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Identification of Natural Enemy in Stem Borers Complex in Sugar cane at Tendaho Sugar Factory, Ethiopia.

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Abstract

Field study was conducted in Tendaho sugarcane plantation to identify the natural enemy of stalk borers under field condition using four commercial sugarcane varieties during 2013/14 cropping season. From 98 surveyed fields, a total of two different cotesia species were identified. the two species of natural enemy of stalk borers: *Cotesia flavies* and *Cotesia sesamiae* were recorded at Tendaho. Among these species, *Cotesia flavies* were the most dominant species. Among the different factors considered variety and cuttings had a significant effect on parasitism of stalk borer. Parasitism of stalk borer increased in the season. Among the different cuttings, ratoon had a significant variation in stalk borer larvae parasitism. Moreover, among the varieties, NCO334 had showed significant variation in percent parasitism of stalk borer larvae as compared to the other varieties in the plantation. as well as, in terms of percent parasitism of stalk borer larvae in the varieties B52/298, NCO334 and N14 showed no significant variation. The natural enemy complex and the level of parasitism recorded were high at the time of study. The percentage parasitism by *Cotesia flavies* and *Cotesia sesamiae* parasitoids was high, about 10.1 – 31.9%. Therefore further study and research work is needed to determine whether these impact on stem borer populations. Also due attention must be given to conserve the natural enemy.

Keywords: Stem borers, parasitoids, sugarcane, parasitism

Introduction

Sugarcane, *Saccharum* spp. L. (Poaceae) is a perennial crop that is grown as a source of sugar primarily in the tropical and subtropical areas of the world, including several countries in Africa, the Mascarene Island and Madagascar (Overholt *et al*. 2003). The taxonomic status and the origins of cultivated sugarcane varieties are not clear but the varieties of noble canes, *Saccharum officinarum* L., are thought to have originated in Melanesia and the ancestral form is thought to be the wild *Saccharum robustum* L. of New Guinea and adjacent islands (Pemberton and Williams, 1969). Other cultivated sugarcanes, *Saccharum barberi* L. and *Saccharum sinense* L., are believed to have been derived through natural hybridization of *S. officinarum* with the wild *Saccharum spontaneum*L. (Stevenson, 1965). Sugarcane has been grown in gardens in New Guinea since time immemorial (Pemberton and Williams, 1969) and cultivation of the crop in Africa and neigh bouring islands was first recorded in the Cape Verde Islands in the early 15th century (Polaszek and Khan, 1998). According to FAO (2011), a total of 23.8 million hectares of land is allocated to sugarcane in 100 countries of the world. So far there is no well

documented reference about how, when and who introduced sugarcane to Ethiopia except the clue provided by Duri (1969) regarding the probable time of introduction; which is estimated to be sometime during the early 18th century (Aregaw, 2002).

Although sugarcane is not an indigenous crop to Ethiopia, it has been grown in some parts of the country even before the commencement of large scale commercial plantation and establishment of the first modern sugar factory at Wonji meant mainly for local consumption (Aregaw, 2000).

Modern production in Ethiopia commenced in 1954 at Wonji by the Dutch Company, Handle Vereening Amsterdam (HVA) with sugar plantation of 5,000 ha. Late in 1962, the company established the second sugar factory, Shoa, expanding the cane plantation by 2000 ha. Similarly, other sugarcane plantations were established at Metahara (over 10,000 ha) and Finchaa (over 8,000 ha) in 1969 and 1998, respectively (Abera and Tesfay, 2001).

