Himachal Journal of Agricultural Research 45(1&2) : 46-50 (2019)

Bioefficacy of newer insecticides against *Plutella xylostella* (L.) infesting cabbage

Namburi Mounica Chowdary* and P.C. Sharma
Department of Entomology
CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176062, India.

*Corresponding author: namburimounica568@gmail.com

Manuscript Received: 24.06.2019; Accepted: 20.07.2019

Abstract

The bioefficacy of newer insecticides against diamondback moth, *Plutella xylostella* (L.) on cabbage was determined. Among different treatments, the per cent reduction of larval population over untreated check was highest in chlorantraniliprole @ 10 g a.i./ha (81.02%), followed by spinosad @ 15 g a.i./ha (78.13%) and indoxacarb @ 40 g a.i./ha (78.02%). The lowest per cent reduction was found in the plots treated with *Bacillus thuringiensis* (45.14%) and azadirachtin (45.52%). Among different treatments highest marketable yield was recorded in chlorantraniliprole (149.92q/ ha) and the lowest marketable yield was observed in azadirachtin (98.1q/ha) and Bt (98.81q/ha). Incremental cost benefit ratio was maximum (1:18.44) in chlorantraniliprole followed by spinosad (1:16.33) and diafenthiuron (1:13.96). The lowest incremental cost benefit ratio was found with novaluron (1:2.48).

Key words: Bioefficacy, insecticides, biopesticides, *Plutella xylostella*, cabbage.

The cabbage (*Brassica oleracea* L. var. *capitata*) is an important cruciferous vegetable crop grown extensively all over the country. During 2017, in India, cabbage was grown over an area of 90.37 lakh ha with 3.99 lakh metric tonnes of production (Anon. 2017a). In Himachal Pradesh, cabbage is being grown in an area of 4093 hectares with production of 1.68 lakh tonnes (Anon. 2017b). Most of the cruciferous vegetables are vulnerable to many insect-pests. Among these, diamondback moth (DBM), *Plutella xylostella* (L.) is the most serious in causing economic losses. In the past 50 years, *P. xylostella* has become one of the most difficult insects in the world to control. Though the moth originated in the Mediterranean area, it has surpassed all the natural barriers and is believed to have become a cosmopolitan pest (Khan *et al.* 1991). It is a major pest on crucifers (Calderon and Hare 1985) and non-cruciferous crops like *Amaranthus viridis* L. (Vastrad 2000). The crop loss due to infestation by the pest in cabbage was estimated to vary from 52 to 100 per cent (Kamala 2006). The excessive dependency on chemical control has led to development of resistance to all major group of insecticides used extensively against *P. xylostella* (Tabashnik *et al.* 1987). The reliance on this single approach has led to ever increasing application rates, decreased effectiveness and eventual breakdown of control efficiency. DBM has developed resistance to as many as 69 insecticides, which is maximum for any other insect-pest (Bills *et al.* 2004). Hence, the present investigations were carried out to evaluate the bioefficacy of newer insecticides against *P. xylostella* on cabbage.

Materials and Methods

The field experiment was laid out at Experimental Farm, Department of Entomology, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur in randomized block design with 10 treatments replicated thrice. Nine insecticides viz., chlorantraniliprole (10 g a.i./ha), cypermethrin (60 g a.i./ha), diafenthiuron (300 g a.i./ha), emamectin benzoate (10 g a.i./ha), indoxacarb (40 g a.i./ha), novaluron (75 g a.i./ha) including three biopesticides, azadirachtin (300 ml/ha), spinosad (15 g a.i./ha) and *Bacillus thuringiensis* (25 g a.i./ha) were selected for the studies. The first application of insecticides and biopesticides was done on appearance of pests on February 28, 2019 using battery operated knapsack sprayer. The second spray was after 15 days of first spray. Larval population count of *P. xylostella* was recorded on 5 tagged plants in each treated plot and untreated check. The observations on larval population were taken after 3, 7 and 14 days of each spray. Per cent reduction/increase (P) over untreated check was worked out by using formula of Fleming and Retnakaran (1985):

$$P = 1 - \left(\frac{\text{Post treatment population in treatment}}{\text{Pretreatment population in treatment}} \times \frac{\text{Pretreatment population in control}}{\text{Post treatment population in control}}\right) \times 100$$

