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Bioefficacy of biological-based insecticides against diamondback moth (*Plutella xylostella*) on cabbage (*Brassica oleracea*)

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The diamondback moth, *Plutella xylostella* (Linn.) (Lepidoptera: Plutellidae), is the most destructive pest of crucifers throughout the world, and is reported to cause more than 90% crop loss (Sarfraz *et al*. 2005) under favourable conditions. In India, it is considered to be the most devastating pest of the cruciferous vegetables as it has assumed the pest status of national importance (Shanker and Raju 2002). In Himachal Pradesh also, the pest is a limiting factor in the production of cruciferous vegetables, particularly cabbage. The exceptional pest status of *P. xylostella* in most parts of the world is due to the diversity and abundance of host plants, the lack or absence of its natural enemies, especially of parasitoids, its ability to migrate to long distances, high rate of fecundity and genetic elasticity facilitating rapid development of resistance to chemical insecticides (Vickers *et al.* 2004).

Therefore, the widespread use of synthetic insecticides on high value crucifer crops has resulted in high level of resistance in *P. xylostella* populations (Khan *et al.* 2008). This has promoted evaluation of alternative pest management strategies mainly biological and cultural (Abdel-Razek *et al*. 2006). Therefore, a study was conducted to evaluate the efficacy of microbial based insecticides with different modes of action for controlling diamondback moth on cabbage.

The present investigations on the bioefficacy of eco-friendly pesticides against diamondback, *P. xylostella* on cabbage (*Brassica oleracea* L. var. *capitata*) in mid hills of Himachal Pradesh were carried out in experimental farm (1 500 above mean sea level.) of the Department of Entomology and Apiculture of the University, Solan, during cropping season of 2005–06. Field trials were laid out in randomized block design. Cabbage variety, 'Pride of India' was transplanted on 9 November 2005. The crop was raised as per package of practices recommended by the University (Yspuhf 2003).The field trial was carried out to test the effectiveness of four biopesticides, viz azadirachtin (Nimbecidine® 300 ppm) @ 2 ml/litre, *Btk* (Halt® 55 000 SU) @ 1 g/litre, spinosad (Spintor® 45 SC) @ 0.33 ml/litre and formulation of *Verticillium lecanii* (Ecocill® 10^8 cfu/g) @ 8×10^{12} conidia/g to manage *P. xylostella*. All the 4 treatments along with control were replicated thrice. Two sprays were carried out at a 15– day interval (27 March and 10 April 2006) in the evening hours by knapsack sprayer. The emulsifying agent Triton X-100 @ 0.02% was added to spray solution (final volume @1 000 Litre/ha). Pre-treatment larval counts of target insects were made on 10 randomly selected plants in each plot including control, whereas post-treatment larval counts were made 4 and 10 days after each spray in all the treatments as well as in control.

Data regarding the efficacy of biopesticides, viz azadirachtin (Nimbecidine® 300ppm @ 2 ml/l), *Btk* (Halt® 55 000 SU @ 1 g/l), *V. lecanii* (Ecocill® 10^8cfu @ 8x 10^{12} conidia/g) and spinosad (Spintor® 45 SC @ 0.33 ml/l) against diamondback, *P. xylostella* on cabbage are presented in the Table 1. It is evident from the Table that the overall efficacy of insecticides against *P. xylostella* that all the treatments were significantly superior to the control. The perusal of data indicated that azadirachtin 0.6 ppm which recorded 1.57 and 0.6 larvae/plant after first and second spray, respectively, proved least effective, followed by *V. lecanii* @ 8×10^{12} conidia/g with mean number of 1.28 and 0.53 larvae/plant. The lowest mean population of 0.97 and 0.21 larvae/plant was recorded in the spray of spinosad 0.015% which was statistically at par with spray of *Btk* 0.1% with mean larval

*Short note

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Table 1 Efficacy of biopesticides against the diamondback moth *(Plutella xylostella*) on cabbage under field conditions

