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INHERITANCE OF RESISTANCE BY A STRAIN OF BEET ARMYWORM TO FENVALERATE, METHOMYL, METHYL PARATHION AND PERMETHRIN

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Abstract

A strain from Tifton (T) GA was resistant to fenvalerate, methyl parathion and permethrin, but susceptible to methomyl in generation one. In generation two the T strain was resistant to fenvalerate, but it was susceptible to methyl parathion, permethrin and methomyl. Results are indicative of a reversion to susceptibility. In generation two reciprocal crosses were made with the T strain and the DOW-Zeneca reference (S) strain. S was susceptible to all four insecticides. LD_'s of all four insecticides for S x T and T were equal. LD_'s of fenvalerate and methomyl for S x T were significantly greater than those for T x S. Linkage for the male of the T strain is shown.

Introduction

Inheritance of resistance of beet armyworm, *Spodoptera exigua* (Hubner), to fenvalerate has been shown in the western USA and northwestern Mexico by Brewer and Trumble (1991). They suggested that inheritance of resistance was polygenic for fenvalerate when a strain from Baja California Norte, Mexico was crossed with a susceptible strain from California.

Larvae of the beet armyworm feed on cotton and vegetable crops in the United States of America (USA). Larvae are more difficult to control in the eastern USA than they are in the western USA [Wolfenbarger and Brewer 1993). No information has been found on inheritance of resistance factors by a strain of this pest from the eastern USA. A strain from T was resistant to fenvalerate, methyl parathion and permethrin (Wolfenbarger and Brewer 1993). This same strain was susceptible to methomyl based on a resistance threshold of 20 µg/larva offered by Wolfenbarger and Wolfenbarger (2001).

The objective was to determine inheritance of resistance factors of T and S strain to fenvalerate, methomyl, methyl parathion and permethrin in larval generation two when parents were crossed reciprocally. LD_'s of the four insecticides were determined for T and S strains and reciprocal crosses of both strains.

Materials and Methods

Larvae of the T strain were obtained from cotton near Tifton, GA. The S strain, from DOW-Zeneca, Inc., was obtained as eggs from Syngenta, Inc., Richmond, CA. [Wolfenbarger and Brewer 1993).

Technical of insecticides (93% to 100% purity) was obtained from manufacturers. Insecticides were diluted in reagent grade acetone. The three classes of insecticides used were organophosphorus, carbamate and pyrethroid.

Larvae were maintained on 12 to 15 ml artificial diet (Shaver and Raulston 1974) in 30 ml plastic cups (Wolfenbarger and Wolfenbarger 2001). Pupae were held for adult emergence as brother-sister or sexed for use with reciprocal crosses. Upon emergence 10 to 20 pairs/strain or cross were placed in a 3.78 L cylindrical cardboard container. A 5% sucrose solution was used as food for moths for their 6 to 18 d lifetime. All available moths were used as described by Wolfenbarger and Brewer (1993). The female is listed first in all crosses.

Each insecticide was diluted in acetone and one µl was applied to the dorsum of the thorax of the larvae which weighed 15 ± 6 mg. Microgram doses of fenvalerate and methyl parathion, methomyl and permethrin ranged from 0.024 to 200, 0.0975 to 100 and 0.0015 to 25, respectively.

Mortalities of larvae were determined after 72 h. Only larvae with no movement following probing were counted as dead. LD_', slope ± (SE) and 95% confidence interval were determined by probit analysis of SAS (1988). LD_' and confidence interval were µg/larva. Overlapping CI values indicate LD_'s which are equal. Significant differences between LD_'s were indicated by non-overlapping confidence intervals. Where slope ± SE ratios were <1.96 the regression was not significantly different from zero. Non-significant regression is shown because it represents a response by that insecticide.

Results

In generation two for T strain LD_'s of permethrin, methyl parathion and methomyl were 773, 70 and 5 fold greater and significantly different from LD_'s for the S strain (Table 1). An LD_' of 20 µg/larva was used as the resistance threshold to determine which insecticides were resistant and which were susceptible. LD_'s of the above insecticides for T were not resistant based on resistance threshold. LD_'s of pyrethroids for the S strain were < 0.01 µg/larva. Both anticholinesterase inhibitors showed LD_'s of < 0.5 µg/larva. The T strain was resistant to fenvalerate even though the strain showed a non-significant regression; a slope ± SE of 0.41 ± 0.22 for 112 larvae and 38% mortality was determined at 200 µg/larva. Results show < 50% mortality at more than 20 µg/larva.

Based on the resistance threshold of the T strain reversion to susceptibility was shown for methyl parathion and permethrin in the first two generations while methomyl was susceptible both generations. The T strain was resistant to fenvalerate both generations.

Of interest was the obvious sex linkage with the male of the T strain by all four of the insecticides. LD_'s for methomyl, permethrin and methyl parathion for the T strain and the S x T strain were equal. LD_'s of methomyl and fenvalerate for the S x T and T were significantly greater than shown by the T x S and S. LD_'s of fenvalerate and methomyl for T x S and S were equal. Methyl parathion and permethrin were not tested with the T x S cross because of insufficient larvae. Results suggest that resistance factors for the T strain are associated with the two X chromosomes of the male and not the XY chromosome of the female.

Slopes of regression of all insecticides used for the T strain were flat (<1). Slopes of regression of insecticides of the S strain were flat [50%] and intermediate (1-2). Slopes of T x S were flat. Twenty-five percent (methyl parathion) of those for S x T were flat, 50% (fenvalerate and methomyl) were intermediate and 25% (permethrin) were steep [>2]. SE of slopes was not large; they ranged from 19% to 31% of the slope. An appropriate number of larvae (133 to 270) were used to treat strains and crosses.

LD_'s were similar for the three classes of insecticides. All showed sex-linkage for response by the T strain. All the insecticides showed greater LD_'s for the hybrids, including males of a strain from T, than when females of the T strain were included in the hybrid.

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Table 1. Toxicity of insecticides to Tifton (T) and reference (S) strains and reciprocal crosses of beet armyworm larvae in second generation. 1990.

Larvae Treated	Slope ± SE	LD_' (µg/Larva)	95% Confidence Interval
		T strain	
		methyl parathion	
153	0.83±0.16	18.25	9.18-67.4
		permethrin	
167	0.77±0.17	7.5	3.67-14.06
		methomyl	
194	0.52±0.13	2.23	0.61-5.02
		S strain	
		methomyl	
191	1.77±0.35	0.42	0.24-0.57
		methyl parathion	
261	0.47±0.13	0.26	0.12-1.26
		permethrin	
133	1.57±0.14	0.0097	0.0075-0.012
		fenvalerate	
239	0.82±0.16	0.0031	0.00065-0.0071
		T x S	
		methomyl	
262	0.79±0.19	0.14	0.016-0.34
		fenvalerate	
276	0.33±0.1	0.058	0.0037-0.2
		S x T	
		methyl parathion	
241	0.47±0.09	11.2	4.68-45.23
		fenvalerate	
141	1.59±0.25	7.78	5.4-11.22
		methomyl	
270	1.33±0.15	6.48	4.74-8.73
		permethrin	
68	2.7±0.85	6.48	2.12-9.67