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Studies on Sugarcane Shoot Borers in South Gujarat

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ABSTRACT: Studies on sugarcane shoot borers were carried out at farmers fields in Tapi district of South Gujarat during 2017-18, 2018-19 and 2019-20. Results revealed that the sugarcane was infested by complex of two shoot borer species *viz., Sesamia inferens* (Walker) and *Chilo sacchariphagus indicus* (Kapur) at early stage in South Gujarat Agroclimatic Zone II. Maximum infestation of sugarcane shoots by *S. inferens* based on number of larvae was observed during first fortnight of December followed by first fortnight of January. Likewise, maximum infestation of sugarcane shoots by *C. sacchariphagus indicus* based on number of larvae collected was observed during first fortnight of January followed by first fortnight of December and February. The maximum population of *S. inferens* was observed (87.76%) than *C. sacchariphagus indicus* (12.24%). Each species were naturally parasitized by complex of two parasitoids *viz., Sturmiopsis inferens* Towns end (Tachinidae: Diptera) and *Cotesia flavipes* Cameron (Hymenoptera: Braconidae). Larvae of *S. inferens* were maximum parasitized by *S. inferens* (58.17%) followed by *C. flavipes* (2.75%). Whereas, larvae of *Chilo* sp. were maximum parasitized by *C. flavipes* (10.29%) followed by *S. inferens* (2.67).

Keywords: *Chilo sacchariphagus indicus, Cotesia flavipes,* parasitization, *Sesamia inferens, Sturmiopsis inferens,* Sugarcane, etc.

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is a perennial grass belonging to family Poaceae. It is cultivated in tropical and subtropical regions throughout the world. Sugarcane is one of the most important cash crops cultivated in India which is a major source of white sugar and jaggery. Sugarcane by virtue of its growth provides homogenous agroecosystem, serving as shelter and food for insects (Chaudhary, 2008). More than 1500 species of insects reported worldwide (Box, 1953). In India, nearly 228 pests are known on sugarcane (David and Nandagopal 1986). These insect pests occur during different phenological cycles of sugarcane (Suasaard *et al*., 2009). Amongst borers, early shoot borer, top borer and stalk borer are the major pests (Patil and Hapase 1981; Madan *et al.*,1999; Singh *et al*., 1973).

Among the insect pests, early shoot borer cause damage mainly at the formative phase of sugarcane. The young larvae bore down through the spindles as also moves upwards and destroying the apical meristem. Consequently, damaged spindle dries up and develops into a conspicuous "dead heart" that can be pulled out easily and emit a rancid odour. The dead mother shoots and tillers have resulted into gap. The early shoot borer can destroy 26 to 65% of mother shoots as well as 6.4, 27.1 and 75% primary, secondary and tertiary tillers and caused a loss of 0.597 tonnes of sugar/ha (Krishnamurthy Rao, 1954; Doss, 1956; Khan and Krishnamurthy Rao, 1956). Also, it causes a loss of 22 to 33% in cane yield, 12% in sugar recovery and 27 % in jaggery (Patil and Hapse 1981). Early shoot borer infestation on mother shoots and millable canes cause severe losses in cane production, juice quality and sucrose content (Avasthy and Tiwari 1986).

Sesamia inferens (Walker) is normally considered as a minor borer pest of sugarcane. It infests the crop while favourable condition created by an early shoot borer *Chilo infescatellus* (Anonymous, 2010). In sugarcane, *S. inferens* causes a 57.31% reduction in cane weight and 36.45% reduction in Brix percentage (Choudhary and Srivastava 2007). Kidane *et al*. (2018) revealed that among the borers in sugarcane, *S. calamistis* and *Chilo partellus* were the most dominant species. Chavan *et al.* (2021) reported the infestation of two species of shoot borers *viz*., *S. inferens* and *Chilo sacchariphagus indicus* (Kapur) in the early stage of sugarcane in

Gujarat and *S. inferens* (84.84%) is dominant over *C. sacchariphagus indicus* (15.16%) in overall incidence in Madhya Pradesh.

