Insect Sci. Application Vol. 4, No. 4, pp. 373–376, 1983
Printed in Great Britain

0191-9040/83$3.00 + 0.00
Pergamon Press Ltd

OVIPOSITION BEHAVIOUR OF SPOTTED BOLLWORM, *EARIAS VITTELLA* FAB. ON SOME COTTON GENOTYPES

H. C. SHARMA* and R. A. AGARWAL
Indian Agricultural Research Institute, New Delhi 110 012, India

(*Received* 27 *July* 1982; *revised* 25 *March* 1983)

Abstract—The oviposition behaviour of spotted bollworm, *Earias vittella* Fab. was studied on 23 cotton genotypes under field and laboratory conditions. There were substantial differences in the number of eggs laid on different genotypes. More eggs were deposited on the bolls compared to leaves and squares. The relative oviposition preference differed under the field and laboratory conditions in the case of some genotypes. Leaf hairiness was significantly and positively correlated with number of eggs laid both under field and laboratory conditions. The effect of oviposition on varietal susceptibility appeared to be modified through other factors, such as gossypol and tannins. However, oviposition non-preference was one of the important resistance mechanisms in some cotton genotypes.

Key Words: Oviposition behaviour, spotted bollworm, cotton bolls, squares, host plant resistance

INTRODUCTION

COTTON is an important commercial crop in Asia, Africa, America and Australia. It is damaged by over 130 species of insects. Among them, the spotted bollworm, *Earias vittella* Fab., is an important pest. Nearly 87% of the reproductives shed to the ground due to bollworms (Deshpande and Nandkarny, 1936). Even the highly toxic insecticides fail to give a satisfactory control of this pest. Considering the colossal losses caused vis-a-vis the limitations of insecticides to control it, host plant resistance can be used as one of the mechanisms to keep bollworm population below economic threshold level. Of the various mechanisms of resistance, non-preference for oviposition may play a significant role in the host plant resistance to insects. Oviposition is a biological response which can be modified by the genotype of the host plant (Budford *et al.*, 1967).

The present studies report the observations on the oviposition behaviour of *E. vittella* on 23 cotton genotypes.

MATERIALS AND METHODS

The experiments were carried out in Delhi, India, during the 1977 and 1978 rainy season. The crop was sown during the 4th week of May. The entries were planted in unreplicated plots of four rows, 3 m long. Sixteen genotypes were tested during 1977 and 23 during 1978 under natural conditions. Cotton genotypes with diverse characters were selected for these studies. The genotypes tested included two lines from *Gossypium arboreum* (Sanguineum and Virnar) and 21 from *G. hirsutum* (SS-265, Bikaneri Nerma, Frego bract, BJR, D-33, JR-81, South Carolina, M-495, Ston. 731N, PS-10, H-14, American Nectariless, 320-F, SH-269, Acala, Hindiweed, Empire, XG-15, RS-89, Cocker-100A and HR-26 No. 8XH.HG-6-IN). Normal agronomic practices were followed for raising the crop. No insecticide was applied in these trials.

Data were collected on the number of eggs laid per 100 squares, bolls and leaves (selected at random) during the peak activity period of the insect.

The oviposition behaviour of the moths was studied under laboratory conditions. The relative oviposition preference was studied in relation to *Gossypium barbadense* (Line-199-5) having smooth leaves (without surface hairs). Twenty varieties studied were divided into five sets of four each with *G. barbadense* as a common check. The cotton branches (20 cm long) from the five test cultivars were kept in a wide mouthed bottle containing water. The bottle containing the branches was kept inside the cage (30 cm^3). The number of eggs laid by 10 females were counted every day for 5 days. The oviposition preference was calculated as follows:

(i) percent egg laying on a genotype:

$$\frac{\text{No. of eggs laid on a genotype}}{\text{Total number of eggs laid on a set}} \times 100$$

(ii) relative oviposition preference:

$$\frac{\text{No. of eggs laid on a test variety} - \text{No. of eggs laid on the check}}{\text{No. of eggs laid on a test variety} + \text{No. of eggs laid on the check.}} \times 100$$

The leaf hairiness was rated on 1–4 scale by touching the under-surface of the leaf by hand. Varieties with dense covering of hairs on the under-surface of leaves were rated as four and those with very little or no hairs (smooth-leaved) as one. This is a quick and fairly reliable technique for evaluating

*Present address: Sorghum Entomologist, International Crops Research, Institute for the Semi-Arid Tropics (ICRISAT), Patancheru P.O. 502 324, A.P., India.

