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Competition Between *Catolaccus grandis* (Hymenoptera: Pteromalidae) and *Bracon vulgaris* (Hymenoptera: Braconidae), Parasitoids of the Boll Weevil

Francisco de Sousa Ramalho[1]*, Ana Maria Camêlo da Silva[2], José Cola Zanuncio[3] and José Eduardo Serrão[3]

Embrapa Algodão; Unidade de Controle Biológico; C. P. 174; 58107-720; Campina Grande - PB - Brasil. [2]Universidade Estadual da Paraíba; Departamento de Biologia; Campina Grande - PB - Brasil. [3] Departamento de Biologia Geral; Universidade Federal de Viçosa; Campus Universitário; Viçosa - MG - Brasil

ABSTRACT

The competition between populations of the parasitoids C. grandis *and* B. vulgaris *was studied using larvae of* Euscepes postfasciatus *(Fairmaire) as an alternative host. A series of biological parameters was observed and related to the competitive abilities of both parasitoid species. They were capable of colonizing and maintaining their populations regardless of host location. The population growth of* C. grandis *and* B. vulgaris, *based on fecundity was not affected by the competition. The parasitism and survivorship to the adult stage were affected by competition, except when the host was located at the bottom of the rearing cage.* C. grandis *performed better than* B. vulgaris *independently of the competition and host location, but it did not exclude the other species.*

Key words: Biological control, *Anthonomus grandis*, competition between parasitoids

INTRODUCTION

The family Braconidae presents many parasitoid species of key-pests of agriculture and stored grains (Wanderley, 1998). Species of the genus *Bracon* are among the main parasitoids of *Anthonomus grandis* Boheman in the United States (Cross and Chesnut, 1971; Cross 1973), where larval parasitization can reach 94 to 100% (Meinken and Slosser, 1982).

There are many ectoparasitoids attacking the boll weevil in Brazil (Ramalho and Wanderley, 1996), but *Bracon vulgaris* Ashmead (Hymenoptera: Braconidae) and *Catolaccus grandis* (Burks) (Hymenoptera: Pteromalidae) are considered the major parasitoids of this pest in many areas where cotton is cultivated in the State of Paraíba, Brazil (Ramalho et al., 1993; Ramalho et al., 1996; Ramalho et al., 2000).

Although both parasitoids exploit the same host, they are somewhat isolated because they prefer to attack hosts at different stages of development. *C. grandis* prefers to parasitize the host after the cotton squares have fallen to the ground (Morales-Ramos and Cate, 1992), while *B. vulgaris* preferably attacks the host infesting cotton bolls while still in the upper part of cotton plants (Ramalho and Wanderley, 1996). This behavior shows the possibility of having a high parasitism rate in biological control programs of *A. grandis* through releases of both parasitoids due to the exploitation of different ecological niches. However, it is important to verify if competition between these parasitoids may exist, and if it could

* Author for correspondence

impair the parasitization of *A. grandis* through biological control programs seeking for the release of both natural enemies. Therefore, the objective of this work was to study the competitive abilities of the parasitoids *C. grandis* and *B. vulgaris* and to determine their impact on the population growth of these species through survival of their immature stages.

MATERIAL AND METHODS

This work was carried out in an acclimatized room at 26 ± 1ºC, relative humidity of 60 ± 10%, and a photoperiod of 16 h. *C. grandis* and *B. vulgaris* were obtained from the colonies of the "UCB-Embrapa Algodão" where they were reared with the alternative host *Euscepes postfasciatus* (Fairmaire) according to Ramalho and Dias (2003). Host larvae were obtained on *Ipomoea potato* which were replaced every 24 h, and those containing eggs of *E. postfasciatus* were placed into plastic trays or paper bags and kept under controlled conditions (28 ± 1°C and relative humidity of 80 ± 10%) to allow for the immature development. Fifth instar larvae of this host were supplied to the parasitoids. Host larvae were collected through a double sieving process. The first sieve had a mesh of 4.0 mm and allowed insects and small pieces of roots to pass through retaining large pieces of the root. The second sieve, with a 2.0 mm mesh separated the larvae from small roots fragments of *I. potato* and dust. Larvae of *E. postfasciatus* collected from the roots were disinfected in a 10% sodium hypochlorite solution during 10 minutes prior to parasitization.

