RESEARCH ARTICLE

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Improving Efficacy of *Trichogramma chilonis* against Shoot borer, *Chilo infuscatellus (Snellen)* in Sugarcane Ecosystem of Tropical India

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ABSTRACT

Field experiment was conducted at Sugarcane Research Station, Melalathur, Tamil Nadu Agricultural University, during 2002 to 2005 in Randomized Block Design, in three replications to study the effect of intercrops and plant extracts on the activities of *Trichogramma chilonis* against sugarcane shoot borer, *Chilo infuscatellus (Snellen)* in late planted sugarcane crop during summer months. The inter crops were sown on 3rd day after planting. *T. chilonis* @ 2.5 cc/ha were released at two intervals (weekly and fortnightly) in the treatment plots from 30th to 75th day after planting. The cane crop was sprayed with 5% tomato extracts + *T.chilonis* @ 2.5 cc/ha at fortnightly interval release recorded the lowest cumulative shoot borer incidence of 8.08% with the highest shoot borer reduction of 70.83% and 43.30% respectively over untreated check and existing practices of *T. chilonis* @ 2.5 cc/ha at fortnightly interval, followed by cane inter cropped with Soybean (5:1) + *T. chilonis* @ 2.5 cc/ha at fortnightly interval release, in which 8.27% of shoot borer incidence with next highest shoot borer reduction of 70.14% and 41.96%, respectively recorded over untreated check and the existing practices of *T. chilonis* @ 2.5 cc/ha at fortnightly interval release. The lower incidence of shoot borer in the above treatments was due to higher parasitization of 32.86% and 30.15% respectively during March-June. The highest sugar yield of 12.45 t/ha was obtained from cane yield of 96.12 t/ha with CCS% of 12.94 in cane crop sprayed with 5% tomato extracts + *T. chilonis* @ 2.5 cc/ha at fortnightly interval, followed by cane intercropped with Soybean (5:1) + *T. chilonis* @ 2.5 cc/ha at fortnightly interval in which, the next higher sugar yield of 12.16 t/ha was obtained from cane yield of 94.18 t/ha with CCS of 12.91%. The above two treatments recorded the additional sugar yield of 15.42% and 13.40%, respectively over existing practices of *T. chilonis* @ 2.5 cc/ha at fortnightly interval and 43.90% and 39.87% additional sugar respectively over untreated control. However, cane inter cropped with Soybean (5:1) + *T. chilonis* @ 2.5 cc/ha at fortnightly interval scored the highest CB ratio of 1:2.77 followed by CB ratio of 1:2.71 in cane sprayed with 5% tomato extract + *T. chilonis* @ 2.5 cc/ha at fortnightly interval.

Key word: Shoot borer, Incidence, Parasitization, cane yield, sugar yield.

INTRODUCTION

Sugarcane is one of the most important commercial crops cultivated extensively in India. Though, India enjoys first rank among the sugarcane growing countries, in terms of area about 3.5 million hectares and the average productivity is 60.7 t/ha with average sugar recovery of 10.2%, which is much less than several other cane producing countries (Balasubramanium, 1991). One of the reasons for the low productivity and recovery is increasing incidence of insect pests and diseases. In sugarcane, shoot borer *Chilo infuscatellus (Snellen)* causes heavy loss by attacking crop and sustaining productivity in semi and tropical agricultural ecosystem (Prasanna and Malavia, 1994) where because of a more conducive environment for shoot borer buildup, losses caused are substantially very high (Sardana and Singh, 2002). The shoot borer, *Chilo infuscatellus* is most active in summer season creating a serious threat for the mid late season planted cane. Generally it attacks mother shoots, kill the growing point thereby cutting off the central leaf shoot which dries up forming a dead heart and thus causing economic damage to an extent of 10 to 55 per cent shoot damage (Thirumurugan *et al*., 2001; Subramanian and Kannappan, 2003). The economic loss is about 25% in cane yield and about 15% in sugar recovery if the crop is affected by shoot borer during early tillering phase and when the shoot borer continuous to attack the cane as cane borer during later cane formation phase, the loss is estimated to be 3.5% reduction in yield for every 5% increase of shoot borer incidence. Though it occurs during the pre-monsoon period the multiplication is favoured by high temperature and low humidity.

