OUTCOME OF TWO-YEAR STUDY OF BOLL WEEVIL CONTROL WITH INUNDATIVE RELEASES OF *CATOLACCUS GRANDIS* (HYMENOPTERA-PTEROMALIDAE) IN TAMAULIPAS MEXICO

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Abstract

The state of Tamaulipas has nearly 1.7 million hectares of agricultural land, and 56% of this area is located in the Northern part of the state, close to the Lower Rio Grande Valley in Texas. Cotton, is an important crop, with boll weevil, *Anthonomus grandis* Boheman. as a most significant factor for producing economic yield. Finding other type of strategies to reduce cotton boll weevil population is very important, because the other major pests (*Heliothis* spp and *Spodoptera exigua*) in most instances have a good natural control, and the presence of Boll weevil means chemical control which disrupts in most cases the equilibrium of natural enemies and insect pests.

Catolaccus grandis (Burks) Hymenoptera- Pteromalydae) seems to be a good alternative for maintaining early infestation of cotton boll weevil under control.

During a period of two years, we evaluated inundative releases of *Catolaccus grandis* Burks at Llera Tamaulipas and we found out that this parasitoid is able to keep boll weevil under control at early season population providing third instar mortality larvae above 80% ; which is high enough to prevent the use of insecticide against this insect. In 1997, we included the use of Bt cotton to integrate both technologies, but we did not have infestation of Tobacco bud worm (*Heliothis virescens* F.), and boll weevil population was not present during the early season (first six weeks of squaring); however, in random samples we found up to 84% of *Catolaccu*s parasitism. Life table during 1996 and 1997 showed that *C. grandis* is the main responsible factor, for killing cotton boll weevil.

Yield of seed cotton during both years, was higher in the *Catolaccus* field than in the commercial check field.

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Introduction

In Mexico, most of the cotton regions have been struggling with boll weevil for many years. This insect is the cause of at least 20 % loss of seed cotton and is responsible for 60 to 70% of the insecticide sprays in the Northeastern region. Boll weevil is a native pest of Meso America (Burke et al 1986), and its movement towards the north has been without the natural enemies that keep this insect under control in its natural region.

Northern Tamaulipas, Mexico, includes nearly 1.0 million hectares of agricultural land representing 56% of the all-state farming land. Grain sorghum and corn are the major crops; cotton is the third most important cash crop (Tables 1) and boll weevil very often takes 25 to 30% and in some cases up to 40% of the investment.

In this study, conducted during three years, 1995, 1996 and 1997, in the Tamaulipas cotton region, we tried to validate the action of *Catolaccus grandis* on the boll weevil third instar larvae. We selected two sites, one in Rio Bravo close to the Lower Rio Grande Valley , and the other at Llera Tamaulipas which is located 300 miles south of Rio Bravo (Fig 1).

Weather conditions during the three years at the experimental sites had a direct influence on the results, as discussed in this paper.

Life tables studies help us to describe survival and mortality of the population showing what stage of the studied insect has the higher mortality. J. A. Morales et al (1995) found out that, in a life table study, *Catolacus grandis* (Burks) was the first cause of mortality of boll weevil third instar larvae.

Materials and Methods

This evaluation was conducted at Llera Tamaulipas Mexico located at longitude:

98° 57' 00" and latitude 23° 19' 30". Llera is located 10 miles south of the Tropic of Cancer.

The study took place in an INIFAP (Instituto Nacional de Investigaciones Forestales Agricolas y Pecuarias) agricultural station. Planting dates were in July. Female adults of *Catolaccus* were released since the beginning of squaring, and infested squares were detected. The dosage used was 617 females per Hectare twice a week (1235 /Ha.).

