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INCIDENCE OF RICE STEM BORERS IN COASTAL ANDHRA PRADESH WITH EMPHASIS ON *SESAMIA INFERENS* (WALKER)

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ABSTRACT

A roving survey was conducted in the rice crop grown in coastal districts of Andhra Pradesh during *rabi*, 2021-22 and 2022-23. Overall mean stem borer incidence varied from 13.59% - 14.83% in both the seasons. Larvae of *Scirpophaga incertulas* (Walker), *Sesamia inferens* (Walker), *Chilo polychrysus* (Meyers) and *Chilo auricilius* (Dudgeon), were recorded from four districts during the survey. Among the stem borers, *S. incertulas* was the most predominant species (53.37%) followed by *S. inferens* (44.7%). Natural larval parasitization (21%) of *S. inferens* by *Cotesia flavipes* Cameron was observed in West Godavari district. The biology of *S. inferens* was studied on rice *cv.* MTU 1121. The average larval period recorded was 32.40± 0.35 days. Total life cycle of *S. inferens* ranged between 41-65 and 46-73 days for male and female moths, respectively. Current study suggests that *S. inferens* could be a potential threat to rice cultivation in coastal Andhra Pradesh.

Key words: survey, rice, *Oryza sativa*, stem borers, dead heart, white ear, destructive sampling, *Scirpophaga incertulas*, *Sesamia inferens*, *Chilo polychrysus*, *Chilo auricilius*, biology, diversity

Rice (*Oryza sativa*, f: Gramineae) is one of the important staple diets for the people of South East Asian countries. India stands first in terms of area under rice cultivation, with 45.07 million hectares and ranks second in rice production with 122.27 million tonnes, accounting for 22.81% of global rice production with an average productivity of 2713 kg/ ha (www.statista.com). Among different insect pests attacking rice, stem borers are the major pests that cause serious yield losses in rice. In India more than six species are known to occur on rice (DRR, 2013). Yellow stem borer (YSB), *Scirpophaga incertulas* (Walker) is the most wide spread, dominant and destructive pest among them. Other stem borers include Pink stem borer (PSB), *Sesamia inferens* (Walker); White stem borer (WSB), *Scirpophaga spp.*; Dark headed striped borer, (DHSB) *Chilo polychrysus* (Meyrick); Striped stem borer (SSB), *Chilo suppressalis* (Walker) and Gold fringed stem borer (GFSB) *Chilo auricilius* Dudgeon. The prevalence of stem borers in rice crop has been facilitated by factors such as continuous survival of stem borer on rice crop due to mono-cropping and staggered plantings of rice throughout the year, reduction in time gap between harvesting of rice and sowing of next crop and increased mechanization in rice cultivation. Changing cropping systems, planting practices might have resulted in the change in species composition of rice stem borers in non-traditional areas. In recent years, the severity of *S. inferens* was reported to be increasing in coastal areas (Jena et al., 2018). West Godavari district rice growers experienced a severe outbreak of *S. inferens* during *rabi* seasons of 2021-22 and 2022-23. Knowledge on the relative abundance of distinct stem borer species infesting rice is crucial for devising appropriate management strategies. A deeper understanding of population variation in the stem borer species among various regions in relation to the host is indispensable. In view of this, survey was conducted to know the relative abundance of stem borer complex in coastal Andhra Pradesh and the pest status of *S. inferens* on rice.

The *S. inferens* (Lepidoptera: Noctuidae) is a polyphagous pest. Occurrence of *S. inferens* is worldwide and it has been observed in India (Panda et al., 1976). It attacks many graminaceous crops viz., maize, rice, sorghum, pearl millet, finger millet, wheat *etc*. and is reaching the status of a major pest (Atwal and Dhaliwal, 1997; Baladhiya et al., 2018). Though the biology of this insect was reported from rice stems of Rexoro and south western corn worm diet (Vega et al., 1985), taraori basmati rice (Gagan et al., 2009), maize (Sharma et al., 2017), wheat (Chaudhari et al., 2018) and banyard millet (Roopika et al., 2022) etc. we had

studied in detail the biology on the mega rice cultivar MTU1121 which supported higher larval population in the field. This information will be helpful to understand the vulnerable life stages of *S. inferens* on rice for devising better pest management strategies.

