

# BIOCONTROL OF INSECT PESTS OF SUGARCANE (*SACCHARUM SP.*)

By

\*Zia-ul-Hussnain, Asia Naheed and Saadia Rizwana  
\*Shakarganj Sugar Research Institute, Jhang, PAKISTAN

## ABSTRACT

Sugarcane (*Saccharum sp.*) crop is habitat of more than 1500 species of insects in the sugar world. Amongst these borers like *Scirpophaga excerptalis*, *Chilo infuscatellus*, *Emmalocera depressella*, *Acigona steniellus* and sucking insect pest *Pyrilla perpusilla* are major devastators to cause considerable loss in yield and quality of the crop. In our country primary and secondary insect pests species identified were 11, while parasites and predators species were 14 in cane fields. Studies revealed that with 75 % infestation of borers, sucrose recovery was 52 % lower. Field data on infestation of *Pyrilla perpusilla* showed that decline in cane yield was 18%. Biocontrol of insect pest of sugarcane crop through artificial rearing of *Trichogramma chilonis* was initiated from 1999 and for *Chrysoperla carnea* from 2002 at the institute. Results of the field studies revealed that under unreleased area of *Trichogramma chilonis*, the infestation of borers was 11.65% and in the released area it was 2.74 %. The acreage covered with the released of the parasites was more than 50 thousands from last five years in cane growing areas of Shakarganj Mills. It was observed that under controlled conditions *Chrysoperla carnea* larvae predated 80% eggs of *Pyrilla perpusilla*. Efficiency of biocontrol of the insect pest can be improved only with integrated management practices of the crop identified, these are resistant varieties, alternate planting dates, trash blanketing of ratoon crop, early harvesting, balanced fertigation, pest-free seed cane and field monitoring.

## INTRODUCTION

More than 1500 species of insects feed on sugarcane plant recorded throughout the world (Box, 1953). A list of about 800 records of parasitoids, predators and pathogens of the 24 key moth borers in Asia and the Indian Ocean islands was compiled, with information on the host stage they attack, host plant or crop and country of record (Sallaman and Allosopp, 2005). It was reported that about 48 species from Indo-Pakistan subcontinent feed on crop (Rehman, 1942). About a dozen of important insects pests have been mentioned from Pakistan (Chaudhry and Ansari, 1988) as well as from province of Sindh (Naqvi, 1975). Amongst them, the borers and leafhoppers are major devastators; those consequently reduce the quality and quantity of cane and cane sugar. Biological control is extensively used in the sugarcane growing regions of South America. In Brazil, the tachinid larval parasitoids, *Metagonistylum minense* (Tns.) and *Paratheresia claripalpis* (Wulp.) and the braconid *Cotesia flavipes* (Cameron) have been routinely released for the control of *D. saccharalis* (IS). Since 1988, parasitoid releases have reduced the infestation intensity from as high as 10% to an average, in 1994 to about 3% (Anon, 1997). Similarly in Venezuela, *Diatraea* spp. occurring there were no longer considered of consequence because of good biological control. This has been achieved initially by releasing the larval parasitoid *M. minense*. Later, *C. flavipes* was released providing more effective control. It was observed that 16% infestation was recorded in 1947 and in 1996 this infection was only 2% (Salazar, 1997). In Colombia, artificially reared larval parasitoids *M. minense* and *P. claripalpis* have been

effective against *D. saccharalis* and *D. indigenella*. Egg parasitoids have also been released. Both *Trichogramma pretiosum* (Riley) and *T. exiguum* have been released; however, no field recoveries have been made of *T. pretiosum*. (Gomez, 1995). In Mexico, biological control is one of several strategies adopted for the control of borer complex, which comprises three species of a *Diatraea* as well as *E. loftini*. The indigenous parasitoid, *Allorhogas pyralophagus* (Marsh), has limited impact, but releases of *M. minense* have had some influence on damage (Pantoja, 1997). In North America, recent attempts have focused on two species of *Cotesia*, viz: *C. flavipes* and *C. chilonis* (Ishii). Although these parasitoids have not yet become established, levels of parasitism by *C. flavipes* and *C. chilonis* were as high as 15% and 55%, respectively (White and Regan, 1999).

