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Influence of Gossypol Content in Okra on Infestation by Shoot and Fruit Borer, *Earias vitella*

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ABSTRACT: Okra is one of the most important vegetables in every Indian kitchen. Considering its production, productivity is very low because of several biotic and abiotic factors. Okra shoot and fruit borer, *Earias vitella,* is the most important biotic factor that contributes to a major share to yield reduction. Exploitation of host plant resistance mechanisms is found to be the most sustainable and eco-friendly method of pest management. In this scenario, the present study was conducted to determine the effect of gossypol, a prominent allelochemical present in okra and other Malvaceae crops, on the incidence of shoot and fruit borer in okra. A total of fifty okra genotypes were screened for their resistance to shoot and fruit borer at the College of Agriculture, Vellanikkara, Kerala Agricultural University, in open field conditions. The fruit damage varied between 3.42 to 85.31 per cent. The least fruit damage was shown by the variety Susthira and the highest by IC 117123. The gossypol content among fifty genotypes also showed significant variation from 0.78 μg g^{-1} to 26.80 μg g^{-1}. The correlation studies revealed a significant negative association (-0.701*) between gossypol content and shoot and fruit borer damage in okra.**

Keywords: Okra, Shoot and fruit borer, *Earias vitella*, Gossypol, Correlation, Host plant resistance.

INTRODUCTION

Okra (*Abelmoschus esculentus* L. (Moench)) is one of the most cultivated vegetable crops in India. There are several biotic and abiotic factors that contribute to the yield reduction in okra. Insect herbivory is the foremost among the different constraints that contribute to yield loss in okra. Among the various pests infesting okra, the shoot and fruit borer (*Earias vitella*) causes the highest yield loss. *E. vitella* reportedly causes up to 57 per cent fruit infestation in okra (Chaudhary and Dadheech 1989).

Earias vitella is an important lepidopteran pest of okra and cotton, and it is distributed all over the tropics. It attacks okra both at the vegetative and fruiting stages, which not only affects its quality but also greatly reduces its yield. Chemical control is the most widely used strategy to manage shoot and fruit borers. However, this is hardly advisable since the use of insecticides during fruiting stages can lead to residues in fruits. Management of crop pests through host plant resistance has gained importance in recent years due to increased awareness among consumers regarding the adverse effects of pesticide use. As a resistance strategy, okra uses several morphological, physiological, and biochemical characteristics. Among these, gossypol and other allellochemicals are the important biochemical components involved in resistance mechanisms. For instance, Sharma and Agarwal (1983) reported that gossypol and other cotton plant secondary substances in squares and bolls acted as biochemical resistance against *E. vittella*. Kanher (2015) reported that higher concentrations of gossypol in the SP and St 7 cotton varieties caused the least boll damage by *E. vitella* and *E. insulana.* However, the studies related to the relation between gossypol content in okra and its effect on shoot and fruit borer incidence are scanty. In this backdrop, a study was conducted to determine the impact of gossypol content in selected genotypes of okra on infestation by the shoot and fruit borer, *E. vitella*.

MATERIALS AND METHODS

The study was conducted by screening fifty okra genotypes in an open field condition at College of Agriculture, Kerala Agricultural University, Vellanikkra, Thrissur (10°32′52.0″N latitude and 76°16′45.5″E longitude at an elevation of 40 m above MSL) from October 2020 to March 2021. The details of genotypes used is given in Table 1. The details of materials used and methods followed for each experiment is described below.

A. Design and layout for screening

The experiment was laid out in a Completely Randomised Design (CRD) with 50 okra genotypes as treatments in 2 replications. Nine plants were maintained in each replication, thus constituting a total experimental population of 900 plants. All the agronomic practices like weeding, fertilizer application and watering were done according to Package of Practice Recommendations of Kerala Agricultural University. Salkeerthi, an okra variety released by KAU and used as a susceptible check in the present study was planted in border rows in the experimental plot about 20 days before the actual planting of genotypes to be screened. No synthetic pesticides were used at any stage of the screening.

B. Screening of okra genotypes for resistance to okra shoot and fruit borer (SFB), Earias vitella

The genotypes in the polybags were regularly observed for infestation. Healthy and damaged fruits were counted during each harvest. Fruit damage were calculated and recorded as per cent damage.

$$\text{Fruit damage (\%)} = \frac{\text{Number of damaged fruits}}{\text{Total number of fruits}} \times 100$$

C. Estimation of gossypol content in fruits

The gossypol content in okra was estimated by using a standard procedure given by Sadasivam and Manickam (1992).

