Int.J.Curr.Microbiol.App.Sci (2020) *9*(9): 1059-1065

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 9 Number 9 (2020)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2020.909.132

Synergistic Action of Seed Oils with Selected Insecticides against *Spodoptera litura* Fab. (Lepidoptera: Noctuidae)

M. S. Kitturmath[*] and V.T. Sannaveerappanavar

Department of Agricultural Entomology, University of Agricultural Sciences, Bangalore, Karnataka, India

**Corresponding author*

Keywords

Insecticide synergists, Seed oils and insecticides, Insecticide resistance management, *Spodoptera litura*

Article Info

Accepted:
10 August 2020
Available Online:
10 September 2020

A B S T R A C T

The synergistic action of insecticides (endosulfan, monocrotophos, methomyl, cypermethrin and indoxacarb) with seed oils (mahua oil, neem oil, pongamia oil and sesamum oil) against field populations of *S. litura* was studied in the Department of Agricultural Entomology, University of Agricultural Sciences, Bangalore. All the seed oils at 0.1% exhibited varying levels of synergism with five insecticides against the third instar larvae of *S. litura*. The toxicity of endosulfan was enhanced to the highest degree by pongamia oil. The neem oil synergised the toxicity of monocrotophos and methomyl to a greater extent. Similarly, sesamum oil exhibited pronounced synergism with cypermethrin. The toxicity of the oxadiazine compound, indoxacarb was synergised to a greater extent by neem oil, closely followed by *Pongamia* oil. By looking into the degree of synergism, the toxicity of endosulfan increased by 12.98- and 10.65- folds by *Pongamia* oil and neem oil, respectively. Similarly, the toxicity of methomyl was synergised to an extent of 3.27- fold by *Pongamia* oil. The seed oils of sesamum and neem synergised the toxicity of cypermethrin and indoxacarb by 7.61- and 1.66- folds, respectively.

Introduction

The tobacco caterpillar, *Spodoptera litura* Fab. (Noctuidae: Lepidoptera) which was known earlier to be a sporadic pest, has emerged as destructive polyphagous pest in the recent past. This pest is distributed throughout southern and eastern world, infesting more than 112 crop species belonging to 44 families, of which 40 species are known from India. This pest is receiving greater attention in recent years in toxicological studies, mainly due to its seemingly unlimited propensity to develop resistance to many insecticides because of high selection pressure. So, resistance in *S. litura* has become one of the major obstacles for the profitable cultivation of commercial crops and vegetables. Hence, insect control methods must incorporate strategies to minimize resistance development and sustain the utility of insecticides. One such approach is the use of seed oils as insecticide synergists. These vegetative oils have meager insecticidal effects of their own, but serve to enhance the toxicity of insecticides to a greater extent when used in combination. The seed oils as insecticide synergists, not only enhance the effectiveness of the insecticides but also bring down the cost of protection and even delay the development of resistance to insecticides by inhibiting the metabolic pathways and thus form the elite component in present day pest management. In this context, a study has been conducted to know the synergistic action of seed oils with selected insecticides against *S. litura*.

Material and Methods

The seed oils of neem, mahua (hippe), *Pongamia* (honge / karanj) and sesamum were tested for their synergistic potential at 0.1 per cent concentration along with five insecticides belonging to different groups *viz*., endosulfan, monocrotophos, methomyl, cypermethrin and indoxacarb at their recommended doses.

The larvae were collected from the cauliflower fields in and around Malur and were reared to F_1 progeny on semisynthetic diet. Uniform sized third instar larvae were exposed to insecticide alone and insecticide and oil mixtures using Potter's spray tower. Liquid soap (0.1%) was added to the spray fluid as an emulsifier. One ml of aqueous fluid containing insecticide and oil was sprayed directly on the larvae held in Petri plates on castor leaf discs (5cm x 5cm) provided with wet cotton wad at 1.1 kg/cm^2 pressure. Each treatment was replicated thrice in batches of fifteen larvae. In case of control, the larvae were sprayed with aqueous fluid devoid of toxicant. The treated larvae along with leaf discs were then transferred to separate plastic boxes (11cm x 7cm x 5cm). The post-treatment operations involved transferring of plastic boxes containing treated larvae into the BOD incubator where 25±1^{o}C temperature and relative humidity of 70 per cent were maintained. The treated larvae were observed for mortality counts at 48 and 96 hrs after the treatment. The fresh castor leaves were provided as and when required. The data were subjected to statistical analysis. Further, the per cent increase in larval mortality due to the combinations over insecticide alone was calculated by using the formula:

% increase in mortality over insecticide alone =

$$\frac{(\text{\% mortality in insecticide + seed oil}) - (\text{\% mortality in insecticide alone})}{\text{\% mortality in insecticide + seed oil}}$$

Finally, the promising insecticide-seed oil combinations were selected for further bio-assays to quantify the level of joint action.

Quantification of synergism

The 'leaf-dip' assay method was adopted to determine the median lethal concentration (LC_{50}) values in order to quantify the level of joint action of promising seed oil-insecticidal combinations. The median lethal concentrations were determined for insecticides alone and insecticide-oil mixtures using third instar larvae (F_1 progeny). For every insecticide, bracketing was done to fix an appropriate dosage range causing five to ninety five per cent mortality of third instar larvae. At least five concentrations in geometric progression were used for each bio-assay. For every concentration, three replications of fifteen larvae were maintained. Fresh, uniform sized castor leaf discs (5cm x 5cm) were immersed in aqueous insecticide dilutions containing 0.1 per cent soap for ten seconds with gentle agitation. The leaf discs dipped in the distilled water containing soap solution served as control. The excess insecticidal fluid present on the leaf discs was allowed to drip-off and the discs were air dried under a ceiling fan. The treated leaf discs were then transferred individually to plastic boxes (11 x 7 x 5cms) with the leaf adaxial surface facing upwards and fifteen third instar larvae (7±1 days old) were released. The post treatment mortality was recorded up to four days at an interval of 24 hours. Observed mortality data were converted into percentages and corrected for control mortality according to Abbott (1925). The corrected mortality values were subjected to probit analysis (Finney, 1971) for developing regression equations for dosage-mortality response and to determine the LC_{50} values.

Similarly, the same 'leaf-dip' assay was employed to establish the median lethal concentrations (LC_{50s}) for the promising seed oil-insecticide combinations. The level of synergism was ascertained by calculating the synergistic ratio (SR) as a quantitative measurement of interaction between the two compounds by using the formula,

$$\text{Synergistic ratio (SR)} = \frac{LC_{50} \text{ of insecticide alone}}{LC_{50} \text{ of insecticide + seed oil combination}}$$

Results and Discussion

The results on the synergistic action of seed oils on the toxicity of different insecticides on the third instar larvae of *S. litura* are presented in the Table 1. The combination of endosulfan and *Pongamia* oil caused the highest larval mortality (82.22%) followed by endosulfan + neem oil (75.56%) and endosulfan + sesamum oil (71.11%) at 96 hours after the treatment. The per cent increase in larval mortality over endosulfan alone was highest for endosulfan + *Pongamia* oil (24.32%) thus indicating strong synergism between them. When monocrotophos was combined with seed oils, the highest larval mortality was observed in case of monocrotophos + neem oil combination (26.67%) which was significantly superior over the larval mortality caused by monocrotophos alone (8.89%). The other seed oils failed to synergise the toxicity of monocrotophos significantly. The per cent increase in larval mortality over monocrotophos alone was also highest in the combination of monocrotophos + neem oil (66.67%). Among the different seed oils, the neem oil significantly enhanced the toxicity of an oxime carbamate, methomyl by causing 97.78% larval mortality and 13.64% increase in larval mortality over methomyl alone. The cypermethrin alone caused only 8.89 per cent larval mortality thus indicated that the test population was highly tolerant to the insecticide. When it was combined with seed oils, sesamum and *Pongamia* oils synergised the toxicity to a greater extent causing 71.11 and 51.11 per cent larval mortality, respectively. The mahua oil failed to enhance the toxicity of pyrethroid, cypermethrin. The per cent increase in larval mortality over cypermethrin alone was highest in the combination of cypermethrin + sesamum oil (87.50%) followed by cypermethrin + *Pongamia* oil (82.61%), cypermethrin + neem oil (66.67%) and cypermethrin + mahua oil (50.00%). The toxicity of an oxadiazine compound, indoxacarb was synergised significantly by seed oils of neem and *Pongamia*. The combination of indoxacarb + neem oil caused the highest larval mortality (93.33%) followed by the combinations of indoxacarb + *Pongamia* oil (88.89%), indoxacarb + mahua oil (86.67%) and indoxacarb + sesamum oil (84.44%). However, the mixing of indoxacarb with seed oils of neem, *Pongamia* and mahua resulted in 26.19, 22.50 and 20.51 per cent increase in larval mortality, respectively over indoxacarb alone.

