SAARC J. Agri., 11(2): 103-116 (2013)

IDENTIFICATION AND DISTRIBUTION OF SUGARCANE STEM BORER IN BANGLADESH

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ABSTRACT

Field surveys were conducted during the cropping season of 2010-2011 to assess the distribution of Sugarcane stem borer species in 12 AEZs of Bangladesh. These surveys documented abundance and their distribution and results clearly showed the existence of the stem borer at all locations surveyed, but with a higher incidence in the Atwary (36%) and initiation of infestation was observed on 20 May. Stem borer incidence and distribution varied significantly among the different locations. Second highest rate of infestation (32%) was recorded in Bashudebpur followed by Dinajpur (31%), Pabna and Akandabaria farm (30%). The lower infestation was recorded in Kaliganj. The percentage of stems attacked at the Kaliganj has never exceeded 23% followed by Rajshahi (28%), Thakurgaon and Faridpur (29%). The rate of infestation of stem borer (*Chilo tumidicostalis*) in different locations varied from 23-36%. While morphological characteristics of stem borer species were identified with standard keys and species composition was only predominated by *Chilo tumidicostalis* Hampson, though previous workers found other borers in addition to this species. The sex ratio of adult moth *Chilo tumidicostalis* was 1:1.42 after emergence from the reared collected pupae from different locations.

Key words: Alternate host, Caterpillar growth stage, Moths, Pupae, Lepidopteran pest, Sugarcane.

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.), a perennial tropical crop with a high self-tolerant nature, is grown for sugar stored in its stem and propagated through stem cuttings. Sugarcane is grown around the world between tropical and sub-tropical

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Received: 28.04.2013

climate (North latitude = 35^0C and South latitude = 35^0C). Sugarcane is cultivated in more than 100 countries of the tropical and sub-tropical regions of the world (Humbert, 1968). Around 70% of the world's sugar is produced from this crop (Chowdhury and Vasil, 1993). Sugarcane is cultivated on an area of about 0.16 million hectare of land which almost 50% area is located in the sugar mills zone, and the remaining 50% is grown in the non-mills zone, where sugarcane is mostly diverted for jaggary and juice production. Presently, 15 sugar mills are in operation under Bangladesh Sugar and Food Industries Corporation (BSFIC) with a capacity of 0.21 million tons of sugar production per year (BSFIC, 2008).

Stem borer, *Chilo tumidicostalis* Hampson is a serious insect pest of sugarcane in Bangladesh (Karim and Islam, 1977), Thailand (Suasa-ard et al., 2000), Nepal, Burma (Williams et al., 1969) and Australia (Sallam, 2006). Incidence of stem borer infestation starts from the end of April and continues up to November. However, it remains most abundant from June to September. Hundred percent crop losses by stem borer infestation were recorded in Setabgonj Sugar Mills in Bangladesh during 1973-1974 cropping season when attack reached as high as 100% due to the stem borer infestation (Karim and Islam, 1977). In India, it caused 8.2-12.6% yield loss sometimes reaching up to 70% with 10.75-48.55 % sugar recovery in endemic areas (Khanna et al., 1957; Butani, 1961). Gupta and Avasthey (1960) also reported 25-70% and 12-60% in cane yield due to primary and secondary infestation, respectively in different sugarcane varieties, along with 0.5-3.5 unit loss of sugar recovery in West Bengal, India. Stem borer is the most destructive pest of sugarcane in growing areas of Bangladesh. Maximum weight losses of 28.73, 18.64 and 18.01% and sucrose losses of 9.74, 11.21 and 15.93% were estimated in Isd 16, Isd 21 and Isd 30 respectively having more than three bores in infested cane (BSFIC, 2008).