Identifying the natural enemy and understanding their significance in the sugarcane production system is the primary step in pest management programme. Identification natural enemy of shoot borer species complex according to their significance has a paramount importance in their management. Therefore, this work was initiated of identify the associated natural enemies with larvae of the shoot borer complex. 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 complied, with information on the host stage they attack, host plant or crop and country of record (Sallaman and Allosopp 2005). This paper provides infestation level, species composition and status of parasitisation of sugarcane shoot borers in Gujarat.

MATERIALS AND METHODS

Study site and condition. The present study was carried out at farmers field in Tapi district of South Gujarat [South Gujarat Agro-climatic Zone II (AES V)] during 2017-18, 2018-19 and 2019-20. Ten farmers sugarcane fields were selected and the recommended package of practices of the zone was followed to raise the crop except insecticidal application.

Species composition of sugarcane shoot borer. In each selected field, monitoring was done at 40 days old sugarcane field and five spots of 3 m row length (four spots from each corner and one spot from center) were selected and the tillers with symptoms of shoot borer damage *viz.*, shoots with basal bore holes and dead heart were collected, dissected and examined in the laboratory. The species of shoot borer was determined based on the morphological characters of larva. Pink shoot borer (PSB), *S. inferens* larvae, were pink and purplish on dorsal side and white at ventral side. Head capsule was orange. Other shoot borer, *C. sacchariphagus indicus* larva has five violet stripes dorsally and dorso-laterally on its body and its head was brown. The percent species composition was calculated based on the proportion of each species observed out of the total number recorded.

Natural parasitization of sugarcane shoot borer. Recovered larvae from the species composition study were reared in the laboratory by providing small pieces of tender sugarcane in small plastic container. The food was changed on alternate day and observed the emergence of parasitoids. Based on this, per cent parasitization was worked out. The emerged parasitoids were sent to ICAR-NBAIR, Bengaluru and Insect Identification Cell, IARI, New Delhi for identification and confirmation.

RESULTS AND DISCUSSION

Species Composition of sugarcane shoot borer. The complex infestation of two shoot borer species *viz.*, *Sesamia inferens* (Walker) and *Chilo sacchariphagus indicus* (Kapur) was noticed at early stage of sugarcane in South Gujarat Agroclimatic Zone II. Maximum infestation of sugarcane shoots by *S. inferens* based on number of larvae were observed during first fortnight of December during all the years under study (51, 28 and 34 larvae during 2017-18, 2018-19 and 2019-20, respectively) followed by first fortnight of January (29, 33 and 29 larvae during 2017-18, 2018-19 and 2019-20, respectively) (Fig. 1). Likewise, Maximum infestation of sugarcane shoots by *S. inferens* based on number of larvae collected was observed during first fortnight of December during all the years (51, 28 and 34 larvae during 2017-18, 2018-19 and 2019-20, respectively) followed by first fortnight of January (29, 33 and 29 larvae during 2017-18, 2018-19 and 2019-20, respectively). Similarly, maximum infestation of sugarcane shoots by *C. sacchariphagus indicus* based on number of larvae collected was observed during first fortnight of January (average 5.67 larvae) followed by first fortnight of December and first fortnight February (average 3.0 larvae) (Fig. 2).

Moreover, maximum diversity of *S. inferens* (84.42, 86.89 and 81.98%) was observed than *C. sacchariphagus indicus* (15.58, 13.11 and 8.03%) during 2017-18, 2018-19 and 2019-20, respectively (Table-1). The pooled data of three years study revealed that maximum population of *S. inferens* was observed (87.76%) than *C. sacchariphagus indicus* (12.24%).

Chavan *et al*. (2021) reported the infestation of two species of shoot borers *viz*., *S. inferens* and *C. sacchariphagus indicus* in the early stage of sugarcane in Gujarat and *S. inferens* (84.84%) is dominant over *C. sacchariphagus indicus* (15.16%) in overall incidence during 2015-16 to 2017-18. *S. inferens* considered to be a minor pest of sugarcane, has attained pest status among sugarcane germplasm in recent years and causing considerable damage, particularly in sugarcane clones in the early stage (Anonymous, 2010). The present study was also in line with Assefa *et al*. (2006) where they studied stem borer complex in sugarcane states of Ethiopia and revealed the presence of three lepidopteran stem borer species on sugarcane, *Busseola* sp., *C. partellus* and *S. calamistis.*

