NOTE: Flight Capacity, Parasitism and Emergence of Five *Trichogramma* (Hymenoptera: Trichogrammatidae) Species from Forest Areas in Brazil

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The flight and parasitism capacities and emergence rate of five *Trichogramma* species [*T. acacioi* (Brun), *T. bruni* (Nagaraja), *T. demoraesi* (Nagaraja), *T. maxacalii* (Voegelé & Pointel) and *T. soaresi* (Nagaraja)] were compared. The flight capacity of these parasitoids was assessed in test units. A tube was placed inside each test unit with a piece of card with 300 *Anagasta kuehniella* (Zeller) (Lepidoptera: Pyralidae) eggs parasitized by one of the *Trichogramma* species. The emerged adults inside the test units were classified according to their position as flyers, non-flyers and walkers. Cards with *A. kuehniella* eggs, parasitized by one of the *Trichogramma* species, were assessed to determine the parasitism rate and emergence of these natural enemies. The data were submitted to analysis of variance and the means compared by the Scott-Knott test at 5% probability. *Trichogramma maxacalii* exhibited better flight capacity than the other species, in addition to good parasitism rate and high percentage of emergence.

KEY WORDS: Biological control; eucalyptus; flight; leaf eaters; quality control; Trichogrammatidae.

Species of the Lepidoptera are outstanding among the insects reported as key pests of the eucalyptus crop (19). Biological control (20), which involves studies of parasitoids that attack different pest life stages, represents an important strategy in integrated pest management.

The *Trichogramma* are the main natural enemies of *Euselasia euploea eucerus* (Hewitson) (Lepidoptera: Riodinidae) and other eucalyptus leaf-eating caterpillars (1). They can be easily multiplied inexpensively for biological control programs and are very efficient (6). *Trichogramma* species collected in eucalyptus plantations include *T. acacioi* (Brun) (1), *T. bruni* (Nagaraja), *T. demoraesi* (Nagaraja) (4), *T. maxacalii* (Voegelé & Pointel) (5,6) and *T. soaresi* (Nagaraja) (4).

Flight capacity is the ability to fly and it is important for parasitoid dispersion during food search and forage and is a simple, quick and inexpensive way to compare *Trichogramma* lineages or species (2,8,12). Parasitism capacities, interactions with the host and emergence rate are also used to select *Trichogramma* lineages or species. Females of these natural enemies possess good parasitism capacity after emergence but this can

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vary among lineages or species (10,15). The emergence rate reflects the number of individuals that will contribute to the following generation, to ensure population balance and the continuity of natural enemies in the environment.

The objective of this study was to compare flight and parasitism capacity and emergence rate of *T. acacioi, T. bruni, T. demoraesi, T. maxacalii* and *T. soaresi* on *A. kuehniella* eggs in the laboratory.

The experiment was carried out in the Entomology Laboratory of the G.W.G. Moraes Insectarium (Agrarian Science Institute, Federal University of Minas Gerais, Municipality of Montes Claros, Minas Gerais State, Brazil). The five *Trichogramma* species were obtained from the rearing stock of this insectarium and had been collected originally from *E. euploea eucerus* eggs in eucalyptus plantations in Minas Gerais, Brazil, in 1983.

Eggs of the alternative host, *A. kuehniella*, were obtained according to Parra *et al.* (7), glued with Arabic gum diluted at 30% to 7.2×0.7 cm pieces of white card, and placed for 60 min under a 25-cm-high ultraviolet light (14). Each piece of card with 300 host eggs was inserted in a glass test tube (12.0×2.0 cm) with a drop of pure honey to feed the adult *Trichogramma*. Thirty recently emerged adults of each *Trichogramma* species were released inside each glass test tube (one parasitoid per ten eggs) and parasitism was allowed for 5 h (9).