There are many borers of sugarcane in the Far East and Australian region. Releasing the egg parasitoid *T. chilonis* reduced infestations of the borer *Argyroplote schistaceana* (Sn.) in Taiwan. Other examples include > 80% parasitism of late instar larvae of the borer *S. grisescens* in Papua New Guinea by *C. flavipes*, and the effective parasitism of *Chilo infuscatellus* (Sn.) by *Trichogramma* sp. in Indonesia (Conlong, 1994a). An extensive biological control programme has been implemented against *E. saccharina* in South Africa. While in many cases successful laboratory rearing has been achieved and field recoveries made; however, their impact on crop damage has not been clear. Currently, the tachinid parasitoid *Sturmiopsis parasitica* (Curr.) has been released and recoveries have been made (Conlong, 1994b). Similarly, a large programme was developed in Mauritius against *C. sacchariphagus*. Since 1939, 30 egg, larval and pupal parasitoids were introduced into Mauritius against this borers. However, only *Xanthopimpla stemmator* (Thun.) and *Trichospilus diatraeae* became established, and neither had an impact on the borer (Conlong, 1998c). It was reported that in Egypt egg parasitoid *Trichogramma lnescens* (West) contributed significantly to the control of this borers. A reduction in the infestation level of between 50% and 60% was achieved at a release rate of 20 000-30 000 per feddan (1 feddan = 0.42 ha) (Williams, 1983).

Different management practices have been applied to borer control in various regions of sugarcane world. Host plant resistance is an important component of any strategy aimed at reducing the economic impact of crop pests. It is based on three factors: antibiosis, antixenosis, and tolerance (Dent, 1991). Antibiosis is based on the plant inhibiting the development of the feeding insect, while antixenosis acts by influencing adult and / larval behaviour on the surface of the host plant. Most studies have focused on antibiosis, although pubescence in sugarcane can be important (Sosa, 1988). Selecting planting date was to reduce damage to the crop caused by *S. cretica* in the Sudan (Amin, 1988). Moreover, crops planted towards the end of the dry season in Papua New Guinea tended to be more heavily attacked by *Sesamia grisescens*, so this practice is now avoided. The planting of a trap crop of maize was shown to influence infestations of *S. calamistis* in Mauritius (Williams, 1983 and Khan *et al.*, 1997). Early harvesting and balanced fertilization has reduced the impact of *E. saccharina* on sugarcane in South Africa (Carnegie, 1981). However, no clear effect of burning the crop at harvest has been proven, unless the crop is severely infested and has suffered drought stress. Under these conditions, trash-blanketing field can reduce damage in the ratooning crop. Using non-infested seed materials when planting is an important aspect of crop hygiene that can help reduce the possibility of a pest becoming established in a crop (Kuppen and Leslie, 1999). In Guyana, it was reported that flash flooding insect pest of sugarcane crop fields for 48 h 2-3 weeks after harvest is the most common procedure used against *Castniomera licus* (Drury) (Duke and Eastwood, 1997). Whatever the monitoring method used, depend on the level of precision and evaluating the results (Southwood, 1975).

The insect pests classified as primary and secondary on the basis of infestation are given in table-1. Parasites and predators that could be used successfully against the insect pests of sugarcane crop are given in table-2.

**Table-1 Primary and secondary insect pests of sugarcane crop**

Sr. No.	Common name	Technical name
	<b>Primary</b>	
1	Sugarcane top borer	<i>Scirpophaga excerptalis</i> Wlk. <i>S. Nivella</i> Fab.
2	Sugarcane stem borer	<i>Chilo infuscatellus</i> Snell.
3	Sugarcane root borer	<i>Emmalocera depressella</i> Swin.
4	Sugarcane leaf hopper	<i>Pyrilla perpusilla</i> Wlk.
5	Sugarcane white fly	<i>Aleurolobus barodensis</i> Mak.
	<b>Secondary</b>	
6	Sugarcane stem borer	<i>(Sesamia inferens</i> Wlk. <i>(Chilo partellus</i> Swinh).
7	Sugarcane black bug	<i>Cavelerius excavatus</i> Dist.
8	Sugarcane mealy bug	<i>Ripersia sacchari</i> G.
9	Sugarcane thrips	<i>Fulmekiola serrata</i> Kobus. <i>Haplothrips</i> sp.
10	Sugarcane (White ants)	<i>Microtermes obesi</i> Holmgren
11	Sugarcane mites	<i>Oligonychus</i> sp. <i>Schizotetranychus</i> sp.

