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Biological Characteristics of *Trichogramma pretiosum* and *Trichogramma acacioi* (Hym.: Trichogrammatidae), Parasitoids of the Avocado Defoliator *Nipteria panacea* (Lep.: Geometridae), on Eggs of *Anagasta kuehniella* (Lep.: Pyralidae)

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ABSTRACT

The objective of this investigation was to study Trichogramma pretiosum *and* T. acacioi *(Hymenoptera: Trichogrammatidae), parasitoids of the avocado defoliator* Nipteria panacea *(Lepidoptera: Geometridae) on the eggs of the alternative host* Anagasta kuehniella *(Lepidoptera: Pyralidae) aiming to use them for biological control of this pest in avocado orchards. The cubic model presented better adjustment for duration of the life cycle of* T. pretiosum *and* T. acacioi *with the host* A. kuehniella *which shows that development rate of these species increases with temperature within the range tested. The number of individuals of both* Trichogramma *species emerged per egg from this host was higher than one. The quadratic model was significant for viability of* T. pretiosum *and* T. acacioi. *This parameter was more affected by extreme temperatures and higher emergence rates of adults of both parasitoids species occurred at temperatures of 20, 25 and 30°C.*

Key words: Avocado, *Trichogramma*, alternative host, mass rearing

INTRODUCTION

The avocado (*Persea americana* Mill.) world production has been approximately 1.2 million tons per year and Brazil is the fourth largest producer but its production is still low. However, avocado production could be higher due to adequate climate and soil for this culture what could meet domestic demand and exports to Mercosul countries especially Argentina and Uruguay (Donadio, 1995).

Avocado represents an alternative for agriculture diversification in the Highlands of the State of Espirito Santo, Brazil where the area cultivated with this fruit increased from 100 hectares to more than 2,000 hectares in 1995 with an annual production over 5,000 tons (Teixeira et al., 1996).
Avocado tree presents many insect pests (Donadio, 1995). The expansion of this culture and the indiscriminate use of chemical products against eventual pests in the State of Espírito Santo have contributed to the appearance of *Nipteria panacea*

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Tierry-Mieg (Lepidoptera: Geometridae) as a defoliator of avocado trees. However, avocado pests and especially *N. panacea* need to be controlled based on ecological criteria with the association of cultural, biological and chemical methods (Pratissoli, 1995). Three main pests of avocado are controlled with insecticides in California but biological control can reduce the number of spraying (Donadio, 1995). On the other hand, such pests have been controlled with biological methods in South Africa and Israel (Donadio 1995). *Trichogramma platneri* Nagakartti (Hymenoptera: Trichogrammatidae) was imported from California and used against two Geometridae defoliators of avocado trees. Other *Trichogramma* species are used against 69 key pests in 34 cultures of 30 countries in 32 million hectares, what shows their importance for biological control (Wajnberg and Hassan, 1994). However, the success of biological control with *Trichogramma* species depends on basic studies on host, temperature, plant architecture and phenology, searching area, wind and chemicals such as insecticides which could affect searching behavior of these organisms (Goodenough and Witz, 1985).

Temperature is the most important physical factor affecting biological aspects such as reproduction type, parasitism (fecundity), duration of development, emergence rate and the longevity of insects (Stern and Bowen, 1963; Butler Júnior and López, 1980; Harrison et al., 1985; Noldus, 1989). Studies on biological and thermal requirements showed that duration of development of *Trichogramma* species are inversely related to temperature increase (Butler Jr. and López, 1980; Harrison et al., 1985; Miura and Kobayashi, 1993), but such effects depend on species or lineages of *Trichogramma* (Bleicher and Parra, 1989). *Trichogramma minutum* Riley presents better development at 32°C; *Trichogramma pretiosum* at 30°C; *Trichogramma dendrolini* Matsumura between 23 and 25°C and *Trichogramma chilonis* Ishii at 20°C (Calvin et al., 1984; Miura and Kobayashi, 1993). These parasitoids can develop between 18 and 30°C (Butler Júnior and López, 1980; Harrison et al., 1985; Pak and Heiningen, 1985) but it can be drastically reduced at temperatures below 17°C (Butler Júnior and López, 1980; Pak and Heiningen, 1985) and above 32°C (Butler Jr. and López, 1980; Pak and Heiningen, 1985; Gross, 1988; Cabello and Vargas, 1989). Higher temperatures can increase mortality (Gross, 1988; Cabello and Vargas, 1989) and it can affect sex rate of *Trichogramma* species (Bowen and Stern, 1966).