Treatment	Dose/l	Mean number of pest larvae/plant (mean of 3 replications)								Overall mean
		First spray				Second spray				
		Pre-treatment count	4 DAS	10 DAS	Mean	Pre-treatment count	4 DAS	10 DAS	Mean	
Azadirachtin (Nimbecidine® 300 ppm)	2 ml	3.57	1.83 (1.35)	1.30 (1.14)	1.57 (1.25)	1.37	0.63 (0.79)	0.37 (0.6)	0.60 (0.69)	1.03 (0.97)
Btk (Halt® 5 WP 55000 SU)	1g	3.87	1.30 (1.14)	0.97 (0.97)	1.08 (1.03)	1.23	0.43 (0.65)	0.20 (0.44)	0.32 (0.55)	0.70 (0.79)
Spinosad (Spintor® 45 SC)	0.33 ml	3.57	1.17 (1.08)	0.77 (0.87)	0.97 (0.97)	0.90	0.30 (0.54)	0.13 (0.35)	0.21 (0.45)	0.50 (0.7)
Verticillium lecanii (Ecocill® 10^8 c f u)	80 g	3.93	1.43 (1.19)	1.13 (1.06)	1.28 (1.13)	1.30	0.63 (0.79)	0.43 (0.64)	0.53 (0.72)	0.90 (0.92)
Untreated check		3.53	3.63 (1.91)	3.93 (1.98)	3.78 (1.94)	4.10	4.23 (2.06)	4.40 (2.09)	4.32 (2.08)	4.05 (2.01)
Mean		3.69	1.87 (1.33)	1.62 (1.20)	1.74 (1.3)	1.78	1.25 (0.97)	1.11 (0.83)	1.18 (0.89)	

	Pre-treatment Treatment (T)		Spray (S)	Date (D)	
	1st	2nd			
SEM±	0.35	0.15	0.03	0.02	0.022
CD (*P*= 0.05)	0.80	0.34	0.069	0.044	0.44

DAS, Days after spray; Figures in parentheses are square root transformed values

count of 1.08 and 0.32 larvae/plant after first and second spray, respectively. In comparison, the mean larval populations of 3.78 and 4.32/plant were recorded in control. Overall mean larval population of 0.50 larvae/plant was recorded in spinosad which was statistically at par with *Btk* which recorded 0.70 larvae/plant. However *V. lecanii* recorded 0.90 larvae/plant which is at par with azadirachtin 0.6 ppm which recorded overall mean population of 1.03 larvae/plant and were least effective in the management of *P. xylostella* (Table 1).

The present observations with regard to superiority of spinosad and *Btk* in management of *P. xylostella* are in conformity with those of Ram *et al*. (2001), Pramnik and Chatterjee (2003) and Mallareddy *et al*. (2004). High mortality of diamondback moth due to spinosad and *Btk* can be attributed to different mode of action of these insecticides than conventional ones. Successful control of diamondback moth with *Btk* formulations Dipel and Delfin (0.075%) was reported by Malathi *et al.* (1999) and Khan *et al*. (2008).

Poor efficacy of Nimbecidine in the present investigation is in close conformity with the reports of Malathi *et al.* (1999) who reported only 26.87% reduction of diamondback moth.

Among all, spinosad 0.015% recorded maximum per cent reduction (78.0%) in the population of *P. xylostella,* followed by *Btk* 0.1% (74.0%). Thus, on the basis of predominance of the pest and availability of the biopesticide, choice can be made between these two chemicals and could be used alternatively with each other for getting desired control of *P. xylostella* and profitable yields.

SUMMARY

Studies on the bio-efficacy of some eco-friendly insecticides, viz azadirachtin (Nimbecidine® 300ppm @ 2 ml/l), *Btk* (Halt® 55 000 SU @ 1 g/l), *Verticillium lecanii* (Ecocill® 10^8cfu @ 8x 10^{12} conidia/g) and spinosad (Spintor® 45 SC @ 0.33 ml/l) against diamondback moth [*Plutella xylostella* (L.)] on cabbage were carried at the experimental farm of University, Nauni, Solan (Himachal Pradesh), during the cropping season of 2005–06. The results revealed that overall efficacy of all the insecticides were significantly superior to the control. Spinosad was most effective against *P. xylostella* which recorded overall mean population of only 0.55 larvae/plant, followed by *Btk* with 0.70 larvae/plant. However, *V. lecanii* and azadirachtin were found to be least effective in controlling the target pest. Thus, on the basis of availability of spinosad and *Btk*, both could be used alternatively with each other for getting desired control of *P. xylostella*.

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