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Bacillus thuringiensis Berliner and Some Insecticides against the Diamond-Back Moth, *Plutella xylostella* (L.) on Cauliflower

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ABSTRACT

In field trials on the control of the diamond-back moth, *Plutella xylostella* on cauliflower, *Bacillus thuringiensis* (Bactospeine^R) gave better control of the pest than all the chemical insecticides tested. Its combination with endosulfan, fenvalerate or diflubenzuron did not improve the efficacy of the pathogen. Yield was significantly higher in *B.t.* - treated plots in both the trials.

Key Words : *Bacillus thuringiensis*, diflubenzuron, neem seed kernel extract, insecticides, *Plutella xylostella*, field efficacy

The diamond-back moth, *Plutella xylostella* (L.) is a major pest of crucifers like cauliflower and cabbage. The bacterial insecticide, *Bacillus thuringiensis* Berliner (*B.t.*)is known to be effective against this pest on cruciferous crops (Asano *et al.*, 1973). The efficacy of *B.t.* may be increased by the addition of sub-lethal doses of pesticides (Benz, 1971; Chenker *et al.*, 1974). Hence in the present studies, the comparative efficacy of *B.t.* either alone or in combination with insecticide was investigated in two field experiments.

MATERIALS AND METHODS

Two field trials were conducted to test the efficacy of *B.t.* (Bactospeine^R) as well as *B.t.* (Thuricide^R) against *P. xylostella* on cauliflower (Var. Best Early) in a randomised block design with three replications at Kambalinayakanpatti village of Ottanchatram taluk, Quaid-e-Milleth district. The different treatments applied in both the field trials are presented in Table 1 and 2. In the first experiment, two rounds of sprays and in the second experiment a single round of treatments were given. The size of the plots was 9 x 3.5 m and 4 x 3 m for the first and second trial respectively. Teepol was used @ 0.1 % as a surfactant. Spraying was given in the evening hours using a hand operated knapsack sprayer (Aspee-Backpack), using a spray fluid volume of 900 lit/ha. Pre- treatment counts on the larval population were recorded in six plants at random in each plot. Subsequent larval counts were taken after the application of treatment at the interval of one, two, six and 13 days in the first experiment and one and two days in the second experiment.

Yield was recorded at the time of harvest by taking the weight of individual flower heads from 10 plants selected at random in each plot. The weights of the individual flower heads were taken along with five leaves as of marketable produce.

RESULTS AND DISCUSSION

The data on the larval population of *P. xylostella* showed that *B.t.* brought about significantly better control of the pest than chemical insecticides as seen by the larval population six days after the first round of spray. Neem seed kernel extract 5 % was as effective as *B.t.* though the data of the first and second days did not reveal this (Table 1). The data recorded after the second round of spray also showed that *B.t.* treatments were significantly better than fenvalerate, diflubenzuron or phenthoate-dichlorvos mixture in reducing the larval population and increasing the flower head weight. In the second experiment also, *B.t.* either as Bactospeine or Thuricide^R was found to be

Table 1. Field efficacy of *Bacillus thuringiensis* and some insecticides against *Plutella xylostella* on cauliflower

