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Egg laying pattern of *Sesamia inferens* on maize (*Zea mays*)

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ABSTRACT

To study the egg laying pattern of *Sesamia inferens* (Walker) on maize (*Zea mays* L.), a set of variable number of 12-day old plants, i e 1, 2, 3 and 4 plants in each set of resistant cultivar HQPM 1 and susceptible cultivar, Basi Local were offered to a single pair of adult *S. inferens* in versatile insect rearing cage. The number of eggs laid on HQPM 1 was 47.7 % more than the number of eggs laid on Basi Local. When only one plant was available for oviposition, the female laid 84% of its eggs complement on it both in case of HQPM 1 and Basi Local. The number of eggs was divided unequally when two plants were made available with the first plant receiving 60-70% of the eggs. The maximum number of plants utilized for depositing the eggs was four out of ten plants offered to the female, although at times, the female oviposited six plants as well but the total number of eggs did not increase when the number of plants exceeded more than four, on contrary, it got reduced. The distribution pattern of eggs on plants resulted in the decline in number of eggs per plant with increase of every additional plant. The egg distribution within a plant showed significantly more percentage (58.57) of eggs on first leaf sheath followed by second leaf sheath (27.19) and least number on basal leaf sheath (14.24). The total oviposition period was observed to be seven days with average fecundity as 405 and maximum number of eggs (174) obtained on second day of emergence of adults.

Key words: Maize, Oviposition pattern, *Sesamia inferens*

Pink stem borer, *Sesamia inferens* (Walker) is one of the major borer pests, which has been recorded mainly on *rabi* maize (*Zea mays* L.) (Jalali and Singh 2002). The losses primarily due to *S. inferens* in *rabi* (winter) maize varies from 25.7 to 78.9% (Chatterji *et al*. 1969). Host plant resistance is one of the successful methods used for the management of this borer. Hence, there is a need to develop maize germplasm with high levels of resistance to insect pests (Bergvinson *et al.* 2002). An understanding of the ovipositional behaviour of *S. inferens* on resistant and susceptible cultivars could be used to evaluate the germplasm to identify the sources of resistance. The oviposition behavior of *Chilo partellus* was found to be an indicator of germplasm susceptibility of maize (Pratap 2012). Also, the non-preference of females for oviposition has been identified to be one of the components of resistance to *C. partellus* in sorghum (Singh and Rana 1984, Alghali 1985, Saxena 1990, Van den Berg and Van den Westhuizen 1997). Given the importance of ovipositional behaviour, the current studies were conducted for *S. inferens.* The present studies thus, can form a basis for germplasm screening techniques of maize against *S. inferens*.

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MATERIALS AND METHODS

The experiment was conducted in the glass house of Directorate of Maize Research, Pusa Campus, New Delhi during spring, 2012. A relatively resistant germplasm of maize, HQPM 1 and susceptible germplasm, Basi Local was selected for the present investigations. The seeds of the maize cultivars used were obtained from the Directorate of Maize Research**.**

The larvae were collected by splitting the infested maize stalks obtained from the field. The rearing was continued on cut pieces of maize stems (7.5 cm long) till pupation. Pupae thus collected were kept in the glass rearing jars (10 cm × 15 cm) for the emergence of adults. Twelve day old 4 potted plants of maize were kept in a versatile insect rearing cage (VIRC) developed by Kumar *et al.* (2012) and adults of *S. inferens* in the ratio of 1:1 (male:female) were transferred to the cage @4 pair per cage (Fig 1) for oviposition. Egg laying was examined on the plants after 4-5 days and the portion of leaf sheath containing eggs was cut and kept for incubation at $27^0 \pm 2^0$C. The eggs thus obtained served as a nucleus culture for the mass rearing of *S. inferens* on artificial diet in the laboratory (Siddiqui *et al*. 1977).

Four 12 day old plants were kept in VIRC and one pair of one day old adult pair of *S. inferens* was released. The plants were watered and maintained in good condition. After five days, the plants were taken out and number of egg masses and number of eggs in each egg mass were counted and recorded. This study was conducted for HQPM 1 and Basi Local and replicated thrice. After observing that all the four plants in both the germplasm were oviposited, the experiment was repeated with ten plants per pair of adults in one VIRC and after five days, the data for number of egg masses and number of eggs per egg mass was recorded.

