THE CONTROL OF THE SUGARCANE PEST TOP BORER (SCIRPOPHAGA NIVELLA FAB*) THROUGH MANY APPROCHES AS INTEGRATED PEST MANAGEMENT

ABSTRACT: The sugarcane (*Saccharum officinarum*) is a very important cultivated crop in many states of India. This crop is grown throughout the year; hence it is infested by a large number of pest (fungus, insects etc.). According to study, sugarcane production is declined by 20-30% or more. Out of several insect pest, *Scirpophaga nivella* (Fabricius) is one of notorious pest of this crop sugarcane. This pest infests sugarcane crop of three months old crop to till harvesting stages and some similar plants too. In an integrated pest management (IPM) several suitable techniques or methods are used in a harmonious manner with least disruption of ecosystem. Thus, IPM is being applied to control the top shoot borer (*S. nivella*). Seven different modules were tested to control infestation of top borer. The percentage of incidence of *S.* nivella in module-4 (*T. chilonis*+ *T. howardi* + carbofaran) were 2.8, 2.2, 1.1 and 0.6 in II, III, IV and V broods respectively which were very less, with highest cane yield of 89.43 t/ha as compared to the other modules tested. From the present work, we would recoomend for the use of carbofuran(pesticide), *Trichogramma chilonis* (Ishii), and *Tetrastichus howardi* (Olliff) for the higher sugarcane production of Variety Co 0238.

***Key words*:**Sugarcane, IPM, *Scirpophaga nivella,Tetrasticushowardi, Trichogramma chilonis,* Carbofuran

INTRODUCTION

The crop sugarcane is cultivated app. in 4 million hectares with an average sugarcane yield of 70-75 tones/hectare. This crop is cultivated for the production of white and brown sugar, khansari and jaggery. This crop is native of warm temperate to tropical region of the old world. There are many other species of Saccharum as *S. aundinaceum, S. edule, S. robustum* and *S. bengalense* etc. the main product of this crop is sugar, contains sucrose, lactose and fructose. It is used in a number of product manufacturing.

Sugarcane is a long duration crop of about 10-18 months and thus likely to be attacked by a number of pests. Khanzada(1993) around 11 insects and mite pests on crop of sugarcane. Some pests of sugarcane crop are bug, early shoot borer, gurdaspur borer,pyrilla, scale insect, stem borer,top shoot borer, termites etc. These pests damage sugarcane crop and reduce sugarproduction.

The top borer *Scirpophaga nivella* bolong to phylum- Arthopoda, class- Insecta, order- Lepidoptera, family- Pyraridae is a serious pest among the moth borers, which leads to a heavy loss in sugarcane production. In subtropical regions of India states like Andhra Pradesh, Bihar, Maharashtra, Madras, Mysore, Orissa and Uttar Predesh, it is found as a major pest while in tropical regions as minor occurrence. A number of crops like Jawar, Kans, Sarkanda, Dab and some others are also likely to be infested by *S. nivella*.

An insect *Tetrastichus howardi* of order- Hymenoptera, family- Eulophidae, is a serious gregarious and endopupal polyphagous parasitoid of many lepidopterans' pests with high degree of potential as biological control of sugarcane top borer too (Baitha and Sinha, 2004; La Salle and Polaszek 2007; Sunil Kumar Ruhela and Anil Tyagi, 2020). *T. howardi* parasitizes the pupa

of sugarcane top borer (Cherian and Subramanian 1940; Puttauaiah ans Sastry 19 58; Vargas et al, 2011).

Another insect *Trichogramma chilonis* of order- Hymenoptera, family- Trichogrammatidae, is a very important polyphagus egg parasitoid of many lepidopterous pests of several crops. It is used as a very effective biological control agent against sugarcane top borer from last decades in Punjab and Sindh, Pakistan (Hashmi and Rahman 1985). The practice of *T. chilonis*gave very successful results to control infestation of Gurdaspur borer (Hamid et al; 1998), *Chilo infusctellus* (Shahid et al; 2007) and sugarcane borer (Khan and Alam 2001; Cock 1985; Cheng 1986; Ashraf et al 1993; Goebell 2006; and Mustafa et al 2006).

