Maharashtra, India

Correspondence
AM Parihar
Department of Entomology,
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola,
Maharashtra, India

Studies on persistence of biorationals against diamondback moth, *Plutella xylostella* L

AM Parihar, DB Undirwade and RM Wadaskar

Abstract
The present investigation was conducted to evaluate five different biorationals, *viz*., *Beauveria bassiana* (1.15% WP), *Metarhizium anisopliae* (1.15% WP), *Bacillus thuringiensis* (0.5% WP), Azadirachtin (300 ppm) and Spinosad (45 SC) against *P. xylostella* larvae at Department of Agricultural Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during 2015-16. F. The data on persistence toxicity study was recorded 1, 5, 10 and 14 days after the application of treatment at an interval of 24 hrs up to the adult emergence. Spinosad registered highest persistence toxicity whereas; *Beauveria* and *Metarhizium* revealed lower ability. PT values based trend of different treatments, on the basis of larval mortality was Spinosad (1085.0) > *B. thuringiensis* (612.5) > Azadirachtin (542.5) > *M. anisopliae* (466.7) and > *B. bassiana* (437.5), whereas, on the basis of adult emergence the descending order of persistence was Spinosad (1214.7) > *B. thuringiensis* (802.9) > *B. bassiana* (705.9) > Azadirachtin (679.4) > *M. anisopliae* (607.8).

Keywords: Biorationals, diamondback moth, persistence and toxicity

1. Introduction

India ranks second in production of cauliflower, broccoli (36% of world production) and cabbage (13% of world production) [1]. Cultivators face several biotic and abiotic stresses responsible for reduced productivity of cabbage and cauliflower. Diamondback moth (*Plutella xylostella* Linnaeus) has retained its status as the most destructive member of the insect pest complex [2]. DBM larvae are voracious defoliators with a potential to destroy entire crop, if left uncontrolled [3]. It causes 50-80 per cent annual loss in the marketable yield [4, 5].

Resistance to virtually all major groups of insecticides has been documented [6] in *P. xylostella* with resistance reported against 82 compounds in Arthropod Pesticide Resistance Database [7] often as a result of indiscriminate use of broad-spectrum synthetic insecticides [8]. Factors like the ability of the pest to migrate long distances, high fecundity, short life cycle, absence of effective natural enemies, continuous brassica cultivation and high selection pressure of insecticides has led to the development of resistance to a wide range of insecticides [8, 9].

Biorational would be a key for designing management strategy in a better way for sustained and economically feasible production and would translate into attainment of higher production and productivity in cabbage and cauliflower in a cost effective way. Thus, present investigation was conducted to evaluate five different biorational viz., entomopathogenic fungi such as Beauveria bassiana (1.15% WP) and Metarhizium anisopliae (1.15% WP), Bacillus thuringiensis (0.5% WP), Azadirachtin (300 ppm) and Spinosad (45 SC) against P. xylostella larvae

2. Material and Methods

2.1 Insects

P. xylostella population collected from Akola district in Maharashtra was used for the bioassay during 2015-16. At least 10-12 second instar (3 day old) larvae of *P. xylostella* from the F_1 population were used for the bioassay.

2.2 Biorationals

Beauveria bassiana 1.15% WP @ 4 gL^{-1}, *Metarhizium anisopliae* 1.15% WP @ 4 gL^{-1}, *Bacillus thuringiensis* 0.5% WP @ 2 gL^{-1}, Azadirachtin 300 ppm @ 5 mlL^{-1} and Spinosad 45 SC @ 0.32 mlL^{-1} were evaluated for their persistence and toxicity at the recommended doses.

2.3 Persistent Toxicity Studies

After 30 days of transplanting, the cauliflower plants in the field were subjected to the application of biorationals at recommended dose. The spraying was undertaken during morning hours ensuring complete coverage of the plant with the spray liquid. In control, plain water spray was undertaken. The leaves of the treated and untreated cauliflower plants were plucked at an interval of 1, 5, 10 and 14 days after the application and were placed in bioassay box with their peduncle covered with a moistened cotton swab.

