Himachal Journal of Agricultural Research Vol. 32(2) : 61-66, 2006

Field evaluation of some biopesticides and insecticides against *Helicoverpa armigera* (Hübner) on spring potato

Aditi Badiyala and D. C. Sharma
Department of Entomology
CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur- 176 062.

Abstract

Field experiments on potato were conducted during spring 2002 and 2003 at Palampur and Malan, district Kangra (H.P.) to test the efficacy and persistence toxicity of biopesticides and organic manures with insecticides against *Helicoverpa armigera* (Hübner). The two-year data at two locations revealed that all the treatments were significantly superior over control among which synthetic pyrethroids, viz. lambda cyhalothrin (0.25 Lha^{-1}) and cypermethrin (0.30 Lha^{-1}) were more effective in reducing the larval population and were significantly at par with each other, followed by *Bacillus thuringiensis* (2.25 Lha^{-1}) and the mixture of cypermethrin + *Beauveria bassiana* (0.15 L+1.125 kg ha^{-1}) both being statistically on par. Other compounds, viz. chlorpyriphos, organic manures (Vikas, Vipul), *B. bassiana* and Achook were statistically superior over untreated check in suppressing *H. armigera* population but proved less effective than the rest. The persistence toxicity data revealed that cypermethrin had the highest (1038.97) persistence toxicity (PT: 14 days) followed by lambda cyhalothrin (1001.78), cypermethrin + *B. bassiana* (777.76), *B. thuringiensis* (740.46), *B. bassiana* (560.11) and Achook (268.33).

Introduction

Potato (*Solanum tuberosum* L.), a short duration crop, being nutritionally superior and capable of producing high amount of food per unit area and time, has a great potential in modern agriculture (Khurana, 2002). In developing countries like India, with large population to feed, potato is perhaps one of the best alternatives to meet the growing food needs. Being a cash crop of Himachal Pradesh, potato commands high preference with the farming community of the state but the average yield is only 91 quintals per hectare (Anonymous, 2000a). One of the major constraints in potato production is the attack of a large number of insect-pests, which cause economic losses to crop both in field as well as in storage. Among the various insect-pests, *Helicoverpa armigera* (Hübner) is an important pest of potato crop in Kangra valley of the state. The caterpillars start attacking the crop during March-April and continue feeding on potato foliage throughout the growth period. In certain years, under favourable conditions, the pest becomes an important limiting factor in potato cultivation when the caterpillars eat up all the green matter (Mishra, 1993), adversely affecting growth of the crop which ultimately results in the production of under-sized tubers and reduction in yield. A number of synthetic chemicals have proved effective against this pest but keeping in view their toxicity hazards and development of resistance, it is imperative to evaluate comparatively safer compounds on this crop. The present studies were, therefore, undertaken to evaluate the efficacy of some organic products, biopesticides and insecticides against *H. armigera* in potato crop under the climatic conditions prevailing in Kangra district of Himachal Pradesh.

Material and Methods

Potato (variety Kufri Jyoti) crop was raised in the experimental farm of the department of Entomology of the university at Palampur and farmer's fields, Malan at an elevations of 1290 and 950 amsl, respectively, as per the recommended package of practices (Anonymous, 2000b) during spring season of 2002 and 2003. The crop was sown in the third week of December at Malan and first week of January at Palampur. The experiment was conducted in randomized block design comprising ten treatments including an untreated control and each treatment was replicated thrice in a plot of 5m x 4m size at Palampur and 5m x 3m at Malan. Three insecticides, viz. chlorpyriphos (Dursban 20EC ; 2.0 L ha^{-1}), lambda

