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Biointensive management of pod borer, *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) on chickpea crop

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ABSTRACT: A field experiment was conducted on the farm of Department of Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to evaluate suitable cost effective combinations of microbial insecticides, plant product and reduced dose of insecticide in an integrated manner for management of *Helicoverpa armigera* (Hûbner) on chickpea. Pooled data on per cent larval reduction after second spray revealed significant superiority of *Ha*NPV alternated with endosulfan (0.07%) at fifteen days after spraying (92.61) and mixed spray of *Ha*NPV with half the recommended dose of endosulfan (88.16). Higher grain yield of 18.47 q/ha and 17.97 q/ha, repectively was also recorded in the same treatments, found on par with each other. In case of pod damage, combination treatment of *Ha*NPV with half the recommended dose of endosulfan recorded minimum pod damage (6.40%). However, *Ha*NPV alternated with endosulfan (0.07%) recorded economic returns of 1:10.14. Thus there is a possibility of alternating *Ha*NPV with chemical insecticides for the effective management of pod borer in chickpea.

KEY WORDS: *Bacillus thuringiensis*, endosulfan, grain yield, *Ha*NPV, incremental cost-benefit ratio, neem seed extract

INTRODUCTION

The gram pod borer, *Helicoverpa armigera* (Hûbner) is major insect pest, causing devastating losses in chickpea crop. The polyphagous nature of this pest and wide geographical spread merits its consideration at an international level (Hardwick, 1965). On chickpea, it is a serious pest at maturity stage of crop, accounting for 90-95 per cent of total damage (Sachan and Katti, 1994). A single larva of *H. armigera* can damage 25-30 pods of gram during its life time (Sharma, 1978). The large upsurge in *Helicoverpa* activity has been largely due to application of broad-spectrum insecticides causing mortality of natural enemies. In addition, this pest has developed resistance to insecticides, resulting in increased dosage and frequency of treatments and has made control by chemicals increasingly unreliable and expensive (Armes *et al.*, 1992).

Integration of biopesticides like *Bacillus thuringiensis* and *Ha*NPV with endosulfan resulted in reduced pod borer damage and increased grain yield (Singh *et al.*, 1999). Similarly, phytoextracts like neem-based formulations were found effective against *H. armigera* larvae (Singh *et al.*, 1993).

However, not much information is available on the performance of bio-rational insecticides like *Ha*NPV, *Bacillus thuringiensis* and neem seed extract against gram pod borer under our situation.

Hence the present investigations were undertaken to evaluate these biorational components in comparison with conventional synthetic insecticide for the management of gram pod borer. In addition, efforts were made to find out a suitable cost effective combination by incorporating microbial insecticides, plant product and reduced dose of insecticide in an integrated manner for management of *H. armigera* on chickpea and to reduce the pesticidal load in chickpea cropping system.

MATERIALS AND METHODS

Pure culture of *Helicoverpa armigera* NPV (from Insect pathology laboratory, Department of Entomology, Dr. PDKV, Akola), *Bacillus thuringiensis* (Dipel supplied by Cheminova India Limited having 17.6 X 10^3 IU/mg) and endosulfan (Endocel supplied by Excel Industries Ltd.) were used in the study.

Five kilograms of finely ground neem seed were soaked overnight in a vessel containing ten litres of water, one day before spraying. Next morning, the extract was decanted and squeezed through muslin cloth. The extract obtained was adjusted for its volume by adding remaining quantity of water to get 5 per cent concentration of neem seed extract.

Trials were conducted for two years at the field of Department of Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during post rainy seasons of 1997-98 and 1998-99. The experiment was laid in randomised block design with 14 treatments and three replications with a plot size of 14.4 sq.m. The experiments were conducted on chickpea (var. Chaffa) and the treatments comprised as follows:

