J. Agr. Sci. Tech. (2014) Vol. 16: 497-503

Biological Control of Sugarcane Top-borer, *Scirpophaga excerptalis* (Walker) (Lepidoptera: Crambidae) through Different Release Levels of *Telenomus beneficiens* (Zehntner) (Hymenoptera: Scelionidae)

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ABSTRACT

***Telenomus beneficiens* is a common egg parasitoid of sugarcane top borer *Scirpophaga excerptalis*; however, in winter time the incidence of the parasitoid on top borer eggs is extremely low. *T. beneficiens* adults were released at various time durations into sugarcane plots to evaluate the parasitic potentiality of the parasitoid against sugarcane top-borer. The egg parasitoid *T. beneficiens* of sugarcane top borer *Scirpophaga excerptalis* (Walker), was released into four sugarcane plots as once, twice, thrice and quadruple time treatments to compare its parasitic potential as a biological control agent. The four releases of the adult parasitoid were made within a time interval of one month and at a rate of 500 adults per plot. Results revealed a significant control of the pest through all the four treatments. The highest mean parasitism of 42.36±10.84% and lowest mean infestation of 12.05±0.99% was recorded for the treatment of quadruple releases, followed by the triple release plot, where 41.38±10.07% of mean parasitism and 12.61±0.78% of mean infestations were observed. As for the double release plot, 26.56±3.72 and 14.46±1.92% mean parasitism and infestation were recorded respectively, whilst in the single release plot, the corresponding figures equaled to 21.94±2.98 and 16.82 ±2.38% as compared with the check plots (15.71±3.03 and 16.82±2.55 %). It is evidenced that triple release results almost coincide with the quadruple release ones, and hence the triple release of the adult parasitoid is effective enough and recommended for the control of sugarcane top borer, *S. excerptalis*.**

Keywords: Parasite *Telenomus beneficiens*, *Scirpophaga excerptalis*, Sugarcane, Top-borer.

INTRODUCTISON

Sugarcane borers are mainly responsible for the lower yields in sugarcane production, and as well for the subsequent low refined sugar. They diminish the number of early grown plants by producing dead hearts that lead to reduced sugar content. Gums, waxes, increase in total acidity, starch and organic nitrogen, are some results of the insect's internal feedings (Hassan, 1984). Losses due to borers have been estimated from 20.78 to 57.9%. Among the borers, *Scirpophaga excerptalis* (Lepidoptera: Crambidae) has been reported as one of the most destructive insects of sugarcane in most parts of the world, including Pakistan (Anwar *et al*., 2004). From literature surveys it is revealed that a limited work has been carried out on sugarcane top-borer parasitoid, *Telenomus beneficiens* (Hymenoptera: Scelionidae). In Indonesia,

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during field trials, *T. beneficiens* was detected from within the egg batches of sugarcane top borer (Chu, 1979). Vu Quang and Nguyen. (1987) also found *T. beneficiens* as a potential egg parasitoid of sugarcane top borer in the field. Rajapakse and Kulasekera (1980) observed *T. beneficiens* as an active bio-control agent for the control of sugarcane top borer. Hikim (1979) reported that *T. beneficiens* is one of the beneficial insects, which parasitized sugarcane top borer egg batches in Pakistan and India. Sugarcane top borer was controlled through releases of *T. beneficiens* in Sarawak (Rothschild, 1970). In Hong Kong, *T. beneficiens* was first used for the biological control of sugarcane top borer (Thornton *et al*., 1975). The pest was controlled by mass augmentation of *T. beneficiens* and *T. dignus* (Gahan) in India (Saxena 1977). The latter was also used for the control of yellow stem borer, *S. incertulas* (Walker) infesting rice in India (Ram and Ram, 2002). Seven *Telenomus* species have been employed for the control of a number of insect pests in various crops including sugarcane top borer through augmentative biological control in African countries (Sithanantham, *et al*. 2002).

