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# SPECIES DIVERSITY OF SUGARCANE SHOOTBORERS IN MAJOR SUGARCANE GROWING DISTRICTS OF ANDHRA PRADESH

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**ABSTRACT**

An extensive roving survey was conducted in different sugarcane growing districts of Andhra Pradesh at different cane developmental stages at bimonthly intervals during 2023-2024. Three shoot borers *viz.,* Early shoot borer, *Chilo infuscatellus*, Inter nodal borer *Chilo sacchariphagus indicus* and Top shoot borer, *Scirpophaga excerptalis* were recorded from 60 farmer fields in four districts *viz.,* Vizianagaram, Anakapalle, Krishna and Tirupati districts of Andhra Pradesh. Relative abundance and Diversity indices were calculated for each district based on population of shoot borers to understand the species composition of shoot borers in Andhra Pradesh. Vizianagaram recorded highest mean relative abundance of ESB (60.50%). While, Anakapalle recorded highest mean relative abundance of INB and TSB (40.20, 50.20). Anakapalle district recorded highest Shannon-Wiener index (1.01), Simpson index of Diversity (00.56) and Pielou's evenness index (00.91) indicating the species richness and evenness as more number of three shoot borer species were collected here. Based on the diversity indices it could be concluded that the sugarcane shoot borers exhibited uniform distribution and higher diversity in Anakapalle district and aggregate distribution type and lowest diversity in case of Krishna, Vizianagaram and Tirupati districts of Andhra Pradesh.

**KEYWORDS:** Diversity indices, Distribution, Simpson index, Shannon-Wiener index Species richness and Evenness.

## INTRODUCTION

Sugarcane (*Saccharum officinarum* L. : Poaceae) is an important commercial crop used for producing sugar, jaggery, ethanol, and various by-products. It is a source of income for millions of farmers and supports numerous ancillary industries such as sugar mills, ethanol production and biomass based power generation. It contributes significantly to the agricultural economy, especially in tropical and subtropical regions. Sugarcane is one of the important cash crops in India, contributing significantly to the agricultural economy and rural livelihoods. Worldwide sugarcane production has a vast and varied market and pivotal for industrial usage of sugar, biofuels, and spirits Brazil is the leading producer with a immerse production of 752.9 million tonnes, followed by India with 446.43 million tonnes. In India, 21% (56.48 lakh $ha^{-1}$) of the agricultural land is used for sugarcane production and yields 22% the total sugarcane in the world with average productivity of 79.03 tonnes $ha^{-1}$ (desagri.gov.in, 2023-24). In Andhra Pradesh, sugarcane was cultivated in an area of 0.66 lakh hectares with an annual production of about 2.10 million tonnes with an average productivity of 76.34 tonnes $ha^{-1}$. The long duration with diverse environmental conditions under which sugarcane is grown in the world encounters broad spectrum of pests and diseases which have come to acquire a place of priority thereby causing economic loss to growers in terms of quality and quantity. Among them, borers are the major destructive pests which cause 8 to 10 per cent cane yield losses at farmer's level and 10 to 15 per cent sugar recovery losses in sugar industries (Ahad *et al.,* 2015). About 45 per cent of yield losses in sugarcane are due to infestation by borer pests alone. The different stages in sugarcane cultivation includes germination, tillering, early growth, grand growth and elongation (Rao *et al.,* 2009). During these stages they are attacked by many pests and most importantly,ESB, *Chilo infuscatellus*, INB, *Chilo sacchariphagus indicus* and TSB, *Scirpophaga excerptalis*, Gurdaspur borer, *Bissetia steniellus* and Root borer, *Polyocha depressella* are the major shoot borer pests distributed in all the sugarcane growing areas of India (Gupta *et al.,* 1993). Knowledge of the relative abundance of distinct shoot borer species infesting sugarcane is very crucial in estimating the targeted control which reduces indiscriminate pesticide use and safer for environmental and economic reasons. The diversity of shoot borers, their species richness and relative abundance in the different sugarcane districts of the Andhra Pradesh has not been fully assessed. In this connection a roving survey was conducted in different sugarcane growing districts of Andhra Pradesh at different growth stages of sugarcane during 2023–2024 to know the sugarcane shoot borer species species diversity and their relative abundance.