Results and Discussion

The perusal of data presented in table 2 indicated that one day before spray, the larval population of *P. xylostella* varied from 7.07-7.77 larvae per plant in all the treatments. The comparative bioefficacy data of different insecticides and biopesticides in the first spray against diamondback moth are given in table 1.

On third day after first spray, all the insecticides showed significant reduction in larval population and were at par with each other except Bt and azadirachtin. The per cent reduction in larval population was in the range of 58.82 to 93.87%. It was significantly highest in indoxacarb (93.87%) followed by diafenthiuron (92.57%). There was 92.28, 91.13 and 91.06 per cent reduction in spinosad, cypermethrin and chlorantraniliprole, respectively. The lowest reduction in number of larvae was found in Bt (58.82%) followed by azadirachtin (71.52%) which were statistically at par with each other. On seven days after first spray, the per cent reduction of larvae ranged from 84.01% to 47.61%. Plots treated with chlorantraniliprole (84.01%) and indoxacarb (78.81%), being at par with each other, showed highest reduction of larval population followed by spinosad (78.47%), emamectin benzoate (77.02%), diafenthiuron (73.62%), cypermethrin (72.5%) and novaluron (70.02%). The lowest per cent reduction of larvae was found in azadirachtin (47.61%) and Bt (54.12%) treated plots.

After 14 days of spray, highest per cent reduction was found in the plots treated with chlorantraniliprole (58.96%). After chlorantraniliprole, the reduction in larval population followed the order of spinosad (57.45%), indoxacarb (51.46%), emamectin benzoate (39.18%), diafenthiuron (30.73%) and novaluron (19.68%). The lowest per cent reduction was found in plots treated with cypermethrin (0.77%). The other treatments with lowest per cent reduction in larval population were Bt (0.92%) and azadirachtin (2.11%).

The second spray was done after 15 days of first spray and the larval count of 14th day after first spray was taken as pre treatment larval count for the second spray. After 3 days of second spray, the per cent reduction in larval population was highest in chlorantraniliprole (96.83%), followed by indoxacarb (94.83), spinosad (92.08%), cypermethrin (81.53%) and emamectin benzoate (80.96%). The reduction was lowest in Bt (54.79%). After 7 days of second spray, highest per cent reduction was found in chlorantraniliprole (81.14%), whereas lowest per cent reduction was found in azadirachtin (59.63%).

After 14 days of second spray, highest reduction of pest population was found in chlorantraniliprole (74.12%), followed by indoxacarb (69.14%), spinosad (68.88%) and emamectin benzoate (55.14%). The lowest per cent reduction in larval population was observed in azadirachtin (33.34%) followed by Bt (41.92%), cypermethrin (44.22%), novaluron (50.48%) and diafenthiuron (52.88%).

Significant differences were found among the various treatments and all the insecticidal treatments were found superior over untreated check on the basis of mean of two sprays. The highest per cent reduction was found in the plots treated with chlorantraniliprole (81.02%) which was closely followed by spinosad (78.13%), indoxacarb (78.02%), being at par with each other. The next insecticides were emamectin benzoate (69.15%), diafenthiuron (66.98%), novaluron (62.82%) and cypermethrin (59.48%). Whereas the lowest per cent reduction was found in plots treated with Bt (45.14%) and azadirachtin (45.52%), being statistically at par.

