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Exploitation of neonate larval behaviour of *Sesamia inferens* on maize for its effective management

Sonali Deole, VK Dubey, Dipti Dash and Rashmi Gauraha

Abstract
The Neonate larval behaviour and duration of the feeding of Sesamia inferens larvae in leaf whorl of the maize plant was studied in 15-20 days old plant by releasing neonate larvae on seven maize hybrid genotypes HISHELL, DKC-9135, Cyrus-G, Prabal, Cyrus, HQPM-1 and Sugar-75 under poly house conditions. The neonate larvae of S. inferens started ballooning immediately after their placement on the leaf sheath. The preference of leaf sheath area was increased with time. Fifty per cent of the larvae showed ballooning behaviour within first 10 minutes. On the basis of 20 larvae, it was found that average time taken to reach the whorl was 27.00 minutes when, the plants were in 4-5 leaf stage and 24.08 minutes when the plants were in 6-7 leaf stage. Maximum feeding in whorl was observed in sugar-75 maize hybrids as 10.02 and 9.95 days during spring 2013-14 and 2014-15, respectively.

Keywords: hishell, hqpm-1, pink stem borer, poly house

Introduction
Maize (*Zea mays* L.), a major cereal crop belonging to the family Poaceae, originated from South America, from where it was taken to all parts of the world (Galinath, 1992; Gonzalez, 2001) [3, 6].
More than 700 million people in the developing world do not have access to sufficient food to meet their need for healthy and productive life (Lisa *et al.*, 2000) [8]. Increase in maize production especially in the rural areas can help reduce the hungry population in the developing countries. The pink borer, *Sesamia inferens* (Walker), is an important pest of graminaceous crops. It is widely distributed in India, Ceylon, Pakistan, Myanmar, Thailand, Vietnam, Indonesia, Philippines, Taiwan, China and Japan (Azuma, 1977; Mia and Iwahashi, 1999) [1, 9]. Changing climatic scenario with modern cultivation practices in rice crop made pink stem borer to achieve pest status in many rice growing regions of India. (Sampath *et al*., 2014) [14].
To formulate proper and effective management it is necessary to understand the biology of *Sesamia inferens*. The larva of pink stem borer after hatching moves in large numbers inside the leaf whorl and remains there up to III instar in gregarious form. In this stage their damage can be identified by oblong hole injury, appear in the plant when the whorl opens, these larvae comes out from the whorl and bore inside the stem. If the movement of the neonate larva from egg mass to leaf whorl and the period of larval stage in the whorl are studied, it will help to formulate an effective management by minimum insecticide application.

Material and Methods
Nucleus culture of pink stem borer *S.inferens*
The larvae and pupae of *S. inferens* collected from maize fields of Research farm IGKV, Raipur and were kept separately in glass jars (10 x 15 cm) under poly house conditions. In the initial stages leaves were used as food for the developing larvae but the later instars were fed on stem portions of older maize plants. The top of each jar containing larvae and pupae was covered with muslin cloth and secured with rubber bands. The larvae were transferred to another clean jar containing fresh food for every 2-3 days till all the larvae pupated. The pupae thus collected from each jar were kept separately for the emergence of moth. The moths (male and female in equal numbers) after emergence were kept in ovipositional glass jars which properly lined with fine white paper and were allowed to lay eggs on maize leaf sheath of 15 days old plant. Four days after release of the moths the plants were removed and the leaf sheaths containing egg portion were cut and kept for further studies. These eggs were used as nucleus culture for mass rearing of *S.inferens.* The reared insect stages were utilized for the study of neonate larval behaviour of pink stem borer.

Behaviour of neonate larvae of *S.inferens* on maize plants

The objective of this experiment was to study the food searching/climbing behaviour of newly hatched larvae from the site of oviposition to the whorl of the plant. The time taken by larvae for reaching to the whorl was also recorded. The freshly hatched larvae were released at the under surface of the first leaf sheath on 15-20 days old maize plants. The movement of the larva was observed. The time taken by the larvae to reach the whorl was also recorded and this was repeated for 20 times.