cyhalothrin (Karate 5EC; 0.25 L ha^{-1}), cypermethrin (Cybil 25 EC ; 0.30 L ha^{-1}), two microbial insecticides *viz. Bacillus thuringiensis* (Dipel 8L; 2.25 L ha^{-1}), and *Beauveria bassiana* (Daman; 2.25 kg ha^{-1}), a tank mixed combination of cypermethrin (Cybil 25 EC ; 0.15 L ha^{-1}) + *B. bassiana* (Daman; 1.125 kg ha^{-1}) at half their recommended concentration, a commercially available neem based product, Achook (1500 ppm Azadirachtin; 2.25 L ha^{-1}), a neem + castor based organic manure i.e. Vikas (450 kg ha^{-1}) and neem based organic manure, Vipul (450 kg ha^{-1}) were tested against *H. armigera* larvae infesting spring potato. The control plots were sprayed with water only. Chlorpyriphos, Vikas and Vipul were applied in the soil twice, first at the time of sowing and second at earthing up. Whereas, Achook, *B. thuringiensis*, *B. bassiana*, lambda cyhalothrin, cypermethrin and cypermethrin + *B. bassiana* were applied on the foliage twice, first at the time of earthing up and second at an interval of 14 days. The incidence of *H. armigera* was recorded by selecting three plants per plot at random and counting the number of larvae per plant before application and 7 and 14 days after first as well as second application. The data were converted to percentage reduction in larval population over control by using Abbott's formula (Abbott, 1925) as modified by Fleming and Retnakaran (1985).

Per cent reduction in larval population over control=

$$\left\{1-\left[\frac{\text{Posttreatment population in treatment}}{\text{Pre treatment population in treatment}}\right]\times\left[\frac{\text{Pre treatment population in control}}{\text{Post treatment population in control}}\right]\right\}\times 100$$

The persistence toxicity was determined by collecting the leaf samples at random from the sprayed plots and bringing to laboratory and neonate larvae of *H. armigera* (15 per treatment, replicated thrice), reared under laboratory conditions were released on treated leaves in Petri plates and kept in incubator at 27±1°C temperature and 85-90 per cent relative humidity. Larval mortality was recorded after 24 and 72 hours in case of insecticides and biopesticides, respectively. Relative persistence toxicity values were calculated as per the method given by Pradhan (1967) as follows:

Relative efficacy = P x T

where, P= period for which the toxicity persisted and T= average residual toxicity, which was calculated by adding values of per cent mortality at different intervals and dividing by total number of observations.

Results and Discussion

Field efficacy of insecticides and biopesticides on H. armigera larvae

During the year 2002, the pre-application larval population at both the locations was homogenously distributed and varied between 1.00 and 1.22 per plant at Palampur and 2.11 to 2.22 per plant at Malan. Post treatment count after 7 days revealed that all the treatments were significantly superior over control. Spray with lambda cyhalothrin and cypermethrin gave 100 per cent reduction in larval population at both the locations, significantly superior over other treatments. These were followed by *B. thuringiensis* (81.23 and 84.04 % reduction in larval count) and cypermethrin + *B. bassiana* (81.23 and 81.68 %), both on par statistically at Palampur and Malan, respectively (Table 1). Reduction in larval population was less in case of Achook (65.44 and 67.77%) and *B. bassiana* (65.44 and 76.18%). In general, the soil treatments proved less effective than foliar treatments. The maximum reduction in larval count was obtained in soil treatment with chlorpyriphos (56.25 and 52.36%) followed by Vikas and Vipul at Palampur and Malan, respectively. Again the synthetic pyrethroids gave the highest reduction in larval population on 14 days i.e. 96.41 and 93.37 per cent in cypermethrin and 95.30 and 91.64 per cent in lambda cyhalothrin, followed by *B. thuringiensis* (71.62 and 77.99 %) and cypermethrin + *B. bassiana* (68.25 and 79.90 %) at the respective locations both being on par statistically. However, *B. bassiana* and Achook showed lower reduction in larval population. After 14 days, soil treatments proved less effective (Table 1). In the second spray, 100 per cent larval reduction was observed in cypermethrin and lambda cyhalothrin, whereas, *B. thuringiensis* (89.35 and 82.20%) and cypermethrin + *B. bassiana* (85.30 and 82.20%) were statistically on par after 7 days at Palampur and Malan, respectively. Rest of the treatments proved less effective. After 14 days, cypermethrin registered 100 per cent larval mortality

Table 1. Effect of biopesticides and insecticides on *H. armigera* larval population in spring potato (2002)