Infested squares of random samples of one meter size each were also taken. These included punctured squares in the plants and on the ground. About ten to twenty from the field in study were collected, taken to the laboratory and analyzed for parasitism or predatism. For the life table study, the cohort system reported by Morales-Ramos J.A. et al 1994, was used. These were tied to a cord. Each cord was also tied 10 to 15 cms (4" to 6") above ground level on the line of plants, the amount of infested squares used varied according to availability. Each cohort was left on the field for two consecutive weeks, then collected and taken to the laboratory for dissection. The number of dead weevil, the cause and the stage at which death occurred was recorded as proposed by Morris and Miller : *x*.- Age interval at which sample was taken, *lx*-The number living at the beginning of the stage noted in *x* column, *dx*.- The number dying within the age interval stated in the *x* column, *dx*F- The mortality factor responsible for *dx*,100 *qx*- Percentage of mortality. *Sx* survival rate within *x.*

The study was conducted in cotton that was planted to evaluate the impact of *Catolaccus grandis* releases versus no releases and conventional management (IPM control for Boll weevil). and the best conditions to show this were obtained at Llera. Each plot had 4-00-00 Hectares and they were 700 Mts. apart from each other.

Planting date in 1996 was July 6, variety used was Deltapine 50, population density was 75,000 pts/Ha, only one irrigation was necessary due to the rainfall. In 1997, field size was 2-00-00 Ha. each plot, planting date was July 31 and Bt cotton Nucotton 33B was used. Releases of *Catolaccus* were on a two-days-a-week basis (Tuesday and Friday), the *Catolaccus* releases started when 30% to 40% of plant population had "match head" square size.

In 1996 at Llera, only "in vivo" adults of Catolaccus were used (Table 2) and 13 different dates were established starting August 27 and ending October 23. Each date consisted of six or twelve groups in each field, each group had 10 squares infested with boll weevil (eggs or first instar larvae). In 1997 in Llera , Catolaccus reared "in vivo" and "in vitro" were used (Table 3). Due to the low adult weevil population at the early season, only three dates of cohorts were established: October 10, 24 and November 21.

Female adults released were reared at the Weslaco Tx. USDA-ARS Subtropical Agricultural Research Laboratory. In all these cases, a commercial check was used which had insect and agricultural management according to the Regional Extension Service.

Results and Discussion

At Llera in 1996, the 4-00-00-Has release field was separated from the 700-Mt. commercial field. The boll weevil infestation observed in the *Catolaccus* field was higher than that in the commercial field. We observed a very slow movement of the boll weevil population in the commercial field; however, the *Catolaccus* field showed an early boll weevil infestation that was maintained under control by inundative releases of Catolaccus (Fig 2).

Results of the life table study in 1996 were grouped in three season: Early season from August 27 to September 13 (Table 4), Mid season from September 17 to Sep. 29 (Table 5) and Late season from October 2 to Oct. 23 (Table 6). During the first season in the *Catolaccus* field, 10% survival and 86% mortality of boll weevil was found in 3rd instar larvae (both feeding and host parasite), during this time, 17% mortality was also found in the commercial plot due to *Catolaccus* (Host and feeding habits). In the Mid season, boll weevil survival in the releasing field was only 16% from the total, while in the check it was 88%. We assumed that the mortality in the check was due to feeding habits.

As expected, in the late season starting from October 2, The Boll weevil survival increased (periodic releases were ended in Sep. 17). In the release field it went up to 55% versus 88% in the check field. There were eight sprays for boll weevil in the commercial field in 1996, and they caused an outbreak of aphids and boll worm that we had to control with insecticide. The *Catolaccus* field had only three sprays against boll weevil at the end of the season.

In 1997, Parasitoids "in vivo" and "in vitro" were used (Table 3). Boll weevil infestation in the *Catolaccus* field was late (six weeks after squaring started) and it was also a very light infestation; however, we had to spray twice for boll weevil at the commercial field. On a regional basis (Mante cotton area) the same trend was observed for boll weevil, one possible reason is that cotton acreage dropped drastically to 95% (from 52,000 Ha. in 1995 to 2,500 Ha. in 1996). However, we were able to set only three dates for cohort studies (Tables 7, 8 and 9).

Results in 1996 and 1997 at Llera Tamaulipas from the release fields gave us information about how inundating releases of *Catolaccus* can help in the management of Boll weevil problem in this region, especially without insects such as Fleahopper and Boll worm during the early season. Fig. 2 shows how the mortality was in 3rd instar boll weevil larvae which is the preferred stage of this parasitoid followed by pupae.

