Cotton Boll Weevil Research in Argentina, Brazil and Paraguay in the Framework of the ICAC / 04 Project

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Overview of Project Activities

The boll weevil, the most destructive pest of the cotton crop in America, spread to Venezuela in 1949, was detected in Brazil in 1983 (Burke *et al.*, 1986) and in Paraguay in 1991, becoming a major cotton pest in this two countries. In 1993 the boll weevil was detected in Argentina in the areas bordering Paraguay (Gómez, 1996) and recently spread up to the Corrientes province (Argentina), about 200 miles from the main Argentine cotton cropping area (E. Cosenzo, personal communication). The serious decrease in cultivated area in Brazil and the drop of production in Paraguay has been associated with the cotton boll weevil. A similar impact is expected in Argentina once the boll weevil becomes fully establishes in the country.

The countries participating in the project, Argentina, Brazil and Paraguay, are the main cotton producers in South America. The control of boll weevil is effected by the use of insecticides that constitute ecological risks, cause development of resistant insects and increase production costs resulting from augmented crop pest infestation. In order to adequately control the boll weevil, the project focuses on the development and improvement of cultural and biological controls, the proper use of insecticides focusing a gradual but steady shift to less toxic products, the monitoring of insecticide resistance and on the dissemination of knowledge to farmers to ensure the production of locally acceptable and effective control methods that have a limited environmental impact (Anon, 1994).

Midway through the project, solid scientific foundations have been built through investigative work. Systematic research to confirm and extend laboratory and field results is carried out through coordinated research activities that encourage learning partnerships between scientific institutions throughout the three participating countries. The knowledge and technologies emerging from this research are harnessed through the different national projects funded by the Project and the respective counterparts, operating within tight financial limits. Therefore, activities in the Project concentrate on where clear advantages compared to alternatives have been established. Thus, in encouraging IPM applications in cotton, the Project focuses on those areas that offer special advantages in meeting present and future needs of the cotton producers in the three countries.

The central objective of the project is the improvement of cotton productivity and the income of producers in Argentina, Brazil and Paraguay, through the development and implementation of Integrated Pest Management strategies in cotton. This broad objective will be met through basic research on bionomics of the boll weevil, validation of control measures, assessment of new control measures, adapting of acquired technology and transferring the technology to farmers (Anon op.cit.).

The aim of this paper is to offer a brief overview of the newest and outstanding results from some of the research activities undertaken in the project.

Outputs from the different Project components

Pesticide Susceptibility and Resistance Monitoring

The long term goal of the activity is the development of a protocol for the pesticide resistance monitoring based on the vial technique. The research involves the assessment of the susceptibility of local strains of *A. grandis* to the different pesticides in use as well as studies on the half life of these products.

Because of the current use pattern for pyrethroids, along with new prospects for registration of several pyrethroid-isomers on cotton, the present study was conducted to quantify relative toxicity of selected pyrethroids and some of their isomers on *A. grandis* and to obtain useful LD_{50} values for monitoring future changes in the susceptibility to these compounds.

By using the same compounds and similar bioassay technique, two populations were tested for susceptibility: a normal susceptible strain from the United States Department of Agriculture (USDA-ARS) rearing facility Starkville, Mississippi, maintained on artificial diet and standard rearing conditions (Stadler and McKibben, 1995) and a local strain collected from cotton in Caacupe, Paraguay (Zerba *et al.*, 1998). The results are shown in Figure 1.

Field Evaluation on the Efficacy of Insecticides for the Cotton Boll Weevil Control

Boll weevil control under field conditions as well as the performance of the respective formulations was assessed. Under low weevil infestations, concentrated suspensions (CS) of the pyrethroid insecticides deltamethrin and β-cyfluthrin showed a better performance than emulsifiable concentrated (EC) β-cyfluthrin (CS) and deltamethrin (CS). However, in the case of high population density of the pest, the results

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of trials with the CS and EC pyrethroids were similar (dos Santos, 1998).

Adult Boll Weevil Feeding Behaviour

The pollen content of the boll weevil gut sampled in northern Argentina was assessed. About 70% from all dissected weevils show pollen grains in their digestive tract. Currently, the specimens are grouped into 18 pollen types belonging particularly to four families: *Malvaceae*, *Compositae*, *Solanaceae* and *Euphorbiaceae*. (Cuadrado, 1998)

Taxonomic Studies on Alternative Host Plants (Malvaceae) of the Boll Weevil

Species of native and grown *Malvaceae*, that may act as 'reproductive hosts' of the boll weevil, were identified. So far a catalog of vascular plants is focusing on the South American species of the *Furcaria* section (genus *Hibiscus*) is in preparation. Different plant collections from Argentina and Brazil have been examined in order to achieve a distribution pattern of Cienfuegosia species. Afterwards, the habitats of these species in northern Argentina were surveyed. Several species have been described as well as their habitat and a key for the determination of species of the genus *Cienfuegosia* from Argentina and Paraguay has been established (Krapovickas, 1998).