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Due to long duration of sugarcane crop, thick canopy, overlapping generations, and concealed habit of the shoot borer makes the chemical control difficult, ineffective and highly expensive. In fact, only 2-3% of the total insecticides consumed per year in India is used for sugarcane pest management (Easwaramoothy and David, 1992) thereby large number of native natural enemies are active in sugarcane ecosystem. Among the various natural enemies reported in the cane ecosystem, egg parasitoid, *Trichogramma chilonis* is one of the parasites on shoot borer under moderately warm climate. However, the high mortality rate of wasp and preponderance of males and poor establishment of parasitoids in the field under hot summer months plays the key role in poor parasitization by *T.chilonis* on shoot borer eggs. The allelochemicals / odours emitted from the plant hosts (sugarcane) or insect hosts (shoot borer) or intercrops / other crops are also playing considerable role in selection of host by parasitoid which ultimately affect the parasitization (Nettles, 1980)

In view to exploit the effect of odour and allelochemicals emitted from the host plants (sugarcane) and non-host plant (intercrops) for enhancing the parasitization by *T. chilonis* on *Chilo infuscatellus (Snellen)* in sugarcane, the present study was conducted at Sugarcane Research Station, Melalathur.

MATERIALS AND METHODS

The field experiment was conducted at Sugarcai Research Station, Melalathur Tamil Nadu Agricultur University during 2002 to 2005 with var. CoG 93076 with twel treatments, replicated thrice in Randomized block design. Tl plot size was 10 m x 0.8 m x 10 rows = 80 m2 (Two cent) ar each plot was separated by 10 m in all the side. The trials we planted during 2nd week of March every year and harveste during 2nd week of March of next year. The convention furrow planting with two budded setts (12 buds/m) w: followed. The recommended agronomical practices wei uniformly followed. The details of treatments were given i the Table 1.

Method of treatments application

The intercrops were sown on 3rd day after cane plantin (DAP). The crude extracts of Neem Seed Kernal Extract (NSKE and tomato (leaf and fruit) extracts were prepared and mad into 5%. The release of *T. chilonis* was done immediatel after spraying extracts every time from 30th day to 75th day a per treatment schedule. Sevidal – 10 kg/ha was applied in tw splits (30th and 60th DAP) as soil application near plant: Before imposing the treatments on 30th DAP, the dead hea symptoms were removed and made in to uniform (zero level in the all treatments.

Table 1. Mean percentage of germination, shoot borer incidence and tiller population

