Impact of Release Intervals and Densities of *Trichogramma chilonis* (Ishii) (Hymenoptera: Trichogrammatidae) Against the Sugarcane Stem Borer, *Chilo infuscatellus* (Lepidoptera; Pyralidae) under Field Conditions

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Abstract: The parasitization of *Trichogramma chilonis* parasitoids was found higher in the blocks where parasitoids were released to control *Chilo infuscatellus* at weekly interval (52.4 %) as compared to fortnight (40.9%) and monthly intervals (32.7%). Mean parasitization was (42.7%) when 80,000 thousand parasitoids were released on monthly basis followed by 41.4% (40,000), 37.8% (20,000) and 34.0% (10,000). However the mean infestation was below economic threshold levels ranging from 5.3 to 6.5 % in all the blocks where the parasitoids were released in variable numbers.

Keywords: Sugarcane, *Trichogramma chilonis, Chilo infuscatellus,* release interval, release densities.

INTRODUCTION

Sugarcane is one of the major crops of Pakistan, grown in Kharif season. It provides raw material to sugar and sugar related products and generates income and employment for the farming community of the country. Sugarcane helps in value addition to essential item for industries like sugar, chipboard and paper etc., and has contributions to agriculture and GDP as 3.6 percent and 0.8 percent, respectively [1]. The average yield of sugarcane in Pakistan is low as compared to the other sugarcane growing countries of the world. This may be due to many factors, of which insect pest are the most important one [2]. There are about 103 insects associated with Sugarcane [3]. Amongst these sugarcane borers are the most damaging ones. According to [4] sugarcane stem borer causes losses up to 36.51%. It became a challenging pest of sugarcane crop, due to feeding inside the plant parts where sprays are difficult to reach and the extensive and injudicious use of insecticides not only create the health hazards and environmental pollution but also resistance in insects against those chemicals. To overcome resistance problem and also to meet the demand of international market for producing good quality agro products, now more stress is given on organic farming and it is imperative to use biological control programme for sugarcane.

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Augmentative, or inundative, biological control is the release of large numbers of natural enemies to augment natural enemy populations or inundate pest populations with natural enemies. The inundate releases of bio-agent for the control of lepidopterous pests are being practiced in more than 32 million ha each year around the world [5]. *Trichogramma chilonis* (Ishii) (Hymenoptera; Trichogrammatidae) is an important egg parasitoid of lepidopterous pests and can be used effectively to manage sugarcane stem borer.. It has been in use in sugarcane, corn, cotton, vegetables and fruits crops for the control of pests since 20 years [6]. The release of *T. chilonis* in China, Switzerland, Canada and former USSR reduced the damage up to 70 to 92% on sugarcane [7] while in Asia, it reduced the incidence of pests in sugarcane by early shoot borer (*Chilo infuscatellus)* from 43 to 82% [8].

The purpose of this study was to assess the relative impact of release intervals on the effectiveness of augmentative biological control and the effectiveness of releasing them in different numbers.

MATERIAL AND METHODS

a) Releasing Interval

Field studies were conducted to determine the most suitable interval for augmentative releases of parasitoid (*T. chilonis*). Three sugarcane plots were selected at experimental farm and borer infestation was recorded on dead heart basis at initial stage. Ten thousand parasitoids were released on weekly, fortnightly and

