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Management of Sugarcane Stem Borer *Chilo infuscatellus* (Snellen) (Lepidoptera: Pyralidae) Through *Trichogramma chilonis* (Ishii) (Hymenoptera: Trichogrammatidae) and Selective Use of Insecticides

Ahmad-Ur-Rahman Saljoqi and Walayat Khan Walayati
Department of Plant Protection, The University of Agriculture, Peshawar, Pakistan

Abstract.- Studies regarding the management of sugarcane stem borer, *Chilo infuscatellus* through different release levels of *Trichogramma chilonis* (Ishii) and selective use of insecticides *i.e.* Corbofuran 3G @ 8 kg/Acre and Thimet 5G @ 10 kg/Acre in comparison with *T. chilonis* were carried out in two different experiments, in the sugarcane fields of the Research Farm Khyber Pakhtunkhwa Agricultural University Peshawar, during 2008. In the first experiment regarding the different release levels of *T. chilonis i.e.* single release (T1, @ 8 Trichocards/Acre), double release (T2, @ 16 Trichocards/Acre), triple release (T3, 24 Trichocards/Acre) quadruple release (T4, 32 Trichocards/Acre) and T5 (Control, no release). Highest mean percent parasitism (62.60%) and lowest mean percent infestation (1.25%) of the sugarcane stem borer was observed in quadruple release plot (T4). It was followed by the triple release plot (T3), with mean percent parasitism of 52.74% and percent infestation of 1.57%. In the 2nd experiment regarding the use of *T. chilonis* in comparison with insecticides in the treated plots, highest mean percent parasitism (66.61%) and lowest mean percent infestation (0.49%) of the sugarcane stem borer was observed in the quadruple release of Trichocards. Increased yield (46.29 tones / ha) was also recorded in the quadruple release of Trichocards. Both insecticides showed statistically same response in percent infestation of sugarcane stem borer and also yield of sugarcane, while higher percent parasitism was recorded in the Carbofuran 3G treated plots as compared with the Thimet 5G treated plots. Based on these results Trichocards (@32 Trichocards/Acre) are recommended for the management of sugarcane stem borer instead of insecticides. Moreover, this practice may have significant role to protect the environment and conserve the natural resources from insecticides contamination.

Key Words: Sugarcane, stem borer, *Trichogramma*, insecticides.

INTRODUCTION

Sugarcane is an important cash crop of Pakistan ranking fourth in the economy of the country. In Pakistan sugar cane is grown on 2.6 million acres. Its annual production is 54741.6 tons and average yield is 37-50 tons ha^1 (Malik and Gurmani, 2005). The average yield of sugarcane in Pakistan is low as compared to the other sugarcane growing countries of the world. Among the different reasons responsible for low yield of sugarcane in Pakistan, insect pests are the most important one. About 103 insects are associated with sugarcane (Kumarasinghe, 1999). In Pakistan, 12 species of insect pests have been reported to be associated with the sugarcane crop (Chaudhry and Ansari, 1988). Among all insect pests, sugarcane stem borer, *Chilo infuscatellus* (Snellen) (Lepidoptera: Pyralidae) is one of the serious problems in reducing the yield of sugarcan crop (Ashraf and Fatima, 1980). It can causes losses up to 36.51% (Aheer *et al*., 1994). Its caterpillars destroy about 20% of the young shoots during April-June annually (Dhaliwal, 2004). The larvae, after hatching reach the plant base, bore into the shoot and feed there. In years of severe infestation, it reduces the sugarcane yield from 30-70% (Anwar *et al*., 2004). The caterpillars feed in the stem and cut off the growing point (central whorl of the leave) causing the later to wilt and dry. The central dead shoot is also called "dead-heart". Such plants never grow further but the dormant buds sprout and produce side-shoots. After the formation of canes, its attack does not produce "dead-hearts" and damage is confined to a few internodes only. Even then, there is a considerable reduction in cane yield and sugar contents (Shahid *et al*., 2007).