The stem borer genus *Chilo* contains 41 species of which *Chilo tumidicostalis* had been so far identified worldwide attacking many crops particularly Graminae/Poaceae family. This species and *Chilo auricilius* are very common and destructive in Bangladesh and India (Khanna et al., 1957; Avasthy, 1983). In addition, internode borers, *Chilo sacchariphagus indicus* Kapur is also a major pest of sugarcane in Peninsular India (Gupta and Avasthy, 1957). Climatic and soil conditions of both Bangladesh and India are almost similar. Besides, availability of alternate hosts during off season facilitates over-wintering of stem borer in Bangladesh. Therefore, there is a high possibility of invasion of the pest in Bangladesh. In such situation, distribution and identification of this pest at certain intervals are essential to know whether any new pest species has invaded in this country. In fact, no comprehensive work has so far been undertaken in Bangladesh to identify the different species of stem borer attacking sugarcane cultivated throughout the country since 1962. In this context, the present study was undertaken to identify and to assess the distribution of sugarcane stem borers in Bangladesh.

MATERIALS AND METHODS

Study site

The survey was conducted at nine locations covering 12 Agro-Ecological Zones (AEZ) of Bangladesh with date of sample collection, date of placing sample in rearing box in the laboratory (Table 1). Stem borer infested sugarcanes were collected from the selected locations from August to September 2011. Nine Sugar Mills zones of Bangladesh namely Atwary, Panchagar Sugar Mills (PSM); Patuadangi farm, Thakurgaon Sugar Mills (TSM); Sultanpur farm, Setabganj Sugar Mills (STSM); Puthia, Rajshahi Sugar Mills (RJSM); Bashudebpur, Natore Sugar Mills (NTSM); BSRI farm, Pabna Sugar Mills (PBSM); Akandabaria farm, Carew & Co. Sugar Mills; Modhukhali, Faridpur Sugar Mills (FSM) and Kaliganj, Mobarakganj Sugar Mills (MKSM) were selected for this study (Figure 1).

Collection of sample

A comprehensive survey was conducted through questionnaire by extensive visit throughout the selected locations during the cropping season of 2010-2011 and stem borer infested sugarcane fields were observed in the morning and afternoon. Adult emergence of *Chilo tumidicostalis* from pupae was recorded by rearing the collected specimen of 9 locations during the period from August to October 2011 and periods of stem borer infestation were recorded for nine locations of Bangladesh during the period from May to June 2011 (Figure 2 & 3). A total of 100 infested sugarcanes (Plate 6) were checked for recording the incidence of target pest in each field of cane grower. Hundred plants were examined randomly at each sugarcane field to obtain the percent infestation of stem borer (Figure 4). At each location, three sugarcane fields were randomly selected from which specimens were collected at random from 3 different cane growers. The percent of stem borer infested sugarcane per location was calculated based on the number of total plants observed and the number of infested plants. Accordingly fifty (50) plant specimens from each location were cut and tied into bundle. The bundle of cane containing borers was brought to Entomology Laboratory of Regional Sugarcane Research Station (RSRS), Thakurgaon as well as Entomology Laboratory of Bangladesh Sugarcane Research Institute (BSRI), Ishurdi, Pabna for morphometric study. Rearing boxes were kept ready before the specimen were carried to the laboratory.

Rearing of sugarcane stem borer

Infested sugarcane collected from different locations were placed separately in netted rearing cage (90 cm × 60 cm) and placed on laboratory desk. In order to culture the specimen larvae were collected by splitting borer infested stem of sugarcane. They were reared in the plastic boxes (23.0 cm in dia. and 10.5 cm high) with pieces of sugarcane stalk as food until pupation. The pupae were kept in a Petri dish (11.5 cm × 1.5 cm) with adequate moisture provided with water-soaked filter paper in the bottom of the Petri dish until the adult emergence. Pupae were then transferred to the

insect rearing cage (60 cm × 60 cm × 90 cm). Stock culture of stem borer was maintained at room temperature ranging from 20-30°C. Adults emerged from full grown pupae at 7-15 days after pupation. Emerged adults were placed separately in a killing jar and their number was counted. Adult moths were then pinned, stretched and preserved for identification.