Among the stem borer species identified, *S. poephaga* was reported for the first time on sugarcane in Ethiopia (Mengistu and Selvaraj, 2013). Moreover, *S. poephaga* inflicted damage both at shoot (3.5 - 54%) and stalk (5.6–28.8%). *S. inferens* also reported at early stage by Choudhary and Shrivastava (2007) in Hoshangabad, Madhya Pradesh. Wijayanti *et al*. (2021) in Java confirmed that along with *Chilo infuscatellus*; *C. sacchariphagus*, *C. auricilius*, *Tetramoera schistaceana*, *Scirpophaga excerptalis* and *S. inferens* were also infesting sugarcane at early stage of the crop. Most of the dead heart shoots were caused by infestation of two borers, *S. inferens* and *T. schistaceana* in Japan (Shimizu *et al*., 2018). The present findings are in line with all these workers in different parts of the world. From the present study it can be concluded that sugarcane was infested by complex of two species of shoot borer, namely *S. inferens* and *C. sacchariphagus indicus*. Moreover, *S. inferens* was found to be predominant shoot borer species in South Gujarat Agroclimatic Zone II.

Moreover, *S. inferens* found to be dominated over *C. sacchariphagus indicus* in South Gujarat at early stage of the crop. Perhaps; this is the first report of occurrence of *S. inferrens* at early stage of the crop and causes damage to shoot in Gujarat.

Natural parasitization of sugarcane shoot borer. The data presented in Fig. 3 and 4 on natural parasitization of sugarcane shoot borers observed in laboratory during 2017-18 to 2019-20 revealed that, each species were naturally parasitized by complex of two parasitoids *viz*., *Sturmiopsis inferens* Townsend (Tachinidae: Diptera) and *Cotesia flavipes* Cameron (Hymenoptera: Braconidae). In case of *S. inferens*, 62.41%, 54.07% and 58.40% per cent parasitization was observed by *S. inferens*during 2017-18, 2018-19 and 2019-20, respectively (Fig. 3). Whereas, 0.39%, 3.67% and 3.78% parasitization was observed by *C. flavipes* during three consecutive years, respectively (Fig. 3).

Moreover, in case of *Chilo* sp. 4.0% parasitization was observed by *S. inferens* during 2017-18 and 2019-20, respectively. Whereas, 14.0 %, 10.67% and 3.57% parasitization was observed by *C. flavipes* during three consecutive years, respectively (Fig. 4). The average data of three years mentioned in Table 2 and 3 revealed that, larvae of *S. inferens* were maximum parasitized (58.17%) by *S. inferens* followed by *C. flavipes* (2.75%). Whereas, larvae of *Chilo* sp. were maximum parasitized by *C. flavipes* (10.29%) followed by *S. inferens* (2.67) in South Gujarat Agro climatic Zone II (AES-V) (Fig. 4).

The results on correlation of per cent natural parasitization of sugarcane shoot borer, *S. inferens* by *S. inferens* and *C. flavipes* with weather parameters *viz.*, maximum temperature, minimum temperature, average temperature, morning relative humidity, evening relative humidity, average relative humidity, wind velocity, sunshine, and rainfall and did not show any positive or negative influence on the parasitism (Table 2 and 3).

Kidane *et al*. (2019) identified *C. flavipes* and *C. sesamiae* as a natural enemy of sugarcane stalk borers and recorded the 10.1 – 31.9% percentage parasitism by *C. flavipes* and *C. sesamiae.* Similarly, Khanzada (1993) noted that *C. flavipes* acts as the larval parasitoid of sugarcane borers. Yaseen *et al*. (2021) reported the dominant species *viz*., *A. flavipes*, *S. inferens* and *Trichogramma* sp., which parasitize the sugarcane shoot borers. Likewise, Shrikant *et al.* (1999) monitor the seasonal activity of *C. flavipes* and recorded the highest levels of parasitism (0.0–17.9%) on graminaceous borers, including sorghum stem borer, *C. partellus* followed by sugarcane internode borer, *C. sacchariphagus indicus* (0.0–8.3%) and sugarcane shoot borer, *C. infuscatellus* (0.0–1.1%).