MATERIALS AND METHODS

Roving survey was conducted in four rice growing districts viz., Vizianagaram (18.1067°N, 83.3956°E), Srikakulam (18.2949°N, 83.8938°E), West Godavari (16.9174°N, 81.3399°E) and Nellore (14.4426°N, 79.9865°E) of Andhra Pradesh where different rice based cropping systems viz., rice - millet, rice - pulse, rice- maize, rice - rice were in vogue during rabi, 2021-22 and 2022-23. From each district three mandals were selected and from each mandal five farmer's fields were surveyed. The stem borer larvae were collected by destructive sampling of dead hearts/white ears (60-80 damaged tillers/field). The collected larvae were identified based on morphological keys (Arora, 2000, Sallam and Allsopp, 2002, Dey and Shashank, 2022). The tiller damage % was calculated as per (Justin and Preetha, 2014) and the relative abundance of stem borer species (Rahaman et al., 2014) was assessed. The larvae of *S. inferens* collected from rice fields in West Godavari (16.7737°N, 81.1885°E) district. The collected larvae reared on the cut stems of *cv*.MTU 1121 rice at Entomology laboratory, S. V. Agricultural College, Tirupati (13.62428^{o}N,79.37827^{o}E) at 28± 2^{o}C (26-30^{o}C) with a relative humidity of 59-80%. The larvae were allowed to pupate and the pupae were kept in acrylic rearing chambers (26.5 cm x 29.5 cm x 29.5 cm) for adult emergence. The cotton swabs dipped in 40% honey solution were provided as food supplement for the adults to encourage egg laying. Adult moths were allowed to oviposit on rice seedlings. Biology of *S. inferens* in rice was studied on the F_1 population maintained on rice stems.

The neonate larvae of *S. inferens* were provided with soft rice stem cuttings and the late larval instars were reared on 8.5 to 10 cm long fresh rice cut stems with one or two internodes. The cut stems were observed daily and replaced after every 2 to 3 days. Larval instars were decided based on the observation of moulted skin and head capsule. Pupal, larval length and breadth in early instars were measured with the help of Olympus trinocular stereo zoom microscope. Observations on larval weight, duration of each instar were also recorded. The pupae were sexed based on morphological features and were kept in acrylic rearing chambers for adult emergence. The weight of male and female adult moths were recorded and per cent adult emergence was calculated. A pair of male and female moths were released onto rice seedlings (3-5 week's old) in ovipositional cages. Pre oviposition, oviposition, post ovipositional periods of female moths were recorded. Plants containing eggs were removed from cages and new plants were kept daily till the death of adults. The number of eggs laid/moth in each cluster, fecundity, egg hatching percentage, incubation period and total developmental period were recorded. Data on various biological parameters were subjected to statistical analysis using descriptive statistics in excel.

RESULTS AND DISCUSSION

Survey on stem borer incidence in the coastal districts of Andhra Pradesh revealed the presence of *S. incertulas*, *S. inferens, C. auricilius* and *C. polychrysus*. The relative abundance of these stem borers varied in different rice based cropping systems of A.P. during rabi, 2021-22 and 2022-23. The mean stem borer incidence ranged between 12.79 to 14.06% in the surveyed districts of Andhra Pradesh (Table 1) during rabi, 2021-22. It's noteworthy that in Nellore, where farmers cultivate rice year-round with staggered planting, *S. incertulas* was the only species found. In contrast, the West Godavari district faced a severe outbreak of *S. inferens* (up to 90%) due to the rice-maize cropping system. Additionally, the presence of *C. auricilius* (2.5 to 23.3%) (Fig. 1) was observed solely in Srikakulam district, where rice crop was surrounded by sugarcane fields. *S. incertulas* was the most predominant species with 54.2% of mean relative abundance followed by *S. inferens* (43.7%) and *C. auricilius* with (2.2%) of the total larval population collected (Fig. 1). It is interesting to note that the infestation of *S. inferens* was more prevalent in the peripheral rice plants of the field rather than in the centre of rice fields. It was observed that late instar larvae of *S. incertulas*, *C. polychrysus* and *C. auricilius* were found singly in a rice tiller whereas *S. inferens* larvae were gregarious.

