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Evaluation of okra genotypes for resistance to shoot and fruit borer, *Earias vittela* (Fabricius)

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Abstract
Twenty one genotypes of okra, collected from different sources were evaluated for resistance to shoot and fruit borer, *Earias vitella* at a field of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS) during two consecutive years. Significant differences were recorded among the genotypes employed for evaluation of resistance. Among all the genotypes per cent fruit damage was lowest in GDO-2 (4.57%), GDO-15 (4.82%) and Korchi (4.97%) and hence graded as highly resistant genotypes. GDO-10 (9.54%) declared as resistant and Parmil (16.71%), Arka Anamika (15.46%) and Parbhani Kranti (17.61%) categorised as susceptible genotypes. Whereas, Julie and OH-016 recorded highest fruit damage *ie.* 21.43 per cent and 20.99 per cent respectively, and registered as highly susceptible genotypes in terms of number as well as weight basis.The antibiosis studies was also undertaken in laboratory conditions among five different graded genotypes. The different biological parameters such as larval survival, larval period, weight of full grown larva and pupa, malformed pupa, adult etc. recorded during this study. The overall results indicated that the survival, development as well as the reproductive behaviour of the pest was adversely affected by resistant varieties.

Keywords: Okra, shoot and fruit borer *Earias vitella*, resistant, susceptible, screening, antibiosis

Introduction

Among vegetable, okra (*Abelmoschus esculentus* (L.) Moench) is a popular and commercially cultivated vegetable crop commonly known as ladies finger or *bhendi*. In India okra is cultivated throughout the year. In Maharashtra state it is cultivated on 23,000 ha area with production of 2,41,500 tons and productivity is 10.5 metric tons per ha (Anonymous, 2014) [1].
Despite large area and quite a good number of cultivars the supply of okra in an Indian market is not fulfilling its demand. Lower productivity would be a major reason for such un matching demand and supply. Critical analysis for such low productivity revealed that major portion of fruit produced is being damaged by dreaded insect pests. Ewete (1983) [5] has reported 72 insect pest species that attack and damage okra crop. Out of which shoot and fruit borer (*Earias* spp) can cause 36 to 90 per cent loss in the fruit yield of okra (Misra *et al*., 2002) [10].
There is also an increasing awareness and demand for healthy food, boosting organic production. So any non-chemical strategy for managing fruit borer could be a welcome approach. One of the tool, which is economical and effective for the management of pest complex is the use of resistant varieties or hybrids. The present investigations were carried out with a view to ascertain the susceptibility/ resistance in okra genotypes against shoot and fruit borer, *E. vitella*.

Materials and Method

Field trial was conducted at Department of Entomology, Dr. P.D.K.V., Akola (MS) during *Kharif* 2012 and *kharif* 2013. Twenty one okra genotypes were tested for the resistance of shoot and fruit borer. Most of the genotypes were collected from parent university Dr. PDKV Akola, some from private company etc. A field experiment was laid under Randomised Block Design with three replications. Observations on field screening of okra genotypes against shoot and fruit borer, *E. vitella* were undertaken at reproductive phase.
To work out the per cent fruit infestation at each picking, number of infested fruits and number of healthy fruits were counted from randomly selected five plants. The weight of healthy and infested fruits was taken and accordingly per cent fruit infestation on number and weight basis was calculated. The means were compared by using Duncan Multiple Range Test. The genotypes were categorized into different grades as per the scale given by Sharma *et al*. (1993) [13].

Shoot and fruit infestation	Category
0-5% Damage	Highly Resistant (HR)
5.1-10% Damage	Resistant (R)
10.1-15% Damage	Moderately Resistant (MR)
15.1-20% Damage	Susceptible (S)
20.1 and above damage	Highly Susceptible (HS)

For Antibiosis

Among twenty one genotypes screened for their resistance/ susceptibility to fruit damage done by *E. vitella* were graded in five groups as per the scale given above. Five different HPR grade genotypes were selected one from each group for studying the antibiosis in laboratory. Twenty five neonate larvae, constituting a replication were reared on okra fruit blocks. Fresh food was provided daily up to pupation. The experiment was replicated five times under ambient temperature in the laboratory and observations on different biological parameters of *E. vitella* as influenced by different HPR graded okra genotypes was recorded accordingly.