Larvae of *E. postfasciatus* were encapsulated using the procedure of Cate (1987) with modifications of Wanderley and Ramalho (1996). The effect of competition between populations of *C. grandis* and *B. vulgaris* were determined with individual and combined populations of these parasitoids in acrylic transparent cages (40 x 40 x 25 cm) similar to those described by Wanderley and Ramalho (1996).

The experiment was done in a randomized complete-block design with six treatments: (1) three males and six females of *C. grandis* + 40 encapsulated larvae of the host at the base of the cage; (2) three males and six females of *C. grandis* + 40 encapsulated larvae of *E. postfasciatus* at the top of the cage; (3) three males and six females of *B. vulgaris* + 40 encapsulated larvae of this host at the base of the cage; (4) three males and six females of *B. vulgaris* + 40 encapsulated larvae of the host at the top of the cage; (5) three males and six females of *C. grandis* + three males and six females of *B. vulgaris* + 40 encapsulated larvae of the host at the base of the cage and (6) three males and six females of *C. grandis* + three males and six females of *B. vulgaris* + 40 encapsulated larvae of this host at the top of the cage. A total of four replicates were used for each treatment.

Each experimental unit was composed of an acrylic cage with 0-24 h-old adults of *C. grandis* and *B. vulgaris*. Two glass tubes with distilled water and covered with a cotton wad were put in the upper part of each cage to keep humidity inside it and to supply water to the parasitoids. Parasitoids were fed with droplets of honey of *Apis mellifera* Linné distributed in the cage's walls with a disposable syringe. Parafilm sheets with 40 or 80 encapsulated larvae of *E. postfasciatus* were daily offered for each experimental unit. The number of eggs deposited and larvae parasitized were quantified with a stereomicroscope, and parasitized larvae were transferred to 500 ml plastic cups and the number of adults of *C. grandis* and/or *B. vulgaris* were quantified immediately after their emergence. Data of each replicate was taken daily, during 80 days.

Data obtained were analyzed with the procedure of PROC GLM and average compared using the test of Student-Newman-Keuls (P= 0.05) (Sas Institute, 2003).

RESULTS AND DISCUSSION

The populations of *C. grandis*, maintained alone, tended to produce more eggs, to parasitize a larger number of larvae and to produce a larger number of descendants than those of *B. vulgaris* with hosts located either at the base or at the top of the cages. Both parasitoid species showed relatively population growth at the end of the study (Figs. 1-3).

Populations of *B. vulgaris* were affected by competition with *C. grandis* with a decrease in the population levels in a relatively short period (Figs. 1-3). However, populations of *C. grandis* were not affected by competition with *B. vulgaris*. Populations of *C. grandis* alone, or in competition with the other parasitoid presented higher densities and longer growth period. *C. grandis* competes with *B. vulgaris* during host searching.

The egg production of *C. grandis* [host at the base: alone vs competition (F=0.24, df=1;3, *P*=0.6573) and host at the top: alone vs competition (F=0.22, df=1;3, *P*=0.6719)] and *B. vulgaris* [host at the base: alone vs competition (F=2.15, df=1;3, *P*=0.2390) and host at the top: alone vs competition (F=6.45, df=1;3, P=0.0847)] was not affected by competition; though parasitism (*C. grandis*: F=85.02, df=1;3, *P*=0.0027 and *B. vulgaris*: F=18.97, df=1;3, *P*=0.0224), and adult emergence of both parasitoids were affected by competition when the host was located at the top of the cages (*C. grandis*: F=80.99, df=1;3, *P*=0.0029 and *B. vulgaris*: F=240.54, df=1;3, *P*=0.0078).