The present study was carried out in Shahpur, Sargodha, Pakistan, where *T. beneficiens* is a common parasitoid of sugarcane top borer. However, in winter the incidence of this parasitoid on top borer eggs is observed as extremely low. Therefore, *T. beneficiens* adults were released at various time duration and frequencies into sugarcane plots to evaluate the potential of the parasitoid against sugarcane top-borer.

MATERIALS AND METHODS

The study was designed to evaluate the parasitic potential of egg parasitoid, *T. beneficiens* against *S. excerptalis*. For this purpose, a field experiment was conducted in Shahpur, Sargodha, which was initiated on 28th March and continued up to last week of August 2009 (full maturity of the crop). The experiment was laid out in the framework of a Randomized Complete Block Design (RCBD). A field of 20 acres was selected for the experiments. The entire field was then divided into five treatment blocks (each 4 acres), including the check. Each treatment was replicated four times. Five rows between each two treatments were assigned to buffer zones.

Mass Rearing of the Adults, *T. beneficiens* and Their Release into the Sugarcane Fields

Egg batches of *S. excerptalis* were initially utilized for mass rearing of egg parasitoid, *T. beneficiens* in the laboratory. For the purpose, sugarcane leaves, bearing egg batches of sugarcane top borer were collected from non-experimental fields and exposed to adult parasitoids in glass jars (10 cm height×2.5 cm diameter) for 5-6 days. The parasitized egg batches were transferred to a number of glass jars (10 cm height×2.5 cm diameter). Adult parasitoids were released soon after emergence into the randomly selected plots. Four releases were made within intervals of 30 day durations, according to the following arrangement, to determine the efficiency of *T. beneficiens* practically in the field.

Treatments arrangement with respective doses of releases of *T. beneficiens* adults.

Treatments no.	Releases	Release rate	Time of release
1	Single	500 adults acre^{-1} (2000 adults/treatment)	March
2	Double	500 adults acre^{-1} (2000 adults/treatment)	March+April
3	Triple	500 adults acre^{-1} (2000 adults/treatment)	March+April+May
4	Quadruple	500 adults acre^{-1} (2000 adults/treatment)	March+April+May+June
5	Control	No release	

There were five treatments including the check, with each treatment replicated four times. Two day old adults at a number of 2,000 of *T. beneficiens* were released in naturally infested fields within the interval of 30 days, once in treatment 1, twice in treatment 2, three times in treatment 3 *vs.* four times in treatment 4, respectively, with no *T. beneficiens* released in control. Each treatment was replicated four times. The data were statistically analyzed, employing MSTATC software package (Steel and Torry, 1980).

RESULTS

Post-release Level of Parasitism of Sugarcane Top Borer Eggs

The findings regarding egg parasitoid adult releases in single, double, triple and quadruple sequences are presented in Tables 1 and 2. The P-values in Table 1 for all the four different times of release are much lower than the levels of significance 0.01 and 0.05, and thus they were concluded as highly significant results for the treatment effects. Further statistical analysis, using Least Significant Different (LSD) test are given in Table 2. The results revealed that after 30 days of first release, percent parasitism of sugarcane top borer eggs was almost the same in all plots as compared with control. After two months past, parasitism was still higher in treated plots (176.38 to 26.89%) than in the untreated control (10.13±2.3%). Parasitism was also significantly lower (16.78±1.02%).) in the single release treatment than in the double (24.81%), triple (26.50%) and quadruple (26.89%), however the latter three did not significantly differ from each other. Parasitism recorded after 3rd release was highest in the triple release plots (37.29%) than in the quadruple ones (35.99%), but there was no significant difference observed

Table 1. Analysis of treatments' effects with respect to doses of releases of *Telenomus beneficiens* adults for parasitism within various time durations of the adults' releases.