Results and Discussion

Per cent mean fruit infestation of *E. vitella* during *Kharif* 2012 and 2013 (on number basis)

Data pertaining to infestation of *E. vitella* on number basis are presented in Table1. The mean fruit infestation levels in *Kharif* 2012 ranged from 4.19 to 20.91 per cent and during 2013 it was from 4.94 to 22.64 per cent.

Pooled mean

The pooled mean results on per cent mean infestation of fruits on number basis by fruit borer indicates that the mean per cent infestation was ranged between 4.57 to 21.43 per cent. Significantly, least infestation was recorded in GDO-2 (4.57%) followed by GDO-15 (4.82%) and Korchi (4.97%). These genotypes were found significantly superior over rest of the genotypes and graded as highly resistant group while the genotype GDO-10 (9.54%) registered as resistant genotype. Maximum infestation of fruit borer was noticed in the genotype Julie (21.43%) and OH-016 (20.99%), and found at par with each other and graded as highly susceptible genotypes

Per cent mean fruit infestation of *E. vitella* during *Kharif* 2012 and 2013 (on weight basis)

The data in respect of mean fruit infestation due to *E. vitella* on weight basis during *Kharif* 2012 ranged from 3.85 to 20.04 per cent and whereas, in *Kharif*2013 recorded 4.42 to 21.64per cent (Table 2).

Pooled mean

During the investigations genotypes GDO-2, Korchi and GDO-15 expressed highly resistant reaction against the *E. vitella* by recording 4.14, 4.51 and 4.56 per cent fruit infestation on weight basis, respectively and found superior over rest of the genotypes, and categorized as highly resistant genotypes.GDO-10 emerged as the next resistant promising genotype in both number and weight basis, followed by moderately resistant genotype *viz.* AKO-45, AKO-106, AKO-107, AKO-114, AKO-118, GDO-1, GDO-3, GDO-4, GDO-6, GDO-20, GDO-21 and Akola Bahar. All these above genotypes screened have been newly evolved by ARS, Sonapur (District Gadchiroli) under Dr. PDKV., Akola showed somewhat resistant attribute against fruit borer.

The susceptible genotypes Parbhani Kranti (16.48%), Parmil (15.67%) found statistically at par with Arka Anamika showing 14.32 per cent fruit infestation on weight basis. Among the highly susceptible category, genotype Julie recorded 20.47 per cent and OH-016 recorded 20.11 per cent fruit infestation on weight basis.

Resistance of Akola Bahar, AKO-45 and AKO-106 was also reported by Bag, (2007) [3]. Thus, the present results are in accordance with his findings. Whereas, Arka Anamika, Parmil and Parbhani Kranti showed susceptibility to *E. vitella* under Akola conditions. Susceptibility of Arka Anamika was also reported by Chaudhary *et al.* (2004) [4] from West Bengal; Mandal *et al*. (2006) [9] from Bihar and Gautam *et al*. (2013) [6] from Varanashi.

Whereas, Sharma and Singh (2010) [12], Nilam Bangar *et al.* (2012) [11], Aziz *et al*. (2012) [2], Gonde *et al*. (2012) [7] categorized Parbhani Kranti as a susceptible genotype against *E. vitella*. Thus, the findings of present investigation in respect to above mentioned genotypes are in close proximity with the previous findings.

