Indian Journal of Entomology Online published Ref. No. e21134 DoI.: 10.5958/IJE.2021.143

DISTRIBUTIONS PATTERN OF PROTECTIVE SILKEN DISCS WEAVED BY LARVAE OF SUGARCANE TOP SHOOT BORER *SCIRPOPHAGA EXCERPTALIS* (WALKER)

Arun Baitha, A K Jaiswal and Anuj Kumar

Division of Crop Protection, ICAR-Indian Institute of Sugarcane Research,
Lucknow 226 002, Uttar Pradesh, India
*Email: arunbaitha@rediffmail.com (corresponding author)

ABSTRACT

The distribution pattern of protective silken discs weaved by larvae of five broods (generations) of top shoot borer *Scirpophaga excerptalis* (Walker) was studied in three early maturing varieties (Co 0238, CoPk 09151 and CoLk 94184) and two mid late varieties (CoLk 13204 and CoLk 8102). The mean number of silken discs guarding the female pupa was more in first, second, third, fourth and fifth broods than male pupa in all varieties. The ranges of the discs protecting the female pupae in all broods (first, second, third, fourth and fifth) varied 3-12, 2-21, 2-17, 3-13 and 2-9, respectively. The male pupae were surrounded by 5.23 (CoLk 8102), 6.93, 8.73, 6.67 and 3.92 (CoPk 05191) discs, respectively which were higher than the other varieties in respective broods. The results allow us to better understand the distribution pattern of silken discs weaved by larvae of different broods of *S. excerptalis* in early and mid-late varieties.

Key words: *Scirpophaga excerptalis*, Crambidae, Lepidoptera, pupal chamber, exit hole, parasitoids, temperature, humidity, protective discs, broods, varietal differences, dynamics

The top shoot borer *Scirpophaga excerptalis* (Walker) (Crambidae: Lepidoptera) is a major sugarcane borer in almost all the important cane growing areas of subtropical India. Its incidence is usually more serious in north Indian sugarcane belt where it causes considerable reduction in yield and quality (Gupta, 1959 and Kalra, 1972). It spends major portion of life cycle within the plant tissues, the short period passed outside is as adult, egg stage and neonate larva (Majumder, 2020). The young caterpillars enter the leaf mid-ribs within a few hours of their hatching from the eggs, and after that the pest remains hidden inside the plant tissues till its emergence as moths. The five broods (generations) of *S.excerptalis* in a calendar year have been observed at Lucknow conditions (Gupta, 1959 and Majumder, 2018).

The first, second, third, fourth and fifth broods appears in March, April, June, August, September and March, respectively. The first and second broods are very distinct, but from the third brood, overlapping of generations is common. On an average, top shoot borer usually completes the life cycle in 45-55 days (6-8 weeks). The top borer pupates within the cane and the exit hole (for subsequent emergence of moths) is formed by the grownup larva 3 to 5 days before pupation under normal conditions but during adverse conditions, the fully grown larva of the fourth and fifth broods (October- November) would form this hole before they enter hibernation. Before pupation, the larva spins out pupal chamber within which it pupates and reduces its size (Gupta, 1954 and David et al., 1986). Usually the exit hole is formed in the nodal region through the bud, but variations are noticed in different agroclimatic conditions (Singh, 1978). The protective silken discs were made in the pupal chamber before the larva actually enters pupation (Kalra, 1972).Since no active defence (development of any protections or spines in the abdomen) against parasitoids at pupal stage is possible, an adequate prophylactic protection (silken discs) is engineered by the larva. It is commonly known that several circular silken protective discs exist in the pupal chamber, their exact number and their distribution pattern (anterior/posterior end of pupa) with reference to gender or broods of the top borer is either inadequately reported. Therefore, the present study was undertaken to gather useful information on number and distribution pattern of discs guarding the male and female pupa of all five broods of *S. excerptalis*.