The flight capacity of the *Trichogramma* species was assessed in test units (8,12) consisting of a PVC cylinder (18 cm high and 11 cm diam) with the inside painted with black latex paint. The bottom of the cylinder was closed with black flexible plastic (larger than the tube diameter) firmly fitted with an approximately 3-cm-thick extruded polystyrene disk with the same diameter as the glass test tube. The edges of the plastic on the outside of the tubes were held in place with an elastic rubber band for better sealing and to prevent parasitoid escape.

A glass test tube (7.5×1.0 cm) was fixed at the center of the bottom of the test unit (extruded polystyrene disk) with adhesive tape. A ring of glue was applied to the inside wall of the test unit, 4 cm from the bottom, as a barrier to parasitoid walking. A piece of card with 300 *A. kuehniella* eggs that were parasitized by one of the *Trichogramma* species and close to adult emergence was placed in each glass tube of the test units. A circle of transparent rigid plastic, larger in diameter than the PVC and brushed with glue 24 h prior to the experiment, was placed on the top of the cylinder as a trap for parasitoids in flight.

The test units were distributed randomly on a counter under a continuous light source and temperature of 25±4°C from the day of installation. This design was used to take advantage of the positive phototropic response of *Trichogramma* (12). Four replications (test units) were used per *Trichogramma* species. The parasitoids were kept in the test units for 3 days after the start of emergence and then frozen.

The number of parasitoids caught on the glue ring ('walkers') in the plastic circle ('flyers') and on the bottom ('non-flyers') was recorded using a hand magnifying glass. The percentage of each group was calculated and compared with the total number of adults emerged. The cards with parasitized *A. kuehniella* eggs were removed from the test units after the death of *Trichogramma* adults and assessed at three predetermined points (superior, mean and inferior parts of the cards) to determine the number of eggs parasitized by counting the eggs blackened under magnification (x40). The emergence rates of *Trichogramma* spp. were calculated by the number of *A. kuehniella* eggs with an opening in their corium. The data were submitted to analysis of variance and the means compared by the Scott-Knott test at 5% probability.

As shown in Figure 1, *T. maxacalii* had greater flight capacity (56.60±6.04%) than the other *Trichogramma* species, which had a similar mean value of 47.11±3.59%. All the *Trichogramma* species had a low number of walker individuals, represented by those caught in the glue ring, with a mean of 13.02±1.07%. *T. maxacalii* had a lower number of non-flyer individuals (31.04±5.25%) than *T. acacioi, T. demoraesi* and *T. soaresi,* with a mean of 44.36±8.10%. *T. bruni* exhibited the lowest parasitism capacity (38.50±7.16%), whereas the other species had similar values, with a mean of 48.50±4.28%. *T. acacioi, T. demoraesi* and *T. maxacalii* had higher emergence rates (pooled mean of 84.81±1.79%) than *T. bruni* and *T. soaresi,* with significantly lower values of 71±2.24% and 80±1.20%, respectively (Fig. 1).