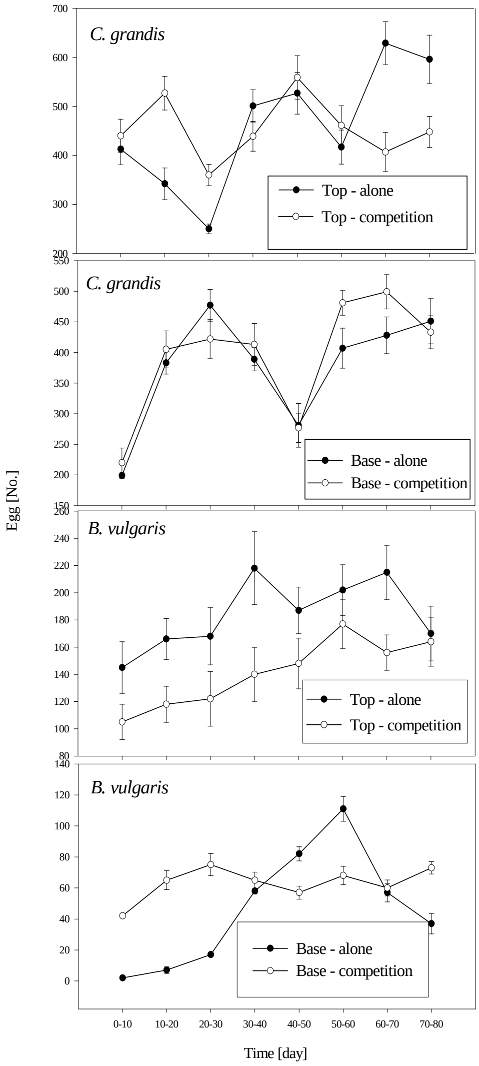

Figure 1 - Egg production per female of *C. grandis* and *B. vulgaris* maintained alone and in competition with *E. postfasciatus* larvae as host.

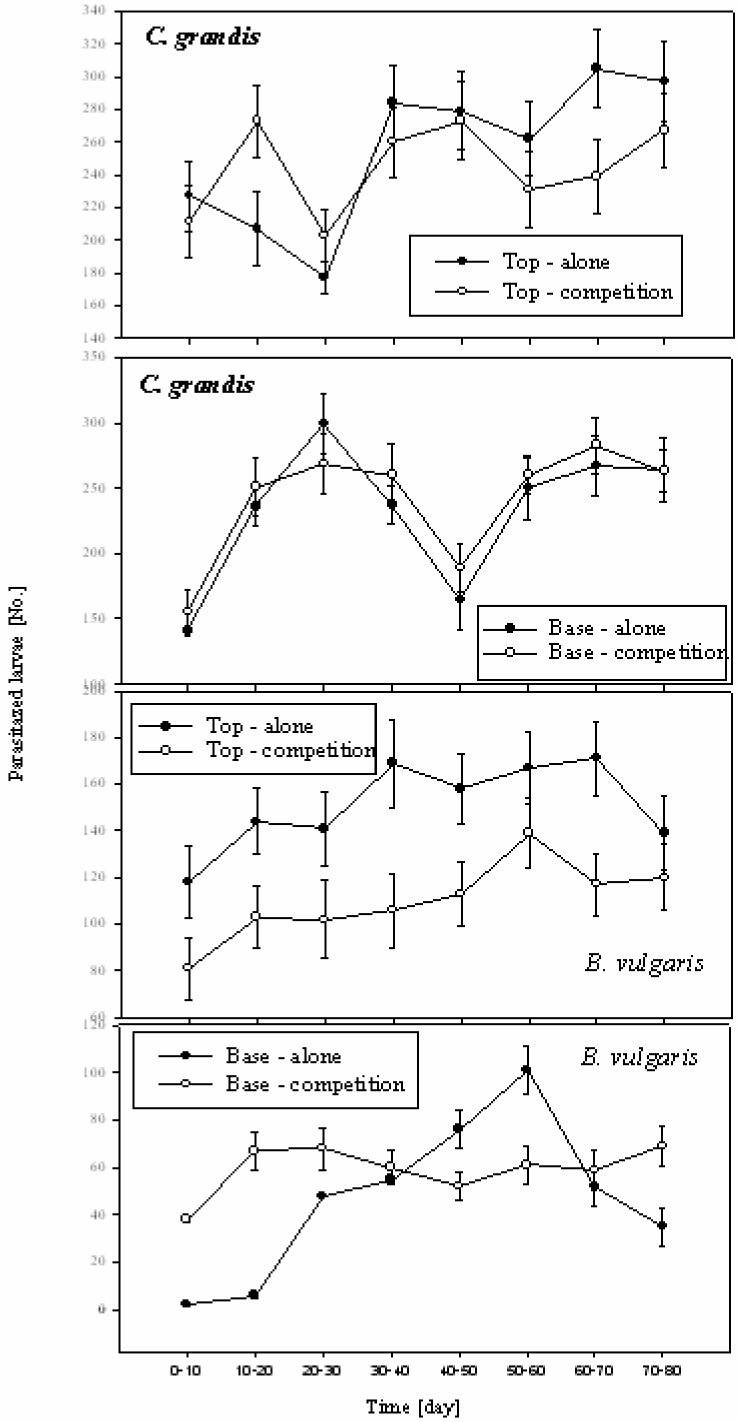

Figure 2 - Parasitism by *C. grandis* and *B. vulgaris* maintained alone and in competition with *E. postfasciatus* larvae as host.