Since from a long time a number of chemical insecticides are used to control insect pests including sugarcane top borer. Over the many decades, group of carbamates insecticides are effectively applied to control many species of insect pests including top borer too. Carbamates are very potent inhibitors of acetylcholinesterase of neural system with lesser half-life in ecosystem. Carbamates have a broad-spectrum activity (Castagnoli et al 2012; Tsiplakou et al 2010). These insecticides are also used to control soil dwelling and foliar feeding insect pests.

The most important carbamate is carbofuran (2,3-dihydro- 2,2-dimethyl-7-benzofuranyl-N-methylcarbamate) is broadly used for insect control (Petty and Juhlman 1972 and Muhammad et al 2020). It is mainly used as insecticide, acaricide and nematicide in agriculture practice for control of pests.

Integrated Pest Management of sugarcane, therefore depends upon monitoring the pest population dynamics and need-based application of pesticides considering economic threshold level of the pest. The infestation and intensity of insect pests on sugar cane is influenced by number of factors such as season, climate, edaphic, cane variety and cultivation practices *etc*. (Venugopal, 2003). In IPM, all or most of the suitable techniques or tactics are used with least disruptionof the ecosystem (Agarwal 1980; Pandey and Singh1997; Sundra 2001; Zeng 2004; Rajendran 2006 and Singh and Singh 2007).

In the present work of IPM on top shoot borer, we studied the contribution of biological agents *viz., Trichogramma chilonis*Ishii, *Tetrastichus howardi*(Olliff) and chemical insecticide carbofuran against sugarcane top shoot borer *Scirpophaga nivella* (Fabricius) in the field of sugarcane (var. Co-0238) which is most commonly cultivated variety in western Uttar Pradesh due to it very high cane yield.

MATERIALS AND METHODS

Eggs of *Corcyra cephalonica* (Stainton) were collected from the Indian Institute of sugarcane research, Shahjahanpur, Uttar Pradesh. Similarly, *Tetrasticus howardi*, *Trichogramma chilonis*and pupa were collected from DSCL, Sugar mill, Rupapur, Hardoi District, Uttar-Pradesh.

For the culture of *Tetrasticus howardi*, 3-4 pupa of silkworm moth were kept in a plastic box along with 20 adults of *Tetrastichus howardi*, then covered with black cloth in the evening and kept overnight. Next day morning adults were removed and parasitized pupa were transferred to another box and maintained at temperature of 25±2 ºCwith 50±5% humidity. After 15 to 20 days the emergence started and adults were transferred to another box having honey cotton swab (diluted with 50% water). Then adults of *Tetrastichus*were transferred to poly-bag

(packet), each packet having about 150-200 adults and carried to sugarcane field for field release. Adults at the rate of 3 packets per acre or 8 packets per hectare were realeased at a gap/interval of one month(30-days) in sugarcane field/experimental area starting from 30 days after planting and thus totally three releases were made as per the treatments.

Trichogramma chilonis is very effective egg parasitoid on several insects. *Corcyra* is a very good and easily available alternative host of *T. chilonis*. It has a very high capacity to breed a large progeny/population in a very short time period in the laboratory. *Corcyra* is cultured in semi crushed maize and their eggs are collected and pasted on paper cards.*Corcyra*eggs are acted as host of *T. chilonis*. Then cards are placed in glass jar and the eggs of Corcyra are parasitized by the *T. chilonis* and then parasitized cards (Trichocards) were stored in refrigerator and removed from refrigerator 12-24 hours before tagging in the sugarcane field. To control sugarcane top shoot borer, Trichocards were tagged in the field at the rate of 50000 eggs per hectare at the interval of 15 days starting from 30 days or one month after planting, and thus totally five releases were made as per the treatments.

The effect of carbofuran was tested by performing experiment at a small scale under control circumstances. We used carbofuran 3% CG (Encapulated), with packet named "Furadan"-crystal for the treatment of sugarcane top shoot borer at different time periods from cane planting. We used carbofuran 3 CG @ 25 kg/ha or 10 kg/acre as guideline of agropedia. To control sugarcane top shoot borer, carbofuran 3 G was applied four times *i.e.* at the time of planting ans at 30, 60, and 90 days after planting as per the treatments.