A susceptible germplasm of maize, Basi local and resistant germplasm, HQPM 1 were used for this study. The experiment was conducted in four sets; each set having 1, 2, 3 and 4 number of plants kept in VIRC cage. In each cage one-day old pair of *S. inferens* adults was released. This was replicated three times for both the germplasm. On fifth day, the pots were taken out of the cage and number of infested plants in each cage were counted and recorded. The number of egg masses laid on each plant were also counted and recorded. The leaf sheaths were removed to count the number of eggs in each egg mass.

Maize cultivar, HQPM 1 only was used to study the age specific fecundity. Staggered sowing of 20 plants everyday was done for 10 days at one day interval. Twelve-day old two plants were kept in VIRC and freshly emerged *Sesamia* moth were released on these plants. Everyday, the plants were replaced with another set of two 12-day old plants for oviposition by the same pair. The number of eggs and egg masses laid by *S. inferens* in the removed plants were recorded daywise. New plants were provided everyday till the female survived. The experiment was replicated seven times.

The data obtained were averaged for each treatment and subjected to one-way analysis of variance (ANOVA) using SPSS16 software using least square design.

RESULTS AND DISCUSSION

Number of plants oviposited by one female out of four plants

Total number of eggs: Initially when up to four plants were provided, the average number of eggs laid per female was 252.3, 280.7, 291.0, and 297.7 on 1, 2, 3 and 4 plants respectively in case of HQPM1 (Table 1). The statistical analysis showed that the average number of eggs laid per female was at par (291.0 and 297.7) when 3 and 4 plants were offered but they were significantly more than the number of eggs (252.3 and 280.7) obtained on 1 and 2 plants (Table 1).

In case of Basi Local, the total number of eggs (207.33) laid on four plants was highest but significantly at par with the number of eggs (193.67) laid on 3 plants. There was no significant difference between the number of eggs 193.67 and 183.67 observed on 3 and 2 plants respectively. The minimum number of eggs (175.33) was observed on single plant (Table 1).

The results suggested that the total number of eggs increase as the number of plants is increased both in HQPM1 and Basi Local.

Number of egg masses per plant: The maximum number of egg masses (9) was observed on 4 plants in case of HQPM1. The number of egg masses was 8.33, 8.33 and 7.67 on 3, 2 and 1 plant respectively. The statistical analysis showed no significant difference among the number of egg masses on increasing the number of plants (Table 2.1). Similarly in Basi local, the number of egg masses was 6.67, 7.33, 8.62 and 7.33 respectively on 1, 2, 3 and 4 plants which were at par (Table 1).

Number of eggs per egg mass: There was no significant difference between the number of eggs per egg mass which ranged from 32.91 to 34.92 in case of HQPM1 (Table 1). In Basi local, the highest number of eggs per egg masses (28.27) were recorded on 4 plants which was significantly at par with the number of eggs per egg mass on single (26.3) and two (25.05) plants. The egg masses on three plants have minimum number of eggs (22.31) (Table 1).

When ten plants were offered to single pair for oviposition, in five cases, four plants were used by females for oviposition wherein the egg masses per plant were 2.0

Table 1 Total number of eggs and egg masses laid by *S. inferens* on variable number of plants of HQPM1 and Basi Local

Number of plants	HQPM 1			Basi Local		
	Av. no. of eggs	Av. no. of egg mass	Eggs/egg mass	Av. no. of eggs	Av. no. of egg mass	Eggs/egg mass
1	252.3±2.02c	7.67	32.91	175.33±8.76bc	6.67	26.3±2.6ab
2	280.7±2.40b	8.33	33.68	183.67±1.85b	7.33	25.05±0.93ab
3	291.0±2.08ab	8.33	34.92	193.33±3.4ab	8.62	22.31±1.25b
4	297.7±5.92a	9.00	33.07	207.33±3.17a	7.33	28.27±1.32a
		NS	NS		NS	

Table 2 Number of plants chosen for oviposition (out of 10 plants) and distribution of eggs of *S. inferens*