Treatment	App.rate (ha^{-1})	Pre-application larval population/plant		% reduction in larval population over control at different days after application*								Yield (q/ha)	
				7 day		14 day&		21 dayx		28 day@			
		Palampur	Malan	Palampur	Malan	Palampur	Malan	Palampur	Malan	Palampur	Malan	Palampur	Malan
Chlorpyriphos[a]	2.0 L	1.11 (1.27)$	2.11 (1.62)	56.25 (48.60)#	52.36 (46.33)	47.89 (43.77)	39.69 (39.01)	34.64 (36.03)	39.13 (38.67)	17.29 (24.51)	23.59 (29.00)	97.00	186.53
Vikas[a]	450 kg	1.11 (1.27)	2.11 (1.62)	47.05 (43.26)	44.50 (41.82)	37.65 (37.75)	30.66 (33.47)	27.33 (31.44)	24.74 (29.70)	13.57 (21.60)	10.90 (18.61)	86.72	175.51
Vipul[a]	450 kg	1.22 (1.31)	2.11 (1.62)	47.05 (43.26)	39.23 (38.74)	36.54 (37.16)	24.22 (29.45)	24.01 (29.33)	21.44 (27.57)	0.00 (3.29)	0.00 (3.29)	88.91	179.78
Achook[f]	2.25 L	1.22 (1.31)	2.22 (1.65)	65.44 (53.98)	67.77 (55.46)	59.30 (50.34)	57.80 (49.47)	68.37 (55.80)	69.30 (56.34)	53.49 (46.99)	66.02 (54.33)	98.85	189.85
Bacillus thuringiensis[f]	2.25 L	1.11 (1.27)	2.11 (1.62)	81.23 (67.62)	84.04 (86.44)	71.62 (57.79)	77.90 (61.94)	89.35 (73.33)	82.20 (65.24)	87.44 (71.84)	78.18 (62.32)	111.91	210.34
Beauveria bassiana[f]	2.25 kg	1.22 (1.31)	2.11 (1.62)	65.44 (53.98)	76.18 (60.78)	63.78 (53.06)	68.80 (56.04)	72.54 (58.88)	75.16 (60.12)	63.88 (53.08)	66.17 (54.42)	102.23	197.39
Lambda cyhalothrin[f]	0.25 L	1.00 (1.22)	2.22 (1.65)	100.0 (86.67)	100.0 (86.67)	95.30 (80.60)	91.64 (73.36)	100.0 (86.67)	100.0 (86.67)	92.67 (78.61)	100.0 (86.67)	131.57	226.94
Cypermethrin[f]	0.30 L	1.22 (1.31)	2.11 (1.62)	100.0 (86.67)	100.0 (86.67)	96.41 (81.59)	93.37 (75.05)	100.0 (86.67)	100.0 (86.67)	100.0 (86.67)	100.0 (86.67)	134.92	231.87
Cypermethrin + *B. bassiana*[f]	0.15L+ 1.125 kg	1.11 (1.27)	2.11 (1.62)	81.23 (67.62)	81.68 (64.67)	68.25 (55.77)	79.90 (63.35)	85.30 (67.53)	82.20 (65.24)	80.44 (63.77)	82.39 (65.18)	109.06	207.65
Control	-	-	-	-	-	-	-	-	-	-	-	64.33	121.13
CD (P=0.05)		(NS)	(NS)	(13.40)	(3.95)	(9.69)	(4.59)	(7.87)	(5.49)	(10.45)	(4.72)	(4.11)	(5.75)

*Mean of 3 replications
[a] Applied in soil
#Figures in parentheses indicate arc sine transformed values
$ Figures in parentheses indicate $\sqrt{x} + 0.5$ transformed values
& on 14th day second spray made after taking observations
[f] Applied on foliage
x 7th day of second foliar application
@ 14th day of second foliar application

at Palampur and Malan and lambda cyhalothrin, 92.67 and 100 per cent reduction followed by *B. thuringiensis* (87.44 and 78.18%), cypermethrin + *B. bassiana* (80.44 and 82.39%), *B. bassiana* (63.88 and 66.17%), Achook (53.49 and 66.02%), chlorpyriphos (17.29 and 23.59%), Vikas (13.57 and 10.91%) and Vipul (0.00 and 0.00 %) at the respective locations.

