Entomon 23(2): 77–82 (1998)

Fecundity and Diurnal Oviposition Behaviour of Sorghum Shoot Fly, *Atherigona soccata* Rondani (Diptera: Muscidae)

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Abstract: The fecundity and diurnal oviposition behaviour of sorghum shoot fly, *Atherigona soccata* Rondani was studied on CSH 5, a susceptible sorghum genotype under greenhouse conditions. Fecundity of shoot flies deprived of 10 day-old sorghum seedlings was drastically reduced, and no fertile eggs were laid after 11 days of host deprivation. However, when provided with host plants, egg production was prolonged, and dropped considerably after the flies were 22 day-old. There were three distinct peaks (6 & 7, 13 & 14, and 18 & 19 days of age) in egg laying activity during adult life span. Further studies with flies of three age groups (7, 13, and 19 day-old) did not show significant differences in diurnal oviposition pattern with age. However, most eggs (60%) were laid between 0800 and 1200 hours. It was evident from the present study that the prolonged egg laying vitality of shoot fly adult when provided with a susceptible host may partly account for the dramatic increase in shoot fly damage as the crop season advances, since there would be a geometric increase in active females with every new generation of flies.

Keywords: Shoot fly, *Atherigona soccata*, sorghum genotypes, fecundity, rate of increase, deadheart, oviposition behaviour.

INTRODUCTION

Sorghum, *Sorghum bicolor* (L.) Moench is an important cereal crop in Africa and Asia. Grain yields on farmers' fields are generally low (500-800 kg ha^{-1}), insect pests being one of the major factors limiting sorghum production. Nearly 150 insect species have been reported as pests of sorghum (Seshu Reddy and Davies, 1979; Jotwani *et al.*,1980). Sorghum shoot fly, *Atherigona soccata* Rondani (Diptera: Muscidae) is one of the most destructive pest of grain sorghum, which attacks 7 to 28 day-old sorghum seedlings (Nwanze *et al.*,1990). The females lay white, elongated, cigar-shaped eggs

Received in June, 1997.

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singly on the undersurface of the leaves, parallel to the midrib. The eggs hatch in 1-2 days, and the larvae crawl along the leaf lamina to reach the plant whorl and then move downward through the central shoot till they reach the growing point. They cut the growing point and feed on the decaying leaf tissues, resulting in deadheart formation. The female has a life span of 30 days.

Oviposition is a biological response which to a large extent is influenced by the genotype of the host plant (Sharma *et al.*,1990). In order to evaluate sorghum genotypes for resistance to the shoot fly, it is necessary to obtain information on fecundity on a susceptible host under greenhouse conditions (Raina, 1982). The present investigations were undertaken to study the influence of withholding oviposition by shoot fly on fecundity, successful infestation, larval survival, and adult emergence, when deprived of and provided with host plant for a better understanding of the rate of increase of the pest during the cropping season. The present paper includes shoot fly diurnal oviposition behaviour in relation to female longevity.

MATERIALS AND METHODS

Influence of withholding Oviposition by Shoot Fly on Fecundity, Successful Infestation, Larval Survival, and Adult Emergence

Susceptible CSH 5 plants were grown in twelve plastic baby bath tubs (42 × 30 × 14 cm). Each tub accommodated 50 plants with a spacing of 15 × 5 cm between rows, and plant hills. When the seedlings were 10 day-old, the tubs were placed in the first compartment (82 × 75 × 60 cm) of a 3-compartment cage and were artificially infested with field collected gravid shoot fly females. The adults were confined with the plants for 12 h. Ten days after infestation, all the deadhearts were harvested and kept in moist sand in a metal tray (60 × 30 × 10 cm) placed in the central compartment (65 × 75 × 60 cm) of the cage for adult emergence. Newly emerged adults entered through a funnel into the last compartment (52 × 75 × 60 cm) and were fed on diet (brewer's yeast powder glucose in 1 : 1 ratio and cotton soaked in 10% sucrose solution in a petri-dish). To collect the flies from the last compartment, it was covered with a thick black cloth (close weave) leaving the collection container as the only source of light. Adult flies collected were kept in a cage (40 × 35 × 30 cm) and provided with diet.