Secondary pest outbreaks, pesticide resistance, more stringent pesticide regulation, and concern about human health and environmental quality have renewed the interest in Integrated Pest Management programs that emphasize the biological control which

* Corresponding author drsaljoqi@yahoo.com
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is very effective pest control strategy (Mohyuddin *et al*., 1997). The safety of biological control is outstanding as many natural enemies are restricted to their host and hence no effect on non- targets species. Biological control is relatively permanent, safe, economical and environment friendly (Shenhmar *et al*., 2003). Among biological agents for stem borer, *Trichogramma* is widely used for its control. *Trichogramma* wasp belongs to the family Trichogrammatidae of order Hymenoptera; these are tiny (0.5 mm long) parasitoids that attack the eggs of over 200 species, mostly Lepidopterans (Saljoqi and Yu-rong, 2004a). Today, *Trichogramma* species are the most widely used insect natural enemy in the world, partly because they are easy to mass rear, they attack many important crop insect pests and can be easily combined with other control measures in the IPM program (Saljoqi *et al*., 2012) . They parasitize insect eggs, especially eggs of moths and butterflies. 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 (Sen, 2003). The inundative releases of bioagents for control of lepidopterous pests are being practiced in more than 32 million hectares each year around the world (Hassan, 1993). Nine species of *Trichogramma* are reared in private or government owned insectaries around the world and released annually on an estimated 80 million acres of agricultural crops and forests in 30 countries (Knutson, 2000; Thomson *et al*., 2006) . *T. chilonis* releases in China, Switzerland, Canada and former USSR reduced the damage up to 70-92% on sugarcane, cotton and corn crops (Lily, 1994). Rafique *et al*. (2007) found *T. chilonis* very effective against the sugarcane stem borer. They recorded 83% reduction of *C. infuscatellus* infestation with the application of *T. chilonis* at 60,000 eggs. Zia *et al*. (2007) reported that the application of *T. chilonis* against *C. infuscatellus* showed a negative correlation with an increase in the number of eggs which indicated that it can be very effectively utilized to control stem borer and it reduces the borer infestation at 2.74%. In sugarcane, *T. chilonis* reduces stalk borer incidence by 55-60% (Shenhmar *et al*. 2003).

The present work deals with the effect of the inundative releases of *T. chilonis* alone and in comparison with the selective use of insecticides, Carbofuran 3G and Thimet 5G against sugarcane stem borer and also to find out their effects on the yield of sugarcane crop.

MATERIALS AND METHODS

The effectiveness of *T. chilonis* and commonly used insecticides, Carbofuran 3G and Thimet 5G @ 8kg/Acre and 10 kg/Acre, respectively was studied for management of sugarcane stem borer, *C. infuscatellus* in the sugarcane field of Khyber Pakhtunkhwa Agricultural University Peshawar Research Farm during 2008. These experiments were laid out in Randomized Complete Block (RCBD) design with three replications.

Effectiveness of T. chilonis

The experiment on the different release levels of *T. chilonis* for the management of *C. infuscatellus* was conducted for six months during April to September 2008. The Trichocards were prepared by using the eggs of *S. cerealella*. The Trichocard preparation method reported by Saljoqi and Yu-rong (2004b) was used in the present experiments. The field was divided into 3 plots. Each plot was subsequently sub-divided into 5-sub plots. Each sub-plot was having size of one Acre and was separated from one another by 1/2 Acre, using as a buffer zone. Five treatments of *T. chilonis* as release levels *i.e.* T1 (single release-8 cards/Acre), T2 (double release-16 cards/Acre), T3 (triple release-24 cards/Acre) and T4 (quadruple release-32 cards/Acre) as well as T5 (control plot-no release) with 20 days interval (0, 20, 40 and 60 days) were used in the experiment. Each card was parasitized by *T. chilonis* having 3000 eggs of *S. cereallela*. First release (0 days release) was done on 16th of April, 2nd on 6th May, 3rd on 26th May and 4th was on 15th June, respectively.