Treatments	Parasitism (%) at various time interval (Days to release)				
	30	60	90	120	150
F-value	12.03	56.95	37.33	186.06	207.75
P-value	0.0004	0.000	0.000	0.000	0.000
Significance	**	**	**	**	**

** Highly significant results.

Table 2. Comparison of mean percent parasitism of adult, *Telenomus beneficiens* following its releases at various rates into the sugarcane fields.[a]

Treatments	Release rate of *T. beneficiens* (adults acre^{-1})	Parasitism (%) at various time interval					Means
		28/4/11	28/5/11	28/6/11	28/7/11	28/8/11	
Single release	500	14.89a	16.78b	20.57c	26.91c	30.61c	21.95c±2.98c
Double release	500	13.68a	24.81a	27.00b	31.76b	35.55b	26.56±3.72b
Triple release	500	14.69a	26.50a	37.29a	59.87a	68.51a	41.38±10.01a
Quadruple release	500	14.34a	26.89a	35.99a	62.82a	71.78a	42.36± 10.83a
Control	No release	9.14b	10.13c	13.68d	21.16 d	24.44d	15.71±3.04d
LSD value 0.05 alpha level =		2.128	2.997	5.428	4.387	4.759	2.77

[a] Means with different letter(s) in columns are significantly different at P<0.05.

between them. However, they were significantly different from double (27.00%), single (20.27%) and control plots (13.68%), which in turn were significantly different from each other. There was no significant difference observed between egg parasitism of sugarcane top borer in quadruple (62.82%) *vs*. triple (59.87%), after the 4th release, the parasitisms for which were much higher than those for the double, single and control plots, i.e. 31.76, 26.91, and 21.16%, respectively. The highest parasitism of *T. beneficiens* was recorded for quadruple release (71.78%) followed by tripe, double, single and the untreated, i.e. 68.51, 35.55, 30.61 and 23.44%, respectively at the end of 150 days past of the first release.

Overall mean parasitism of sugarcane top borer eggs by *T. beneficiens* adults revealed that mean parasitism of *T. beneficiens* was 21.94% within a range of 14.89 to 30.61% in the single release plot. This was followed by double release plot (26.56%), triple 41.38% within a range of 14.69 to 68.5% and quadruple release plot of 42.36% within a range of 14.34 to 71.78%. The lowest parasitism recorded for control plot (15.71%) within a range of 9.14 to 24.44%. Statistical analysis revealed that the rate parasitism of *T. beneficiens* did not differ significantly in triple treatment from those in the quadruple release plots, whereas single and double releases were found out as significantly different from each other.

Post-release Level of Infestation of Sugarcane by Top Borer (*S. excerptalis*)

The findings regarding egg parasitoid adult releases in single, double, triple and quadruple sequences are presented in Tables 3 and 4. The *P*-values in Table 3 for the level of infestation at the first four time duration intervals (30, 60, 90 and 120 days to release) show all the results as non-significant while the *P-value*= 0.0003 for

Table 3. Analysis of treatments' effects with respect to doses of releases of *Telenomus beneficiens*'s adults within various times durations of the adults' releases.

Treatments	Percent infestation at various time intervals (days to release)				
	30	60	90	120	150
F-value	0.10	0.84	1.24	2.63	13.03
P-value	0.9794	0.5240	0.3447	0.0868	0.0003
Significant	NS[a]	NS	NS	NS	**

[a] Non-significant, **: Highly significant.

Table 4. Comparison of mean rate of infestation of sugarcane top borer following release of adult *Telenomus beneficiens* at various rates into the sugarcane fields.[a]

Treatments	Release rate *T. beneficiens* (adults acre^{-1})	Percent infestation at various time interval					Means
		28/4/11	28/5/11	28/6/11	28/7/11	28/8/11	
Single release	500	11.01 a	13.25 a	15.69 a	19.77 a	24.40 ab	16.82±2.39a
Double release	500	10.41 a	10.87 a	15.62 a	17.60 a	20.36 b	14.96± 1.92a
Triple release	500	11.58 a	12.33 a	12.41 a	13.24 a	13.54 c	12.61±0.34 a
Quadruple release	500	10.82 a	11.50 a	11.83 a	12.92 a	13.18 c	12.05 ±0.44a
Control	No release	11.72 a	15.35 a	17.38 a	20.53 a	26.81 a	18.36± 2.55a
LSD value 0.05 alpha level =		5.201	5.866	6.538	6.784	5.289	5.153

[a] Means with different letter(s) in columns are significantly different at P<0.05.

infestation after 150 days past of the release is much more pronounced than the levels of significance (0.01 and 0.05) and thus concluded as highly significant as regards the treatments' effects.

