Tobacco Budworm Control Without Resistance: Is It Possible?

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Control of late season populations of *Heliothis* has long been difficult for cotton producers. Resistance to organophosphate (OP) insecticides in the tobacco budworm was a problem in the late 1960s and early 1970s that threatened cotton production in a number of areas of the state.

Replacement of OP insecticides by pyrethroids resulted in the reestablishment of successful *Heliothis* control and worked well for about 10 years. Originally, permethrin and envalerate were the most widely used. More recently, cypermethrin has become the standard for *Heliothis* control. However, in 1985, control difficulties were reported for late season populations in several areas of Texas, most notably Uvalde, Fort Stockton and the Garden City areas.

Field collections of *Heliothis* larvae were made in these areas and sent to the Insecticide Toxicology Laboratory in College Station to obtain laboratory verification of the field control difficulties. That the problem was serious was suggested by the studies of Charles Allen and Warren Multer in the field. They found control failures with all pyrethroids they tested in the Fort Stockton area.

We obtained sufficient larvae from the Garden City collections to run dose-response studies with permethrin in December 1985. We chose permethrin to test, based on the fact that we have had extensive experience with it. In addition to permethrin only, we tested a permethrin/chlordimeform combination. We tested by exposing first instar larvae to films of insecticide in glass vials. We had previously established the validity of this technique (unpublished data, this lab) and know it worked well for target site resistance. In addition, it allowed us to test insects more rapidly and without the extensive rearing necessary to obtain sufficient third instar larvae for the work.

The field population proved to be mixed, consisting partly of susceptible (S) and partly of resistant (R) insects. Based on comparing the R part of the population with our laboratory strain, about 16-fold resistance to permethrin was present. Chlordimeform/permethrin combinations synergized permethrin by 16 fold in the R insects and by 5 fold in S insects. Therefore, there was only 5-fold resistance to the combination, and permethrin in combination with chlordimeform was as toxic to R insects as permethrin only was to S insects.

We had a difficult time establishing a colony from the Uvalde insects. Finally, we had enough to start testing by mid-January 1986. In this case we have done our work with cypermethrin. Again, the field population is mixed in its response. For the R component of the population, the LC_{10} value is about 50 micrograms per vial as opposed to 0.15 micrograms per vial for the S insects. This is a difference of 333-fold. Clearly, a serious problem exists.

Pyrethroid/chlordimeform combos have proven useful.

To date, we have not had time or insects to run tests with chlordimeform/cypermethrin combinations. Based on past experience with other insects, we expect there will be at least some synergism.

The high level of resistance and its presence in first instar larvae indicate that the mechanism of resistance is of the target insensitivity or kdr (for knockdown resistance) type. This is a particularly serious type of resistance since it is very broad in expression. Insects with kdr-resistance to pyrethroids are resistant to all pyrethroids. Levels tend to be highest to the most toxic materials.

There is a problem based on these results. It seems obvious that control of late season *H. virescens* populations may prove difficult in the future. The question is, what to do about it?

Two other places of which we are aware have recently faced similar problems. These are Australia and Zimbabwe in southern Africa. Both have dealt with the problem by restricting pyrethroid use to a control window, a brief period of time in which the need for pyrethroids is greatest. They have also restricted the number of pyrethroid sprays that are recommended to no more than three per season.

If more control is needed, either before or after the pyrethroid window, soft (biodegradable) insecticides are being used.

Several other approaches are possible. One involves the use of pyrethroid/chlordimeform combinations. These combinations have proven useful in the past, particularly against *H. virescens* where they are more effective than against *H. zea*. We have already shown the combination worked at Garden City. We plan to test it against Uvalde insects soon.