The objective of this work was to study biological characteristics of the *N. panacea* parasitoids *T. pretiosum* and *T. acacioi* on the eggs of the alternative host *Anagasta kuehniella* Zeller (Lepidoptera: Pyralidae) aiming to use them in programs of biological control of this pest in avocado orchards.

MATERIALS AND METHODS

Trichogramma populations L8 and Tapera were obtained from eggs of *N. panacea* (Pratissoli and Fornazier, 1999). Both populations were maintained in the Laboratory of Entomology of the CCAUFES with eggs of the alternative host *A. kuehniella*. Population L8 was identified as *T. acacioi* and Tapera as *T. pretiosum*. The experiment started with newly emerged *T. acacioi* and *T. pretiosum* females individualized with eggs of the alternative host *A. kuehniella* in glass tubes of 3.5 cm x 0.5 cm closed with plastic PVC film. These females were fed with droplets of honey deposited in the internal part of each tube. An identified blue card (3.5 cm x 0.5 cm) with 40 eggs of *A. kuehniella* turned unviable after 50 minutes under a germicidal lamp (Parra and Zucchi, 1997) was put each on 20 tubes and parasitoid species were maintained at the temperatures of 15, 20, 25, 30 and 35 $\pm$ 1°C. Parasitism was allowed during 24 hours and parasitoid females were removed under stereoscopic microscope after this period and tubes (containing the card with parasitized eggs) were maintained in aclimatized chambers. The duration of development cycle, the percentage of emergence (viability), and number of individuals of parasitoids per host egg were determined for both *Trichogramma* species in the morning and in the afternoon, at approximately the same time hour.

Host eggs with a hole made by *Trichogramma* adults were counted to evaluate emergence rate of these parasitoids. Number of individuals of parasitoids per host egg was evaluated by counting their number emerged from each lot of host eggs.