After the pre-oviposition period of three days, 10 females were collected every day from the cage, and released on 10 day-old seedlings for 12 h. The females were deprived of sorghum seedlings at 1 day interval for a duration of 18 days under greenhouse conditions at 26–30±3°C, 60–75±5% RH, and a photoperiod of 12 : 12 (L:D) hours. Observations were recorded on retention duration (days), total number of plants, plants with eggs, total number of eggs, number of plants with unhatched eggs, number of deadhearts, number of dead larvae, number of dead pupae, and number of emerged adults. The biological and damage parameters were calculated as follows:

$$\text{Fecundity} = \frac{\text{total number of eggs}}{\text{number of females released}}$$

$$\%\ \text{successful infestation} = \frac{\text{total number of deadhearts}}{\text{total plants with eggs}} \times 100$$

% larval survival

$$= \frac{\text{total no. of deadhearts} - \text{total no. of dead larvae}}{\text{total no. of deadhearts}} \times 100$$

Proportion of adult emergence from deadheart plants

$$= \frac{\text{total number of emerged adults}}{\text{total number of deadhearts}} \times 100$$

Pattern of Shoot Fly Oviposition in Relation to Female Longevity

To obtain shoot fly culture, same procedure as above was adopted. After the pre-oviposition period of three days, 25 gravid females were collected from the cage, and released (5 females/2 pots/cage) on 10 day-old seedlings, provided with diet and were allowed to lay eggs for 24 h. Twenty-four hours after exposure, the seedlings were replaced daily with fresh ones, till death of all adult flies. Observations were recorded on the number of eggs laid per female per day.

Temporal and Diurnal Patterns of Shoot Fly Ovipositional Behaviour in Relation to Female Age

To obtain shoot fly culture, same procedure as above was adopted. This experiment was conducted based on the results obtained from pattern of shoot fly oviposition in relation to female longevity under greenhouse conditions. Shoot fly females in three distinct age groups (7, 13, and 19 day-old) were used.

After the pre-oviposition period of three days, 15 gravid females of each age group were collected from the rearing cage and released (5 females/2 pots/cage) on 10 day-old seedlings at 2 h intervals for about 24 h. Twenty-four hours after exposure, the seedlings were replaced daily with fresh ones, till death of all adult flies. The experiment was replicated three times and observations were recorded on the number of eggs laid every 2 h. Data were statistically analysed using a Least Significant Difference (LSD) test at 5% probability level.

RESULTS

Influence of withholding Oviposition by Shoot Fly on Fecundity, Successful Infestation, Larval Survival, Adult Emergence

Fecundity of shoot flies deprived of sorghum seedlings was drastically reduced, and no fertile eggs were laid after 11 days of host deprivation, even when subsequently provided with host plants (Table 1). Percent successful infestation *i.e.*, expression of deadhearts dropped considerably after 11 days of host deprivation. A great percentage of the larvae survived from 1-11 days. Same trend occurred in adult emergence.

Pattern of Shoot Fly Oviposition in Relation to Female Longevity

However, when provided with host plants, egg viability and successful development were prolonged, and dropped considerably after the flies were 22 day-old (Table 2). More than 90% of eggs hatched. There were three distinct peaks (based on weekly intervals) in egg laying activity during the adult life span. Peaks in oviposition occurred at 6 & 7, 13 & 14, and 18 & 19 days of age, and were as high as 4.5 eggs female^{-1} day^{-1}.

Table 1: Effect of Withholding Oviposition by Host Deprivation by Shoot Fly on Biological Parameters

Adult age (days)	Retention duration (days)	Fecundity Eggs/female	% successful infestation	% larval survival	Proportion of adult emergency
1	Pre-ovi	–	–	–	–
2	"	–	–	–	–
3	"	–	–	–	–
4	1	5.2	76.7	69.0	29.7
5	2	4.3	85.8	89.7	32.8
6	3	4.4	81.8	87.8	14.8
7	4	2.6	67.8	72.0	26.0
8	5	3.6	48.8	58.0	32.0
9	6	4.7	89.8	79.0	36.0
10	7	1.9	72.7	25.0	40.0
11	8	1.3	40.0	20.0	20.0
12	9	2.4	67.8	54.8	54.7
13	10	1.9	24.0	22.2	26.0
14	11	2.8	52.8	21.7	30.0
15	12	1.2	0.0	0.0	0.0
16	13	3.9	2.2	0.0	0.0
17	14	4.0	2.3	0.0	0.0
18	15	2.1	0.0	0.0	0.0
19	16	1.7	0.0	0.0	0.0
20	17	1.3	0.0	0.0	0.0
21	18	0.6	0.0	0.0	0.0

Temporal and Diurnal Patterns of Shoot Fly Ovipositional Behaviour in Relation to Female Age

Further studies with flies of three age groups (7, 13, and 19 days) did not show significant differences in diurnal oviposition pattern with age. However, most eggs (60%) were laid between 0800 and 1200 hours (Table 3).