T1 – *Ha*NPV (250 LE/ha) alone
T2 - *Bt. kurstaki* (Dipel) (1 l/ha) alone,
T3 – Endosulfan (0.07 %) alone
T4 - Neem seed extract (5 %) alone
T5 – *Ha*NPV (250 LE/ha) + endosulfan (0.035 %)
T6 - *Bt. kurstaki* (1 l/ha) + endosulfan (0.035 %)
T7 – NSE 5 % + endosulfan (0.035 %)
T8 – NSE 5 % + *Ha*NPV (250 LE/ha)
T9 – NSE 5 % + *Bt. kurstaki* (1 l/ha)
T10 – *Ha*NPV (250 LE/ha) alternated with endosulfan (0.07 %) at 15-day interval in the second spray
T11 – *Ha*NPV (250 LE/ha) alternated with *Bt. kurstaki* (1 l/ha) at 15-day interval in the second spray
T12 – *Ha*NPV (250 LE/ha) alternated with NSE 5 % at 15-day interval in the second spray
T13 – Control (water spray)
T14 – Untreated control

In all treatments two sprays were applied during each season of which the first spray was initiated after attaining ETL and second spray was repeated after fifteen days. At the time of spraying soap powder @ 2 g / l was added with NSE with a view to have a better coverage and to impart adhesive properties. Similarly, UV protectant Ranipal (10%) aqueous solution was added @ 1ml/l of spray mixture of NPV to prolong the efficiency of virus in the atmosphere.

Observations on larval population were recorded from ten randomly selected plants in each plot one day before spraying and subsequently 3, 7 and 15 days after each spraying. The two years' field data on larval population were converted into per cent larval reduction and subjected to analysis of variance. At the time of harvesting, damaged as well as healthy pods were counted from tagged plants and per cent pod damage was computed. Seed yield per plot was recorded and subjected to analysis of variance.

At the end Incremental Cost - Benefit Ratio based on total grain yield in terms of rupees, cost of treatments, labour charges and cost of application was calculated at the prevailing market rates in order to identify the cost effective treatment against *H. armigera* on chickpea.

RESULTS AND DISCUSSION

Larval population

Pooled results of two seasons (Table 1) revealed that treatment of *Ha*NPV alternated with endosulfan showed highest larval reduction (72.57%) three days after second spray. It was followed by *Ha*NPV + half the recommended dose of endosulfan (67.02 %) and endosulfan alone (61.98 %) and both these treatments were on par with each other.

However, seven days after second spraying *Ha*NPV alternated with endosulfan and combination of *Ha*NPV + half the recommended dose of endosulfan ranked as the best treatments showing 81.99 per cent and 77.71 per cent reduction in larval population, respectively and were statistically on par with each other. The application of endosulfan alone was the next effective treatment causing 71.72 per cent decline in the larval population and it was closely followed by combination of *Bt. kurstaki* + half the recommended dose of endosulfan (67.97%). However, the latter treatment was on par with NSE + half the recommended dose of endosulfan (63.24%).

A similar trend was observed at fifteen days after spraying. The per cent larval reduction varied from 14.44 to 92.61. The highest reduction of larval population was observed in the treatments of *Ha*NPV alternated with endosulfan (92.61%) and *Ha*NPV + half the recommended dose of endosulfan (88.16 %). These two treatments were on par with each other. The latter treatment was also statistically on par with sole treatment of endosulfan (83.13%) which in turn was statistically equal to that of *Bt. kurstaki* + half the recommended dose of endosulfan (80.91%) in this respect.

The pooled data of two seasons revealed that the treatment of *Ha*NPV alternated with endosulfan was closely followed by *Ha*NPV + half the recommended dose of endosulfan and they proved to be best treatments. These results are comparable with those of Jayaraj *et al.* (1987), Pawar *et al.* (1987) and Sanap and Pawar (1998).

The findings regarding the efficacy of mixed spray of *Ha*NPV + half the recommended dose of endosulfan could be compared with the earlier reports of Rabindra and Jayaraj (1988), Vyas and Lakhchaura (1996a) and Satpute (1992).

Pod damage

Pooled data on the per cent pod damage in the different treatments (Table 1) indicated that the plot sprayed with a combination of *Ha*NPV + half the recommended dose of endosulfan recorded lowest pod damage (6.40%), followed by *Ha*NPV alternated with endosulfan (7.18%) and endosulfan alone (7.85%). Of these the latter two treatments were on par with each other. The next effective treatment was combination of *Bt. kurstaki* + half the recommended dose of endosulfan (8.98%) which was followed by NSE + half the recommended dose of endosulfan (9.90%). The sole treatment of NSE recorded higher pod borer damage (16.61%) compared to other treatments.

