



Research Article

Impact of *Trichogramma* release regimes and combination with mass trapping on sugarcane internode borer (*Chilo sacchariphagus indicus*) management

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ABSTRACT: Large area study on the impact of six versus ten releases of the biocontrol agent, *Trichogramma chilonis*, besides large plot assessment of ten releases with and without mass trapping (by pheromone traps) for eco-safe management of the sugarcane internode borer (INB) - *Chilo sacchariphagus indicus* Kapur were undertaken in Natems Sugar factory area, Koppedu Taluk, Chittoor District, Andhra Pradesh, South India. In 2017-18, a large contiguous sugarcane crop area of 400 hectares received six releases of *T. chilonis* (as Tricho cards @ 5cc/ha/release) in alternate weeks during 5-7 months age of crop, followed by four additional releases during 8-9 months age (totalling ten releases) in 40 hectares area, besides assigning a no release block of 40 hectares in adjacent area. Harvest-time sampling in each treatment block showed that the INB distribution (per cent canes infested) was 80 % in control (no release) block, while it was 42 and 27 %, respectively, for six and ten releases. The INB intensity (per cent internodes infested) was also more (6.2 %) in control block whereas it was only 3.2 % and 1.5 %, in the two respective release regimes. Based on these results the cost-effectiveness of both the regimes was ascertained. In 2018-19, the impact of ten releases of *T. chilonis* (@5cc/hectare /release) versus same regime plus mass trapping (@25 pheromone traps/ha) was compared in large plots (each of 2.0 ha) along with an untreated control plot. Harvest-time samples showed that INB distribution was 70.3% in control block, compared to 48.3% in *Trichogramma* release block versus 19.8% in block combining *Trichogramma* and mass trapping. The respective INB intensity was 6.04 %, 4.04 % and 2.17 % while the estimated cane yields were 81.0, 86.2 and 92.5 tons/ha, respectively. The cost: benefit ratios for *Trichogramma* release with and without mass trapping were comparable, so confirming that both are cost-effective alternatives to chemical insecticide use in sugarcane agro-ecosystems.

KEY WORDS: *Chilo sacchariphagus indicus*, Internode borer, mass trapping, sugarcane, *Trichogramma* releases

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INTRODUCTION

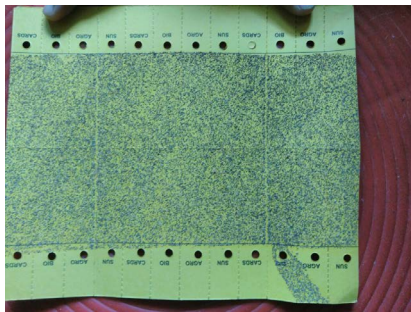
Biocontrol of sugarcane borers with inundative releases of *Trichogramma* has been widely recommended globally (Sithanantham *et al.*, 2013). The scope to optimize the release regimes of *Trichogramma chilonis* Ishii based on local severity levels of the sugarcane internode borer (*Chilo sacchariphagus indicus* Kapur) has been illustrated in a sugar mill R&D network project in South India (Sithanantham *et al.*, 2015). Bhavani *et al.* (2016) demonstrated the potential for combining *Trichogramma* releases and pheromone-based mass trapping for eco-safe and economical management of sugarcane early shoot borer (*Chilo infuscatellus* Snellen) and internode borer, *Chilo sacchariphagus indicus* Kapur

in South India. More recent on-station studies in Bihar by Hari Chand *et al.* (2018) have shown that season-long mass trapping could reduce the incidence levels of three sugarcane borers (*Chilo infuscatellus* Snellen, *Chilo auricilius* Dudgeon and *Scirpophaga exceptalis* Walker) by a range of 48-57 percent, resulting in an increase in cane yield by 5.63 tonnes/ha

The present study included large area impact validation of two regimes of *Trichogramma* releases for INB biocontrol, besides large block assessment of relative benefit of *Trichogramma* release alone versus with pheromone-based mass trapping in Natems Sugar Mill area of Andhra Pradesh, India.