Table 1: Mean fruit infestation of *E. vitella* (F.) in different okra genotypes (on number basis)

Treatment No.	Genotypes	Per cent fruit infestation			Grade
		2012	2013	Pooled mean	
T1	AKO-45	11.19 (3.32)^{cd}	9.23 (3.02)^{gh}	10.21 (3.18)^{ef}	MR
T2	AKO-106	13.71 (3.68)^{bcd}	11.41 (3.37)^{defg}	12.56 (3.54)^{cdef}	MR
T3	AKO-107	12.10 (3.46)^{cd}	11.91 (3.40)^{defg}	12.01 (3.46)^{def}	MR
T4	AKO-114	14.70 (3.81)^{abc}	14.81 (3.83)^{bcdef}	14.76 (3.82)^{bcd}	MR
T5	AKO-118	14.53 (3.80)^{abc}	14.74 (3.82)^{bcdef}	14.63 (3.82)^{bcd}	MR
T6	GDO-1	15.33 (3.90)^{abc}	11.91 (3.44)^{defg}	13.62 (3.68)^{bcde}	MR
T7	GDO-2	4.19 (2.02)^{e}	4.94 (2.18)^{hi}	4.57 (2.13)^{g}	HR
T8	GDO-3	10.97 (3.30)^{cd}	13.03 (3.57)^{cdefg}	12.00 (3.46)^{def}	MR
T9	GDO-4	10.79 (3.27)^{cd}	14.02 (3.73)^{cdefg}	12.41 (3.52)^{cdef}	MR
T10	GDO-6	15.18 (3.86)^{abc}	11.47 (3.37)^{defg}	13.33 (3.63)^{bcde}	MR
T11	GDO-10	8.95	10.13	9.54	R

		(2.96) d	(3.15)fg	(3.05) f	
T12	GDO-15	4.44 (2.09) e	5.21 (2.24) hi	4.82 (2.18) g	HR
T13	GDO-20	15.78 (3.96)abc	11.38 (3.35)efg	13.58 (3.67)bcde	MR
T14	GDO-21	14.53 (3.76)abcd	12.98 (3.58)cdefg	13.75 (3.69)bcde	MR
T15	Korchi	4.24 (2.02) e	5.71 (2.36) hi	4.97 (2.21) g	HR
T16	Julie	20.22 (4.47)ab	22.64 (4.71) a	21.43 (4.62) a	HS
T17	Parmil	16.23 (4.01)abc	17.18 (4.13)abcd	16.71 (4.08)abc	S
T18	OH-016	20.91 (4.56) a	21.07 (4.59)ab	20.99 (4.58) a	HS
T19	Akola Bahar	11.56 (3.39) cd	13.91 (3.71)cdefg	12.73 (3.56)cdef	MR
T20	ArkaAnamika	14.19 (3.74)bcd	16.72 (4.09)abcde	15.46 (3.92)bcd	S
T21	ParbhaniKranti	16.25 (3.99)abc	18.97 (4.34)abc	17.61 (4.17)ab	S
'F'test		Sig.	Sig.	Sig.	
SE(m)±		0.28	0.27	0.19	
CD at 5%		0.81	0.78	0.57	
CV%		14.05	13.41	9.82	

Figures in parentheses are square root transformed values.

Table 2: Mean fruit infestation of *E. vitella* (F.) in different okra genotypes (on weight basis)

