

EFFECT OF *Telenomus remus* NIXON (HYMENOPTERA: SCHELIONIDAE) DENSITY ON CONTROL OF *Spodoptera frugiperda* (SMITH) (LEPIDOPTERA: NOCTUIDAE) EGG MASSES UPON RELEASE IN A MAIZE FIELD

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ABSTRACT - The impact of releasing different densities (0, 6, 9 and 12 adult females m⁻²) of the egg parasitoid *Telenomus remus* Nixon on maize plants artificially infested with *Spodoptera frugiperda* (Smith) egg masses (one m⁻²) was evaluated. Egg masses were pinned in the mid-rib of the plant 36 days after planting. One egg mass contained approximately 65 eggs. The experimental design was in a randomized complete block design with five replications (16 m² plots). There was a significant effect on percentage of parasitism egg masses. The highest parasitism values were verified in plots where 9 or 12 females of *T. remus* m⁻² were released, respectively, 74 and 88.3 %. The relationship between percentage of parasitized egg masses and parasitoid densities was quadratic ($Y = 16.8 + 9.98 X - 0.35 X^2$, $r^2 = 0.99$). The natural occurrence of *Trichogramma* spp. was relatively constant over the egg masses fixed on maize plants (52.5%). However, the average *T. remus* parasitism on the eggs of a mass was much higher, representing 80.4% while the parasitism was only 21.3% in the case of *Trichogramma*. The presence of both parasitoids was responsible for up to 97.5% of parasitism, obtained from plots with a released density of 12 *T. remus* female m⁻².

Key words: Insecta, fall armyworm, biological control, maize pest, parasitoid.

EFEITO DA DENSIDADE DE *Telenomus remus* NIXON (HYMENOPTERA: SCHELIONIDAE) NO CONTROLE DE OVOS DE *Spodoptera frugiperda* (LEPIDOPTERA: NOCTUIDAE) EM LIBERAÇÕES DE CAMPO, NA CULTURA DO MILHO

RESUMO - Pesquisas foram realizadas para verificar o impacto da liberação de diferentes densidades (0, 6, 9 e 12 fêmeas m⁻²) de *Telenomus remus* Nixon em plantas de milho infestadas artificialmente com massas de ovos (uma m⁻²) de *Spodoptera frugiperda* (J. E. Smith), fixadas na nervura principal da planta através de um grampo, 36 dias após o plantio. Cada massa de ovos continha cerca de 65 ovos. O delineamento experimental foi de blocos ao acaso, com cinco repetições (parcelas de 16 m²). Os valores mais altos de parasitismo foram verificados nas parcelas onde foram liberadas 9 ou 12 fêmeas de *T. remus* m⁻², respectivamente, 74 e 88,3%. A relação entre a percentagem de massas de ovos parasitadas e a densidade de parasitóides foi quadrática ($Y = 16,8 + 9,98 X - 0,35 X^2$, $r^2 = 0,99$). A ocorrência natural de *Trichogramma* spp. sobre as massas de ovos de *S. frugiperda* foi relativamente constante (52,5%), no entanto, o parasitismo médio de *T. remus* em cada massa de ovos foi

maior, representando 80,4%, enquanto que o parasitismo por *Trichogramma* representou 21,3%. A presença de ambos os parasitóides foi responsável por um índice de parasitismo de até 97,5%, obtido nas parcelas onde foram liberadas 12 fêmeas de *T. remus* m⁻².

Palavras-chave: Insecta, lagarta-do-cartucho, controle biológico, praga de milho, parasitóide

The fall armyworm, *Spodoptera frugiperda* (Smith) (Lepidoptera: Noctuidae) is considered polyphagous and an important pest in maize in the Americas (Leiderman & Sauer, 1953; Wiseman *et al.*, 1966; Carvalho, 1970). Grain losses due to the damage of this pest can be up to 57.6% depending on plant development stage and maize type (Cruz & Turpin, 1982, 1983, Cruz *et al.*, 1996, 1999). The control of this insect pest on maize is based only on chemical pesticides, with increasing use each year in total acreage and number of applications; however without achieving the desirable control level (Notz, 1972; Cruz, 1995). Biological control using parasitoids or predators has been considered an ecological alternative as integrated pest management tactics (Cruz, 1995) because of the danger of chemical pesticide applications.