1. Large area impact validation for two release regimes of *Trichogramma chilonis*

The impact validation study was undertaken in 400 hectares of contiguous crop area with the cane variety V.46 under Natems Sugars, Koppedu, Chittoor, Andhra Pradesh during 2017-18. During 5-7 months crop age, six releases were made in alternate weeks (T1), while four additional releases (totalling ten releases) during 8-9 months age in same crop but limited to 40 hectares area (T2), while another 40 hectare crop in the adjacent village was kept as control (no release) (T3). The releases of *T. chilonis* @5cc/ha, were made with Tricho cards stapled on underside of leaves (see plate1) across forty equi-distant release points per hectare.



Tricho cards-close



Tricho card releasing in field

Plate 1. Tricho cards-close up and fixing them in sugarcane leaves

The sugarcane crops were grown as per recommended agronomic practices except that no insecticide was applied during the study period. Data on the Internode Borer (INB) incidence on cane basis (distribution) and on internode basis (intensity) were collected at harvest time sampling by back-tracking of crop age (months) based on recording the positions of the borer infestation symptom (bore hole) in different internode positions from the cane base (see Plate 2).

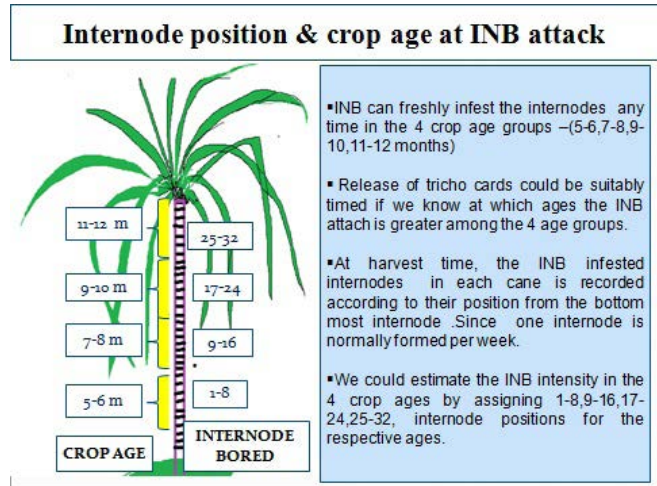


Plate 2. Chart of crop age-wise position of internodes in backtracking INB infestation

This methodology obviates the cumbersome recording of borer infestation in the standing crop and based on the robust assumption of each successive internode representing a week in the phenology, as described by Sithanatham *et al.* (2017). For each treatment, there were eight random samples (replicates) of one cent (40sq.m) area each, both for recording the borer infestation as well as the number of millable canes at harvest, besides the cane weight from a bundle of fifty randomly chosen canes per sample, which enabled estimating the cane yield per hectare. The area-wide cane yields could not be recorded due to the machine harvesting system and rigid weighing procedures in tractor loads adopted at factory-level.

2. Large plot impact of *Trichogramma* alone and in combination with mass trapping

During 2018-19 season, the impact validation of *Trichogramma* releases, both alone and in combination with mass trapping (with pheromone traps) during 5-9 month crop stage was undertaken in a seven hectare farm growing same cane variety (V-46) in the same sugar factory area. The following three treatments were imposed in blocks of 2 hectare each, with 0.25 ha of buffer area for all treatment blocks.

- T1- Ten releases (weekly) of *T. chilonis* (@5cc/ha per release
- T2- Same as T1 plus mass trapping (25 pheromone traps/ha)
- T3- Untreated control block

The traps used were of Delta Plus design along rubber septa as pheromone luring (see Plate3).