Table 1. Oviposition behaviour of spotted bollworm *Earias vittella* on different cotton varieties in 1977 rainy season under natural conditions

S. No.	Variety	Eggs laid/100 squares/bolls: Squares	Bolls	Total eggs
1	Sanguineum	30	30	60
2	Virnar	14	24	38
3	RS-89	20	18	38
4	SS-265	28	10	38
5	Bikaneri Verma	14	16	30
6	Hindiweed	14	14	28
7	H-14	16	10	26
8	JR-81	8	18	26
9	D-33	8	14	22
10	BJR	10	12	22
11	Frego bract	6	16	22
12	320-F	8	12	20
13	XG-15	10	10	20
14	PS-10	10	8	18
15	M-495	14	4	18
16	SH-269	8	8	16
	Average	14	16	30

cotton germplasm for hairiness and is commonly used in screening for jassid resistance.

Simple correlations were computed to find out the relationship between the parameters studied.

RESULTS AND DISCUSSION

Results on the oviposition behaviour of female moths in the field are given in Tables 1 and 2. During the 1977 crop season (Table 1), the number of eggs laid varied from 16 on SH-269 to 60 on Sanguineum. In 1978, the minimum of 10 eggs were recorded on Cocker 100A and maximum of 74 eggs on American Nectariless (Table 2). Varieties with deep serrated leaves such as Sanguineum, Virnar and RS-89, were preferred for oviposition. Hairy varieties in general were preferred for oviposition, but, fewer eggs were recorded in BJR, South Carolina and M-495. Smooth-leaved varieties were comparatively less preferred. For oviposition, the female moths preferred the bracts on the green bolls, followed by lower surface of leaves and square bracts.

Under laboratory conditions (Table 3), the oviposition varied from 4% eggs on HR-26 No. 8XH.HG-6-IN to 44% on M-495. Varieties Empire, Cocker 100A, XG-15, HR-26 No. 8XH.HG-6-IN and *G. barbadense* were not preferred for oviposition. The relative ovipositional preference differed substantially in the case of some genotypes the field and laboratory conditions. These differences were mainly because oviposition under laboratory conditions was only confined to leaves, while in the field the moths deposited eggs on bolls, squares and leaves in a free-choice situation. Also, the interacting environmental conditions were different in the two situations under consideration. The genotypes M-495, SH-269 and Hindiweed, though less preferred for oviposition under field conditions were heavily oviposited on in the laboratory, while the reverse was true in the case of Sanguineum, Virnar, RS-89 and SS-265. Varieties Empire, Cocker 100A, XG-15 and HR-26 No. 8xH. HG-6-IN were less preferred for oviposition both under laboratory as well as field conditions.

Leaf hairiness was found to be positively and significantly correlated with ovipositional preference in the field ($r = 0.58$) and laboratory conditions ($r = 0.67$). However, the relationship between the oviposition behaviour of the moths under field and laboratory conditions was poor ($r = 0.20$). The extent of oviposition on a genotype was negatively correlated with tannin content of shoot tips ($r = -0.22$), gossypol content of squares ($r = -0.44$ during 1977 and -0.24 during 1978), and tannin content of bolls ($r = -0.22$). However, gossypol content of bolls did

Table 2. Oviposition behaviour of spotted bollworm *Earias vittella* on different cotton varieties in 1978 rainy season under natural conditions.

S. No.	Variety	Eggs laid/100 leaves squares or bolls: Leaves	Squares	Bolls	Total eggs	Hairiness score	ROP*
1	American Nectariless	30	4	40	74	3	76
2	Sanguineum	8	20	40	68	4	74
3	SS-265	18	20	28	66	3	73
4	Acala	12	12	42	66	3	72
5	Virnar	14	10	30	54	3	69
6	Bikaneri Nerma	14	18	18	50	3	67
7	D-33	12	2	28	42	2	58
8	JR-81	14	8	16	38	3	55
9	RS-89	4	6	24	34	3	54
10	PS-10	10	8	16	34	1	54
11	Ston. 731N	22	2	10	34	1	54
12	Empire	22	2	8	32	1	52
13	M-495	14	8	8	30	4	50
14	H-14	8	0	20	28	2	47
15	320-F	10	2	16	28	2	47
16	BJR	6	2	20	28	3	47
17	South Carolina	6	4	16	26	3	44
18	SH-269	12	0	12	24	2	41
19	Frego bract	22	0	4	26	2	38
20	HR-26 No. 8XH.HG-6-IN	12	0	8	20	1	33
21	Hindiweed	0	8	8	16	2	23
22	XG-15	8	0	6	14	2	16
23	Cocker-100A	6	0	4	10	1	—
		12	6	18	36		