S. No	Treatments	Germination (%)	Shoot borer incidence (%)			% of reduc-tion over control	% of reduc-tion over T_2	Tiller population 000'/ha	% of parasitization in trap card
			60th day	90th day	Cumulative / pooled				
T_1	*Trichogramma chilonis* @ 2.5 cc/ha at weekly interval	70.38	6.75	7.45	14.20	49.03	0.35	180.11	18.75
T_2	*T. chilonis* @ 2.5 cc/ha at fortnightly interval	73.17	6.67	7.58	14.25	48.81	--	181.76	10.50
T_3	Cane + Soyabean (5:1) + *T. chilonis* @ 2.5 cc/ha at weekly interval	72.41	4.13	4.44	8.57	68.89	39.85	136.02	28.60
T_4	Cane + Soyabean (5:1) + *T. chilonis* @ 2.5 cc/ha at fortnightly interval	79.30	3.95	4.32	8.27	70.14	41.96	188.96	30.15
T_5	Cane + Green gram (5:1) + *T. chilonis* @ 2.5 cc/ha at weekly interval	76.49	7.15	9.03	16.18	41.45	(-) 13.26	187.61	11.35
T_6	Cane + Green gram (5:1) + *T. chilonis* @ 2.5 cc/ha at fortnightly interval	76.17	7.08	9.21	16.29	40.06	(-) 14.32	184.79	14.82
T_7	Cane sprayed with NSKE @ 5% + *T. chilonis* @ 2.5 cc/ha at weekly interval	76.57	7.53	8.58	16.11	40.38	(-) 13.05	188.02	14.76
T_8	Cane sprayed with NSKE @ 5% + *T. chilonis* @ 2.5 cc/ha at fortnightly interval	78.32	8.84	10.80	19.64	29.01	(-) 37.82	186.42	13.80
T_9	Cane sprayed with tomato extract @ 5% + *T. chilonis* @ 2.5 cc/ha at weekly interval	80.30	4.50	5.55	10.05	63.86	29.47	171.56	29.42
T_{10}	Cane sprayed with tomato extract @ 5% + *T. chilonis* @ 2.5 cc/ha at fortnightly interval	77.95	3.85	4.23	8.08	70.83	43.30	199.59	32.86
T_{11}	Sevidol AG @ 10Kg/ha	80.21	6.17	7.53	13.66	50.49	4.14	167.19	2.20
T_{12}	Untreated control	79.16	14.01	13.69	27.70	--	(-) 94.39	147.92	2.00
	CD (P = 0.05)	NS	2.02	1.67	2.28	--	--	15.27	1.85

Method of observation

Shoot borer - From one middle row in each plot, number of dead heart with respect to total number of shoots were counted on 60th and 90th days after planting. The percentage of shoot borer incidence and cumulative / pooled per cent incidence were worked out.

Yield Parameter: At the time of harvest, cane population, cane yield and commercial cane sugar (%) were recorded and sugar yield was worked out. The data obtained were analysed statistically and treatments were compared (Panse and Sukhatme, 1985).

Inter crops: The intercrops of soybean, green gram were sown in 5:1 ratio and pods were harvested on 90th days and plants were incorporated by *in-situ.*

Weather parameters: During the period of experiments the maximum, minimum temperature and relative humidity were recorded daily and monthly mean was worked out. The rainfall was also recorded during the experimental period.

Recovery evaluation study: The recovery evaluation studies were conducted 7 days after every release by *Corcyra* eggs in trap card method and mean percentage of parasitization was worked out for each treatments. The adults emerged from the trap card were segregated into male and female and the sex ratio was sorted out.

RESULTS AND DISCUSSION

Effect of treatments on germination: The germination data sown in the table 1 revealed that the treatments have no effect on germination. It ranged from 70.38% to 80.30 %. The variation was due to environmental factors.

Effect of treatments on shoot borer incidence: Shoot borer incidence recorded on 60th day revealed that cane crop sprayed with 5% tomato extract + *T. chilonis* @ 2.5 cc/ha at fortnightly interval release had recorded the lowest shoot borer incidence of 3.85%, followed by cane + soybean (5:1) + *T. chilonis* @ 2.5 cc/ha at fortnightly interval release (3.95%) against the highest of 14.01% in untreated control (Table 1). Similarly on 90th day, cane crop sprayed with 5% tomato extract + *T. chilonis* @ 2.5 cc/ha at fortnightly interval release and cane + soybean (5:1) + *T. chilonis* @ 2.5 cc/ha at fortnightly interval had registered the lowest shoot borer incidence of 4.23% and 4.32%, respectively.

The mean percentage of pooled/cumulative incidence showed that cane crop sprayed with 5% tomato extract + *T. chilonis* @ 2.5 cc/ha at fortnightly interval recorded the lowest cumulative incidence of 8.08% with highest of 70.83% and 43.30% shoot borer reduction over untreated control and the existing practices of *T. chilonis* @ 2.5 cc/ha at fortnightly interval releases, respectively followed by cane + soybean (5:1) + *T. chilonis* @ 2.5 cc/ha at fortnightly interval in which 8.27% of cumulative shoot borer incidence was recorded, which registered the next highest shoot borer reduction of 70.14% and 41.96% respectively over untreated control and the existing method of *T. chilonis* @ 2.5 cc/ha release at fortnightly interval.