2.4 Bioassays

Second instar larvae of *P. xylostella* were exposed to these treated and untreated leaves and allowed to feed. The set of experiment was replicated twice. The observations on the mortality of the larvae were recorded regularly at an interval of 24 hrs up to 5 days for data on larval mortality whereas, up to 15 days for assessment of toxicity up to adult emergence. Moribund larvae and deformed pupa or adult at any stage of the observation were treated as dead.

2.5 Data Analysis

The mortalities recorded in each treatment were converted to corrected per cent mortalities using Abbott's formula [10] and used for further computation of persistent toxicity (PT) values. PT values refer to the product of average percentage residual toxicity (t) and the period (p) for which toxicity is observed [11]. The average residual toxicity was calculated by adding the values of corrected percentage mortalities at 1, 7, 10 and 14 days of observations and then dividing the total by number of observations [11] delineated as under.

$$\text{Average mortality} = \frac{\text{Corrected mortality}}{\text{No. of observation in mortality}}$$

$$\text{Persistence toxicity} = \frac{\text{Average mortality}}{\text{Period of observation}} \times \text{day in mortality recorded}$$

3. Results

3.1 Persistent toxicity of biorationals against *P. xylostella*

3.1.1 On the basis of larval mortality assessed 5 days after treatment.

The data generated in the laboratory on toxicity and persistence of different treatments against *P. xylostella* (Table 1 and 2) revealed significantly higher mortalities during the first few days after application of the treatments, which further declined as the period advanced. The treatments of Spinosad resulted in 100 per cent mortality of *P. xylostella* when fed with the treated food of first day i.e. 24 hours after the treatments. It was followed by treatments of and *Bacillus thuringiensis,* Azadirachtin and *Metarhizium anisopliae* with 70.0 per cent mortality, whereas, *Beauveria bassiana* registered 70.0 per cent mortality.

The similar trend of results with decreasing larval mortality was recorded in the experiment conducted with treated food after fifth day of the treatments. The maximum mortality of 100 per cent was recorded in the treatments of Spinosad and was followed by *B. thuringiensis* with 60.0 per cent larval mortality, whereas, *B. bassiana, M. anisopliae* and Azadirachtin recorded 45.0 per cent larval mortality.

In case of larvae fed with the treated food, 10 days after application of treatments; larval mortality of 85 per cent was observed due to Spinosad and was followed by the treatments *B. thuringiensis*, Azadirachtin and *B. bassiana*, *M. anisopliae* with 35.0 and 25.0 per cent larval mortality of *P. xylostella,* respectively.

The treatment of Spinosad recorded the highest larval mortality (25.0%) when the larvae were fed with the treated food after 14th day of applications and was followed by the treatments of *B. thuringiensis,* Azadirachtin and *B. bassiana* with 10.0, 5.0 and 5.0 per cent mortality, respectively, whereas, *M. anisopliae* recorded no mortality.

Based on the PT values Spinosad was 2.5 times efficacious than *Beauveria bassiana,* whereas *B. thuringiensis* (1.4 fold), Azadirachtin (1.2 fold), *M. anisopliae* (1.1 fold), efficacious than *Beauveria bassiana* (1.0). Based on the PT values, the descending order of persistence of different treatments was Spinosad (1085.0) > *B. thuringiensis* (612.5) > Azadirachtin (542.5) > *M. anisopliae* (466.7) and > *B. bassiana* (437.5).

3.1.2 On the basis of mortality assessed 15 days after treatment (up to adult emergence).

The effect of biorational treatments on mortality of *P. xylostella* (Table 1 and 3) was assessed on the basis of adult emergence. Similar, to data on larval basis the data generated in the laboratory on toxicity and persistence of different treatments against *P. xylostella* revealed significantly higher mortalities during the first few days after application of the treatments, which further declined as the days advanced.

The treatments of Spinosad and *Bacillus thuringiensis* resulted in 100 per cent mortality of *P. xylostella* larvae when fed with the treated food of first day i.e. 24 hours after the treatments. It was followed by the treatments of *B. bassiana*, Azadirachtin and *M. anisopliae* with 94.1, 94.1 and 82.4 per cent mortality, respectively.