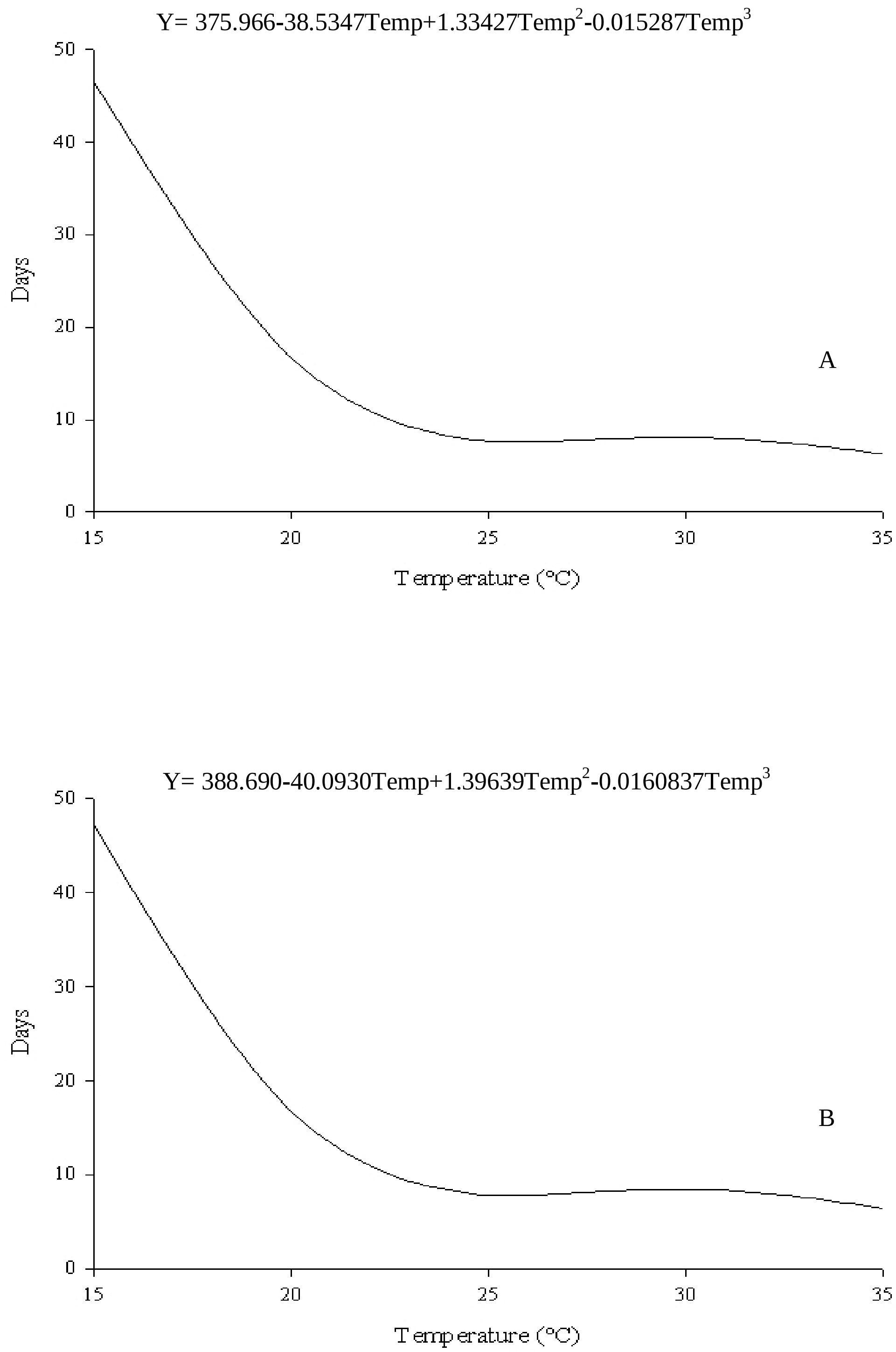


Figure 1 - Developmental period (days) from egg to adult of *Trichogramma pretiosum* (A) and *Trichogramma acacioi* (B) (Hymenoptera: Trichogrammatidae) on eggs of *Anagasta kuehniella* (Lepidoptera: Pyralidae) under different temperatures. 70 $\pm$ 10% R.H. and photofase of 14 hours.

The experiment was developed in a completely randomized design and results were submitted to variance and regression analysis at the temperatures of 15, 20, 25, 30 and 35 ± 1°C.

RESULTS AND DISCUSSION

The cubic model was significant and it showed the best fit to adjust duration of development cycle of *T. pretiosum* and *T. acacioi* with the host *A. kuehniella* (Fig 1). This model showed that development rate of these parasitoids increased with thermic elevation, what means that the period from egg to adult increased with temperature decrease. This result represented a similar pattern for insects and it resembled those of Butler Júnior and López (1980), Harrison et al. (1985), Bleicher and Parra (1989) and Pratissoli (1995).

Number of individuals of *T. pretiosum* and *T. acacioi* per egg of *A. kuehniella* was higher than one with similar results at all temperatures (Table 1). *T. pretiosum* produced one individual per egg of *Scrobipalpuloides* (= *Tuta*) *absoluta* Meyrick (Lepidoptera: Gelechiidae) at different temperatures (Pratissoli, 1995) but this number could vary with the host because this species presented higher number of individuals per egg of *Phthorimaea operculella* Zeller (Lepidoptera: Gelechiidae) at 25°C. It was possible that differences on parasitism rate could also be related to characteristics of host eggs because parasitism rate of *T. pretiosum* was higher on *A. kuehniella* than on *S. cerealella* (Gomes, 1997). For this reason, it was possible that physical and chemical characteristics of host eggs were important factors affecting this trait.