*R.O.P. = Relative ovipositional preference with respect to Cocker-100A

Table 3. Oviposition behaviour of spotted bollworm *Earias vittella* on different cotton varieties under laboratory conditions

S. No.	Variety	Eggs laid (%)	Relative oviposition preference (%)
1	M-495	44 ± 2	71
2	Acala	35 ± 3	65
3	Hindiweed	31 ± 1	61
4	SH-269	29 ± 2	59
5	South Carolina	27 ± 3	57
6	Virnar	26 ± 1	55
7	JR-81	26 ± 1	55
8	Frego bract	24 ± 2	53
9	Digvijay	24 ± 2	52
10	SS-265	23 ± 2	50
11	Sanguineum	22 ± 2	50
12	Okra leaf mutant	22 ± 2	49
13	RS-89	21 ± 1	48
14	Bikaneri Nerma	19 ± 2	44
15	American Nectariless	19 ± 2	44
16	Empire	16 ± 3	36
17	Cocker-100A	14 ± 2	31
18	XG-15	8 ± 2	5
19	HR-26 No. 8XH.HG-6-IN	4 ± 3	32
20	*G. barbadense*	8 ± 1	

not show a definite relationship with oviposition behaviour ($r = 0.38$ during 1977, and 0.003 during 1978) (Sharma and Agarwal, 1982c,d). The higher gossypol content of squares possibly inhibited oviposition. Also, more eggs were recorded on bolls as compared to the squares. Higher gossypol content has been reported to reduce oviposition of *Anthonomus grandis* (Maxwell *et al.*, 1966; Budford *et al.*, 1968). The extent of oviposition was positively correlated with larval population in sheddings ($r = 0.30$) and green bolls ($r = 0.36$) (Sharma and Agarwal, 1982c).

Oviposition preference under field and laboratory conditions, however, was weakly correlated with the bollworm damage in shed bolls ($r = 0.16$) and green bolls ($r = 0.34$) (Sharma and Agarwal, 1982c). The correlation coefficient between shoot damage and oviposition on different genotypes was also lower ($r = 0.14$) (Sharma and Agarwal, 1982d). Thus, the extent of oviposition did not appear to affect the susceptibility or resistance of a variety though, apparently, there were substantial differences in egg deposition on different genotypes. The lower degree of relationship between oviposition and insect damage could be attributed to other mechanism(s) of resistance operating in the cotton plant. This was well documented by the experiments carried out on varietal susceptibility (Sharma and Agarwal, 1982c), larval survival and development (Sharma *et al.*, 1982), and consumption and utilization of bolls by the larvae (Sharma and Agarwal, 1982b). Antibiotic compounds in the pigment glands (gossypol, tannins, phenols, etc.) act as principle resistance factor(s) in the cotton plant (Bottger *et al.*, 1964; Chan and Waiss Jr., 1978; Elliger *et al.*, 1978; Lukefahr and Martin, 1966; Shaver and Lukefahr, 1969; Stipanovic *et al.*, 1976, 1977; Sharma and Agarwal, 1982a). A number of factors influence the extent of bollworm damage in cotton. These factors act either individually or in combination. The lower degree of shoot damage in HR-26 No. 8XH.HG-6-IN, Ston. 731N, Cocker 100A and Empire have been attributed to ovipositional non-preference because of their smooth leaves (Sharma and Agarwal, 1982d). The lower susceptibility of Cocker 100A and HR-26 No. 8XH.HG-6-IN to bollworm in sheddings and green bolls have also been partly attributed to lower oviposition on these genotypes (Sharma and Agarwal, 1982c).

The foregoing observations and those made earlier (Mehta and Saxena, 1970; Agarwal and Katiyar, 1974) indicate that leaf hairiness largely affects the oviposition behaviour of the spotted bollworm moths. The oviposition behaviour also appeared to be influenced by other factors, such as leaf shape, gossypol and tannin content and the environment. The influence of ovipositional non-preference on varietal susceptibility is modified by the interaction of antibiotic factors. However, this is one of the important resistance mechanisms against *E. vittella* in some cotton genotypes.