Table.1 Synergistic action of seed oils on the toxicity of different insecticides on *Spodoptera litura*

Treatments	Endosulfan (0.087%) + seed oils		Monocrotophos (0.054%)+ seed oils		Methomyl (0.064%) + seed oils		Cypermethrin (0.0125%) + seed oils		Indoxacarb (0.0073%) + seed oils	
	larval mortality (%) at 96 hours after treatment	Increase in larval mortality (%) over endosulfan alone	Larval mortality (%) at 96 hours after treatment	Increase in Larval mortality (%) over monocrotophos alone	larval mortality (%) at 96 hours after treatment	Increase in larval mortality (%) over methomyl alone	Larval mortality (%) at 96 Hours after treatment	Increase in larval mortality (%) over cypermethrin alone	Larval mortality (%) at 96 hours after treatment	**Increase in Larval mortality (%) Over indoxacarb alone**
Insecticide alone	62.22 (52.19) [b]	_	8.89 (17.12) [b]	_	84.44 (66.87) [c]	_	8.89 (17.12) [d]	_	68.89 (56.31) [b]	**_**
Mahua oil (0.1%)	68.89 (56.13) [b]	9.68	13.33 (21.41) [b]	33.31	86.67 (68.59) [bc]	2.57	17.78 (24.64) [cd]	50.00	86.67 (69.02) [a]	**20.51**
Neem oil (0.1%)	75.56 (60.42) [ab]	17.65	26.67 (30.97) [a]	66.67	97.78 (84.63) [a]	13.64	26.67 (30.97) [c]	66.67	93.33 (77.68) [a]	**26.19**
***Pongamia* oil (0.1%)**	82.22 (65.15) [a]	24.32	20.00 (26.36) [ab]	55.56	91.11 (72.88) [bc]	7.32	51.11 (45.69) [b]	82.61	88.89 (71.17) [a]	**22.50**
Sesamum oil (0.1%)	71.11 (57.70) [b]	12.50	17.78 (24.85) [ab]	50.00	86.67 (68.59) [bc]	2.57	71.11 (57.70) [a]	87.50	84.44 (66.87) [ab]	**18.42**
Control (water spray)	0.00 (0.00) [c]	_	0.00 (0.00) [c]	_	0.00 (0.00) [d]	_	0.00 (0.00) [e]	_	0.00 (0.00) [c]	**-**
S.Em ± CD @ 5%	**2.36 7.27**	**_ _**	**2.34 7.22**	**_ _**	**2.64 8.14**	**_ _**	**3.08 9.48**	**_ _**	**3.67 11.33**	**_ _**