The aforesaid findings regarding effectiveness of *Ha*NPV + half the recommended dose of endosulfan on reducing the pod damage is in confirmation with the reports of Ujagir *et al.* (1997), Jayaraj *et al.* (1987 &1989) and Vyas and Lakhchaura (1996 b).

Grain Yield

The pooled grain yield of chickpea (Table 1) revealed that maximum yield was harvested from the plots treated with *Ha*NPV alternated with endosulfan (18.47 q/ ha). However, this treatment was found to be on par with *Ha*NPV + half the recommended dose of endosulfan (17.97q/ ha). These were followed by application of endosulfan alone (17.10 q/ ha), *Bt. kurstaki* + half the recommended dose of endosulfan (16.45 q/ ha) as

Table 1 Effect of various treatments on larval population of *H. armigera*, pod damage and seed yield of chickpea

Treatment	Mean *H. armigera* population reduction days after second spray $			Mean pod borer damage (%)*	Grain yield q/ ha
	3	7	15		
1. HaNPV (250 LE/ha)	15.27 (22.96)	45.22 (42.24)	72.36 (58.31)	12.12 (3.47)	14.42
2. *Bt. kurstaki* (1 lit/ha)	37.16 (37.53)	42.15 (40.48)	68.03 (55.58)	12.83 (3.57)	14.29
3. Endosulfan (0.07%)	61.98 (51.94)	71.72 (57.89)	83.13 (65.92)	7.85 (2.79)	17.10
4. NSE (5%)	25.56 (30.33)	35.42 (36.50)	59.79 (50.67)	16.61 (4.07)	11.44
5. HaNPV (250 LE/ha) + endosulfan (0.035%)	67.02 (54.96)	77.71 (61.85)	88.16 (70.04)	6.40 (2.52)	17.97
6. *Bt. kurstaki* (1 lit/ha) + endosulfan (0.035%)	56.41 (48.69)	67.97 (55.56)	80.91 (64.19)	8.98 (2.98)	16.45
7. NSE (5%) + endosulfan (0.035%)	52.97 (46.71)	63.24 (52.70)	76.41 (61.00)	9.90 (3.13)	15.70
8. NSE (5%) + HaNPV (250 LE/ha)	48.23 (43.99)	56.57 (48.78)	74.44 (59.67)	10.6 (3.25)	14.83
9. NSE (5%) + *Bt. kurstaki* (1 lit/ha)	44.43 (41.80)	54.28 (47.47)	68.21 (55.71)	14.45 (3.79)	13.26
10. HaNPV (250 LE/ha alternated with endosulfan (0.07%)	72.57 (58.44)	81.99 (64.92)	92.61 (74.26)	7.18 (2.67)	18.47
11. HaNPV (250 LE/ha) alternated with *Bt. kurstaki* (1 lit/ha)	36.50 (37.16)	50.68 (45.39)	61.00 (51.36)	13.83 (3.71)	13.73
12. HaNPV (250 LE/ha) alternated with NSE (5%)	34.11 (35.71)	44.18 (41.65)	57.11 (49.10)	15.24 (3.90)	12.54
13. Control (water spray)	6.54 (14.79)	13.06 (21.15)	19.60 (26.24)	19.34 (4.39)	10.44
14. Untreated control	5.46 (13.49)	10.91 (19.26)	14.44 (22.26)	20.27 (4.50)	9.98
SEM±	1.01	1.08	1.58	0.038	0.43
CD (P=0.05)	3.08	3.31	4.81	0.12	1.30

N. B. : $ Figures in parentheses are corresponding arcsine transformation values. * Figures in parentheses are corresponding square root transformation values.

well as NSE + half the recommended dose of endosulfan (15.70 q/ ha); the first two treatments being statistically on par.

The present results on maximum grain yield obtained in the treatment where *Ha*NPV was alternated with endosulfan are in conformity with that of Rabindra & Jayaraj (1988) and Pawar *et al.* (1990).