During the 2003 crop season, comparatively higher pest population was recorded at both the locations, the pre-application larval counts ranged between 1.22 and 1.44 per plant at Palampur and 2.33 to 2.56 per plant at Malan (Table 2). On seventh day of application, lambda cyhalothrin gave 96.37 per cent and cypermethrin 100 per cent reduction in larval population at Palampur, whereas at Malan, the reduction was 100 per cent in both the treatments. The reduction in larval count in *B. thuringiensis* was 88.02 and 84.82 per cent and that in cypermethrin + *B. bassiana* was 82.74 and 84.11 per cent at the two locations, respectively. Other treatments showed comparatively less reduction in larval count (Table 2). On fourteenth day of first foliar application, similar trend of treatments was observed. Post treatment larval counts after 7 days (second spray) revealed that cypermethrin recorded 100 per cent mortality at both the locations and lambda cyhalothrin gave 96.93 and 100 per cent reduction followed by *B. thuringiensis* (87.08 and 89.74%), cypermethrin + *B. bassiana* (85.60 and 83.29%) at Palampur and Malan, respectively. Achook and *B. bassiana* were less effective. The soil treatments viz. chlorpyriphos, Vikas and Vipul showed lower larval reduction. After 14 days of second spray, cypermethrin and lambda cyhalothrin maintained their superiority both giving 100 per cent reduction at the two locations. The trend of the rest of the treatments was similar as observed in first spray.

The present results are in concordance with Srivastava *et al.* (1991) who reported high efficacy of lambda cyhalothrin and cypermethrin against *H. armigera* on cotton. Our results support those of Mehta *et al.* (1991) and Garg and Kashyap (1994) who reported cypermethrin (0.004%) to be effective against *H. armigera* larvae on chickpea. The effectiveness of *B. thuringiensis* var. *kurstaki* (Dipel 8L) in reducing the larval population of *H. armigera* was reported by Kulat *et al.* (1999) on chickpea and Praveen *et al.*(2001) on tomato. High efficacy of mixture of cypermethrin and *B. bassiana* against the larvae of this pest was reported by Anonymous (2000b).

Persistence toxicity

The persistence toxicity data revealed that on 0 day, (insects released 2 hours after spray), maximum larval mortality (100%) was observed in lambda cyhalothrin and cypermethrin followed by cypermethrin + *B. bassiana* (82.22%) and *B. thuringiensis* (77.78%) both being at par statistically. Comparatively lower larval mortality was observed in *B. bassiana* (57.78%) and Achook (46.67%). On 3 and 7 days of spray, similar trend of larval mortality was observed. However, on 14 days, lower mortality (0 to 28.89%) was obtained in different treatments. The index of persistent toxicity revealed the order of tested insecticides as: cypermethrin (1038.97) > lambda cyhalothrin (1001.78) > cypermethrin + *B. bassiana* (777.76) > *B. thuringiensis* (740.46) > *B. bassiana* (560.11) > Achook (268.33) (Table 3).

Crop yield

The data on tuber yield at the time of harvest indicated that the highest yield at Palampur and Malan during 2002 was obtained in cypermethrin (134.92 and 231.87) and lambda cyhalothrin (131.57 and 226.84 q/ha) respectively, both on par statistically but significantly superior over other treatments. These were followed by *B. thuringiensis* (111.91 and 210.34 q/ha) and cypermethrin + *B. bassiana* (109.06 and 207.65 q/ha) at Palampur and Malan, respectively, both being statistically at par. However, Achook and *B. bassiana* recorded comparatively lower tuber yield as compared to other foliar treatments. Among the soil treatments, chlorpyriphos registered 97.00 and 186.53 q/ha yield at Palampur and Malan, respectively, followed by Vikas and Vipul, although all the treatments were significantly superior over control (Table 1). A similar trend in tuber yield was observed during 2003 (Table 2).

Conclusion

From these studies, it was concluded that lambda cyhalothrin and cypermethrin proved best against *H. armigera* larvae on spring potato. However, keeping in view the environmental hazards of synthetic chemicals and need of organic farming, the best alternative was the application of *B. thuringiensis* or mixture of cypermethrin and *B. bassiana*, that could be advocated in the IPM programme for potato.