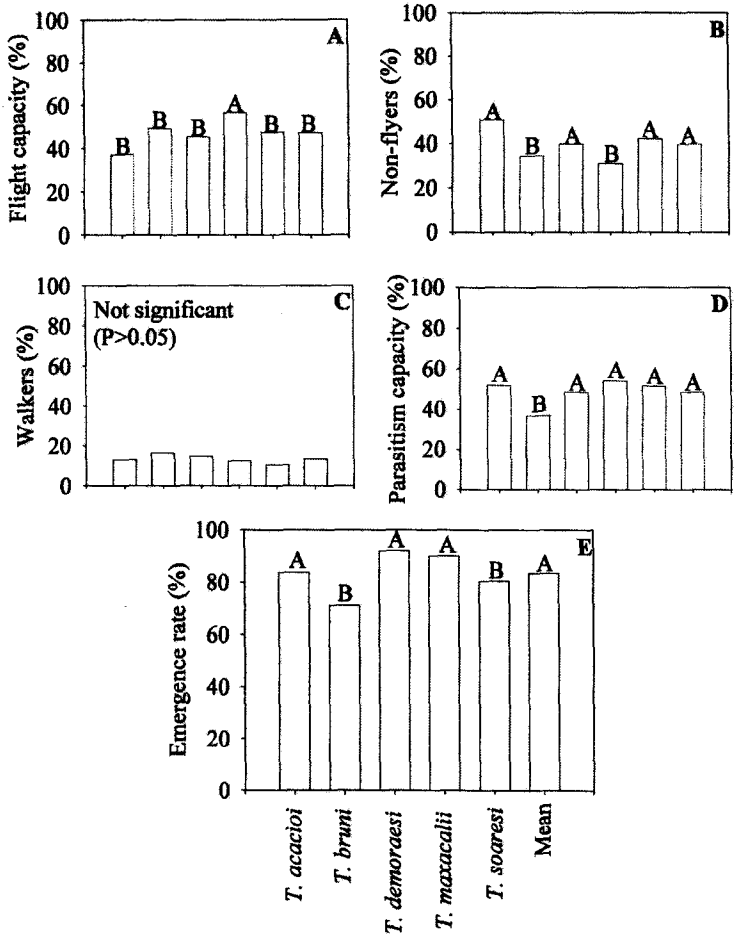

Fig. 1. Flight capacity (A), non-flyers (B), walkers (C), parasitism capacity (D) and emergence rate (E) of five *Trichogramma* species. Municipality of Montes Claros, Minas Gerais State, Brazil. Within each section, bars with the same letter do not differ statistically at the 5% level of probability (Scott-Knott).

Trichogramma maxacalii demonstrated a higher flight capacity (56.60±6.04%) than the other *Trichogramma* species but with values lower than that reported for *T. pretiosum* from *A. kuehniella* eggs (81.1±4.20%) (12) and similar to those of two *T. brassicae* lineages emerging from this host (72% and 61%) (2). This shows that the flight capacity could vary with the biological and behavioral characteristics of *Trichogramma* lineages or species. This is important, because *Trichogramma* species with high numbers of adult flyers are more likely to disperse in the field. Thus, *T. maxacalii* could disperse more easily and have better possibilities of finding and parasitizing Lepidoptera eggs in the field. On the other hand, those with a high percentage of non-flyers and walker insects, characterized by individuals arriving at the top of the glass test tube inside the test unit without starting flying but rather walking towards the cylinder bottom, could be less effective for biological control.

Trichogramma bruni exhibited the lowest level of parasitism capacity on *A. kuehniella* eggs, but it has been reported as abundant and frequent in forest areas (13). Being extremely polyphagous, it may compensate for its low parasitism capacity by parasitizing a great number of hosts in the forest habitat, which allows it to maintain its population density (13,19). The variability in the parasitism capacity among the *Trichogramma* species was in line with the report for *T. pretiosum* with 69.4±14.0; *Trichogrammatoidea bactrae* (Nagaraja) with 71.9±13.1; *T. minutum* (Riley) with 32.0±22.8; *T. platineri* (Nagarkatti) with 25.8±13.6; *T. ostriniae with* 43.6±26.5; and *T. brassicae* with 22.4±18.9 on *Plutella xylostella* (Linnaeus) (Lepidoptera: Plutellidae) eggs (17). Our results were obtained in the laboratory and they represent the parasitism potential of these species. On the other hand, these *Trichogramma* species could have a higher variability in their parasitism due to the impact of factors such as temperature and humidity in the field (11,16).

The higher emergence rates of *T. acacioi, T. demoraesi* and *T. maxacalii* with *A. kuehniella* are similar to those observed for *T. pretiosum* with this host in the laboratory (87.03%) (3). This indicates that these species may produce a greater number of descendants in a shorter period, to be liberated in the field.

Flight capacity, parasitism and emergence rate are important yet variable attributes among the *Trichogramma* species and should be considered when evaluating the number of individuals of this genus to be released for biological control of eucalyptus leaf-eating caterpillars.

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