C. grandis, independent of host location (base vs top: F=1.85, df=1;3, *P*=0.2670) deposited a larger number of eggs and consequently a larger number of *E. postfasciatus* larvae was parasitized (base vs top: F=0.10, df=1;3, *P*=0.7719); however, independently of host location (base vs top: F=3.13, df=1;3, *P*=0.1750), the emergence of adults was relatively low. This could be attributed to the cannibalistic behavior of the larvae of *C. grandis*. The *C. grandis* larvae could also destroy *B. vulgaris* larvae because its females did not discriminate parasitized hosts. These results suggested that females of *C. grandis* possibly deposited their eggs in parasitized larvae of *A. grandis* by *B. vulgaris* in cotton plants. The presence of females of one parasitoid did not inhibit oviposition by the other and they did not discriminate parasitized hosts. Female parasitoids with good strategy effectiveness to locate the host might have a competitive advantage and this was particularly important when densities of the host were low (Godfray, 1994).

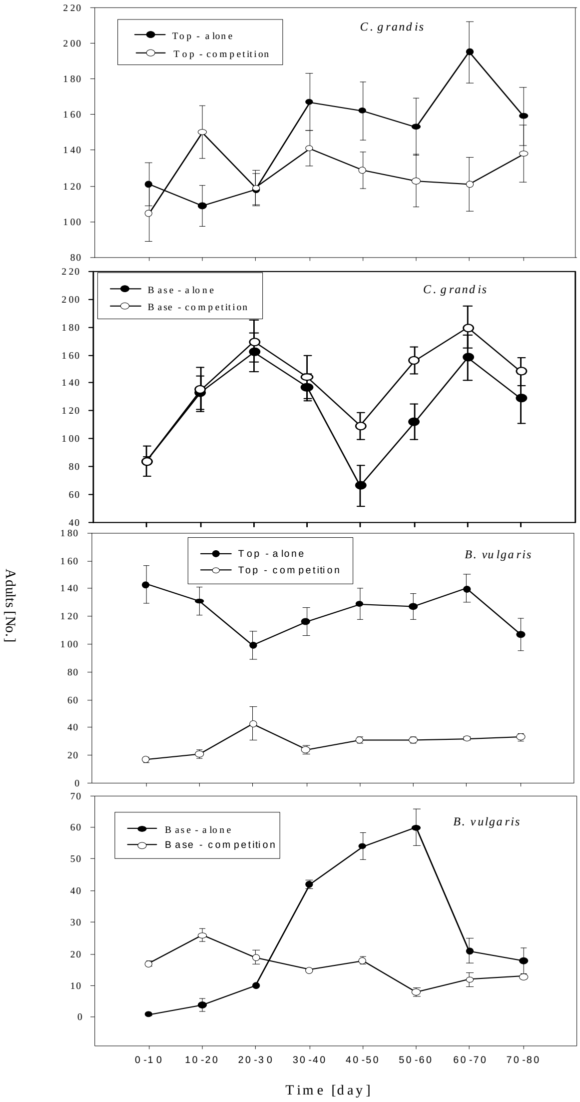

Figure 3 - Population growth of *C. grandis* and *B. vulgaris* maintained alone and in competition with *E. postfasciatus* larvae as host.

The populations of *B. vulgaris* maintained alone, or in competition deposited higher number of eggs (top vs base: F=80.17, df=1;3, *P*=0.0029 and top vs base; F=15.08, df=1;3, *P*=0.0303, respectively) and produced higher number of parasitized larvae (top vs base: F=86.38, df=1;3, *P*=0.0026 and top vs base: F=15.41, df=1;3, *P*=0.0294, respectively) and adults (top vs base:

F=32.61, df=1;3, *P*=0.0107 and top vs base: F=47.69, df=1;3, *P*=0.0062, respectively) with the host at the top than at the base of the cages; however, this behavior was not verified in *C. grandis* populations (eggs: alone: top vs base: F=4.42, df=1;3, *P*=0.1262 and competition: top vs base: F=1.85, df=1;3, *P*=0.2670, parasitized larvae: alone: top vs base: F=4.75, df=1;3, *P*=0.1174 and competition: top vs base: F=0.10, df=1;3, *P*=0.7719, and adults: alone: F=7.86, df=1;3, *P*=0.1071 e competition: top vs base: F=3.13, df=1;3, *P*=0.1750).