RESULT AND DISCUSSION

The mean fruit damage of fifty genotypes of okra and its gossypol content is represented in Table 2.

The mean fruit damage varied greatly throughout the fifty genotypes studied, ranging from 3.42 to 85.31 per cent. Susthira had the least mean fruit damage of 3.42 per cent and it is significantly superior among all the other genotypes. The NBPGR accession IC 282294 had comparatively lower fruit damage of 11.53 per cent, but it was different from Susthira. The genotypes Aruna, IC 140906, IC 218900 and IC 128885 had mean fruit damage of 20.14 per cent, 27.14 per cent, 27.37 percent, and 29.04 per cent respectively, and were statistically on par with each other. The highest mean fruit damage of 85.31 per cent was shown by IC 117123, followed by IC 282266 (76.6%), and both were significantly different from each other. These were followed by IC 282284 (75.85%) and IC 128076 (75.32%), both of which were statistically on par with each other. Infestation by *E. vitella* on okra has been studied extensively by several workers (Afzal *et al*., 2015; Halder *et al.,* 2015; Jalgaonkar *et al.,* 2018). Kumar *et al.* (2020), who evaluated thirty genotypes of okra, observed shoot damage of 9.00 to 33.07 per cent and fruit damage of 12.52 to 36.55 per cent. In another study, mean fruit damage varying from 4.57 to 21.43 per cent among 21. Observations on infestation by *E. vitella* on twenty four genotypes of okra by Reddy *et al.* (2023) showed shoot and fruit damage to vary from 5.86 to 20.36 and 11.03 to 35.09 per cent respectively. Similarly, Patel *et al.* (2023) screened twelve varieties of okra and found that shoot infestation varied from 4.33 per cent in Rudra to 24.66 per cent in Rajrani. Fruit damage was also varied among varieties, ranging from 4.94 per cent to 31.62 per cent. The high degree of resistance in Susthira has been reported previously by Karuppaiyan (2006), who observed that two accessions, namely, Susthira and EC 305760, both belonging to *A. caillei* alone, were resistant to *E. vitella* among the 144 genotypes of okra evaluated. Balakrishnan *et al.* (2011) at KAU also reported that the use of Susthira, as a parent in breeding programme resulted in lower shoot and fruit damage in the resultant hybrid. The above findings further corroborate the results of the current study.

There was a significant difference in gossypol content in fifty genotypes of okra evaluated, and it varied from 0.78 µg g^{-1} to 26.80 µg g^{-1}. The highest gossypol was noticed in Susthira (26.80 µg g^{-1}), followed by IC 282294 (16.50 µg g^{-1}), IC 128883 (12.09 µg g^{-1}), and Aruna (11.50 µg g^{-1}) with a mean fruit damage of 3.42 per cent, 11.53 per cent, 35.33 per cent and 20.14 per cent respectively. On the other hand, the lowest gossypol content was recorded in IC 128055 (0.78 µg g^{-1}), IC 282266 (0.78 µg g^{-1}), IC 117123 (0.80 µg g^{-1}), IC 128075 (0.85 µg g^{-1}) and IC 282284 (0.99 µg g^{-1}) with a mean fruit damage of 61.73 per cent, 76.60 per cent, 85.31 per cent, 69.41 per cent and 75.85 per cent respectively. The correlation studies concluded a significant negative correlation (-0.701***) between gossypol content and fruit borer damage (Fig. 1).

There are a few studies available on the association between gossypol content and shoot and fruit borer infestations in okra. However, the present study is in close confirmation with Karuppaiyan (2006), who identified a higher concentration of gossypol (8.11 µg g^{-1}) in the shoot and fruit borer resistant genotype okra, *A. caillei.*

According to Klein *et al*. (1982), BR-8 cotton's high gossypol content made it resistant to infestation by spotted boll worms. This result is in line with that of Sharma *et al.* (1982), who found a negative correlation between the incidence of spotted bollworm and gossypol concentration. Moreover, Chakrabartyi *et al.* (2002) found that susceptible cotton strains had lower gossypol levels than resistant cotton. These findings are consistent with those of Dongre and Rahalkar (1980), who observed that *E. vittella* larvae maintained in laboratories on 1.00 per cent gossypol-treated leaves had a declining larval survival rate. Kanher *et al.* (2015) stated that the resistant cotton variety SP had a higher gossypol content (0.152 mg/g) as compared to the susceptible variety ST 7 (0.026 mg/g). The larval weight of *Helicovepa armigera* was reduced when fed a diet containing 3 nmol g^{-1} compared to a non-gossypol diet (Krempl *et al*., 2016). All these reports are in line with the present studies.

