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STATUS OF THE "ATTRACT & CONTROL" TECHNOLOGY IN BOLL WEEVIL PREVENTION, SUPPRESSION & ERADICATION PROGRAMS IN LATIN AMERICA DURING CROP CYCLES 2002/2003 & 2003/2004

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Abstract

The use of the "Attract & Control" technology (based on the Bait Stick) in boll weevil control, prevention, suppression and eradication programs continues to play an important role in Argentina, Bolivia, Colombia and Paraguay.

The "Bait Stick" (known as the BWACT® in the USA, the Tubo Mata Bicudo or TMB® in Brazil and the Tubo Mata Picudo or TMP® in Spanish speaking Latin America) has been successfully used by Paraguay (annually in about 500,000 program acres) for 8 years and by Colombia (annually in about 100,000 program acres) for 4 years in their National Cotton Programs. For 9 years, the country of Argentina has successfully used pheromone traps and TMPs as part of their National Program to detect, eradicate and prevent the establishment of boll weevils in their major cotton zones (currently in about 600,000 program acres). The Argentines (SENASA) have a strong desire to collaborate in a Multi-National Boll Weevil Program with Brazil in the states of Parana and Sao Paulo (about 250,000 planted acres) and with Paraguay (about 500,000 planted acres) and Bolivia (about 30,000 planted acres); planning for the Multi-National Program is in the early stages and meaningful progress is anticipated in 2004.

The "Bait Stick" or TMB/TMP results from the national and state area-wide programs in Argentina, Brazil, Colombia and Paraguay have been outstanding. Where used correctly, boll weevil populations have been reduced by 95+%, seed cotton yields have been increased an average of 350 lbs. per acre and the requirements for massive insecticide usage for boll weevil control has been substantially reduced. When used according to recommendations, the TMB/TMP, as an additive to programs, has greatly contributed to the elimination of economic damage from boll weevils at an approximate per acre cost of $8.80 per crop cycle and resulted in an average "cost to benefit" ratio of "$1 to $12".

TMB/TMP Product improvements and results from the aforementioned programs are presented herein.

Index terms: *Anthonomus grandis*, boll weevil eradication, BWACT, Grandlure.

Introduction

During 1990, the USDA-ARS Boll Weevil Research Lab introduced the "Bait Stick" to the cotton industry (Smith et al., 1991) as an alternative, new approach for the control of cotton boll weevils, an approach that was "preventive" and predicted to result in the reduction of damaging weevil populations and insecticide costs.

The "Bait Stick" technology was patented by the USDA in 1990 and licensed to Plato Industries, Inc. in January 1992; during the same time frame, product development efforts were initiated under a Cooperative Research and Development Agreement with the USDA's Boll Weevil Research Lab. Through collaborative work, EPA Experimental Use Permits were obtained and in December 1993, the US EPA granted the "Bait Stick" the first "low risk-low use" insecticide registration in the USA. A key factor in the EPA's decision for granting the registration was the potential use for this technology in the US Boll Weevil Eradication Programs (BWEPs). The "Bait Stick" was introduced commercially in the USA as the Boll Weevil Attract & Control Tube (BWACT), in Brazil as the Tubo Mata Bicudo (TMB) and in Spanish speaking Latin America as the Tubo Mata Picudo (TMP). A comprehensive history of the commercial development of the technology, with an extensive bibliography, was presented in the 2001 NCC's Beltwide Cotton Conference (Plato et al., 2001).

The technology created strong interest in Latin America as it offered a new approach for solving a serious economic barrier to profitable cotton production, the boll weevil. In Nicaragua (1993) and Argentina (1994), national programs using the TMPs were designed and implemented against the boll weevil. The Argentine program (PNPEPA) was much larger and more complex; it had to prevent the invasion of weevils from Brazil and Paraguay and to eradicate those that did before reproduction and dispersal. The program has been economical and effective in preventing weevils from reaching, infesting, establishing, damaging and dispersing into its main production areas (at that time about 1,875,000 planted acres). This program consisted of 1) strategically placed boll weevil traps for monitoring migrating weevils, 2) TMPs for killing weevils before they reached cotton producing fields, and 3) applications of insecticides and installations of TMPs to eliminate outbreaks detected in fields producing cotton. In Nicaragua, the program was based on installations of TMPs at planting (1 per 1.75 acres) and at stalk destruction (1 per 1.75 acres) on 100% of the acreage; during 1993-1995, the program was very successful

in eliminating large populations of weevils (McKibben et al., 1994) and in reducing the requirement for insecticide applications to prevent weevil damage (Daxl et al., 1995). The Argentine and Nicaraguan programs led to expanded interest and TMB/TMP use in other Latin American countries.

