COMPARATIVE EFFICACY OF SELECTED LESS MAMMALIAN TOXIC INSECTICIDES AGAINST TOBACCO CUTWORM (*SPODOPTERA LITURA*)

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Abstract. Tobacco plant (*Nicotiana tabacum*) is susceptible for cutworm damage (*Spodoptera litura*) particularly during its vegetative phase. Chlorpyrifos is the currently used insecticide and its direct application is toxic to mammalians and causes environmental pollution too. Therefore it is required to phase out chlorpyrifos with a replacement of an alternative insecticide. A nursery trial was carried out to assess the comparative efficacy of five less mammalian toxic insecticides; Methoxyfenozide, Spinosad, Tebufenozide, Etofenoprox, Flubendiamide with Chlorpyrifos (standard check) at the rates of 10 ml, 15 ml, 10 ml, 10 ml, 4 g and 20 ml respectively per 10 l of water in a commercial tobacco nursery at Galewela, Sri Lanka. The experiment was laid out in Randomized Complete Block Design with seven treatments including the control (water). There were three replicates of each treatment where 10 identical cutworms of second instar level were introduced randomly to each treatment plot. Mean larval mortality was recorded at 1, 3, 5, 7, 9, 12 and 15 days following the application. Results revealed that Chlorpyrifos and Methoxyfenozide were found to be superlative insecticides against *Spodoptera litura* recording mean larval mortalities of 8.333 and 8.667 respectively at seven days after application followed by Spinosad and Flubendiamide registering mean larval mortalities of 6.333 and 4.000 respectively. Etofenoprox and Tebufenozide proved to be ineffective as they inflicted a low level of mortality. Therefore, Methoxyfenozide can substitute for chlorpyrifos discontinuing its application.

Keywords: Tobacco, *Spodoptera litura*, Chlorpyrifos

1.0 Introduction: In Sri Lanka, cigarette tobacco production is done by the registered farmers for a pre-trade agreement while other types are grown purely on freelance basis and hence cigarette tobacco production has a better accountability. It is a great matter of concern that, tobacco plant is susceptible for cutworm damage during its life cycle eventually making inconsistent production. It causes a considerable damage to the tobacco plant particularly in the vegetative growth. The cutworm damage is more severe in the field level and in many cases it is present in the nursery level too. It has been clearly discovered the demerits of the prevailing pest and chemical control has been playing a leading role for a long period of time as it has become more successful in its efficacies. Chlorpyrifos 40 EC, a broad spectrum contact insecticide, belonging to the chemical group of Organophosphate, is commonly used to control tobacco cutworm, *Spodoptera litura.* Direct application of organophosphate insecticides including Chlorpyrifos is toxic and causes environmental pollution (Racke, 1993). In the environment, the organophosphate insecticide residues and the degraded ingredients pollute the soil, water, air and food. These compounds harm not only non beneficial insects but also beneficial insects, beneficial soil organisms and other animals including human beings. Therefore, usage of Chlorpyrifos is supposed to be phased out from the tobacco cultivations in the island wide. The objective of this study was to discontinue the usage of Chlorpyrifos by replacing a possible alternative means of insecticide thereby obtaining reduced environmental toxicity that would lead to the sustainability of the tobacco production.