Eventhough seed cotton yield is not a parameter associated directly with the objective of this study, it is important to mention that, as shown in table No. 10, *Catolaccus* field yielded 20.0% and 32% more than the commercial check in 1996 and 1997 respectively.

Summary and Conclusions

Parasitism observed in the Commercial field in both years was consistently lower than in the *Catolaccus* releasing field.

Boll weevil population in 1997 was not present in the early stages during the first fruiting weeks at the *Catolaccus* field.

Parasitism due to *C. grandis was* shown to be the responsible for highest mortality of boll weevil population.

In 1997, we sprayed in the commercial check three times for boll weevil and none in the Catolaccus field.

Low population of *Heliothis virescens* in the field did not permit the evaluation of the Bt cotton as a complement of this insect's pest management.

Rainfall registered in 1996 during the cotton season, reduced the effectiveness of the insecticides spray for boll weevil, and this situation appears normal in this area; therefore, that makes the biological control of *A. grandis* an important tool for insect control in the commercial cotton.

An outbreak of aphids was caused at the beginning of the insecticides spray which had to be controlled by insecticide spray also. Seed cotton yield *in* the *Catolaccus* field for both years was 20% and 32% higher than in the check field.

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Table 1. Cotton Acreage and Yield in Northern Tamaulipas Mexico 1990-1997

Year	Hectares Planted	Hectares Harvested	Total Yield Ton.	Yield Ton/ha
1990	11,339	10,661	19,117	1.793
1991	73,974	60,425	109,658	1.815
1992	5,870	5,770	7,044	1.221
1993	3,523	2,951	4,578	1.551
1994	25,351	24,288	26,876	1.109
1995	48,282	37,689	39,598	1.051
1996	22,051	20,302	20,505	1.010
1997	12,668	12,668	20,812	1.643

Table No 2.- *Catolaccus* females release dates in Llera Tam. Mexico 1996

Release Date	# Females
August 6	3,960
August 9	4,000
August 13	4,600
August 16	4,600
August 20	3,820
August 23	3,820
August 27	3,900
August 29	3,820
Sept. 03	3,800
Sept. 06	3,800
Sept. 10	4,100
Sept. 13	3,000
Sept. 17	3,000
Sept. 24	3,000
Total	**53,220**

Table No 3.- *Catolaccus* Female Release Dates in Llera Tam. Mexico 1997

Release Date	# Females "In vivo"	"In vitro"
Sept. 16	800	
Sept. 19	800	
Sept. 23	800	
Sept. 26	580	140
Sept. 30	800	
Oct. 3	430	370
Oct. 7	400	400
Oct. 10	535	265
Oct. 14	800	
Oct. 17	535	265
Oct. 21	800	
Oct. 24	800	
Oct. 28		800
Oct. 31		800
Total	**8080**	**3040**

Table 4.- Life Table Analysis from Boll Weevil Cohorts in the Llera-Mante Area, Tamaulipas Mexico. h= 261 Cohorts from August 27 to September 13, 1996.

Stage	lx	qx %	ind %
	Catolaccus Release Field		
Egg	256	12.11	1.4
Instar 1	225	0.00	0.0
Instar 2	225	16.00	1.93
U.M.[a]		1.93	
Instar 3	189	86.24	63.67
U.M.[a]		26.17	
M.P.[b]		37.13	
Pupa	26	0.00	0.0
Adult	26		
N= 261	Commercial field		
Egg	261	17.62	13.44
Instar 1	215	0.00	0.0
Instar 2	215	41.15	1.80
U.M.[a]		1.80	
Instar 3	209	19.14	14.87
U.M.[a]		10.05	7.81
M.P.[b]		9.09	7.06
Pupa	169	2.96	1.92
Adult	164		

lx = Survival from Eggs to Stage x
qx= Mortality Occurring During Stage x
ind= Indispensable Mortality Occurred During Stage x
a= Unexplained Mortality
b= Mortality Due to *Catolaccus grandis*

Table 5.- Life Table Analysis from Boll Weevil Cohorts in the Llera-Mante area, Tamaulipas Mexico. n= 319 Cohorts from September 17 to September 29, 1996.