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## MATERIAL AND METHODS

A random roving survey was conducted in different 60 farmers fields located in 12 villages of four sugarcane growing districts of Andhra Pradesh *viz.,* Vizianagaram (18.34° N & 83.21° E), Anakapalle (17.80° N & 82.96° E), Krishna (16.11° N & 80.93° E) and Tirupati (13.37° N & 79.32° E) during April 2023 to May 2024 (Figure

where, H′=Shannon diversity index

∑=Sum from species 1 to species

J′=Evenness of allotment of individuals among the species

$H_{max}$=Maximum species diversity

1). Destructive Sampling was done at different growth stages of sugarcane *viz.,* tillering, grand growth and harvesting. From each district, three villages and from each village, five farmers were selected for the survey. The survey techniques were followed as suggested by Rao *et al.,* 2009. Shoot borer larvae were collected by destructive sampling method from ten randomly selected spots and from each spot 10 plants were selected for larval collection. The Shannon–Wiener's, Simpson's and Pielou's evenness indices were used to determine the species diversity, richness and evenness. The Shannon–Wiener index was calculated to find out alpha of major species compared to the rare species. In taxonomic or ecological research, similarity indices provide quantitative bases of assessment in comparing species composition or biodiversity. The relative abundance and diversity indices were calculated using following formulae

$$\text{Relative abundance (\%)} = \frac{\text{Total number of individuals for each species}}{\text{Total number of individuals of all species}} \times 100$$

Shannon-Wiener index (H') (Shannon and Weaver, 1949)

$$H' = -\sum\left(\frac{n1}{n2} \text{ X } ln\ \frac{n1}{N}\right)$$

where ni is the number of individuals of amount (biomass) of each of the species and N is the total number of individuals for the site.

Simpson index of Diversity (D) (Simpson, 1949)

$$D = 1 - \sum_{i=1}^{S} (p_i)^2$$

pi=Proportion of total sample belonging to the $i^{th}$ species; S=Numbers of species

Pielou's evenness index (E) (Pielou, 1966)

$$J' = \frac{H'}{H_{max}}$$

(H')=log2S

Species richness : The number of different species found in particular environment or site.

## RESULT AND DISCUSSION

The survey conducted in 60 farmers fields in 12 villages in four coastal districts of Andhra Pradesh. This study clearly indicated the presence of three major shoot borer species among the surveyed districts of Andhra Pradesh *viz.,* ESB, *C. infuscatellus*, INB, *C. sacchariphagus indicus* and TSB, *S. excerptalis* by considering the morphological characters of larvae, adults and damage symptoms.

The nature and symptoms of damage were very distinc ti nsugarcan ea spe rth edamag ecause db ydifferent shoot borers. Early shoot borer, (*C. infuscatellus*) is severe at germination to tillering. The larvae is creamish with five violet stripes located dorsally and dorso laterally on its body with dark brown head. Adult Moth is small, slender, greyish brown or straw coloured with labial palpi projected upwards. Larva makes entrance hole at the ground level of sugarcane causes dead hearts which can be easily pulled out. The dead heart emits offensive smell, and it will be identified upto 45-50 days after sowing and in the set plantings rather than ratoon (Fig. 1).

Inter nodal borer (*C. sacchariphagus indicus*) affected the crop from cane formation to harvest. Moth is small, straw coloured. Forewings have a marginal dark line and the hind wings are whitish caterpillar has a white body with dark spots and a brown head. The larva bores at the nodal region and enters the stem. The tissues turn red and the hole is usually plugged with excreta. A larva may attack a number of nodes. Moth is medium sized, creamy white, slightly bigger than early shoot borer moth (Fig. 1).