The use of natural enemies to suppress fall armyworm populations is recommended particularly for areas where chemicals are no more effective due to pest resistance or even due to environment concerns (Hanson & Hilje, 1993; Leppla & Williams, 1992).

Among several groups of insects, egg parasitoids such as *Telenomus* spp. (Hymenoptera: Scelionidae) have deserved great attention in different countries. This natural enemy has been considered to have great potential to control lepidopteran pests in crops such as cotton, rice, sugarcane and maize, as well as forest species and other crops of economic importance (Strand & Vinson, 1982; Orr, 1988; Navarro, 1993; Polaszek & Foerster, 1997). *Telenomus remus* Nixon is considered highly specific for species of the genus *Spodoptera* (Schwartz & Gerling, 1974; Patel *et al.*,

1979; Dass & Parshad, 1984; Kumar *et al.*, 1984; Siabato, 1995), including *S. frugiperda* (Wojcik *et al.*, 1976; Waddill & Witcomb, 1982; Hernández *et al.*, 1989; Cruz & Figueiredo, 1994; Cruz, 1995). According to Kemp & Simmons (1978) better levels of parasitism are obtained from areas with a greater number of egg hosts, although in some cases this response is not achieved (Yu *et al.*, 1984; Yu & Byers, 1994). Thus, it is important to know the amount of parasitoid to be released and the distribution points according to the host infestation level. *Telenomus remus* introduced in India in 1974 to control *Spodoptera litura* (Fabricius) in tobacco crop, was responsible for 60% of parasitized eggs from a release of 50,000 parasitoids 0.2 ha⁻¹ week⁻¹ (Patel *et al.*, 1979). In Venezuela, Hernandez *et al.* (1989) observed parasitism levels varying from 60 to 80% in natural fall armyworm *S. frugiperda* egg masses infestation, after three consecutive weekly releases in maize. Similar levels of parasitism were observed in Colombia, after the release of 15,000,000 *T. remus* in 627 ha of rice, 507 of maize, 490 of cotton, 350 of soybean and 50 of sorghum (Siabato, 1995). The efficiency of *T. remus* alone or integrated with Baculovirus on the control of *S. frugiperda* population in maize field was reported by Figueiredo *et al.* (1999). The objective of this work was to evaluate the impact of releasing *T. remus* at different densities to control fall armyworm, *S. frugiperda* egg masses in maize.

Material and Methods

The research was conducted at Embrapa National Maize and Sorghum Research Center, Sete Lagoas, MG, latitude of 19° 28' 00" S. and longitude

of 44° 15' 08" W., using the BR 205 maize hybrid, following local recommendations (Embrapa, 1982). The experimental design was a complete randomized block with four treatments (parasitoid density) and five replications. Each plot (16 m²) was composed of four maize rows, four meters long. The distance between plots was six meters. The center of each plot was marked with a pole where the parasitoids (24-hour old) were released in four densities: 0, 6, 9 and 12 adult females m⁻². Daily natural egg mass surveys and removal to the laboratory were made inside the experimental unit before the artificial infestation and throughout the experimental period. The parasitoid was released 36 days after planting (DAP). The maize plants were at the 6-8-leaf stage (59 ± 1.5 cm tall). Just before the parasitoid release, the infestation with fall armyworm egg masses (24 hours old) was made (16 per plot, i. e. one m⁻²). The average number of egg/mass was around 65. Egg masses were pinned in the mid-rib of the plant (36 days after planting) and one meter apart from each other. Forty-eight hours after infestation/release, the egg masses were removed to the laboratory. The removed egg masses were individually placed inside vials (2.5 x 10.0 cm), under 25 ± 2° C, RH 70 ± 10 % with a 12-hour photoperiod. Evaluations were based on the parasitism (%) by *T. remus* and on the presence of other natural enemies. Analysis of variance was performed on the data and regression curves were calculated. Means were compared by Duncan's multiple range test (P ≤ 0.05).