The similar trend of results with decreasing larval mortality was recorded in the experiment conducted with treated food after fifth day of the treatments. The maximum mortality of 100 per cent was recorded due to Spinosad. These treatments were followed by the treatments of *B. thuringiensis*, *B. bassiana, M. anisopliae* and Azadirachtin recording 76.5, 76.5, 58.8 and 52.9 per cent larval mortality, respectively.

In case of larvae fed with the treated food, 10 days after application of treatments; larval mortality of 100 per cent was observed due to Spinosad and was followed by the treatments *B. thuringiensis*, *B. bassiana*, Azadirachtin and *M. anisopliae* recording 47.1, 41.2, 41.2, and 41.2 per cent larval mortality of *P. xylostella,* respectively.

The treatment of Spinosad recorded the highest larval mortality (47.1%) when the larvae were fed with the treated food after 14th day of applications and was followed by the treatments of *B. thuringiensis* and Azadirachtin with 5.9 per cent mortality, whereas, *M. anisopliae* and *B. bassiana* recorded no mortality on food after 14 days of treatment.

Based on the PT values Spinosad was 2.0 times efficacious than *M. anisopliae,* whereas *B. thuringiensis* (1.3 fold), *B. bassiana* (1.2 fold), Azadirachtin (1.1 fold) efficacious than *M. anisopliae* (1.0). Based on the PT values, the descending order of persistence of different treatments was worked out as: Spinosad (1214.7) > *B. thuringiensis* (802.9) > *B. bassiana* (705.9) > Azadirachtin (679.4) > *M. anisopliae* (607.8).

Table 1: Mean Per cent Mortality of *P. xylostella* larvae (upto adult emergence).

Treatment name	Dose	Days after treatment	Observation period (Days)								
			1	2	3	4	5	6	7	12	15
Metarhizium anisopliae (1.15% WP)	4 gm/l	1	0.0	10.0	30.0	50.0	70.0	75.0	75.0	80.0	85.0
		5	0.0	0.0	20.0	35.0	45.0	55.0	55.0	60.0	65.0
		10	0.0	0.0	0.0	15.0	25.0	40.0	40.0	45.0	50.0
		14	0.0	0.0	0.0	0.0	0.0	0.0	10.0	10.0	15.0
Beauveria bassiana (1.15% WP)	4 gm/l	1	0.0	5.0	25.0	45.0	50.0	70.0	85.0	85.0	95.0
		5	0.0	0.0	20.0	30.0	45.0	60.0	65.0	70.0	80.0
		10	0.0	0.0	5.0	15.0	25.0	30.0	40.0	40.0	50.0
		14	0.0	0.0	0.0	0.0	5.0	10.0	10.0	15.0	15.0
Bacillus thuringiensis (0.5% WP)	2 gm/l	1	0.0	15.0	25.0	50.0	70.0	85.0	95.0	100.0	100.0
		5	0.0	10.0	20.0	40.0	60.0	65.0	70.0	75.0	80.0
		10	0.0	0.0	10.0	30.0	35.0	40.0	50.0	50.0	55.0
		14	0.0	0.0	0.0	5.0	10.0	10.0	15.0	20.0	20.0
Azadirachtin (300ppm)	5 ml/l	1	0.0	10.0	35.0	55.0	70.0	75.0	85.0	85.0	95.0
		5	0.0	5.0	20.0	40.0	45.0	50.0	50.0	50.0	60.0
		10	0.0	0.0	10.0	30.0	35.0	40.0	50.0	50.0	50.0
		14	0.0	0.0	0.0	0.0	5.0	10.0	10.0	10.0	20.0
Spinosad (45 SC)	0.32ml/l	1	30.0	70.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
		5	15.0	45.0	70.0	90.0	100.0	100.0	100.0	100.0	100.0
		10	0.0	15.0	40.0	65.0	85.0	100.0	100.0	100.0	100.0
		14	0.0	0.0	15.0	20.0	25.0	30.0	45.0	45.0	55.0
Control			0.0	0.0	0.0	0.0	0.0	0.0	10.0	10.0	15.0

Table 2: Persistent toxicity of different treatments against *P. xylostella* on the basis of larval mortality