Total plants	Plants oviposited (n)	Frequency of choosing n no. of plants	Av. number of eggs/female	Av. no. of eggs/plant	Av. no. of total egg mass/ plant	Av. no. of egg mass/ plant
10	4	5	352.40±29.46	88.10±7.36a	8.00±1.3	2.00±0.32
10	5	1	315.00	63.00ab	6.00	1.20
10	6	4	296.00±43.66	43.66±7.27b	11.20±1.65	1.87±0.28
			NS		NS	NS

Table 3 Percent distribution of eggs of *S. inferens* on HQPM 1 and Basi Local

Germplasm	Number of plants	Between the plants (mean of 3 replications)			
		Plant number (% eggs)			
		1	2	3	4
HQPM 1	1	100.00			
	2	58.99	41.01		
	3	58.62±2.83a	29.54±1.36b	11.85±3.6c	
	4	50.57±6.53	29.67±3.15	14.31±5.15	5.45±3.13
Basi Local	1	100.00			
	2	70.18	29.82		
	3	59.46±5.60a	31.82±6.55b	8.72±2.01c	
	4	54.16±7.04a	29.76±3.82b	10.62±0.5c	5.47±2.73c
		Within the plant (mean of 3 replications)			
	Basal	*First*		*Second*	
HQPM 1	14.24±2.01c	58.57±2.72a		27.18±2.54b	
Basi Local	10.57±4.37b	80.01±1.39a		9.41±3.15b	

(Table 2). The average number of eggs was 352.4 on four plants. In one case, five plants were oviposited and the number of eggs was 315. The number of egg mass per plant was observed to be 1.2. In the remaining four cases, six plants each were oviposited by females with the average number of eggs observed to be 296. The average number of egg mass per plant was 1.87. The statistical analysis showed that there was no significant difference between the total number of eggs per female, average number of egg masses per plant and number of eggs per egg mass

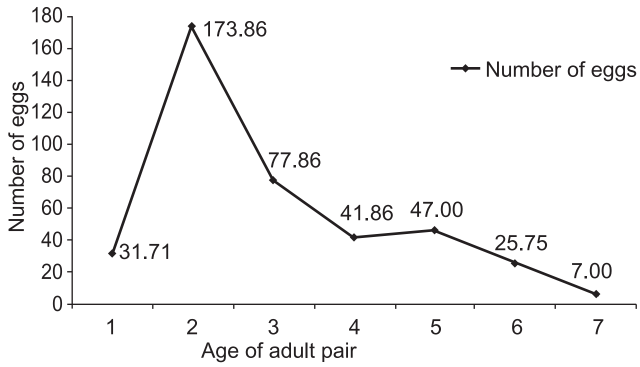

Fig 1 Trend of number of eggs during oviposition period of *S. inferens* (Age specific fecundity)

Distribution pattern of eggs among and within the plant

Distribution of eggs between the plants: In case of HQPM 1, the average percent distribution of eggs was 58.99 and 41.01 on plant 1 and 2 respectively in case of two plants. The percent distribution was 58.62, 29.54 and 11.85 on plant 1, 2 and 3 when three plants were kept in the cage while 50.57, 29.67, 14.31 and 5.45 percent eggs were observed on first, second, third and fourth plant respectively when four plants were offered to female (Table 3).

In case of Basi Local, 70.18 percent eggs were laid on first plant and remaining 29.82 percent eggs were laid on second plant when two plants were kept in the cage, while the percent distribution of eggs was 59, 46, 31.82 and 8.72 on three plants. Similarly when 4 plants were offered to female, 54.16, 29.76, 10.62 and 5.47 percent eggs were observed on first, second, third and fourth plant (Table 3).

Distribution of eggs within the plant: To study the distribution of eggs within plant, the number of eggs in each egg mass and number of egg masses in each leaf sheath (basal, first and second) were recorded in HQPM 1 and Basi Local. Significantly higher number of eggs (58.57 percent) was recorded in first leaf sheath followed by number of eggs (27.18 percent) on second leaf sheath. Significantly lowest number of eggs (14.24) was deposited in basal leaf sheath in case of HQPM 1 (Table 3).