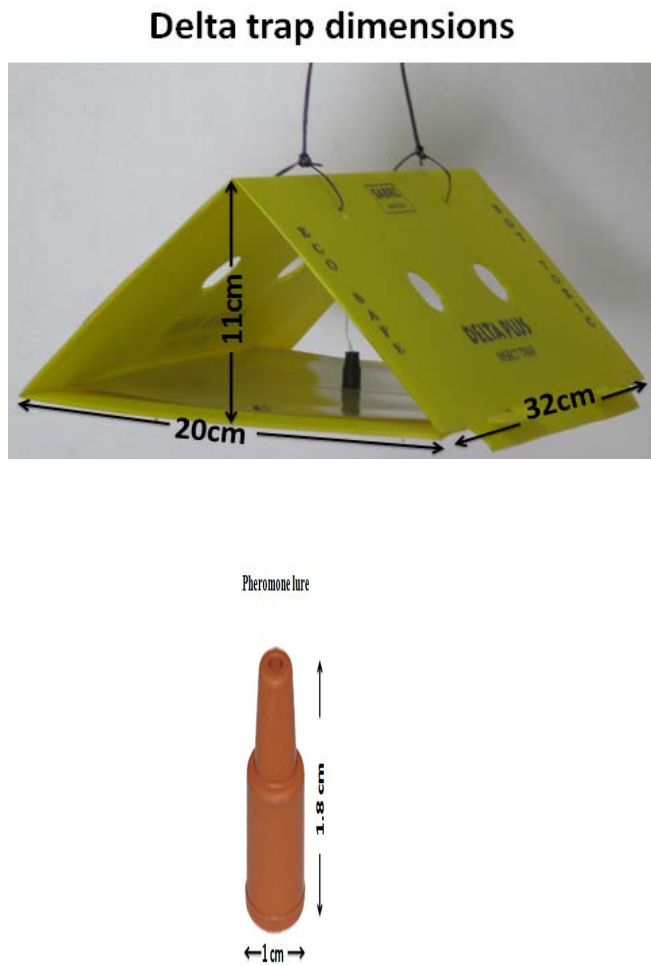


Plate 3. Delta trap and rubber septa lure used in mass trapping

The superiority of this trap design over the alternative trap types like funnel trap and water basin trap has been confirmed by Sithanatham *et.al.* (2019). Twenty five pheromone traps were deployed per hectare, based on the justifications given by Bhavani *et.al.* (2016). The mass-reared *T. chilonis* and pheromone traps (Delta Plus) with rubber septa lures (loaded with 3 mg INB pheromone) were availed from Sun Agro Biotech Research Centre, Chennai .

Data on the borer infestation severity and cane yield were recorded as in the previous study. The data were subject to Analysis of Variance (ANOVA) as per Gomez and Gomez (1983).

Table 1. Relative impact of two release regimes of *Trichogramma chilonis* on INB incidence

Treatments	INB distribution (Cane basis) (%)	INB intensity (Internode basis (%))
T1	42.0	3.3
T2	27.2	1.52
T3	80.2	6.26
Significance	**	**
CD (p=0.05)	18.07	2.09

RESULTS AND DISCUSSION

Large-area impact study of two *Trichogramma* release regimes

The differences between treatments in INB distribution and intensity were significant (Table1.).

The INB distribution (per cent canes damaged) was about 80 % in block without release of Trico cards (T3) compared to about 42 % under six releases (T2) and about 27 % under ten releases, the reduction in INB distributions due to six and ten releases being 50 and 69 per cent respectively, over the borer level in control treatment. While the INB intensity (per cent internodes damaged) in no release (T3) block was 6.26 percent, it was 3.33 and 1.52 percent respectively for six and ten release blocks, the respective reduction being about 48 and 76 percent. Based on their expected positive impacts on cane yield, it was ascertained that both regimes were cost-effective.

The INB intensity (percent internodes bored) pattern among the four crop ages was mostly consistent among the three treatments compared (Fig.1)

While the no release (T3) fields showed about 4.0, 6.1, 6.5 and 2.8 per cent INB intensity during 5-6, 7-8, 9-10 and 11-12 months age of crop, the respective INB intensity for the two release regimes (T1 and T2 both) were consistently less at all four crop ages, also indicating the cumulative effect over the crop ages.

