Influence Of Bhendi Cultivars On The Developmental Biology And Preference Of Shoot And Fruit Borer, Earias Vitella Fabricius (Noctuidae: Lepidoptera)

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Abstract- *Nine okra cultivars were tested for its influence against the development and preference of E. vitella. In this study it was found that, the cultivar Arka Anamika recorded the lowest total larval duration (14.33 days) and the highest total larval duration (19 days) was exerted by the cultivar Vishnu and Slender. Regarding feeding cultivars Vishnu and Slender were not preferred by any larvae even upto 8 h (multichoice test) of exposure. But under no choice test cultivar Vishnu and Slender recorded lowest length of fruit damage. Cultivar Arka Anamika was most preferred host for oviposition and least preferred was Vishnu.*

Keywords- E. vitella, bhendi borer, cultivars of okra

I. INTRODUCTION

Okra or bhendi is one of the important vegetables in India. It is being grown throughout the tropical, sub-tropical and in the warmer parts of temperate regions. The nutritional value of 100 g of okra fruit is characterized 1.9 g protein, 0.2 g fat, 6.4 g carbohydrate, 0.7 g minerals and 1.2 g fibers. In India it is cultivated in 0.349 M ha with the production of 3.344 M mt and average productivity of 9.6 mt ha-1. The okra major producing states in India are Uttar Pradesh, Bihar, Orissa, West Bengal, Andhra Pradesh and Karnataka. In West Bengal, 0.662 M mt of okra is produced from 58,400 ha with an average productivity of 11.4 mt ha-1 (NCPAH INDIA, 2009) and this state stands first in the production and productivity in India. Okra, being a short duration crop and high yielding vegetable (varies from 5-7 t ha-1 in summer to 8-10 t ha-1 in the winter), growers get more profit per unit area (Somkumar et al., 1997). Commonly growing varieties of okra in India are Kamini, Pusa Mukhamali, Parbhani Kranti, Co 1, Aruna, Glorry, M 10 and Arka Anamika (N. H. B, 2008). Though okra is widely cultivated as a summer crop in South India, three main planting seasons such as February-March, June-July and October-November are being followed in Tamil Nadu and the crop occupies 3400 ha with the productivity of 6.5 mt ha-1 in state (Pavan kumar, 2009). The productivity and fruit quality of okra is highly influenced by many insect pest including fruit borers, sucking pests and leaf feeders and among which the shoot and fruit borer Earias vitella Fabricius causes heavy economic loss (Mote, 1978). Sardhana and Dutta (1989) estimated that the loss by the pest was over 38.7% whereas Raut and Sonone (1979) reported 76.4% damage to the fruits. E. vitella is a polyphagous insect (Vedamoorthy and Reed, 1977; Sivasastra et al., 1983; Sundaraj and David, 1987) and they are known to attack 38 species of plants (Hirmath, 1976). The use of insecticides even though, are effective has led to environmental problems, bio-accumulation of residues and resurgence of sucking pests. To offset these hazards, it has become imminent to seek for protection by way of non-chemical methods. In this context evolution of few botanicals assumes much significance for the economical and residue free pest control.

Information about incidence of E. vitella on okra and its relationship with weather factors are scanty and are crucial for the development of ecologically sound management practices.

II. MATERIALS AND METHODS

2.1. Studies on the influence of bhendi cultivars on the developmental biology of E. vitella

2.1.1. Mass culture of E. vitella

A laboratory culture of E. vitella was established with pupae collected from bhendi fields in our University experimental farm at Annamalainagar. Collected pupae were transferred into a metal cage of 30 x 30 x 30 cm in size with access door at the front side and kept in standard laboratory conditions of 25 ± 2oC temperature and 75 ± 5% relative humidity. Emerged adults were collected from the cage and released into another adult's cage @ 20 (1:1 female male ratio) per cage and provided with a twig of bhendi (cultivar: Arka Anamika). The stalk of the twig was kept in a conical flask filled with water. The twig consisted tender fruits of bhendi and leaves. Adults were fed with 10% sucrose solution fortified with 0.1 per cent ABDEC© multivitamin solution provided on daily basis in a cotton wick attached to a small glass tube.

The moths were allowed to mate and lay eggs. The eggs thus laid were collected and incubated at 25 ± 2 C

temperature and 75 ± 5% relative humidity and the emerging larvae utilized for subsequent culture maintenance, as well as for developmental biology and preference studies. Fresh buds and young fruits were supplied regularly for the larvae till pre pupation to maintain the laboratory culture.