MATERIALS AND METHODS

The observations were made at the ICAR-Indian Institute of Sugarcane Research, Lucknow with three early maturing varieties (Co 0238, CoLk 94184 and CoPk 09151) and two mid late varieties (CoLk 13204 and CoLk 8102). The damaged shoots of each brood were collected from autumn planted cane at exit hole

stage (the stage before the emergence of moths) in the month of April, June, July, September and March, respectively during 2019-2020. The autumn planted crop faces all the five broods of *S. excerptalis*. The damaged shoots were split longitudinally and total number of silken discs observed along with anterior and posterior end of pupa. The gender of male and female pupa was determined on the basis of buff coloured or crimson abdomen in females due to the formation of the anal tuft (Majumder, 2018). Posterior end of the female pupa is initially white and later turning orange while male pupa remains white. The data on mean number of silken discs in the pupal chamber along with their distribution at the anterior and posterior end of pupa were analysed statistically.

RESULTS AND DISCUSSION

The mean number of silken discs guarding the female pupa in first brood of *S. excerptalis* was 9.60 (maximum) comprised of 8.00 at anterior and 1.60 discs at the posterior end in CoLk 13204 (Table 1). However, male pupa was protected by 5.23 discs with 4.00 at the anterior and 1.23 at the posterior end of pupa which was maximum in CoLk 8102. The maximum number of silken discs protecting female and male pupa (second brood) was 8.06 and 6.93 discs in CoPk 05191. However, the anterior and posterior ends of female and male pupa were guarded by 6.28 and 1.78 discs and 5.62 and 1.34 discs, respectively. The mean number of discs in female pupa was found to vary 4-21 between in CoPk 05191 whereas in male pupa it varied 2-12 in CoLk 8102. Baitha et al. (2021) reported that 6 to 17 silken discs are made towards the exit hole (anterior side) by female pupa where as 5 to 12 discs by male pupa in variety CoLk 11203. Four to twelve discs are made towards the exit hole and sometimes a few are formed at the posterior end of pupae (Kalra and Sidhu, 1965), without mentioned variety and gender of pupa.

In third brood, mean number of discs protecting female pupa was 7.38 (maximum) which was distributed as 6.33 and 1.05 discs at the anterior and posterior end of pupae, respectively in CoLk 13204. However male pupa was guarded by 8.73 discs (maximum) in CoPk 05191 with 6.82 at anterior and 1.91 discs at the posterior end (Table 1).The anterior end of pupa in all varieties towards exit hole was protected by more number of discs than posterior end. This exit hole (covered with several protective silken discs) renders the grown up caterpillar or the newly formed pupa of top borer vulnerable to parasitisation by *Isotima javensis* and newly hatched grubs gain access to the host pupa by biting its way through the nest of 7 to 12 silken discs (Gupta, 1954; Kalra and David, 1967 and Kalra et al., 1980). The female pupa of third brood always showed more number of discs than male pupa (Majumder, 2018). But in our studies male pupa was guarded more number of discs, it may due to reactions of early and mid late varieties.

The mean number of silken discs protecting female pupa in fourth brood was 8.83 (maximum) with 7.00 and 1.83 at the anterior and posterior end of CoPk 05191 whereas in Co 0238, 6.40 discs were distributed with 5.50 and 0.90, respectively. On the other hand, the male pupae were surrounded by 6.67 discs (maximum) with 5.33 and 1.33 at the anterior and posterior end of pupae in CoPk 05191. As many as 14 discs were observed in the fourth brood (averaging eight) which is higher in comparison to earlier broods (Majumder, 2018). The fifth brood or the winter brood or the over winter brood hibernates in winter, it didn't cut exit hole immediately. The larva prepared an exit hole only after the completion of hibernation and it was sealed by few silken protective discs and retreats in the pupal chamber. The mean number of discs varied from 3.17- 5.08 with 2.50-3.05 and 0.67- 2.17, respectively at the anterior and posterior end of female pupae in all varieties. However, male pupae were surrounded by 3.00 to 3.92 discs in observed varieties. A larva of the fifth brood weaved protecting disc (2 to 3) after the hibernation and if the leaf sheath covering is removed, the larva produces a longer exit tunnel extending beyond the cane epidermis (Majumder, 2018). In this stage pupation takes place very close to the exit hole.

