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RESEARCH PAPER

Studies on time-mortality response of diamondback moth, *Plutela xylostella* L. larvae to different insecticides and in combination with streptocycline

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Abstract : The toxicity of insecticides with bactericide and individual insecticides to test insect was quantified by adopting leaf dip bioassay method and the compatibility was assessed based on median lethal time (LT_{50}). The results clearly revealed that in some combinations toxicity was enhanced while in others the toxicity was lowered. Among seven insecticides in combination with bactericide streptocycline tested for efficacy, four insecticides (chlorantraniliprole, flubendiamide, proton® and profenophos) showed synergistic effect (SF 1.09, 1.04, 1.03 and 1.03, respectively), whereas three insecticides (indoxcarb, novaluron and hamla®) were antagonistic (SF 0.95, 0.94 and 0.92, respectively) against *P. xylostella* larvae.

Key Words : Diamondback moth, Insecticide, Bactericide, Synergism, Antagonism

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INTRODUCTION

Among various insect pests, diamondback moth is the most serious in causing economic loss on cole crops. Though, the moth originated in the Mediterranean area, it has surpassed all the natural barriers and is believed to have become a cosmopolitan pest (Meyriche, 1928). Diamondback moth, *P. xylostella* is one of the most destructive pests of cruciferous vegetables in the world and has been reported from at least 128 countries. In recent years, DBM acquired serious dimension and has become major limiting factor for successful cultivation of cabbage in India (Sexena *et al.*, 1989; Srinivasan and Krishnamoorthy, 1991). Diamondback moth is known to cause yield loss in cabbage from 31 per cent (Abraham and Padmanabhan, 1968) to 100 per cent (Cardleron and Hare, 1986) and the annual cost for managing this pest is estimated to be US $1 billion (Talekar, 1992).

The number of chemicals involved in plant protection is too many and the information on compatibility of individual chemical is scattered in the literature. Common growers find difficulty in ascertaining the compatibility of agro-chemicals. Hence, based on experience Gray (1914) prepared a chart showing compatibility of some insecticides, fungicides and bactericides. Later several charts were developed or updated by Frear (1979), Gruzdyed *et al.* (1983) for the chemicals in use with additional information regarding incompatibility under certain crops, season, aging of mixtures and many other factors. Later Baicu (1980) suggested studying compatibility

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Table A : Details of agrochemicals selected for the bioassay

Sr. No.	Common name	Chemical name	Trade name and formulation	Manufacturing company
Insecticides				
1.	Chlorantraniliprole	3-bromo-*N*-[4-chloro-2-methyl-6-[(methylamino)carbonyl] phenyl]-1-(3-chloro-2-pyridinyl)-1H-pyrazole-5-carboxamide	Coragen® 18.5 SC	E.I. Dupont India Pvt. Ltd., Gurgaon, Haryana
2.	Flubendiamide	3-iodo-*N'*-(2-mesyl-1,1-dimethylethyl)-*N*-{4-[1,2,2,2-tetrafluoro-1-(trifluoromethyl)ethyl]-*o*-tolyl}phthalamide	Fame® 480 SC	Bayer Crop Science India Ltd., Mumbai
3.	Chlorpyriphos + Cypermethrin	*O,O*-diethyl *O*-3,5,6-trichloro-2-pyridyl phosphorothioate +	Hamla® 505 EC	Gharda Chemicals Ltd., Mumbai
4.	Proton	Cocktail of botanicals *viz.*, Langdu root extract (*Stellerachamaejasme* L.)- 2.9 %, CGL extract- 1.50 %, *Brassica campestris*L.- 0.5 %, Eugenol- 9.0 %, Siberian cocklour fruit extract-10 %, Trace elements- 10 % (Venkateshalu*et al*.,2009)	Proton®	United Crop Care, Mumbai
5.	Indoxacarb	Methyl(S)-N-[7-choloro-2,3,4a,5-tetrahydro-4a-Hethoxycarbomyl) indeno [1,2-e]-[1,3,4] oxadiazin-2-ylcarbonyl]-4-(trifluromethoxy)carinilat	Avaunt® 14.5 EC	E.I. Dupont India Pvt. Ltd., Gurgaon, Haryana
6.	Novaluron	1- ô 3-Chloro-4-(1, 1,2-trifluro-2-trifluoromethoxyethoxy) Phenyl	Rimon® 10 EC	Indofil Chemical Company, Mumbai
7.	Profenophos	O-(4-Bromo-2-chlorophenyl)-O-ethyl-S-propyl phosphorothioate	Curacron® 50 EC	Syngenta India Ltd., Mumbai
Bactericide				
1.	Streptocycline	s-Triazine,hexahydro-1,3,5-tris(2,2,3-trichloropropionyl)- (8CI)	Streptocycline®	Hindustan Antibiotics Ltd., Pimri,Pune

in different stages including determination of chemicals and physical properties, biological activity of compounds, field tests of effectiveness, phytotoxcity and yield after treatment. Several insecticide molecules are available in market, but many of them are not tested for the compatibility or recommended by reputed research institutes. Hence, it is necessary to investigate the compatibility of the most common agro-chemicals with respect to insect pest management in cabbage ecosystem. Therefore, the present research was planned with the objective to know influence of bactericide on the bio-efficacy of insecticides.