Discussion and Program Results

The "'Bait Stick" technology is more widely used in Latin American programs than in the USA BWEPs for many different reasons, but primarily due to the biology of the boll weevil in tropical environments and operational differences between the Latin American and the USA programs. Between the two, there are substantial differences in boll weevil habitats, weevil activity between crops, alternate hosts, farming operations, climates, availability of farm labor, availability of aerial and ground application equipment, flexibility in program operations, and availability of financial resources.

According to studies conducted by Gutierrez (personal communication, 2000), "pheromone based technologies for boll weevil suppression would appear to be extremely promising for large areas of South America. At current prices, it would appear to be less expensive and it would reduce if not eliminate the negative human and environmental health effects, and hence be more sustainable" than conventional insecticide programs. In his studies, he postulates that 30% of a boll weevil population (within 200 yards of a TMB/TMP) are attracted each day and removed from that environmental area. Thus, with the effective TMB/TMP "killing life" of 6 to 7 weeks, each TMB/TMP has the potential to eliminate an "existing 30,000 per acre weevil population" during 4 weeks and still have a continued "killing activity" for another 3 weeks, to "take-out" migrating weevils that move into a TMB/TMP zone from areas outside the 200 yard zone. This is one of the important reasons for the success of the Latin American programs which made multiple year (2 to 3) TMB/TMP installations at planting and at stalk destruction.

The recommended use of the BWACT/TMB/TMP in IPM and in area wide control, suppression, eradication and prevention programs, based on several years of field experience and results from Argentina, Bolivia, Brazil, Colombia, Nicaragua, Paraguay and the USA, are outlined in the following; each country program has certain variations, but the general use recommendations for Latin America are:

- At the end of a crop cycle, when weevil dispersal commences (weekly trap counts measuring 4+ per trap) or at crop defoliation, BWACTs are installed at one per 200 to 250 feet on all sides of the field perimeters to attract and kill emerging/migrating weevils that occur between sprays; 30 days after this installation or at crop destruction, BWACTs should be installed at the 100 to 125 feet spacing, between those at 200 to 250 feet. This program should continue after stalk destruction, with BWACTs remaining around the field at least until 3 weeks after stalk destruction to attract and kill any weevils emerging from the residual squares and bolls of the crop.
- After stalk destruction, on large farms with "well defined" weevil refugios, a few traps should be installed adjacent to the refugios, and if weevil captures occur, a barrier line of BWACTs (one per 200 feet) should be installed along the side of, or around, any adjacent refugios capturing weevils. The barrier program should continue so long as there are captures in the traps.
- After stalk destruction, on small family farm fields (normally 1 to 5 ac.), 1 to 2 traps should be installed on "down wind" field borders, and if weevil captures occur, a barrier line of BWACTs (one per 200 feet) should be installed along the side of, or around, any fields capturing weevils. The barrier program should continue with replacements each 45 to 50 days, as long as there are captures in the traps.
- At planting of the next crop, BWACTs should be installed (on the "up-wind sides" and adjacent refugio sides) as soon as fields are planted (one per 200 to 250 feet and again 30 days later, in between the first installations, at the 100 to 125 feet positions), around all fields.
- With small producers, in small fields of 1 to 5 acres, at planting of the next crop, BWACTs should be installed (on the "up-wind sides" and adjacent refugio sides) as soon as fields are planted at an equivalent use rate of one per field, a minimum of 1 per 2.5 acres.
- In planted fields, two to three weeks before the "pin-head square" stage, an adequate number of traps should be installed to determine if 1, 2, 3 or if any, "pin-head" sprays would be required. Subsequent to this, no further weevil insecticide applications (unless punctured square data "trigger" an application) or BWACT installations should be made until weevil dispersal occurs at the end of the crop.