Identification of sugarcane stem borer (*Chilo tumidicostalis* Hampson)

The major characteristics used to identify the adult male and female of sugarcane stem borer at different stages are given in appendix I. Specimens were primarily identified with the help of taxonomic keys described by Butani (1956), Alam (1967) and Butani and Jotwani (1984) (Appendix II). The laboratory reared freshly emerged adults (moths) collected from nine locations were compared with adult characteristics (Plate 1-6). For this purpose specific characters of each specimen were studied thoroughly and checked with the characters of the keys and all the characters were studied under binocular microscope. Larval (caterpillar) characteristics were also considered to confirm the identification.

Design and Statistical analysis: The experiment was laid out in Completely Randomized Design (CRD) with three replications. The treatment means were compared using Duncan's Multiple Range Test i.e. DMRT (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Infested samples with larvae collected from different locations, number of pupae and number of total adult individuals emerged from the laboratory-reared sugarcane are presented in Table 2. The recently emerged adults collected from nine locations of Bangladesh belong to the genus *Chilo* under the family Pyralidae. In the present study through identifying characteristics keys as described by Butani (1956), it might be assumed that only *Chilo tumidicostalis* would be the major pest of sugarcane in all the nine locations of Bangladesh. The present results are supported by Isaac and Rao (1941) and Isaac and Venkataraman (1941) who had shown the same larval and pupal characters of stem borer.

Morphological variations were not observed among the emerged adults of both male and female. The results indicated that the morphological characteristics of larva, pupa and adults were completely comparable to that of *Chilo tumidicostalis* only. Thus, only one species *tumidicostalis* belonging to the genus *Chilo* under the family Pyralidae was identified. Avasthy (1983) reported that two species of *Chilo* (i.e., *Chilo tumidicostalis* and *Chilo auriciliusi*) had bored into sugarcane, corn and paddy. He observed that these species also had attacked other plants under the family Graminae/Poaceae. Kapur (1950) reported that *Argyria tumidicostalis* later renamed as *Chilo tumidicostalis* Hampson was the major borer pest of sugarcane which prevails in Bangladesh.

Number of pupae emerged

The highest number of pupae (73) was produced from larvae of infested sugarcane collected from Patuadangi farm, Thakurgaon (Table 2). The second highest number of pupae (70) was obtained from the samples with larvae collected from Sultanpur farm, Setabganj. On the other hand, the lowest number of pupae (56) was found from the collected samples with larvae of Akandabaria farm, Carew & Co., Dorshona. Almost similar number of pupae viz., 60, 62, 65, 67, 68 and 69 were recorded from the sugarcane samples (with larvae) of Kaliganj, BSRI farm, Pabna, Puthia, Modhukhali, Bashudebpur and Atwary, respectively.

Number of Adults emerged

From the Figure 2 the highest number of adults (50) emerged from the pupae were recorded from Patuadangi farm followed by Atwary, Sultanpur farm and Modhukhali (49). The lowest number of adults (45) emerged from the pupae of Akandabaria (Carew & Co.) followed by BSRI farm (46). The number of adults emerged from the pupae of Puthia, Kaliganj and Bashudebpur were 47, 47 and 48, respectively.

Male and female Sex Ratio

The numbers of male and female stem borer moths emerged from the pupae of different locations are presented in Table 2. The highest number (24) of male moths emerged from the pupae of Patuadangi farm and the second highest number (22) of male moths emerged from Sultanpur farm. Number of male moths of 21 and 20 emerged from the pupae of the samples was collected from Atwary and Bashudebpur, respectively. Male moth emergence was poor from the pupae of samples collected from Modhukhali (19), Puthia (18), BSRI farm (18), Kaliganj (18) and Akandabaria farm (17). The highest number (30) of female moths emerged from the pupae of the samples from Modhukhali and the second highest number (29) from the samples of Puthia and Kaliganj followed by Atwary (28), Bashudebpur (28), BSRI farm (28) and Akandabaria farm (28). Twenty seven and twenty six female moths emerged individually from the pupae of samples collected from Sultanpur farm and Patuadangi farm. The number of female moth emergence ranged from 26-30. The lowest number (26) of female moth emerged from the pupae of samples collected from Patuadangi farm. A total of 430 moths emerged from the collected specimens of 9 different locations. Of them, 177 were males and 253 were females with a sex ratio of 1:1.42.