2.0 Methodology: The experiment was conducted during May 2015 to mid of June 2015 at a commercial tobacco nursery situated in Thalakiriyagama, Galewela. The first experiment was a trial carried out in nursery level where six insecticides were assessed for their comparative efficacies to control the tobacco cutworm *(Spodoptera litura*). Randomized Complete Block Design (RCBD) was used as the experimental design and blocks were laid out along the slope of the land. There were three blocks and each block was divided into seven plots. There were seven treatments including water applied control and each treatment was replicated thrice. Standard size of a nursery bed was 1.06 × 4.58 m. 10 cutworms which were former cultured and reared up to the second instar, were introduced to each treatment plot. The insecticide treatments were sprayed at recommended doses and spray application was made with hand operated knapsack sprayer having 16 L capacity. Tested active ingredients included Methoxyfenozide 10 mL, Spinosad 15 mL, Tebufenozide 10 mL, Etofenoprox 10 mL, Flubendiamide 4 g and present recommended Chlorpyrifos 20 mL. All recommended doses were diluted in 10 L of water. Live number of larvae of *Spodoptera litura* was recorded from each treatment plot just before and after 1, 3, 5, 7, 9, 12 and 15 days of application of the insecticides. Data counts on number of larvae were log transformed. All log transformed data were statistically analyzed according to ANOVA statistical procedure and the mean larval number from each treatment was compared by Turkey's Multiple Range Test at 5% The second experiment was an insecticidal bioassay which was conducted to estimate the Median Lethal Concentration (LC_{50}) of Methoxyfenozide which was screened out from the nursery trial as it produced good results. The bioassay was conducted in an experimental kit consisting of 60 petri dishes. Six concentration levels of Methoxyfenozide were prepared in accordance with the serial dilution and it started from the highest to the lowest concentration where dilution was carried out in a standardized manner. Tested concentrations of Methoxyfenozide included 2 mL/1 L of water, 1 mL/1 L of water, 0.5 mL/ 1 L of water, 0.25 mL/1 L of water, 0.125

significant level.

mL/1 L of water and 0 mL/1 L of water. Each concentration level was comprised with 10 replications and single cutworm at its second instar level was used per each replicate. Used cutworms were cultured and reared in uniform way by providing same environmental regimes and same nutritional conditions. Leaves were cut from the outer layers of green cabbage plants with same maturity into 2.7 cm diameter discs using a cork borer and each of them was introduced to separate petri dishes (replicates). 5 ml volume of each concentration level was topically applied to each replicate. Number of dead larvae was recorded from each concentration level of Methoxyfenozide. Probit method, which was a binary data analysis technique, was used to analyze the data.

3.0 Results:

Table 3.1 Mean larval number in nursery plots treated with different insecticides:

Treatment	Days after application							
	0	1	3	5	7	9	12	15
Control	10.0^{A}	10.0000^{A}	$9.6667^{\mathbf{A}}$	9.3333^{A}	8.6667^{A}	8.0000^{A}	6.3333^{A}	2.3333^{A}
Methoxyfenozide	10.0^{A}	8.3333^{BC}	$4.3333^{\mathbf{C}}$	2.3333^{C}	1.3333^{C}	1.3333^{C}	1.3333^{B}	0.3333^{B}
Spinosad	10.0^{A}	8.6667^{ABC}	$5.6667^{\mathbf{B}}$	4.3333^{B}	3.6667^{B}	3.6667^{B}	3.3333^{A}	1.0000^{B}
Tebufenozide	10.0^{A}	8.6667^{ABC}	$6.6667^{\mathbf{B}}$	5.3333^{B}	4.3333^{B}	4.0000^{AB}	4.3333^{A}	1.0000^{B}
Etofenoprox	10.0^{A}	9.3333^{AB}	$7.0000^{\mathbf{B}}$	5.6667^{B}	4.6667^{B}	4.3333^{AB}	4.0000^{A}	1.0000^{B}
Flubendiamide	10.0^{A}	9.0000^{AB}	$6.3333^{\mathbf{B}}$	5.0000^{B}	4.0000^{B}	3.6667^{B}	4.0000^{A}	0.0000^{B}
Chlorpyrifos	10.0^{A}	7.3333^{C}	4.0000^{C}	2.3333^{C}	1.6667^{C}	1.3333^{C}	1.333^{B}	0.0000^{B}

