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SYNERGISTIC EFFECT OF NEEM AND *Pongamia* OILS ON THE BIOEFFICACY OF DELTAMETHRIN AGAINST DIAMONDBACK MOTH, *Plutella xylostella* (L.) (LEPIDOPTERA: YPONOMEUTIDAE) ON CABBAGE

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ABSTRACT: Laboratory and field studies were conducted to assess the synergistic effect of two plant oils *viz*., neem and *Pongamia* on the bioefficacy of deltamethrin 2.5 EC against diamondback moth, *Plutella xylostella* (L.) on cabbage during 2007-2009 at Indian Institute of Horticultural Research, Bangalore. Under laboratory conditions, the combination of deltamethrin @ 0.5 mL/L and *pongamia* oil (0.2 %) resulted in highest efficacy (86.67 %) followed by deltamethrin (0.5 mL/L) and *Pongamia* oil (0.1 %). Under field conditions also, *Pongamia* oil (0.2 %) with deltamethrin (1mL/L) showed good synergism both in terms of reducing *P. xylostella* and in realizing higher marketable yield of cabbage. The findings indicate the potential of plant oils as synergists of synthetic pyrethroids.

Keywords : Diamondback moth, neem oil, *Plutella xylostella*, *Pongamia* oil, synergists

INTRODUCTION

The diamondback moth (DBM), *Plutella xylostella* (L.) has a history of developing resistance to most of the insecticides used against it (Talekar, 1992). Insecticide resistance and control failures are now common and in certain cases, profitable production of cruciferous vegetables has become increasingly difficult (Raju, 1996; Regupathy, 1996). One of the options for the effective control of insect strains known to be resistant to insecticides is to use synergists along with insecticides. Various seed oils *viz*., cotton seed oil, neem oil, *Pongamia* oil, *mahua* oil and sesamum oil were reported to synergise the toxicity of the insecticides to varying levels and can also be used in resistance monitoring studies as inhibitors of MFO's in place of costly synthetic synergists like piperonyl butoxide (Suneel Kumar and Sannveerappanavar, 2003). At present, the synthetic synergists' like piperonyl butoxide are expensive and have to undergo the formalities of registration which involves generating data on various toxicological effects. Keeping in view the availability and economy of the synergists, two plant origin oils *viz*., neem and *Pongamia* oils were tried as synergists along with deltamethrin, a commonly used insecticide against *P. xylostella* on cabbage under laboratory and field conditions.

MATERIALS AND METHODS

The efficacy of two plant oils *viz*., neem and *Pongamia* oil as synergists along with deltamethrin 2.5 EC was tested under laboratory conditions during 2007 with deltamethrin at 0.5 mL/L and both oils at 0.1 and 0.2 per cent concentration. Other treatments included neem and *Pongamia* oils at 0.1, 0.2 and 1 per cent alone and deltamethrin at 0.5mL/L along with control. The experiment was conducted in Completely Randomised Design. Ten third instar larvae of diamondback moth were released in the petri plates containing cabbage leaf disc. The larvae were exposed to the insecticide alone and insecticide + oil mixtures under Potters's spray tower. Liquid soap of 0.1 % was added to the spray fluid as an emulsifier. Two ml of diluted insecticide and insecticide + oil mixture containing soap and other treatments were sprayed directly on the larvae held in Petri dishes at 10 lbs/in^2 pressure and the treated larvae were maintained at 25 ± 1 °C. Each treatment was replicated thrice with 10 larvae as one replication. The treated insects were observed for mortality counts in all the replications of each treatment at 48 hours after treatment. Data were subjected to analysis of variance (ANOVA) and treatment

Table 1. Effect of neem and *Pongamia* oils in enhancing the bio-efficacy of deltamethrin against *P. xylostella*

Treatments	Percent mortality of DBM at 48 HAT	Reduction over control(%)
Deltamethrin 2.5 EC @ 0.5 mL/L	43.33* (41.15)^{de}	30.00
Deltamethrin 2.5 EC @ 0.5mL/L + Neem oil (0.1 %)	53.33 (46.92)^{cd}	50.00
Deltamethrin 2.5 EC @ 0.5mL/L + Neem oil (0.2%)	70.00 (57.70)^{bc}	56.67
Deltamethrin 2.5 EC @ 0.5mL/L + *Pongamia* oil(0.1 %)	80.00 (63.72)^{ab}	66.66
Deltamethrin 2.5 EC @ 0.5ml/l + *Pongamia* Oil (0.2 %)	86.67 (68.85)^{a}	73.34
Pongamia oil (0.1 %)	23.33 (28.78)^{f}	10.00
Pongamia oil (0.2 %)	26.67 (30.78)^{ef}	13.33
Neem oil (0.1 %)	23.33 (28.78)^{f}	10.00
Neem oil (0.2 %)	46.67 (43.08)^{d}	33.34
Neem oil (1.0 %)	60.00 (50.65)^{cd}	46.67
Pongamia oil (1.0 %)	53.33 (46.92)^{cd}	40.00
Control	13.33 (21.15)^{f}	-
CD (*p=0.05*)	**10.19**	
CV (%)	**13.74**	

* Mean of 3 replications
** Figures in parentheses are arc sine transformed values
*** Treatments denoted with same alphabet are statistically non significant.