Sugarcane is one of the major cash crops providing immense income for many countries around the world. In Ethiopia, sugar industry plays a great role in the country's economy. Sugar and its by products are used for local consumption and export. The industry has also created job opportunity for a large number of people. International Sugar Organization (ISO) estimated, the present annual consumption of sugar in Ethiopia is 3.5 kilogram per capita; this is considered low even by Africa standards, which is estimated to be 20 kilograms per capital (ISO, 2003). The report also revealed that in order to reach to the Africa standard, Ethiopia still needs to produce an additional 80,000 metric tons per year to satisfy the current total demand. Thus, much effort has to be made to increase sugar production in the country. To bridge the gap between supply and demand as well as to exploit the international market, Ethiopia is on the verge of establishing new sugar factories in many corner of the country with large tract of sugarcane plantation besides expanding the existing ones. From the newly established plantations Tendaho sugarcane estate is the largest and when fully planted it will cover around 50, 000 hectares.

In addition to the aforementioned efforts, intensification of sugarcane cultivation is of a paramount importance. However, weeds, disease and insect pests are among the major constrains of sugarcane production in the country. In Ethiopia, insect damage to sugarcane has been recognized since the establishment of the first sugarcane plantation. Presence of world major sugarcane insect pest has also been reported in the first three sugarcane plantations of the country. According to Tesfay and Solomon (2007), about 14 insect pests are reported from the sugarcane plantation of Ethiopia. Despite record of these insect pests, only few: *Heteronychus licas* Klug (Coleoptera: Scarabaeidae), *Macrotermes sp. a*nd *Odontotermes sp.* (Isoptera: Termitidae), *Sesamia calamistis Hampson and Busseola spp.* (Lepidoptera: Noctuide), *Chilo partellus* Swinhoe (Lepidoptera: Crambidae) are considered to be economically important (Abera and Tesfay, 2001; Yoseph *et al*., 2006; Tesfay and Solomon, 2007).

The lepidopterous stem and cob borers are among the most injurious insect pest of maize, sorghum, millet, rice and sugarcane in sub Saharan Africa (Kfir *et al.*, 2002). Maes (1998) listed 21 species of stem borers that cause economic losses, however, within any region crop combination, a small sub set are damaging (Kfir *et al.*, 2002)

In the Ethiopia sugar estates; although no quantified yield loss report exists, it is observed that the sugarcane plantations are suffering from damage of stalk borer species complex. It is usually difficult to estimate the loss caused by borers. However, different methods have been developed to estimate the amount of sucrose lost because of bores. In Papua New Guinea (Ramu), losses of 0.82 tons of cane per hectare, 0.13 tons of sugar per hectare and 0.15% pol were estimated for every 1% of bored and rotting stalks (Eastwood *et al*, 1998; Kuniata, 1998; Allsopp and Sallam, 2001). Similarly, in Mauritius, *C. sacchariphagus* caused an average loss of 0.8% recoverable sucrose for every 1% of internodes bored (Ganeshan, 2001). In Indonesia, the yield loss due to *C. sacchariphagus* was reported to reach up to 10% of recoverable sugar for 20% internodes bored (Kuniata, 1994). Up to 43% reduction in recoverable sucrose was recorded in Taiwan due to 8.9% level of infestation by stem borers (Cheng, 1994).

The sugarcane borer larvae damage the plant in several ways. They reduce total biomass, quantity and quality of sugarcane. Tunnelling in the stalk reduces stalk weight as well as makes the stalk susceptible to lodging and breakage. Larval entry holes also serves as a point of entrance for pathogens especially red rot disease (Ogunwolu *et al.*, 1991). The damage by insects reduces cane yield and adversely affects the

quality of cane juice, which results in lower recovery of sucrose in the mill (Kuniata, 1998, 2000; Posey, 2004). In addition, larval feeding results in increased fibre, glucose, fructose and rafenose contents and reduced glucose/fructose ratio (Eastwood *et al.*, 1998; Posey, 2004).

Identifying the natural enemy and understanding their significance in the sugarcane production system is the primary step in pest management program. In this regard, no attempts that indicated the presence of natural enemy of stem borer (Yoseph *et al*., 2006), no extensive works have been undertaken in Tendaho sugarcane plantations. Identification natural enemy of stem borer species complex according to their significance to the estates has a paramount importance in their management. therefore this work was initiated with the of identify the associated natural enemies with larvae of the stem borer complex.