Treatment name	Dose	Period of observations (Days)				P	T	PT	RE	ORE
		1	5	10	14					
Metarhizium anisopliae (1.15% WP)	4 gm/l	70.0	45.0	25.0	0.0	10	46.7	466.7	1.1	4
Beauveria bassiana (1.15% WP)	4 gm/l	50.0	45.0	25.0	5.0	14	31.3	437.5	1.0	5
Bacillus thuringiensis (0.5% WP)	2 gm/l	70.0	60.0	35.0	10.0	14	43.8	612.5	1.4	2
Azadirachtin(300 ppm)	5 ml/l	70.0	45.0	35.0	5.0	14	38.8	542.5	1.2	3
Spinosad (45 SC)	0.32ml/l	100.0	100.0	85.0	25.0	14	77.5	1085.0	2.5	1

Table 3: Persistent toxicity of different treatments against *P. xylostella* on the basis of adult emergence

Treatment name	Dose	Period of observations (Days)				P	T	PT	RE	ORE
		1	5	10	14					
Metarhizium anisopliae (1.15% WP)	4 gm/l	82.4	58.8	41.2	0.0	10	60.8	607.8	1.0	5
Beauveria bassiana (1.15% WP)	4 gm/l	94.1	76.5	41.2	0.0	10	70.6	705.9	1.2	3
Bacillus thuringiensis (0.5% WP)	2 gm/l	100.0	76.5	47.1	5.9	14	57.4	802.9	1.3	2
Azadirachtin(300 ppm)	5 ml/l	94.1	52.9	41.2	5.9	14	48.5	679.4	1.1	4
Spinosad (45 SC)	0.32ml/l	100.0	100.0	100.0	47.1	14	86.8	1214.7	2.0	1

P : Period for which toxicity persisted (Days). T: Average residual toxicity (Per cent) PT: Persistence toxicity (Days) RE : Relative Efficacy (= PT value of most efficacious / PT value of least efficacious) ORE : Order of relative efficacy

4. Discussion

Use of pesticides had brought adverse changes in environment as well as the biotic balance, which lead to numerous problems like residues, resurgence and resistance [12]. To overcome these adversaries, use of Biointensive Pest Management System (BIPS) is the need of hour. No doubt insecticides are more effective as compared to biorationals but among the newer and safer chemistries, spinosad and emamectin benzoate were more effective against all instars of diamondback moth [13], whereas, study on bio-efficacy on cabbage under polyhouse condition inferred that Coragen @ 50 ml/ha was the most effective treatment in reducing the infestation of DBM followed by spinosad @ 150 ml/ha.[14] Higher efficacy of spinosad on cauliflower indicating superiority of spinosad [15] was also reported which strongly supports findings of the present study.

In the study on relative toxicity of some insecticides against 3rd instar larvae of *P. xylostella* on cabbage, the order of relative toxicity of insecticides was spinosad > *B.t.* > cartap-hydrochloride > cypermethrin > quinalphos > endosulfan > azadirachtin [16] which corroborates with the present findings on spinosad, *B.t.* and azadirachtin. *B. thuringiensis* formulations Agree and Dipel showed effective control rates of third instars until 10 days after treatment, but on the 15th day, Agree was significantly more efficient than Dipel[12] whereas, present study revealed higher efficacy of Bt on food 5 days after treatment.

Field-cum laboratory study on residual toxicity of five neem based pesticides against third instar larvae of *P. Xylostella,* inferred that Neemazal was the most toxic and persistent pesticide as initially it offered maximum kill of larvae and continued to give mortality even after 10th day of spraying [17] which reflects higher efficacy trend over the present findings. Significantly higher mortalities were recorded during the first few days after application of treatments, which further declined as the days advanced for NSE 5%, Spinosad 45 SC and Azadirachtin 1500 ppm. Spinosad 45 SC was best treatment with 76.38 to 100% larval mortality up to 5 days [18]. Based on the toxicity and persistence, it was observed that the botanicals were more effective than biopesticides which is in line with the present findings.

5. Conclusion
It can be inferred that, though, the biorationals are not as effective as the newer chemistries, but the data reveals their potency to form an alternative for the pest management in cabbage and cauliflower ecosystem in an eco friendly manner.

6. Acknowledgement
Authors are thankful to the Head, Department of Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola for providing necessary facilities.