MATERIAL AND METHODS

Seven insecticides and one bactericide were selected for the expirements and these are presented in Table A.

Bioassay :

For every insecticide and bactericide mixture and individual insecticide, keeping the company's recommendation or farmer's practice as the base, five concentrations in geometric progression were used for each bioassay experiment. For every concentration, three replications of 30 third instar larvae were maintained and the leaves treated with water served as control. Fresh and uniform sized cabbage leaves were dipped in insecticide dilutions for thirty seconds and dried under room temperature. The cut ends of petioles of treated leaves were provided with wet cotton wads to retain the vigour. The treated cabbage leaves were placed in Petridishes. Thirty early third instar larvae of *P. xylostella* were released on treated leaves in each Petridish. The treated larvae were maintained in room temperature and the mortality was recorded at 6, 12, 24, 36, 42 and 48 hours after the treatment.

Observed mortality data were converted to percentages and corrected for control mortality according to Abbott (1925). Observed mortality data were converted to percentage and were subjected to probit analysis (Finney, 1971) for obtaining regression equations for time mortality response and to determine the LT_{50} values.

Synergistic factor (SF) :

The synergistic factor (Kalayanasundaram and Das, 1985) for mixed formulation were calculated after calculating the LT_{50} and LT_{99} for each combination.

$$\text{Synergistic factor} = \frac{\text{Toxicity of insecticide alone}}{\text{Toxicity of insecticide + Bactericide}}$$

A SF value > 1 indicates synergism and an SF value < 1 indicates antagonism.

RESULTS AND DISCUSSION

Compatibility of pesticides is the behaviour of combination with reference to active component that is, whether it has maintained, reduced or potentiated its insecticidal activity. The changes in chemical contents of individual components, their respective characters, formulation, qualities etc., occurring in the mixtures have not been studied deeply for majority of chemicals. If a new chemical discovered then studying its behaviour in the presence of other chemicals is equally important to exploit utilization of more than one chemical at a time in combination. However, only few attempts have been made to study the compatibility problem in the light of increase in number of chemicals. Hence, attempts were made to study the compatibility of insecticides in combination with bactericide under laboratory conditions by using third instar larvae of *P. xylostella*as test insect. The toxicity of insecticides with bactericide and individual insecticides to test insect was quantified by adopting leaf dip bioassay method and the compatibility was assessed based median lethal time (LT_{50}).

The results clearly revealed that in some combinations toxicity was enhanced while in others the toxicity was lowered. The median lethal concentrations of seven insecticides were chlorantraniliprole (27.58 h), flubendiamide (30.33 h), novaluron (40.82 h), indoxacarb (32.35 h), Proton® (35.15 h), Hamla® (28.21 h) and profenophos (36.19 h).

Later the extent of loss or gain in toxicity of test insecticides when mixed with bactericide was quantified based on median lethal time(LT_{50}) and synergistic factor to ascertain the compatibility, some combinations were more toxic and some were less toxic to the test insect compared to insecticides alone. As noticed from the earlier trials inherent insecticidal properties possessed by the bactericide contributed to the larval mortality. Thus, additive effect of the bactericide with insecticides accounted for increase in mortality over insecticides alone and the antagonistic effect may be due to

Table 1 : The time-mortality response of *P. xylostella* larvae to selected insecticides and in combination with streptocycline