The lower incidence of shoot borer in the above two treatments are due to, increased parasitoid activities which reflect in higher parasitization of 32.86% and 30.15% respectively in trap card recovery evaluation. The results gain support from the findings of Nordlund *et al.* (1984) who reported extract of tomato when applied on corn, the parasitization of *Heliothis zea* by *T. pretiosum* was increased. Similarly Altieri (1981) reported the parasitization of host egg by *Trichogramma* was significantly higher in inter planted soybean and corn or weedy soybean plots than in weed and soybean or corn monoculture.

Effect of weather factors on activity of *T. chilonis*: The abiotic factors presented in table 2 & Fig. 1 highlighted that the maximum temperature was recorded during summer months (April to June). It was ranged between 37oC to 39.2oC with low relative humidity (43.3% to 50.7%). This plays the major role in the percentage of parasitization of shoot borer egg by *T. chilonis.* In the trap card, more population of male wasps was emerged than female (Male : Female ratio was 1.3 : 0.7). This result is fall on line with the finding of Metcalfe and Breniera (1969). They reported high ratio of male populations at high temperature during summer.

Table 2. Weather parameters recorded during March 2002 to February 2005 at Sugarcane Research Station, Melalathur

Month	Minimum Temperature (°C)				Maximum Temperature (°C)				R.H. (%)				Rainfall (mm)			
	2002	2003	2004	Mean	2002	2003	2004	Mean	2002	2003	2004	Mean	2002	2003	2004	Mean
March	21.7	21.0	20.9	21.2	33.2	32.2	33.2	32.8	44.5	41.4	45.3	43.7	--	--	--	--
April	27.5	25.0	22.5	25.0	35.0	39.0	38.5	37.5	44.3	50.0	45.7	46.7	28	80	13.4	40.5
May	30.1	30.1	28.7	29.6	38.3	38.3	38.7	38.4	43.1	43.0	43.9	43.3	46.8	--	22.8	23.2
June	28.6	26.1	28.3	27.7	33.6	44.4	39.7	39.2	48.3	61.5	42.2	50.7	15.3	6.4	45.4	87.5
July	26.4	26.3	24.4	25.7	33.7	35.5	35.7	35.0	52.0	76.1	55.3	61.1	14.6	2.0	193.7	70.1
August	24.8	25.3	24.7	24.9	32.1	41.0	39.0	37.4	65.8	76.6	68.4	70.3	293.5	45.0	146.5	161.7
September	24.7	24.9	24.6	24.6	29.9	29.2	29.9	29.7	63.0	65.4	63.2	64.1	494.4	104.5	428.4	372.4
October	26.1	25.9	24.8	25.6	28.6	27.9	28.9	28.5	81.0	79.5	75.4	78.6	86.2	111.2	186.1	127.8
November	22.2	21.8	22.5	22.2	27.2	27.4	28.5	27.7	70.2	69.5	68.7	79.5	23.3	138.0	318.1	159.8
December	22.2	21.9	20.8	21.6	27.7	26.9	27.8	27.5	78.6	72.4	71.4	74.1	259.1	62.2	87.6	136.3
January of next year	18.1	18.0	19.2	18.4	28.3	29.0	28.5	28.6	74.5	73.0	73.0	74.8	1.00	--	--	0.33
February of next year	19.7	19.8	19.8	19.8	28.9	28.8	28.9	28.9	62.1	61.1	61.3	61.5	--	--	--	--