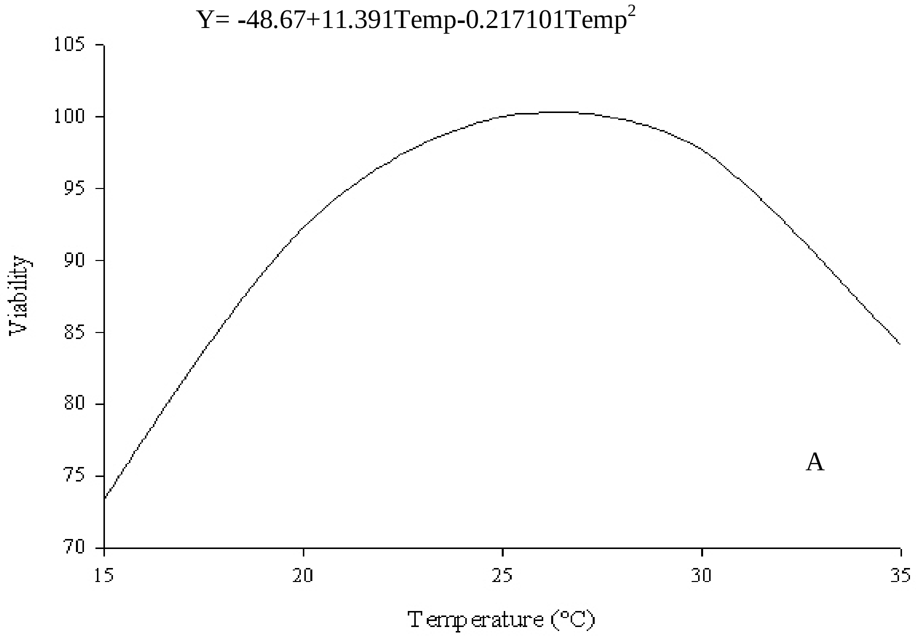
Table 1 - Number of individuals of *Trichogramma pretiosum* and *Trichogramma acacioi* (Hymenoptera: Trichogrammatidae) per egg of *Anagasta kuehniella* (Lepidoptera: Pyralidae) under different temperatures. 70 + 10% R.H. and fotofase of 14 hours.

Temperature (°C)	***Trichogramma pretiosum***	***Trichogramma acacioi***
15	1.05 aA	1.02 aA
20	1.03 aA	1.03 aA
25	1.03 aA	1.01 aA
30	1.01 aA	1.02 aA
35	1.02 aA	1.02 aA

[1]Means followed by the same capital letter in the column or small letter in the line do not differ between themselves by the test of Tukey at 5% probability level

The quadratic model was significant and also showed the best fit for viability of *T. pretiosum* and *T. acacioi* (Fig 2) what showed that viability from egg to adult of these parasitoids varied with temperature. Viability of *T. pretiosum* and *T. acacioi* was more affected by extreme temperatures with higher emergence rate for both parasitoids species at 20, 25 and 30°C which was similar to results of Pratissoli (1995) with the hosts *S. absoluta* and *P. operculella*. Similar results were also obtained with higher emergence rate for eight *Trichogramma* lineages between 20 and 30°C (Anunciada, 1983) while emergence rate of *T. galloi* was lower at 18°C (Cônsoli and Parra, 1991). Emergence rate of *Trichogramma atopovirilia* Oatman and Platner and *T. pretiosum* was also affected by temperatures below 20°C but this effect could vary because Bleicher and Parra (1989) showed similar viability for several *Trichogramma* species in higher temperatures (18 to 32°C).

Period from egg to adult of *T. pretiosum* and *T. acacioi* was inversely proportional to temperature increase with lower emergence rate of both *Trichogramma* species at 15 and 35ºC. Number of individuals of *T. pretiosum* and *T. acacioi* per egg of the alternative host *A. kuehniella* was near one. This number was not affected by temperature but sex rate of both parasitoid species was affected by temperature with higher values at 15ºC.