Assefa *et al.* (2006) in Ethiopia reported that two larval parasitoids, the native *C. sesamae* and the exotic *C. flavipes* and a pupal parasitoid, *Linnaemya* sp. (Diptera:Tachnidae) were recorded from stem borers, *Busseola* sp., C. *partellus* and *S. calamistis*. The level of parasitism by these indigenous and exotic natural enemies was very low, ranging from 2.3 to 6.3%. The tachinid, *S. inferens* parasitized shoot borer throughout the year at Coimbatore (David *et al.*, 1980) but hibernated in larvae of *C. auricilius* under north Indian conditions (Chandra and Avasthy 1988). Several exotic species of tachinids were evaluated against sugarcane borers in the laboratory and field with partial or no success (David *et al.*, 1986). In field studies, *C. flavipes* was most active on *C. partellus* in sorghum followed by internode borer and shoot borer of sugarcane in tropical India (Shrikant *et al.*, 1999). The present results were more or less similar to past workers in different parts of India and also in World. The tachinid *S. inferens* caused 11.2–17.2% parasitism of shoot borer and weather parameters had little influence on the parasitoid at Coimbatore during five-year study period (Anonymous, 2010).

The natural enemy complex and the level of parasitism recorded were high at the time of study and further study and more monitoring and research is needed to determine whether these impact on shoot borers population. Therefore, the impact of natural enemies might be enhanced through habitat management. Hence, awareness should be created among researchers and stakeholders to conserve these beneficial organisms. There is a need to conduct a study on the population dynamics of these pests and their natural enemies to have a clear understanding of the natural enemy complex and its impact on commercial sugarcane farms.

Table 1: Species compositions of sugarcane shoot borers (2017-18 to 2019-20).

Observation period (Month with Fortnight)	Species Composition (%)							
	2017-18		2018-19		2019-20		Pooled	
	S	C	S	C	S	C	S	C
December I	96.23	3.77	87.50	12.50	91.89	8.11	92.62	7.38
December II	90.91	9.09	90.48	9.52	95.45	4.55	92.31	7.69
January I	85.29	14.71	86.84	13.16	80.56	19.44	84.26	15.74
January II	72.73	27.27	84.62	15.38	100.00	0.00	87.80	12.20
February I	76.92	23.08	85.00	15.00	-	-	81.82	18.18
Min	72.73	3.77	84.62	9.52	80.56	0	81.82	7.38
Max	96.23	27.27	90.48	15.38	100	19.44	92.62	18.18
Mean ± SD	84.42 ± 9.69	15.58 ± 9.69	86.89 ± 2.34	13.11 ± 2.34	81.98 ± 8.30	8.03 ± 8.30	87.76 ± 4.79	12.24 ± 4.79
S= *Sesamia inferens* (Walker), C= *Chilo sacchariphagus indicus* (Kapur)								

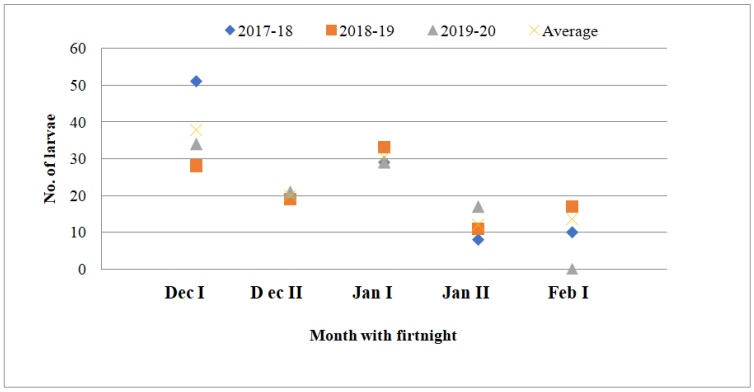

Fig. 1. Infestation level of *Sesamia inferens* based on number of larvae collected during 2017-18 to 2019-20**.**