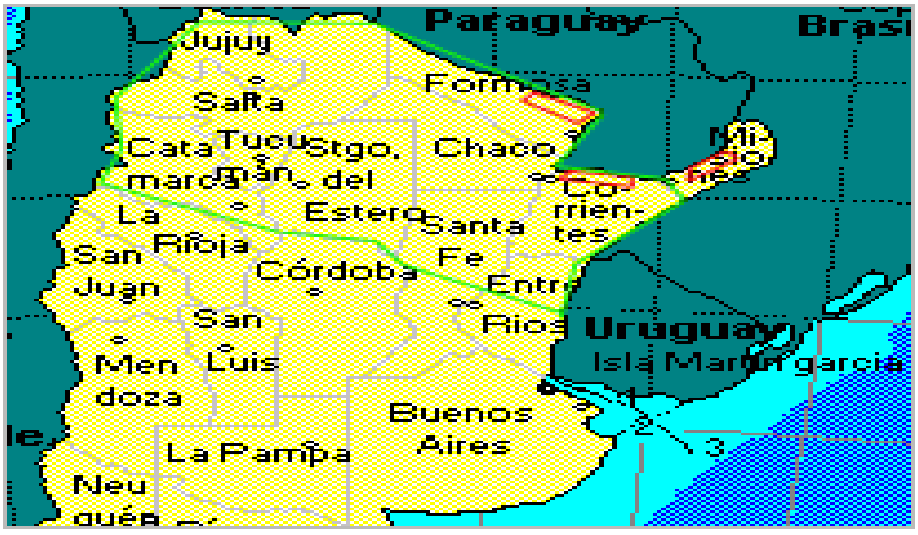
These general recommendations for Latin America are applicable for a BWEP, an area-wide "Suppression Program" or for an IPM program. In the Brazilian, Colombian and Paraguayan Programs (when used repeatedly, according to recommendations), the TMPs have been instrumental in reducing boll weevil populations to very low levels and this has permitted the crop to be produced without economic damage from weevils. This has been accomplished by installations of TMPs in all fields of infested zones at planting, at stalk destruction and in some situations, installations along the side of, or around "well defined" refugios.

As a result of Plato Industries participating in the aforementioned programs, significant improvements were made in use methodology and TMB/TMP product quality (stronger control tubes, longer residual control, better pheromone liberation and better stakes for installations) and packaging (better pheromone packages and individually packaged TMBs/TMPs).

Argentina

The equivalent of the USDA in Argentina, SENASA, has a National Program for the Prevention and Eradication of the Boll Weevil (PNPEPA). It started in 1994 and is based upon strategically placed boll weevil traps for monitoring migrating weevils, TMPs for killing weevils before they reach cotton producing fields, applications of insecticides and TMPs to eliminate outbreaks detected in producing cotton fields and at crop termination, programs of complete stalk destruction. The success of the National Program is measured by weevil captures in 15,000 to 20,000 boll weevil traps that are placed in the main cotton producing provinces and by the elimination of infestations that periodically occur in about 200 acres of cotton in the provinces of Corrientes and Formosa, adjacent to Paraguay. Until recently there were no weevils captured in any provinces, except for migratory weevils from Paraguay that reached the northeast provinces of Formosa, Corrientes and Misiones; however, in the off season of 2002/2003, a few weevils were captured in the northern part of the Chaco Province.

While migrations have been successfully halted with traps and TMPs, and infestations have been eliminated with insecticide applications and TMP installations for 9 years, SENASA and the cotton industry are very concerned. They want to move the "line of defense" against the weevils northward, into the countries of Bolivia (about 30,000 planted acres), Paraguay (about 500,000 planted acres) and Brazil (Parana and Sao Paulo, about 250,000 acres). The most acceptable and practical way for all parties to accomplish this is through a Multi-National Boll Weevil Program.



Bolivia

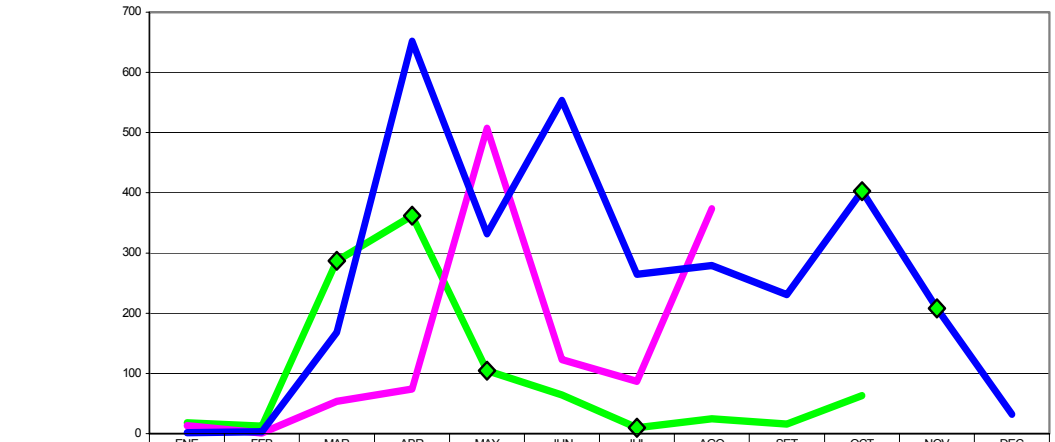
The Bolivian Ministry of Agriculture, thru its department of plant protection, SENASAG, will be starting a program in 2004 to reactivate cotton production. To accomplish this goal, they must eliminate the boll weevil from the production scheme. Thus, a National Program similar to that of Paraguay is under study for implementation.