2.1.2. Developmental biology

Studies on comparative developmental biology of E. vitella were conducted in the laboratory on 9 varieties of bhendi under controlled conditions of temperature (25 ± 2oC) and relative humidity (75 ± 5%). The varieties used were Vishnu, Slender, T8, Manisha 211, Rasi 20, US 7109, Glorry, M 10, and Arka Anamika. This was a no-choice test.

Newly emerged first instar larvae collected from the culture were transferred individually to separate glass rectangular jars (100 ml capacity) and reared until pupation by supplying buds and young fruits of respective variety. Each variety was considered as a treatment and was replicated five times. The observations on different biological parameters such as total duration of the larval stage, length and weight of the final instar larva were made. A cm scale was used to measure the length and the weight was measured using electronic balance. Per cent pupation and per cent adult emergence were noted. In addition to this larval and pre-pupal mortality was also recorded.

The adults emerged from respective variety were sexed and released in a glass jar for oviposition separately and covered with muslin cloth and supplied with sucrose solution (10%). Adult longevity and fecundity were recorded. The eggs laid were collected and observed for their hatching and egg period and per cent hatchability was calculated.

2.2. Studies on the influence of bhendi cultivars on the feeding preference of E. vitella

To find out susceptible and resistant cultivars a feeding preference assay was performed by following multiple choice methods. Young fruits of selected cultivars were kept at equal distance in a circular manner, in a metal container (36 x 15 cm) and 15 numbers of four hours pre-starved third instar larvae were released at the centre. After 4 and 8 h of released, the numbers of larvae settled on the respective cultivars was recorded. There were nine treatments and replicated three times.

Further a no-choice test was also conducted with four hours pre-starved third instar larvae. In this experiment a larvae was introduced onto a fruit of respective cultivar in individual container. The length of the fruit eaten by the larva was measured after 8h. There were nine treatments and replicated three times.

2.3. Studies on the influence of bhendi cultivars on the ovipositional preference of E.vitella

To find out the ovipositional preference of E. vitella, 45 days old potted plants of all the above mentioned nine cultivars of bhendi were placed in an ovipositional cage (175 x 175 x 175 cms) made up of net to perform multichoice test. Ten pairs of newly emerged adults were released into the cage. Once in 24 hours, the plants kept in the ovipositional cage were observed for eggs and recorded. Numbers of eggs per cultivar was calculated and then most preferred variety for oviposition was identified. This was replicated three times. The values recorded were subjected to analysis of variance and the means were separated using DMRT.

III. RESULTS AND DISCUSSION

3.1. Studies on the influence of bhendi cultivars on the developmental biology of E. vitella

Neonates of E. vitella were reared from its eclosion day till adults emergence on the fruits of nine cultivars such as Vishnu, Slender, T 8, Manisha 211, Rasi 20, US 7109, Glorry, M 10 and Arka Anamika individually to assess their influence on the various life stages of E. vitella.

The cultivar Arka Anamika recorded the lowest total larval duration (14.33 days). The highest total larval duration (19 days) was exerted by the cultivars Slender. The cultivars like Glorry, M 10 and T 8 were recorded 15.33 to 15.66 days of mean total larval duration. The cultivars Vishnu and Slender were recorded extended total larval duration as 18.33 and 19.00 days respectively and on par with each other when analysed statistically.

Larval lengths of the final instars were ranged from 1.2 to 1.6 cm. the cultivars T 8 recorded the shortest larva of the final instar of E. vitella (1.2 cm) and the longest was (1.6 cm) in the cultivar Arka Anamika. When analysed statistically all the cultivars were on par except Arka Anamika.

Finally the larval weight, the larva reared on Arka Anamika gained the maximum of 0.0630 mg whereas the cultivar Slender recorded the lowest weigh of 0.0214 mg. DMRT ranking showed that all the treatments were significantly differ from each other. There was no larval mortality recorded during the experiment (Table 1).

