WHITEFLY

G. D. Butler, Jr., Research Entomologist, Western Cotton Research Laboratory, ARS, USDA, Phoenix, Arizona

In the field, whitefly adults overwintered on cheeseweed, Malva parviflora L.; prickly lettuce, Lactuca serriola L.; and sunflower, Helianthus annus L. By the end of March, the whiteflies left the weed hosts and became established on squash, watermelon, and canteloupe. In mid-July, after movement into cotton plantings, whitefly adult populations were highest in cotton fields in areas where these crops had been grown. Populations in cotton in all areas increased after mid-July at an exponential rate, doubling every six to 10 days, until mid-August in most areas.

PERMETHRIN RESISTANCE IN THE TOBACCO BUDWORM

L. A. Crowder, T. F. Watson, M. P. Jensen
Department of Entomology

Selection for Permethrin Resistance

Selection of tobacco budworm, Heliothis virescens, (TBW) larvae with permethrin at the LD_{80} level produced strong tolerance toward this compound (Table 1). The response by larvae to permethrin selection progressed through a series of changes that closely resemble a population demonstrating increased resistance to a selecting agent. The LD_{50} and LD_{95} levels of the F_1 generation were 4.8 and 37 ug/g, respectively. These values have been typical for field-collected TBW in Arizona since 1978 with control in the field readily achieved. After 11 generations of continuous selection pressure, the LD_{50} in the F_{12} generation increased 37-fold compared to the LD_{50} of the F_1.

If the permethrin-selected strain from the present study (LD_{50}=180) is compared to a standard susceptible laboratory strain (LD_{50}=0.28 in 1979) from Tucson, Arizona, the difference in LD_{50}'s for permethrin is 600-fold. But field strains have a much higher "tolerance" than laboratory strains due to a cross-resistance to other insecticides to which the laboratory strain has never been exposed.

Repression of Resistance by Chlordimeform

TBW larvae were selected with a (1:1 permethrin:-chlordimeform mixture at the LD_{80} level during 10 of 11 generations (Table 1). By the F_{12} generation, the degree of resistance to either permethrin or the mixture was scarcely different from levels established in the F_1.

Table 1. Dosage-morality data[1/] of permethrin and permethrin:phlordimeform on the tobacco budworm subjected to LD_{80} pressure for several generations

Generation	Permethrin					Permethrin:Chlordimeform (1:1)			
	LD_{50}[2/]	SD	LD_{95}[2/]	Slope	RR[3/]	LD_{50}	SD	LD_{95}	Slope
1	4.8 a[4/]	0.8	37	2.1	-	4.9 a	1.3	48	2.1
2	Pressure					Pressure			
3	8.8 a	4.0	110	1.5	1.8	7.2 a	2.3	120	2.1
4	Pressure					Pressure			
5	Pressure					Pressure			
6	4.6 a	1.2	42	1.7	0.9	No Pressure	5/		
7	Pressure					Pressure			
8	10 a	1.5	39	3.2	2.1	2.1 a	0.6	20	1.8
9	Pressure					Pressure			
10	100 b	20	1100	1.9	22	2.3 a	0.7	120	1.2
11	Pressure					Pressure			
12	180 c	28	1200	2.1	37	3.5 a	0.8	38	1.6

1/ Data analyzed by computer probit analysis (Finney 1952)
2/ ug/g
3/ RR = Resistance Ratio = LD_{50} of F_x/LD_{50} of F_1
4/ LD_{50} values followed by the same letter are not significantly different at P = 0.05 as analyzed by Student-Newman-Keuls test
5/ Insufficient number of larvae

The tolerance level to permethrin alone was also computed in the F_{12}. After 10 generations of selection with permethrin:chlordimeform, the susceptibility to permethrin in this strain had not changed when compared to base-line levels established in the F_1 of the parent strain.

This investigation demonstrates that induction of permethrin resistance in TBW through selection might be delayed or prevented by the addition of chlordimeform to the selecting agent. The reason why the permethrin:chlordimeform selected strain did not develop any tolerance to permethrin or to the mixture is not known.

Cross-Resistance to Cypermethrin

The level of cross-resistance to cypermethrin is given in Table 2. The LD_{50}'s for the permethrin-selected and field strains were 63.0 and 8.0, respectively. This represents a 7.9-fold difference and suggests that the permethrin-selected strain has developed cross-resistance to cypermethrin. More striking were the 95% mortality data. The LD_{95} values for the resistant and field strains were 1600 and 31.0, respectively, a difference of 52-fold.

Table 2. Relative Cross-Resistance to Cypermethrin in Permethrin-Selected (P_s) Larvae of the Tobacco Budworm

Dosage Level (ug/g)	Strain		RR[1/]
	Susceptible[2/]	P_s[3/]	
LD_{50}	8.0	63.0	7.9
LD_{95}	31.0	1600	52

1/ RR = Resistance Ratio = LD_{50} of F_x/LD_{50} of F_1
2/ Crowder et al. (1981 field strain; unpublished data)
3/ Selected at LD_{80} pressure during 11 of 12 generations

The extent of cross-resistance to other pyrethroids in the TBW is not known. However, this study shows that it is likely that once the TBW has acquired resistance to one pyrethroid, it will eventually show resistance to others.

Synergism of Permethrin by Chlordimeform

The ability of chlordimeform to synergize permethrin against the TBW is shown in Table 3. It was found that if the TBW population was susceptible to permethrin, no synergism occurred. However, when the insecticide mixture (permethrin:chlordimeform) was applied to a highly tolerant population of TBW, synergism was noted.

Table 3. Synergistic Ratios (SR)[1/] for a Permethrin:Chlordimeform Mixture against Larvae of a Permethrin-Selected (P_s) Strain[2/] of the Tobacco Budworm

Treatment	Generation							
	F_1				F_{12}			
	LD_{50}[3/]	LD_{95}[3/]	Slope	SR	LD_{50}	LD_{95}	Slope	SR
Permethrin	4.8	37	2.1	--	180 a[4/]	1200	2.1	--
Permethrin + Chlordimeform (1:1)	4.9	48	2.1	0	51 b	200	2.8	3.5

1/ SR for LD_{50}'s = $\frac{LD_{50} \text{ of Permethrin}}{LD_{50} \text{ of Permethrin + Chlordimeform}}$
2/ Selected at LD_{80} pressure during 11 of 12 generations
3/ ug/g
4/ Values followed by the same letter are not significantly different at P = 0.05 level, ANOVA