In case of Basi Local, 80.01 percent eggs were deposited in first leaf sheath while second leaf sheath and basal leaf sheath recorded 9.41 and 10.57 precent eggs respectively (Table 3).

Age specific fecundity of S. inferens: The average number of eggs laid by *S. inferens* at 1, 2, 3, 4, 5, 6 and 7 days was 31.71, 173.86, 77.86, 41.86, 47.00, 25.75 and 7.00 respectively (Fig 1). The freshly emerged female (0-1 day old) laid very few eggs (31.71). Significantly higher number of eggs (173.86) was observed one day after the emergence of adult. The total oviposition period was observed to be 7 days.

The total number of plants used for ovipsition, oviposition site and number of eggs per plant are the important parameters for studying the oviposition behaviour of an insect. Oviposition site choice by female is a selective strategy to take advantage of enemy-free space (Williams 2012). Berger (1989) stated that egg batch size and the number of eggs/plant are important for the ballooning behaviour of newly hatched larvae and subsequent increase in the levels of plant infestation.

The results obtained in the present investigation where female was given choice to lay eggs on one and up to four plants, indicated that as the number of plants increased, the females distributed their eggs among all the plants offered for oviposition. This oviposition preference pattern of *Sesamia* is supposed to correspond to the availability of food for its larvae. When the number of plants was less, the females tended to lay more eggs per plant which result in early consumption of the food source, forced emigration, exposure to predators, thus increased larval mortality.

The data on number of plants used for oviposition suggested that four plants were enough to support the full potential of female although at times the female used up to six plants for oviposition (Table 2). Also, the maximum number of eggs obtained on 4 plants suggested that 4 plants of any germplasm will be an optimum number for the female to offload its full complement of eggs. In view of the low carrying capacity of the thin stems of maize at susceptible age of oviposition and securing the food for its neonates, the female tended to distribute eggs on at least four plants as evident from the percent distribution of eggs when 10 plants were offered per female. The behavior may be supported by the fact that females secure their offspring from exposure to natural enemies by selecting more than one plant for oviposition which maximizes unpredictability of larval dispersion to a searching parasitoid (Gripenberg *et al*. 2010). The selection of more plants for oviposition may also be supported by avoidance of host already laden with eggs as is reported by Setamou and Schulthess (1995) who reported that female adults of *S. calamistis* either tend not to oviposit on plants already occupied, and/or they do not lay more than one egg batch/plant.

The distribution pattern of eggs within the plant suggested that the first leaf sheath of maize plant bears maximum load of eggs irrespective of the germplasm (Table 3). The basal leaf sheath received the least number of eggs. The results are in accordance with that of Ateyim *et al.* (2009) who reported that the part of the plant most preferred by the moths for egg laying was the middle portion with a mean number of 71.0 eggs compared to the upper and lower portions of the plant with mean numbers of 18.3 and 14.4 eggs, respectively. Similarly, the distribution of the eggs laid by the moth on different leaf sheaths of ten maize genotypes indicated that the moth preferred to lay maximum number of eggs (>55 percent) on the first leaf sheath irrespective of the genotype (Sekhar *et al.* 2009).

The maximum number of eggs laid by 1-2 day old female represented the usual trend of egg laying by many lepidopterans. Most eggs of *C. partellus* are laid during the first three oviposition nights (Pats 1994). Oviposition started the first night after the mating, peaked during the second night and then gradually decreased until the fifth night in case of maize stem borer, *Busseola fusca* (Calatayud *et al.* 2007).

CONCLUSION

The distribution pattern of eggs represent a broad approach to studying plant–herbivore interactions not only at herbivore level but at the parasitoid level too as insect-parasitoid population dynamics are highly influenced by distribution pattern of host eggs on the plant. By monitoring the adult population of *Sesamia*, the data on number of plants infested by one female can help estimate the damage and ultimately the crop loss in the standing crop. The total number of plants preferred for oviposition will strengthen the base for using the ovipositional colonization by *S. inferens* as a cue for determination of susceptibility of maize genotypes. Hence, the current studies may help in devising monitoring, research and control strategies of *S. inferens* on maize.

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