(Khanzada, 1993)

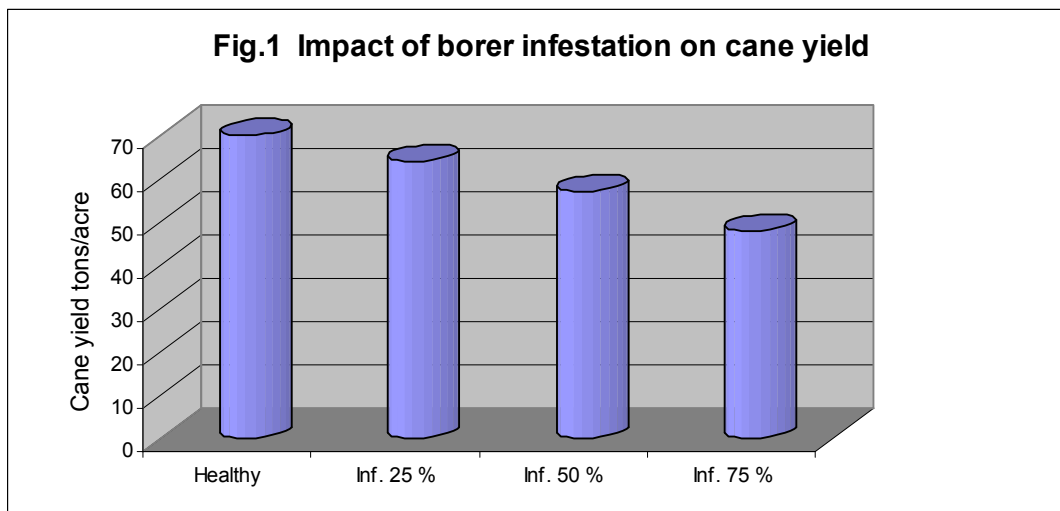
**Table-2 Parasites and predators of insect pests of sugarcane crop**

Sr. No.	Name of parasite/predator	Name of pest – host	Nature of parasitism
1	<i>Trichogramma chilonis</i>	Stem borer	Egg
	“	Root borer	“
2	<i>Apantles (Cotesia) flavipes</i>	Top, stem & root borers	Larvae
3	<i>Elasmus zehntneri</i>	Top borer	“
4	<i>Telenomus dignus</i>	Top borer	“
5	<i>Coccinella septempunctera</i>	All borers	Eggs
6	<i>Epiricania melanoleuca</i>	<i>Pyrilla</i>	Nymph and adults
7	<i>Pyriloxenos compactus</i>	“	“
8	<i>Tetrastichus pyrillae</i>	“	Eggs
9	Spiders	“	All stages
10	<i>Chrysopa</i> sp.		Egg and nymph predator
11	<i>Coccinella septempunctera</i>		Egg predators
12	<i>Azotus</i> sp.	White fly	Nymph and pupae
13	<i>Encarsia</i>		Pupae
14	<i>Chrysopa</i> and <i>Coccinella</i> species		Predator

(Khanzada, 1993)

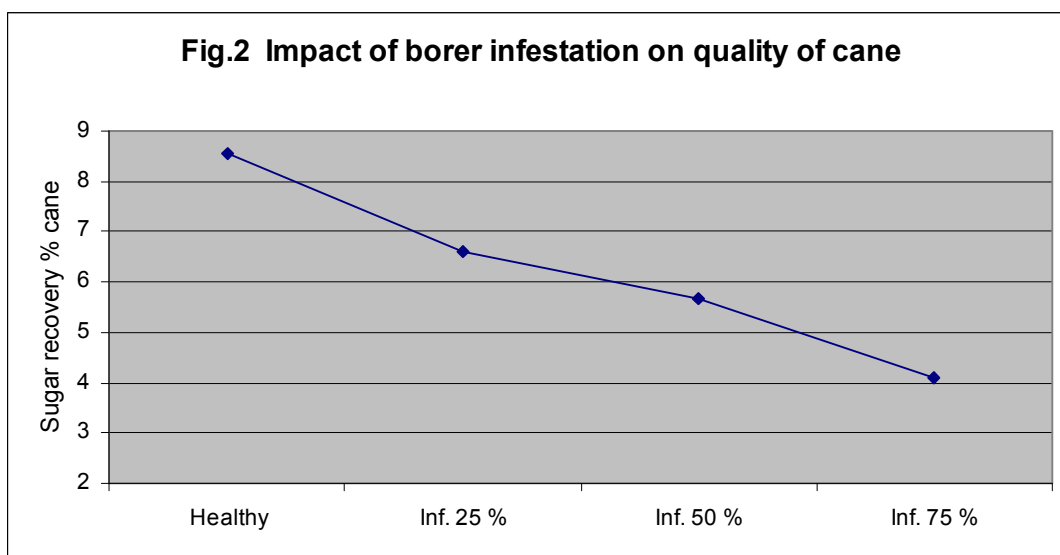
### **Impact of borers infestation on yield of sugar cane crop**

Results of an experiment conducted on impact of borers infestation on cane yield during 2002-2004 are given in Fig.1. It was observed that cane yield of 70 tons per acre was harvested from healthy crop, while losses cane yield was 9, 19 and 31 with borer infestation of 25 %, 50 % and 75 %, respectively.