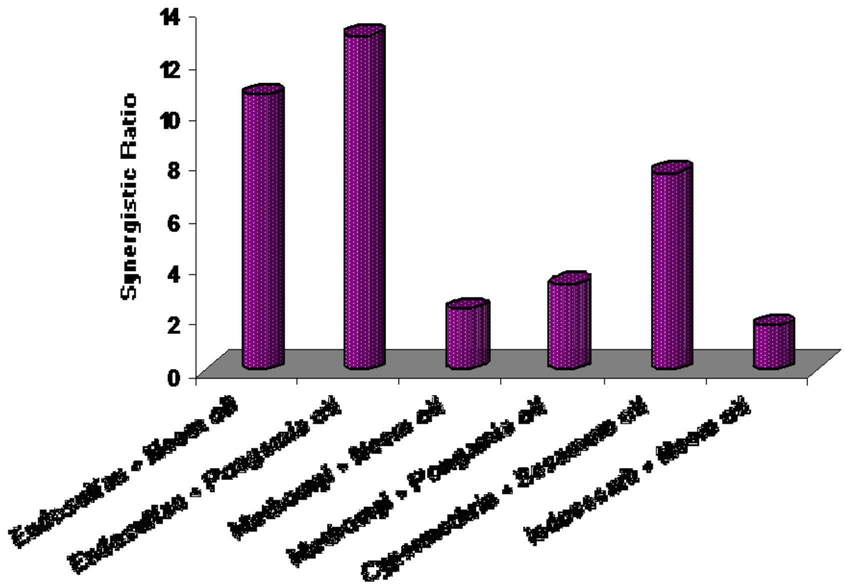
Table.2 Probit analysis of dosage - mortality response of *Spodoptera litura* larvae to insecticides and selected combinations of insecticide and seed oils

Treatment	χ^2 (n-2)	Regression Equation	LC_{50} (µg a.i. ml^{-1})	Fiducial Limit (95%) (µg a.i. ml^{-1})
Endosulfan	0.44 (3)	Y = -5.20658+1.85794x	634.36	**499.76 – 798.37**
Methomyl	2.54 (3)	Y = -4.29159+2.12205x	105.29	**85.07 – 129.50**
Cypermethrin	4.12 (4)	Y = -4.67738+1.65442x	671.75	**527.92 – 854.77**
Indoxacarb	2.15 (4)	Y = -1.24189+1.52984x	6.48	**5.02 – 8.39**
Endosulfan + Neem oil	3.21 (5)	Y = -2.58255+1.45521x	59.54	**44.66 - 76.77**
Endosulfan + *Pongamia* oil	3.44 (4)	Y = -3.19486+1.89165x	48.86	**38.96 - 60.53**
Methomyl + Neem oil	1.30 (4)	Y = -2.69633+1.62743x	45.37	**35.70 - 58.56**
Methomyl + *Pongamia* oil	2.35 (4)	Y = -2.78959+1.84962x	32.23	**25.87 - 40.27**
Cypermethrin + Sesamum oil	2.10 (5)	Y = -2.44879+1.25863x	88.23	**66.51 - 118.21**
Indoxacarb + Neem oil	**1.09 (3)**	**Y = -1.44310+2.43536x**	**3.91**	**3.24 - 4.73**

Table.3 The extent of synergistic effect of seed oils on the toxicity of insecticides to *Spodoptera litura*

Treatment	LC_{50} (µg a.i. ml^{-1})	Synergistic Ratio (SR)
Endosulfan	634.36	_
Endosulfan + Neem oil	59.54	**10.65**
Endosulfan + Pongamia oil	48.86	**12.98**
Methomyl	105.29	_
Methomyl + Neem oil	45.37	**2.32**
Methomyl + Pongamia oil	32.23	**3.27**
Cypermethrin	671.75	_
Cypermethrin + Sesamum oil	88.23	**7.61**
Indoxacarb	6.48	_
Indoxacarb + Neem oil	**3.91**	**1.66**

Figure.1 The extent of synergism by seed oils on the toxicity of insecticides to *S. litura*



The relative degree of synergism between the selected combinations was quantified by establishing the median lethal concentrations (LC_{50s}) (Table 2) and synergistic ratios (Table 3 and Fig. 1). The LC_{50} values of the organochlorine compound, endosulfan was 634.36 µg a.i. ml^{-1}. When the insecticide was combined with *Pongamia* and neem oils (both at 0.1%), the LC_{50} of endosulfan was reduced to 48.86 and 59.54 µg a.i. ml^{-1}, respectively. Similarly, the LC_{50} of methomyl was reduced from 105.29 µg a.i. ml^{-1} to 32.23 and 45.37 µg a.i. ml^{-1} when it was combined with *Pongamia* and neem seed oils (both at 0.1%), respectively. The addition of sesamum oil (0.1%) also drastically reduced the LC_{50} of cypermethrin from 671.75 to 88.23 µg a.i. ml^{-1}. Likewise, the LC_{50} of indoxacarb (6.48 µg a.i. ml^{-1}) was reduced to 3.91 µg a.i. ml^{-1} by adding neem oil (0.1%).