Treatments	Mean* number of larvae/plant-days after treatment								
	Pre-treatment	1	2	6	0£	1	2	6	Flower head weight (g) $\bar{X} \pm SE$ (n=10)
B.t. @300g/ha	7.9	3.11^{ab}	2.11^{a}	1.22^{a}	2.64	1.01^{a}	0.72^{a}	0.21^{a}	$702.50^{a} \pm 1.6$
B.t. @600g/ha	8.21	2.61^{a}	1.95^{a}	1.89^{a}	2.38	0.94^{a}	0.84^{ab}	0.33^{a}	$652.50^{ab} \pm 1.1$
B.t. @300g/ha + endosulfan @ 50g a.i/ha	8.98	3.61^{ab}	2.56^{a}	1.78^{a}	3.05	1.88^{bc}	1.22^{b}	0.44^{a}	$610.80^{bcd} \pm 1.9$
B.t. @300g/ha + diflubenzuron @250 g a.i/ha	9.20	3.00^{ab}	2.43^{a}	2.28^{ab}	2.66	2.38^{cd}	1.94^{bc}	0.33^{a}	$650.80^{bcd} \pm 1.3$
B.t. @300g/ha + fenvalerate @250 g a.i/ha	8.38	3.83^{ab}	3.37^{ab}	2.11^{a}	2.88	1.94^{bc}	1.82^{c}	0.49^{a}	$616.66^{bcd} \pm 1.8$
Fenvalerate @250 g a.i/ha	7.61	4.16^{ab}	5.22^{abc}	5.22^{d}	3.10	2.71^{d}	2.66^{e}	1.49^{cd}	$574.66^{cd} \pm 1.2$
Diflubenzuron @200 g a.i/ha	8.26	5.83^{b}	4.67^{abc}	5.10^{cd}	2.83	1.99^{c}	2.10^{cde}	1.50^{d}	$586.66^{cd} \pm 1.9$
Phenthoate @400 g a.i/ha+Dichlorvos @ 400 g a.i/ha	11.46	3.00^{ab}	4.72^{abc}	2.89^{abc}	2.49	1.38^{ab}	1.83^{c}	0.88^{b}	$608.33^{bcd} \pm 1.7$
Neem seed kernel extract 5%	11.31	5.83^{b}	6.89^{bc}	2.5^{ab}	3.06	2.10^{c}	2.38^{de}	1.05^{bc}	$606.66^{bcd} \pm 1.3$
Control	6.88	9.89^{c}	7.65^{c}	4.44^{bcd}	2.77	3.15^{e}	3.49^{f}	2.77^{e}	$571.60^{d} \pm 1.1$

£ Time of second spray

** In a column, means followed by similar letters are not different statistically (P=0.05) by DMRT

significantly better than the different chemical insecticides tested in reducing the larval population with the exception of quinalphos (Table 2). In case of flower head weight also, *B.t.* treatments were significantly superior to all the other treatments except quinalphos and phosalone. The other treatments were ineffective.

The effectiveness of *B.t.* against *P. xylostella* has been reported earlier from our country. Atwal and Singh (1969) could obtain 89.6 per cent mortality of *P. xylostella* with *B.t.* (Thuricide) on cauliflower. Excellent control of *P. xylostella* on radish was also achieved by Narayanan *et al.* (1973), when different formulations of *B.t. Viz.*, Dipel^{R}, Thuricide HPSC, Bactospeine and Thuricide 90 TS were tried under laboratory conditions. Varma and Gill (1977) reported that Thuricide HPSC and Dipel WP were more promising than Bactospeine and Thuricide 90 TS. Dipel and Thuricide HPSC also showed persistence up to 16 days. Biotrol BTB^{R}, a preparation of *B.t.* was as effective as sprays of fenthion, fenitrothion, carbaryl, endosulfan, dichlorvos, phoxim or malathion in the control of *P. xylostella* on cabbage (Rajamohan and Jayaraj, 1978).

Results also showed that *B.t.* was able to cause quick knock down effect of the pest and was found to be better than insecticides like monocrotophos, ethion, endosulfan, dichlorvos, phenthoate, fenvalerate, fluvalinate, cypermethrin, as well as phenthoate + dichlorvos mixture. The present findings from the field experiments showed that combining *B.t.* with

Table 2. Field efficacy of *Bacillus thuringiensis* and some insecticides against *Plutella xylostella* on cauliflower