Table 2 Overall incremental cost- benefit ratio of various treatments on chickpea

Treatment / conc. or dose	Total insecticide (lit or kg)	Price in Rs./lit or Rs./kg	Cost of insecticide Rs. /ha	Total cost of plant protection Rs./ha	Yield q/ha	Net gain over control q/ha	Gross Realization Rs./ha	Realization over control Rs./ha	ICBR	Rank
HaNPV (250 LE/ha)	0.50	1700	850.00	1070.0	14.42	3.98	16763.25	4626.75	1: 4.3	5
Bt. kurstaki (1 lit/ha)	2.00	700	1400.00	1620.0	14.29	3.85	16612.13	4475.63	1: 2.8	10
Endosulfan (0.07%)	2.39	198	473.22	693.2	17.10	6.66	19878.75	7742.25	1: 11.2	1
NSE (5%)	59.75	4	239.00	459.0	11.44	1.00	13299.00	1162.50	1: 2.5	11
HaNPV (250 LE/ha) + Endosulfan (0.035%)	0.50 1.195	1700 198	850.00 236.61	1306.6	17.97	7.53	20890.13	8753.63	1: 6.7	4
Bt. kurstaki (1 lit/ha) + Endosulfan (0.035%)	2.00 1.195	700 198	1400.00 236.61	1856.6	16.45	6.01	19123.13	6986.63	1: 3.8	7
NSE (5%) + Endosulfan (0.035%)	59.75 1.195	4 198	239.00 236.61	695.6	15.70	5.26	18251.25	6114.75	1: 8.8	3
NSE (5%) +HaNPV (250 LE/ha)	59.75 0.50	4 1700	239.00 850.00	1309.0	14.83	4.39	17239.88	5103.38	1: 3.9	6
NSE (5%) +*Bt. kurstaki* (1 lit/ha)	59.75 2.00	4 700	239.00 1400.00	1859.0	13.26	2.82	15414.75	3278.25	1: 1.8	12
HaNPV (250 LE/ha) alternated with Endosulfan (0.07%)	1.39	1700 198	425.00 275.22	920.2	18.47	8.03	21471.38	9334.88	1: 10.1	2
HaNPV (250 LE/ha) alternated with *Bt. kurstaki* (1 lit/ha)	1.00	1700 700	425.00 700.00	1345.0	13.73	3.29	15961.13	3824.63	1: 2.8	9
HaNPV (250 LE/ha) alternated with NSE (5%)	34.75	1700 4	425.00 139.00	784.0	12.54	2.10	14577.75	2441.25	1: 3.1	8
Control (water spray)					10.44	-	12136.50			

Note: Price of chickpea grain (Average) Rs. 1162.50 /q: Labour charges Rs. 25/ day: Spray pump charges Rs. 10 /day

Quantity of water required for spray- i. First spray 500 lit./ ha. ii. Second spray 695 lit/ha

HaNPV 250 LE= 250 ml

The effect of *Ha*NPV + half the recommended dose of endosulfan in achieving increased grain yield is in tune with the findings of Thakur (1990), Satpute (1992) and Ujagir *et al.* (1997).

Economics of various treatments

The pooled results on the economics of the various treatments (Table 2), indicated that treatment of endosulfan alone recorded highest ICBR of 1:11.17 due to its low cost of application. It was followed by the treatment of *Ha*NPV alternated with endosulfan (1:10.14), NSE + half the recommended dose of endosulfan (1:8.79) and HaNPV + half the recommended dose of endosulfan (1:6.70).

Next in order were the treatments, *Ha*NPV alone (1:4.32), NSE + *Ha*NPV (1:3.90), *Bt. kurstaki* + half the recommended dose of endosulfan (1:3.76) and *Ha*NPV alternated with NSE (1:3.11).

These findings indicated the possibility of alternating NPV with chemical insecticides to manage the pod borer problem in chickpea ecosystem.

REFERENCES

Armes, N. T., Jadhav, D. R., Bond, G. S. and King, A. B. S. 1992. Insecticide resistance in *Helicoverpa armigera* in South India. *Pesticide Science*, **34**: 355-364.

Hardwick, D. F. 1965. The corn earworm complex. *Memoirs of the Entomological Society of Canada*, **40**: 1-247.