Top shoot borer *S. excerptalis* female has tuft of orange red coloured hairs at the tip of the abdomen. In case of certain males, each of the forewings has a black spot. caterpillar is creamy white in colour with yellow head. Some of the caterpillar are white in colour and have black colour dorsal line with red colour head. A number of shot holes on affected leaves due to biting across the spindle, reddish brown charred dead heart that cannot be



**Table 1. Collection locations of sugarcane shoot borers from different districts o fAndhra Pradesh during 2023-24**

| S. No | District | Village | Geographic coordinates | |
|---|---|---|---|---|
| | | | Latitude (°N) | Longitude (°E) |
| 1. | | Perumallapalle | 13.37 | 79.32 |
| 2. | Tirupati | Sanambatla | 13.58 | 79.35 |
| 3. | | Mittapalem | 13.60 | 79.32 |
| 4. | | Kottapenta | 18.57 | 83.35 |
| 5. | Vizianagaram | Gollapalli | 18.63 | 83.34 |
| 6. | | Bobbili | 18.34 | 83.21 |
| 7. | | Govada | 17.80 | 82.96 |

| | | | | |
|---|---|---|---|---|
| 8. | Anakapalle | Bangarammapalem | 17.68 | 83.00 |
| 9. | | Venkupalem | 17.69 | 83.00 |
| 10. | | Challapalle | 16.11 | 80.93 |
| 11. | Krishna | Lakshmipuram | 16.39 | 81.44 |
| 12. | | Lankapalle | 16.22 | 80.84 |

**Table 2. Per cent incidence and Relative abundance (Mean ± SE) of Sugar cane shoot borers in surveyed districts of Andhra Pradesh during 2023-2024**

| Districts | ESB (*C. infuscatellus)* | INB (*C. sacchariphagus indicus*) | TSB (*S. excerptalis*) | Cumulative incidence of shoot borers for districts |
|---|---|---|---|---|
| Vizianagaram | 60.50 ± 0.05 | 12.80 ± 0.01 | 6.50 ± 0.06 | 30.82 |
| Anakapalle | 30.20 ± 0.05 | 40.20 ± 0.05 | 50.20 ± 0.05 | 41.58 |
| Krishna | 6.30 ± 0.03 | 25.50 ± 0.03 | 25.30 ± 0.02 | 33.07 |
| Tirupati | 3.00 ± 0.02 | 21.50 ± 0.05 | 18.00 ± 0.04 | 25.93 |

easily pulled out at later stages of the crop are damage symptoms. Interference with apical growth gives rise to side shoots and critical bunchy top symptom (Fig.1).

From Table 2 it was clearly indicated that the Among the four surveyed districts of Andhra Pradesh Anakapalle district recorded the highest overall cumulative incidence of three shoot borers of 41.58% followed by Krishna (33.07%), Vizianagaram (30.82%). Least cumulative incidence was recorded in Tirupati district of 25.93%. (60.50%) followed by Anakapalle (30.20%), Krishna (6.30%) and Tirupati (3.00%) respectively. Similar trend of relative abundance in case of INB, TSB was also observed in which Anakapalle recorded highest mean relative abundance (40.20, 50.20) followed by Krishna (25.50%, 25.30%), Tirupati (21.50%, 18.00%) and lowest abundance was recorded in Vizianagaram (12.80%,6.50%) (Table 2).

Survey in different growth stages of sugarcane in Andhra Pradesh revealed that 100% damage was due to INB during grand growth stage and vegetative stage was attacked by both ESB (35.50%) and INB (64.50%), whereas INB (57.50%) and TSB (42.50%) was recorded at harvesting (Fig.2).