Brazil

Area-wide programs that started in 2000, to reactivate cotton in the northeast states of Brazil, have changed to recommendations for individual implementation. Cotton production in Northeast Brazil is typically small grower, 1 to 5 acres per farm, low tech and low inputs. In this region, the boll weevil has been widely established for about 15 years and it was the main reason for cotton acreage in the Northeast to decrease from 7.5 million acres of mostly "perennial" cotton to less than 125,000 acres of conventional and semi-perennial cotton in 2002. There is a consensus among the leading cotton specialists that the only practical, economical and environmentally acceptable solution for the boll weevil problem in the Northeast of Brazil is the area-wide destruction of cotton stalks and installations of TMBs (1 per 2.5 acres) at the end of the crop cycle and TMB installations (1 per 2.5 acres) at planting. However, government and grower funds are not available for the implementation of such programs.

EMBRAPA's National Cotton Research Center (CNPA) has completed 3 years of replicated field tests with the TMB in the state of Paraíba. Their tests were designed to answer the questions regarding how to best use the TMB in the Northeast of Brazil. The tests were well designed, provided good statistical information and defined "how to best use" the TMB in the northeast of Brazil.

Typical results of 90+% population reductions from first year TMB programs with "at planting and end of crop" installations are expressed in the following:

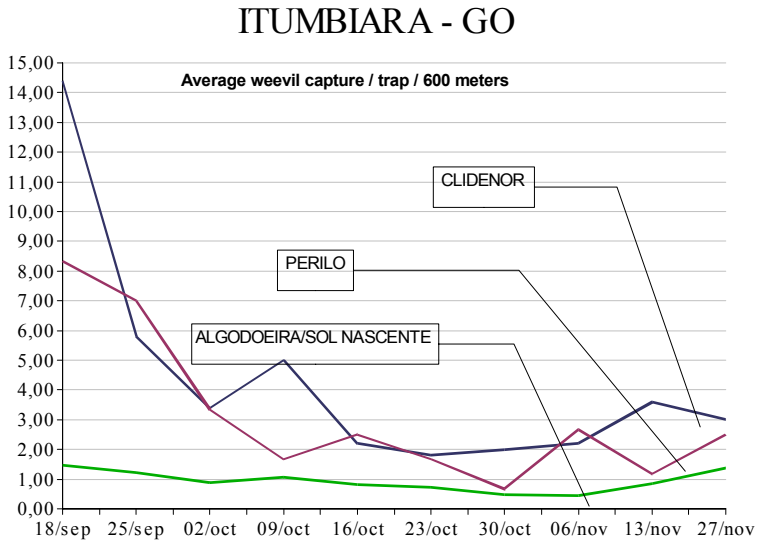


	ENE	FEB	MAR	ABR	MAY	JUN	JUL	AGO	SET	OCT	NOV	DEC
Palotina ano 2002	17.8	12.2	287.1	361.8	104.6	64	9.8	24.6	15.6	63.07		
Palotina ano 2000	13.5	1.2	53.4	74	507.1	123	86.8	373.8				
Palotina ano2001	1.6	3.2	168.3	652	331.7	553.8	264.8	279.4	230.9	403	208	32.2

Figure 1. Effect of a 2001/2002 TMB Program with "at planting and end of the crop" installations on a historically high weevil population in 160 acre isolated, cottonseed production farm. Palotina, Parana.