Jayaraj, S., Rabindra, R. J. and Narayanan, K. 1989. Development and use of microbial agents for control of *Heliothis* in India, pp. 483–504. In: King, E. G. and Jackson, R. D. (Eds). Increasing the effectiveness of natural enemies, Proceedings of International Workshop on Biological control of *Heliothis*, November 11-15, 1985, New Delhi, India.

Jayaraj, S., Rabindra, R. J. and Santharam, G. 1987. Control of *Heliothis armigera* (Hübner) on chickpea and Lablab bean by nuclear polyhedrosis virus. *Indian Journal of Agricultural Sciences*, **57** (10): 738-741.

Pawar, V. M., Aleemuddin, M. and Bhosale, B. B. 1987. Bioefficacy of HaNPV in comparison with endosulfan against pod borer on chickpea. *International Chickpea Newsletter*, **16**: 4-6.

Pawar, V. M., Chundurwar, R. D., Kadam, B. S., Thombare, U. T., Dhawandkar, S. D. and Seeras, N. R. 1990. Field efficacy of nuclear polyhedrosis virus against *H. armigera* (Lepidoptera: Noctuidae) on gram (*Cicer arietinum*) in Maharashtra. *Indian Journal of Agricultural Sciences*, **60**: 287-289.

Rabindra, R. J. and Jayaraj, S. 1988. Efficacy of nuclear polyhedrosis virus with adjuvant as high volume and ultra low volume applications against *Heliothis armigera* (Hübner) on chickpea. *Tropical Pest Management*, **34**: 441-444.

Sachan, J. N. and Katti, G. 1994. Integrated pest management. Paper presented in International Symposium on Pulses Research, April 2-6, 1994. IARI, New Delhi, India.

Sanap, M. M. and Pawar, V. M. 1998. Integrated management of *Helicoverpa armigera* on gram (*Cicer arietium*). *Indian Journal of Agricultural Sciences*, **68**: 162-164.

Satpute, U. S. 1992. Management of *Helicoverpa armigera* (Hübner) on chickpea, *Cicer arietinum* L. through nuclear polyhedrosis virus. Ph.D. dissertation, Department of Agricultural Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India.

Sharma, S. K. 1978. Studies on biology and extent of damage by gram pod borer, *Heliothis armigera*. M. Sc. (Agri.) thesis, Haryana Agriculture University, Hissar, India.

Singh, B., Yadav, R. P. and Singh, R. 1993. Bioefficacy of some common phyto-extracts against pod borer, *Helicoverpa armigera* (Hübner) infesting chickpea crop. Paper presented in National Conference on Ecofriendly approaches in the management of pests, diseases and industrial effluents, December, 1993, University of Agriculture and Technology, Kanpur, India.

Singh, P. P., Monobrullah, M. and Singh, B. 1999. Field efficacy of some microbial pesticides against gram pod borer, *Helicoverpa armigera* (Hubner) in chickpea. *Shashpa*, **6**: 63-66.

Thakur, R. C. 1990. Present status of *Heliothis* on pulses and strategies for its management in Madhya Pradesh, pp. 91-99. In: Sachan, J. N. (Eds.), Current Status and Future Strategies, Proceedings of first National workshop on *Heliothis* management, August 30-31, 1990 Kanpur, Uttar Pradesh, India.

Ujagir, R., Chaubey, A. K., Sehgal, V. K., Saini, G. C. and Singh, J. P. 1997. Evaluation of some insecticides against *Helicoverpa armigera* on chickpea at Badaun, Uttar Pradesh, India. *International Chickpea Pigeonpea Newsletter*, **4**: 22-24.

Vyas, H. G. and Lakhchaura, B. D. 1996a. Evaluation of *Heliothis* nuclear polyhedrosis virus for control of *H. armigera* on chickpea at Pantnagar (UP). *Gujarat Agricultural University Research Journal*, **21**: 50-54.

Vyas, H. G. and Lakhchaura, B. D. 1996b. Effect of nuclear polyhedrosis virus of *Helicoverpa armigera* on pod damage and yield of chickpea at Pantnagar (UP). *Journal of Maharashtra Agricultural University*, **21**: 302-305.

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