Table 2. Effect of biopesticides and insecticides on *H. armigera* larval population in spring potato (2003)

Treatment	App.rate (ha^{-1})	Pre-application larval population/plant		% reduction in larval population over control at different days after application*								Yield (q/ha)	
				7 day		14 day&		21 day×		28 day@			
		Palampur	Malan	Palampur	Malan	Palampur	Malan	Palampur	Malan	Palampur	Malan	Palampur	Malan
Chlorpyriphos[a]	2.0 L	1.44 (1.39)$	2.44 (1.71)	51.72 (45.97)#	52.57 (46.46)	44.74 (41.96)	46.38 (42.91)	36.60 (37.21)	42.17 (40.46)	21.49 (27.30)	30.23 (33.33)	60.02	171.24
Vikas[a]	450 kg	1.44 (1.39)	2.44 (1.71)	47.05 (42.25)	44.74 (41.96)	44.74 (41.96)	42.57 (40.70)	30.10 (33.20)	33.85 (35.53)	15.68 (23.28)	17.22 (24.51)	55.47	159.63
Vipul[a]	450 kg	1.33 (1.35)	2.44 (1.71)	34.96 (36.23)	42.30 (40.55)	32.78 (34.91)	39.99 (39.21)	20.64 (26.81)	22.67 (28.41)	9.68 (15.94)	11.44 (17.32)	54.83	156.37
Achook[f]	2.25 L	1.33 (1.35)	2.33 (1.68)	69.62 (56.63)	64.25 (53.29)	60.00 (50.29)	55.12 (47.93)	74.67 (59.86)	71.08 (57.50)	54.36 (47.53)	58.84 (50.07)	63.08	176.48
Bacillus thuringiensis[f]	2.25 L	1.44 (1.39)	2.56 (1.75)	88.02 (69.75)	84.82 (67.05)	79.01 (62.73)	77.62 (61.76)	87.08 (69.03)	89.74 (73.56)	84.23 (66.60)	91.99 (75.45)	81.80	197.77
Beauveria bassiana[f]	2.25 kg	1.33 (1.35)	2.56 (1.75)	69.62 (56.63)	72.59 (58.42)	66.39 (54.55)	68.63 (55.93)	78.24 (62.17)	63.14 (52.60)	65.64 (54.09)	66.86 (54.87)	69.00	186.85
Lambda cyhalothrin[f]	0.25 L	1.44 (1.39)	2.44 (1.71)	96.37 (81.55)	92.34 (75.88)	93.42 (76.80)	88.75 (70.60)	96.93 (82.11)	100.0 (86.67)	100.0 (86.67)	100.0 (86.67)	98.87	208.43
Cypermethrin[f]	0.30 L	1.22 (1.31)	2.56 (1.75)	100.0 (86.67)	95.52 (74.11)	96.08 (81.29)	91.90 (73.62)	100.0 (86.67)	100.0 (86.67)	100.0 (86.67)	100.0 (86.67)	102.76	213.49
Cypermethrin + *B. bassiana*[f]	0.15L+ 1.125 kg	1.33 (1.35)	2.44 (1.71)	82.74 (65.73)	84.11 (66.49)	77.48 (61.65)	72.25 (58.20)	85.60 (67.96)	83.29 (65.86)	77.27 (61.82)	87.00 (68.84)	78.68	194.26
Control	-	-	-	-	-	-	-	-	-	-	-	35.92	114.71
CD (P=0.05)		(NS)	(NS)	(7.36)	(6.44)	(8.22)	(3.92)	(7.31)	(7.08)	(8.88)	(8.96)	(5.11)	(5.17)

*Mean of 3 replications

#Figures in parentheses indicate arc sine transformed values,

$ Figures in parentheses indicate $\sqrt{x + 0.5}$ transformed values,

[a] Applied in soil,

& on 14th day second spray made after taking observations

× 7th day of second foliar application,

@ 14th day of second foliar application,

[f] Applied on foliage

Table 3. Persistence toxicity of biopesticides and insecticides against *H. armigera* on spring potato