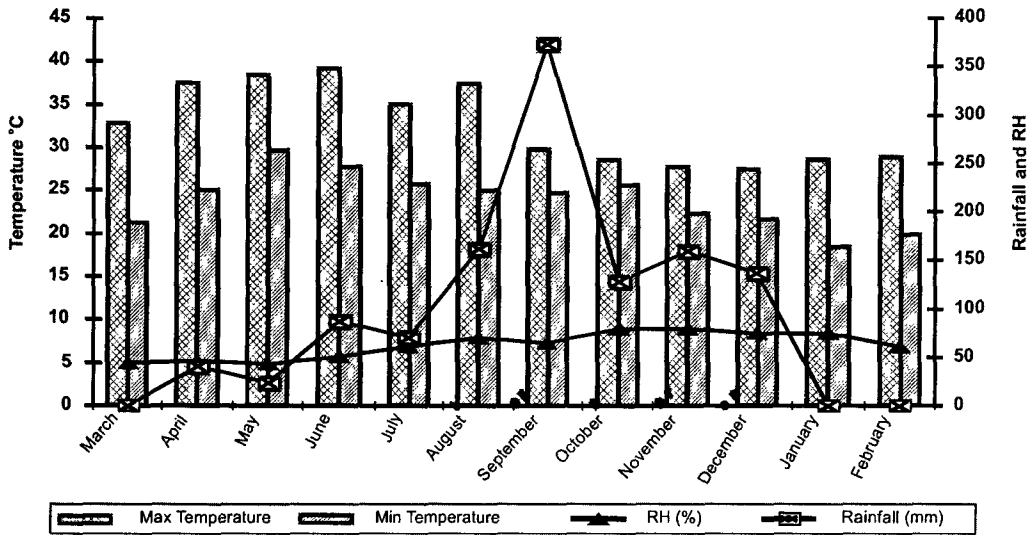

Fig. 1. Mean weather parameter during the cropping period (2002- 05)

Effect of treatments on yield parameters

Cane population: The highest cane population of 1,12,590 canes/ha was recorded in cane crop sprayed with 5% tomato extract + *T. chilonis* @ 2.5 cc/ha at fortnightly interval, followed by cane + soybean (5:1) + *T. chilonis* @ 2.5 cc/ha at fortnightly interval (1,09,320 canes/ha) as compared to 92,710 canes/ha in untreated control (Table.3).

Commercial cane sugar (%) : There is no significant variation in CCS% among the various treatments.

Cane yield: The cane yield data presented in table.3 revealed that the highest cane yield of 96.12 t/ha was registered in cane crop sprayed with 5% tomato extract + *T. chilonis* @ 2.5 cc/ha at fortnightly interval, followed by cane + soybean (5:1) + *T. chilonis* @ 2.5 cc/ha at fortnightly interval (94.18 t/ha) as compared to 68.53 t/ha in untreated control and 82.03 t/ha in existing method of *T. chilonis* @ 2.5 cc/ha at fortnightly interval and 80.52 t/ha in Sevidal 4G @ 12.5 Kg/ha.

Sugar yield: The cane crop sprayed with 5% tomato extract + *T. chilonis* @ 2.5 cc/ha at fortnight interval release registered the highest sugar yield of 12.45 t/ha, which was 15.42% and 43.90% higher sugar yield over the existing practices of *T. chilonis* @ 2.5 cc/ha at fortnightly interval and untreated control, respectively. The next higher sugar yield of 12.16 t/ha was obtained in cane + soybean (5:1) + *T. chilonis* @ 2.5 cc/ha at fortnightly interval, which recorded 13.40% and 39.87% of additional sugar yield over the existing practices of *T. chilonis* @ 2.5 cc/ha at fortnightly interval and untreated

Table 3. Mean Cane population, Cane yield, CCS% and Sugar yield (Mean of three trials)