Group 1=Module -A (Treatment with *T. howardi*)
Group 2=Module -B (Treatment with *T. chilonis*)
Group 3=Module -C (Treatment with Carbofuran)
Group 4=Module -1 (Treatment with *T. howardi+ T.chilonis)*
Group 5=Module -2 (Treatment with *T.chilonis*+ Carbofuran)
Group 6=Module -3(Treatment with *T.howardi*+ Carbofuran)
Group 7=Module -4(Treatment with *T.howardi +T.chilonis*+ Carbofuran)
Group 8=Control/untreated

To record data of top shoot borer infestation, the numbers of infested tillers were counted from the total number on the basis of dead hearts. The following formula was used to find out the percentage (%) of top shoot borer infestation.

$$\%\ \text{Borer infestation} = \frac{Number\ of\ infested\ tillers}{Total\ number\ of\ tillers} \times 100$$

To record data of top shoot borer infestation, the number of infested/damaged internodes were counted from the total number. The following formula was used to find out the percentage (%).

$$\%\ \text{Borer infestation} = \frac{Number\ of\ infested\ internodes}{Total\ number\ of\ internodes} \times 100$$

RESULTS AND DISCUSSION

The percentage of incidence of *S. nivella* in module-A (*T.howardi*) were 6.8±0.05, 5.5±0.12, 4.7±0.10 and 3.5±0.11 in II, III, IV, and V broods, respectively with cane yield of 85.34 t/ha. The percentage of incidence of *S. nivella* in module-B (*T. chilonis*) were 4.5±0.04, 3.2±0.07, 1.5±0.12 and 0.8±0.08 in II, III, IV and V broods respectively with cane yield of 85.84 t/ha. The percentage of incidence of *S. nivella* in module-C (carbofuran) were 3.8±0.13, 3.9±0.13, 3.2±0.08 and 1.8±0.06 08 in II, III, IV and V broods, respectively with cane yield of 84.54 t/ha.

The percentage of incidence of *S. nivella* in module-1(*T. howardi* +*T. chilonis*) were 4.5±0.01, 3.2±0.04, 1.5±0.08, 2.7±0.14 in II, III, IV and V broods, respectively with cane yield of 83.45 t/ha. The percentage of incidence of *S. nivella* in module-2 (*T. chinolis* + carbofuran) were 3.2±0.04, 2.5±0.01, 1.2±0.04 and 1.2±0.05 in II, III, IV and V broods, respectively with cane yield of 85.84 t/ha.The percentage of incidence of *S. nivella* in module-3 (*T.howardi*+carbofuran) were 3.6±0.07, 2.6±0.04, 1.8±0.07 and 1.4±0.04 in II, III, IV and V broods, respectively with cane yield of 86.65 t/ha.

The percentage of incidence of *S. nivella* in module-4 (*T. chilonis*+ *T. howardi*+ carbofuran) were 2.8±0.09, 2.2±0.04, 1.1±0.03 and 0.6±0.03 in II, III, IV and V broods, respectively which were very less, wit maximum cane yield of 89.43 t/hac. The percentage of incidence of *S. nivella* in control (untreated) sugarcane were 9.2±0.11, 10.9±0.11, 13.3±0.03, and 14.7±0.12 in II, III, IV and V broods, respectively which were very high, with least cane yield of 72.81 t/ha (Table-1).

Table-1: Means (±SE) percentage incidence in sugarcane by *Scirpophaga nivella* and sugarcane yield in different modules.