Table 1. Influence of various bhendi cultivars on the larval development of *E. vitella*

S.No	Cultivars	*Mean total larval duration (First to final instar) (days)	*Mean larval length (final instar) (cm)	*Mean larval weight (final instar) (mg)	*Mean larval mortality (%)
1	Vishnu	18.33 ± 0.13 (4.33)^{ab}	1.3 ± 0.01 (1.15)^{b}	0.0323 ± 0.0026 (0.5682)^{a}	Nil
2	Slender	19.00 ± 0.21 (4.41)^{a}	1.3 ± 0.02 (1.15)^{b}	0.0214 ± 0.0024 (0.1462)^{h}	Nil
3	T 8	15.66 ± 0.24 (4.02)^{def}	1.2 ± 0.03 (1.11)^{b}	0.0404 ± 0.0021 (0.2009)^{e}	Nil
4	Manisha 211	16.66 ± 0.18 (4.14)^{bcd}	1.3 ± 0.01 (1.15)^{b}	0.0541 ± 0.0027 (0.2325)^{e}	Nil
5	Rasi 20	16.33 ± 0.26 (4.10)^{cde}	1.3 ± 0.01 (1.15)^{b}	0.0510 ± 0.0026 (0.2258)^{f}	Nil
6	US 7109	17.33 ± 0.24 (4.22)^{abc}	1.4 ± 0.02 (1.18)^{b}	0.0371 ± 0.0027 (0.1926)^{g}	Nil
7	Glory	15.66 ± 0.19 (4.01)^{def}	1.4 ± 0.02 (1.18)^{b}	0.0542 ± 0.0025 (0.2328)^{d}	Nil
8	M 10	15.33 ± 0.20 (3.97)^{efg}	1.4 ± 0.02 (1.17)^{b}	0.0581 ± 0.0023 (0.2410)^{c}	Nil
9	Arka Anamika	14.33 ± 0.22 (3.85)^{fg}	1.6 ± 0.01 (1.20)^{a}	0.0630 ± 0.0028 (0.2509)^{b}	Nil
CD (P=0.05%)		0.213	0.101	0.0004	

*Mean of five replications
Figures in parentheses are √ transformed
Values with various alphabets differ significantly (DMRT comparison)
Value ± SD

Cent per cent mortality of pre-pupa was recorded in the treatment where the cultivar Slender was used as a host. This was followed by cultivar Vishnu where 80% mortality was recorded Viz., pre-pupal mortalities 73.33, 66.66, 53.33 and 26.66 per cent were recorded in US 7109, Glorry, T 8 and Manisha 211 respectively. There was no pre-pupal mortality in the treatments such as Rasi 20, M 10 and Arka Anamika and cent per cent pupation was achieved.

Regarding the adult emergence of Arka Anamika, M 10, Glorry and Rasi 20 recorded cent per cent emergence. Seventy five and 50 per cent adult emergence were recorded in Manisha 211 and T 8 respectively. There was no adult emergence in the cultivars Vishnu and US 7109. In the case of Slender cent per cent pre pupal mortality recorded earlier. So, there was no data about per cent adult emergence (Table 2).

Table 2. Influence of various bhendi cultivars on the pre-pupal development and pupal development of E. vitella

S.No	Cultivars	Pre-pupal development		Pupal development
		Per cent pre-pupal mortality	Per cent pupation	Per cent adult emergence
1	Vishnu	80.00 (63.43)^{d}	20.00 (26.55)^{f}	0 (0.0)d
2	Slender	100.00 (89.19)^{c}	0.00 (0.00)^{g}	-
3	T 8	53.33 (46.90)^{d}	46.67 (43.08)^{c}	50 (44.20)c
4	Manisha 211	26.66 (31.08)^{c}	73.34 (58.90)^{b}	75 (58.35)b
5	Rasi 20	0.00 (0.00)^{b}	100.00 (89.19)^{a}	100 (89.19)a
6	US 7109	73.33 (58.90)^{e}	26.67 (31.08)^{e}	0 (0.0)d
7	Glory	66.66 (57.50)^{b}	33.33 (35.26)^{d}	100 (89.19)a
8	M 10	0.00 (0.00)^{a}	100.00 (89.19)^{a}	100 (89.19)a
9	Arka Anamika	0.00 (0.00)^{a}	100.00 (89.19)^{a}	100 (89.19)a
CD (P=0.05%)		1.831	2.683	2.74

*Mean of three replications
Figures in parentheses are √ transformed
Values with various alphabets differ significantly (DMRT comparison)
Value ± SD

There was no significant difference in the adult longevity of both female and male. But fecundity varied very much. In Arka Anamika, 138.66 eggs/female was recorded. This was followed by T 8 and Rasi 20. The least number of eggs were recorded in cultivar Glorry. There was no much difference in the mean egg period and mean per cent hatchability (Table 3) except in the cultivar Arka Anamika.