Treatment No.	Genotypes	Per cent fruit infestation			Grade
		2012	2013	Pooled mean	
T1	AKO-45	10.28 (3.17)cde	8.54 (2.90)gh	9.41 (3.04)ef	MR
T2	AKO-106	12.86 (3.57) cd	10.55 (3.23)efg	11.70 (3.41)ef	MR
T3	AKO-107	11.18 (3.32)cde	11.41 (3.32)bcdefg	11.30 (3.33) def	MR
T4	AKO-114	13.83 (3.69)bcd	14.41 (3.77)bcde	14.12 (3.76)bcd	MR
T5	AKO-118	13.70 (3.69)bcd	14.06 (3.73)bcdef	13.88 (3.71)bcd	MR
T6	GDO-1	14.36 (3.78)abcd	11.33 (3.36)bcdefg	12.84 (3.57)bcde	MR
T7	GDO-2	3.85 (1.94) f	4.42 (2.10)i	4.14 (2.03) g	HR
T8	GDO-3	9.80 (3.12) de	12.34 (3.47)bcdefg	11.07 (3.32) def	MR
T9	GDO-4	10.08 (3.16)cde	13.13 (3.60)bcdefg	11.60 (3.41)cdef	MR
T10	GDO-6	14.27 (3.74)abcd	10.88 (3.29)defg	12.57 (3.52)bcde	MR
T11	GDO-10	8.00 (2.79) e	9.60 (3.06)fg	8.80 (2.93) f	R
T12	GDO-15	4.14 (2.02) f	4.98 (2.23) hi	4.56 (2.13) g	HR
T13	GDO-20	14.93 (3.85)abcd	10.41 (3.21)efg	12.67 (3.55)bcde	MR
T14	GDO-21	13.10 (3.56) cd	12.16 (3.46)bcdefg	12.63 (3.52)bcde	MR
T15	Korchi	4.04 (1.97) f	4.99 (2.20)i	4.51 (2.10) g	HR
T16	Julie	19.31 (4.39)ab	21.64 (4.65) a	20.47 (4.52) a	HS
T17	Parmil	15.22 (3.89)abc	16.13 (4.01)abc	15.67 (3.96)abc	S
T18	OH-016	20.04 (4.47) a	20.19 (4.49) a	20.11 (4.48) a	HS
T19	Akola Bahar	10.45 (3.23)cde	13.06 (3.60)bcdefg	11.75 (3.42)cdef	MR
T20	ArkaAnamika	12.83	15.80	14.32	S

		(3.57)^{cd}	(3.97)^{abcd}	(3.78)^{bcd}	
T21	ParbhaniKranti	15.35 (3.87)^{abcd}	17.60 (4.19)^{ab}	16.48 (4.05)^{ab}	S
'F'test		Sig.	Sig.	Sig.	
SE(m)±		0.26	0.24	0.20	
CD at 5%		0.75	0.70	0.56	
CV%		13.65	12.43	10.02	

Figures in parentheses are square root transformed values.

Antibiosis Studies

Earias vitella larvae reared on fruits of different okra genotypes (Table 3)

i. Larval survival (%)

Significantly lowest per cent survival of *E. vitella* larvae was recorded in highly resistant genotype GDO-15 (38.80%), followed by resistant genotype GDO-10 (60.00%) and moderatelyresistant genotype AKO-114 (66.80%). Whereas, Julie registered highest survival of *E. vitella* larvae (73.00%) followed by susceptible genotype Parbhani Kranti (71.00%).

ii. Larval period (days)

The range of larval developmental period was 8.25 ± 0.18 to 10.60 ± 0.53 days. Mean larval period of *E. vitella* was the shortest in Julie (8.25±0.18 days) and the longest in GDO-15(10.60±0.53 days). The larvae fed on the genotype GDO-10 recorded the mean larval period of 9.34 ± 1.36 days and was statistically on par with AKO-114 (9.86 ± 0.92 days) and Parbhani Kranti (9.65 ± 0.22 days).

iii. Weight of full grown larva (mg)

E. vitella larvae reared on the highly resistant genotype GDO-15 recorded significantly lowest weight of the full grown larva (89.39 ± 1.18 mg) and was statistically superior over rest of the treatments which was followed by the resistant genotype GDO-10 (96.9 ± 0.80 mg), moderately resistant genotype AKO-114 (100.03 ± 1.52 mg) and susceptible genotype Parbhani Kranti (102.8 ± 1.56 mg). Highest weight was gained by the borer reared on the highly susceptible genotype Julie (110.46 ± 1.75 mg) might be due to high palatability, consumption preference by the larva.

iv. Pupal weight (mg)

Larvae reared on fruit blocks of highly resistant genotype GDO-15 transformed in to the lowest weight pupa (49.31 ± 1.08 mg), followed by borer reared on resistant genotype GDO-10 (50.80 ± 1.11 mg) and moderately resistant genotype AKO-114 (56.01 ± 1.80 mg). Whereas, heaviest pupa was transformed by the borer reared on highly susceptible genotype Julie (60.43 ± 0.75 mg).

v. Pupal period (days)

Prolonged pupal period was noticed in the highly resistant genotype GDO-15 (9.00 ± 0.35 days). However, it was statistically on par with resistant genotype GDO-10 and moderately resistant genotype AKO-114 recording the mean pupal period of 8.55 ± 1.04 and 8.30 ± 0.28 days, respectively.