Gossypol is a natural phenol seen in cotton and some other plants belonging to the family Malvaceae. It is a highly reactive compound, mainly due to the presence of two aldehyde groups and six phenolic hydroxyl groups. Gossypol decreases the nutritional quality of fruits by forming complexes with the amino acids, proteins, and enzymes. Thus making the host plant less nutritious, and that could be the possible reason for the antibiotic effect of gossypol on the growth and development of invading insects and thereby making the crop resistant to the infestation (Sharma and Agarwal 1983; Kovacic, 2003; Dodou, 2005; Celorio-Mancera *et al.,* 2011).

Table 1: Details of okra genotypes used for the study.

Sr. No.	Genotypes	Source
1.	Susthira	KAU, Thrissur
2.	Anjitha	KAU, Thrissur
3.	Manjima	KAU, Thrissur
4.	Aruna	KAU, Thrissur
5.	IC 140906	ICAR-NBPGR
6.	ArkaAnamika	IIHR, Bangalore
7.	P6	TNAU, Coimbatore
8.	PusaBhindi 5	IARI, Delhi
9.	Aanakomban	Farmers field
10.	IC 282275	ICAR-NBPGR
11.	IC 282272	ICAR-NBPGR
12.	IC 282265	ICAR-NBPGR
13.	IC 140902	ICAR-NBPGR
14.	IC 128893	ICAR-NBPGR
15.	IC 128080	ICAR-NBPGR
16.	IC 282283	ICAR-NBPGR
17.	IC 282284	ICAR-NBPGR
18.	IC 117229	ICAR-NBPGR
19.	IC 128057	ICAR-NBPGR
20.	IC 24137	ICAR-NBPGR
21.	EC 329424	ICAR-NBPGR
22.	IC 218900	ICAR-NBPGR
23.	IC 140910	ICAR-NBPGR
24.	IC 128078	ICAR-NBPGR
25.	Salkeerthi	KAU, Thrissur
26.	IC 128888	ICAR-NBPGR
27.	IC 282295	ICAR-NBPGR
28.	IC 128890	ICAR-NBPGR
29.	IC 117226	ICAR-NBPGR
30.	IC 140907	ICAR-NBPGR
31.	IC 282294	ICAR-NBPGR
32.	IC 128885	ICAR-NBPGR
33.	IC 128892	ICAR-NBPGR
34.	IC 282283	ICAR-NBPGR
35.	IC 128894	ICAR-NBPGR
36.	IC 128883	ICAR-NBPGR
37.	IC 128075	ICAR-NBPGR
38.	IC 128055	ICAR-NBPGR
39.	IC 128035	ICAR-NBPGR
40.	IC 128076	ICAR-NBPGR
41.	IC 117123	ICAR-NBPGR
42.	IC 128068	ICAR-NBPGR
43.	IC 128079	ICAR-NBPGR
44.	IC 128887	ICAR-NBPGR
45.	IC 117202	ICAR-NBPGR
46.	IC 117235	ICAR-NBPGR
47.	IC 43748	ICAR-NBPGR
48.	IC 282278	ICAR-NBPGR
49.	IC 140909	ICAR-NBPGR
50.	IC 282266	ICAR-NBPGR

KAU: Kerala Agricultural University; ICAR -NBPGR: Indian Council of Agricultural research - National Bureau of plant Genetic Resources; TNAU: Tamil Nadu Agricultural University; IARI: Indian Agricultural Research Institute; IIHR: Indian Institute of Horticultural Research

Table 2: Mean fruit damage and gossypol content of different okra genotypes.