The plots were regularly monitored at 10 days interval and the data was collected after 10 days of release in each plot respectively.

Field application

The adult of *T. chilonis* which emerged in 24 hours, stapled in the fields during the treatments *i.e.* in single release 8 Trichocards were stapled, 16 cards in double release at zero and 20 days interval, 24 cards

in triple release at the 40 days interval and 32 cards in quadruple released plot at the 60 days interval were stapled, respectively. The control plots were kept with out cards. The cards were stapled randomly in the fields at 5-different places in each plot with the sugarcane leaves at the rate of 8 cards/Acre.

Determination of infestation and parasitism

The efficacy of *T. chilonis* at different release levels on percent infestation of sugarcane stem borer, *C. infuscatellus* was determined by selecting thirty canes from five different places in each plot of sugarcane. The data were collected from dead hearts till 25th June, while percent infestation data on the internode damage was taken by inspecting 30 canes in each plot from 25th June to the end of September.

The percent parasitism was determined from each plot by selecting 150 cane (30 canes from each sub-plot) were examined for borer eggs at 10 days interval. The leaves with egg batch of sugarcane stem borer, *C. infuscatellus* were cut in size of 3 inches from the cane. To keep the leaves fresh, they were kept in the Petri dish with moist tissue paper and then were reared to laboratory for rearing and emergence of *T. chilonis*. The percent parasitism was determined by using the following formula:

$$\text{Percent parasitism} = \frac{\text{No. of parasitoids emerged}}{\text{Total No. of eggs}} \times 100$$

Insecticide application along with Trichocards

To compare the efficacy of selected use of insecticides, Carbofuran 3G and Thimet 5G with Trichocards, the field was divided into three plots; each plot was divided into four sub plots. Each sub-plot was having size of one Acre and each sub-plot was separated from one another by 1/2 Acre area, using as a buffer zone. At five to six leaf stage of the sugarcane crop, the plots were treated with the related treatments. There were four treatments *i.e.* T1 (quadruple release-32 cards/Acre), T2 (Carbofuran 3G @ 8 kg/Acre), T3 (Thimet 5G @ 10 kg/Acre) and T4 (control plot-no release).

Culture was maintained for the Trichocards in the laboratory. The Trichocards card having approximately 3000 *S. cerealella*, parasitoid egg by *T. chilonis*. These cards were stapled @ 8 cards each at 0, 20, 40 and 60 days intervals. The insecticides were applied by broadcast method in the first week of April. After the application of these insecticides, the treated plots were irrigated.

The data on percent parasitism by *T.chilonis* and on percent infestation of sugarcane stem borer was collected, by using the methodology already described above for the experiment of the effectiveness of *T. chilonis*. Yield data was collected for each treatment and then converted to tones/ha. Data were analyzed by using M Stat-C computer programme and the means were separated by using DMR-test (Gomez and Gomez, 1984).

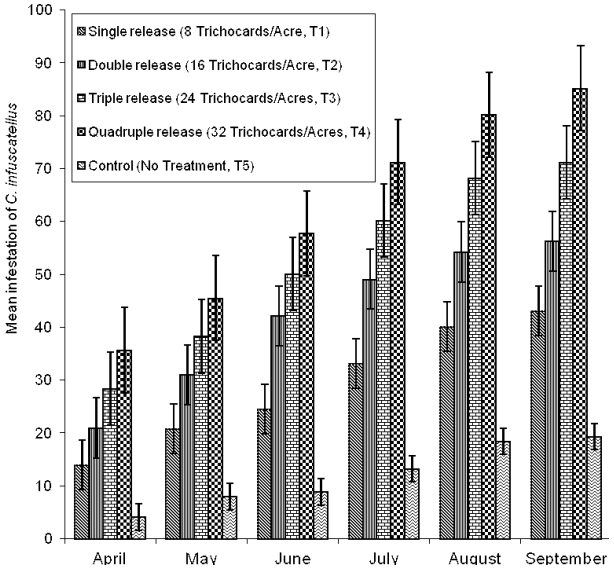

Fig. 1. *Trichogramma chilonis* (Ishii) effectiveness on the infestation of *Chilo infuscatellus* (Snellen) in the sugarcane field of Agricultural University, Peshawar Research Farm during April – September 2008.