S. No	Treatments	Millable cane population 000'/ha	CCS (%)	Cane yield t/ha	Sugar yield t/ha	% of Additional sugar yield over control	CB ratio
T_1	*Trichogramma chilonis* @ 2.5 cc/ha at weekly interval	92.57	12.84	76.20	9.78	12.60	1:2.23
T_2	*T. chilonis* @ 2.5 cc/ha at fortnightly interval	102.06	12.84	82.03	10.53	21.14	1:2.41
T_3	Cane + Soybean (5:1) + *T. chilonis* @ 2.5 cc/ha at weekly interval	107.84	12.65	91.55	11.58	33.29	1:2.64
T_4	Cane + Soybean (5:1) + *T. chilonis* @ 2.5 cc/ha at fortnightly interval	109.32	12.91	94.18	12.16	39.87	1:2.77
T_5	Cane + Green gram (5:1) + *T. chilonis* @ 2.5 cc/ha at weekly interval	100.36	12.86	79.14	10.16	17.19	1:2.32
T_6	Cane + Green gram (5:1) + *T. chilonis* @ 2.5 cc/ha at fortnightly interval	99.92	12.81	79.98	10.24	17.95	1:2.34
T_7	Cane sprayed with NSKE @ 5% + *T. chilonis* @ 2.5 cc/ha at weekly interval	96.40	12.86	76.69	9.87	13.72	1:2.17
T_8	Cane sprayed with NSKE @ 5% + *T. chilonis* @ 2.5 cc/ha at fortnightly interval	100.98	12.88	77.79	10.02	15.40	1:2.24
T_9	Cane sprayed with tomato extract @ 5% + *T. chilonis* @ 2.5 cc/ha at weekly interval	107.54	12.86	91.79	11.80	35.86	1:2.57
T_{10}	Cane sprayed with tomato extract @ 5% + *T. chilonis* @ 2.5 cc/ha at fortnightly interval	112.59	12.94	96.12	12.45	43.90	1:2.71
T_{11}	Sevidol @ 10Kg/ha	102.95	12.82	80.52	10.33	18.57	1:2.31
T_{12}	Untreated control	92.71	12.69	68.53	8.70	--	1:1.99
	CD (p=0.05)	3.86	NS	6.76	0.96	--	--

Table 4a. Inter crops yields

Treatment	Mean pod borers incidence	Mean yield / ha	Additional income (Rs.)
T_3	14.33%	25 Kgs	250
T_4	15.85%	23 Kgs	230
T_5	12.50%	24 Kgs	240
T_6	14.87%	20 Kgs	200

control. Whereas, the existing practices of *T. chilonis* @ 2.5 cc/ha at fortnightly and untreated control recorded the sugar yield of 10.53 t/ha and 8.70 t/ha, respectively. The increased

Table 4b. Cost benefit analysis

Input / Outputs		Price (Rs.)
1. Cost of 15 cc of *T. chilonis*	:	36.00
2. Cost for spraying of NSKE-5% per ha, including inputs / spraying.	:	250.00
3. Cost for spraying of 5% tomato extract (leaf & fruits) per ha including inputs / spraying	:	300.00
4. Cost of greengram seeds, sowing charge for one crop	:	150.00
5. Cost of sowing of soybean, sowing charge for one crop	:	165.00
6. Sevidol 1 Kg	:	50.00
Charge for two application		100.00
7. Cultivation expenses	:	43,750.00
8. Sugar prices	:	1000/quintal
9. Price for soybean, green gram	:	10/Kg

quantities of cane yield and sugar yield obtained in cane + soybean (5:1) + *T. chilonis* @ 2.5 cc/ha at fortnight interval and cane crop sprayed with 5% tomato extract + *T. chilonis* @ 2.5 cc/ha at fortnightly might be due to increased parasitoid activities by the odours / allelochemicals emitted from the tomato extracts and soybean crops which ultimately enhanced the parasitization and thereby reduced the incidence of shoot borer.

Additional income from intercrops: The incidence of pod borers was recorded in intercrops it was ranged from 12.50% to 15.85%. The pods were harvested in the intercrop treatments and data are presented in Table 4.