The mean stem borer incidence ranged between 13.30 to 16.85% in surveyed mandals of Andhra Pradesh, *rabi*, 2022-23. Out of the total rice stem borers collected, *S. incertulas* was the most predominant species with 52.3% mean relative abundance followed by *S. inferens* (45.8%) >*C. auricilius* (1.8%) >*C. polychrysus* (0.1%). Among the different surveyed mandals, highest stem borer incidence of 17.64% (Table 1) was recorded in Dendhuluru, West Godavari district which was predominated with *S. inferens* population (98.1%) (Fig. 2). *C. polychrysus* (0.1%) was reported

Table 1. Incidence of rice stem borers in Coastal Andhra Pradesh (rabi, 2021-22 and 2022-23)

District	Mandal*	(%) incidence (Mean ± SE)**		Prevailing cropping systems in district***
		Rabi 2021-22 (Dry season)	*Rabi* 2022-23 (Dry season)	
Srikakulam	Sarubujjili	13.33± 0.35	14.75± 0.30	rice-rice rice-ragi rice-maize rice-green gram rice-sugarcane
	Srikakulam	14.95± 0.47	15.03± 0.47	
	Amadalavalasa	13.89± 0.72	NA	
	Lankam	NA	14.64± 0.55	
	Mean incidence	14.06	14.81	
Vizianagaram	Gurla	13.80± 0.94	14.29± 0.60	rice-rice rice-ragi rice-maize rice-green gram rice-sugarcane
	Nandhigama	13.97± 0.89	14.09± 0.29	
	Badangi	13.29± 0.50	NA	
	Therlam	NA	14.72± 0.61	
	Mean incidence	13.69	14.36	
West Godavari	Dendhuluru	14.52± 0.82	17.64± 0.20	rice-rice rice-maize rice-green gram
	Bhimadole	14.96± 0.66	16.54± 0.53	
	Nallajerla	12.03± 0.52	16.36± 0.14	
	Mean incidence	13.84	16.85	
Nellore	Venkatagiri	12.58± 0.51	13.59± 0.76	rice-rice mono cropping
	Dagadarthi	12.93 ± 0.99	NA	
	Kavali	12.86 ± 0.81	NA	
	Dakkili	NA	12.91± 0.38	
	Naidupeta	NA	13.41± 0.32	
	Mean incidence	12.79	13.30	
	Overall mean	13.59	14.83	

*Mean of data from five farmers' fields in each mandal, **% deadhearts/white ears
***The prevailing cropping systems reported based on the observations during the survey; NA- Not available

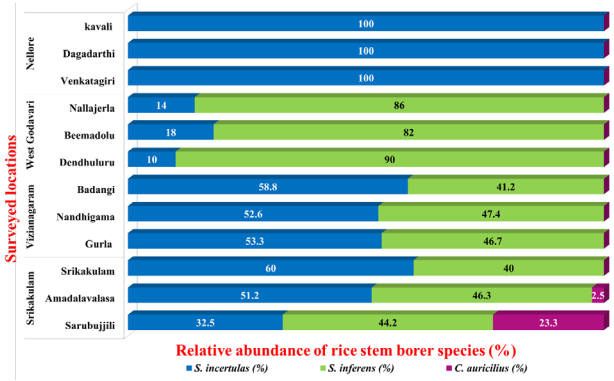

Fig. 1. Relative abundance of rice stems borers in coastal Andhra Pradesh (rabi, 2021-22)