Duration of the feeding in the whorl

Duration of the feeding of *Sesamia inferens* larvae in leaf whorl of the plant was studied in 15-20 days old plant by releasing neonate larvae on seven maize hybrid genotypes HISHELL, DKC-9135, Cyrus-G, Prabal, Cyrus, HQPM-1 and Sugar-75. Twenty five larvae were released to under surface of lower leaf of plant. This was done in the morning hours of the day and feeding of the larvae inside the whorl was observed daily. The duration of whorl feeding was judged by:

1) Observing the period of whorl damage.
2) In later stages by dissecting the whorl and observing the presence of larvae in the whorl.

Result and Discussion

In the present investigation soon after the hatching out from the eggs the neonate larva of *S.inferens*; how does show the climbing behaviour towards the leaf whorl, establishment in whorl and dispersal were studied. These behavioural studies could be utilized in resistance breeding programme and integrated pest management against pink stem borer.

The freshly hatched larvae obtained from culture were manually released at the lower surface of the first leaf sheath, with the help of fine camel hair brush in 15 days (4 -5 leaf stages) old crop, as this position is the most preferred site of egg laying by *Sesamia inferens*. The movement of larvae just after release was observed. The newly hatched pink borer larvae being a noctuid avoid light and neonate larvae started ballooning immediately after their placement on the leaves and about 50 percent of the larvae showed this behaviour within first 10 minutes. Ballooning allows the larvae to disperse quickly from one plant to another, reducing the time of exposure to desiccation, which seems to critical factor for the survival of young larvae. However, majority of the ballooned larvae did not reach the ground and again climbed to the plants.

The larval settling in leaf sheaths was noticed immediately after ballooning. The larvae present on leaves shifted to lower surface of plant and moved towards leaf sheath through side corners. This behaviour might be due to their tendency to find dark and moist places to avoid desiccation. However, the movement towards leaf sheath was not directed and sometimes larvae appeared confused. The preference of larvae for leaf sheath area increased with time. No leaf feeding was observed up to first 1 hour of infestation. It appears that larvae were more interested in dispersal rather than feeding during early phases.

Interplant dispersal

Two days after infestation, more than half of the larvae were found on the infested plant, a significantly higher proportion than on any surrounding plants. About 40 per cent dispersed to adjoining plants in the same row. The 10 per cent larvae reached to adjoining plants through dispersal. The time taken by the larvae to reach the whorl from the place of release was recorded. On the basis of 20 larvae, it was found that average time taken to reach the whorl was 27.00 minutes when the plants were in 4-5 leaf stage and, 24.08 minutes when, the plants were in 6-7 leaf stage. As soon as they reach the whorl, they enter the whorl through the gap between the folds of two leaves and starts feeding on tender folded leaves. After 24 hours later the presence of the young larvae confirmed on the basis of oblong hole injury in leaves, which are caused by the larvae during feeding in the whorl.

Duration of feeding in whorl

The duration for which the larvae of pink stem borer remain inside the whorl was studied in seven maize hybrid genotypes viz., HISHELL, DKC-9135, Cyrus-G, Prabal, Cyrus, HQPM-1 and Sugar-75 during 2013 and 2014.During 2013, the maximum feeding was observed in sugar -75 (10.25days), which were higher than other six genotypes. The duration of feeding in, HISHELL, DKC-9135, Cyrus-G, Prabal, Cyrus and HQPM-1 was 6.06, 6.16, 7.13, 7.03, 6.66and 5.86 days, respectively. The feeding pattern was same during 2014 which was maximum in maize genotype sugar -75 (9.95 days) and was significantly higher than all hybrids. The minimum duration of feeding was recorded in maize hybrid HQPM-1 (6.50 days) (Table 1 and Fig.1).

