IMPACT OF *Catolaccus grandis Burks* (HYMENOPTERA: PTEROMALIDAE) FIELD RELEASES ON COTTON BOLL WEEVIL IN THE HUASTECA REGION OF MEXICO

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Abstract

We established boll weevil cohorts in check and release fields and constructed life tables to assess the mortality of boll weevil immatures assignable to *Catolaccus grandis* (Burks) and other agents. Field sites in Mexico were at Estacion Cuauhtemoc, Tamaulipas and Ebano, San Luis Potosi during late summer of 1999. Results from the release sites indicate that *Catolaccus grandis* was the main mortality factor of boll weevil, primarily of third instar larvae. Seasonal average mortality of third instars was higher at the Cuauhtemoc release plot (72.4%) than at the Ebano release plot (64.3%), as was mortality rate from egg to adult (86.1% vs. 72.5%). However, mortality due to *C. grandis* parasitism was much lower at Cuauhtemoc than that recorded at Ebano during the crucial early period of boll weevil infestation and establishment, and the effect of the parasitoids was not sufficient to prevent high damage in the release plot at Cuauhtemoc). In contrast, the higher mortality occurring at Ebano during the early infestation period (> 70%) may have resulted in a slower population increase and lower overall densities of boll weevil and percent damaged fruit. At Ebano, satisfactory control of boll weevil was observed in the release field while the check required 11 insecticide applications for boll weevil control.

Introduction

In Mexico, most of the cotton regions have been struggling with boll weevil, *Anthonomus grandis* Boheman, for many years. Its damage to seed cotton yield is annually estimated to be at least 20 % and it is responsible for 60 to 70 % of the insecticide sprays in the Northeastern region, where cotton is the third most important cash crop (Vargas et al. 1998). The boll weevil is the most important insect pest of cotton production in northeastern Mexico, not only for yield losses and insecticide control costs, but its importance and impact on the integrated pest management of the Heliothine complex and other lepidopterans that may be held in check by natural enemies when non-target insecticide induced mortality is minimized. Research on *Catolaccus grandis* (Burks) has demonstrated its potential as an augmentative biological control agent for suppression of the boll weevil in experimental and commercial cotton fields in Llera, Tamaulipas, Mexico (Vargas et al 1998). Our objectives were to evaluate releases of *C. grandis* in other production areas of Mexico.

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Materials and Methods

Field sites were in northeastern Mexico at two experiments stations of the Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias (INIFAP) located at Estación Cuauhtemoc, Tamaulipas, and Ebano, San Luis Potosi. Plots were planted during the first week of August, 1999. *Catolaccus grandis* release plots were planted to a Bt cotton (NuCOTON) and the commercial check planted to Deltapine 50. Plot size of check and release fields at Cuauhtemoc were 2.5 acres and at Ebano were 10 acres.

The parasitoids were produced at Rio Bravo Experiment Station Laboratory, using boll weevil pupae from APHIS Biological Control Center at Mission, Texas. Prior to release, parasitoids were exposed to boll weevil larvae for two days in the laboratory. Parasitoids were released twice per week with each release at the rate of 600 females per hectare. At the Cuauhtemoc station, 12 releases were conducted beginning September 27. At Ebano, 14 releases were conducted beginning September 20. The last release was November 4 for both locations. The release fields were 500 meters apart from check fields which were managed according to commercial practices.

Squares samples were taken twice a week by recording damaged and undamaged squares by boll weevil. Sample units were one square meter and sample size was 8 and 10 samples at Cuauhtemoc and Ebano, respectively.

To get estimates of generational mortality of boll weevil, we established cohorts and constructed life tables (Morales-Ramos, et al. 1995). Ten infested (egg or 1st instar boll weevil) squares were attached to a one meter cord. Ten of these cords with infested squares were placed on the ground beneath the cotton canopy twice per week for four weeks at Cuauhtemoc and six weeks at Ebano. The cohorts were left in the field for two weeks (sufficiently long for all mortality factors to occur or for adult weevils to emerge from squares). The squares were recovered from the field and inspected in the laboratory to determine if and at what life stage any mortality occurred, and the cause of the mortality according to the method described by Sturm and Sterling (1986). Life table analysis was used to measure stage specific mortality. The effect of parasitism by *C. grandis*, predation by ants, and unexplained mortality were evaluated by calculating stage and factor specific mortality rates (q_x) and indispensable mortality (I_x) according to Southwood (1978). Unexplained mortality included the combination of desiccation, diseases, and mortality induced from feeding or venomization by adult *C. grandis* females. These three factors cannot be unambiguously identified from cohort samples (Morales-Ramos et al. 1995).