The additional income of Rs. 250/ha and Rs. 230/ha were obtained in cane + soybean (5:1) + *T. chilonis* @ 2.5 cc/ha at weekly interval and fortnight interval, respectively and additional income of Rs. 240/ha and Rs. 200/ha were obtained in cane + greengram (5:1) + *T. chilonis* @ 2.5 cc/ha at weekly interval and fortnight interval respectively.

Cost benefit ratio: The cost benefit ratio for the treatments was worked out based on the following prices of inputs and outputs.

The cane + soybean (5:1) + *T. chilonis* @ 2.5 cc/ha at fortnight interval had registered the highest CB ratio of 1 : 2.77, followed by cane crop sprayed with 5% tomato extract + *T. chilonis* @ 2.5 cc/ha at fortnight interval (1 : 2.71). The next highest CB ratio of 1 : 2.64 was recorded in cane + soybean (5:1) + *T. chilonis* @ 2.5 cc/ha at weekly interval as compared to CB ratio of 1 : 1.99 in untreated control.

CONCLUSION

Cane crop interplanted with Soybean (5:1) + *T. chilonis* @ 2.5 cc/ha at fortnight interval and cane crop sprayed with 5% tomato extracts *T. Chilonis* @ 2.5 cc/ha at fort night interval from 30th to 75th day increased the parasitization of *Chilo infuscatellus* eggs by *T. chilonis* and ultimately resulted in lowest shoot borer incidence of 8.27% and 8.08% with shoot borer reduction of 70.14% and 70.83% over untreated control and 41.96% and 43.30% shoot borer reduction over existing method of *T. chilonis* release of 2.55cc/ha at fortnight interval. The above treatments registered the highest CB ratio of 1:2:77 and 1:2:71 respectively.

REFERENCES

Altieri, M.A. (1981). Weeds may augments biological control of insects. *Calif. Agric*, 35:22-24.

Balasubramanium, M. (1991). Strategy for insecticidal efficiency in Sugarcane Pest Management. In "Bio-control technology for sugarcane pest management (Eds) David, H and Easwaramoorthy, S. pp 321-336.

Easwaramoorthy, S. and David, H. (1992). Augmentation of native natural enemies for the control of Sugarcane pests – prospects and problems. In "Emerging Trends in Biological Control of Pyhtophagous insects" (Eds.) T.N. Ananthakrishnan. pp 199-212.

Metcalfe, J.R and Breniera, (1969). Egg parasites (*Trichogramma spp.*) for control of sugarcane moth borers. In: Pests of sugarcane. J.R. Williams, J.R. Wetcalfe, R.W. Mungomery and R. Mathes (Eds.) Elsevier publ. &Co. Amsterdam p:81-116.

Nettles, W. (1980). Adult *Eucelatoria sp.* response to volatiles from cotton and okra plants and from larvae of *Heliothis virescens*, *Spodoptera eridania* and *Estigmene acrea*. *Environ. Entomol.*, **9**:759-763.

Nordlund,D.A., Chalfant, R.B and Luvis, W.G. (1984). Arthoropods Populations, yields and damage in monoculture and poly culture of corns, beans, tomatoes. *Agri. Ecosyst. Environ.*, **11:** 353-763.

Prasanna G.I. and Malavia A. (1994). Survey of sugarcane pest in Saurashtra region *GAU Res. J.*, **20:**143-145.

Panse V.G. and Sukhatme., P.K.(1985). Statistical methods for Agricultural Workers, ICAR, New Delhi.

Sardana, H.R. and Singh, Amerika (2002). Integrated Pest Management in Sugarcane. *Co-operative Sugar*, **33(5)** : 393 – 401.

Subramanian, S. and Kannappan, K. (2003). Evaluation of IPM components in the management of shoot borer of sugarcane in Cauvery Delta region, Tamil Nadu. *Co-operative Sugar.*, **34(11):** 879-882.

Thirumurugan, A, Shah, S.E. and Venkatachalam, S.R. (2001). Effect of time of planting on incidence of shoot borer *Chilo infuscatellus*, yield and quality *Co-operative Sugar.*, **32(7):** 549 – 551.

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