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Antixenosis resistance in okra and their hybrid derivatives against shoot and fruit borer *Earias vittella* (Fab.)

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Abstract

The present study was undertaken to analyse the antixenosis mechanisms of resistance in okra accessions and their hybrid derivatives against Shoot and Fruit borer *E. vittella*. With regard to the free choice feeding preference, the accessions Salem Local, Hy1 and Hy2 were not preferred by any larvae even up to 8 hrs. In confined condition, the accession Hy2 recorded lowest length of fruit damage by the larvae in 8 hrs. The accession Arka Anamika fruit was bored up to a length 7.8 cm by the larvae in 8 hrs. On studying the preference of *E. vittella* moths for oviposition, the accession Hy2 and Hy4 were least preferred by *E. vittella* adult moths. In the fruit of the okra accessions, the accession Hy2 had the maximum number, high length and breadth of trichomes. It was observed that the fruit length of Arka Anamika was greater than other accessions. Regarding fruit width of Salem Local was greater than other accessions. Fruit angle to stem of accession Hy4 was higher than other accessions.

Keywords: Okra, *Earias vittella,* Feeding preference, Oviposition preference, Bio physical bases of resistance

1. Introduction

Okra, *Abelmoschus esculentus* L. (Moench), is an economically important vegetable crop grown in tropical and sub-tropical parts of the world. Okra is mainly grown for its young immature fruits and consumed as a vegetable, raw, cooked or fried. It is a common ingredient of soups and sauces. The fruits can be conserved by drying or pickling. The leaves are sometimes used as cattle feed, the fibers from the stem for cordage, and the seeds as a substitute for coffee. Okra seeds contain a considerable amount of good quality oil and protein. It has good nutritional value, particularly the high content of Vitamin C (30 mg/100 g), Calcium (90 mg/100 g), Iron (1.5 mg/100 g) and other minerals like magnesium and potassium, Vitamin A, B, fats and carbohydrates [1].

One of the important limiting factors in the cultivation of okra is insect pests. The spotted bollworms are the most dreaded pests causing serious turn down of the produce terms of quality as well as quantity [2, 3]. *Earias* spp. is distinguished from other pests of okra by its marked tendency for fruit and stem boring. The larvae enter the terminal bud of the vegetable and channel down from the growing point. Severely attack, results in wilting of top leaves and collapsing of main stem [4]. The larvae also bore into the flower buds, flowers and fruits of the crop. Serious decline in production of bhendi due to fruit and shoot borer has been reported.

The use of crop varieties showing resistance to insects is being practiced since last six decades in modern agricultural production systems. Continuous rise in the food production costs in the developing countries has elevated the need to use the varieties having resistance against herbivore pests [5]. Insect resistant cultivars can be used as sole control method and also interact synergistically with biological, chemical and cultural control methods to reduce the infestation of pest insects [6]. Considering the above facts, the experiment has been undertaken with an objective, to study the antixenosis mechanisms of resistance in okra accessions and their hybrids against shoot and fruit borer *E. vitella.*

2. Materials and Methods

Based on preliminary and confirmatory field screening of 38 okra accessions for resistance against the shoot and fruit borer, *Earias vittella,* three promising accessions namely Salem Local, Madurai Local and Anu were selected [7] and by further crossing them, six viable hybrids (F1) obtained and used for further studies.

2.1. Crossing techniques
The selected immature buds which are likely to open during the next day morning were emasculated in the previous day evening between 3.00 and 6.00 pm. The tip of the corolla of the flower bud was cut-off and a vertical cut was given to the united calyx. The calyx and corolla were gently removed including stamina column without injuring the gunoecium. The emasculated flower buds (female) and the flower buds selected as male were also covered with a butter paper cover. Enough care was taken not to disturb the style and stigma of the emasculated flower buds. The anthers that dehisced between 7.00 and 9.00 am were collected and used for dusting over the stigma of emasculated flower. The pollinated flowers were covered with a butter paper cover and labelled. Thus, plant –to-plant direct and reciprocal crosses were affected. Hybridization process was carried out for about 25 days until sufficient quantity of hybrid seeds were produced. The crossed seeds were collected separately by maintaining individuality. The details of F1 hybrids given below.

F1 Hybrids	Parentage
Hybrid 1	Salem Local × Madurai Local
Hybrid 2	Madurai Local × Salem Local
Hybrid 3	Salem Local × Anu
Hybrid 4	Anu × Salem Local
Hybrid 5	Madurai Local × Anu
Hybrid 6	Anu× Madurai Local

For pot culture studies, ten accessions (three parents, six hybrids and a susceptible check) of okra plants were maintained in earthen pots of 30cm high and 30cm dia. Pots were filled with the potting mixture comprising two parts of soil and one part of sand. Then the seeds were irrigated regularly. Two plants per pot were maintained for further studies. For comparison, a susceptible check Arka Anamika was also used.

