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Selection of *Trichogramma* species for controlling the Diamondback moth

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ABSTRACT

Biological characteristics of the egg parasitoids *Trichogramma acacioi, T. atopovirilia, and T. bennetti* were studied to select the one with better performance on the control of the Diamondback moth, *Plutella xylostella*. Parasitism rate, viability, and sex ratio were studied. Parasitism rate ranged from 1.67 to 41.33%. *T. atopovirilia* and *T. acacioi* were respectively the most and less aggressive species. The viability ranged from 6.20% for *T. acacioi* to 53.34% for *T. atopovirilia*. There were no differences on sex ratio ($P < 0.05$) that remained above 0,88. *T. atopovirilia* was the species with best performance in the laboratory when rearing on the Diamondback moth eggs.

Keywords: *Plutella xylostella*, biological control, egg parasitoids, parasitism, sex ratio, viability.

RESUMO

Seleção de espécies de *Trichogramma* visando o controle da traça-das-crucíferas

Foram estudados os aspectos biológicos das espécies *Trichogramma acacioi, T. atopovirilia e T. bennetti*, com o objetivo de selecionar aquela com melhor desempenho, para utilização no controle da traça-das-crucíferas, *Plutella xylostella*. As características biológicas avaliadas foram parasitismo, viabilidade e razão sexual. A taxa de parasitismo variou entre 1,67 e 41,33%, sendo o maior valor observado para o *T. atopovirilia* e, o menor, para *T. acacioi*. A viabilidade variou entre 6,20% para *T. acacioi* a 53,34% para *T. atopovirilia.* Não houve diferença significativa para a razão sexual, ($P<0,05$), que ficou acima de 0,88. *T. atopovirilia* foi a espécie de melhor desempenho em laboratório quando criada sobre ovos da traça-das-crucíferas.

Palavras-chave: *Plutella xylostella*, controle biológico, parasitóide de ovos, parasitismo, agressividade, razão sexual.

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The Diamondback moth, *Plutella xylostella* (L.) (Lepidoptera: *Plutellidae*), is a cosmopolitan microlepdoptera. It is the most important pest for crucifer crops, particularly for cabbage. In a global range, the Diamondback moth causes production losses up to 60%. For this reason, the use of control measures to keep the pest population below the damage level is unavoidable (Imenes *et al*., 2002).

The Diamondback moth control is complex due to the all year round presence of cabbage fields, which guarantees abundant and continuous forage to the pest. In addition, the feeding behavior inside the cabbage heads gives larvae an extra protection (Imenes *et al*., 2002). Traditionally, the Diamondback moth is controlled by chemical insecticides. Up to four weekly sprays are carried out in the fields, using different active principles, either as a single ingredient or in mixes, which favors the breeding of pest resistant populations (Villas Boas *et al*., 2004). The intensive use of chemicals can also result in a resurgence of the target-pest, as well as give rise to new pests. The bulk of these chemicals has a high level of both biological action and environmental persistence, with potential to cause harm to consumers and workers engaged in the production process (Pereira *et al*., 2004a).

The high socio-economic cost of traditional insecticides opens a door to the search for alternatives to pest control that combine efficiency and ecological compatibility. The use of biological agents is a relevant tool in the development of integrated pest management programs, which are an option to reduce the insecticide use in the Diamondback moth control. The insects of the *Trichogramma* genus are a promising alternative as biological agents. *Trichogramma* are micro-hymennoptera that parasitize eggs of countless agricultural and forestry pests, mainly Lepidoptera. These insects are under use in biological control programs of a number of crops, in inundative releases, in about 23 countries (Hassan *et al*., 1998). According to Haji *et al*. (2002), the use of *Trichogramma* is experiencing a mounting growth in latest years. Their mass production is easy and cheap and, with large amounts of *Trichogramma* at hand, inundative releases can quickly suppress the pest in a step prior to crop damage. To achieve good results with natural enemies, it is important to know their biological characteristics when in interaction with the target host. The selection of the most adequate parasitoid species is vital for any program of biological control (Parra *et al*., 2002).

The objective of this work was to study the development of *Trichogramma acacioi* (Brun, Moraes & Soares), *T. atopovirilia* (Oatmam & Platiner), and *T. bennetti* (Nagaraja & Nagarkatti) using the Diamondback moth as host, aiming at the identification of the most suitable species for use in programs of biological control of this pest.

MATERIAL AND METHODS

The experiment was carried out at the Entomology Sector, at the Nucleus

for Scientific and Technological Development on Phytosanitary Management (NUDEMAFI), located at the Center for Agricultural Sciences of UFES (CCA-UFES), in Alegre, ES. During the experiment, the temperature was kept at 25±1°C and, the relative humidity, at 70±10%. A 14-hour photoperiod was used.