Acknowledgements—The senior author is thankful to Aspee Agricultural Research and Development foundation for financial help. Our thanks are also due to Mr. I. Krishnamurty for typing the manuscript.

REFERENCES

Agarwal R. A. and Katiyar K. N. (1974) Ovipositional preference and damage by spotted bollworm (*Earias fabia* Stoll) in cotton. *Cotton Development* **4,** 28–30.

Bottger G. T., Sheehan E. T. and Lukefahr M. J. (1964) Relation of gossypol content of cotton plants for insect resistance. *J. econ. Ent.* **57,** 283–285.

Budford W. T., Jenkins J. N. and Maxwell F. G. (1967) laboratory technique to evaluate boll weevils' ovipositional preference among cotton lines. *Crop Sci.* **7,** 579–581.

Budford W. T., Jenkins J. N. and Maxwell F. G. (1968) A boll weevil oviposition suppression factor in cotton. *Crop Sci.* **8,** 647–649.

Chan B. G. and Waiss Jr. A. C. (1978) Condensed tannin, an antibiotic chemical from *Gossypium hirsutum*. *J. Insect. Physiol.* **24,** 113–118.

Deshpande B. P. and Nandkarny N. T. (1936) The spotted bollworms of cotton, *Earias fabia* Stoll and *Earias insulana* Boisd. in South Gujarat, Bombay Presidency. *I.C.A.R. Sci. Monogr.* **10,** 1–208.

Elliger C. A., Chan B. G. and Waiss Jr., A. C. (1978) Relative toxicity of minor cotton terpenoids compared to gossypol. *J. econ. Ent.* **71,** 161–164.

Lukefahr M. J. and Martin D. F. (1966) Cotton plant pigments as a source of resistance to the bollworm and tobacco budworm. *J. econ. Ent.* **59,** 176–179.

Maxwell F. G., Lafever H. H. and Jenkins J. N. (1966) Influence of glandless genes in cotton on feeding, oviposition and development of boll weevil in the laboratory *J. econ. Ent.* **59,** 585–588.

Mehta R. C. and Saxena K. N. (1970) Ovipositional responses of the cotton spotted bollworm, *Earias fabia* (Lepidoptera: Noctuidae) in relation to its establishment in various plants. *Ent. exp. Appl.* **13,** 10–20.

Sharma H. C. and Agarwal R. A. (1982a) Effect of some antibiotic compounds in *Gossypium* on the post-embryonic development of spotted bollworm (*Earias vittella*). *Ent. exp. Appl.* **31,** 225–228.

Sharma H. C. and Agarwal R. A. (1982b) Consumption and utilization of bolls of different cotton genotypes by larvae of *Earias vittella* Fab. and effect of gossypol and tannins on food utilization. *Zeit. angew. Zool.* **68,** 13–38.

Sharma H. C. and Agarwal R. A. (1982c) Factors affecting genotypic susceptibility to spotted bollworm (*Earias vittella* Fab.) in cotton. *Insect Sci. Application* (in press).

Sharma H. C. and Agarwal R. A. (1982d) Resistance mechanism of some cotton genotypes to shoot damage by spotted bollworm (*Earias vittella* Fab.). *Protection Ecology* (Holland) (in press).

Sharma H. C., Agarwal R. A. and Munshi Singh (1982) Effect of some antibiotic compounds in cotton on post-embryonic development of spotted bollworm (*Earias vittella* Fab.) and mechanism of resistance in *Gossypium arboreum*. *Proc. Indian. Acad. Sci.* (*Anim. Sci.*) **91,** 67–77.

Shaver T. N. and Lukefahr M. J. (1969) Effect of flavonoid pigments and gossypol on the growth and development of bollworm, tobacco budworm and pink bollworm, *J. econ. Ent.* **69,** 643–646.

Stipanovic R. D., Bell A. A. and Lukefahr M. J. (1976) Natural insecticides of cotton, structural analysis and toxicology of Heliocides. *172 nd. Nat. Mfg. Amer. Chem. Soc.* Aug. 29–Sept. 3, 1976. San Francisco.

Stipanovic R. D., Bell A. A., O'Brien D. H. and Lukefahr M. J. (1977) Heliocide-H_2 an insecticidal sesquiterpenod from cotton *(Gossypium)*. *Tetrahedron Lett.* 567–570.