7. References
1. Vanitha SM, Chaurasia SNS, Singh PM, Naik PS. Vegetable statistics. Technical bulletin no. 51, IIVR, Varanasi. 2013, 250.
2. Srinivasan R, Shelton AM, Collins HL. (Eds). Proceedings of the sixth international workshop on management of the diamondback moth and other crucifer insect pests. Shanhua, Taiwan: AVRDC – The World Vegetable Centre; 2011, 321.
3. Kibata GN. The diamondback moth: a problem pest of brassica crops in Kenya. *In*: Sivapragasam, A., Loke, W.H., Hussan, A.K. & Lim G.S. (Eds.) The management of diamondback moth and other crucifer pests: Proceedings of the third international workshop, october 1996, Kuala Lumpur, Malaysia, Malaysian Agricultural Research Institute. 1997, 47-53.
4. Devjani P, Singh TK. Field density and biology of diamondback moth, *Plutella xylostella* L. (Lepidoptera: Yponomeutidae) on cauliflower in Manipur. Journal of Advanced Zoology. 1999; 20(1):53-55.
5. Ayalew G. Comparison of yield loss on cabbage from diamondback moth, *Plutella xylostella* L. (Lepidoptera: Plutellidae) using two insecticides. Crop Protection. 2006; 25:915-919.
6. Perez CJ, Shelton AM, Derksen RC. Effects of field application technology and *B. thuringiensis* subspecies *kurstarki*-resistant *P. xylostella*. Journal of Economic Entomology. 1995; 88:1113-1119.
7. Anonymous. Arthropod Pesticide Resistance Database. 2012; East Lansing: Michigan State Univ. http://www.pesticideresistance.com/index.php.
8. Furlong MJ, Wright DJ, Dosdall LM. Diamondback moth ecology and management: Problems, progress and prospects. Annual Review of Entomology. 2013; 58:517-541.
9. Talekar NS, Shelton AM. Biology, ecology, and management of the diamondback moth. Annual Review of Entomology. 1993; 38:275-301.
10. Abbott WS. A method of computing the effectiveness of an insecticide. Journal of Economic Entomology. 1925; 18:256-267.
11. Pradhan, S. Strategy of integrated pest control. Indian Journal of Entomology. 1967; 29:105-122.
12. Moraes CP, Foerster LA. Toxicity and residual control of *Plutella xylostella* L. (Lepidoptera: Plutellidae) with *Bacillus thuringiensis* Berliner and insecticides, Ciência Rural, Santa Maria. 2012; 42(8):1335-1340.
13. Rafiq MN. Insecticide resistance in diamondback moth, *Plutella xylostella*. (L.) {Lepidoptera: Plutellidae} and strategies of its management. Unpublished PhD thesis submitted to Department of Entomology, Faculty of Crop and Food Sciences, University of Arid Agriculture, Rawalpindi. Pakistan, 2005.
14. Vaseem M, Singh H, Kaushlendra Kumar, Ali M. Efficacy of newer insecticides against diamondback moth (*Plutella xylostella* Linn.) on cabbage under poly house condition. Journal of Experimental Zoology. 2014; 17(2):487-489.
15. Chauhan SK, Raju SVS, Meena BM, Nagar R, Kirar VS. Meena SC. Bio-efficacy of newer molecular insecticides against diamondback Moth (*Plutella xylostella* L.) on cauliflower. Agriculture for sustainable development. 2014; 2(1):22-26.
16. Singh V, Singh PK, Thakur BS, Sharma Sanjay. Relative toxicity of insecticides against diamondback moth (*Plutella xylostella* L.) in cabbage (*Brassica oleracea* var. *capitata*). Current Advances in Agricultural Sciences. 2014; 6(2):203-204.
17. Yadav N, Kumar Ashok, Yadav Ranjana, Yadav Renu, Kumar Manish. Persistence of different neem based pesticides against diamondback moth, *Plutella xylostella* Linn. International Journal of Plant Protection. 2009; 2(1):17-19.
18. Borkar SL, Sarode SV, Bisane KD. Persistent toxicity of botanicals and biopesticides against *Helicoverpa armigera* (Hubner) in cotton. Indian Journal of Entomology. 2013; 75(2):154-156.