*Means that do not share a same letter are significantly different at p= 0.05

However, the post treatment counts soon after a day of treatment were found significant indicating differential efficacy of the treatments. Chlorpyriphos was found to be effective with 7.33 mean numbers of live larvae. Methoxyfenozide was found to be second effective insecticide which shared the statistical similarity with Chlorpyrifos. At third day after application Chlorpyriphos was again found to be effective with 4.0000 mean numbers of live larvae, followed by Methoxyfenozide (4.33) which was statistically on par with Chlorpyrifos. The latter was found as effective as Spinosad (5.667), which in turn was at par with Tebufenozide (5.33), Flubendiamide (6.33) and Etofenoprox (7.00). At 5 days after treatment, both Chlorpyriphos and Methoxyfenozide were statistically superior as they recorded the lowest number of live larvae (2.33) in the treated plots. The next best treatment was Spinosad (4.33) which was statistically on par with Flubendiamide (5.00), Tebufenozide (5.33) and Etofenoprox (5.66). At seventh day of application, Methoxyfenozide (1.33) was statistically superior as it registered the lowest number of live larvae in the treated plots which was on par with Chlorpyrifos (1.66), followed by Spinosad (3.667) which was in turn statistically on par with Flubendiamide (4.00), Tebufenozide (4.33) and Etofenoprox (5.33). With referring to the post treatment counts after nine days of treatment, both the Chlorpyrifos and Methoxyfenozide were the most effective chemicals as they registered the least mean number (1.33) of live larvae. Flubendiamide (3.667) and Spinosad (3.667) were next best two treatments which were in turn on par with Tebufenozide (4.00) and Etofenoprox (4.33) that were found statistically equivalent to above mentioned two treatments. At 12 days after treatment, both Chlorpyriphos and Methoxyfenozide were statistically superior as they recorded the lowest mean number of live larvae (1.33) in the treated plots. In the final post treatment count after 15 days of application, the mean larval number of all the treatment plots including the control plot has drastically reduced. All the applied insecticide treatments were statistically on par with each other where Chlorpyrifos and Flubendiamide recorded zero larval existence, followed by Methoxyfenozide (0.33), Spinosad (1.00), Tebufenozide (1.00) and Etofenoprox (1.00).

Probability	Dose (L)	95% Fiducial Limits	
0.50	0.0006879	0.0004192	0.00126
0.75	0.00141	0.0008644	0.00485
0.85	0.00214	0.00119	0.01167
0.90	0.00289	0.00148	0.02246

Table 3.2 Estimated probabilities of larval mortality corresponding to insecticidal doses

When probabilities are estimated using the normal distribution function, the LC_{50} (median lethal concentration) for Log10 (Dose) is -3.16245 (95% confidence interval of -3.37755 to -2.90069), which corresponds to a probability of 0.50 of the standard normal distribution. Corresponding values for LC_{75} and LC_{90} are -2.8506 (95% confidence interval of -3.06327 to -2.3447) and -2.53874 (-2.82864 to -1.64859). These probabilities on the original scale correspond to 0.0006879 (LC_{50}), 0.00141(LC_{75}), and 0.00289 (LC_{90}), respectively.

4.0 Discussion: Kulkarni (1989) reported Chlorpyriphos bait as quite effective in controlling *Spodoptera litura* in groundnut, where he observed 63.77 to 72.14 per cent reduction of larval population over check during summer. This lends support to the present findings. The Methoxyfenozide compound in the present study proved its high efficacy against *Spodoptera. litura* by causing mortality to as less as 1.33 larvae at 7 days after treatment from an area of 0.636m^2. High efficacy of Methoxyfenozide for the control of cutworms is on record. As Spinsoad is reported to be effective against caterpillars in general (Dandale *et al.,* 2000), the moderate efficacy in the present study might be possibly due to the variation in its mode of application adopted. There are some reports on the efficacy of Tebufenozide (Smagghe & Degheele, 1994) indicating its high efficacy against *Spodoptera litura* and excellent results with Etofenoprox against many lepidopteron insects (Udagawa *et al*, 1986). But in the current study, Etofenoprox and Tebufenozide proved to be ineffective possibly due to the change in mode of application and the reduced dosage used.

Conclusion: In the first experiment, Methoxyfenozide at recommended dosage was found to be superior to other selected treatments. Chlorpyriphos which was taken as the standard check, also found to be effective with 2.33 mean number of live larvae. Both insecticides have the sustainability in their toxicities up to the ninth day after application. In the second experiment of insecticidal bioassay, the Median Lethal Concentration (LC_{50}) of Methoxyfenozide against the tobacco cutworm was found as 0.6879 mL diluted in 1L of water.

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