The present findings are similar to the results of Vaseem *et al.* (2014) who observed that on cabbage under polyhouse condition, chlorantraniliprole @ 50 ml/ha was best treatment against *P. xylostella* followed by spinosad @ 150 ml/ha and indoxacarb @ 230 ml/ha. The present findings are also supported by the results of the studies conducted by Sahu *et al.* (2018) which revealed that, among all the treatments chlorantraniliprole 20 SC @ 40 g a.i./ ha was the most effective insecticide in reducing the *P. xylostella* larval population, damage intensity and increasing the head yield. Hannig *et al*. (2009) and Zhen-di *et al*. (2014) also stated that chlorantranilipole was effective against *P. xylostella.* Jat *et al.* (2017) observed that among different biopesticides like spinosad, Bt and SlNPV against *Spodoptera litura* in cabbage, the treatment comprising of Btk (Dipel 8L) was least effective with minimum reduction of larval population (55.24 to 56.09%). Devi and Tayde (2017) tested some bioagents (*Bacillus thuringiensis* and *Beauveria bassiana*) and botanicals (NSKE, tobacco, *Dhatura* and *Lantana camera*). They observed the highest per cent reduction of diamondback moth larvae in cabbage with *B. thuringiensis* (61.22%). Reddy *et al*. (2018) reported that among spinosad, lufenuron, fipronil, emamectin benzoate, chlorpyrifos, novaluron, indoxacarb and azadirachtin, spinosad ranked first in efficacy with a reduction of 58.82% over check and azadirachtin showed least efficacy with per cent reduction of 32.01% only.

Data presented in the table 2 revealed that among different treatments, highest marketable yield (q/ha) was recorded in chlorantraniliprole (149.92q) followed by indoxacarb (136.27q), spinosad (137.48q), emamectin benzoate (126.51q), diafenthiuron (121.46q), novaluron (116.19q) and cypermethrin (105.33q). The lowest marketable yield (q/ha) was observed in untreated check (91.85q), followed by azadirachtin (98.1q) and Bt (98.81q). Incremental Cost benefit ratio was maximum (1:18.44) in chlorantraniliprole followed by spinosad (1:16.33), diafenthiuron (1:13.96) and indoxacarb (1:11.52). The lowest cost benefit ratio was found with novaluron (1:2.48). Highest marketable yields of cabbage and cost benefit ratios were also reported by Nikam *et al.* (2014), Narendra (2017) and Sawant and Patil (2018) in chlorantraniliprole treated plots. Sawant and Patil (2018) reported a cost benefit ratio of 1:16.40 for chlorantraniliprole in cabbage. Among other bioagents like Bt, *Beauveria bassiana*, neem, tobacco, *Datura* and *L. camera* applied against DBM on cabbage, Devi and Tayde (2017) reported highest cost benefit ratio (1:6.90) for NSKE which also corroborate the present findings.

Table 1. Effect of different insecticides on per cent reduction of *P. xylostella* larvae during rabi 2018-19