The results on the rate of infestation of *S. excerptalis* using LSD test (Table 4) were also found non-significant among treated *vs.* untreated plots, i.e. 11.01, 10.41, 11.58, 10.82 and 11.72% in single, double, triple, quadruple and control, respectively, after 30 days past of first release of *T. beneficiens*. Similar results were observed following the second release of adult parasitoids, *T. beneficiens* within these plots (13.25, 10.87, 12.33, 10.50 and 11.50%).

Sugarcane top borer density did not increase significantly after third release of *T. beneficiens* in the respective treatments, while similar results were obtained after 120 days past of first release (after 30 days past of the 4th release), *viz*; 19.77% in single, 17.60% in double, 13.24% in triple, 12.92% in quadruple, and finally 20.53% for control. However, pest density was significantly increased in single (24.40%), double (20.36%) and control (26.81%) as compared with triple (13.54%), and quadruple (13.18%) after 150 days past of the first and 60 days past of the 4th releases, respectively.

The effectiveness on the basis of overall mean observations after treatments, showed that the lowest infestation of top borer was recorded in the quadruple release plot (12.05), followed by triple release plot (12.61), double release plot (14.96), single release plot (16.82) and the control plot (18.36%).

DISCUSSION

The percent parasitism by *T. beneficiens* on the eggs of *S. excerptalis* and the rate of infestation by *S. excerptalis* was significantly influenced by the inundative releases of *T. beneficiens* adults at different time durations as compared with check plots. However, the triple release treatment (500 adults acre^{-1}) produced significantly more effective results as compared with the other treatments.

The present findings clearly indicate that quadruple releases lead to more effective results than the other treatments, thereby suggesting that inundative releases of the parasitoid ultimately suppressed the pest population to a greater extent. However, it required constant efforts and observations in order to achieve the target objective.

It is evident that the inundative releases of *T. beneficiens* play a vital role in increasing the rate of parasitism of *S. excerptalis* eggs followed by a subsequent reduction in the pest population. Mohyuddin *et al*. (1988) have reported their study results in consistence with the present study. There is a dire need for continuous inputs as well as cooperative work throughout the sugarcane growing belt and in particular where the pest is a more serious problem. The present study suggests a step further for more releases to observe the effectiveness and make comparisons with the quadruple release. This will open new avenues and give a clear picture of the number of releases and finally of the economy of the established biological control Such information will prove an added tool in the modern pest management programme to handle the crises more confidently.

The presence of the parasitized eggs in the control plots showed that *T. beneficiens* is present in the area with up to 24.44 percent parasitism recorded for the month of August. Moreover, the seasonal percentage of the parasitized eggs in the single, double, triple and quadruple releases i.e. 21.94, 26.56, 41.38 and 42.36% revealed that these releases were somewhat augmentative rather than inundative. There is a need to monitor the field population of *T. beneficiens* in the target area with further releases to be made accordingly. This bears a greatly bright future scope along with concepts for introducing environment friendly technologies.

The results also reflected that the rate of infestation was lowered through the quadruple treatment to a desired extent;

however, this was reasonable so far as the single, double and triple releases are concerned. It is important to mention that in biological experiments the environment factors do play significant roles in keeping the entire scenario on the go. In case the weather conditions are conducive to the parasitoid establishment, then there are greater chances of success or otherwise it could lead to jeopardized situations.