Biology of A. grandis on Alternative Hosts

The feeding of adult boll weevil adults on different Malvaceae species as *Hibiscus rosa-sinensis*, *H. schizopetalus*, Malvaviscus sp., and *Abutilon striatum* was evaluated. Weevils who fed on *H. rosa-sinensis* and *H. schizopetalus* were observed to have higher longevity. No oviposition was found in laboratory conditions, however the highest frequency of mating was recorded on *H. rosa-sinensis* (D. Gabriel, personal communication).

Biological Control of the Cotton Boll Weevil by Pathogenic Fungi

The pathogenicity of seven strains of the fungus species *Beauveria bassiana* and *Metarhizium anisopliae* as well as the selectivity of five insecticides to *B. bassiana* was assessed under laboratory conditions. The strains PL-43 of *M. anisopliae* and 624 and 635 of *B. bassiana* show the highest efficacy against the boll weevil causing mortality at the fourth day after treatment. The insecticide endosulfan show fungistatic activity upon *M. anisopliae* while Deltamethrin, Lambdacyalothrin and Betacyfluthrin had little effect on fungus growing (R. P. Almeida, personal communication) .

Molecular Studies on Local Populations of Anthonomus grandis

The characterization of *A. grandis* populations by DNA molecular markers is based on : 1) the analysis of the variability in sequences from mitochondrial DNA in order to establish migration patterns and interpopulation genic flow; 2) the comparison of RAPDs variability among populations of different geographic origin and among those which attack cotton versus those that live in native plants; and 3) to begin the research of microsatellite sequences typical for *A. grandis* in order to establish the genetic bases of the pesticide susceptibility as well as other markers of agronomic importance.

Three populations have been studied using the technique of RAPDs, one from Mississippi (USA), and two from Paraguay. Differences among them have been found, and the characteristic stripes of the Paraguay populations would be 9-7, 3-6 and 6-1. Matrices of gene frequencies and the phenograms were calculated and indicated a great differentiation of the two populations of Paraguay in relation to the one of USA, and confirm that the two populations of Paraguay studied are different. As the differentiation between the two populations from Paraguay is low the genetic flow between them is high (3 migrants a year) (Lanteri *et al.*, 1998).

Technology Transfer to Farmers and Extensionists

A very intensive and complete work has been performed in the three countries in the framework of technology and knowledge transference on IPM strategies to farmers and extensionists. The activity was aimed on IPM technology in cotton by means of modernization of cropping system and increasing of productivity in order to contribute to the socio-economic improvement of farmers.

Further considerations

The strategy to promote teamwork is driven primarily by the conviction that multidisciplinary and multi institutional research enhances the quality and relevance of research. The principles of trans-disciplinary research conducted by collaborative teams, consisting of researchers from Argentina, Brazil and Paraguay, has taken firm hold. This basis for developing the project activities has generated a fresh optimism and enthusiasm for research on IPM strategies to control the cotton boll weevil.

As knowledge on the boll weevil natural history and infestation dynamics expands, the potential for development of new control strategies of the pest grows. Over the last three years of the Project, boll weevil research has played an increasingly important role in improving monitoring and control of the pest. If wise use of this scientific information is to be assured in the future, key applications for pest control use need to be better understood, not only by decision-makers but also by the farmers.

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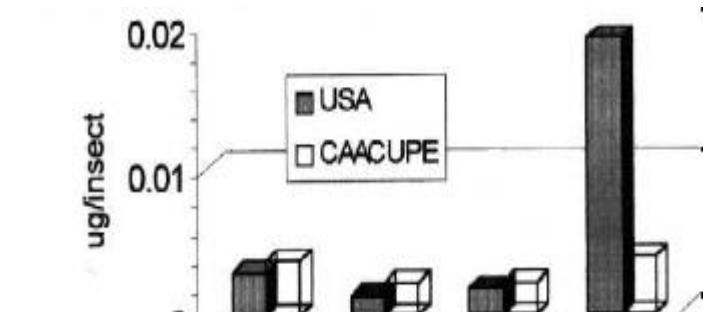
Figure 1. Pesticide susceptibility of two boll weevil strains: USDA-ARS and Caacupé, Paraguay. (Cyper = cypermethrin; Delta = deltamethrin; β-cyper = β-cypermethrin; M-para = methyl - parathion)



	Cyper	Delta	ß-cyper	M-para
USA	0.0029	0.0013	0.0018	0.019
CAACUPE	0.0037	0.0022	0.0022	0.0039

As shown in Figure 1 :

- The LD_{50} data obtained from bioassays with pyrethroids show no significant differences with the two strains.
- The LD_{50} obtained with methyl-parathion was higher for the USDA-ARS Mississippi strain than the LD_{50} obtained from the bioassays with the strain collected in Caacupé - Paraguay.
- The toxicity data obtained can be used as the baseline information for future pesticide resistance monitoring programs in the framework of cotton IPM.
- The USDA-ARS Mississippi strain shows a higher tolerance (or resistance) to the OP pesticides. The origin of this difference could be the previous history of this strain due the intensive and extensive use of OP pesticidess in the US cotton cropping areas.