Periods and rate of infestation by *Chilo tumidicostalis* in different locations

From the figure 3 the initiation of infestation by stem borer was observed on 20 May in Atwary, 22 May in Patuadangi farm and 25 May in Sultanpur farm. On the other hand, stem borer infestation was found on 10 June in Rajshahi, 15 June in Natore, 18 June in Faridpur, 16 June in Pabna, 14 June in Akandabaria farm and 20 June in Mobarakganj. Panchagor, Thakurgaon and Dinajpur mills zones were the most *Chilo tumidicostalis* Hampson prone areas in Bangladesh. These zones have medium high

land, sandy and sandy loam soil texture, rain fed in March, April and May but were rainy in June, July and August because these areas are closer to Dargilling and Himaloy. Sugarcane is a major crop in these areas covering 14-18 months in the field. Maize and Rice is the alternate/sequential crop which is alternate host of sugarcane stem borer. In these areas, sugarcane is planted in the early season. For this reason, stem borer infestation reached as high as 100% in Sultanpur farm and Dinajpur (Karim and Islam, 1977).

Survey record on the infestation rate of stem borer in different locations

From the figure 4 survey report indicates that the highest rate of infestation (36%) was observed in Atwary. Second highest rate of infestation (32%) was recorded in Bashudebpur followed by Dinajpur (31%), Pabna and Akandabaria farm (30%). The lower infestation was recorded in Kaliganj (23%), followed by Rajshahi (28%), Thakurgaon and Faridpur (29%). The rate of infestation of stem borer (*Chilo tumidicostalis*) in different locations varied from 23-36%.

Distribution of stem borer on host and locality

Stem borer, *Chilo tumidicostalis* (Hampson) was the most abundant species which recorded 430 individuals that emerged from 590 pupae (72.88%) reared in infested sugarcane collected from 9 different locations situated at North, South, West and Central regions of Bangladesh. These species predominantly emerged from the specimens collected from Thakurgaon but became gradually infrequent in the infested sugarcane collected from Dinajpur, Panchagor, Natore, Faridpur, Rajshahi, Pabna, Kaliganj and Dorshona (Figure 3). The present study indicated that *Chilo tumidicostalis* is the most damaging insect pest that bored into the sugarcane, though previous workers found other borers in addition to *Chilo auricilius.* Other borers which attack maize and rice choose sugarcane as alternate host. A research report was found in the web site that there were many species of *Chilo* so far identified worldwide which attack many crops particularly under Graminae/Poaceae family. The genus *Chilo* contains 41 species and of them, 8 species (i.e., *Chilo agamemnon*, *C. auricilius, C. infuscatellus, C. orichalocociliellus, C. partellus, C. sacchariphagus, C. terrenellus and C. tumidicostalis*) have damage potential in Australian cane if they invade the mainland. Additionally, two *Chilo* species of Australia (i.e., *Chilo polychrysus* and *C. suppressalis)* are major pest of rice and minor pest of sugarcane in some countries in Asia (David and Easwaramoorthy, 1990). However, *Chilo suppressalis* appears to be strictly a pest of rice, but there is no evidence in the literature that it can survive on sugarcane. Two other species (*Chilo diffusilineus* and *C. zacconius*) were found in Africa but might have negligible impact. The remaining 29 *Chilo* genera are not known to be the pests of sugarcane.