RESULTS AND DISCUSSION

Effectiveness of T. chilonis

Infestation

It is evident from the data presented in Figure 1 that lowest infestation was recorded in quadruple release plot (T4) throughout the period of study from April-September. It was followed by triple release plot (T3), double release plot (T2) and single release plot (T1) in reducing the percent infestation of sugarcane stem borer. However in the control (T5), the infestation was comparatively higher than all the

treatments. Statistical analyzed data of the seasonal pooled mean percent infestation presented in Table I showed that lowest percent infestation (1.25%) was observed in T_4, followed by 1.57%, 2.38% and 4.14% recorded in T3, T_2 and T1, respectively. Significantly highest percent infestation (9.31%) was recorded in T_5. It is clear that *T. chilonis* and their number of releases play a vital role in the reduction of pest infestation. The data clearly indicated that population of *T. chilonis* is directly proportional to the reduction percentage of *C. infuscatellus*. When the population of *T. chilonis* was low infestation of *C. infuscatellus* remained high but as the concentration of *T. chilonis* parasitized eggs increased gradually the population of *C. infuscatellus* also decreased and reduction percentage increased that indicated the effectiveness of *T. chilonis*. These results are in agreement with the findings of Bharati *et al.* (2002), Shenhmar *et al.* (2003), Soula *et al.* (2003), Bhat *et al.* (2004), Hoffmann and Baumgartner (2005), Shahid *et al.* (2007) and Ahmad *et al.* (2012).

Table I.- ***Trichogramma chilonis*** **(Ishii) effectiveness on the seasonal pooled mean infestation and seasonal pooled field parasitism of** ***Chilo infuscatellus*** **(Snellen) in the sugarcane field of the Agricultural University, Peshawar Research Farm during April-September, 2008.**

Treatment	Trichocards/Acre	Seasonal pooled mean percent infestation	Seasonal pooled mean percent parasitism
Single release (T_1)	8	4.14± 0.58 b	29.29± 1.83 d
Double release (T_2)	16	2.38± 0.34 c	42.29± 1.89 c
Triple release (T_3)	24	1.57± 0.43 cd	52.74± 1.97 b
Quadruple release (T_4)	32	1.25± 0.43 d	62.60± 1.97a
Control (T_5)	No treatment (0)	9.31± 0.57e	11.99± 0.82e
LSD		0.984	3.457

Means in columns, separately followed by the same letter(s) are non significant at 5% level of probability, using DMR-Test.

Parasitism

The data collected on filed percent parasitism of *C. infuscatellus* by *T. chilonis* are presented in Figure 2. Highest percent parasitism was recorded in T_4, followed T_3, T2 and T1 from April - September. All the treatments were found significantly different with one another during the entire period of study. An eminent variation was found among the Trichocard released fields compared with the control.

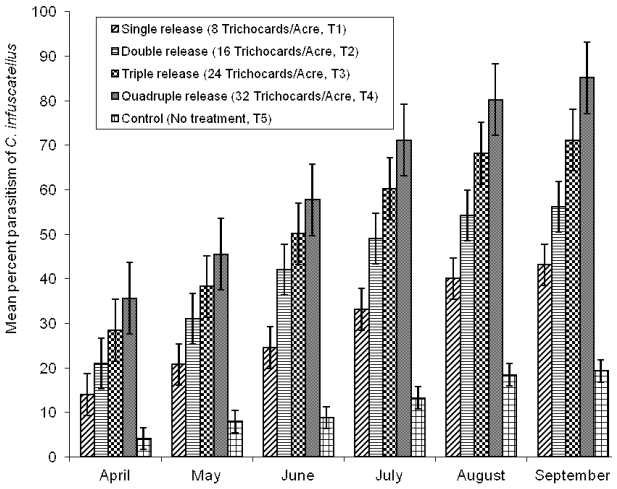

Fig. 2. *Trichogramma chilonis* (Ishii) effectiveness on the field parasitism of *Chilo infuscatellus* (Snellen) in the sugarcane field of Agricultural University, Peshawar Research Farm during April – September 2008.