ISSN: 1814-8085 / E-ISSN: 1927-5129/12

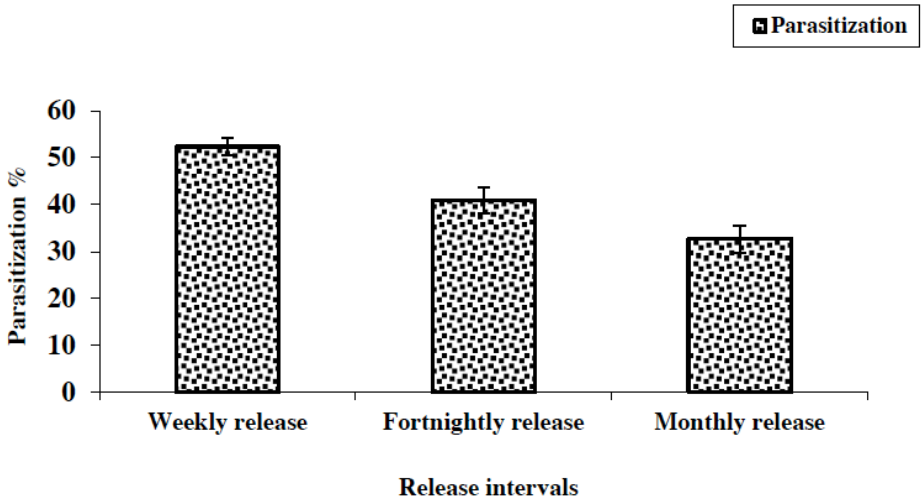

Figure1: Impact of release intervals on parasitism of *T. chilonis* for efficient management of sugarcane stem borer.

monthly basis in A, B and C plots, respectively. To monitor the establishment of parasitoids, cards were prepared with the Angoumois grain moth eggs (irradiated at 25 Gy) @ 100 eggs / card. These cards were stapled to the sugarcane leaves at uniform distances in the field at the rate of 10 cards/ plot, at the next day of parasitoid release and then at weekly interval. Angoumois grain moth eggs cards were brought to laboratory and percent parasitization/ 24 h was recorded.

b) Releasing Density

To determine the impact of density (release rate) of *T. chilonis* for management of sugarcane stem borer, five plots (A, B, C, D and E) were selected and borer infestation was recorded on dead heart basis in each plot. In plots A, B, C and D parasitoids were released in a geometrical progression i.e. 10,000, 20,000, 40,000 and 80,000, respectively on monthly basis. Ten cards (with 100 irradiated eggs each) were placed for monitoring the establishment of parasitoids. Plot E was left as check without any control measures. Observations were taken on weekly basis. Host eggs were collected from the field and parasitization was recorded. Borer infestation was recorded on inter-node basis at the time of harvest.

STATISTICAL ANALYSIS

All statistical analyses were conducted by using Statistix® Version 8.1, Analytical Software, Inc., and Tallahassee, FL, USA.

RESULTS

Results revealed that establishment of the parasitoids was significantly higher (52.4%) in the blocks where releases were given at weekly intervals as compared to those blocks where releases were made on fortnightly (40.9%) and monthly (32.7%) basis (Figure **1**, Table **1**). Mean infestation percentages in all blocks ranged from 3.1-7.6, which were below economic threshold level (Figure **2**). But significantly higher infestation percentages were observed in blocks where monthly releases were made, followed by fortnightly and weekly intervals (Table **2**). The mean parasitism and infestation percentages recorded when *T. chilonis* was releases on weekly, fortnightly and monthly basis were 52.4 and 3.1, 40.9 and 5.1, and 32.7 and 6.7, respectively. Similarly, there were significant variations in parasitism and infestation rates when *T. chilonis* was released at different densities viz., 10,000, 20,000, 40,000 and 80,000 (Figures **3** and **4**, Tables **3** and **4**). Maximum mean parasitization percentage by the parasitoids (42.7 %) was recorded in

Table 1: Analysis of Variance for Effect of Different Release Intervals of *T. chilonis* on Parasitization of Sugarcane Stem Borer Eggs (Two-Way ANOVA)

Source	Degree of Freedom	F value	Probability
Releasing intervals	2	177.33**	0.000
Months	8	49.78**	0.000
Releasing intervals x Months	16	1.27 NS	0.238