Results and Discussion

The total number of natural oviposition by *S. frugiperda* found in the experimental area was only eight. From those egg masses, only one was found to be parasitized by *T. remus*. This parasitized egg mass was found three days after the release of the parasitoid. No other egg parasitoid was found.

Predation on egg masses from artificial infestation

Doru luteipes (Scudder) (Dermaptera: Forficulidae) was the main predator found inside the experimental area. According to Reis *et al.* (1988) and Cruz & Oliveira (1997) this predator has shown a great potential as a biological control agent against two key pests of maize, the fall armyworm, *S. frugiperda* and the corn earworm *Helicoverpa zea* (Boddie). Cruz & Oliveira (1997) reported the results of a survey during six years in an area close to the present research. The predator occurred during all months of the year, with the greatest occurrence during the summer period (December to February). On average, 42.8% of the plants showed this insect, and in some cases reaching 95%. In this experiment, predators were responsible for 6% of predation of the egg masses from the artificial infestation. Predation by this insect can reach up to 50% in maize (Yu & Byers, 1994) and 91 to 98% in cotton (Jones *et al.*, 1977). Sá (1991) reported an inverse relationship between parasitism and predation of corn earworm *H. zea* eggs when parasitized by *T. pretiosum*. Losey & Calvin (1991) also reported a significant effect of predation on eggs of *Ostrinia nubilalis* (Hubner) parasitized by *T. pretiosum* in sweet corn. According to Smith (1996) the level of predation should be considered when releasing parasitoids to guarantee success and low cost of the biological control program.

Occurrence of *T. remus* on egg masses

The parasitism verified in check treatments (without releasing parasitoid) was due to the dispersion of the insect, since they were not present in the area, as verified on samples evaluated on a previous date. This indicates that the distance between plots (6 m) was not enough to isolate them. The parasitism in the check plot was 16.3% (Table 1), indicating the dispersion and search ability to survive

TABLE 1. Parasitism of fall armyworm, *Spodoptera frugiperda*, after releasing *Telenomus remus* females at different densities, in maize field.

Number of females of <i>T. remus</i> released m ⁻²	Egg masses parasitized by <i>T. remus</i> (%) ¹	Egg masses parasitized by <i>Trichogramma</i> spp. (%) ¹	Egg masses parasitized by <i>Telenomus</i> and/or <i>Trichogramma</i> (%) ¹
0	16.3 ± 6.2 B	46.7 ± 5.8 A	46.7 ± 5.8 C
6	67.4 ± 3.4 A	53.7 ± 4.1 A	82.6 ± 4.6 B
9	74.4 ± 4.2 A	57.0 ± 6.1 A	91.7 ± 2.7 AB
12	88.3 ± 4.1 A	52.7 ± 6.2 A	97.5 ± 2.5 A
Mean	61.6	52.5	79.6
CV (%)	16.7	7.4	5.5

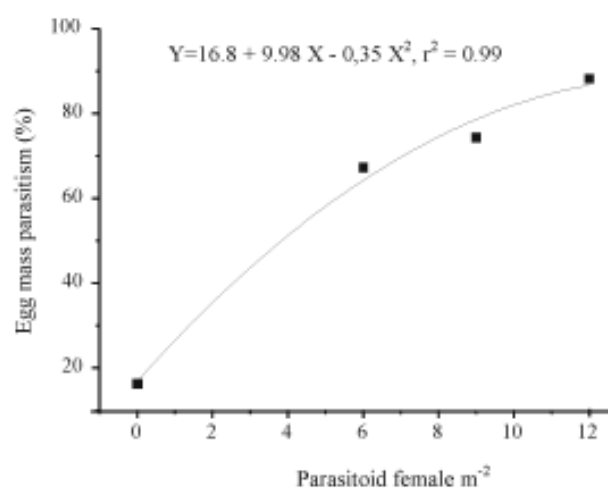
¹Means within each column followed by the same letter are not significantly different ($P \leq 0.05$; Duncan's multiple range test).