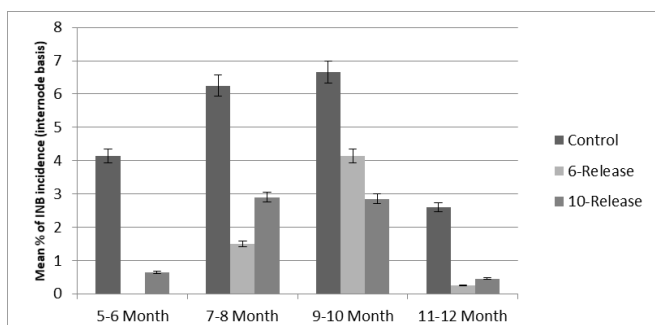


Fig 1. Crop age-wise INB incidence pattern for the three treatments compared

Results of impact by combination of *Trichogramma* releases and mass trapping

The differences among the three treatments were significant for both INB distribution (cane basis %) and intensity (internode basis %), besides for sugarcane yield (Table 2).

Table 2. Summary of results on internode borer incidence and sugarcane yield

Treatments	INB distribution (Cane basis) (%)	INB intensity (Internode basis) (%)	Sugarcane yield (ha)
T1	48.3	4.04	86.2
T2	19.8	2.17	92.6
T3	70.3	6.04	81.0
Significance	**	**	**
CD (p=0.05)	4.17	0.47	2.50

** : Significant at p=0.01

The results showed that the INB distribution (cane basis percent) was reduced from 70.3 % in control block to 48.3 % in *Trichogramma* release block, while the block with *Trichogramma* plus pheromone trapping showed the least incidence (19.8 %). This accounted for reduction due to *Trichogramma* alone by 31%, versus 72% when combined with pheromone trapping. The INB intensity was found to be reduced from 6.04%, to 4.04% and 2.17 %, respectively.

While the cane yield was 81.0 tons/ha in no release (control) plot, the respective yield in the two comparison treatments being 86.2 tons/ha and 92.5 tons/ha. Based on the prevailing cost for *Trichogramma* releases being Rs: 3,000/

ha. (10 x5cc @ Rs.60/cc) and pheromone trapping cost estimated as Rs: 3,000/ha (25 xRs120/trap), the combined treatments cost was reckoned as Rs.6, 000/ha. Based on the minimum support price of cane at Rs.2000/tonne, the benefit for *Trichogramma* release alone was Rs.10, 400 (5.2 tons@ Rs.2000/ton), and when combined with mass trapping it was Rs.23, 000 (11.5tons @Rs2000/ton). The respective cost-benefit ratios were 1:3.5 and 1:3.8. The benefit due to mass trapping alone was estimated as Rs.12, 600 (6.3tonxRs2000/ton), the cost: benefit ratio of such component alone being reckoned as 1:4.2.

While the large area release impact study confirmed the benefits of both six and ten release regimes for *Trichogramma*, the consistent reduction in INB distribution and intensity levels for the two release regimes, besides the impressive cost: benefit ratios (1:7 to1:11) are in conformity with findings from *Trichogramma* release regime comparisons for six versus 12 or 24 releases made in Sakthi Sugars area in Tamilnadu by Geetha *et al.* (2009).

The observed large block impact of *Trichogramma* releases alone and in combination with mass trapping in significantly reducing the distribution and intensity of INB along with concurrent cane yield improvements are also in conformity with similar impact observed for both INB and Early shoot borer (ESB) together in another zone of Andhra Pradesh by Bhavani *et al.*, (2016) which estimated the combined benefit to be about 11tonnes/ha (96.42 tonnes/ha versus 85.50 tonnes/ha in control block), and pheromone trapping alone contributing to yield increase by 4.0 tonnes/ha.

CONCLUSIONS

Based on the present large area impact validation of *Trichogramma* release regimes and the synergy effect of combining *Trichogramma* with mass trapping for INB, the benefits of *Trichogramma*-based biocontrol combined with pheromone-based mass trapping could be widely promoted by more sugar factory R&D networking, so to impart a cascading effect on awareness and adoption among sugarcane farmers as more cost-effective and eco-safe alternative to chemical insecticide use and so conserve sugarcane ecosystem biodiversity.

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