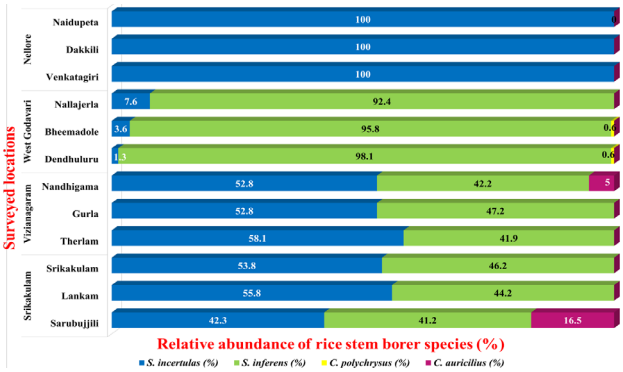

Fig. 2. Relative abundance of rice stems borers in coastal Andhra Pradesh (rabi, 2022-23)

from West Godavari alone in *rabi,* (dry season) 2022-23. *C. auricilius*, was recorded in Sarubujjili (16.5%) and Nandhigama (5%) mandals of Srikakulam and Viziangaram districts, respectively where surrounding crops were sugarcane and maize. *C. auricilius* incidence in rice could be attributed to a possible migration of *C. auricilius* (a primary pest of sugarcane) to rice fields in that region.

The neonate *S. inferens* larvae bored into the stem and reached downwards and started feeding from third internode onwards. They fed gregariously inside the rice stem and the inner contents were eaten away leading to extensive tunnelling which may or may not result in formation of dead heart. The entrance of bored holes were filled with fresh brown coloured excreta. The site of pupation was either inside the 2nd or 3rd internodal

regions of stem or inside the leaf sheath which was covering main tiller i.e. 10-14 cm above the ground. During the survey in Dendhuluru and Bhimadole mandals of West Godavari district, the abundance of *S. inferens* was higher than usual in infested tillers. With the increased incidence of *S. inferens* there was a natural parasitization up to 21% by late larval parasitiod, *C. flavipes* (Braconidae: Hymenoptera) (Fig. 3 a,b). Khan et al. (1991) also reported *C. flavipes* as a larval parasitoid of *S. inferens*. *S. incertulas* was reported as predominant species in Andhra Pradesh (Sudharani et al., 2023), Shivamogga, Karnataka (Pallavi and Sharanabasappa, 2018) and in Pusa, Bihar (Kumbhar and Singh, 2020) compared to other stem borers.

Keeping in view the upsurge in damage by *S. inferens* in rabi, detailed studies on the biology of *S. inferens* in rice were carried out. The eggs were laid either singly or in groups of two to three in the axils of leaf sheath and concealed inside the leaf sheath of the rice stem thus invisible to the naked eye. Some eggs were also laid on the auricle. The eggs were hemispherical, with fine ridges running from top to down. The freshly laid eggs were creamish yellow white in colour and developed to pink colour after 3 days and finally turned to greyish black colour just before hatching, with the head visible clearly from outside. Further, incubation period of eggs was recorded as 5.33± 0.12 days and mean number of eggs per cluster were 84± 3.06 with a range of 56-118 eggs/ female moth. Mean percent hatchability of eggs was 75.35± 0.75. Similar results were reported on rice (Gagan et al., 2009; Aggarwal et al., 2004) and Wheat (Chaudari et al., 2018). But mean incubation period of 6.82± 0.05 days, with a percent hatchability of 92.19± 0.01 was observed on maize (Viswajyothi et al., 2019). A mean hatchability of 68.19± 1.16% was reported in barnyard millet (Roopika et al., 2022).