Results and Discussion

Table 1 shows the results of the analysis of life tables for all pooled boll weevil cohorts at Cuauhtemoc. Approximately 20 percent mortality occurred in the egg stage in both check and release fields, while survival of boll weevil from the egg to adult stage was 78.5 and 13.9 percent in the check and release fields, respectively. In the release field, 72.4 percent mortality occurred in third instar larvae, with 64.9 percent attributable to parasitism by *C. grandis*. For second instar larvae and pupae, the apparent mortality was approximately 12% and 28%, respectively. Almost neglible mortality of larvae and pupae was recorded in the check.

Figure 1 shows the apparent mortality percentages of boll weevil third instar larvae due to parasitism by *C. grandis* recorded for each sample date during the evaluation at the Cuauhtemoc release plot. For the second cohort sample date, the apparent mortality dropped below 40%. It is very important that high percent mortality be obtained by augmentive release of parasitoids during early season infestation by boll weevil to limit pest population increase.

The results of the analysis of life tables for all pooled boll weevil cohorts at Ebano (Table 2) shows 12-15 percent mortality occurred in the egg stage in both check and release fields, while survival of boll weevil from the egg to adult stage was 83.4 and 27.5 percent in the check and release fields, respectively. In the release field, 64.3 percent mortality occurred in third instar larvae, with 62.2 percent attributable to parasitism by *C. grandis*. For second instar larvae and pupae, the apparent mortality was approximately 10% and 2.4%, respectively. Very low mortality of larvae and pupae was recorded in the check.

The apparent mortality percentages of boll weevil third instar larvae attributable to parasitism by *C. grandis* for each sample date during the evaluation at the Ebano release plot is shown in Figure 2. More than 70 percent mortality of boll weevil third instars was recorded in the first three sample dates then mortality dropped to below 20 percent on the fifth sample before increasing in later sample dates.

Seasonal average mortality of third instars was higher at Cuauhtemoc (72.4%) than at Ebano (64.3%) as was mortality rate from egg to adult emergence (86.1% vs. 72.5%). However, during the early period of boll weevil infestation and establishment, mortality due to *C. grandis* parasitism was much lower at Cuauhtemoc than that recorded at Ebano and the effect of the parasitoids was not sufficient to prevent high damage in the release plot at Cuauhtemoc (Fig. 1). In contrast, the higher mortality occurring at Ebano during the early infestation period (> 70%) may have resulted in a slower population increase and lower overall densities of boll weevil and percent damaged fruit (Fig. 2). At Ebano, satisfactory control of boll weevil was observed in the release field while the check required 11 insecticide applications for boll weevil control.

Summary and Conclusions

In the two locations where the evaluation of *C. grandis* was conducted, results show that augmentative releases of this parasitoid can inflict significant mortality on boll weevil populations, primarily due to parasitism of third instars, but also of second instars and pupae (either by parasitism or from feeding or venomization by adult *C. grandis* females. When sustained high mortality of first and second generations of boll weevil is obtained as a consequence of *C. grandis* releases, effective suppression of boll weevil populations may be feasible in the absence of insecticide applications. However, low rates of parasitism of immatures during early season will likely result in higher late-season populations of weevils that require repeated insecticide applications to reduce pest damage. Growers and plant protection personnel in southern Tamaulipas are interested in the further testing, evaluation, and demonstration of the technology of using *C. grandis* for boll weevil suppression as a compatible tool in a total integrated pest management system for cotton.

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Table 1. Life table analysis of boll weevil cohorts at Cuauhtemoc, Tam. From October 06 to November 05, 1999.

