Spodoptera litura nuclear polyhedrosis virus (NPV-S) as a component in Integrated Pest Management (IPM) of *Spodoptera litura* (Fab.) on cabbage

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ABSTRACT

Field tests were conducted to evaluate the effect of *Spodoptera litura* (Fab.) nuclear polyhedrosis virus (NPV-S) alone and in combination with endosulfan and neemarin (neem seed kernel extract) against *S. litura* in cabbage. Treatment with NPV-S (500 LE/ha) + Endosulfan (625 ml/ha) was better in reducing the larval population and increasing yield than other treatments. However, considering cost benefit ratio (CBR), treatment with endosulfan (1250 ml/ha) alone was found to be the most beneficial as compared with other treatments.

Key words: *Spodoptera litura*, biopesticide, NPV-S, neemarin, endosulfan, cabbage.

INTRODUCTION

Spodoptera litura (Fab.) (Lepidoptera: Noctuidae), is a serious polyphagous pest of several cultivated crops and has attained global importance. Widespread development of resistance to chemical insecticides including the widely used pyrethroids has been reported in *S. litura* (Ahmad *et al.*, 2007). In recent years the problem of resistance to chemical has worsened, resulting in 20-30% crop loss due to pests in India (Bhargava *et al.*, 2008) and causing widespread hardship especially amongst poor farmers. In addition to the development of resistance in pests, indiscriminate and injudicious use of pesticides has grossly poisoned almost each component of the biosphere, caused resurgence of pests and reduction of natural enemies in agroecosystems allowing rapid rebund of target and minor pests. Thus, considerable emphasis is being laid on the use of nuclear polyhedrosis virus (NPV) as a microbial pesticide which is species specific and ecologically safe and under certain situations they cause epizootics in the field which provide added control of pests in nature (Caballero *et al.*, 1992 ; Cory *et al.*, 1997). Charati *et al.* (1999) also reported the enhanced activity of endosulfan treated NPV giving lower LT_{50} value after treatment. Therefore, present study was conducted to assess the use of NPV as biopesticides effectively in Integrated Pest Management (IPM).

METERIALS AND METHODS

The field trials were conducted for the control of *S. litura* on cabbage, *Brassica oleracea* L. var. *capitata* (var. Golden Acre) at Agricultural Research Station, Durgapura, Jaipur. The plot size was 2×3 m^2 with 60 cm and 45cm spacing. One-month-old seedlings of cabbage were transplanted in the field and the normal recommended agronomical practices were used during the crop season. Nine treatments [(T_1: NPV-S (250 LE/ha); T_2: NPV-S (500 LE/ha); T_3: Endosulfan (1250 ml/ha); T_4: Neemarin (700 ml/ha); T_5: NPV-S (250 LE/ha) + Endosulfan (625 ml/ha); T_6: NPV-S (500 LE/ha) + Endosulfan (625 ml/ha); T_7: NPV-S (250 LE/ha) + Neemarin (700 ml/ha); T_8: NPV-S (500 LE/ha) + Neemarin (700 ml/ha); T_9: Untreated control)] were tested in Randomised Block Design (RBD) and replicated thrice. Spraying of insecticides was scheduled in two spray applications with high volume of knapsack sprayer @ 500 lit/ha. The first spray was 45 days after transplanting and the second given after a fortnight interval. While pre-treatment observations were taken at 24h before spray, the post treatment observations were recorded at 7 and 14 day after spray (DAS). Larval population was also recorded at the time of harvest and only 5cm stem of cabbage at the time of harvest was kept while recording the yield. The data regarding larval population and yield were subjected to analysis of variance (ANOVA). Cost benefit ratio (CBR) was also assessed by dividing the net monetary return (C) by the total additional cost due to treatments as worked out (B) (Nagrare and More, 1998).

RESULTS AND DISCUSSION

It is evident from the result that application of NPV–S (500 LE/ ha) + endosulfan (625 ml/ ha) and NPV- S (250 LE/ ha) + endosulfan (625 ml/ha) recorded better insect control and yield than with NPV-S (500 LE/ ha), NPV-S (250LE/ha) and endosulfan (1250ml/ha) alone (Tables 1 and 2). Similarly, Singh *et al.* (2000) also reported that biopesticides in combination with endosulfan were more effective by significantly reducing pod damage and

Table 1. Field efficacy of NPV-S alone and in combination with insecticides on the infestation of *Spodoptera litura* on cabbage crop.