The neonate larvae were pale whitish in colour with black head. From the second instar onwards they developed the pink colour and the colouration improved with increase in larval age. The various larval morphometrics in each instar are detailed in Table 2. In the present study, six larval instars were recorded followed by a pre pupal stage. The observed mean larval period was 32.40± 0.35 days. Similar findings were reported on wheat (Chaudhari et al., 2018) and maize (Viswajyothi et al., 2019). Gagan et al. (2009) reported eight larval instars with increased duration (67.44± 0.55 days) on taroari basmati rice. Decrease in larval duration (29.95± 0.16 days) was observed on maize crop (Viswajyothi et al., 2019). The pre- pupa remained inside the stem and secreted white silken threads and after 2.10± 0.15 days it entered into pupal stage. The pre-pupa gradually changed to obtect pupa within two days (Table 2). Pupation took place inside the larval tunnel of rice stem as observed by Chaudhari et al. (2018).

The pupae were sexed depending on the position of genital opening. The average weight, length and breadth of male and female pupa are given in Table 3. Female pupae were comparatively bigger in size than males (Chaudhari et al., 2018 and Gagan et al., 2009). The pupal period in male was 8.20± 0.10 days (7-10 days) and 11.73± 0.18 days (9-15 days) in female which is similar to the findings of Gagan et al. (2009) who reported pupal duration of 7-12 and 10-16 days in male and female. The average length and breadth of pupae grown in rice were slightly greater than the *S. inferens* pupae grown in maize (Viswajyothi et al., 2019) and wheat (Chaudhari et al., 2018). Male pupal period was comparatively similar to the report of Gagan et al. (2009). However, in female, it had taken longer time to complete its pupal period than in wheat (Chaudhari et al., 2018) and maize (Viswajyothi et al., 2019).

The adult moth was small, stout and fawn coloured with prominent sexual dimorphism. The female moth was larger in size than the male with tufts of hairs on the

Fig. 3a. *C. flavipes*

Fig. 3b. *S. inferens* larva *parasitised by C. flavipes*

Table 2. Morphometrics of larval instars of *S. inferens*

Instar	Larval length (mm)		Larval width (mm)		Larval weight (mg)		Larval period (days)	
	Range	Mean± SE	Range	Mean± SE	Range	Mean± SE	Range	Mean± SE
I	1.22-2.87	2.13± 0.11	0.31-0.56	0.42± 0.01	0.11-0.33	0.24± 0.01	3-4	3.60± 0.06
II	3.43 - 4.92	4. 05± 0.02	0.41 -0.74	0.56± 0.02	2.58 - 9.51	4.89± 0.31	3-5	4.23± 0.12
III	6.21 - 10.20	8.11± 0.25	1.63 – 2.12	1.80± 0.02	19.10 - 58.90	37.58± 1.56	4-6	5.03± 0.15
IV	11.89 - 16.96	14.54± 0.23	1.85 - 2.39	2.10± 0.05	48.12 - 84.63	64.17± 2.07	5-7	5.63± 0.09
V	19.65 - 22.49	20.92±0.13	2.44 - 2.96	2.71± 0.03	101.21-141.56	122.97± 2.33	5-8	6.53± 0.19
VI	25.00 - 28.25	26.51± 0.22	3.38 - 3.85	3.57± 0.04	180.43 - 238.45	211.55± 2.87	6-9	7.37± 0.18
Pre Pupa	15.00- 18.90	17.41± 0.06	2.82-3.45	3.13± 0.02	101.65- 195.80	141.95± 3.29	1- 3	2.10± 0.15