Stage	nx	qx	Ix
Check field			
Egg	887	19.4	18.9
Instar 1	715	1.3	1.0
Instar 2	706	0.3	0.2
Instar 3	704	1.0	0.8
U. M.	(704)	1.0	0.8
M. P.	(697)	0.0	0.0
M. A. P.	(697)	0.0	0.0
Pupa	697	0.1	0.1
U. M.	(697)	0.0	0.0
M. P.	(697)	0.1	0.1
Adult	696	-	-
Catolaccus release field			
Egg	899	19.1	3.3
Instar 1	727	2.1	0.3
Instar 2	712	11.8	1.9
Instar 3	628	72.4	36.6
U. M.	(628)	6.7	3.4
M. P.	(586)	64.9	32.0
M. A. P.	(189)	2.5	2.6
Pupa	173	27.7	5.3
U. M.	(173)	6.4	1.2
M. P.	(162)	21.4	4.1
Adult	125	-	-

nx is number of live individuals starting stage x, qx is percent of individuals dying during stage x, and Ix is the percent indispensable mortality occurring during stage x. U.M. is unexplained mortality (includes dessication, diseases, and host feeding). M.P. is *C. grandis* parasitism mortality. M.A.P. is ant predation mortality.

Table 2. Life table analysis of boll weevil cohorts at Ebano, S.L.P. from September 24 to November 05, 1999.

Stage	nx	qx	Ix
Check field			
Egg	1243	14.7	14.4
Instar 1	1060	0.0	0.0
Instar 2	1060	1.2	1.0
Instar 3	1047	0.8	0.6
U. M.	(1047)	0.2	0.2
M. P.	(1045)	0.4	0.3
M. A. P.	(1041)	0.2	0.2
Pupa	1039	0.2	0.2
U. M.	(1039)	0.2	0.2
M. P.	(1037)	0.0	0.0
Adult	1037	-	-
Catolaccus release field			
Egg	1196	12.1	3.8
Instar 1	1051	0.3	0.1
Instar 2	1048	10.0	3.1
Instar 3	943	64.3	49.5
U. M.	(943)	1.9	1.5
M. P.	(925)	62.2	47.8
M. A. P.	(340)	0.3	1.0
Pupa	337	2.4	0.7
U. M.	(337)	2.1	0.6
M. P.	(330)	0.3	0.1
Adult	329	-	-

nx is number of live individuals starting stage x, qx is percent of individuals dying during stage x, and Ix is the percent indispensable mortality occurring during stage x. U.M. is unexplained mortality (includes desiccation, diseases, and host feeding). M.P. is *C. grandis* parasitism mortality. M.A.P. is ant predation mortality.

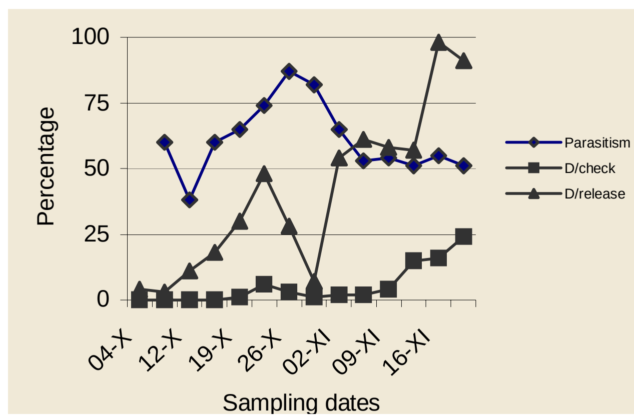

Figure 1. Damage of boll weevil and Parasitism caused by C. grandis in cohorts. Cuauhtemoc, Tam. 1999.

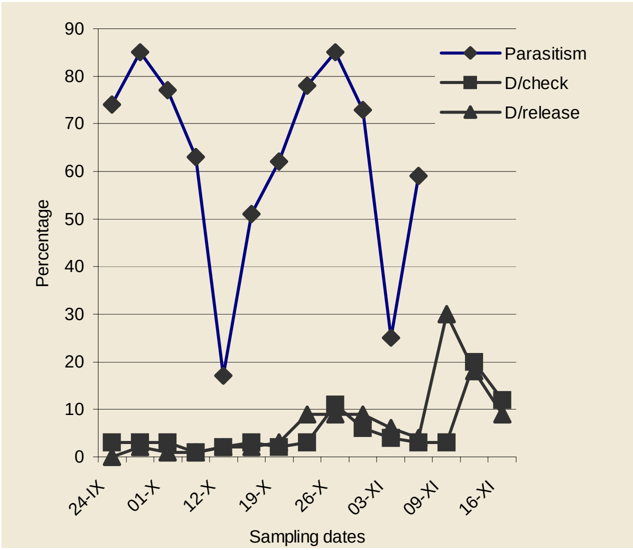

Figure 2. Damage of boll weevil and their parasitism caused by C. grandis in cohorts. Ebano, SLP. 1999s.