Materials and Methods

Description of the study Area

Tendaho is situated in the lower Awash plain in Afar Regional Government State at $11^0 44`$ N latitude and $41^0\ 05`$ E longitude and at an altitude of 374 m a.s.l. The estate is located at about 610 km southeast of Addis Ababa. The total area is about 50,000 hectares from these 17,000 hectares was planted till now with estimated average cane yield of 147 tons/ha. It receives an average of 200 mm annual rainfall distribution (from June to September). The mean minimum and maximum temperatures are 22.91^{o}C and 37.72^{o}C, respectively. The estate sugarcane production is undertaken with irrigation (Tadesse, 2004).

Reports of WWDSE-WPCSI (water works design and supervision Enterprise in association with water and power consultancy services, India) 2005 suggested soils of Tendaho are classified into four major soil types (Fluvisols, vertisols, Solonetz and regosols) and into eleven soil units of which fluvisols and vertisols cover about 47 and 39% of the gross surveyed area respectively. Ph value range from 7.0 to 8.5 (slightly to moderately alkaline).

Meteorology data during the study period

Monthly average rainfall, temperature and relative humidity were recorded during the study period. They were collected from the Tendaho Meteorology Station and presented in table 1.

Table 1. Monthly average metrology data of the sugarcane plantations from June to January 2014

Site	Months	Rainfall (mm)	Temperature (^{o}C)*		Relative humidity (%)	
			Minimum	Maximum	Minimum	Maximum
Tendaho	Jun.	0.0	26.9	43.3	31	44
	Jul.	38.6	27.4	41.5	37	63
	Aug.	1.9	28.8	38	40	78
	Sept.	0.0	26.3	40.2	37	65
	Oct.	9.8	36	40.8	38	61
	Nov.	0.0	22.5	40.5	47	70
	Dec	0.0	16	36.5	46	63
	Junu.	0.0	20.4	35.8	50	65

*= The temperature data were collected at 1.5 m above ground

Natural Enemy of Stalk Borers.

Twenty-five heavily infested plants at younger stage were randomly selected from each field on different varieties; larvae found on a plant/stalk were collected and taken to the laboratory where they were reared until parasitoids emergence. Larvae were reared on piece of sugarcane stalk whereas cocoons were kept in Petri dishes until adult of the natural enemy emerged. Percent parasitism was calculated per susceptible stage of the stem borer by using the following formula.

$$\text{Parasitism (\%)} = \frac{\text{Number of parasitized larvae}}{\text{Number of healthy larvae + Number of parasitized larvae}} X100$$

Data analyses

The data analyses were done using the JMPIN version 4.0.3 One way ANOVA were carried out for the data in the field monitoring of stalk borer and natural enemies observation. For each pair of means minimum significant difference (MSD) was calculated by Tukey-Kramer method. All the field data were checked for normality.

Results and Discussion

Natural Enemy of Stalk Borers

Level of parasitism of stalk borer larvae feeding in different sugarcane Varieties grown in Ratoon plant.

There was a highly significant difference in the number of wasp emerged from the larvae collected from the population of the four different sugarcane variety of stalk borer ($F_{(3, 32)} = 3.01$ and $p=<0.0444$) (Table 13). Peak parasitism was observed in N14, B52/298 and CO680 but the least was in NCO334 (Table 13). A significant parasitism difference was detected between larvae recovered from N14, B52/298 and CO680, and NCO334 (Table 13). The level of parasitism in different sampling days showed increasing trend in N14 and CO680 and decreasing in B52/298 and NCO334 (Figure 8). Natural enemies such as larval parasitoids, *Cotesia Sesamiae* Cameron (Hymenoptera: Braconidae) and *Cotesia flavipes* Cameron (Hymenoptera: Braconidae), and pupal parasitoid, *Linnaemya sp,* (Diptera: Tachnidae), were reported prevalent in sugarcane plantation of Ethiopia (Yoseph *et al.,* 2006).