**Mean± SE (n=30); SE - Standard error

pronotum. Antenna was short and pectinate in the male and filiform in the female. The hind wings are white. The average longevity of male moth was 4.67± 0.19 days and the female about 7.30± 0.12 days. The duration of pre-oviposition, oviposition and post-oviposition period was observed (Table 3). The total life cycle was completed within 52.7± 0.32 days in males as compared to 58.87± 0.27 days (Table 3) in females on rice (*cv*. MTU 1121). Gagan et al. (2009) reported mean total developmental period of 78.76 and 82.50 days in male and female *S. inferens* in basmati rice. Pre-oviposition (1.65± 0.21 days) and oviposition period (4.82± 0.54 days) were in tune with the reports of Singh (2013) while post oviposition period corresponded with the findings of (1.4± 0.26 days) Gagan et al. (2009). Rahman and Khalequzzaman, (2004) reported 55.41 days as the total developmental period at a constant temperature of 25 ^{O}C. Chaudhari et al. (2018) reported similar trend of pre and post oviposition period. Comparatively lesser longevity of male (3.92± 0.23) and female (5.05± 0.28) days were reported by Viswajyothi et al. (2019) in maize with a total developmental period of 47.65± 0.24 and 49.93± 0.21 days in male and female moths respectively. The differences in the outcome of current study in contrary to the reports of earlier workers may be due to the difference in host plants, genotype or due to variation in weather parameters in different geographical regions and cropping system practices at the time of experimentation. The significant findings in this study are that *S. inferen*s eggs are invisible to the naked eye due to oviposition in the leaf sheaths; extensive larval tunnelling without significant symptoms and nocturnal habit of the adults make it difficult for the farmers to identify the pest incidence to warrant timely control measures.

Table 3. Biological parameters of *S. inferens* in rice

Parameters	Range	Mean± SE
Pupal period (days)		
Male	7-10	8.20± 0.10
Female	9-15	11.73± 0.18
Pupal length (mm)		
Male	12.52 - 15.89	14.06± 0.19
Female	16.02 - 18.62	17.28± 0.21
Pupal width (mm)		
Male	2.86- 4.89	3.88± 0.17
Female	3.53 - 4.57	4.11± 0.02
Pupal weight (mg)		
Male	104.50- 159.10	129.18± 2.44
Female	156.50- 214.80	182.13± 4.76
Pre-oviposition period (days)	1-2	1.6± 0.10
Oviposition period (days)	3-5	4.15± 0.15
Post-oviposition period (days)	1-2	1.45± 0.15
Fecundity (No. per female)	148-278	202.83± 5.85
Eggs per cluster (No's)	56-118	84± 3.06
Incubation period (days)	4-7	5.33± 0.12
Hatchability (%)	55.36-84.62	75.35± 0.75
Male : Female Ratio	1.21:1	-
Adult longevity (days)		
Male	3-6	4.67± 0.19
Female	6-9	7.30± 0.12
Developmental period (days)		
Larva	26-39	32.40± 0.35
Male	41-65	52.70± 0.32
Female	46-73	58.87± 0.27

*Mean± SE (n=30); SE - Standard error

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AUTHOR CONTRIBUTION STATEMENT

APPK and RM contributed to conceptualization, methodology, data analysis and research supervision. YS performed the experiments and data analysis. YS wrote the original manuscript, APPK and RM reviewed and edited the manuscript. All authors have read and agreed to the published version of the manuscript.

CONFLICT OF INTEREST

No conflict of interest.

REFERENCES

Aggarwal R, Singh J, Shukla K K. 2004. Biology of pink stem borer, *Sesamia inferens* Walker on rice crop. Indian Journal of Ecology 31: 66-67.

Arora G S. 2000. Studies on some Indian Pyralid species of economic importance, Part I. 167 pp. Crambinae, Schoenobiinae, Nymphulinae, Phycitinae and Galleriinae (Lepidoptera: Pyralidae) Records of The Zoological Survey of India. pp. 35-69

Atwal A S, Dhaliwal G S. 1997. Agricultural pests of South Asia and their management. Kalyani Publishers, New Delhi. pp. 179-200.

Baladhiya H C, Sisodiya D B, Pathan N P. 2018. A review on pink stem borer, *Sesamia inferens* Walker: A threat to cereals. Journal of Entomology and Zoology Studies 6(3): 1235-1239.

Chaudhari N S, Patel A A, Deb S, Patel P S. 2018. Biology of pink stem borer, *Sesamia inferens* (Walker) on wheat. An International e Journal 7(2): 133-147.

Dey A, Shashank P R. 2022. Taxonomic studies on graminaceous stem borers from North India. Indian Journal of Entomology 6-23.

DRR. 2013. Progress Report. Vol 2 Crop Protection. Entomology and Pathology. All India Coordinated Rice Improvement Programme. Directorate of Rice Research, Rajendranagar, Hyderabad.