Table 3. Influence of bhendi cultivars on the adult longevity, fecundity and egg hatchability

S. No	Cultivars	Mean adult longevity (days)		Fecundity/female	Mean egg period (days)	Mean per cent hatchability
		Female	Male			
1	Vishnu	-	-	-	-	-
2	Slender	-	-	-	-	-
3	T 8	6.71 ± 1.50	5.38 ± 1.44	93.00 ± 3.59	4.000 ± 1.0	63.33
4	Manisha 211	6.82 ± 1.32	5.29 ± 1.20	78.33 ± 4.42	3.3 ± 1.0	65.00
5	Rasi 20	6.42 ± 1.37	5.30 ± 1.35	9.30 ± 6.39	3.3 ± 1.0	62.00
6	US 7109	-		-	-	-
7	Glory	6.51 ± 1.40	5.28 ± 1.30	75.40 ± 7.28	3.6 ± 1.2	68.66
8	M 10	6.48 ± 1.45	5.21 ± 1.35	89.36 ± 6.45	3.3 ± 1.0	62.66
9	Arka Anamika	6.61 ± 2.0	5.25 ± 1.20	138.66 ± 9.22	3.6 ± 1.0	90.66

Value ± SD

3.2. Studies on the influence of bhendi cultivars on the feeding preference of E. vitella

The multiple choice tests cultivar of Arka Anamika was the most preferred host among all other cultivars tested. Out of 15 larvae released five larvae preferred Arka Anamika. This was followed by Glorry, US 7109, Rasi 20 and T 8. The cultivars Vishnu and Slender were not preferred by any larvae even upto 8 h.

In the no-choice test length of fruit bored by a 3rd instar E. vitella larvae measured in the various treatments clearly showed the preference of the larva towards various cultivars. The cultivar Arka Anamika fruit was bored up to a length of 7.5 cm by the larva in 8 h. this was followed by Glorry, T 8 and Rasi 20. The cultivars Vishnu and Slender recorded lowest length of fruit damage and that was 0.25 and 0.34 cm respectively (Table 4).

Table 4. Influence of bhendi cultivars on the feeding preference of 3rd instar larva of E. vitella (Free choice test and No choice test)

S.No	Cultivars	Free choice test		No choice test
		*No. of larvae preferred after		*Fruit damage in 8 h (in length) (cm)
		4 h	8 h	
1	Vishnu	1	0 (0.70)^{c}	0.25 ± 0.2 (0.50)^{d}
2	Slender	1	0 (0.70)^{c}	0.34 ± 0.1 (0.58)^{d}
3	T 8	1	2 (1.58)^{b}	5.1 ± 0.1 (2.25)^{b}
4	Manisha 211	1	1 (1.24)^{b}	2.0 ± 0.1 (1.41)^{c}
5	Rasi 20	1	1 (1.24)^{b}	5.0 ± 0.1 (2.23)^{b}
6	US 7109	1	2 (1.58)^{b}	1.5 ± 0.1 (1.22)^{d}
7	Glory	1	2 (1.58)^{b}	5.2 ± 0.1 (2.28)^{b}
8	M 10	2	1 (1.24)^{b}	2.7 ± 0.2 (1.64)^{c}
9	Arka Anamika	5	5 (2.34)^{a}	7.5 ± 0.1 (2.73)^{a}
CD (P=0.05%)			0.534	0.212

*Mean of three replications
Figures in parentheses are √ transformed
Values with various alphabets differ significantly (DMRT comparison)
Value ± SD

3.4. Studies on the influence of bhendi cultivars on the ovipositional preference of E. vitella

Cultivar Arka Anamika was most preferred host for oviposition. Around 134 eggs were recorded per plant of the cultivar Arka Anamika. The least preferred was Vishnu where only 10 eggs were laid and this was followed by Slender (12 eggs/plant) (Table 5). When analysed statistically Arka Anamika ranked first regarding ovipositional preference. The cultivar Vishnu and Slender was on par. All other treatments were found on par with other.

Table 5. Influence of bhendi cultivars on the oviposition of E. vitella

S.No	Cultivars	No. of eggs/plant
1	Vishnu	10 ± 4.0 (3.13)[c]
2	Slender	12 ± 3.0 (3.71)[c]
3	T 8	78 ± 10.5 (9.12)[b]
4	Manisha 211	90 ± 11.4 (9.96)[b]
5	Rasi 20	88 ± 11.2 (9.45)[b]
6	US 7109	83 ± 9.2 (9.38)[b]
7	Glory	90 ± 10.1 (9.88)[b]
8	M 10	80 ± 12.3 (9.41)[b]
9	Arka Anamika	134 ± 10.38 (12.44)[a]
CD (P=0.05%)		2.142

*Mean of three replications
Figures in parentheses are √ transformed
Values with various alphabets differ significantly (DMRT comparison)
Value ± SD

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