Treatment	Concentration (%)	1DBS	Per cent reduction of larvae after indicated days of spray						
			First spray			Second spray			Mean
			3DAS	7DAS	14DAS	3DAS	7DAS	14DAS	
Chlorantraniliprole	0.002	7.13	91.06 (72.97)	84.01 (66.42)	58.96 (50.21)	96.83 (81.80)	81.14 (64.32)	74.12 (59.67)	81.02 (64.16)
Cypermethrin	0.01	7.20	91.13 (73.43)	72.50 (58.51)	0.77 (5.00)	81.53 (64.76)	66.75 (54.83)	44.22 (41.58)	59.48 (50.47)
Diafenthiuron	0.05	7.07	92.57 (74.19)	73.62 (59.13)	30.73 (33.47)	79.58 (64.28)	72.49 (58.50)	52.88 (46.71)	66.98 (54.92)
Emamectin benzoate	0.002	7.13	84.75 (67.63)	77.02 (61.37)	39.18 (38.71)	80.96 (64.33)	77.84 (62.55)	55.14 (47.93)	69.15 (56.26)
Indoxacarb	0.015	7.47	93.87 (76.40)	78.81 (62.62)	51.46 (45.82)	94.83 (79.40)	79.99 (63.46)	69.14 (56.24)	78.02 (62.02)
Novaluron	0.01	7.17	90.81 (72.91)	70.02 (56.82)	19.68 (26.20)	75.41 (60.47)	70.55 (57.13)	50.48 (45.26)	62.82 (52.42)
Azadirachtin	0.00015	7.67	71.52 (57.73)	47.61 (43.60)	2.11 (8.17)	58.90 (50.11)	59.63 (50.53)	33.34 (35.02)	45.52 (42.41)
Spinosad	0.003	7.10	92.28 (75.00)	78.47 (62.36)	57.45 (49.31)	92.08 (77.00)	79.63 (63.22)	68.88 (56.10)	78.13 (62.10)
Bacillus thuringiensis	0.0005	7.77	58.82 (50.38)	54.12 (47.35)	0.92 (4.74)	54.79 (48.02)	60.29 (50.97)	41.92 (40.08)	45.14 (42.16)
CD (P=0.05)		NS	(8.71)	(4.98)	(7.38)	(14.97)	(7.41)	(10.87)	(4.35)
SE mean±		0.91	(2.89)	(1.65)	(2.44)	(4.95)	(2.45)	(3.60)	(1.44)

Figures in the parentheses are arc sin transformed values; 1DBS= One day before spray; DAS= Days after spray; NS= Non-significant

Table 2. Economics of different insecticides in cabbage during 2018-19

Treatment	Yield (q/ha)	Increase in yield over untreated check (q/ha)	Cost of insecticides for 2 sprays (Rs./ha)	Labour charges for 2 sprays (Rs./ha)	Total cost of plant protection per ha	Value of additional yield over untreated check (Rs./ha)	Incremental benefit (Rs./ha)	I.C.B.R.	Rank
Chlorantraniliprole	149.92	58.07	2086	900	2986	58074	55587	1:18.44	1
Spinosad	137.48	45.63	1733	900	2633	45632	43499	1:16.33	2
Diafenthiuron	121.46	29.61	1080	900	1980	29615	28135	1:13.96	3
Cypermethrin	105.33	13.48	480	900	1380	13481	12601	1:8.77	4
Indoxacarb	136.27	44.42	2648	900	3548	44424	41375	1:11.52	5
Emamectin benzoate	126.52	34.67	2400	900	3300	34667	31867	1:9.5	6
Azadirachtin	98.11	6.25	345	900	1245	6255	5510	1:4.02	7
Bacillus thuringiensis	98.81	6.96	900	900	1800	6963	5663	1:2.87	8
Novaluron	116.19	24.34	6090	900	6990	24341	17851	1:2.48	9
Untreated check	91.85	-	-	-	-	-	-	-	–

I.C.B.R.: Incremental cost benefit ratio

Cost of insecticides (per litre or kg): Chlorantraniliprole: Rs. 1930, Cypermethrin: Rs. 400, Diafenthiuron: Rs. 900, Emamectin benzoate: Rs. 6000, Indoxacarb: Rs. 4800, Novaluron: Rs. 4060, Azadirachtin: Rs. 575, Spinosad: Rs. 26000, *Bacillus thuringiensis*: Rs.1440; Labour required for each spray: 2; Labour charges for each spray: Rs. 450

Sale price of cabbage: Rs. 1000 per quintal

Conclusion

Chlorantraniliprole proved highly effective in reducing the larval population along with higher cost-benefit ratio, whereas, among different biopesticides, spinosad showed best results in controlling *P. xylostella* larvae compared to azadirachtin and Bt.

References

Anonymous 2017a. www.agricoop.nic.in (3.05.2019).

Anonymous 2017b. Department of Agriculture, Shimla, Himachal Pradesh.