Data regarding seasonal pooled mean of percent parasitism are presented in Table I. Statistical analysis of the data showed that all treatments were significantly different among each other. Percent parasitism 29.29% was recorded in T_1 followed 42.29%, 52.74% and 62.60% recorded in T2, T3 and T4, respectively. Lowest percent parasitism (11.99%) was observed in T5. Our present findings are agreed to those of Muhammad and Muhyuddin (1987), Ashraf *et al.* (I993) and Mustafa *et al.* (2006) who reported that by the use of Trichogramma, favorably affect natural enemies of sugarcane stem borer *C. infuscatellus.*

Insecticide application along with Trichocards

Infestation

The data regarding percent infestation of *C. infuscatellus* presented in Figure 3 showed that lowest percent infestation was observed in T1 (quadruple release-32 cards/Acre) from April-September. In T2 (Carbofuran 3G) and T3 (Thimet 5G) almost statistically same percent parasitism was observed,

while in T4 (control) significantly highest percent infestation was recorded from April-September. The data presented in Table II regarding the seasonal pooled mean percent infestation of *C. Infuscatellus* revealed that lowest mean infestation (0.49%) was recorded in the T1. Statistically same mean percent infestation was observed in T2 and T3 where 0.84 and 0.94 percent infestation was recorded, respectively. However highest infestation (7.72%) was recorded in T4. In this case our results almost coincide with Ullah *et al*. (2012). They compared the potential of *T. chilonis* with Basudin 60 EC and Furadan 3G against *C. infuscatellus.* They found best results with the inundative release of Trichocards @ 30 cards/acre each card having almost 3500 *Sitotroga cerealella* eggs parasitoized by *T. chilonis*. Nadeem and Hamed (2011) also reported the effectiveness of *T. chilonis* to suppress the borer damage below to economic threshold level by comparing the borer damage between bio-control released and other treatments plots of the sugarcane fields.

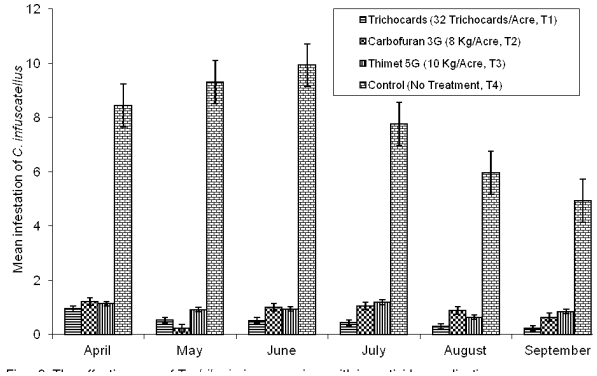

Fig. 3. The effectiveness of *T. chilonis* in comparison with insecticides application on the infestation of *C. infuscatellus* in the sugarcane field of Agricultural University, Peshawar Research Farm during April – September 2008.

Parasitism

The data concerning to percent parasitism is presented in Figure 4. It is clear from the data obtained from April-September that highest percent parasitism was recorded in T_1, followed by T_4. Lowest percent parasitism was observed in T3, followed by T2 recorded at most of the time intervals. Data pertaining to seasonal pooled mean of percent parasitism by *T. chilonis* presented in Table II showed that all treatments were significantly different among each other. Highest parasitism (66.61%) was observed in T_1 followed by 11.97% and 8.45% recorded in T4 and T2, respectively. Lowest parasitism (7.68%) was found in T3. Our results coincides with the work done by Muhammad *et al.* (2007) and Ullah *et al.* (2012), where they worked on effectiveness of *T. chilonis* against sugarcane borer and achieved similar results. Selvaraj *et al.* (1994) also worked on the effectiveness of the same biological agent against this pest and found positive results. Similar results were also obtained by Kumarasinghe (2008) who reported that the impact of *T. chilonis* is the best management in the reduction of percent infestation by sugarcane stem borer and increasing the percent parasitism rate of *C. infuscatellus.*