The behavior of *B. vulgaris* females to produce higher population levels when the host was located at the top of the cages was similar to host searching behavior of this parasitoid in field conditions (Ramalho and Wanderley, 1996). Similar results were reported for *B. mellitor* (Adams et al. 1969). On the other hand, population densities of *C. grandis* were similar with the host at the top, or at the base of the cages what differs from its behavior under field conditions (Johnson et al., 1973; Ramalho and Wanderley, 1996; Ramalho et al., 2000). It was possible that the height of the cages had a more accentuated impact on *C. grandis* than on *B. vulgaris* and that it was not enough to affect population dynamics of this parasitoid.

B. vulgaris and *C. grandis* produced a larger number of descendants independent of the host location at the base, or at the top of the cages. These results indicated that possibly both species could colonize and maintain their populations in cotton fields with *A. grandis* larvae in cotton squares on the soil or in bolls and/or squares in the superior part of cotton plants.

The populations of *B. vulgaris* alone and competing for the host at the top of the cages produced approximately five and two fold more individuals, than those with the host at the base of the cages; while *C. grandis* produced similar number of descendants independently of host location, respectively. These results showed that *C. grandis* could not drive populations of *B. vulgaris* to extinction even being the dominant species in situations of competition (host at the base or at the top of the cages). These data differed from those observed for *C. grandis,* which took populations of *B. mellitor* towards extinction when competing with the latter species independent of host location (O'Neil and Cate, 1985). However, competition between parasitoids is a complex interaction and it is necessary to identify relevant variables of this process under field conditions. High mortality rates of *A. grandis* could be obtained in programs of biological control with periodical releases of *C. grandis* and *B. vulgaris* because surviving populations of the latter species would have a complementary action to that of *C. grandis.* The impact of this behavior will be more relevant when cotton bolls attacked by *A. grandis* start to appear because the synchronization of *B. vulgaris* with this host occurs in this period.

C. grandis prefers to parasitize *A. grandis* larvae in abscised squares in the cotton agroecosystem (Ramalho, 1994; Ramalho and Wanderley, 1996). However, in this study, *C. grandis*, independent of competition, was effective against this host on the base and in the top of the cages. This was also reported on a competition study between populations of *B. mellitor* and *C. grandis* but the impact of this last natural enemy was not affected by host location (O'Neil and Cate, 1985). These results suggested that probably *C. grandis* could maintain its populations in the cotton field, parasitizing *A. grandis* larvae in bolls if squares infested by this pest were not present on the ground.

The interaction between *C. grandis* and *B. vulgaris* on biological control programs of *A. grandis* is important because these species compete for the same nutritional resource (Berberet and Bisges, 1998). *C. grandis* showed better performance than *B. vulgaris* independent of competition or host location but it did not drive the latter species to extinction (Fig. 3). However, O'Neil and Cate (1985) reported that *C. grandis* led populations of *B. mellitor* to extinction when competing for the host independent of its location. Probably, the competition between parasitoids is function of the species.

Probably *B. vulgaris* has a complementary action to that of *C. grandis* under natural conditions during the production of squares in cotton plants. This would provide a higher parasitism rate of *A. grandis* than that of a single species with a primary action during this period. However, competition intensity in the dynamic cotton ecosystem might differ from that observed in the laboratory. Therefore, it is recommended to study if interactions between populations of *C. grandis* and *B. vulgaris* are complementary in controlling *A. grandis* in cotton fields.

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RESUMO

C*atolaccus grandis* (Burks) e *Bracon vulgaris* Ashmead são os principais parasitóides do bicudo-do-algodoeiro *Anthonomus grandis* Boheman no Nordeste do Brasil. É importante que se determinem as interações entre esses parasitóides e o seu efeito em programas de controle biológico dessa praga com os mesmos. A competição entre os parasitóides *C. grandis* e *B. vulgaris* foi estudada, utilizando-se larvas de *Euscepes postfasciatus* Fairmaire como hospedeiro alternativo. A fecundidade de *C. grandis* e *B. vulgaris* baseada na produção de ovos, não foi afetada pela competição, mas o parasitismo e a produção de adultos desses parasitóides foram afetados pela competição, exceto quando o hospedeiro se encontrava na base da caixa de criação. Independentemente da competição e da localização do hospedeiro, *C. grandis* apresentou melhor desempenho que *B. vulgaris,* mas não excluiu as populações da outra espécie de parasitóide.

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