Table 2. Efficacy of plant oils as synergists with Deltamethrin for *P. xylostella* management (2008)

Treatments	No. of *P. xylostella* larvae/3 plants after*				Yield (kg/ plot)
	I spray	II spray	III spray	Pooled average	
Deltamethrin 2.5 EC @ 0.5 mL/L	11.00 (3.39)^{d}	13.00 (3.67)^{cb}	6.67 (2.68)^{cb}	10.22	16.35
Deltamethrin 2.5 EC @ 1 mL/L	5.87 (2.48)^{c}	5.00 (2.35)^{ba}	1.33 (1.29)^{ba}	4.06	18.64
Deltamethrin 2.5 EC @ 0.5 mL/L + Neem oil (0.2 %)	3.67 (2.42)^{cb}	2.67 (1.77)^{e}	3.33 (1.95)^{e}	3.22	19.47
Deltamethrin 2.5 EC @ 0.5 mL/L + *Pongamia oil* (0.2 %)	3.67 (2.03)^{ba}	6.33 (2.61)^{b}	0.00 (0.71)^{a}	3.33	17.15
Deltamethrin 2.5 EC @ 1 mL/L + Neem oil (0.2 %)	3.33 (1.95)^{a}	2.33 (1.68)^{dc}	1.00 (1.22)^{dc}	2.22	21.83
Deltamethrin 2.5 EC @ 1 mL/L + *Pongamia oil* (0.2 %)	1.67 (1.72)^{a}	1.67 (1.46)^{ed}	0.67 (1.05)^{ed}	1.33	22.75
Neem oil (0.2 %)	14.00 (3.81)^{e}	14.67 (3.89)^{dc}	7.33 (2.80)^{d}	12.00	13.53
Pongamia oil (0.2 %)	12.33 (3.58)^{ed}	16.67 (4.14)^{d}	4.00 (2.11)^{c}	11.00	15.60
Neem soap (1.0 %)	2.33 (1.68)^{a}	7.33 (2.80)^{b}	3.67 (2.04)^{c}	4.44	20.75
Control	14.33 (3.85)^{e}	14.33 (3.85)^{e}	11.67 (3.48)^{e}	13.44	11.52
CD (*p=0.05*)	**0.39**	**0.26**	**0.37**		**5.13**
CV (%)	**8.49**	**5.28**	**11.11**		**16.84**

* Mean of 3 replications

** Figures in parentheses are square root x + 0.5 transformed values

*** Treatments denoted with same alphabet are statistically non significant.

means were compared using DMRT.

Field trials were conducted on cabbage in the research farm of Indian Institute of Horticultural Research, Bangalore (12^{0} 58' N; 77^{0} 35'E), India during 2008 and 2009. For field evaluation, same treatments tested in the laboratory, except oils at 0.1 per cent, were used besides neem soap (1.0%) (Table 2). The experiments were carried out using the cabbage *cv.* Unnati. The experiment was laid out in a Randomized Block Design with three replications. The seedlings were transplanted at a spacing of 45 cm x 45 cm in a plot size of 2.5 m x 3 m in the second week of February in both the years. The recommended package of practices was followed for cultivation of the crop. Three sprays of

Table 3 : Efficacy of plant oils as synergists with deltamethrin against *P. xylostella* (2009)

Treatments	No. of *P. xylostella* larvae/3 plants after*				Yield (kg/ plot)
	I spray	II spray	III spray	Pooled average	
Deltamethrin 2.5 EC @ 0.5 mL/L	9.33 (3.13)^{d}	16.33 (4.10)^{ef}	4.67 (2.28)^{bc}	10.11	15.31
Deltamethrin 2.5 EC @ 1 mL/L	6.33 (2.62)^{c}	11.67 (3.48)^{d}	4.67 (2.27)^{bc}	7.56	17.54
Deltamethrin 2.5 EC @ 0.5 mL/L + Neem oil 0.2 %	6.33 (2.62)^{c}	6.67 (2.68)^{c}	3.33 (2.04)^{bc}	5.44	16.91
Deltamethrin 2.5 EC @ 0.5 mL/L + *Pongamia oil* (0.2 %)	1.33 (1.00)^{a}	4.67 (2.27)^{b}	0.66 (1.17)^{c}	2.22	18.42
Deltamethrin 2.5 EC @ 1 mL/L + *Neem* oil (0.2 %)	10.33 (3.26)^{d}	7.67 (2.80)^{e}	0.67 (1.05)^{c}	6.22	21.01
Deltamethrin 2.5 EC @ 1 mL/L + *Pongamia* oil (0.2 %)	0.67 (1.05)^{b}	3.33 (1.95)^{a}	0.33 (0.88)^{c}	1.44	22.33
Neem oil (0.2 %)	10.67 (3.34)^{d}	17.67 (4.26)^{f}	5.33 (2.42)^{bc}	11.22	12.80
Pongamia oil (0.2 %)	9.67 (3.26)^{d}	16.00 (4.06)^{e}	5.00 (2.35)^{bc}	10.22	14.86
Neem soap (1.0 %)	3.67 (2.04)^{b}	7.33 (2.77)^{c}	3.67 (1.97)^{b}	4.89	19.93
Control	12.00 (3.53)^{d}	21.00 (4.63)^{g}	6.00 (2.55)^{c}	13.00	12.10
CD (*p=0.05*)	**0.39**	**0.18**	**0.50**		**4.03**
CV (%)	**8.75**	**3.22**	**15.30**		**13.73**