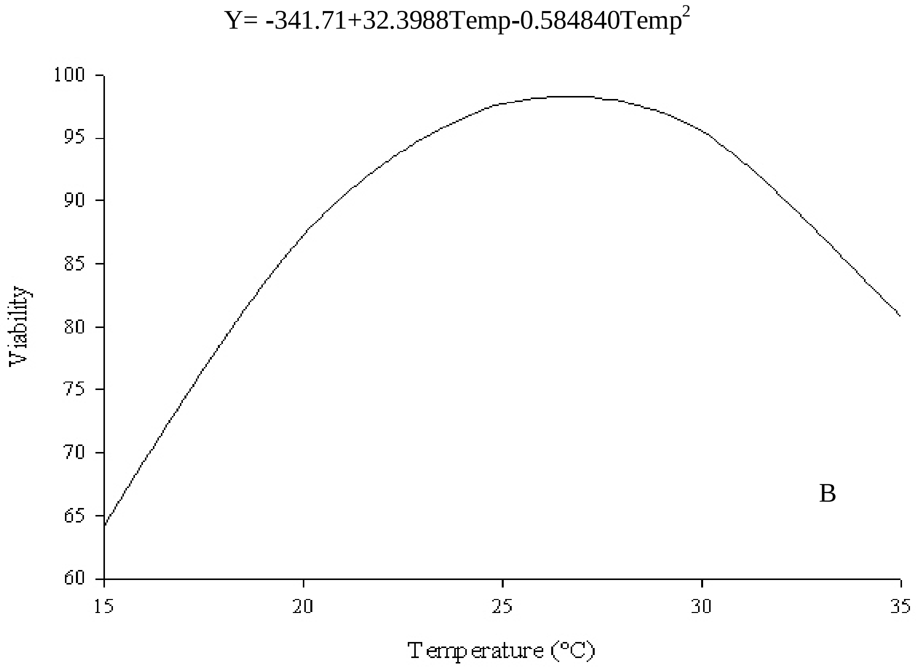


Figure 2 - Viability from egg to adult (%) of *Trichogramma pretiosum* (A) and *Trichogramma acacioi* (B) (Hymenoptera: Trichogrammatidae) on eggs of *Anagasta kuehniella* (Lepidoptera: Pyralidae) under different temperatures. 70 $\pm$ 10% R.H. and photofase of 14 hours.

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RESUMO

O objetivo deste trabalho foi estudar a biologia de *Trichogramma pretiosum* Riley e *Trichogramma acacioi* Brun, Moraes and Soares (Hymenoptera: Trichogrammatidae), parasitóides de *Nipteria panacea* Thierry-Mieg (Lepidoptera: Geometridae), sobre ovos do hospedeiro alternativo *Anagasta kuehniella* Zeller (Lepidoptera: Pyralidae), visando à utilização desses inimigos naturais em programas de controle biológico dessa praga em pomares de abacateiro. O modelo cúbico foi significativo e apresentou o melhor ajuste para a duração do ciclo biológico de *T. pretiosum* e de *T. acacioi* no hospedeiro *A. kuehniella*, mostrando que a velocidade de desenvolvimento dessas espécies aumenta com a elevação da temperatura. O número de indivíduos por ovo de *A. kuehniella*, para as duas espécies de *Trichogramma* foi maior que um. O modelo quadrático apresentou melhor ajuste para a razão sexual de *T. pretiosum* e *T. acacioi*, com maior emergência de fêmeas desses parasitóides a 15°C e aumento da produção de machos com aumento da temperatura. O modelo quadrático foi, também, significativo para a viabilidade de *T. pretiosum* e *T. acacioi*, a qual foi mais afetada por temperaturas extremas, enquanto a taxa de emergência desses parasitóides foi maior nas temperaturas de 20°, 25° e 30°C.

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