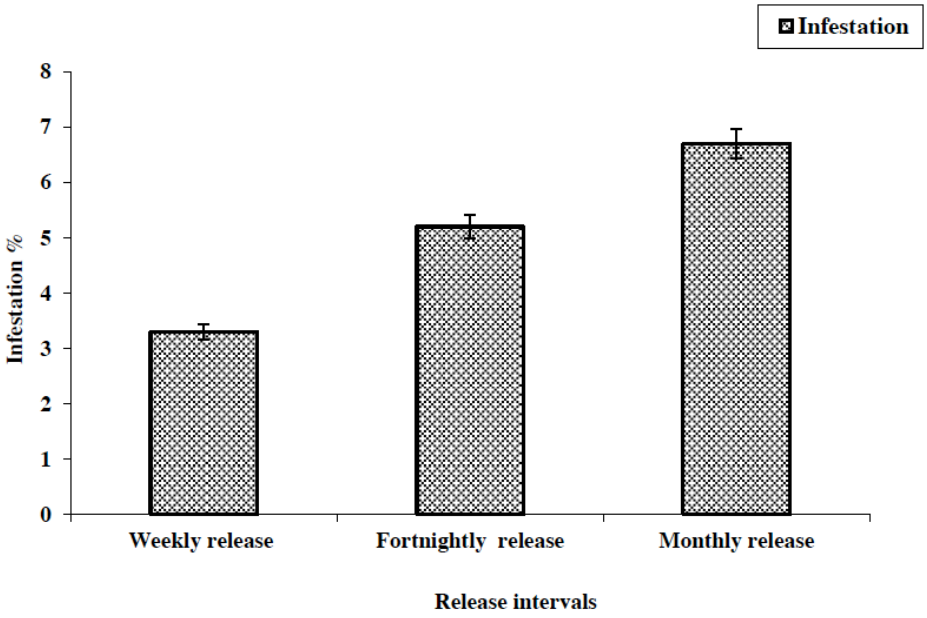

Figure 2: Impact of release intervals on infestation percentage of sugarcane stem borer.

Table 2: Analysis of Variance for Effect of Different Release Intervals of *T. chilonis* on Infestation Levels of *C. infuscatellus* in Sugarcane Field (Two-Way ANOVA)

Source	Degree of Freedom	F value	Probability
Releasing intervals	2	63.07**	0.000
Months	8	27.21**	0.000
Releasing intervals x Months	16	1.61 NS	0.084

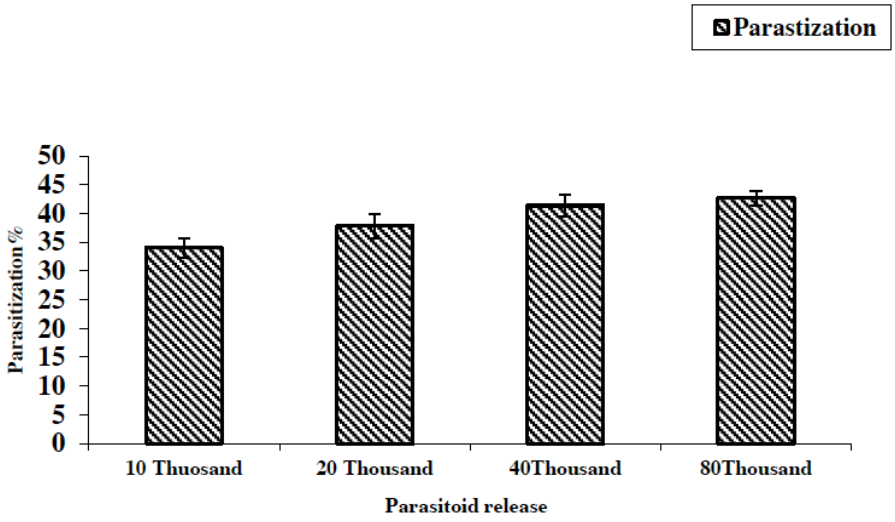

Figure 3: Effect of different densities of bio-control agents *T. chilonis* on parasitism percentage for management of sugarcane stem borer.

blocks treated with 80,000 parasitoids, followed by 40000 (41.4%), 20000 (37.8%) and 10000 (34.0%), respectively (Figure **3**). However, the infestation was below economic threshold level ranging from 5.3 to 6.5% in all treatment blocks (Figure **4**).

DISCUSSION

Results revealed that interval of bio-control agent releases played an efficient role for management of borers. The mean parasitization percent of the parasitoids was higher in the blocks where releases