Treatment	Dosage (%)	Per cent mortality*						
		0 day	1 day	3 days	7 days	14 days	PT	Relative PT
Achook (Azadirachtin 0.15%)	0.3	51.11 (45.62)	46.67 (43.07)	35.55 (36.57)	20.00 (26.55)	0.0 (1.48)	268.33	0.26
Dipel 8 L (*Bacillus thuringiensis)*	0.3	84.45 (66.84)	77.78 (61.90)	60.00 (50.75)	33.33 (35.25)	8.89 (17.11)	740.46	0.71
Daman (*Beauveria bassiana)*	0.3	66.67 (54.72)	57.78 (49.46)	44.45 (41.79)	26.67 (31.08)	4.47 (10.47)	560.11	0.54
Karate5 EC (Lambda cyhalothrin)	0.03	100.0 (88.45)	93.33 (75.00)	86.67 (68.56)	53.33 (46.89)	24.45 (29.57)	1001.78	0.96
Cybil 25 EC (Cypermethrin)	0.04	100.0 (88.45)	97.73 (83.97)	88.89 (70.71)	55.55 (48.18)	28.89 (32.47)	1038.97	1.00
Cybil + Daman (Cypermethrin + *B. bassiana)*	0.02 + 0.15	86.67 (68.99)	82.22 (65.13)	62.22 (52.07)	35.55 (36.57)	11.11 (19.26)	777.76	0.75
Control	Water spray	0.0 (1.48)	0.0 (1.48)	0.0 (1.48)	0.0 (1.48)	0.0 (1.48)	0.0	-
CD (P=0.05)		(4.69)	(6.40)	(3.41)	(1.96)	(6.25)		

*Mean of three replications, Figures in parentheses indicate arc sine transformed values,
PT = Index of persistent toxicity.

References

Abbott, W. S. 1925. A method for computing the effectiveness of an insecticide. *Journal of Economic Entomology* 18: 265-267.

Anonymous. 2000 a. *Package of practices for rabi crops in Himachal Pradesh.* Directorate of Extension Education, CSKHPKVV, Palampur. pp. 31-39.

Anonymous. 2000 b. *Annual Progress Report.* Directorate of Extension Education, CSKHPKVV, Palampur. pp. 31-33.

Fleming, R. and Retnakaran, A. 1985. Evaluating single treatment data using Abbott's formula with reference to insecticides. *Journal of Economic Entomology* 79: 1179-81.

Garg, R. and Kashyap, N. P. 1994. Relative efficacy of six insecticides against gram pod borer, *Helicoverpa armigera* (Hubner) on chick-pea. *Indian Journal of Plant Protection* 22(2): 187-90.

Khurana, S.M.P. 2002. Possible R& D linkages and strategies for sustainable potato production in India. *Journal of the Indian Potato Association* 29 (1-2):1-18.

Kulat, S. S., Nimbalkar, S. A., Radki, S. G. and Tambe, V. J. 1999. Evaluation of biopesticides and neem seed kernel extract against *Helicoverpa armigera* on chick-pea. *Indian Journal of Entomology* 61(1): 19-21.

Mehta, P. K., Singh, M. and Kashyap, N. P. 1991. Evaluation of different insecticides against gram pod borer, *Helicoverpa armigera* (Hubner). *Himachal Journal of Agricultural Research* 17(1&2): 14-16.

Mishra, S. S. 1993. Strategies of pest management in potato. *Pesticides Information* 19: 16-27.

Pradhan, S. 1967. Strategy of integrated pest control. *Indian Journal of Entomology* 29: 105-22.

Praveen, P. M., Dhandapani, M. and Kennedy, J. S. 2001. Efficacy of *Bacillus thuringiensis* var. *kurstaki* formulations for the management of tomato fruit borer, *Helicoverpa armigera. Pestology* 25: 58-61.

Srivastava, K. P., Gajbhiye, V. T. and Agnihotri, N. P. 1991. Bioefficacy of new synthetic pyrethroids against cotton bollworms. *Pestology* 25: 4-5.