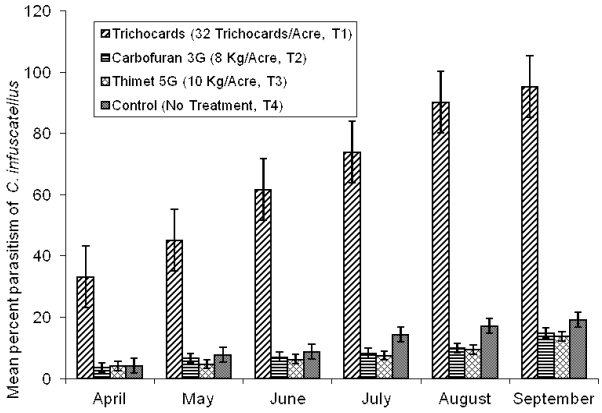

Fig. 4. The effectiveness of *T. chilonis* in comparison with insecticides application on the parasitism of *C. infuscatellus* in the sugarcane field of Agricultural University, Peshawar Research Farm during April – September 2008.

Total yield (tones/ha)

The data concerning to total yield of sugarcane crop is presented in Figure 5. Mean values of the data indicated that highest yield (46.29 t/ha) was recorded in Trichocards (T_1), followed by Carbofuran 3G treated plot (T_2) (40.43 t/ha). Mean yield of 39.37 tones/ha was observed in Thimet 5G treated plot (T_3), while lowest yield of 27.45 tones/ha was noted in control plot (T_4). It is clear from the data that the use of Trichocards (@32 cards/Acre) is more effective for the control of sugarcane stem borer which gave higher yield (46.29 t/ha) as compared with all other treatments. These results are in agreement with the

findings of Ullah *et al*. (2012) who reported that biological control resulted in reduced pest damage, significantly increased yield, reduced cost pest control and conservation of natural enemies. Gul *et al*. (2008) also recorded improved yield of sugar cane by utilizing *T. chilonis* against sugar cane borer infestation.

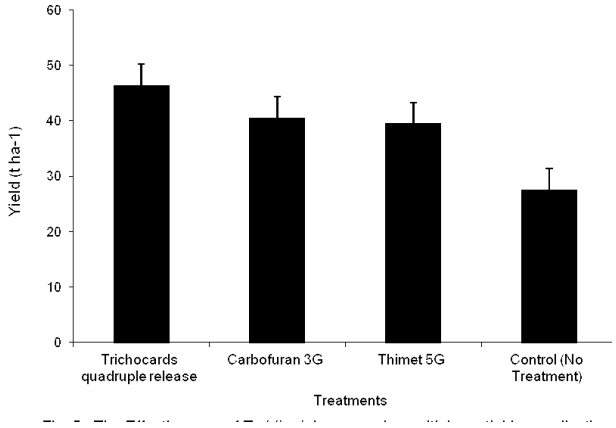

Fig. 5. The effectiveness of *T. chilonis* in comparison with insecticides application against *C. infuscatellus* in the yield of sugarcane field (tha-1) in the sugarcane field of Agricultural University, Peshawar Research Farm during April – September 2008.

RECOMMENDATIONS

On the basis of these two experiments, it is concluded that Trichocards release was the best strategy for the management of sugarcane stem borer. Quadruple release in comparison to single, double, triple release, use of insecticides had eminent effect on reducing the sugarcane stem borer infestation, increasing the parasitism rate of *T. chilonis* and increasing the yield of sugarcane. Therefore, quadruple release of Trichocards is recommended for control of sugarcane stem borer. Moreover this strategy may be environment friendly and is the best substitute for the chemical insecticides.

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