The wide variations are observed in the number of silken discs weaved by larvae of different broods (first to fifth) and greatly influenced by the cane variety and growth stage of the cane. Temperature is the most dominant factor in the sugarcane agro ecosystem that modulates the development, survival, feeding, fecundity, disc formation and dispersal of *S. excerptalis* (Gupta, 1959). It is not clear what influences the larva to weave so many protective discs in early as well as mid late varieties and how the larva determines how many discs will be needed for its safety. The emerging moth from the pupating tunnel pushes the silken discs forward with its head and by partially dislodging the discs it makes it way forward (Majumder, 2018). The silken discs are not broken or punctured; rather these discs remain mostly intact at the centre. In the process of emergence of the moth a lot of scales are left behind in the tunnel on dislodged silken discs. Probably these

Table 1. Distribution of silken discs guarding female/ male pupa of *S.excerptalis* in sugarcane

Variety	Brood	♀/ ♂ Pupa	Mean± S.Em No. of silken discs	Anterior	Posterior
		♀	6.27± 0.69 (3-12)	4.82± 0.57 (3-9)	1.45± 0.28 (0-3)
Co 0238	I	♂	4.56± 0.41 (3-7)	4.22± 0.43 (3-7)	0.22± 0.15 (0-1)
CoLk 94184	I	♀	8.45± 0.43 (6-11)	6.27± 0.65 (4-10)	2.18± 0.44 (0-5)
		♂	4.22± 0.36 (3-6)	3.33± 0.24 (3-5)	0.89± 0.31(0-2)
CoPk 05191	I	♀	6.56± 0.56 (5-10)	5.44± 0.60 (3-9)	1.11± 0.31 (0-2)
		♂	4.40± 0.68(2-6)	4.00± 0.55 (2-5)	0.40± 0.24 (0-1)
CoLk 13204	I	♀	9.60± 0.40 (9-11)	8.00± 0.71(6-10)	1.60± 0.51 (0-3)
		♂	5.00± 0.32 (4-6)	3.80± 0.58 (2-5)	1.20± 0.49 (0-3)
CoLk 8102	I	♀	6.86± 1.06 (3-12)	5.00± 1.00(2-10)	1.86± 0.40 (1-4)
		♂	5.23± 0.46 (3-8)	4.00±0.36 (3-7)	1.23± 0.26 (0-3)
Co 0238	II	♀	4.0± 0.26 (0-5)	4.0± 0.26 (0-5)	0.00
		♂	3.83± 0.70 (2-7)	3.50± 0. 62 (2-6)	0.50± 0.22 (0-1)
CoLk 94184	II	♀	4.93± 0.41(2-8)	4.07± 0.38 (2-7)	0.93± 0.21 (0-2)
		♂	4.17± 0.40 (3-5)	3.67± 0.49 (2-5)	0.59± 0.34 (0-2)
CoPk 05191	II	♀	8.06± 0.60 (4-21)	6.28± 0.60 (2-19)	1.78± 0.22 (0-5)
		♂	6.93± 0.44 (3-11)	5.62± 0.44 (1-11)	1.34± 0.24 (0-4)