The parasitoid collected from the stem borer are two larval parasitoids, the native *Cotesia sesamiae* Cameron (Hymenoptera: Braconidae) and the exotic *Cotesia flavipes* Cameron (Hymenoptera: Braconidae), were reared from stem borers collected. The level of parasitism by these indigenous and exotic natural enemies was high ranging from 10.1 – 31.9% (Table 13).

Previous studies in sorghum and maize fields of Ethiopia (Getu *et al.,* 2001; Yitaferu and walker, 1997, Gebre-Amlak, 1985) reported a large number of parasitoids to be associated with stalk borers. However, only few of these were recorded in this study. The braconid, *Cotesia flavipes,* was the only exotic parasitoid of stem borers recorded in this study. This larval parasitoid was introduced from Pakistan in to Kenya (overhotl *et al.,* 1994) from where it was released to other African countries (overholt, 1998). The parasitoid was never been released in Ethiopia, but it was recently found established on *C.partellus, S. calamistis* and *B. fusca* in maize and sorghum (Getu *et al.,* 2001). *C. flavies* required low precipitation, high evapo transpiration, high minimum temperature and less fertile soil was more or less similar to the requirements of *C. partellus,* which was the most suitable host for *C. flavipes* (Emana *et al.,* 2001).The recovery of this parasitoid in a sugarcane field at Tendaho estate may indicate its suitability of the environment and permanent establishment in the country for borer management. The other parasitoids recorded in this study are the indigenous braconid larval parasitoid, *C. sesamiae. C. sesamiae* parasitoid was reported to be a common parasitoid of stem borers in cereal grains (Getu *et al.,* 2001). 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. Mean (+ SE) percentage parasitism of stalk borer larvae on different sugarcane varieties in ratoon crop per varieties.

Variety	Over all mean ± SE
NCO334	10.10 ± 5.10a
CO680	28.50 ± 5.03b
B52/298	29.35 ± 5.28b
N14	32.00 ± 7.40b
F - value	3.01
P- value	<0.0444

Means followed by the same letter (s) are not significantly different from each other at 5%, Tukey–Kramer Test.