* Mean of 3 replications

** Figures in parentheses are square root x + 0.5 transformed values

*** Treatments denoted with same alphabet are statistically non significant.

various treatments were given starting from the crop primordial stage at 15 days interval. Observations on the number of diamondback larva were recorded on three randomly selected plants from each replication, two days after each spraying. Marketable head yield was recorded on plot basis. Data on the number of larvae/plant was transformed to square root of x + 0.5 values, before subjecting them to ANOVA for statistical scrutiny.

RESULTS AND DISCUSSION

Laboratory studies

All the treatments tested for the management of diamondback moth, *P. xylostella* except *pongamia* oil (0.1 % and 0.2 %) were effective over control. Of all the treatments,

deltamethrin (0.5 mL/L) + *Pongamia* oil (0.2 %) was the most effective (86.67 % mortality) followed by deltamethrin @ 0.5 mL/L + *Pongamia* oil @ 0.1 per cent (80.00). Deltamethrin alone resulted in only 43.33 per cent mortality of *P. xylostella* (Table 1).

Field Evaluation - First Year

Of different treatments tried in the field for the *P. xylostella* management, least number of larva were observed in the treatments deltamethrin @1 mL/L + *Pongamia* oil (0.2 %) (1.67/ 3 plants), neem soap (1.0%) (2.33/3 plants), deltamethrin @1 mL/L + 0.2 % (3.33/3 plants), Deltamethrin 0.5 mL/ L + 0.2 % *Pongamia* oil after the first spray. Pooled averages over three sprays revealed deltamethrin 1 mL/L + 0.2 % Pongamia oil (1.33/3 plants) as best treatment followed by deltamethrin 1 mL/L + 0.2 per cent neem oil (2.22 mL/L) (Table 2). However, when yield is taken into consideration, deltamethrin 1 mL/L + *Pongamia* oil (0.2 %) gave the highest yield of 22.75 kg/plot followed by deltamethrin@ 1mL/L + 0.2 % neem oil (21.83 kg/plot) and neem soap 1 % (20.75 kg/ plot) when compared to control (11.52 kg/plot).

Field Evaluation – Second Year

Results followed more or less similar trend in the following year. Least number of larvae was recorded in the treatments deltamethrin 1 mL/L + *Pongamia* oil 0.2 per cent (0.67/ 3 plants), deltamethrin 0.5 mL/L + 0.2 % Pongini oil (P.O). (1.33/3 plants) and neem soap 1 % (3.67/ 3 plants) after the first spray. After second and third sprays also deltamethrin 1 mL/L + 0.2 % *Pongini Pongamia* oil gave highest efficacy (3.33 and 0.33 larvae/3 plants). Pooled averages over three sprays also revealed deltamethrin 1 mL/L + 0.2 % as the best treatment in the management of *P. xylostella* (1.44 larvae/3 plants). When yield is taken into consideration, deltamethrin 1 mL/L + 0.2 % *Pongamia* oil gave the highest yield of 22.33 kg/plot followed by deltamethrin 1 mL/L + 0.2 % neem oil (21.01 kg/plot) and neem soap 1 % (19.93 kg/plot) when compared to control (12.10 kg/plot).

Suneel Kumar and Sannaveerappanavar (2003) recorded sesamum oil and *Pongamia* oil synergism with synthetic pyrethroids *viz*., fenvalerate to the tune of 84.79 and 88.52 per cent, respectively whereas in case of deltamethrin it was 77.19 and 85.65 per cent over pyrethroids alone under laboratory conditions. Similarly, the toxicity of lambda-cyhalothrin was synergized to a greater extent by sesamum oil followed by *Pongamia* oil. Similar observations for synergism of fenvalerate toxicity to field populations of *Helicoverpa armigera* were reported by Sundaramoorthy and Chitra (1992) and Manoharan and Uthamasamy (1993). Gavi Gowda (1996) opined that *Pongamia* oil acted as an MFO inhibitor and the inhibition of the oxidases by *Pongamia* oil may be the reason for synergism of methomyl toxicity. Results from the present study are in conformity with the earlier reports that the *Pongamia* oil may be acting as a MFO inhibitor.

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