DISCUSSION

The number of eggs laid per shoot fly female when provided with host plant has been examined in several studies (Kundu and Kishore, 1970; Raina, 1982), but the subsequent impact on eggs resulting from host deprivation was not investigated in these studies. Therefore, experiments on the fecundity of shoot fly deprived of and with access to sorghum seedlings provided useful information in determining the rate of increase of the pest. There was evidence of a decrease in fecundity of shoot fly when deprived of sorghum seedlings, and after 11 days of host deprivation, the eggs laid were infertile. Whereas flies with access to host plants had longer duration in eggs laying activity during adult life span and more than 90% of the eggs hatched. Sorghum shoot fly is host specific (Ogwaro, 1978; Raina and Kibuka, 1983) and gravid females used in the present study did not prefer to lay eggs on cage walls or in petri-dishes containing diet in the cage, when deprived of sorghum. The fecundity of 62 eggs/female in a period of 1-19 days obtained in the present study when shoot flies had access to seedlings was lower than the 78 eggs/female reported by Raina (1982) on CSH 1. Meksongsee *et*

Table 2: Pattern of Shoot Fly Oviposition in Relation to Female Longevity (days)

Adult age (days)	Oviposition duration (days)	No. of females		Total No. of of eggs laid	Average no. of eggs per female	hatched	% eggs
		Alive	Laid eggs		1/*	2/**	
1	Pre-ovi	–	–	–	–	–	–
2	"	–	–	–	–	–	–
3	"	–	–	–	–	–	–
4	1	25	25	181	7.2	7.3	99.2
5	2	25	15	34	1.4	2.3	100.0
6	3	25	25	151	6.0	6.0	98.8
7	4	25	20	124	5.0	6.2	96.8
8	5	25	15	107	4.3	7.2	99.8
9	6	25	15	20	2.0	3.4	92.0
10	7	25	25	140	5.6	5.6	97.8
11	8	25	25	62	2.5	2.5	95.2
12	9	20	14	40	2.0	2.9	100.0
13	10	20	14	65	3.3	4.6	93.8
14	11	20	18	91	4.6	5.1	92.7
15	12	16	8	12	0.8	1.5	100.0
16	13	8	0	0	0.0	0.0	0.0
17	14	8	3	4	0.5	1.3	100.0
18	15	7	6	36	5.1	6.0	72.7
19	16	7	7	27	3.9	3.9	88.8
20	17	7	7	13	1.9	1.9	100.0
21	18	5	5	7	1.4	1.4	100.0
22	19	1	1	5	5.0	5.0	100.0

* Number of eggs laid/female based on the number of females alive

** Number of eggs laid/female based on actual number of females that laid eggs

Table 3: Temporal and Diurnal Patterns of Shoot fly Ovipositional Behaviour in Relation to Female Age

Time interval (hours)	Number of eggs laid Age of adult females (days)		
	7 day-old	13 day-old	19 day-old
0600 - 0800	2.0bc	1.0cd	0.0d
0800 - 1000	15.7a	8.3a	5.3a
1000 - 1200	14.7a	6.7ab	3.8b
1200 - 1400	11.7ab	5.3b	2.7bc
1400 - 1600	7.3abc	2.7c	2.0c

Means within a column followed by the same letter are not significantly different at P=0.05 using a Least Significance Difference (LSD) test.

al. (1978) reported from Thailand that the shoot flies laid an average of 235 eggs. The variations in fecundity could be due to differences in exposure periods, time interval to locate a host plant, adult longevity due to different environmental conditions, and diet fed to the adults.

Studies on diurnal oviposition pattern of flies show that up to 60% of the total eggs were laid between 0800 and 1200 hours. This was associated with photoactic stimuli (e.g. colour) and optimum temperature and relative humidity. It was evident from the present study that the prolonged egg laying vitality of shoot fly adult when provided with a susceptible host may partly account for the dramatic increase in shoot fly damage as the crop season advances, since there would be a geometric increase in active females with every new generation of flies.

ACKNOWLEDGEMENTS

We are grateful to Mr. J. Raja Rao and Mr. K. Hareendranath for technical assistance in the greenhouse. This paper was approved as Journal Article No. 2082 by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502324, Andhra Pradesh, India.

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