Bills PS, Sanchez DM and Whalon M. 2004. Resistance Database, http:// www. cips. msu. edu/ resistance /rmdb

Calderon JI and Hare CJ. 1986. Control of diamondback moth in South East Asia by profenofos. In: Diamondback moth management (eds) Talekar NS and Griggs TD, Proc. First International Workshop, AVRDC, Taiwan, 289-295.

Devi HD and Tayde AR. 2017. Comparative efficacy of bio-agents and botanicals on the management of diamondback moth (*Plutella xylostella* Linn.) on cabbage under Allahabad agroclimatic conditions. International Journal of Current Microbiology and Applied Sciences **6** (7): 711-716.

Fleming R and Retanakaran A. 1985. Evaluating single treatment data formula with reference to insecticides. Journal of Economic Entomology **78**: 1179-1181.

Hannig GT, Ziegler M and Marçon PG. 2009. Feeding cessation effects of chlorantraniliprole, a new anthranilic diamide insecticide, in comparison with several insecticides in distinct chemical classes and mode of action groups. Pest Management Science **65** (9): 969-974.

Jat GC, Swaminathan R, Yadav PC, Swati, Deshwal HL, Choudhary S and Yadav SK. 2017. Relative efficacy and economics of bio-pesticides against *Spodoptera litura* (Fab.) on cabbage. International Journal of Current Microbiology and Applied Sciences **6** (6): 1853-1866.

Kamala NV. 2006. Investigations on natural enemies of diamondback moth, *Plutella xylostella* L. (Lepidoptera: Yponomeutidae) with special emphasis on life history traits of

Trichogrammatids. Ph.D. Thesis, University of Agricultural Sciences, Bangalore.

Khan KH, Nagaraj GN and Srinivas RSY. 1991. Integrated pest management demonstrations in cabbage. Plant Protection Bulletin **43**: 11-13.

Narendra PK. 2017. Bioefficacy of newly evolved novel insecticides against cabbage pests. M.Sc. (Agri.) Thesis, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.), India.

Nikam TA, Chandele AG, Gade RS and Gaikwad SM. 2014. Efficacy of chemical insecticides against diamondback moth, *Plutella xylostella* L. on cabbage under field condition. Trends in Biosciences **7** (12): 1196-1199.

Reddy MS, Sathua SK, Sulagitti Arjun and Singh NN. 2018. Bio-efficacy of different novel insecticides and their interaction between numbers of sprays against diamondback moth (*Plutella xylostella* L.) infesting cabbage. Journal of Entomological Research **42** (1): 51-56.

Sahu JK, Upadhayay D, Singh V and Jha B. 2018. Efficacy of different insecticides against diamondback moth, *Plutella xylostella* Linn. on cabbage. International Journal of Current Microbiology and Applied Sciences **7**: 3251-3258.

Sawant CG and Patil CS. 2018. Boi-efficacy of newer insecticides against diamondback moth (*Plutella xylostella* Linn.) in cabbage at farmer's field. International Journal of Current Microbiology and Applied Sciences **7** (7): 2986-2998

Tabashnik BE, Cushing NL, Johnson MW. 1987. Diamondback moth (Lepidoptera: Plutellidae) resistance to insecticides in Hawaii: intra-island variation and cross resistance. Journal of Economic Entomology **80**: 1091-1099.

Vaseem M, Singh H, Kumar K, Ali M. 2014. Efficacy of newer insecticides against diamondback moth (*Plutella xylostella* Linn.) on cabbage under poly house condition. Journal of Experimental Zoology **17** (2): 487-489

Vastrad AS. 2000. Insecticide resistance in diamondback moth, *Plutella xylostella* L. and its management. Ph.D. Thesis, University of Agricultural Sciences, Dharwad.

Zhen-di HU, Xia F, Qing-shen L, Huan-yu C, Zhen-yu L, Fei Y, Pei L and Xiwu G. 2014. Biochemical mechanism of chlorantraniliprole resistance in the diamondback moth, *Plutella xylostella* Linn. Journal of Integrative Agriculture **8** (2): 205-20.