Stem borer, *Chilo tumidicostalis* (Hampson) is originally an Asian species. Populations in Madagascar, Malaysia, Mauritius and Reunion have probably been introduced by human in the mid 1800s (Williams, 1983). *Chilo tumidicostalis* is reported to feed exclusively on sugarcane, found in Bangladesh, India, Myanmar, Nepal and Thailand (David and Easwaramoorthy, 1990; Suasa-ard et al., 2000). It is known as the Bengal borer in India and used to be considered a major pest of

sugarcane in Purnea and adjoining parts of Bhagalpur, Munger and Darbhanga districts of Bihar, but its importance seems to have declined during the 1980s (Kumar and Kalra, 1987). However, in Thailand, *C. tumidicostalis* used to be considered a major pest of sugarcane until the late nineties, when it unexpectedly became the most important pest of sugarcane. Severe outbreaks were reported in the provinces of Sa Kaew and Buri Rum in Thailand (Suasa-ard et al., 2000) and Dinajpur, Setabganj in Bangladesh (Karim and Islam, 1977) where infestation reached up to 100%. However, this insect pest should have a high spread and colonization potential in sugarcane growing areas, especially in North Queensland, Taiwan and Pakistan (Sallam and Allsopp, 2002; Cheng et al., 1997; Ullah et al., 2006).

CONCLUSION

The present study indicated that *Chilo tumidicostalis* Hampson is the only insect pest that bored into sugarcane, though previous workers found other borers in addition to *Chilo tumidicostalis*. Other borers which attack sugarcane are the rice, maize borer and they choose sugarcane as alternate host. However, it is now essential to undertake more research work to find out other borers which may have been attacking sugarcane as alternate host. Another study could be conducted to identify some of the borers invading Graminae/Poaceae crops of Bangladesh.

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Table 1. Name of locations, date of collection and placement of sugarcane samples in rearing boxes in the Entomology Laboratories

Selected locations	Date of sample collection	Date of sample placement in rearing box	Laboratory
Atwary, Panchagor Sugar Mills (PSM)	24 August 2011	25 August 2011	RSRS, Thakurgaon
Patuadangi farm, Thakurgaon Sugar Mills (TSM)	26 August 2011	27 August 2011	RSRS, Thakurgaon
Sultanpur farm, Setabganj Sugar Mills (STSM)	25 August2011	26 August 2011	RSRS, Thakurgaon
Puthia, Rajshahi Sugar Mills (RJSM)	10 September 2011	11 September 2011	BSRI, Ishurdi, Pabna
Bashudebpur, Natore Sugar Mills (NTSM)	11 September 2011	12 September 2011	BSRI, Ishurdi, Pabna
Modhukhali, Faridpur Sugar Mills (FSM)	12 September 2011	13 September 2011	BSRI, Ishurdi, Pabna
BSRI farm, Pabna Sugar Mills (PBSM)	17 September 2011	18 September 2011	BSRI, Ishurdi, Pabna
Akandabaria, Carew & Co. Sugar Mills (Carew & Co.)	18 September 2011	20 September 2011	BSRI, Ishurdi, Pabna
Kaliganj, Mobarakganj Sugar Mills (MKSM)	19 September 2011	21 September 2011	BSRI, Ishurdi, Pabna

Table 2. The number of stem borer moth emerged from infested sugarcane samples from Nine sugar Mills of Bangladesh

Selected locations	Number of observed samples	Number of pupae produced	Number of adult emerged	♂ and ♀ ratio of *Chilo tumidicostalis*	
				♂	♀
Atwary, Panchagor Sugar Mills (PSM)	100	69	49	21 (30.43)	28 (40.58)
Patuadangi farm, Thakurgaon Sugar Mills (TSM)	100	73	50	24 (32.88)	26 (35.62)
Sultanpur farm, Setabganj Sugar Mills (STSM)	100	70	49	22 (31.43)	27 (38.57)
Puthia, Rajshahi Sugar Mills (RJSM)	100	65	47	18 (27.69)	29 (44.62)
Bashudebpur, Natore Sugar Mills (NTSM)	100	68	48	20 (29.41)	28 (41.18)
Modhukhali, Faridpur Sugar Mills (FSM)	100	67	49	19 (28.36)	30 (44.78)
BSRI farm, Pabna Sugar Mills (PBSM)	100	62	46	18 (30.00)	28 (46.67)
Akandabaria, Carew & Co. Sugar Mills (Carew & Co.)	100	56	45	17 (30.36)	28 (50.00)
Kaliganj, Mobarakganj Sugar Mills (MKSM)	100	60	47	18 (29.03)	29 (46.77)
Total	900	590	430	177	253