In the above, the average weevil captures (Oct. 2001 – Oct. 2002) in 14 traps (Plato Model) were compared to captures in the same number of traps during two previous crops (Jan. 2000 – Oct. 2001). The TMB program was installed during the 2001/2002 crop at planting (10-23/11-24-01) and at defoliations (3-13/4-11) and stalk destruction (5-24/7-4-02) at 80 and 40 meter spacing, respectively. It should be mentioned that due to all of the different varieties being planted, there were extended planting and harvesting periods of about 4 months each. This presented a major challenge to obtaining a meaningful reduction of this isolated population.

Another example of TMB results from the production zone of Itumbiara, Goias are in Figure 2; this is a zone with very high weevil populations, and during the 2001/2002 crop, the farms listed in the Figure received an average of 10 applications solely for weevils. The best expression of results is from the farm Algodoeira/Sol Nascente which had complete installations at planting (3) and at the end of the crop (2).



CLIDENOR (18 ha.): at end of crop, 1 TMB / 5 ha. installed [5-30-02]; at planting [11-18-02] no installation of TMBs.

PERILO (76 ha.): at end of crop, 1TMB/1ha/in 2 installations [80:40 meters, 5-30-02 & 6-13-02]; at planting[11-8-02] TMBs installed at 60 meter spacing along side refugios.

ALGODOEIRA/SOL N.(200 ha): at the end of crop, 1TMB/1ha/in 3 installations, 1st. at 80 meters [5- 30-02], 2nd. at 40 meters [6-13-02] & 3rd. at 80 meters [8-17-02]; at planting [11-16-02] 1st. installation, 1TMB at 60 meters; 2nd TMB to be installed?

Figure 2.

Colombia

In May 2000, Conalgodon (the National Cotton Production Association) launched, as part of its National Cotton Reactivation Program, a National Plan for the Control of the Cotton Boll Weevil. Colombia continues to have many internal security problems and this deters advancement of the National Cotton Program. Additionally, as with most other countries, there is a significant segment of the plant protection industry opposed to changing boll weevil control methodologies and they have continued to successfully delay the National Plan for the Control of the Cotton Boll Weevil.

While the Boll Weevil Control Program is mandatory by law for anyone growing cotton and is tied to crop financing, there are problems in enforcement. The objective is to increase cotton production from about 100,000 acres to 500,000; however, to accomplish this, the boll weevil must be taken out of the production scheme. The Reactivation Program contemplates that the National Plan for the Control of the Cotton Boll Weevil will solve the problem by implementing a program of boll weevil traps for monitoring, 2 TMPs per 2.5 acres (one at stalk destruction and again at planting), 100% stalk destruction and concentrated crop plantings in each production zone.

The results of the National Program have been excellent in the interior of the country and in certain parts of the Coastal production zones, even though there has not been a 100% compliance of the producers. However, in the Coastal Zone of the Sinu, there has not been a good implementation of the Program. The lack of implementation is due to many factors. As an effort to overcome this problem area, an isolated field test has been established in the Zone for the 2003/2004 and 2004/2005 crops to demonstrate that this is a practicable way to "take the boll weevil out of the production scheme" and to eliminate it as an economically damaging pest. The data from this test will be presented at the NCC Beltwide Conference of 2005.

Paraguay

In 1997, a 5-year National Plan to Reactivate Cotton was launched; it was based on a "pilot project" that had been conducted in 1995 and 1996 in two production zones of about 100,000 acres for 2 years. The National Plan was designed to eliminate economic damage from the boll weevil (by using TMPs at planting and at stalk destruction), improve soils through crop rotation and fertilizers, improve seed quality, control insecticide quality, provide crop financing, provide technical services and expand R&D activities for crop production. This program was and is strategically important to Paraguay because cotton is the number one "cash" crop for about 120,000 small, family farms, each averaging 2 to 5 acres of cotton. The "scheme of cotton production" employs and involves about 1.5 million people, a third of the country's population.
The National Program has been surveyed by USA, Brazilian and Colombian delegations with a focus on the boll weevil aspects; their reports to the Ministry of Agriculture (MAG) were positive and supportive for program continuation. Their data illustrated that during the 1999/2000 crop, there was no economic damage from boll weevils to the crop, only 1 weevil had been captured in traps and no sprays required for the boll weevil control.