The Diamondback moth eggs were obtained from mass-rearing, according to the methodology adopted by Barros & Vendramin (1999). The rearing and multiplication of the *Trichogramma* species were based on the methodology described by Parra *et al*. (1997), adapted to the conditions of the Entomology Sector at the NUDEMAFI. The species *T. acacioi*, *T. atopovirilia*, and *T. bennetti* were evaluated, using 75 near-borne females, 25 from each species. Individual females were placed in glass tubes (8.5 x 2.4 cm), closed with PVC film. In each tube, we introduced a azure cardboard (3,5 X 0,5cm) containing 30 *P. xylostella* eggs, with less than 12 hours of age. Eggs were collected from collard leaf disks using a moistened thin hairy brush, and then glued in the cardboards with Arabic gum at 10%. At the end of 24 hours, females were removed from the tubes, which were kept in an acclimatized chamber (25±1°C, 70±10% RH, and 14-hour photoperiod) until adults' emergence.

For all the species studied, parasitism rate, viability, and sexual ratio were assessed. The experiment was carried out in a completely randomized design. Data were submitted to the analysis of variance and means were compared by the Tukey test, $P < 0.05$.

RESULTS AND DISCUSSION

There were significant differences among the three *Trichogramma* species when reared on the Diamondback moth. The parasitism rate varied from 1.67, for *T. acacioi*, to 41.33%, for *T. atopovirilia* (Table 1). Differences in the parasitism rate occur due to the direct dependence of parasitism potential on the parasitoid species and/or strain, host, and environmental conditions (Hassan, 1997). Bleicher & Parra (1990), in a study with three *T. pretiosum* strains, observed that a population from Goiânia attacked twice more eggs of *Anagasta kuehniella* (Zeller) (Lepidoptera: Pyralidae) than a population from Iguatu. Bezerra & Parra (2004), when evaluated the biology and parasitism of *T. atopovirilia* and *T. pretiosum* in eggs of S*podoptera frugiperda* (J.E. Smith) (Lepidoptera, Noctuidae), also observed differences: *T. atopovirilia* show better acceptability and parasitism capacity over the host than *T. pretiosum*.

Table 1. Parasitism rate, viability, and sexual ratio of *Trichogramma atopovirilia*, *T. bennetti*, and *T. acacioi* reared in *Plutella xylostella* eggs (Taxa de parasitismo, viabilidade e razão sexual de *T. atopovirilia*, *T. bennetti*, *e T. acacioi* criados em ovos de *Plutella xylostella*). Alegre, UFES, 2006.

Species	Parasitism rate[1] (%)	Viabilility[1]	Sexual ratio[1]
T. atopovirilia[2]	41,33± 3,12 a	53,34± 1,02 a	0,88± 0,06 a
T. bennetti[2]	12,00± 2,08 b	43,40± 2,72 b	0,97± 0,08 a
T. acacioi[2]	1,67± 1,26 c	6,20± 1,35 c	0,99± 0,01 a

Means followed by the same letter in the column did not differ from each other, Tukey test, $P < 0.05$ (médias seguidas de mesma letra na coluna não diferem entre si, teste de Tukey, $p<0,05$); [1]/Means are followed by the standard means error (as médias são seguidas pelo erro-padrão da média); [2]/Lab conditions to rear the *Trichogramma* were 25±1°C, RH = 70±10%, and 14-h photoperiod (as condições de laboratório para a criação do *Trichogramma* foram 25±1°C, UR = 70±10% e fotoperíodo de 14 h)

Viability also differed significantly ($P < 0.05$) among *Trichogramma* species, ranging from 6.20%, for *T. acacioi*, to 53.34%, for *T. atopovirilia* (Table 1). *Trichogramma* viability is a factor closely related to the parasitoid-host affinity (Bezerra & Parra, 2004). In *Trichogramma* production, quality control considers viability as satisfactory when the rate of borne adults exceeds 85% (Navarro, 1998). Thus, the species used in the present study expressed low affinity to the host. Gonçalves *et al*. (2003), when assessing the quality of *T. pretiosum* reared in *Sitotroga cerealella* (Oliver) (Lepidoptera: Gelechiidae) eggs, observed viability levels above 89%, which denotes host quality and species affinity.

The sexual rate was similar in the three *Trichogramma* species, with values above 0.88 (Table 1). Considering that the quality control on *Trichogramma* production requires a sexual rate equal or above 0.5 (Navarro, 1998), the three species meet the criterion. These species are well-adapted to lab conditions, since they already produced several generations in such environment. Therefore, sexual rates are high (Pereira *et al*., 2004b), differing from the results reported by Navarro & Marcano (1999) for *T. atopovirilia* and *T. pretiosum* fed in eggs of *Helicoverpa zea* (Bod.) (Lepidoptera: Noctuidae), respectively 0.56 and 0.49.

Among the studied species, *T. atopovirilia* had the strongest affinity to the Diamondback moth for use in programs of biological control. *T. atopovirilia* showed the highest egg parasitism and viability, and a satisfactory sexual rate.

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