Stage	lx	qx	ind
	*Catolaccu*s release field		
Egg	319	10.97	2.01
Instar 1	284	0.00	0.0
Instar 2	284	19.01	3.83
U.M.a			3.83
Instar 3	230	72.17	42.28
U.M.[a]			19.61
M.P.[b]			22.67
Pupa	64	18.75	3.76
Adult	52		
N= 356	Commercial field		
Egg	356	3.93	3.60
Instar 1	342	0.00	0.0
Instar 2	342	23.27	1.04
U.M.a			1.04
Instar 3	338	6.80	6.42
U.M.[a]		6.51	6.14
M.P.[b]		0.30	0.28
Pupa	315	0.63	0.56
Adult	313		

lx = Survival from Eggs to Stage x
qx= Mortality Occurring During Stage x
ind= Indispensable Mortality Occurred During Stage x
a= Unexplained Mortality
b= Mortality due to *Catolaccus grandis*

Table 6.- Life Table Analysis from Boll Weevil Cohorts in the Llera-Mante Area, Tamaulipas Mexico. n=280 Cohorts from October 2 to October 23, 1996

Stage	lx	qx	ind
	Catolaccus release field		
Egg	280	0.71	0.40
Instar 1	278	0.00	0.00
Instar 2	278	2.52	1.42
U.M.a			1.42
Instar 3	271	40.59	37.58
U.M.[a]			20.16
M.P.[b]			17.42
Pupa	161	4.35	2.50
Adult	154		
N= 284	Commercial Field		
Egg	284	1.06	0.94
Instar 1	281	0.36	0.31
Instar 2	280	0.71	0.63
U.M.a			0.63
Instar 3	278	7.55	7.19
U.M.[a]		7.55	7.19
M.P.[b]		0.00	0.0
Pupa	257	2.72	2.46
Adult	250		

lx = Survival from Eggs to Stage x
qx= Mortality Occurring During Stage x
ind= Indispensable Mortality Occurred During Stage x
a= Unexplained Mortality
b= Mortality Due to *Catolaccus grandis*

Table 7.- Life Table Analysis from Boll Weevil Cohorts in the Llera-Mante area, Tamaulipas Mexico. n=65 Cohorts from October 10, 1997.

Stage	lx	qx	ind
	Catolaccus Release Field		
Egg	65	29.23	1.91
Instar 1	46	0.00	0.00
Instar 2	46	30.43	2.02
U.M.a			1.42
Instar 3	32	90.63	44.62
U.M.[a]		6.25	3.08
M.P.b		84.38	41.54
Pupa	3	0.0	0.00
Adult	3		
n=40 Cohorts	Commercial Field		
Egg	40	22.50	21.05
Instar 1	31	0.0	0.00
Instar 2	31	0.0	0.00
U.M.a			0.00
Instar 3	29	0.00	5.00
U.M.[a]		0.00	2.50
M.P.[b]		0.00	2.50
Pupa	29	2.72	0.00
Adult	29		

lx = Survival from Eggs to Stage x
qx= Mortality Occurring During Stage x
ind= Indispensable Mortality Occurred During Stage x
a= Unexplained Mortality
b= Mortality due to *Catolaccus grandis*

Table 8. Life Table Analysis from Boll Weevil Cohorts in the Llera-Mante Area, Tamauliipas Mexico. N=70 cohorts from October 24, 1997.