In Paraguay, from a MAG standpoint, the performance of the TMPs had been measured primarily through a "trapping" program of up to 1200 traps in the major production zones; this type of trap data as presented below in Figure 3 and other data as illustrated in Figure 4 are similar to the approach used by the US BWEPs to measure their program success. The zones and average boll weevil captures per month are illustrated in the following Figures 3 and 4:

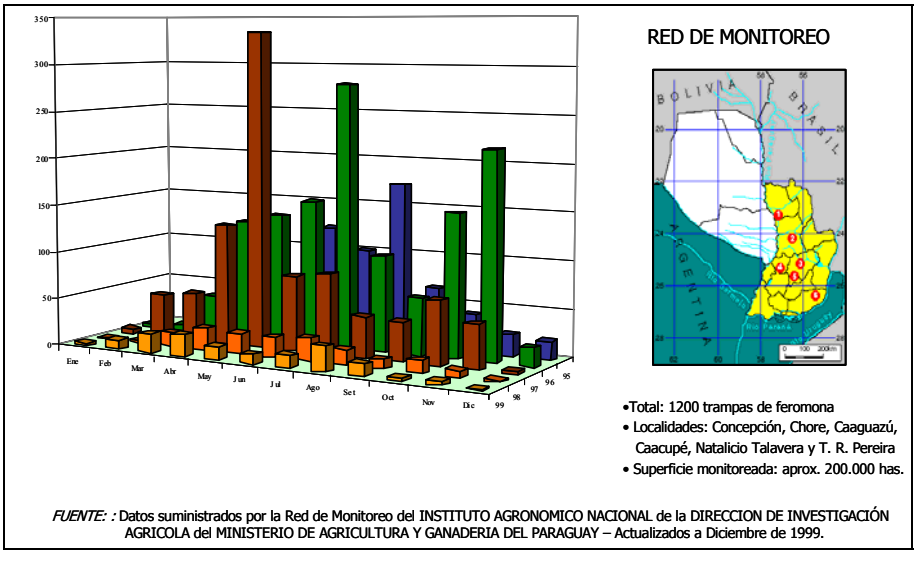


Figure 3. Boll weevil captures in traps declined more than 94% with the correct implementation of the National Program.

In the following Figure 4, key data from 3 years of TMP installations are presented as a comparison of trap captures to a 3-year average prior to TMP installations and a comparison of the average number of insecticide applications required to produce each crop during 1997-2000. This data remains some of the best area wide program data from Paraguay.

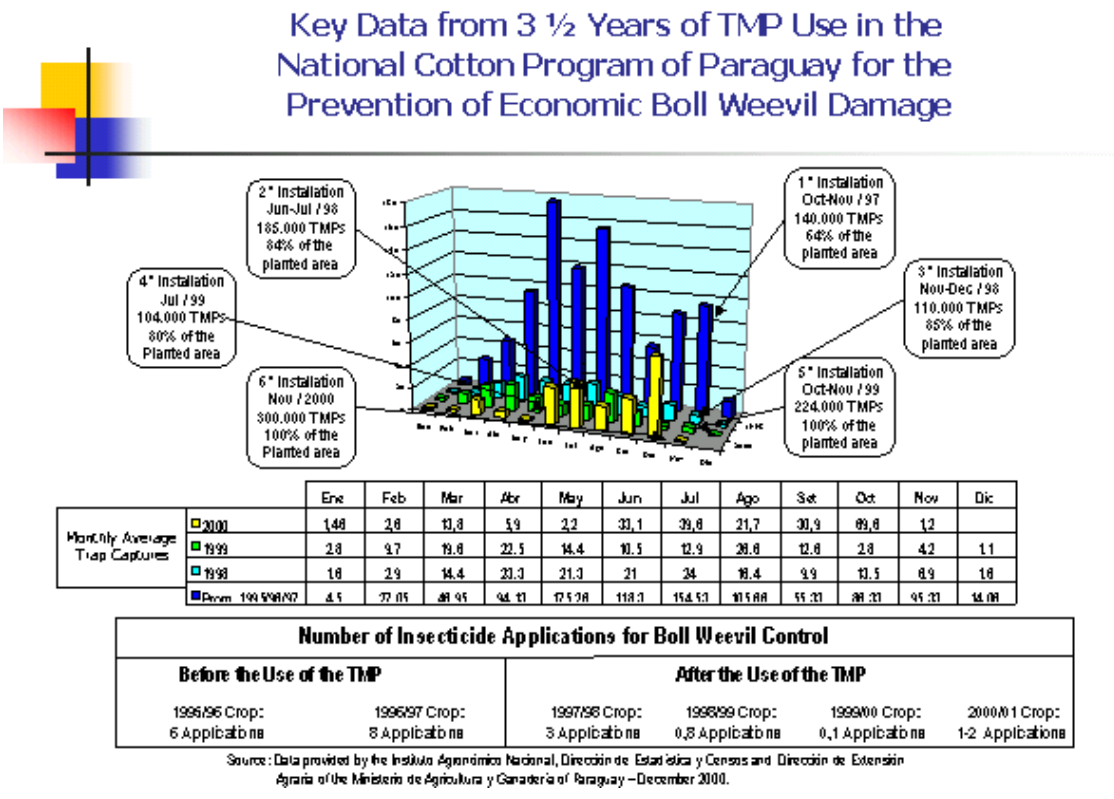


Figure 4.