These ideas could be shared clearly with Saxena (1977) and Sithanantham *et al*. (2002) who studied the effectiveness of *T. beneficiens* and found the impact of *T. beneficiens* in reducing the level of infestation inflicted by sugarcane top borer. This could be termed as significant breakthrough in integrated pest management.

T. beneficiens releases at different intervals were made according to the phenology of *S. excerptalis* with the releases being made with the appearance of top borer adults in the field of sugarcane, leading to a synchronization of the egg parasitoid with the host *S. excerptalis*. Light traps and if possible pheromone traps for mating disruptions can play a vital role in the precise timing of *Telenomus* sp. releases. This will be an add advantage to promote biological control agents and to set-up a bio-ecological zone of pest and pesticide free nature.

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کنترل بیولوژیک ساقه خوار جوانه نیشکر *Scirpophaga excerptalis* (Walker) (Lepidoptera: Crambidae) از طریق رهاسازی (در سطوح مختلف) زنبور پارازیتویید *Telenomus beneficiens* (Zehntner)(Hymenoptera: Scelionidae)

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چکیده

Telenomus bebefucuens پارازیتویید رایجی علیه ساقه خوار جوانه نیشکر (*Scirpophaga excerptalis*) است، اما در ایام زمستان جمعیت این پارازیتویید روی تخم‌های میزبان فوق‌العاده کم می‌شود. برای ارزیابی توان بالقوه این پارازیتویید علیه آفت مذکور، حشرات بالغ *T. beneficiens* در مدت زمانهای متفاوت در کرت‌های نیشکر رهاسازی شدند. به به منظور مقایسهٔ توان بالقوه زنبور *T. beneficiens* به عنوان پارازیتویید تخم ساقه خوار جوانه نیشکر، *S. excerptalis* حشرات کامل زنبور به صورت یک، دو، سه و چهار بار در کرت‌های نیشکر رهاسازی شدند. هر تیمار دارای چهار تکرار بود. در کرت‌هایی که چهار بار رهاسازی حشرات کامل پارازیتویید صورت گرفت، فواصل زمانی یک ماه و تعداد حشرات کامل در هر کرت ۵۰۰ عدد بود. نتایج نشان دهنده کنترل معنی دار آفت در هر چهار تیمار بود. بالاترین میانگین پارازیته شدن آفت (٪ ۰/۹۹ ± ۴۲/۳۶) و کمترین معدل آلودگی محصول (٪ ۰/۹۹ ± ۱۲/۰۵) در تیمار چهار مرتبه رهاسازی پارازیتویید و به دنبال آن در تیمار سه مرتبه رهاسازی که در آن میانگین پارازیته شدن آفات ٪ ۱۰/۰۷ ± ۴۱/۳۸ و متوسط آلودگی محصول ٪ ۰/۷۸ ± ۱۲/۶۱ بود، مشاهده شد. در تیمار (treatment) دو مرتبه رهاسازی، میانگین‌های ٪ ۳/۷۲ ± ۲۶/۵۶ و ٪ ۱/۹۲ ± ۱۴/۴۶ به ترتیب برای میزان پارازیتیسم و درصد آلودگی به آفت گزارش شدند. در کرت‌های یک بار رهاسازی زنبور پارازیتویید، میانگین‌های مربوطه ۲/۹۸±۲۱/۹۴ و ۲۱ ±۱۶/۸۲ درصد در مقایسه با کرت‌های کنترل (٪۳/۰۳ ± ۱۵/۷۱ و ٪ ۲/۵۵ ± ۱۶/۸۲ درصد) تعیین شد. نهایتاً مشخص شد که نتایج مربوط به تیمار سه مرتبه رهاسازی زنبور پارازیتویید تقریباً مشابه تیمار چهار مرتبه رهاسازی است و لذا سه بار رهاسازی حشرات کامل پارازیتویید به اندازهٔ کافی مؤثر بوده و برای کنترل آفت ساقه خوار جوانه نیشکر (*S. excerptalis*) توصیه می شود.