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Insecticide resistance in field populations of tobacco caterpillar, *Spodoptera litura* Fabricius (Lepidoptera: Noctuidae)

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ABSTRACT: Assessment of insecticide resistance in field populations of *Spodotera litura* collected from three districts of Kerala against certain commonly used insecticide molecules like chlorpyriphos, quinalphos, lambda cyhalothrin and cypermethrin showed that population collected from Aleppy was found to be susceptible for all the chemicals tested with resistance ratio -1, population collected from Thiruvananthapuram was found to be resistant with resistance ratios of 6.14, 2.46, 8.50 and 6.47 respectively followed by Pathanamthitta with resistance ratios of 2.62, 1.03, 2.29 and 1.34 for chlorpyriphos, quinalphos, lambda cyhalothrin and cypermethrin respectively.

KEY WORDS: *Spodoptera litura*, insecticide resistance, insecticides

INTRODUCTION

Tobacco caterpillar, *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae) is a polyphagous insect pest causing heavy damage to more than 115 species of plants and various agricultural crops (Atwal and Dhaliwal, 2009). It is also known as tobacco cutworm and is an native pest of several economically important crops grown all over the South Asian countries causing more than 26-100 % yield losses (Dhir *et al*., 1992). In order to alleviate the losses due to this pest, farmers often resorted to chemical interventions involving conventional organophosphates, carbamates, synthetic pyrethroids and some selected new chemistry molecules resulted in development of resistance and subsequent control failures (Kranthi *et al*., 2002; Abbas *et al.,* 2014; Saleem *et al.,* 2016).

In India, organophosphates and synthetic pyrethroids have been used as dominant insecticides in tobacco caterpillar management programs. In early 1980s, mid-1990s and early 2000s, its population in Andhra Pradesh and Tamil Nadu were highly resistant to synthetic pyrethroids, lindane, endosulfan, carbaryl and malathion (Kranthi *et al.,* 2002).

Resistance to insecticides is one of the major obstacles associated with the chemical control of insect pests. *S. litura* has been shown to be resistant to a wide range of insecticides, which has led to the unpredictable out breaks of the pest and subsequent crop failures (Ahmad *et al.,* 2007). *S. litura* from Indo-Pakistan subcontinent has been reported to evolve resistance to synthetic pyrethroids, organophosphates and carbamates (Saleem *et al.,* 2008). Resistance against old

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generation insecticides like quinalphos, monocrotophos, lindane and endosulfan was observed in the population of *S.litura* in Pakistan (Ahmad *et al.,* 2008).

Insecticide resistance is one of the most important phenomenon that threatens sustainable pest management programmes. Hence it is important to detect resistance at its budding level and monitor its increase and further spread so as to implement appropriate measures to restrain its increase. Hence the present study was undertaken to assess the resistance levels in field collected *S. litura* in South Kerala.

MATERIALS AND METHODS

The study pertaining to assessment of insecticide resistance in tobacco caterpillar, *Spodoptera litura* Fabricius (Lepidoptera: Noctuidae) against the widely used chemicals like chlorpyriphos, quinalphos, lambda-cyhalothrin and cypermethrin was carried out in department of Agricultural Entomology, College of Agriculture, Vellayani during 2014-2015.

Field collection of larvae: The eggs and first instar larvae of *S.litura* collected from the infested vegetable fields grown in the three different districts of South Kerala *viz.* Aleppy (field with no previous history of pesticide application), Thiruvananthapuram and Pathanamthitta. The three populations were mass reared on artificial diet (Gupta *et al*., 2005) for continuous supply of second instar larvae for conducting bioassay.

Insecticides: The second instar larvae of *S.litura* were tested against different concentrations of commonly used insecticides belonging to different groups' *viz.* chlorpyriphos (classic 20 EC), quinalphos (ekalux 25 EC), cypermethrin (mehagit 10 EC) and lambda-cyhalothrin (karate 5 EC). Bioassay was carried out by using commercial grade formulations of insecticides.

Bioassay: Leaf dip bioassay as described by Hill and Foster (2000) was conducted to determine the response *S. litura* against the test insecticides. Fresh untreated castor leaves were collected from the field and dipped in accurate dilutions of test insecticides for 25-30 seconds with gentle agitation. The treated leaves were pat dried by using tissue papers to remove excess moisture and kept in polyvinyl containers (8cm × 11cm). Ten freshly moulted second instar larvae were released in to the plastic containers with treated leaves. The containers were covered with muslin cloth by using rubber bands to prevent the escape of the larvae. Each insecticide was treated at 7 different concentrations in three replications. Mortality was noted after 12, 24 and 48 hours of treatment. All the mortality data were corrected for the control treatment using Abbott's formula. The data was subjected to Probit analysis using SPSS software to calculate LC_{50} for each insecticide with 95 % corresponding fiducial limits. The population with least LC_{50} was considered as susceptible reference and degree of resistance attained by *S. litura* (Resistance ratio) was calculated by dividing the higher LC_{50} value of a population with a lower LC_{50} value of susceptible reference for each insecticide.