It should be mentioned that the National Program for Boll Weevil Control was not implemented at stalk destruction in May/June 2000 and as may be noted in the above Figure 4, this resulted in larger weevil captures in June-October 2000 and an increased use of weevil insecticides in the 2000/2001 crop.

During the last three years, an NGO (Non Governmental Organization) in Paraguay has studied the declining conditions of cotton production and reported the impact of the boll weevil damage to cotton production (GEO, 2003). In Figure 5, the impact of weevil damage on a national level, during the last 6 years, is illustrated as the average kilograms of seed cotton production per hectare. According to the NGO, the production statistics are official and from the Bureau of Statistics of MAG.

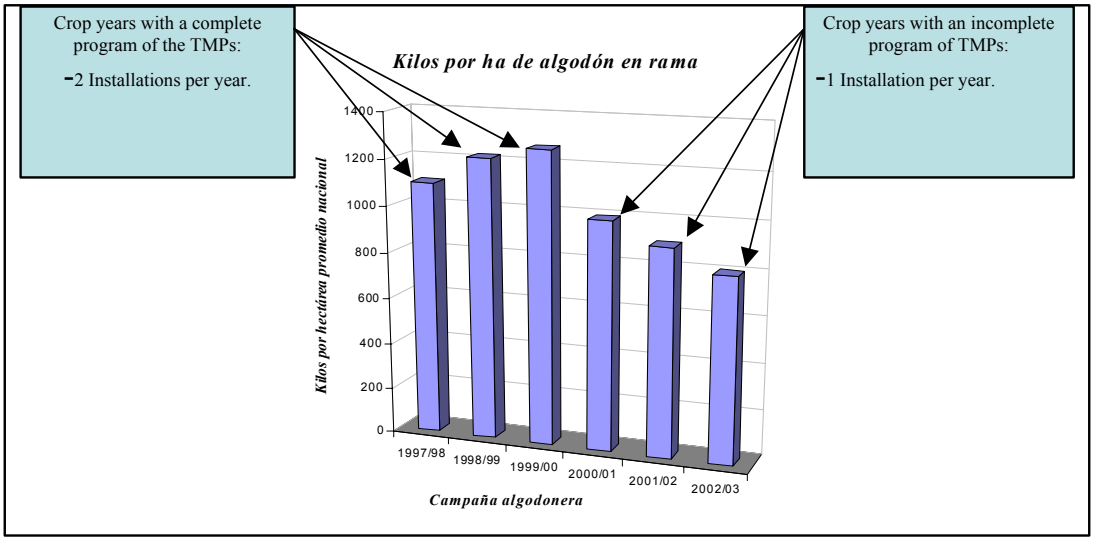


Figure 5. Average Seed Cotton Production 1997 – 2003.

The failure to fully implement the weevil program in 2000/2001 thru 2002/2003 resulted in an average seed cotton loss of 370 kilograms per hectare or 326 pounds per acre. Unfortunately, this is expected to be case again in the 2003/2004 crop, with an anticipated loss of 400 kilograms per hectare (350 pounds per acre).

In Figure 6, there is a comparison of the average % square damage from weevils in a zone that had complete installations of the TMPs, as compared to the average square damage of the other production zones in the NGO study. The data demonstrate a 95+% reduction in damage, when the TMP Program is implemented correctly.