Treatments	Pre-treatment population (in %)	Per cent reduction in larval population after			
		1st spray		2nd spray	
		7 DAS	14 DAS	7 DAS	14 DAS
T_1	2.30	25.61	40.39	60.06	72.28
T_2	2.27	42.80	61.98	78.26	87.24
T_3	2.33	53.57	68.13	85.78	93.65
T_4	2.26	23.14	37.65	60.78	69.13
T_5	2.27	27.03	43.80	88.14	95.35
T_6	2.13	45.56	59.63	93.85	98.25
T_7	1.99	30.19	45.00	66.34	79.34
T_8	2.23	43.12	60.03	81.71	90.53
T_9	2.40	3.41	8.39	11.67	13.45
$SE_{M\pm}$	-	2.67	1.77	2.45	1.78
C.D.					
$P \leq 0.05$	NS	8.001	58.304	7.343	5.33
$P \leq 0.01$	NS	11.01	7.308	10.11	7.34

DAS = Days after spray, NS = Not significant.

enhancing crop yield. The interaction of endosulfan was found to be synergistic with NPV, which resulted in a significantly higher percentage of mortality than NPV or endosulfan alone, suggesting supplemental synergism as described by Sathiah *et al.* (1990). Synergism may be due to physiological stress, reduction of phagocytic haemocytes caused by the chemicals or inhibition of the insects detoxification system by the micro organism (Boman, 1981) and could be due to breakdown of insecticidal resistance by entomopathogens when properly introduced in the pest population (Rud and Bellonick, 1984).

However, application of endosulfan alone was found to be superior over NPV as it had knockdown effect unlike NPV and moreover, NPV has long incubation period which allows the larvae to inflict considerable damage to the plant (Bell, 1991). Between two different concentrations of NPV (500 LE/ha and 250 LE/ha) used, NPV at 500 LE/ha was superior in percentage reduction of larval population. Similarly, Mohan *et al.* (1996) recorded that NPV at 300 LE/ha was more effective in terms of yield as compared to NPV at 200 LE/ha and NPV at 100 LE/ha.Neemarin (Biotech International Ltd., New Delhi) application combined with NPV was found superior as compared to their individual application. Similar enhanced activity of NPV by azadirachtin (an active ingredient of neem) was also reported by Cook *et al.* (1996). Koppenhofer and Kaya (2000) reported that neem seed kernel extract enhanced the activity of NPV by suppressing overall consumption, fecundity, survival, larval weight and growth rate of *Helicoverpa virescens*. The additive effect may be attributed to the antifeedent and insecticidal activity as well as disruption of insect growth and development (Beckage *et al.*, 1998) and inhibition of hormone and enzyme activity by azadirachtin (Smith and Mitchell, 1988). Moreover, botanicals have been known to cause the weakening of gut tissues by way of facilitating the active and early proliferation of viral bodies for subsequent pathogenesis of larvae (Murugan *et al.*, 1999).

Treatment of endosulan alone stood out as the most benefit deriving treatment by giving highest CBR. The

Table 2. Influence of application of NPV-S alone and in combination with insecticides on yield and Cost benefit ratio.

Treatments	Yield (kg/ha)	Per cent increase in in yield over control	CBR
T_1	13610	44.32	1 : 3.1
T_2	13876	47.14	1 : 5.5
T_3	14190	50.47	1 : 22.45
T_4	12391	31.39	1 : 11.4
T_5	14422	52.93	1 : 15.1
T_6	15372	62.93	1 : 16.4
T_7	13711	45.39	1 : 6.7
T_8	13970	48.13	1 : 8.5
T_9	9431	-	-
$SE_{M\pm}$	1.05	-	-
C.D.			
P d $\leq$ 0.05	314.7		
$P \leq 0.01$	433.68	—	—

results are in agreement with the findings of Kulat *et al.*, (1999), Cherry *et al.* (2000) and Ratna Kumari and Chandrasekaran (2008). The CBR was significantly higher in endosulfan treated plots whereas, treatment with NPV alone gave lowest CBR because of its high cost of application. Even, the treatment with NPV had lost its fourth place (in case of larval population reduction and yield) to neemarin due to the lower cost of the latter. Therefore, the cost is an important factor in the choice of treatment. Although, NPVs are not so economical with respect to CBR, the rise is inevitable because of their potency, specificity and safety. Hence, NPV-S can be taken up as the component in IPM in the preview of its higher manufacturing cost.

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REFERANCES

Ahmad, M., Arif, M. I. and Ahmad, M. 2007. Occurrence of insecticide resistance in field populations of *Spodoptera litura* (Lepidoptera: Noctuidae) in Pakistan. *Crop Protection*, **26** (6): 809-817.

Beckage, N. E., Metcalf, J. S., Nielson, B. D. and Nerbet, J. S. 1998. Disruptive effects of azadirachtin on develop ment of *Cotesia congregate* in host tobacco horn worm larvae. *Archieves of Biochemistry and Physio logy*, **9**: 47-65.