Male **:** Female = 1 **:** 1.42

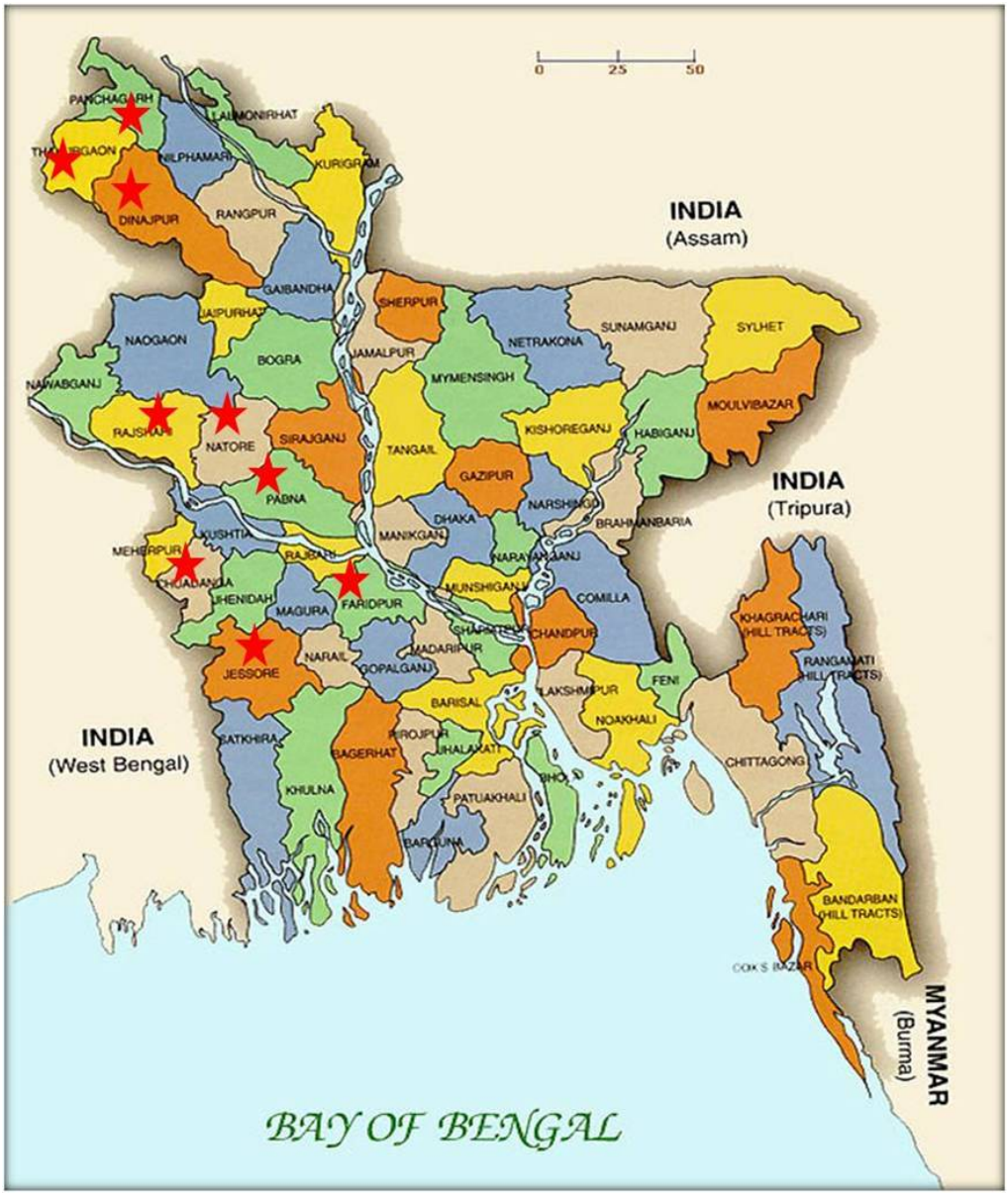
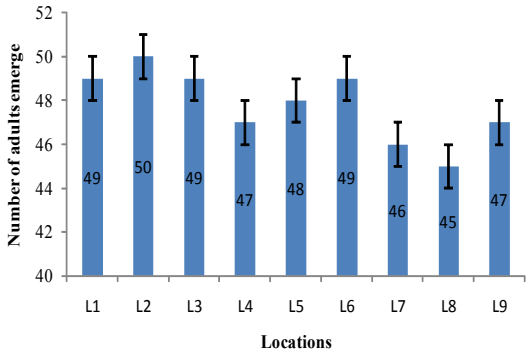