A cursory examination from the 60 farmer fields from 12 villages of 4 districts indicated Vizianagaram recorded highest mean relative abundance of ESB



**Table 3. Diversity indices of Sugar cane shoot borers in surveyed districts of Andhra Pradesh during 2023-2024**

| Districts | Richness (S) | Shannon-Wiener index (H') | Simpson index of Diversity (D) | Pielou's evenness index (E) |
|---|---|---|---|---|
| Vizianagaram | 3.00 | 00.81 | 00.50 | 00.74 |
| Anakapalle | 3.00 | 1.01 | 00.56 | 00.91 |
| Krishna | 3.00 | 00.82 | 00.51 | 00.75 |
| Tirupati | 3.00 | 00.74 | 00.39 | 00.67 |

Diversity indices were worked out for the four surveyed districts based on the population of sugarcane shoot borers collected in each district. From Table 3 it was evident that the species richness is same for all areas as all three species of shoot borers *viz.*, ESB, INB and TSB present in all surveyed districts in A.P. Shannon- Wiener index was high for Anakapalle district (1.01) as the three species of shoot borers collected were high the aggregated dispersion patterns for rice stem borers speciesrichness and the evenness of the community increase. The range of Simpson index of Diversity and Pielou's evenness index ranges from 0 to 1. 0 and near values represents lower diversity and evenness whereas values near to 1 and 1 indicated the higher diversity and evenness.

The results are in line with the findings of Lenonard and Gration (2015) who admitted that rice stem borer exhibitedbothuniformandaggregatetypeofdistributions. Bonaventure *et al*. (2018) also conducted similar kind of investigation in irrigated lowland rice ecosystem in Kilombero, Tanzania and confirmed an aggregated dispersion pattern for stem borers. The current findings are in accordance with Rani *et al.* (2023) who reported the diversity of rice stem borers in AP, they also confirmed

in number compared to other districts which indicated the species richness in that particular area. Followed by Krishna (00.82), Vizianagaram (00.81) and lowest was recorded in Tirupati (00.74). Simpson index of Diversity was also followed the same trend as Anakapalle district recorded the high D value of 00.56 followed by Krishna (00.51), Vizianagaram (00.50) and least was recorded in Tirupati (00.39). Pielou's evenness index was also high in Anakapalle (00.91) as it comprised all the species of shoot borers with high number of larvae indicated the population swer eevenl ydistributed .Followe db yKrishna (00.75), Vizianagaram (00.74) and least diversity was recorded in Tirupati (00.67). All the values of diversity indices values were mostly on par for Both Krishna and Vizianagaram districts as it was mostly dominated by one species compare to other. From these findings it is clearly noticed that sugarcane shoot borers exhibited uniform distribution in case of Anakapalle district and aggregate distribution in case of Krishna, Vizianagaram and Tirupati districts of Andhra Pradesh.

The range of Shannon-Wiener index is 0 to 1 sometimes 1.5 to 3.5 (for high number of population) Shannon-Wiener index increases when both

Ndemah *et al.* (2001) and Gounou and Schulthess (2004) also reported the aggregate spatial distribution behavior of lepidopteran rice stem borers. Arbab (2014) who reported random distribution of *C. supressalis* in rice fields in Iran. Widyaningrum (2015) also studied the arthropods biodiversity by employing diversity indices in Indonesia. Moolman *et al.* (2013) reported a high diversity of stemborer parasitoids in South Africa. Otieno *et al.* (2006) also reported the higher Shannon-Wiener index (1.67) in cropping systems for lepidopteran stem borers in Kenya. Which supports the current findings of diversity of sugarcane shoot borers in Andhra Pradesh.

From this present study on the survey of shoot borers depicted the uniform and aggregated distribution patterns of shoot borers in surveyed districts of Andhra Pradesh. High species diversity and evenness reported from Anakapalle district followed by Krishna, Vizianagaram and Tirupati. Diversity indices were useful in predicting the species composition and their diversity in particular locality which in turn used for to predict their abundance which is useful to manage insect pests efficiently.



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