Treatments	Dose g a.i/ha	Mean* number of larvae/plant-days after treatment			Flower head weight (g) $\bar{X} \pm$ SE (n=10)
		Pre treatment	1	2	
B.t. (Bactospeine^R)	600	1.83	0.83^{ab}	0.44^{a}	$698.33^{a} \pm 1.37$
B.t. (Thuricide^R)	600	2.05	0.71^{a}	0.55^{a}	$700.00^{a} \pm 1.00$
Quinalphos	450	2.27	1.05^{abc}	1.10^{b}	$670.00^{ab} \pm 2.12$
Monocrotophos	650	2.21	1.49^{cde}	1.32^{bc}	$587.5^{c} \pm 1.04$
Ethion	700	2.38	1.38^{cde}	1.16^{bc}	$620.00^{bc} \pm 2.27$
Endosulfan	800	2.27	1.72^{efg}	1.33^{bc}	$611.66^{bc} \pm 1.53$
Phosalone	800	2.27	1.32^{cde}	1.22^{bc}	$663.33^{ab} \pm 1.53$
Dichlorvos	800	1.88	1.16^{bcd}	1.11^{b}	$583.33^{c} \pm 1.32$
Phenthoate	800	2.21	1.60^{dcf}	1.38^{bc}	$596.66^{c} \pm 1.51$
Cypermethrin	100	2.11	1.99^{fg}	1.60^{bc}	$621.66^{bc} \pm 1.94$
Fluvalinate	120	2.16	2.10^{g}	1.55^{bc}	$598.33^{c} \pm 1.32$
Control	—	1.99	2.77^{h}	2.88^{d}	$566.66^{c} \pm 1.42$

* In a column, means followed by similar letters are not different statistically (P=0.05) by DMRT

insecticides did not improve the efficacy against *P. xylostella*. In earlier studies also, insecticides like mevinphos, naled, parathion (Creighton *et al.*, 1970), endosulfan, methomyl (Creighton *et al.*, 1972), phosphamidon, methyl demeton-S, dimethoate (Hamilton and Attia, 1977) and malathion (Varma and Gill, 1980) did not increase the activity of *B.t.* Yen and Hsiao (1977) and Krishnaiah *et al.* (1981) however could increase the toxicity of *B.t.* (Dipel) to *P. xylostella* by the addition of carbaryl, methomyl, acephate and chlordimeform.

Most of the insecticides found to be ineffective against *P. xylostella* in the present investigation were reported earlier to be effective against *P. xylostella* on various crops. The present findings indicate that the pest has developed resistance to these insecticides. One of the reasons for the pest developing resistance is increased selection pressure caused by repeated application of insecticides. In the present investigation, enquiries with the farmers revealed that they had been applying almost all the insecticides including synthetic pyrethroids as frequently as once in every four to five days. Hence the field strains of *P. xylostella* could have developed resistance to the insecticides. Observations on the comparative susceptibility of different field strains collected from different geographic locations to insecticides could throw more light on this.

The present studies also showed that *B.t.* was found to be better than diflubenzuron. Similarly, in pot culture study also diflubenzuron was not effective in controlling the larval population (Justin, 1987). Less effectiveness of diflubenzuron against *P. xylostella* has already been reported by Theunissen and Ouden (1978) and Hong (1981). Neem seed kernel extract at 5 % was not as effective as *B.t.* against *P. xylostella*. Tan and Sudderuddin (1978) also found that either water or alcohol extracts of different parts of neem seed, leaf, bark, twig or wood only partially protected *Brassica* spp. plants against *P. xylostella* attack. Azadirachtin, however, has been reported to be possessing

good antifeedant effect against *P. xylostella* on cabbage by Ruscoe (1972).

REFERENCES

ASANO, S., SAKAKIBARA, H., KITAGAKI, T., NAKAMURA, K. and MATSUSHITA, Y. 1973. Laboratory and field evaluation of the effectiveness of *Bacillus thuringiensis* products (Thuricide) against some lepidopterous pests of crucifers. *Japan J. Appl. Entomol. Zool.*, **17**, 91-96.

ATWAL, A.S., and SINGH, K. 1969. Comparative efficacy of *Bacillus thuringiensis* Berliner and some contact insecticides against *Pieris brassicae* L. and *Plutella xylostella* (L.) on cauliflower. *Indian J. Entomol.*, **31**, 361-363.