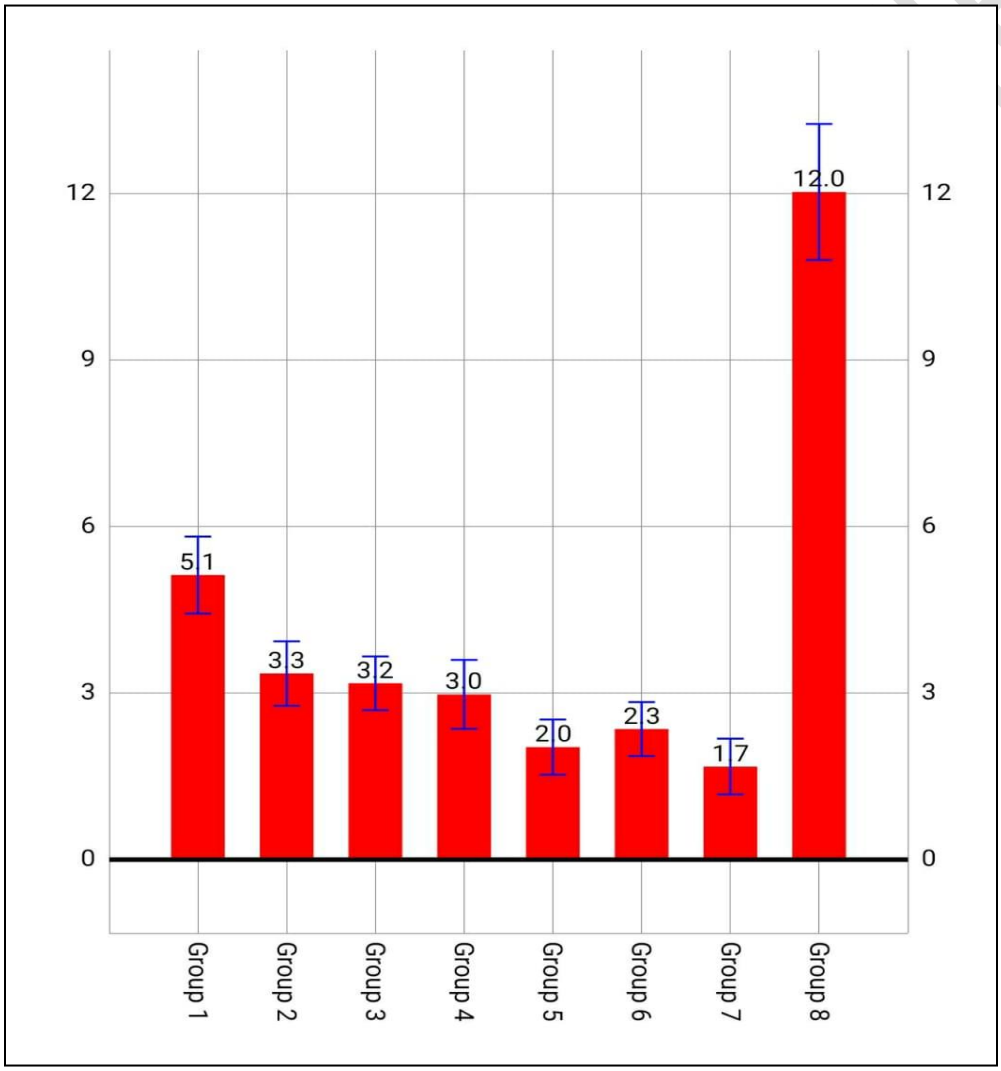
Timings / Module	Percentage incidence of *Scirpophaga nivella*				Cane yield (t/ha)
	II brood	III brood	IV brood	V brood	
MA:*T.howardi*	6.8±0.05	5.5±0.12	4.7±0.10	3.5±0.11	85.34
MB:*T.chilonis*	4.5±0.04	3.2±0.07	1.5±0.12	0.8±0.08	89.50
MC: Carbofuran	3.8±0.13	3.9±0.13	3.2±0.08	1.8±0.06	84.54
M1: *T.chilonis*+ *T. howardi*	4.5±0.10	3.2±0.04	1.5±0.08	2.7±0.14	83.45
M2: *T.chilonis*+ Carbofuran	3.2±0.04	2.5±0.10	1.2±0.04	1.2±0.05	85.84
M3: *T.howardi*+ Carbofuran	3.6±0.07	2.6±0.04	1.8±0.07	1.4±0.04	86.65
M4: *T.chilonis*+ *T.howardi*+	2.8±0.09	2.2±0.04	1.1±0.03	0.6±0.03	89.43

Carbofuran					
Control	9.2±0.11	10.9±0.11	13.3±0.03	14.7±0.12	72.81

(Each value is the mean of five values with SE=Standard error of mean)

Tukey's multiple-range-test ($p<0.05$) $p<0.001$, Calculated F value=24.809, Critical F valve=2.422

Fig. 1: Comparison of percentage of incidence of *S. nivella* in different modules