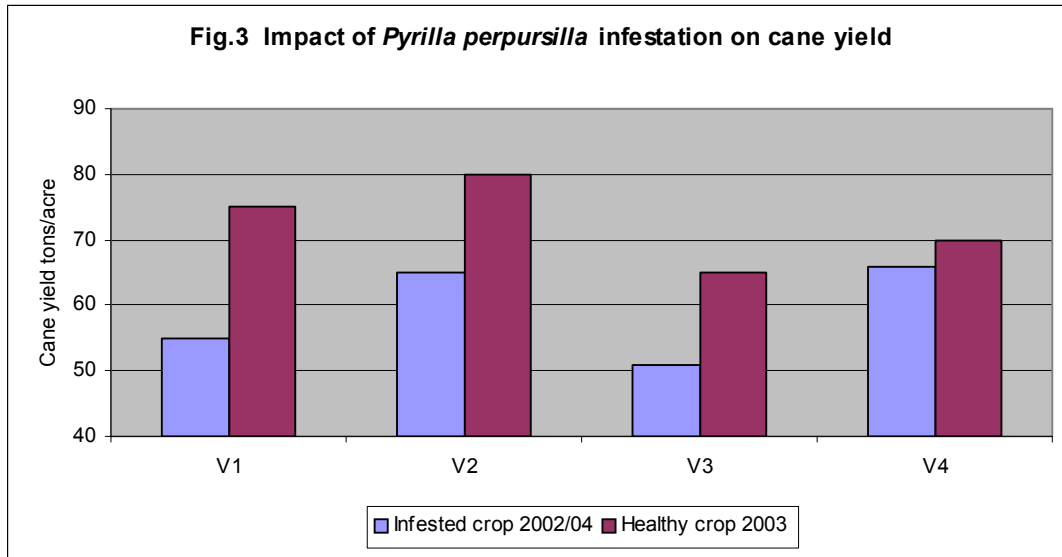
**Impact of borers infestation on quality of cane crop**

Another experiment was conducted on impact of borers infestation on quality of cane crop (Fig.2). Infestation of borer complex was recorded on internode basis. Quality analysis (sugar recovery % cane) of the crop having infestation of 25 %, 50 %, and 75 % was done from October to April of 2002-04. Results indicated that sugar recovery % cane of healthy crop was 8.56. Decline in sugar recovery was 22, 34, and 52 % with borers infestation of 25, 50, and 75 %, respectively.



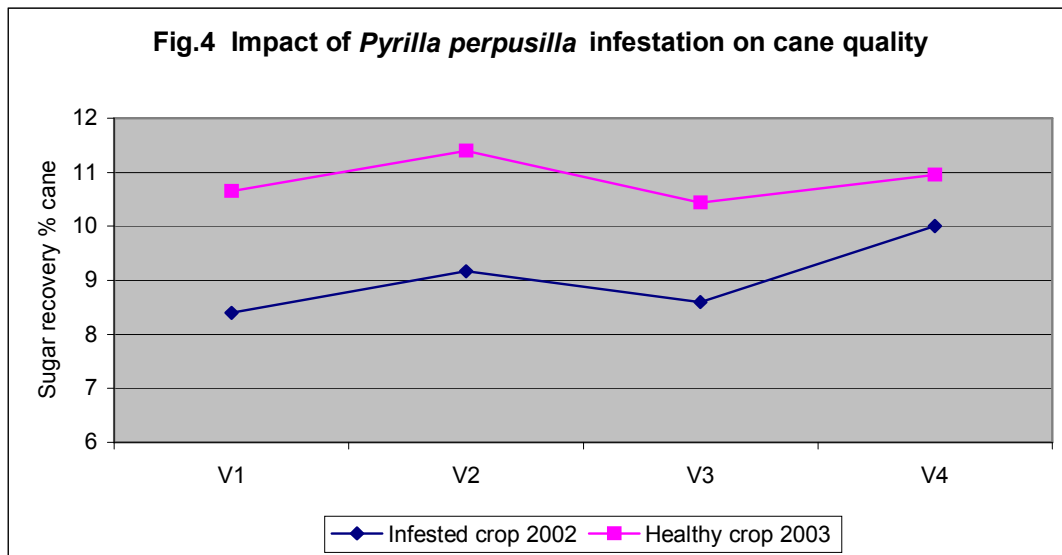
**Impact of *Pyrilla perpusilla* infestation on yield of sugar cane crop**

