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**Resistance Management Still Key to Whitefly Control**

Born in the midst of crisis, the whitefly resistance management program in Arizona approaches its third summer with its champions optimistic that its success of two seasons ago will continue. However, to do so will take cooperation, compromise and knowledge — in the same ample doses that it took to start the program.

"Success of the Arizona whitefly resistance management program is measured in the short-term by growers experiencing improved control in the field, as indicated by the per-acre numbers of whitefly treatments per season," says Timothy J. Dennehy, group leader, University of Arizona Department of Entomology's Extension Arthropod Resistance Management Laboratory (EARML).

"In the long-term, success will mean sustaining the effectiveness of the entire suite of whitefly insecticides, but especially the synergized pyrethroids," he adds.

Even in the hardest-hit resistance areas, whitefly control was achieved in 1996 and 1997, validating that resistance management really works. "In areas such as Gila Bend, where we documented the highest levels of pyrethroid resistance in 1995, many of the fields that received eight to 12 whitefly treatments in 1995 required only one to four insecticide applications in 1996 and this trend was sustained in the 1997 season," Dennehy says.

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Statewide averages for season-long numbers of whitefly treatments per cotton field were estimated to have been reduced from 6.6 in 1995 to 1.8 in 1997, according to research by Peter C. Ellsworth, associate Integrated Pest Management (IPM) specialist with the University of Arizona Maricopa Agricultural Center.

As for the long-term objective, it will take continuous resistance monitoring and close cooperation between government, industry and grower. This is especially true as effective new insecticides like insect growth regulators (IGR) begin to win registration on vegetable crops and a traditional vegetable insecticide (chloronicotinyl) begins to cross over for use on cotton.

**A Sticky, Costly Problem**

Ever since the late 1980s, the silverleaf whitefly has threatened production of cotton, melons, vegetables and ornamental crops in the southwestern deserts of the United States.

The microscopic adult whitefly is fragile in appearance, almost fairy-like with translucent wings. But there is nothing fragile about the damage it can cause. In cotton, the sugars excreted during whitefly feeding make the cotton fibers sticky and can promote growth of sooty mold, both of which reduce quality. Its ferocious reproduction cycle makes it a prime candidate for resistance. One female can produce 100 female offspring which, in turn, can produce 10,000 females which can create one million, and so on.

As early as 1991, university researchers and Cotton Inc. became increasingly more anxious about suspected resistance showing up in field tests. In 1992, the hard to accept fact was that pyrethroids alone were providing insufficient control, and were recommended only in combinations with other insecticides.

**Unprecedented Cooperation Emerges**

Out of the shadows that foretold doom came action. First, the Sticky Cotton Action Team was formed with representatives from across the industry coming together to initiate a whitefly monitoring plan. Cotton Inc. provided the funding again in 1994 to EARML for intensified resistance monitoring efforts across Arizona and to determine practical steps that growers could follow.

This led to the creation of the Southwest Whitefly Resistance Management Working Group, whose purpose was to develop an integrated resistance management (IRM) plan. By 1995, a plan was in place to reduce grower reliance on pyrethroids, but it wasn't enough.

In 1995, a full-blown crisis had arisen. Whiteflies, unstoppable by traditional insecticides, cost the cotton industry in Arizona millions of dollars. Meanwhile, research efforts continue to find solutions. In a field experiment of mammoth proportions, more than 180 acres of cotton at the UA Maricopa Agricultural Center became the focal point for efficacy, product rotation and resistance management studies.

Eyes turned around the world to Israel, whose whitefly problems in the 1980s were a devastating blow to that country's cotton production. Israeli producers were successfully controlling the whitefly with the registration of two new non-cross resistant insect growth regulators (IGR), added to an aggressive integrated resistance management plan.

Led by Peter C. Ellsworth, and supported by an entourage of growers and industry representatives, EPA approval was sought and granted for an unusual dual Section 18 registration for IGRs Knack® by Valent and Applaud® by AgrEvo. By obtaining two new products, a rotation program could be reestablished rather than putting too much pressure on any one product.

Now the group had the tools to develop a detailed and farmer-friendly integrated resistance management plan. Communicated to growers through extension and media, positive results in the field were evident almost immediately.

**Recommendations for Sustaining Success**

"The Arizona whitefly project is an excellent example of the agrochemical industries working together with all elements of agribusiness to develop programs that keep the industry healthy," says Gary Thompson, a scientist at Dow Agrosciences and a member of the Insecticide Resistance Action Committee (IRAC). IRAC is composed of scientists from every major agrochemical company in the world.

"It is regional programs such as the one in Arizona with strong local leadership that are most effective. It will take careful management and continued dedication to research, monitoring and education to maintain or increase productivity on the fewest acres," Thompson adds.

Dennehy agrees. "Arizona's challenge now is to sustain its successful whitefly resistance management program which will take the cooperation of the cotton and chemical industries," he says. "We've always had a good history of sitting across the table with each other and working out solutions."

Resistance management recommendations to continue successful control of whitefly were the subject of a paper delivered at the 1998 Beltwide Cotton Conferences by Dennehy and co-author, I. Denholm, of the Department of Biological and Ecological Chemistry, IACR-Rothamsted, United Kingdom. Those recommendations are as follows:

- Limit and harmonize IGR use. Once per-season use of each product, Applaud and Knack, is recommended.
- Limit and harmonize chloronicotinyl use. Prevent a succession of systemic and foliar sprays treatments on the same crop. If the chloronicotinyls are registered for use on cotton, EARML "strongly endorses" limiting their use on cotton to treatments against early-season sucking pests (aphids and lygus bugs) and limiting its use specifically against whitefly.

- Diversify insecticides used against whiteflies. After using IGRs, if foliar sprays are needed to control whiteflies on cotton, growers should use conventional chemicals instead of chloronicotinyls. It is critical that pyrethroids, when needed, be reserved for late-season use in cotton.

Equally important as the aforementioned recommendations, says Dennehy, is the commitment to monitoring resistance. "Evaluation is critical to the success of the cotton program and for allowing the strategy to be modified to account for unforeseen circumstances. We also need to be vigilant in tracking changes in whitefly susceptibility to chloronicotinyl and IGR compounds in glasshouses and on vegetables and melon crops since resistance in these settings pose a threat to whitefly management in cotton."

**Industry is Involved**

Agrochemical companies which are among the benefactors supporting EARML are also active in the Insecticide Resistance Action Committee (IRAC). Since 1984, IRAC has assessed the magnitude of resistance worldwide and has worked to develop long-term solutions and management strategies.

Hot spots such as Egypt's struggle with the organophosphate-resistant armyworm and India's battle with the pyrethroid-resistant diamond-back moth are among IRAC's projects. By the year 2000, IRAC will have invested more than $1 million in scientific studies to prolong the effective use of insecticides around the world.

"IRAC in the United States concentrates much of its research and educational efforts in resistance management strategies for cotton producers," says Thompson. "Insects are well adapted to cotton and it is grown in hot climates that favor multiple generations. We aggravate the problem by growing the same crop over and over again, creating havens for insects to multiply. However, with safe insect control products the farmer can produce more per area and minimize inputs such as land, water and fertilizers."

An insecticide resistance management teaching kit was recently produced for extension personnel by IRAC. And, IRAC grants to universities in the South, for example, are giving researchers an opportunity to unlock the secrets to the cotton bollworm and tobacco budworm's growing resistance to pyrethroids. IRAC members meet regularly to discuss new grant proposals and educational programs.

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