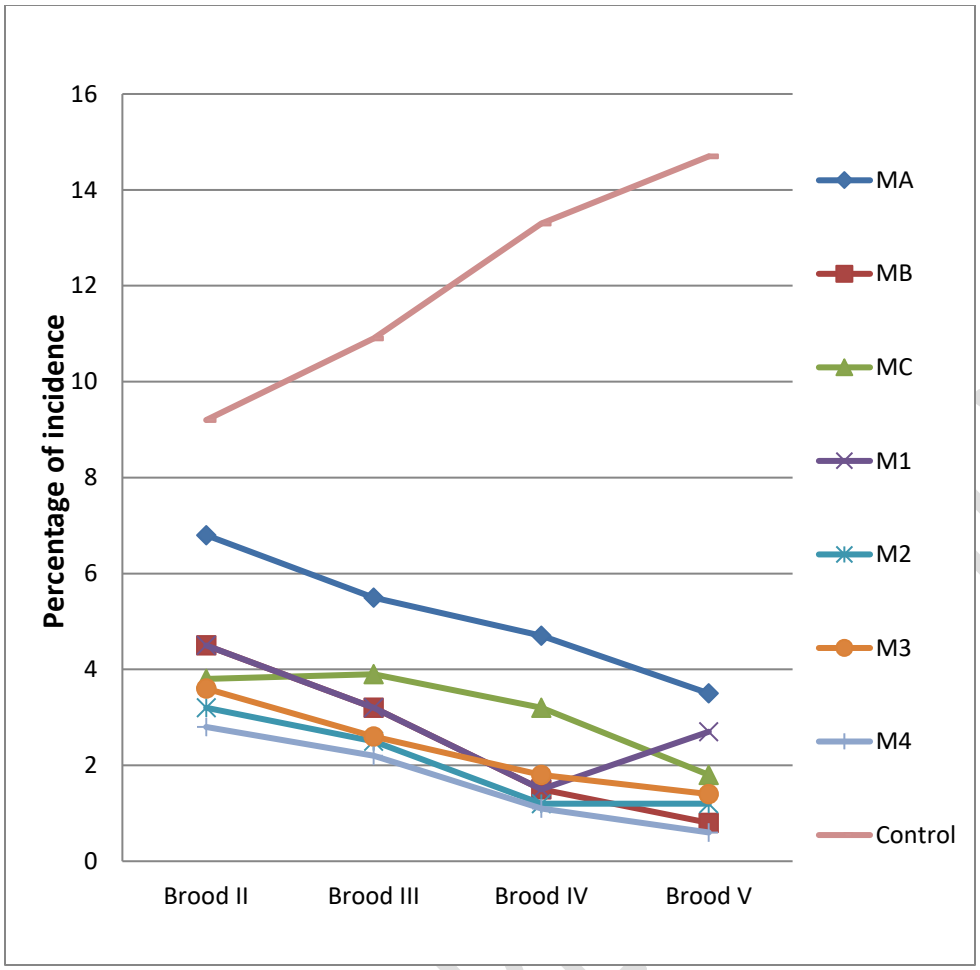


Fig. 2: Percentage of incidence of *S. nivella* in different modules

The mean±SE percentage of incidence of the sugarcane top borer (*S. nivella)* in different treatment modules (A, B, C, 1, 2, 3, & 4) and control were shown in fig. The mean±SE percentage of *S. nivella* in modules A, B, C, 1, 2, 3, and 4 were 5.12±0.69, 2.5±0.83, 2.87±0.36, 2.9±0.62, 2.02±0.49, 2.20±0.47, and 1.6±0.50 repectively. While in control (untreated) the mean±SE percentage of incidence was 12.02±1.42, which was higher as comparison to all treatment modules. IPM module-4 shows very less percentage of incidences among all treatment modules.

Fig.3 shows sugar yields influenced by different treatment modules. The sugar yields in modules-A, B, C, 1, 2, 3, and 4 were 85.34, 89.34, 84.54, 83.45, 85.84, 86.65 and 89.43 t/ha respectively.

Fig. 4 shows the comparison of sugar yields in treatment modules with reference to control. The sugar yield in control (untreated) was 72.81 t/ha.