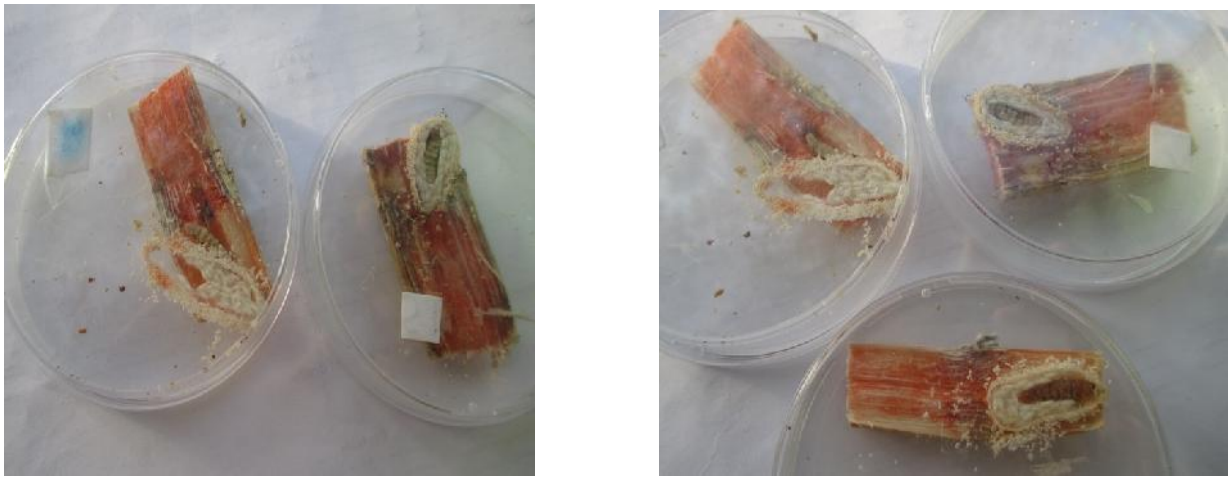

Plate 1 Cocoons emerged from larvae

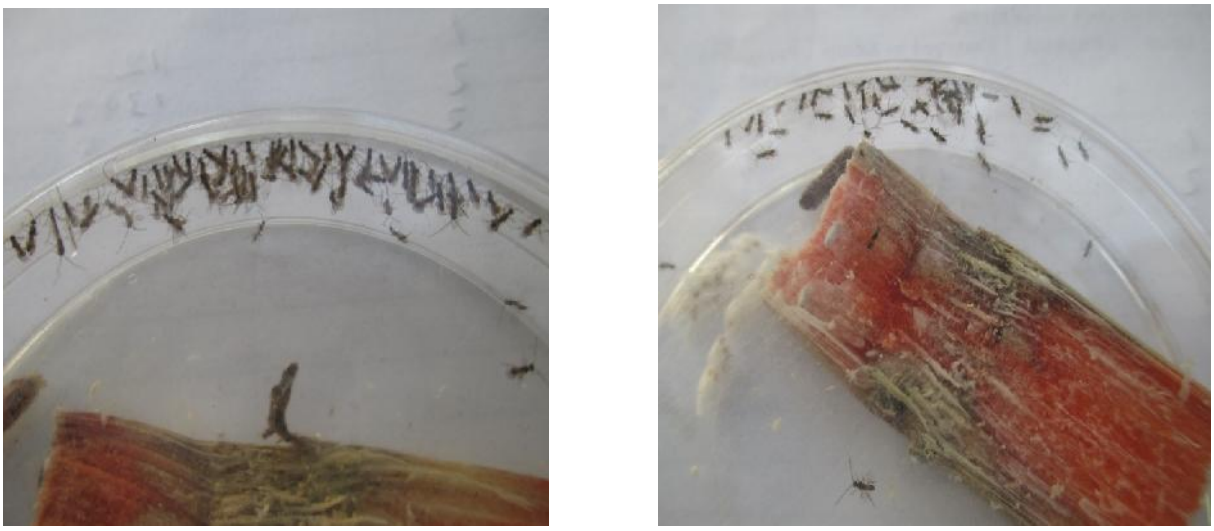

Plate 2 Parasitoid emerged from cocoons

Parasitoid emerged from cocoons

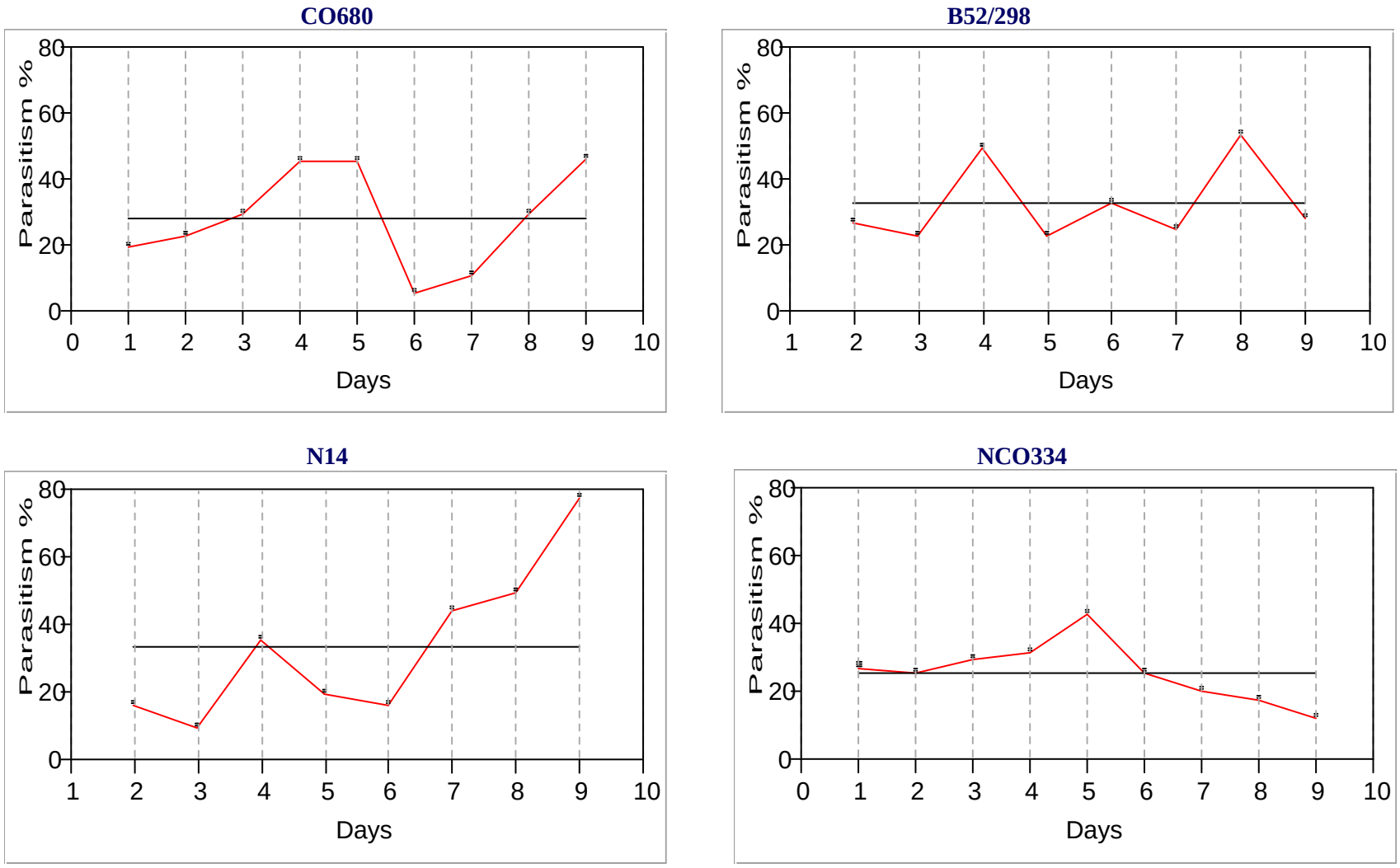

Figure 1. Percent parasitism of stalk borer larva on different sugarcane varieties over sampling days.

Conclusion

Two different Cotesia species belonging to one families were identified. These are; *Cotesia flavies* and *Cotesia sesamiae* Moreover, based on analysis, *Cotesia flavies* larvae parasitoid were recorded as the most dominant species in the plantation. There is a threat that *E. succharina* could invade sugarcane fields already being present in the estates. Intense supervision is required to control the level of infestation by borers and prevent colonization of sugarcane by *E. saccharina*.

In addition, the study revealed that among the different factors considered in the study, variety and cuttings had a significant effect on parasitism stalk borers larvae. Percent parasitism increased in ratoon crop as compared to plant cane. On the other hand, among the varieties, NCO334 had showed significant variation in percent parasitism of stalk borer larvae as compared to the other varieties in the plantation. as well as, in terms of percent parasitism of stalk borer larvae in the varieties B52/298, NCO334 and N14 showed no significant variation. The natural enemy complex and the level of parasitism recorded were high at the time of study. The percentage parasitism by *Cotesia flavies* and *Cotesia sesamiae* parasitoids was high, about 10.1 – 31.9%. Therefore further study and research work is needed to determine whether these impact on stem borer populations. Also due attention must be given to conserve the natural enemy.

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 stem borer populations. Therefore, the impact of natural enemies may be enhanced through habitat management. Hence, awareness should be created among researchers and stack holders to conserve these beneficial organisms.

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