and establish in new areas. The percentage of fall armyworm egg masses parasitized by *T. remus* was not significantly different among released densities, with an average of 76.7% (Table 1). This average can be considered outstanding since values between 60 and 70% are common (Patel *et al.*, 1979; Smith, 1996). The relationship between percentage of parasitized egg masses and parasitoid densities (Figure 1) was quadratic ($Y = 16.8 + 9.98 X - 0.35 X^2$, $r^2 = 0.99$). When 12 females m⁻² were used, parasitism was 88.3%. However, the curve was ascendant indicating that greater parasitism could be expected with higher densities.

Occurrence of *T. remus* and/or *Trichogramma* spp.

The natural occurrence of *Trichogramma* spp. itself or together with *T. remus* was relatively constant over the egg masses fixed on maize plants. The average egg masses parasitized by *Trichogramma* spp. was 52.5% (Table 1). However, the most important point to consider here is that, altogether, the two species of parasitoids were responsible for up to 97.5% of parasitism, obtained from plots with a released density of 12 *T. remus*

female m⁻². This average parasitism was not significantly different from plots with nine females m⁻² (91.7% parasitism). The field mutual interference of these parasitoids can hinder the evaluation of the impact of each species alone. However, based on the results presented here, there seems to be a potential for using both parasitoids in biological control program of *S. frugiperda* on maize crop.

**FIGURE 1.** Relationship between fall armyworm (*Spodoptera frugiperda*) egg masses parasitism and densities of the parasitoid *Telenomus remus*.

Considering that *Trichogramma* was already in the maize field, it seems that *T. remus* is more aggressive towards *S. frugiperda* egg masses, as pointed out by Hamada (1992) in relation to *S. litura*, where the natural egg mass parasitism was 2.9% for *Trichogramma* spp. and 16.1% for *Telenomus* sp. Besides, an average of only 21.3% of the egg in a mass was parasitized by *Trichogramma*, compared with 80.4% in the case of *T. remus* (Table 2).

TABLE 2. Parasitism (%) of *Telenomus remus* and *Trichogramma* spp. in fall armyworm (*Spodoptera frugiperda*) egg masses after releasing *T. remus*, in maize field.

Number of females of <i>T. remus</i> released m ⁻²	Parasitism of <i>T. remus</i> per egg mass (%) ¹	Parasitism of <i>Trichogramma</i> spp. per egg mass (%) ¹
0	78.7 ± 5.9 A	20.2 ± 1.3 A
6	75.9 ± 4.7 A	21.2 ± 2.8 A
9	81.9 ± 7.9 A	22.3 ± 5.0 A
12	84.9 ± 5.0 A	21.3 ± 4.5 A
Mean	80.4	21.3
CV (%)	8.4	19.5

¹ Means within each column followed by the same letter are not significantly different ($P \leq 0.05$; Duncan's multiple range test).

Inundative releases require the number of parasitoids to be synchronized with the beginning of pest oviposition, and its density which is frequently difficult to determine in the field. Sometimes it can be greater than the parasitism potential of a natural enemy. For these reasons, the inoculative releases are more reasonable to improve the parasitoid performance over the pest. In this experiment the parasitoid was released only once. Probably releasing at different periods of time can enhance the parasitoid

action. Further, studies are evidently necessary using a density of at least 12 female/egg masses as a starting point, but varying the fall armyworm egg mass density per area in maize fields. Also, in tactics of integrated pest management using biological control, the possible inter-specific competition or even the advantage of two or more natural enemies such as *Trichogramma* spp. and *T. remus* should be considered in achieving a better control of *S. frugiperda* in maize crop.

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