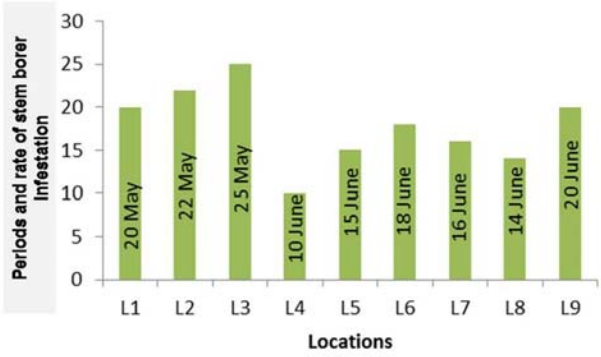
Figure 1. Stars in the map showing nine selected locations under 12 Agro-Ecological Zones (AEZ) of Bangladesh



L_1 = PSM, L_2= TSM, L_3= STSM, L_4= RJSM, L_5= NTSM, L_6= FSM, L_7= PBSM,

L_8= Carew & Co. and L_9= MKSM, Standard bar indicates standard error.

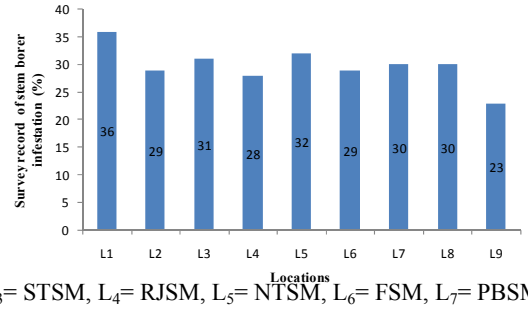
Figure 2. Adult emergence from the pupae of *Chilo tumidicostalis* reared from the collected specimens of nine locations of Bangladesh during August-October, 2011



L_1 = PSM, L_2= TSM, L_3= STSM, L_4= RJSM, L_5= NTSM, L_6= FSM, L_7= PBSM,

L_8= Carew & Co. and L_9= MKSM

Figure 3. Periods and rate of infestation by stem borer in nine locations of Bangladesh during May-June, 2011 (P<0.01).



L_1 = PSM, L_2= TSM, L_3= STSM, L_4= RJSM, L_5= NTSM, L_6= FSM, L_7= PBSM,

L_8= Carew & Co. and L_9= MKSM

Figure 4. Mean percent infestation by stem borer in nine locations of Bangladesh during the cropping season of 2010-2011 (P<0.01).