2.2. Antixenosis mechanisms of resistance
2.2.3. Feeding preference of *E. vittella*
Feeding preference assay was conducted with free choice test to find out resistant accessions. Tender fruits of the accessions were kept at equal distance in circular manner, in a metal container (36x15cm) and 10 numbers of four hours pre - starved third instar larvae were released at the centre. After 1,2,4,6 and 8 h of release, the numbers of larvae settled on the respective accession was recorded. This was replicated five times. Further a no- choice test was also conducted with four hours pre - starved third instar larvae. In this experiment a larva was introduced and a fruit of respective accessions in individual container. The length of the fruit eaten (tunnelling) by the larva was measured after 8h. This was replicated five times.

2.2.4. Ovipositional preference of *E. vittella*
To find out the ovipositional preference of *E. vittella,* 45 days old potted plants of all the accessions of okra were placed in an oviposition cage (175×175×175cms) made up of net to perform free choice test. Ten pairs of newly emerged adults were released in to the cage. Once in 24 hours, the plants kept in the oviposition cage were observed for eggs and recorded. Number of eggs per accession was calculated and then most preferred accession for oviposition was identified. This was replicated five times.

2.3. Bio physical bases of resistance
2.3.1. Trichome density
Fruit bits of known area were boiled in hot water for 20 minutes. Then the fruit bits were transferred to 20 ml of ethanol and again boiled for 20 minutes. This was done to remove the chlorophyll content. Then the fruit bits were boiled in 20ml of lactic acid for 20 minutes. The number of trichome hairs were counted by using a compound microscope and expressed in number per cm^2. The sampleswere collected at three different parts of fruit of the same accession and replicated ten times [8].

2.3.2. Length and breadth of the trichome hairs
Thin fruit sections of accession were taken and length and breadth of the trichome hairs were measured after processing the fruit bits as above. The samples were collected at three different parts of fruits of the same accession and replicated ten times measurements were done by using a compound microscope with the micrometer standardized.

2.3.3. Fruit length, fruit width and fruit angle
Twenty randomly selected fruit were harvested from each accession and fruit length and fruit width was measured by tracing with the help of a graph paper. Whereas angle between the fruit and the mean stem/ branch was measure by using a protractor.

2.3.4. Statistical analysis
The data gathered were statistically analysed using IRRISTAT software and the critical difference values were arrived at.

3. Results
In free choice test, the larvae were allowed to select the fruits of accessions and when observed for feeding, the accessions Salem Local, Hy1 and Hy2 were not preferred by any larvae even up to 8 hrs. The susceptible check Arka Anamika was infested to the maximum. Among the okra test accessions Hy5 was most preferred by *E. vittella* larvae. In no choice test, the length of fruit bored (tunneling) by third instar *E. vittella* larvae measured in various accessions. It was observed that the accession Hy2 recorded lowest length of fruit damage (0.08) by the larvae in 8hrs. The accession Arka Anamika fruit was bored up to a length 7.8 cm by the larvae in 8 hrs. In both the fruit feeding preference, the accession Hy2 was less preferred by *E. vittella* larvae.

On studying the preference of *E. vittella* moths for oviposition on the accession and their hybrids, significant variation was observed among the test accessions. When the adult moths were allowed to lay eggs as a free choice among the test accessions, the accession Hy2 and Hy4 were least preferred by *E. vittella* adult moths. The susceptible check, Arka Anamika was preferred to the maximum for oviposition. Totally 64 eggs were laid by adults of *E. vittella* (Table.1).

Various biophysical bases of resistance operative in the test accessions were investigated. Fruits of the accession Hy2 had the maximum number of trichomes followed by Hy4. Length and breadth of the trichomes were the maximum in the accession Hy2. Least number, length and breadth of trichomes were noticed on the accession Arka Anamika (Table.2).

Other biophysical factors in fruits of the selected okra accessions and their hybrids were studied. It was observed that the fruit length of Arka Anamika was greater than other accessions. Regarding fruit width, accession Salem Local was greater than other accessions. Fruit angle to stem / branch of accession Hy4 was higher than other accessions (Table.3).

4. Discussion

The accession Hy2 was less preferred by *E. vittella.* Parentage of this accession is Madurai Local and Salem Local. The accession Salem Local and Madurai Local were collected from a hilly region in Madurai and Salem districts respectively. Wild relatives or their derivatives have been reported to possess resistance against fruit worm, *H. armigera* [9].

With reference to fruit feeding preference of *E. vittella* larvae, the accession Hy2 was not preferred by larvae up to 8 hrs. The same trend was observed in no choice condition also. With reference to the oviposition preference of *E. Vittella,* female moths least preferred the accession Hy2 on which only 11 eggs were laid. This was followed by accession Hy1. This may be possibly due to the wild origin that possess insect and disease resistance [10]. Accession Arka Anamika was most preferred host for oviposition.

