Cotton insect pest control on a small farm: an approach of successful biological control using *Trichogramma*

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Insecticides are commonly used on cotton insect pests and their high costs has limited the economic viability of the cotton crop, specially on small farms. Chemicals have also affected the efficacy of natural enemies leading to inefficient control. Damage caused by the cotton leafworm (*Alabama argillacea*), one of the most important cotton pests, results in economic losses. To control *A. argillacea* and other insect pests in cotton crop a combination of inundative release of *Trichogramma pretiosum*, cultural and chemical controls were used to keep the pest densities below the economic threshold.

**Keywords**: cotton insect pests, *Trichogramma* release, chemical control, upland cotton

The desired characteristics of the insecticides changed after the concept of the integrated pest management (IPM) (Metcalf 1980) was introduced. Generally insecticides were considered appropriate to be used in the IPM, if they combine insect pest control with a minimum of adverse influence on beneficial species (Sing & Varma 1986).

Flanders (1927) showed the possibility of mass rearing of *Trichogramma* on *Sitotroga cerealella*. Since then, studies have been conducted to determine the optimal performance of *Trichogramma* as a biological control agent. Releases number, pest density, released *Trichogramma* species or strains, vigour, methodology of release, plant phenology, presence of other natural enemies and proximity of insecticide treated areas (King & Coleman 1989) and control strategies can influence the parasitoid efficiency (Almeida et al. 1998).

Almeida (1996) evaluated the insecticide costs in comparison to biological control using *Trichogramma* wasps for controlling the cotton leafworm. Fourteen out of the fifteen insecticides analysed were more expensive than the *Trichogramma* release cost (100 thousand parasitoids per ha = US$ 3.33). Eleven insecticides were 100% more expensive than the cost of *Trichogramma*. Only deltamethrin cost (a pyrethroid insecticide) was less than the cotton leafworm parasitoid. However, its use is only recommended after 70 and 80 days from the beginning of the cotton crop season, respectively in upland and perennial cotton, due to its harmful effect on natural enemies.

Around 18 different species of *Trichogramma* are being mass reared to control insect pest on 18 millions of hectares in 16 countries (Hassan 1996) and 24 *Trichogramma* species were reported for the South America with approximately half of these species are present in Brazil (Zucchi & Monteiro 1996). *Trichogramma* wasps occur naturally in almost every terrestrial habitat, and some aquatic habitats as well. They parasitize insect eggs, especially eggs of moths and butterflies. Some of the most important caterpillar pests of field crops, forests, and fruit and nut trees are attacked by *Trichogramma* wasps. However, in most crop production systems, the number of caterpillar eggs destroyed by native populations of *Trichogramma* is not sufficient to prevent the pest from reaching damaging levels (Knutson 1998).

The potential for use of *Trichogramma* spp. to control insect pest in a field Integrated Pest Management program has been reported (Trumble & Alvarado-Rodriguez 1993, Bakhetia et al. 1996, Greenberg 1998, Ashraf et al. 1999). This work integrated biological, cultural and chemical control in a small farm for controlling upland cotton key pest in dryland season.

**MATERIAL AND METHODS**

This study was carried out in Juarez Tavora, Paraiba State, Brazil, in dryland upland cotton, during the 1996 harvest. The cotton CNPA 7H cultivar was used in this study.
Inundative releases of *Trichogramma pretiosum* were performed in a total area of 1 ha. Fifteen release devices of *Trichogramma* were installed (Fig. 1) and 100,000 pupae of *T. pretiosum* were released weekly per ha. The distance between release devices was of 30 m and a minimum height of 50 cm from the ground was used to avoid problems with rain. The released parasitoids were mass reared at the Entomology Laboratory of the National Center for Research on Cotton, Embrapa.

*Alabama argillacea* (cotton leafworm) eggs parasitism by *T. pretiosum* was evaluated by counting the number of parasitised and unparasitised eggs on all leaves of twenty plants weekly. In total twelve samples were done. The first cotton leafworm eggs and cotton aphid colonies were observed at the 14th day of planting.

The economic thresholds used to start chemical control of the cotton leafworm, *Aphis gossypii* (cotton aphid) and *Anthonomus grandis* (cotton boll weevil) were of 22-50% (larvae < and > than 15 cm), 70% of attacked plants (minimum of 5 aphids/colony) and 10% of squares with damage (squares with oviposition- and/or feeding punctures), respectively. The presence of cotton leafworm and cotton aphid colonies was evaluated in the three leaves of the plant apex. Squares of 5mm diameter from the upper middle part of the plant were used to detect the cotton boll weevil population level. A total of 50 plants were sampled weekly per ha.

The insecticides diflubenzuron 25 WP (12.5 g a.i./ha), monocrotophos 400 EC (120.0 g a.i./ha) and endosulfan EC 350 (525 g a.i./ha) and betacyfluthrin 125 CS (7.5 g a.i./ha) were sprayed respectively for the cotton leafworm, the cotton aphid and the cotton boll weevil, when the economic threshold established for each insect pest was reached. These insecticides were applied using a knapsack sprayer.

Cultural control based on the collection and destruction of squares dropped on the ground was used to preclude the boll weevil emergence and reinfestation of the cotton field (Almeida & Silva 1999).

Percentage of *Trichogramma* parasitism and other natural enemies, population level of the cotton insect pests and the seed cotton yield were evaluated.
RESULTS AND DISCUSSION

*Trichogramma pretiosum* biocontrol maintained high level of parasitism on the cotton leafworm from the first release reaching the mean percentage of 82% (Fig. 2). Almeida *et al.* (1995) comparing two releasing techniques (Adults vs pupae) found that the maximum parasitism of *Trichogramma pretiosum* on *A. argillacea* in perennial cotton was of 71%. Almeida (2000) determined the parasitism on *A. argillacea* of 78% in perennial cotton and reported its strong capacity of parasitising eggs independently of its location on the plant.

The insecticide diflubenzuron was used at the 21st day after planting to avoid the increase of the cotton leafworm population (larvae < 15 mm). These two measures led to the reduction of the cotton leafworm larvae to 0% level. A half dose of the insecticide monocrotophos was used as a strategy to preclude negative effects on the natural enemies.

The efficient control of the cotton leafworm made it possible to reduce the number of chemical applications by 55-70% (from 10-15 applications to 4.5 applications) compared with other small farms using exclusively chemical control. This led to an increase in other natural enemies populations (Coccinellidae, Chrysopidae, Syrphidae) (Fig. 3). Garcia-Roa (1991) stated that the economic and ecological advantages on cotton crop obtained with biological control using *Trichogramma* are valuable, once the farmers reduce the chemical control by at least 50% and the biological balance is re-established in the agroecosystem and the activity of other natural enemies.
is renewed. Knutson (1998) reported that the successful use of augmentative releases of *Trichogramma* in IPM programs will depend on a sound and thorough research program, favourable economics, commercial investment, and the development of an Extension program to transfer this technology to crop consultants and growers.

A new device for *Trichogramma* pupae release was used. The time it took to release the *Trichogramma* wasps, *i.e.* the replacement of the eggcards of all release devices was about sixteen minutes per ha. Using a knapsack sprayer for chemical application only one application of approximately 1.2 ha can be done in a day. The seed cotton yield was of 1,419.00 kg/ha.

REFERENCES


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