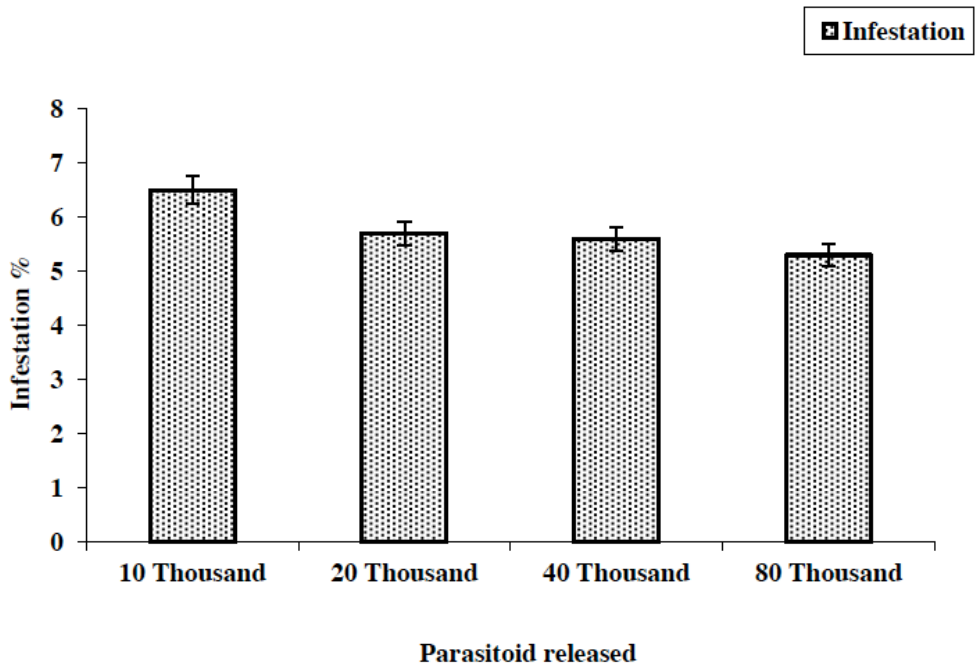

Figure 4: Effect of different densities of *T. chilonis* on infestation of sugarcane stem borer.

Table 3: Analysis of Variance for Effect of Different Densities of *T. chilonis* on Parasitization Rates of Sugarcane Stem Borer Eggs

Source	Degree of Freedom	F value	Probability
Releasing densities	3	23.73**	0.000
Months	8	80.35**	0.000
Releasing densities x Months	16	0.26 NS	0.999

Table 4: Analysis of Variance for Effect of Different Densities of *T. chilonis* on Infestation Rates of *C. infuscatellus in* Sugarcane Field

Source	Degree of Freedom	F value	Probability
Releasing densities	3	3.00*	0.032
Months	8	41.49**	0.000
Releasing densities x Months	16	0.32 NS	0.999

were given at weekly intervals as compared to the blocks where releases were made on fortnightly and monthly basis [9]. Investigated the effectiveness of egg parasitoid, *Trichogramma chilonis* at 10, 15 and 20 days intervals with highest infestation (25.95%) in control treatment and lowest (16.57%) observed after 10 days intervals of field releases followed by 15 and 20 days interval with infestation of 17.14 and 17.52% respectively. The results of earlier workers are similar to the current outcomes [10-14] *T. chilonis* was released at 50000 per acre with 10 days interval from July to October [15].

Although percent parasitism were higher in the blocks where eighty thousands parasitoids were released monthly, mean infestation showed non-significant difference when parasitoids were released in variable quantities. It has been observed that increasing the number of biological control agents released into an environment would not always increase the level of pest control and would only increase the cost of implementing biological control [16-18]. Thus, if increasing the release rate does not improve control, releasing fewer natural enemies would result in more efficient and economically beneficial. As

the release rates increase, the ratio of the number of prey per natural enemy decreases. Thus, although higher release rates increase the number of natural enemies in an environment, fewer preys may be attacked by each natural enemy. If fewer natural enemies are able to affect the same number of prey as larger numbers, release rates become less significant [19-22]. Density-dependent survival and other factors can result in greater mortality of natural enemies at high release rates, which can ultimately result in the same number of natural enemies settling in an area regardless of release rate [23, 24]. In several cases the fecundity of natural enemies increased at lower release rates [25-27]. This can result in similar population densities of natural enemies over time in high and low release rate treatments. Density-dependent dispersal of natural enemies may occur at higher rates with high release densities, resulting in similar population densities compared to low release treatments in the target area [28]. In some cases, lower release rates may actually provide better control than higher rates [29]. One mechanism by which lower release rates might be more effective is through mutual interference. This occurs when parasites or predators that are searching for a host encounter each other, which can cause one or both to stop searching and possibly leave the area [30].

CONCLUSION AND RECOMENDATION

It is concluded that parasitoids may be released at monthly interval @10000 parasitoids / acre for the successful and economical control of sugarcane stem borer.

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Received on 01-07-2012 Accepted on 02-08-2012 Published on 13-09-2012

http://dx.doi.org/10.6000/1927-5129.2012.08.02.36