With regard to density of trichomes and their length and breadth, among the accessions, Hy2 had maximum number of trichomes and this accession was least preferred by *E. vittella* larvae in both free choice and no choice test [11] found negative correlation of increased fruit hair density of bhendi towards resistance to *E. vittella.* [8] also reported that a significant negative correlation was observed between trichome density and borer incidence Further, high trichome density might be imparting the physical barrier for the borer rendering their non- preference over the low trichome genotypes. Earlier, Sharma and Singh [12] reported a significant negative correlation between trichome density and borer infestation in okra. Similar observations were also documented by Halder *et al.* [13] where in significant negative correlation existed between trichome density in pods and pod borer infestation and damage severity in mungbean.

Regarding fruit characters, fruit length of Arka Anamika was greater and fruit width of Hy2 was greater than other accessions. Lengthy fruits were found more suitable for damage by *Earias* as they harbored more larvae/fruit. Present study was in accordance with Halder and Srinivasan [14] was reported similar finding on *Maruca* infesting cowpea and also found that pod infestation was higher in genotypes that had highest pod length than other genotypes. Kamashi and Srinivasan [15] also reported the influence host physical property on the degree of infestation.

In all the evaluations, Hy2 recorded lowest fruit damage by the fruit borer in contrast to the susceptible accession Arka Anamika. Sharma and Jat [16] reported that Arka Anamika was highly preferable variety in resistance studies on okra. However the findings did not agree with those of Muazzma Akhter *et al.* [17] who stated that Arka Anamika was found to be less preferred by *E. vittella*.

5. Conclusion

It is concluded that, the accession Hy2 was less preferred by *E.vittella.* But, more in depth and also repeated field and glasshouse evaluations are necessary. Only after ascertaining the resistance potentials by repeated evaluation, a promising accession/ hybrid could be recommended for large scale cultivation.

Table 1: Feeding and oviposition preferences of *E. vittella* towards fruits of okra accession and their hybrids.

S. No	Name of the accession	Larval feeding preference		Adult oviposition preference
		No. of the larvae preferred after 8 hr (Free choice)	Tunnel length in 8hr (cm) (No choice)	No. of eggs / plant
1	Salem Local	0 (0.00)	0.36 (0.36)	16 (16.00)
2	Madurai Local	1 (5.65)	0.32 (0.32)	22 (22.00)
3	Anu	1 (5.65)	1.20 (1.20)	32 (32.00)
4	Hy1	0 (0.00)	0.22 (0.22)	12 (12.00)
5	Hy2	0 (0.00)	0.08 (0.08)	11 (11.00)
6	Hy3	1 (5.67)	1.80 (1.80)	38 (38.00)
7	Hy4	1 (5.70)	0.10 (0.10)	14 (14.00)
8	Hy5	2 (8.11)	1.76 (1.76)	42 (42.00)
9	Hy6	1 (5.65)	2.80 (2.80)	37 (37.00)
10	Arka Anamika (S check)	4 (11.52)	7.8 (7.78)	64 (64.00)
	CD (p = 0.05)	1.77	1.18	0.873

Each value is a mean of five replications.
Values in parentheses are arc sine transformed

Table 2: Trichome density on the fruit surface of the selected okra accession and their hybrids.

S. No	Name of the accession	Trichome density No/cm^2	Trichome length (μ)	Trichome breath (μ)
1	Salem Local	96.6	320.4	11.4
2	Madurai Local	92.2	315.4	12.2
3	Anu	90.5	312.6	11.9
4	Hy1	88.2	322.4	13.10
5	Hy2	112.4	368.7	24.8
6	Hy3	82.4	302.8	14.4
7	Hy4	106.6	345.5	14.6
8	Hy5	74.2	311.4	10.8
9	Hy6	70.6	296.5	14.6
10	Arka Anamika (S check)	48.8	234.6	18.6
	CD (p = 0.05)	0.88	1.28	2.08

Each value is a mean of ten replications.

Table 3: Biophysical bases of resistance in okra accession and their hybrids.

S. No	Name of the accession	Fruit length (cm)	Fruit width (cm)	Fruit angle (o)
1	Salem Local	11.80	1.56	28.80
2	Madurai Local	12.20	1.48	26.0
3	Anu	12.40	1.52	27.22
4	Hy1	13.82	1.32	31.40
5	Hy2	14.40	1.40	32.20
6	Hy3	13.16	1.46	25.0
7	Hy4	14.20	1.36	34.50
8	Hy5	13.20	1.32	26.60
9	Hy6	13.60	1.36	27.86
10	Arka Anamika (S check)	14.50	1.30	22.10
	CD (p = 0.05)	1.32	1.62	1.16

Each value is a mean of twenty replications.

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