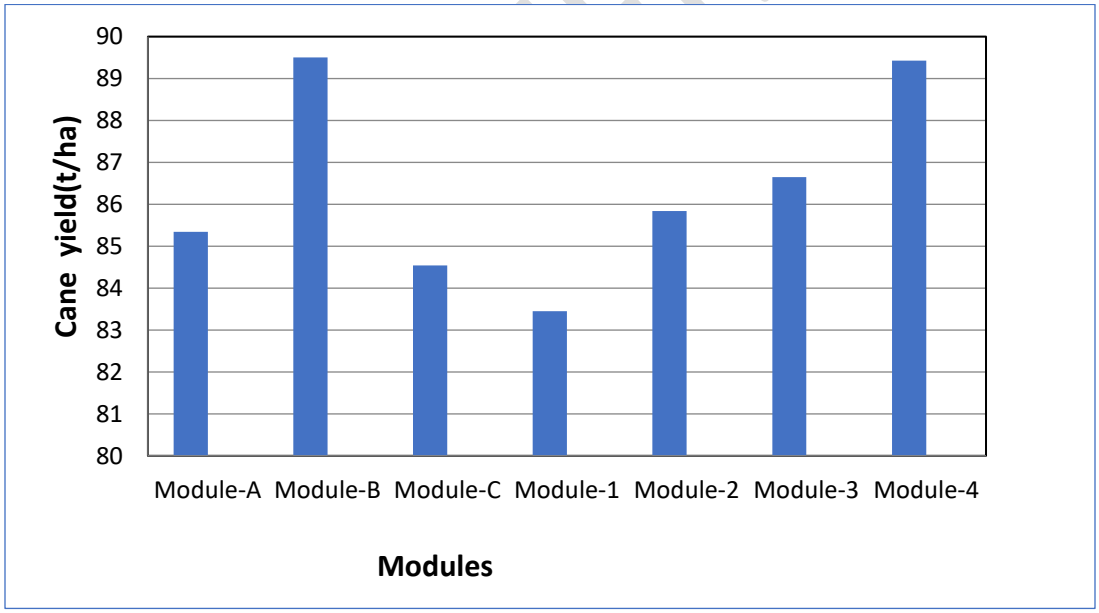


Fig. 3: Sugarcane yields influenced by seven different modules

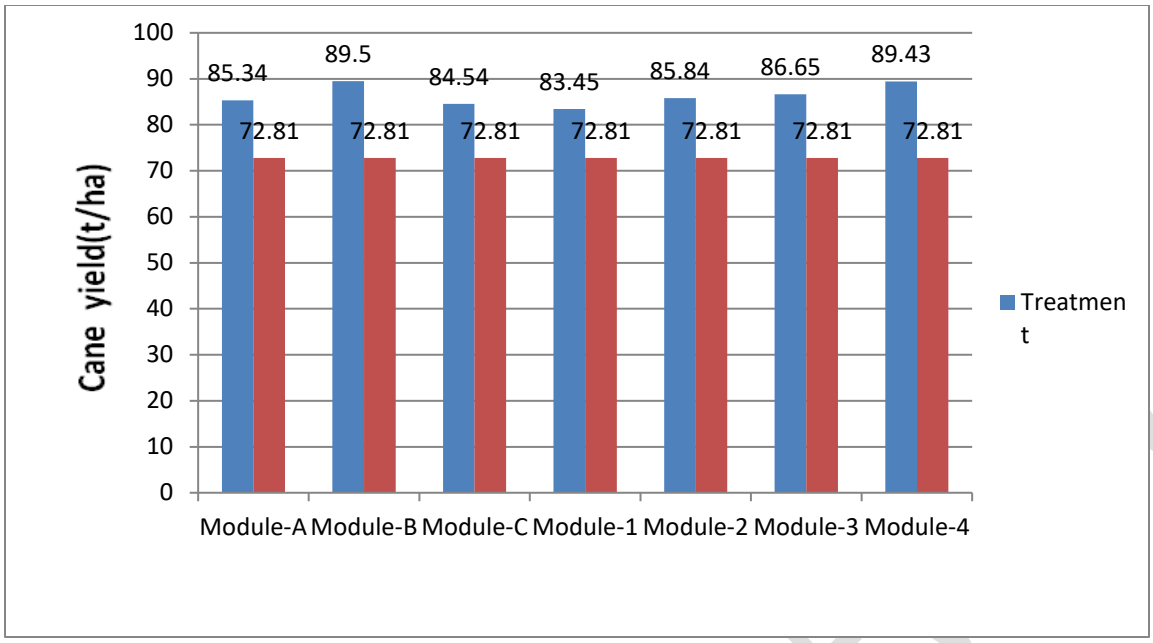


Fig. 4: Comparison of sugar yields of different modules (treatments) with control (untreated)