CoLk 13204	II	♀	6.13± 0.91 (3-9)	5.00± 0.78 (3-9)	1.13± 0.44 (0-3)
		♂	4.86± 0.55 (3-7)	3.86± 0.67 (2-7)	1.14± 0.40 (0-3)
CoLk 8102	II	♀	7.27± 0.42 (2-12)	6.35± 0.40 (2-12)	0.92± 0.17 (0-2)
		♂	6.67± 0.89 (2-15)	5.67± 0.73 (2-12)	1.00± 0.32 (0-4)
Co 0238	III	♀	5.87± 0.53 (3-10)	5.13± 0.52 (2-9)	0.73± 0.15 (0-2)
		♂	6.00± 1.20 (2-14)	5.60± 0.96 (2-11)	0.50± 0.31 (0-3)
CoLk 94184	III	♀	5.25± 0.80 (2-9)	4.88± 0.61 (2-7)	0.38± 0.26 (0-2)
		♂	5.36± 1.11 (3-15)	5.36± 1.11 (3-15)	0.00
CoPk 05191	III	♀	6.77± 0.90 (2-13)	4.92± 0.88 (1-11)	1.31± 0.26 (0-3)
		♂	8.73± 0.94 (4-14)	6.82± 0.76 (3-11)	1.91± 0.55 (0-6)
CoLk 13204		♀	7.38± 0.70 (3-17)	6.33± 0.49 (2-11)	1.05± 0.33 (0-6)
	III	♂	5.75± 0.48 (2-13)	5.14± 0.40 (2-12)	0.64± 0.16 (0-3)
CoLk 8102		♀	5.92± 0.71 (2-14)	5.38± 0.63 (2-14)	0.54± 0.19 (0-3)
	III	♂	5.38± 0.39 (3-9)	5.05± 0.39 (2-9)	0.43± 0.15 (0-2)
Co 0238	IV	♀	6.40± 0.37 (5-8)	5.50± 0.34 (4-7)	0.90± 0.35 (0-3)
		♂	5.60± 0.48 (3-8)	4.70± 0.40 (3-7)	0.90± 0.23 (0-2)
CoLk 94184	IV	♀	4.33± 0.67 (3-7)	4.00± 0.45 (3-5)	0.33± 0.33 (0-2)
		♂	4.45± 0.67 (2-9)	4.00± 0.45 (2-7)	0.45± 0.25 (0-2)
CoPk 05191	IV	♀	8.83± 1.01 (6-13)	7.00± 0.86 (5-10)	1.83± 0.60 (0-4)
		♂	6.67± 0.88 (4-9)	5.33± 0.80 (3-8)	1.33± 0.42 (0-3)
CoLk 13204	IV	♀	5.18± 0.32 (3-9)	4.97± 0.29 (3-8)	0.21± 0.11 (0-3)
		♂	4.74± 0.25 (1-10)	4.20± 0.18 (1-6)	0.54± 0.14 (0-4)
CoLk 8102	IV	♀	5.00± 1.05 (3-8)	4.40± 0.93(2-7)	0.60± 0.24 (0-1)
		♂	4.50± 0.96 (2-6)	3.50± 0.50(2-4)	1.00± 0.58 (0-2)
Co 0238	V	♀	3.91± 0.31 (3-6)	2.82± 0.26 (2-4)	1.09± 0.21 (0-2)
		♂	3.33± 0.21 (3-4)	2.33± 0.33 (2-4)	1.09± 0.21 (0-2)
CoLk 94184	V	♀	3.17± 0.48 (2-5)	2.50± 0.34 (2-4)	0.67± 0.33 (0-2)
		♂	3.00± 0.27 (2-4)	2.38± 0.26 (1-3)	0.75± 0.25 (0-2)
CoPk 05191	V	♀	4.00± 0.37 (3-5)	2.50± 0.22 (2-3)	1.50± 0.22 (1-2)
		♂	3.92± 0.26 (3-5)	2.83± 0.21 (2-4)	1.08± 0.15 (0-2)
CoLk 13204	V	♀	4.63± 0.32 (2-7)	3.05± 0.25 (1-5)	1.58± 0.22 (0-4)
		♂	3.48± 0.16 (3-5)	2.57± 0.19 (2-5)	0.90± 0.07 (0-1)
CoLk 8102	V	♀	5.08± 0.56 (2-9)	2.92± 0.26 (2-4)	2.17± 0.41 (0-5)
		♂	3.27± 0.34 (1-6)	2.20± 0.28 (1-5)	1.09± 0.23 (0-3)