Table 1: Duration of feeding in whorl by S. inferens in different maize hybrids

Maize Hybrids	Days (2013-14)	Days (2014-15)
HISHELL	6.06	6.50
DKC-9135	6.16	7.30
Cyrus-G	7.13	8.01
Prabal	7.03	8.16
Cyrus	6.66	7.56
HQPM-1	5.86	6.23
Sugar-75	10.02	9.95
S.Em ±	0.410	0.362
C.D.	1.25**	1.10**

**Significant at 1% level

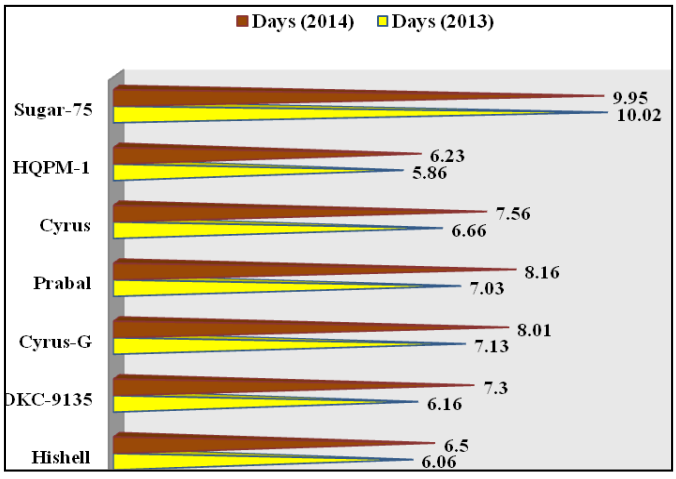

Fig 1: Duration of feeding in whorl by *S.inferens* in different maize hybrids

Ballooning behaviour shown by neonate larva of Sesamia inferens

Neonate larvae feeding in whorl of maize

Many scientists also found that all the first instar larvae, hatched from the egg mass on a plant may reach the whorl of the same plant. Many of them may disperse to the other neighboring plant (Pats and Ekbom, 1992 and Ganguli and Ganguli, 1996) [10, 4] through ballooning behaviour of I instar larvae of pyralid moth *C.partellus*. It was found that 55 per cent of the newly hatched larvae left the young maize plant on silk threads within 2 hours of their release. The maternal factor plays an important role in larvae dispersal. (Berger, 1989) [2] Ganguli *et al*. (1998) [5] reported that the young maize plants were preferred by neonate larvae as 60 per cent neonate larvae reached to the leaf whorl within 26.8 minutes when, the plant were in seven leaf stage and also studied the duration of feeding in six maize inbred lines during kharif 1993 and 1994 and found that, once the *Chilo partellus* larvae reach the inside of the whorl, they continuously feed in the leaf whorl and crawl down and enter inside the shoot by making entry holes. Sithole (1987) [15] also reported the dispersal of newly hatched larvae and concluded that the neonate larvae hang into the air and infest neighboring plants, serving to reduce competition between larvae that hatch from same egg mass and thereby increase their survival chances and the dispersal ability decline with increase in the age of larvae. Roome (1980) [13] also observed that young larvae of *Chilo partellus* (Swinhoe) do not feed prior to dispersal, further it was emphasized that gestation is not an important factor in the larval acceptance of an oviposited plant.

Similar findings have been reported with *C. partellus* by Reyes (1987) [12] who reported that the larvae remain in whorl for about 3 instars; this period lasts for about 10 days. Then the larvae enter the stem. The movement of the larvae of *C. partellus* after hatching from the egg is very well described by Leuschner (1990) [7] and Ganguli *et al*. (1998) [5]. They observed that first of all the freshly hatched larvae are attracted towards the whorl of plant. As soon as they reach, they enter inside the whorl and starts feeding on tender folded leaves at the bottom of whorl by making pin holes. The symptoms of pin hole injury caused by newly hatched larvae appeared little later when injured leaves grow and open gradually. Reddy (2003) [11] studied the *Sesamia inferens* larval establishment under field conditions by releasing 1,2,5,10,15 and 20 larvae/plant and found that larval recovery in leaf whorl was maximum at 1 day after infestation, subsequently from 7 days after infestation and onwards the larval recovery declined steeply.

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