Treatments (ppm)	χ^2	Regression equation Y= a ± bx	LT_{50} (h)	Fiducial limits at 95% (h)	LT_{99} (h)	SF	Type of action
Chlorantraniliprole	6.95	4.53±3.14x	27.58	24.14-33.27	151.52		
Chlorantraniliprole + Streptocycline	6.21	4.47±3.06x	25.09	23.06-31.01	147.08	1.09	Synergistic
Flubendiamide	2.89	3.85±2.60x	30.33	25.73-38.70	237.77		
Flubendiamide + Streptocycline	3.32	4.15±2.89x	29.01	24.97-37.06	230.56	1.04	Synergistic
Novaluron	10.17	5.78±3.58x	40.82	33.81-58.48	181.60		
Novaluron + Streptocycline	11.30	5.97±3.62x	42.62	34.26-60.23	187.99	0.95	Antagonistic
Indoxacarb	3.51	5.93±3.93x	32.35	29.07-37.51	126.38		
Novaluron + Streptocycline	4.39	6.17±4.03x	34.09	30.78-39.56	131.02	0.94	Antagonistic
Proton®	4.84	5.57±3.60x	35.15	31.22-41.57	155.32		
Proton® + Streptocycline	4.16	5.21±3.23x	34.06	31.04-40.86	152.39	1.03	Synergistic
Hamla®	5.24	4.59±3.16x	28.21	24.71-33.94	153.22		
Hamla® + Streptocycline	5.95	4.86±3.89x	30.43	25.68-35.04	159.45	0.92	Antagonistic
Profenophos	5.69	6.65±4.26x	36.19	32.77-41.53	127.01		
Profenophos + Streptocycline	5.42	6.48±3.96x	35.04	31.56-40.21	125.89	1.03	Synergistic

Table 2 : Compatibility chart for agro-chemicals tested against *P. xylostella* larvae

Agro-chemicals	Streptocycline
Chlorantraniliprole	+
Flubendiamide	+
Novaluron	-
Indoxacarb	-
Proton®	+
Hamla®	-
Profenophos	+

+ = Compatible - = Incompitable

in-sensitization of insecticidal target sites, resulted in decrease in the susceptibility of pest species involved.

In combination with bactericide streptocycline, LT_{50} values of novaluron, indoxacarb and Hamla® comparatively increased to 42.62, 34.09 and 30.43 h, respectively. Streptocycline interacted antagonistically with novaluron (SF 0.95), indoxacarb (SF 0.94) and Hamla® (SF 0.92). However, in combination with streptocycline, LT_{50} of four insecticides (chlorantraniliprole, flubendiamide, Proton® and profenophos) decreased. These four insecticides when combined with streptocycline, the mortality were increased as compared when insecticides used alone. In combination with streptocycline the LT_{50} values of four insecticides were chlorantraniliprole (25.09 h) (SF 1.09), flubendiamide (29.01 h) (SF 1.04), Proton® (34.06 h) (SF 1.03) and profenophos (35.04 h) (SF 1.03). These four insecticides when combined with streptocycline the LT_{50} values were decreased which shows synergistic nature (Table 1).

No specific studies are available in the literature involving compatibility of above chemical combinations against *P. xylostella* for comparison. However, Raju and Rao (1983) found agrimycin-100 (streptomycin + oxytetracycline) @ 200 ppm + copper oxychloride @ 0.3 per cent + phosalone @ 0.1 per cent applied in late September and 3 more times at 15 days interval gave good control of *Scirtothrips dorsalis* (Hood) and *Hemi tarsonemus latus* (Banks). Vekateswarlu and Ramapandu (1992) reported on compatibility bactericide with insecticides in the control of citrus canker and leaf miner in acidlime. Plots sprayed with streptomycin + tetracycline + copper oxychloride + fenvalerate recorded lowest intensity of canker and *Phyllocnistis citrella*. Pramanik *et al.* (2000) studied on cumulative effect of bactericide and insecticides on detritivore soil arthropods. The combined effects of ampicillin sulphate(bactericide) with the insecticides (endosulfan 35% EC and heptachlor 20 % EC) were highly inhibitory. Haseeb *et al.* (2000) reported on pesticidal effects of two bactericides (kasugamycin and oxolinic acid) in combination three chitin synthesis inhibitors (chlorfluazuron, flufenoxuron and teflubenzuron) were nontoxic on *Diadegma semiclausum* Hellen. Jim *et al.* (2012) reported that application of bactericide streptomycin in combination with fungicides and biological in fruit orchards had affected on European honey bees. From the above discussion present investigations on compatibility can be concluded that insecticides tested were compatible with streptocycline except the novaluron, indoxcarb and Hamla®.

Compatibility conclusion :

From the results of *in vitro* experiments on the interaction of agro-chemicals, a compatibility chart has been prepared and presented in the Table 2. It may be said that insecticides namely chlorantraniliprole, flubendiamide, Proton® and profenophos in combination with streptocycline were clearly compatible against test insect. However, novaluron, indoxacarb and Hamla® in combination with streptocycline were clearly incompatible against test insect. Interestingly, some of the combinations which behaved differently against test insect are to be viewed differently on the basis of desirable action exhibited by the chemicals in the mixture. A mixture of insecticide in combination with bactericide may cause desirable effect on insect or *vice- versa*. If a mixture intended to suppress insect, failed to accomplish and causes adverse effects, such a combination may be rejected. For example, novaluron, indoxacarb and Hamla® in combination with streptocycline resulted in lowering of toxicity to test insect. The literature review also highlighted such variations in compatibility of pesticides this may be due to variability in test organism or crop. In most of the studies, where compatibility among agro-chemicals tried were too low to exert desirable effects. Hence, further combination is needed regarding compatibility and bio-efficacy and compatibility of various pesticidal mixtures at their recommended doses in the laboratory and under field conditions. These combinations can be evaluated for phytotoxicity in field conditions. Baseline studies can be undertaken for individual insecticides, so that the folds of resistance can be worked out.