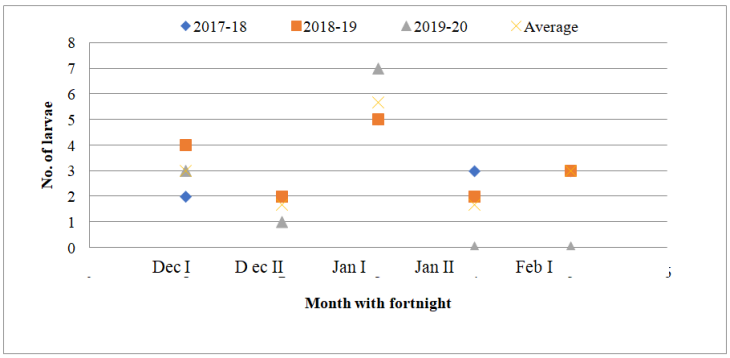

Fig. 2. Infestation level of *Chilo sacchariphagus indicus* based on number of larvae collected during 2017-18 to 2019-20.

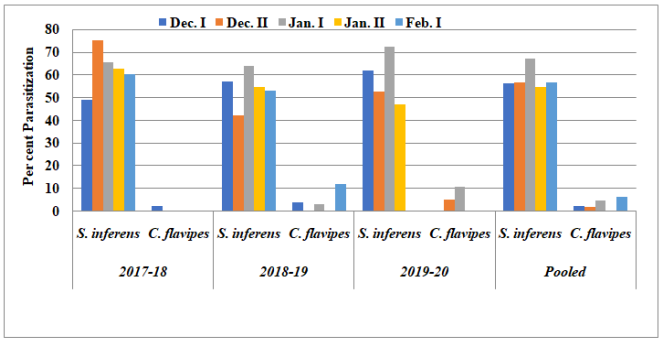

Fig. 3. Natural parasitization of sugarcane shoots borer, *Sesamia inferens* (2017-18 to 2019-20).

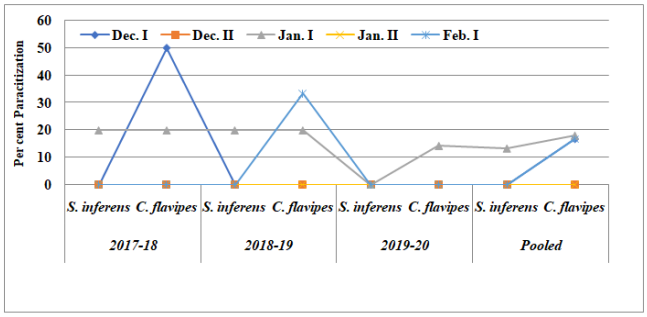

Fig. 4. Natural parasitization of sugarcane shoots borer, *Chilo sacchararipha*gus *indicus* (2017-18 to 2019-20).

CONCLUSIONS

From the above study, it can be concluded that the complex infestation of two shoot borer species *viz.*, *Sesamia inferens* (Walker) and *Chilo sacchariphagus indicus* (Kapur) was noticed at early stage of sugarcane in South Gujarat Agroclimatic Zone II. Maximum infestation of sugarcane shoots by *S. inferens* based on number of larvae was observed during first fortnight of December (average of 38 larvae followed by first fortnight of January (average of 30 larvae). Likewise, maximum infestation of sugarcane shoots by *C. sacchariphagus indicus* based on number of larvae collected was observed during first fortnight of January (average 5.67 larvae) followed by first fortnight of December and February (average 3.0 larvae) (Fig. 2). The maximum population of *S. inferens* was observed (87.76%) than *C. sacchariphagus indicus* (12.24%). Each species were naturally parasitized by complex of two parasitoids *viz.*, *Sturmiopsis inferens* Townsend

(Tachinidae: Diptera) and *Cotesia flavipes* Cameron (Hymenoptera: Braconidae). Larvae of *S. inferens* were maximum parasitized (58.17%) by *S. inferens* followed by *C. flavipes* (2.75%). Whereas, larvae of *Chilo* sp. were maximum parasitized by *C. flavipes* (10.29%) followed by *S. inferens* (2.67).

FUTURE SCOPE

Due to the impact of climate change, status of pest incidence also has been changed in many cropping system. In case of sugarcane, pink borer, *S. inferens* became dominant over the earlier major pest, *C. sacchariphagus indicus* in South Gujarat ecosystem. So, there is a need to study the detail life cycle, alternate host and integrated management practices of this major pest.

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