Figures in parentheses range are of disc numbers; Co 0238, CoLk 94184 and CoPk 09151 (early maturing varieties) and CoLk 13204 and CoLk 8102 (mid late varieties)

scales act as the solid lubricant for the safe movement of the adult body in the tunnel. The larva could apparently sense the ambient situation well and accordingly weaves the silken discs to maintain the required temperature and humidity around the pupa in pupal chamber and to protect possible ingress of the parasitoids (Gupta, 1958 and Baitha et al., 2021). The results allow us to better understand the distribution pattern of silken discs weaved by larvae of different broods of *S. excerptalis* in early and mid-late varieties.

ACKNOWLEDGEMENTS

The authors thank the Director, ICAR-Indian Institute of Sugarcane Research, Lucknow for the necessary facilities. The help rendered by Mr Anuj Kumar, Ankit K Mishra,Ms Deepmala Kurre (MSc students), Santosh Kumar Pandey, Sandeep Sharma and Arpit Maurya are also thankfully acknowledged.

Author Contribution Statement

The authors (AB, AKJ, AK) contributed to the study conception and field experimentation). Materials preparation, data collection and analysis were performed by AB, AKJ, AK The first draft of the manuscript was written by AB and all authors commented on previous version of the manuscript. All authors read and approved the final manuscript. No ethical issue related to animal is involved in the experimentation.

Conflicts of Interest / Competing Interests

Authors do not have any conflict of interest.

REFERENCES

Baitha A, Singh M R, Kumar A. 2021. Silken discs weaved by larva of sugarcane top shoot borer, *Scirpophaga excerptalis* (Walker) (Crambidae: Lepidoptera). Annals of Plant Protection Sciences 29(2): 171-172.

David H, Easwaramoorthy S, Jayanti R. 1986. Sugarcane Entomology in India. Sugarcane Breeding Institute, Coimbatore, India. 564 pp.

Gupta B D.1954. A note on the scope of biological control of sugarcane pests. Proceedings. All India Conference of Sugarcane Research and Development Workers, India. pp. 229-235.

Gupta B D. 1959. Insect pests of sugarcane in India-III. The top borer, *Scirpophaga nivella* Fabr. Indian Sugar 9 (6): 127-149.

Kalra A N, David H. 1967. Control of sugarcane top borer, *Scirpophaga nivella* F. through an indigenous parasite, *Isotima javensis* Rohwer (Ichneumonidae: Hymenoptera). Indian Sugar 16 (12): 883-888.

Kalra A N. 1972. Beware of top borer attack in your sugarcane crop. Cane Grower's Bulletin (Oct-Dec): 25-28.

Kalra A N, Tiwari N K, Chandra J. 1980. Laboratory behaviour and multiplication of *Isotima javensis* Rohwer, a pupal parasite of sugarcane top borer, *Tryporyza nivella* Fabr. Proceedings. Thirty Deccan Sugar Technologists Association Convention, India. pp. 13-20.

Majumder S K D. 2018. Top borer of Sugarcane. Online Gatha- The Endless Tale, Lucknow. 280 pp.

Majumder S K D. 2020. Moth borer of Sugarcane. Daya Publishing House, New Delhi, 639 pp.

Singh O P. 1978. A note on some new observations on sugarcane top borer, *Tryporyza nivella* F. Indian Sugar Crops Journal 5: 30-36.

(Manuscript Received: July, 2021; Revised: October, 2021;
Accepted: October, 2021; Online Published: January, 2022)
Online published (Preview) in www.entosocindia.org Ref. No. e21134