Observations on yearly basis were recorded on impact of *Pyrilla perpusilla* infestation on cane yield during 2002, 2003 to 2004 infestation year (Fig. 3). It was observed that all varieties of sugarcane tested, behaved differently during infestation and non-infestation years. The maximum cane yield decline to 20 tons per acre in variety V1 and minimum cane yield decline of 4 tons was recorded in variety V4. An average loss of 13.3 tons per acre yield was recorded due to *Pyrilla perpusilla* infestation.



**Impact of *Pyrilla perpusilla* infestation on quality of cane crop**

Overall season sugar recovery was recorded during *Pyrilla perpusilla* infestation year (2002) and infestation free year (2003). The results indicated that different varieties behaved differently to loss of sugar recovery % cane. Variety V4 showed stability in its quality during both the years. Maximum loss of sugar recovery % cane was recorded in V1 followed by V2. The variety V4 was relatively resistant to *Pyrilla perpusilla*. Data recorded on impact of *Pyrilla perpusilla* infestation on quality of cane varieties is given in fig.4.



**Background**

Chemical control of insect pests of sugarcane has given non-significant results and has added higher costs to production. Natural enemies particularly insect parasitoids are important components of control strategies used against borers in most industries of sugar world (Padmanabhan *et al.*, 1992). Keeping this in view, biocontrol of insect pest was started, with an aim to develop environment friendly, low cost and efficient control of insect pest of

sugarcane crop. It was observed that infestation of borers was high in humid years and infestation of *Pyrilla perpusilla* was severe during dry years. This variation has provided conditions to establish relationship between infestation of the pest and its impact on cane yield and quality. The evaluation period was 1999 to 2004.

### **Location**

The Biological Pest Control Laboratory of Shakarganj Sugar Research Institute (SSRI) of *Trichogramma chilonis* for control of borer complex was established in 1999 and *Chrysoperla carnea* for control of borers and *Pyrilla perpusilla* was established in 2002. This predator and parasitoids are being released for control of the insect pests of sugarcane crop. The studies on efficacy of the parasitoids and the predators were performed in collaboration with Vice President Agriculture Shakarganj Mills Limited Jhang. Data was collected for five years (1999-04) for infestation % of borers in unreleased and released areas of *Trichogramma chilonis*.

### **Sampling**

Infestation % of borers in both released and unreleased plots with *Trichogramma chilonis* was taken by sampling from March to September each year. Nymph of *Pyrilla perpusilla* per stalk and larvae of borers on internode basis were counted in a randomly selected block of 20 x 20 m. Quality analysis for sugar recovery % cane of healthy and infested samples of borers was done from October-April.

### **Rearing of Host and Parasites**

*Trichogramma chilonis* has proved most effective egg parasite against root, shoot and stem borers. Millions of parasitised eggs were released at different interval in the field. A store grains pest *Sitotroga cerealella* is a good alternate host of *Trichogramma chilonis* and has a capacity to breed a large population in shortest possible time in the laboratory.

*Sitotroga* is reared of the laboratory, under controlled environment. Its eggs are collected and pasted on cards. *Sitotroga* eggs, act as host of *Trichogramma*. Cards are placed in plastic jars and eggs of *Sitotroga* are parasitized by *Trichogramma chilonis*.

### **Release of *Trichogramma chilonis* for control of borer complex**

As and when required, cards are taken to the field and punched on the under surface of leaves to avoid direct exposure to sunlight. In 2-3 days *Trichogramma chilonis* in infested eggs complete their life cycle and adults come out of eggs. *Trichogramma chilonis* search out the eggs of borers and lays their own eggs through ovipositor. *Trichogramma chilonis* has wide chance to spread its generation on sugarcane, maize and rice borer. The eggs of borers are parasitized, and *Trichogramma chilonis* complete its life cycle in borer eggs. Parasite has start life cycle of 7-8 days, thus releases must coincide with the presence of host (insect) eggs in the field. A cyclic chain of *Trichogramma chilonis* parasitism is developed in cane fields. In favorable environments, 70-80% borer's eggs parasitism is noticed which bring down the pest population to less than 5%. In unfavorable conditions more frequent releases are required to establish parasitism in the cane fields. This is the cheapest, efficient and environmental friendly method of borer control.