Sr. No.	Genotypes	Mean fruit damage (%)	Mean Gossypol content (μg g^{-1})
1.	Susthira	3.42 (0.12)	26.80
2.	Anjitha	45.92 (0.74)	7.40
3.	Manjima	60.71 (0.91)	2.33
4.	Aruna	20.14 (0.52)	11.50
5.	IC 140906	27.21 (0.53)	10.30
6.	ArkaAnamika	36.31 (0.64)	5.40
7.	P6	41.45 (0.69)	5.21
8.	PusaBhindi 5	35.21 (0.30)	6.10
9.	Aanakomban	34.72 (0.62)	6.90
10.	IC 282275	43.75 (0.72)	5.20
11.	IC 282272	52.22 (0.80)	4.70
12.	IC 282265	56.66 (0.85)	2.30
13.	IC 140902	65.75 (0.97)	1.60
14.	IC 128893	48.77 (0.77)	10.10
15.	IC 128080	61.87 (0.91)	8.90
16.	IC 282283	50.36 (0.78)	5.60
17.	IC 282284	75.85 (1.10)	0.99
18.	IC 117229	39.81 (0.68)	10.30
19.	IC 128057	49.37 (0.77)	8.50
20.	IC 24137	47.62 (0.76)	4.31
21.	EC 329424	51.91 (0.80)	7.85
22.	IC 218900	27.37 (0.54)	10.40
23.	IC 140910	46.95 (0.75)	11.00
24.	IC 128078	45.95 (0.47)	4.21
25.	Salkeerthi	65. 17 (0.94)	2.31
26.	IC 128888	46.66 (0.75)	6.49
27.	IC 282295	32.00 (0.59)	9.80
28.	IC 128890	44.82 (0.73)	7.54
29.	IC 117226	45.09 (0.73)	10.10
30.	IC 140907	45.81 (0.74)	9.52
31.	IC 282294	11.53 (14.35)	16.50
32.	IC 128885	29.04 (0.56)	9.87
33.	IC 128892	46.73 (0.75)	8.56
34.	IC 282283	53.21 (0.81)	3.36
35.	IC 128894	53.73 (0.82)	2.21
36.	IC 128883	35.33 (0.63)	12.09
37.	IC 128075	69.41 (0.99)	0.95
38.	IC 128055	61.73 (0.90)	0.78
39.	IC 128035	49.97 (0.78)	10.01
40.	IC 128076	75.32 (1.06)	1.30
41.	IC 117123	85.31 (1.98)	0.85
42.	IC 128068	45.61 (0.73)	9.24
43.	IC 128079	43.57 (0.71)	9.82
44.	IC 128887	48.80 (0.77)	7.90
45.	IC 117202	44.70 (0.72)	10.05
46.	IC 117235	69.16 (0.99)	2.30
47.	IC 43748	74.18 (1.06)	1.31
48.	IC 282278	41.86 (0.96)	6.21
49.	IC 140909	47.81 (0.76)	5.42
50.	IC 282266	76.60 (1.06)	0.80
CD (0.05)		**(0.365)**	**0.282**

Figures in the parenthesis are arc sign transformed value

CD: Critical difference

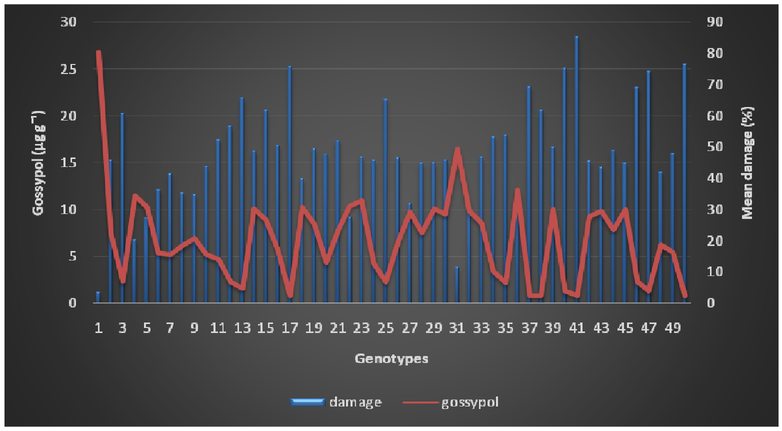

Fig. 1. Influence of gossypol in okra on incidence of shoot and fruit borer.

CONCLUSIONS

Along with many biochemical and morphological parameters, the gossypol content of plants play a prominent role in making a host plant resistant or susceptible to insect attack. The study on the effect of gossypol content of okra on infestation by shoot and fruit borer *Earias vitella* revealed a negative correlation between gossypol content and fruit damage.

FUTURE SCOPE

The presence of allelochemicals such as gossypol and phenols limits the growth and development of the shoot and fruit borer in okra. As a result, these biochemical parameters can be employed as markers to identify resistant and susceptible genotypes without requiring field testing. Furthermore, understanding the biochemical roots of resistance can be used to improve existing shoot and fruit susceptible varieties.

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Conflict of Interest. None.

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