RESULTS AND DISCUSSION

Toxicity of chlorpyriphos to the population of *S. litura* collected from three locations is presented in Table 1. LC_{50} of chlorpyriphos observed in the population of *S. litura* collected from Aleppy was 0.64 ppm after 48 hours of treatment with fiducial limits (95 %) of 0.43-0.84 ppm. However, the LC_{50} of chlorpyriphos was 1.68 ppm after 48 hours of treatment in population of *S .litura* sampled from Pathanamthitta with fiducial limits of 1.10-3.73 ppm and higher LC_{50} of chlorpyriphos (3.93 ppm) were observed in population collected from Thiruvananthapuram with corresponding fiducial limits worked out to be 4.70 - 6.16 ppm respectively. The population of *S. litura* collected from Thiruvananthapuram and Pathanamthitta showed the resistance ratios of 6.14 and 2.62 respectively when compared to susceptible population collected from Aleppy.

Toxicity of quinalphos to the population of *S.litura* collected from three locations is presented in

Table 2. LC_{50} of quinalphos observed in the population of *S.litura* collected from Aleppy was 3.93 ppm after 48 hours of treatment with fiducial limits (95 %) of 3.31 – 4.41 ppm. However, the LC_{50} of quinalphos was 4.08 ppm after 48 hours of treatment in population of *S.litura* sampled from Pathanamthitta with fiducial limits of 3.54 – 4.53 ppm and it was 9.68 ppm in population collected from Thiruvananthapuram with corresponding fiducial limits worked out to be 4.16–5.28 ppm respectively. The population of *S. litura* collected from Thiruvananthapuram and Pathanamthitta showed the resistance ratios of 2.46 and 1.03 and respectively.

Toxicity of lambda-cyhalothrin to the population of *S. litura* collected from three locations is presented in Table 3. LC_{50} of lambda-cyhalothrin observed in the population of *S.litura* collected from Aleppy was 3.05 ppm after 48 hours of treatment with fiducial limits (95 %) of 2.72-3.36 ppm. However, the LC_{50} of lambda-cyhalothrin was 7.00 ppm after 48 hours of treatment in population of *S. litura* sampled from Pathanamthitta with fiducial limits of 6.31-7.66 ppm and it was 25.93 ppm in population collected from Thiruvananthapuram with corresponding fiducial limits worked out to be 22.31-29.61 ppm respectively. The population of *S. litura* collected from Pathanamthitta showed the resistance ratio of 2.29 and higher resistance ratio of 8.50 fold was noticed in population of *S. litura* collected from Thiruvananthapuram.

Toxicity of cypermethrin to the population of *S. litura* collected from three locations is presented in Table 4. LC_{50} of cypermethrin observed in the population of *S.litura* collected from Aleppy was 1.98 ppm after 48 hours of treatment with fiducial limits (95 %) of 3.27-4.30 ppm. However, the LC_{50} of cypermethrin was 2.67 ppm after 48 hours of treatment in population of *S.litura* sampled from Pathanamthitta with fiducial limits of 2.24-3.03 ppm and it was12.83 ppm in population collected from Thiruvananthapuram with corresponding fiducial limits worked out to be 10.49-14.77 ppm respectively. The population of *S. litura* collected from Pathanamthitta showed the resistance ratio of 1.34 and higher resistance ratio of 6.47 fold was

Table 1. LC_{50} values of chlorpyriphos tested with different selected populations of *S. litura*

Location	LC_{50} (ppm)	FL at 95% CL		χ^2	Slope(± SE)	df	Resistance ratio based on LC_{50}
		Lower	Upper				
Thiruvananthapuram	3.93	4.70	6.16	8.84	2.75 (± 0.317)	7	6.14
Pathanamthitta	1.68	1.10	3.73	7.54	1.81 (± 0.257)	6	2.62
Aleppy	0.64	0.43	0.84	5.07	1.62 (± 0.293)	6	1

LC_{50} – Lethal concentration

Table 2. LC_{50} values of quinalphos tested with different selected populations of *S. litura*

Location	LC_{50} (ppm)	FL at 95% CL		χ^2	Slope(± SE)	df	Resistance ratio based on LC_{50}
		Lower	Upper				
Thiruvananthapuram	9.68	4.16	5.28	11.87	3.15 (± 0.261)	14	2.46
Pathanamthitta	4.08	3.54	4.53	3.30	3.67 (± 0.438)	8	1.03
Aleppy	3.93	3.31	4.41	4.18	3.38 (± 0.427)	8	1

LC_{50} – Lethal concentration

Table 3. LC_{50} values of lambda-cyhalothrin tested with different selected populations of *S. litura*