Plate 1. Seven spots present in terminal side of adult *Chilo tumidicostalis*

Plate 2. Two – five tier eggs of *Chilo tumidicostalis*

Plate 3. Four pinkish brown stripes (mature larva)

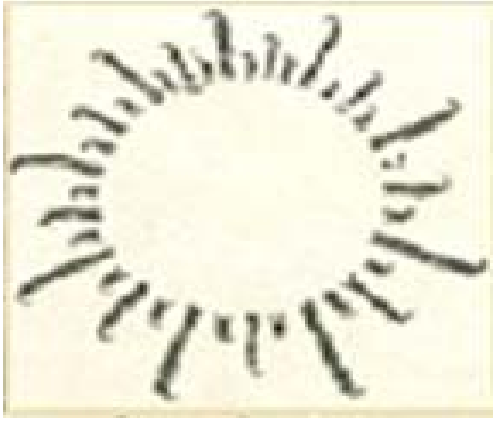


Plate 4. Complete crochets on planta of prolegs in triple series

Plate 5. The 5th, 6th, and 7th abdominal segments chitinized and branched spines

Plate 6. Entry wholes by stem borer in sugarcane

Appendix I. Characteristics of egg, larva, pupa and adult of sugarcane stem borer

Egg stage

Behaviour of egg laying	Time of egg laying	Oviposition period (day)	Number of eggs in total life	Egg size	Egg colour
On Ist, 2nd and 3rd top leaves, leaf sheath in rows of 2-5 tiers (Plate 2).	Evening	4	500-800 and eggs are uncovered	Length: 1.2 mm Width: 0.8 mm	Dirty white with light greenish tinge but reddish at hatching

Larval stage

Crochet on the prolegs	Average larval period (days)	Number and colour of stripes	Number of instar	Average larvae size	Larval colour
Complete crochets on planta of prologs are arranged in triple series (triordinal) (Plate 4).	27-70	Four pinkish brown stripes are alike (Plate 3).	5	Young: 1-3 mm Mature: 3 mm	White with black/orange head, later stage creamy. Dark brown spots bearing hairs on body segments.

Pupal stage

Characteristics	Average pupal period (days)	Average pupal size	Pupal colour
1. Front of fronto-clypeal region extends upward forming hard ridge like projections. 2. The 5th, 6th and 7th abdominal segments with prominent hard and branched spines (Plate 5).	7-15 up to 22 days in cool weather	Long: 16 – 20 mm	Brown

Adult stage

Behaviour of egg laying	Adult longevity (day)	Adult colour	Width at wingspan		Difference at ♀ and ♂	
			♀ (mm)	♂ (mm)	♀	♂
Nocturnal	3-8	Yellowish with narrow brown lines on forewing (Plate 1).	25-40	18-30	Anal part U-shaped	Thick hair on anal part

Appendix II. Standard Key for Identification of sugarcane borer pests

Particulars	Stalk borer (*Chilo auricilius*)	Plassey borer (*Chilo tumidicostalis*)	Internode borer (*Chilo sachariphagous indicus*)
Number of stripes	Five: Almost alike	Four: Almost alike	Four: Almost alike
Colour of stripes	Violet	Pinkish brown	Violet
Colour of tubercles	Grey	Grey	Jet black
Crochet on the prolegs	Complete crochets with biordinal spines in the prolegs	Complete crochets with triordinal spines in the prologs	Complete crochets with triordinal spines in the prolegs
Egg	Egg laid in egg mass of 2-5. Total of 47-146 eggs.	Egg lay in 4-5 tiers. Total of 500-800 eggs. Eggs are uncovered.	Egg laid cluster in 2-3 parallel rows. Total eggs of few to 414.
larvae	Head black	Black/ orange colour head	Head black
Adult	Forewing straw colour with golden spot. Hindwing straw colour with silvery fringe	Forewing dark brown scales. Terminal series of black spots present. Hindwing light brown scales. Seven spots present in terminal side.	Straw colour with slightly dark spot on forewing.

According to Butani (1956)