Gagan J, Lakhi R, Ram S. 2009. Biology of pink borer, *Sesamia inferens* (Walker) on Taraori Basmati rice. Annals of Biology 25(1): 41-45.

Justin C G L, Preetha G. 2014. Survey on the occurrence, distribution pattern and management of stem borers on rice in Kanya Kumari district, Tamil Nadu. Journal of Entomology and Zoology Studies 2(67): 86-90.

Jena M, Adak, T, Rath P C, Gowda G B, Patil NB, Prasanthi G, Mohapatra S D. 2018. Paradigm shift of insect pests in rice ecosystem and their management strategy. ORYZA-An International Journal on Rice 55: 82-89.

Katti G, Chitra Shanker, Padma Kumari A P, Pasalu I C. 2011. Rice stem borers in India-species composition and distribution. Technical bulletin No 59. Directorate of Rice Research, Rajendranagar, Hyderabad. pp. 89

Khan Z R, Litsinger J A, Barrion A T, Villanueva F F D, Fernandez N J, Taylo L D. 1991. World Bibliography of Rice Stem Borers. 1794-1990. IRRI-International Rice Research Institute and ICIPE -International Centre of Insect Physiology and Ecology. ISBN 971-22-0015-9

Kumbhar C R, Singh S P N. 2020. Species compositions of rice stem borers in different rice cultivation system under north Bihar condition. Journal of Entomology and Zoology Studies. 8(4): 1906-1909

Panda N, Samala A P, Patra N C, Reddy T G. 1976. Relative abundance of the lepidopterous stalk borers of rice in Bhubaneshwar. Indian Journal of Entomology 6: 45-53.

Pallavi D, Sharanabasappa M P. 2018. Relative abundance of yellow stem borer and pink stem borer on paddy. Journal of Entomology and Zoology Studies 6(4): 668-67.

Rahaman M M, Islam K S, Jahan M, Mamun M A A. 2014. Relative abundance of stem borer species and natural enemies in rice ecosystem at Madhupur, Tangail, Bangladesh. Journal of the Bangladesh Agricultural University 12(452-2016-35820): 267-272.

Rahman M T, Khalequzzaman M. 2004. Temperature requirements for the development and survival of rice stem borers in laboratory conditions. Entomologia Sinica 11(1): 47-60.

Roopika M, Srinivasan G, Shanthi M. 2022. Biology of Pink Stem Borer, *Sesamia inferens* Walker on Barnyard Millet, *Echinochloa frumentacea*. Indian Journal of Entomology 137-139.

Sallam M S, Allsopp P G. 2002. Preparedness for borer incursion *Chilo* incursion management plan. Bureau of Sugar Experiment Stations Queensland, Australia. pp.126.

Sharma H, Jaglan M S, Yadav S S. 2017. Biology of pink stem borer, *Sesamia inferens* (Walker) on maize, *Zea mays*. Journal of Applied and Natural Science 9(4): 1994-2003.

Singh B. 2013. Bionomics of pink stem borer, *Sesamia inferens* Walker (Lepidoptera: Noctuidae) in paddy-wheat cropping system. Ph.D. dissertation, PAU, Ludhiana.

Sudharani D, Chiranjeevi C H, Madhumathi T, Krishnam Raju S, Nafeez Umar S. 2023. Abundance, distribution and divergence of stem borer species and predators in rice ecosystem of Krishna district, Andhra Pradesh. Applied Ecology and Environmental Research 21(1): 133-156.

Vega C R, Hong Su Ma, Heinrichs E A. 1985. Rearing pink stem borer *Sesamia inferens* on the south western corn borer diet. IRRN 10(4): 17

Viswajyothi K, Aggarwal N, Jindal J. 2019. The biology of *Sesamia inferens* (Walker) (Lepidoptera: Noctuidae) on maize in the north western plains of India. Acta Phytopathologica et Entomologica Hungarica 54(1): 69-84.

www.statista.com - Accessed on 16-06-2023

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