In module-A (*T. howardi*), an average percentage of incidence of *S. nivella* was 5.12 and the percentage of reduction over control was 57.40 % with cane yield 85.34 t/ha. The additional cane yield over control was 12.53 t/ha. The cost as treatment and net return were Rs.780 and Rs.33590 respectively with Cost: benefit Ratio (C: B Ratio)-1:44.07.

In module-B (*T. chilonis*), an average percentage of incidence of *S. nivella* was 2.50 and the percentage of reduction over control was 79.03 % with cane yield 89.50 t/ha. The additional cane yield over control was 16.69 t/ha. The cost as treatment and net return were Rs.450 and Rs.45447 respectively with C: B Ratio-1:101.99.

In module-C (Carbofuran), an average percentage of incidence of *S. nivella* was 2.87 and the percentage of reduction over control was 76.12 % with cane yield 84.54 t/ha. The additional cane yield over control was 11.73 t/ha. The cost as treatment and net return were Rs.8250 and Rs.24007 respectively with C: B Ratio-1:3.91.

In module-1 (*T. howardi* + *T. chilonis*), an average percentage of incidence of *S. nivella* was 2.97 and the percentage of reduction over control was 75.29 % with cane yield 83.45 t/ha. The additional cane yield over control was 10.64 t/ha. The cost as treatment and net return were Rs.1230 and Rs.28030 respectively with C: B Ratio-1:23.78.

In module-2 (*T. chilonis*+ Carbofuran), an average percentage of incidence of *S. nivella* was 2.02 and the percentage of reduction over control was 83.19 % with cane yield 85.84 t/ha. The additional cane yield over control was 13.03 t/ha. The cost as treatment and net return were Rs.9030 and Rs.26802 respectively with C: B Ratio-1:3.96.

In module-3 (*T. howardi* + Carbofuran), an average percentage of incidence of *S. nivella* was 2.20 and the percentage of reduction over control was 81.69 % with cane yield 86.65 t/ha. The additional cane yield over control was 13.84 t/ha. The cost as treatment and net return were Rs.8700 and Rs.29360 respectively with C: B Ratio-1:5.54.

In module-4 (*T. chilonis* + *T. howardi* + *T. chilonis*), an average percentage of incidence of *S. nivella* was 1.67 and the percentage of reduction over control was 86.25 % with cane yield 89.43 t/ha. The additional cane yield over control was 16.62 t/ha. The cost as treatment and net return were Rs.9840 and Rs.36225 respectively with C: B Ratio-1:5.54.

The maximum reduction over control i.e., 86.25% was seen in module-4 (IPM: *T. chilonis*+*T. howardi*+Carbofuran) and minimum in module-A among the all-treatment modules. The maximum C: B ratio was in Module-B (*T. chilonis*) and minimum in module-C (Carbofuran) but the maximum net return was in module-4 (IPM) and minimum in module-C (Carbofuran).

With respect to efficiency of *T.howardi*,the result of this study and experiment are in accordance with Baitha, Sinha (2004); La salle, Polaszek (2007); Pastori (2008) and Vargas *et al*. (2011). Similarly, with respect to efficiency of *T. chilonis*, the results of the present experiment and study are in the same line with the work of Hasmi, Raham (1985); Cock (1985); Cheng (1986); Asraf et al (1993); Hamid et al (1998); Khan, Alam (2001); Goebell et al (2006); Mustafa et al (**20060 and Shahid et al (2007**) in controlling various lepidopteran borers in sugarcane.

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With respect to efficiency and effectiveness of carbofuran, the results of present study are in accordance with Malik and Chaudhary (1990), Patel et al (1993); Khan andJan (1994); Pandey and Singh (1997); Mishra et al (1998); Sardana (2001); Khaliq (2005); Balikai *et al*. (2014-15);Tippannavar *et al*. (2016) and Bhavani (2016) in controlling various lepidopteran borers in sugarcane.

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