Bell, M. R. 1991. Effectiveness of microbial control of *Heliothis armigera*, developing on early season wild *Germanium spp*. infield and field cage test. *Journal of Economic Entomology*, **84**: 851-854.

Bhargava, M. C., Choudhary, R. K. and Jain, P. C. 2008. Genetic Engineering of plants for insect resistance. In: *Entomology: Novel Approaches* (Jain, P.C. and Bhargava, M. C. eds.). New India Publishing, New Delhi, India. 133-144 **PP.**

Boman, H.G. 1981. Insect responses to microbial infections. In: *Microbial Control of Pests and Plant Diseases 1970-1980* (Burges, H.D. ed.), Academic Press London. 949 **PP**.

Caballero, P., Aldebis, H. K., Varga Osuna, E. and Santiago-Alvarez, C. 1992. Epizootics caused by a nuclear polyhedrosis virus in populations of *Spodoptera litura* in southern Spain. *Biological Science and Technology*, **2**: 35-38.

Charati, S. N., Pawar, V. M. and Sakhare, M. V. 1999. Potentiation of *Helicoverpa armigera* nucleopoly hedrosis virus with different insecticides. *Journal of Maharashtra Agricultural University*, **24**(1): 119-120.

Cherry, A. J., Rabindra, F. J., Parnell, M. A., Geetha, N., Kennedy, J. S. and Grzywacz, D. 2000. Field evaluation of *Helicoverpa armigera* nucleopolyhedrosis virus formulations for control of the chickpea podborer, *H. armigera* (Hubner), on chick pea (*Cicer arietinum* var. Shoba) in southern India. *Crop protection*, **19:** 51-60.

Cook, S. P., Webb, R. E. and Kevin, T. W. 1996. Potential enhancement of the gypsy moth (Lepidoptera: Lymantridae) nucleopolyhedrosis virus with triterpene azadirachtin. *Environmental Entomolgy*, **25**:1209- 1214.

Cory, J. S., Hails, R. S. and Sait, S.M. 1997. Baculovirus ecology. In: *The Baculoviruses* (Miller L. K. ed.). Plenum Press, New York. 301-339 **PP.**

Kopenhofer, A. M. and Kaya, H. K. 2000. Interaction of a NPV with azadirachtin and imidacloprid. *Journal of Invertebrate Pathology*, **75**: 84-86.

Kulat, S. S., Nimbalkar, S. A., Radke, S. G. and Tambe, V. J. 1999. Evaluation of biopesticides and neem seed extract against *Helicoverpa armigera* on chickpea. *Indian Journal of Entomology*, **61**:19-22.

Mohan, K. S., Asokan, R. and Gopalkrishnan, C. 1996. Isolation and field application of a nuclear polyhe drosis virus for the control of fruit borer, *Helicoverpa armigera* (Hub.) on tomato. *Pest Management in Horticultural Ecosystem*, **2**: 1-8.

Murugan, K., Sivaramakrishnan, S., Senthil Kumar, N., Jeyabalan, D. and Senthil Nathan, S. 1999. Potentiality effects of neem on nucleopolyhedrovirus treatment of *Spodoptera litura* (Fab.). *Insect Science and Application*, **19** (2/3): 229-235.

Nagrare, V. S. and More, G. D. 1998. Economics in using bioagents against *Helicoverpa armigera* on pigeon pea. *Indian Journal of Entomology*, **60** (2): 203-206.

Ratna Kumari, B. and Chandrasekaran, S. 2008. Efficacy of neem products and insecticides against cotton stem weevil, *Pempherulus afflnis* Faust in Coimbatore. *Madras Agricultural Journal*, **95** (1-6): 229-232.

Rud, E.W. and Bellonick, S. 1984. Efficacy of combination of nuclear polyhedrosis virus and permethrin against the white cut worm, *Euxoa scandens* Piley (Lepido-ptera: Noctuidae). *Journal of Economic Entomology*, **77**: 989-994.

Sathiah, N., Jayaraj, S. and Rabindra, R.J. 1990. Laboratory evaluation of combined efficacy of nuclear polyhedrosis virus and insecticides against *Heliothis armigera* larvae. *Entomon*, **15**: 117-119.

Singh Vikram, Mathur, N. M., Kalyan, R. K., Hussain Akhtar and Sharma, G. K. 2000. Evaluation of some IPM modules against *Helicoverpa armigera* on chickpea. *Indian Journal of Entomology*, **60**: 24-27.

Smith, S. L. and Mitchell, M. J. 1988. Effect of azadirachtin on insect cytochrome P-450 dependent ecdysone 20-monoxygenase activity. *Biochemical Biophysical Research Communications*, **154**: 559-563.

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