Location	LC_{50} (ppm)	FL at 95% CL		χ^2	Slope(± SE)	df	Resistance ratio based on LC_{50}
		Lower	Upper				
Thiruvananthapuram	25.93	22.31	29.61	4.64	1.40(± 0.218)	14	8.50
Pathanamthitta	7.00	6.31	7.66	1.11	1.45 (± 0.183)	10	2.29
Aleppy	3.05	2.72	3.36	0.939	1.42 (± 0.178)	10	1

LC_{50} –Lethal concentration

Table 4. LC_{50} values of cypermethrin tested with different selected populations of *S. litura*

Location	LC_{50} (ppm)	FL at 95% CL		χ^2	Slope(± SE)	df	Resistance ratio based on LC_{50}
		Lower	Upper				
Thiruvananthapuram	12.83	10.49	14.77	12.07	1.13 (± 0.179)	14	6.47
Pathanamthitta	2.67	2.24	3.03	0.817	1.35 (± 0.301)	6	1.34
Aleppy	1.98	1.27	2.15	6.541	1.24 (± 0.219)	6	1

LC_{50} –Lethal concentration

noticed in population of *S. litura* collected from Thiruvananthapuram.

The *S. litura* population collected from Thiruvananthapuram and Aleppy had the maximum andminimum LC_{50} values. However, data showed that *S. litura* populations collected from aleppy and Pathanamthitta are on par against quinalphos with reference to the overlapped fiducial limits, while resistance levels of the three populations were significantly different with respect to other test chemicals chlorpyriphos, cypermethrin and lambda-cyhalohrin.

Genetic inheritance and indiscriminate application of insecticides are the two major factors responsible for resistance phenomenon in insects. Tobacco caterpillar has a short life cycle with very high fecundity as a result it is often exposed to multiple sprays of insecticides used for containing it which led to high selection pressure which finally resulted in resistance development. The results of the present study are in close conformity with the findings of Kranthi *et al.* (2001, 2002) who also reported the insecticide resistance in *S. litura* against the chlorpyriphos, quinalphos and cypermethrin in India. Though several research works have been conducted on insecticide resistance against tobacco caterpillar, studies in Kerala was scanty. Thus the present study was undertaken as a maiden attempt in assessing the extent of insecticide resistance of *S.litura* in Kerala. Further studies have to be taken up to delay the development of resistance through various management programmes.

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REFERENCES

Ahmad M., Sayyed A. H., Saleem M. A. and Ahmad M. (2008). Evidence for field evolved resistance to newer insecticides in *Spodoptera litura* (Lepidoptera: Noctuidae) from Pakistan. Crop Protection 27: 1367-1372.

Ahmad M., Sayyed A.H., Crickmore N. and Saleem M.A. (2007). Genetics and mechanism of resistance to deltamethrin in a field population of *Spodoptera litura* (Lepidoptera: Noctuidae). Pest Management Science 63: 1002-1010.

Atwal A.S. and Dhaliwal G.S. (2009). *Agricultural Pests of South Asia and their Management*. Kalyani Publishers, New Delhi. 300p.

Dhir B.C., Mohapatra H.K. and Senapati B. (1992). Assessment of crop loss in groundnut due to tobacco caterpillar, *Spodoptera litura* (F.). Indian Journal of Plant Protection 20(2): 215-217.

Gupta G.P., Rani S., Birah A. and Raghuraman M. (2005). Improved artificial diet for mass reaing of the tobacco caterpillar, *Spodoptera litura* (Lepidoptera: Noctuidae). International Journal of Tropical Insect Science 25(1):55-58.

Hill T. A. and Foster R. E. (2000). Effect of insecticides on diamondback moth (Lepidoptera: Plutellidae) and its parasitoid, *Diadegma insulare* (Hymenoptera: Ichneumonidae). Journal of Economic Entomology 93: 763-768.

Kranthi K.R., Jadhav D.R., Kranthi S., Wanjari R.R., Ali S.S. and Russell D.A. (2002). Insecticide resistance in five major insect pests of cotton in India. Crop Protection 21: 449-460.

Kranthi K.R., Jadhav D.R., Wanjari R.R., Ali S.S., and Russell D. (2001). Carbamate and organophosphate resistance in cotton pests in India, 1995 to 1999. Bulletin of Entomological Research 91: 37-46.

Saleem M. A., Ahmad M., Ahmad M., Aslam M., and Sayyed A.H. (2008). Resistance to Selected Organochlorin, Organophosphate, Carbamate and Pyrethroid, in *Spodoptera litura* (Lepidoptera: Noctuidae) from Pakistan. Journal of Economic Entomology 101: 1667-1675.

Saleem M., Hussain D., Ghouse G., Abbas M. and Fisher S.W. (2016). Monitoring of insecticide resistance in *Spodoptera litura* (Lepidoptera: Noctuidae) from four districts of Punjab, Pakistan to conventional and new chemistry insecticides. Crop Protection 79:177-184.

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