Highly significant control of borers infestation was established through periodic release of *Trichogramma chilonis* in cane growing areas of Shakarganj Mills Limited, Jhang. The results have indicated that the infestation of borers was 11.65 % during 1999-2000 in unreleased area and 2.75 % in released area. Periodic increase in acreage of *Trichogramma chilonis* applications was done in the area. After five years during 2003-2004 infestations of










borers was 6.05 % in unreleased area and 1.73 % in released area. The results have indicated that application of *Trichogramma* is useful, efficient and environment friendly. Detail of acreage covered through release of *Trichogramma* for control of borers infestation is given in table-3.

**Table-3 Acreage covered and impact of *Trichogramma chilonis* on infestation of borers complex in released and unreleased areas (1999-04)**

Year	Acreage	Infestation %	
		Released area	Unreleased area
1999-2000	12131	2.74	11.65
2000-2001	36607	2.13	8.21
2001-2002	41497	1.86	7.86
2002-2003	50998	1.65	7.31
2003-2004	62518	1.73	6.05

(2.47 acres = 1 hectare)

**Steps involved in lab rearing of *Trichogramma chilonis*.**











Step 1	Rearing of <i>Sitotroga</i> (wheat grains)	
Step 2	Rearing condition: Humidity 60-70%. Temperature 28-30°C	
Step 3	28-30 days of emergence Shifted for egg laying in the jars	
Step 4	Collection of <i>Sitotroga</i> eggs	
Step 5	Pasting of 1500 eggs on paper card 3''x2''	
Step 6	Parasitism by <i>Trichogramma chilonis</i>	
Step 7	Collection of parasitized <i>Sitotroga</i> eggs	
Step 8	<i>Trichogramma</i> cards were stored at a Temperature of 6-8°C. Distributed: March to September	
Step 9	Monitoring based field releases of <i>T. chilonis</i> for biocontrol of borer complex	

### Studies on efficacy of *Chrysoperla carnea*

*Chrysoperla carnea* commonly known, as *Chrysopa* is the most effective predator. It is utilized for the control of borers complex and *Pyrilla perpusilla* of sugarcane crop. It has the same host (*Sitotroga*) as *Trichogramma chilonis*. *Chrysoperla carnea* has the peculiarity of eating eggs, larvae and nymphs of all types of borers, *Pyrilla*, white fly, bugs and mites. It can be reared and released in all seasons. Rearing of *Chrysopa carnea* is more technical, expensive and time consuming.

Lab. studies conducted at SSRI, has shown that *Chrysoperla* larvae of 7-8 days life period has given 80 % predation to the eggs population of *Pyrilla*. In another study at the lab of the institute indicated that through release of *Chrysoperla* larvae, 65 % mortality of nymph of *Pyrilla perpusilla* was recorded.

#### The following steps were involved in lab rearing of *Chrysoperla carnea*.

Rearing of <i>Sitotroga</i> eggs Temperature 27-30 °C Humidity 60-70 %	
Freezing of <i>Sitotroga</i> eggs	
Filling of 1/3 of capsules by <i>Sitotroga</i> eggs + 2 eggs of <i>Chrysoperla carnea</i>	
Singling of hatched larva Refilling with <i>Sitotroga</i> eggs	
Pupal formation Opening of capsules	
Transfer of <i>Chrysoperla carnea</i> adults in glass cages	
Artificial feeding of Adults 150-200 adults per cage	
Egg laying on hard paper sheet Duration 24 hours	
Field release Hatching after 3-4 days)	
Attack of the <i>Chrysoperla</i> larvae of third instar on target pest of sugar cane borers and <i>Pyrilla</i> (all stages)	



## RECOMMENDATIONS

- Field applications of *T. chilonis* cards and *C. carnea* sheets should be pest scouting based
- Efficiency of biocontrol could be increased with trash blanketing, balanced fertigation, pest-free seed and appropriate field monitoring
- Efforts are now required to develop transgenic plants of sugarcane for resistance against major infesting insect pests like borers and *Pyrilla perpusilla*
- All the sugar mills should immediately establish *T. chilonis* and *C. carnea* rearing labs. *T. chilonis* cards and *C. carnea* sheets produced should be given on highly subsidized price to cane growers.

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