BENZ, G. 1971. Synergism of micro-organisms and chemical insecticides. In *"Microbial control of Insects and Mites"* (H.D. Burges and N.W. Hussey, eds), pp 327-355. Academic Press, New York.

CHENKER-SANG, FINKE, B.R., SCHULTY, J.T., CARLSON, R.B. and PRESHOLD, F.I. 1974. E ffects of certain organophosphate and carbamate insecticides on *Bacillus thuringiensis*. *J. Econ. Entomol.*, **67**, 471-473.

CREIGHTON, C.S., McFADDEN, T.L. and BELL, J.V. 1970. Pathogens and chemicals tested against caterpillars on cabbage. *Prog. Res. Rep.*, ARS, USDA, 114, 10 pp.

CREIGHTON, C.S., McFADDEN, T.L., CUTHBERT, R.B. and ONSAGAR, J.A. 1972. C ontrol of four species of caterpillars on cabbage with *Bacillus thuringiensis* Var. *alesti* 1969-70. *J. Econ. Entomol.*, **65**, 1399-1402.

HAMILTON, J.T. and ATTIA, F.I. 1977. Effects of mixtures of *Bacillus thuringiensis* and pesticides on *Plutella xylostella* and the parasite *Thyraealla collaris*. *J. Econ. Entomol.*, **70**, 146-148.

HONG, J.K. 1981. A laboratory study of insect growth regulators against the diamond-back moth, *Plutella xylostella* (Plutellidae) larvae. *Malays. J. Appl. Biol.*, **10**, 57-62.

JUSTIN, C.G.L. 1987. Studies on increasing the effectiveness of *Bacillus thuringiensis* Berliner against certain lepidopterous pests with particular reference to the diamond-back moth, *Plutella xylostella* (L.). M.Sc. (Ag.) Thesis, T.N.A.U., Coimbatore.

KRISHNAIAH, K., MOHAN, N.J. and PRASAD, V.G. 1981. Efficacy of *Bacillus thuringiensis* Ber. for the control of lepidopterous pests of vegetable crops. *Entomon*, **6**, 87-93.

NARAYANAN, K., JAYARAJ, S., and SUBRAMANIAM, T.R. 1973. Control of diamond back moth caterpillar, *Plutella xylostella* (L.) and the green peach aphid, *Myzus persicae* (Sulzer) with insecticides and *Bacillus thuringiensis* Berliner. *Madras Agric. J.*, **62**, 498-503.

RAJAMOHAN, N. and JAYARAJ, S. 1978. Field efficacy of *Bacillus thuringiensis* and some other insecticides against pests of cabbage. *Indian J. Agric. Sci.*, **48**, 672-675.

RUSCOE, C.N.E. 1972. Growth disruption effects of an insect antifeedant. *Nature News Biol.*, **236**, 159-160.

TAN, M.T. and SUDDERUDDIN, K.I.1978. Effects of neem tree (*Azadirachta indica*) extracts on diamond-back moth (*Plutella xylostella* L.). *Malays. J.Appl. Biol.* **7**, 1-9.

THEUNISSEN, J. and OUDEN, H.D. 1978. Influence of some insecticides on the development of caterpillar populations on cabbage. *Neth. J. Plant Pathol.*, **84**, 157-165.

VARMA, G.C. and GILL, G.S. 1977. Laboratory studies in the comparative efficacy of biotic insecticides for the control of *Plutella xylostella*. *J. Res., Punjab Agric. Univ.*, **14**, 304-308.

VARMA, G.C. and GILL, G.S. 1980. Additive effect of pesticides on *Bacillus thuringiensis* Berliner formulations for the control of *Plutella xylostella* (L.). *J. Res,. Punjab Agric. Univ.*, **17**, 157-162.

YEN, D.J. and HSIAO, W.F. 1977. Susceptibility of the diamond-back moth, *Plutella xylostella* to the combinations of micro-pathogens and chemical insecticides. pp. 114-118. In : *Special Issue, Annual Meeting of Agricultural Societies*, Taiwan, ROC.