The toxicity of endosulfan was synergised to a greater extent by *Pongamia* and neem oils with the corresponding synergistic ratios of 12.98- and 10.65- folds. As observed in the present study, the pronounced synergism of several organochlorine compounds by *Pongamia* oil against *Helicoverpa armigera* (Gavi Gowda, 1996), *Pluitella xylostella* (Suneel Kumar, 2001), *Musca domestica* (Anon., 1966) and *Tribolium castaneum* (Parmar *et al*., 1975) have been well documented. Likewise, the sesamum oil produced pronounced synergism with cypermethrin (7.61- fold). The synthetic pyrethroids are mainly detoxified by oxidases in insects. The inhibition of MFOs by sesamum oil might be the reason for higher level of synergism of toxicity of cypermethrin. In the same way, sesamum oil was found to be the best synergist for synthetic pyrethroids against *S. litura* (Rame Gowda, 1999), *H. armigera* (Gavi Gowda, 1996) and *P. xylostella* (Suneel Kumar, 2001). The toxicity of an oxime carbamate, methomyl was synergised to a moderate extent by *Pongamia* and neem oils with synergistic ratios of 3.27 and 2.32, respectively. The inhibition of the oxidases by *Pongamia* oil might be the reason for synergism of methomyl toxicity. The present findings are in agreement with the findings of

Suneel Kumar (2001) who also obtained 14.88- and 8.42- fold synergism of methomyl by the addition of *Pongamia* oil and neem oil, respectively against diamondback moth larvae. On the other hand, neem oil synergized the toxicity of indoxacarb only to certain extent with the synergistic ratio of 1.66- fold.

It is evident from the present study that, oils of *Pongamia* and neem showed better synergistic effect with endosulfan and methomyl against third instar larvae of *S. litura*. Likewise, sesamum oil exhibited pronounced synergism with synthetic pyrethroid, cypermethrin. On the other hand, neem oil produced lesser synergistic activity with the oxadiazine compound, indoxacarb.

References

Abbott, W.S., (1925). A method for computing the effectiveness of an insecticides. *J. Econ. Entomol.*, 18: 265-267.

Anonymous, (1966). *Annual Report*, Regional Research Laboratory, Hyderabad, C.S.I.R., India, 33: 22-28.

Finney, D.J., (1971). *Probit analysis*. Third edition. S. Chand and Co. Ltd. New Delhi. pp333.

Gavi Gowda, (1996). Studies on synergism with reference to the insecticide resistance management of *Helicoverpa armigera* (Hubner). *Ph.D. Thesis*, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu.

Parmar, B.S., S. Attri, R.P. Singh and S.K. Mukherje (1975). Karanja oil as a synergist for chlorinated insecticides. *Pesticides*, 29-30.

Rame Gowda, G.K. (1999). Studies on resistance to insecticides in *Spodoptera litura* (Fabricius) on groundnut. *M.Sc. (Agri) Thesis*, University of Agricultural Sciences, Dharwad, Karnataka.

Suneel Kumar, G.V. (2001). Synergism of synthetic insecticides by selected seed oils against diamondback moth, *Plutella xylostella* (L) (Lepidoptera: Yponomeutidae). *M.Sc. (Agri) Thesis*, University of Agricultural Sciences, Bangalore, Karnataka.

How to cite this article:

Kitturmath, M.S. and Sannaveerappanavar, V.T. 2020. Synergistic Action of Seed Oils with Selected Insecticides against *Spodoptera litura* Fab. (Lepidoptera: Noctuidae). *Int.J.Curr.Microbiol.App.Sci.* 9(09): 1059-1065. doi: https://doi.org/10.20546/ijcmas.2020.909.132