Stage	lx	qx	ind
	Catolaccus Release Field		
Egg	70	30.00	1.22
Instar 1	49	0.00	0.00
Instar 2	49	57.14	3.81
U.M.a			3.81
Instar 3	21	90.84	27.14
U.M.[a]		4.76	1.43
M.P.[b]		85.71	25.71
Pupa	2	0.00	0.00
Adult	2		
N= 48	Commercial Field		
Egg	48	25.00	18.75
Instar 1	36	0.00	0.00
Instar 2	36	5.56	3.31
U.M.a		5.56	3.31
Instar 3	34	20.59	14.58
U.M.[a]		5.88	4.17
M.P.[b]		14.71	10.42
Pupa	27	0.00	0.00
Adult	27		

lx = Survival from Eggs to Stage x
qx= Mortality Occurring During Stage x
ind= Indispensable Mortality Occurred During Stage x
a= Unexplained Mortality
b= Mortality Due to *Catolaccus grandis*

Table 9. Life table Analysis from Boll Weevil Cohorts inthe Llera-Mante Area, Tamaulipas Mexico. n= 29 Cohorts from November 21, 1997

Stage	lx	qx	ind
	Catolaccus release field		
Egg	29	27.59	9.20
Instar 1	21	0.00	0.00
Instar 2	21	0.00	0.00
U.M.a		0.00	0.00
Instar 3	21	66.67	48.28
U.M.[a]		4.76	3.45
M.P.[b]		61.90	44.83
Pupa	7	0.00	0.00
Adult	7		

lx = Survival from Eggs to Stage x
qx= Mortality Occurring During Stage x
ind= Indispensable Mortality Occurred During Stage x
a= Unexplained Mortality
b= Mortality Due to Catolaccus grandis

Table No. 10 Seed Cotton Production in the *Catolaccus* Test in 1996 and 1997 Llera Tamaulipas Mexico.

	Kilograms per Hectare			
Treatment	1996	% inc.	1997	%inc.
Catolaccus field	1,664	20.0	2,256	32.0
Commercial Field	1,332		1,534	

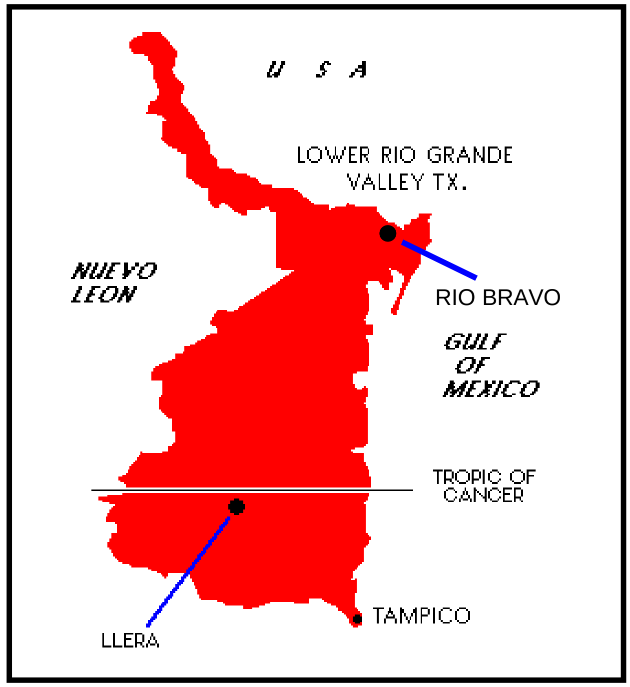

Figure 1. Catolaccus Field Evaluation Test Tamaulipas Mexico.

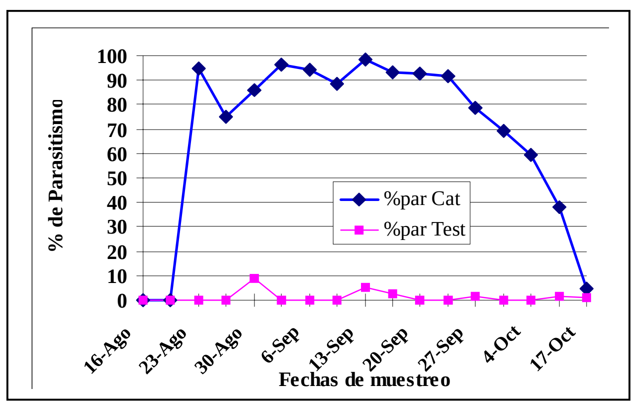

Figure 2. Parasitism of Catolaccus in release field and commercial field at Llera Tamaulipas 1996.