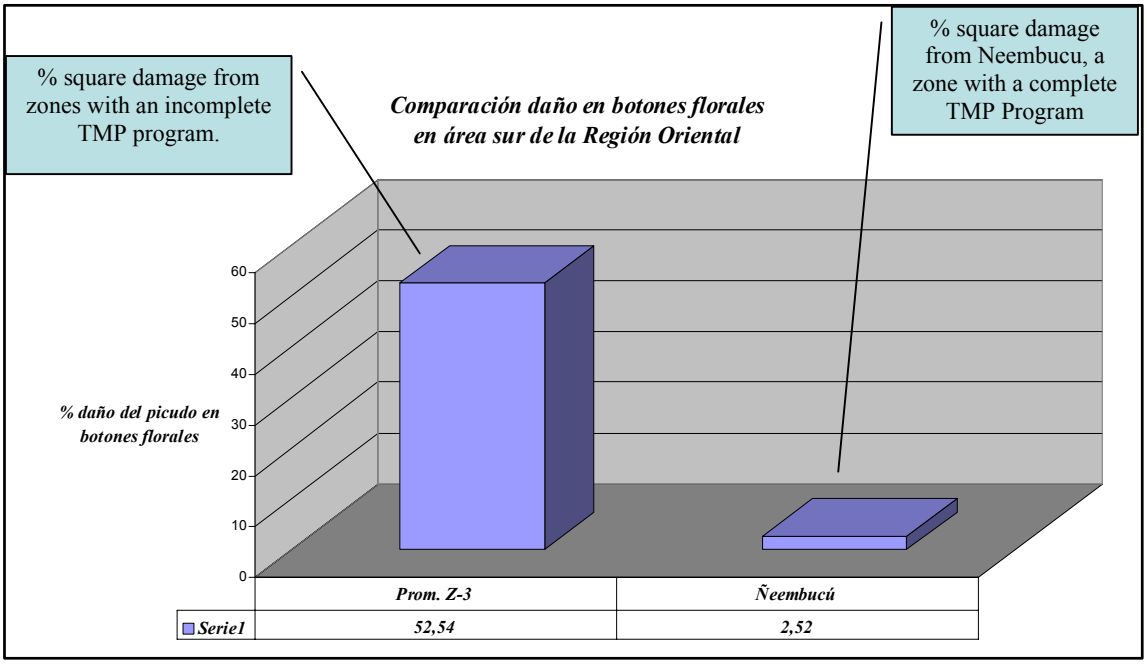


Figure 6. Average % Square Damage during 2002/2003.

The data from the Paraguay Program clearly illustrate the need for 100% compliance and for TMP installations at planting and at stalk destruction. Otherwise, the following will be repeated:

- The boll weevil will cause more serious economic damage.
- Beneficial insect populations will be decimated by 6 to 8 applications of toxic insecticides (for weevils), applied through knapsack sprayers by "campesino" producers who have only very little knowledge about the correct use of such products.
- Yields will drop.
- Cotton will become unprofitable (for various reasons, including increased costs due to the weevil).
- The planted area will probably be reduced.
- The lack of cotton production will create more serious social problems, such as has occurred in other countries of Central and South America.

Conclusion

In Latin America and the USA, the use of the "Bait Stick" technology in boll weevil control, prevention, suppression and eradication programs has been validated various times; it has made good progress and played an important role in an approximate 2 million acres of area-wide programs in Argentina, Bolivia, Brazil, Colombia and Paraguay. The development and use history of the TMB/TMP in IPM and area wide programs clearly illustrates that the product and its related technology of "attraction and control" provide an alternative to conventional spray programs (wash day, weekly or bi-weekly) and to "IPM - Integrated Pesticide Management" programs. The TMB/TMP has been demonstrated during several years, in more than 150 field tests, to be an ideal "tool" (product) for incorporation into true "IPM -Integrated Pest Management" programs.

In Latin America, the availability of labor for TMB/TMP installations, the year round boll weevil activity and the 42 + days of weevil "attraction and kill" by the TMBs/TMPs makes the technology very suitable for use in IPM and area-wide programs. Whereas, BWACT use in USA programs has been limited for many different reasons, but primarily due to labor for installations and the "operational design" of programs (with limited labor).

Historical and current data illustrate that in order to have a successful National Cotton Production Program in a weevil infested region, the weevil has to be "taken out" of the production scheme. In Latin America, mandatory concentrated plantings and TMB/TMP installations at planting and subsequently during a "complete" stalk destruction program have been very economical, effective and environmentally friendly tactics to use for eliminating economic damage from the weevil. Where used according to recommendations, the TMB/TMP programs have eliminated the economic damage from boll weevils at an approximate per acre cost of $8.80 per crop cycle and resulted in an average "cost to benefit" ratio of $1 to $12.

In boll weevil infested regions and countries where the technology is not used, it is primarily due to political, competitive and/or operational factors, not for technical and economic reasons.

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