REFERENCES

Abbott, W.S. (1925). A method of computing the effectiveness of an insecticide. *J. Eco.Ento.*, **18** : 265-267.

Abraham, E.V. and Padmanabhan, M.D. (1968). Bionomics and control of the diamondback moth, *Plutella xylostella* Linn. *Indian J. Agric. Sci.*, **20** : 513-519.

Baicu, T. (1980). Study and classification of the compatibility of pesticides. *Probl. Prot. Plant.*, **6** : 271-279.

Cardleron, J.J. and Hare, C.J. (1986). Control of diamondback moth in South East Asia by profenofos. In: Diamondback moth management, Proceedings of the First International Workshop (Eds. N.S. Talekar and T.D. Griggs) AVRDC, Taiwan, 347-357pp.

Finney, D.T. (1971). *Probit analysis*. (3rd Ed.), Cambridge University Press, 333 pp.

Frear, D.E.H. (1979). Compatibility of common spray materials. *Agril. Chem.*, **4** : 25-28.

Frohlich, G. (1990). The methodology of determining symbionticide effects of chemical agents on greenfly model in combination with *Acyrthosiphon pisum* on *Viciafaba* L. *Beitr. Trop. Landwir. & Veterin.*, **28**(3) : 311-323.

Gray, P. (1914). The compatibility of insecticides and fungicides. Monthly bullitten of California July 1914.

Gruzdyed, G.S., Zinchenko, V.A., Kalilin, V.A. and Soutsov, R.I. (1983). *The chemical protection of plants.* 438-443pp.

Haseeb, M., Amano, H. and Nemoto, H. (2000). Pesticidal effects on mortality and parasitism rates of *Diadegmasemiclausum*, a parasitoid of the diamondback moth. *Biocontrol*, **45**(2) : 165-178.

Jim, A., Doug, G. and Themis, M. (2012). Fungicides, bactericides, and biologicals for deciduous tree fruit, nut, strawberry and vine Crops. UC Davis, Department of Plant Pathology, Bulletin, 1-53pp.

Kalayanasundaram, M. and Das, P.K. (1985). Larvicidal and synergistic activity of plant extracts for mosquito control. *Indian J. Med. Res.*, **82** : 19-21.

Meyriche, E. (1928). *A revised handbook of British Lepidoptera*, (London: Watkins and Doncaster Eds.), 803 pp.

Pramanik, R., Sarkar, K. and Joy, V.C. (2000). Cumulative effect of bactericide and insecticides on nutrient release from leaf litter by detritivore soil arthropods. *Biodiversity and environment*. Proceedings of the National Seminar on Environmental Biology, Visva-Bharati University, Santiniketan, India, 3-5 April, 2000. 102-109pp.

Raju, K.S. and Rao, G.S. (1983). Effect of combined applications of bactericides and insecticides in the control of bacterial leaf spot and sucking pests on chilli. Proceedings of National Seminar on the Production Technology of Tomato and Chillies. 170-174pp.

Sexena, J.D., Rai, S., Srivastava, K.M. and Sinha, S.R. (1989). Resistance in the field populations of diamondback moth to some commonly used synthetic pyrethroids. *Indian J.Ento.*, **51**: 265-268.

Srinivasan, K. and Krishnamoorthy, P.N. (1991). Indian mustard as a trap crop for management of major lepidopterous pests of cabbage. *Trop. Pest Mgmt.*, **37** (1) : 26-32.

Talekar, N.S. (1992). Management of DBM and other crucifer pests: Proceedings of the Second International Workshop, Shanhua, Taiwan, Asian Vegetable Research and Development Centre, 603pp.

Venkateshalu, A.G., Srinivas, SushilaNadagouda and Hanumantharaya, L. (2009). Bio-efficacy of proton, a plant product against fruit borer, *Helicoverpa armigera* (Hubner) on chilli. *Karnataka J. Agric. Sci.*, **22**(3) : 557-558.

Vekateswarlu, C. and Ramapandu, S. (1992). Compatability of fungicides and bactericide with insecticides in the control of citrus canker and leafminer in acidlime. *Indian J. Pl. Pro.*, **20**(1): 27-31.