Table 3: Antibiosis mechanism in okra genotypes against *Earias vitella.*

Tr. No	Genotypes	Larval survival %	Larval period (days)	Wt of full grown larva (mg)	Wt of pupa (mg)	Pupal period (days)	Malformed pupa %	Adult emergence %	Malformed adult %	Av. Fecundity/ female	Longevity of male (days)	Longevity of female (days)
T_1 HR	GDO-15	38.80 (38.52)*	10.60±0.53	89.39±1.18	49.31±1.08	9.00±0.35	10.53 (3.32)**	80.07 (8.95)***	8.08 (2.92)**	237.40±9.56	7.80±1.30	9.00±0.71
T_2 R	GDO-10	60.00 (50.78)	9.34±1.36	96.9±0.80	50.80±1.11	8.55±1.04	6.25 (2.59)	86.50 (9.30)	3.73 (2.05)	272.00±7.58	8.20±1.10	9.40±0.55
T_3 MR	AKO-114	66.8 (54.89)	9.86±0.92	100.03±1.52	56.01±1.80	8.30±0.28	2.00 (1.58)	91.26 (9.55)	1.20 (1.30)	281.00±8.22	8.80±0.84	9.60±0.55
T_4 S	Parbhani Kranti	71.00 (57.44)	9.65±0.22	102.8±1.56	58.10±0.55	8.10±0.22	0.00 (0.71)	93.56 (9.67)	0.00 (0.71)	331.20±16.95	9.40±0.89	11.00±0.71
T_5 HS	Julie	73.00 (58.70)	8.25±0.18	110.46±1.75	60.43±0.75	6.85±0.49	0.00 (0.71)	96.40 (9.82)	0.00 (0.71)	348.60±17.17	10.40±0.55	12.40±0.55
	'F'test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
	SEm±	1.02	0.27	0.63	0.51	0.25	0.06	0.04	0.06	5.65	0.43	0.28
	CD at 5%	3.01	0.78	1.85	1.5	0.74	0.17	0.12	0.18	16.67	1.28	0.81
	CV%	4.38	6.23	1.4	2.07	6.85	7.27	0.92	8.94	4.3	10.87	6.00

* Figures in parentheses are arc sine transformed values.

* *Figures in parentheses are $\sqrt{x+0.5}$ transformed values.

** *Figures in parenthesis are square root transformed values.

vi. Malformed pupa (%)

No malformation was observed in pupal stages of *E. vitella* reared on the highly susceptible Julie and susceptible Parbhani Kranti genotypes. However, the pupal malformation was the highest in the highly resistant genotype GDO-15 (10.53%), followed by resistant genotype GDO-10 (6.25%) and lowest in moderately resistant genotype AKO-114 (2.00%).

vii. Adult emergence (%)

Significant difference was observed among the adult emergence when the larvae of *E. vitella* reared on the different genotypes. Borer reared on the highly resistant genotype GDO-15 registered 80.07 per cent adult emergence which was significantly the lowest than rest of the genotypes tested. The highest adult emergence was noticed in highly susceptible Julie (96.40%). Therefore, it is inferred that the resistant okra genotypes limited the multiplication of *E. vitella*. On the contrary susceptible genotypes favoured the multiplication of *E. vitella.*

viii. Malformed adults (%)

No adult malformation was recorded in highly susceptible Julie and susceptible Parbhani Kranti. Whereas, the highest adult malformation was noticed in GDO-15 with 8.08 per cent malformation which was followed by resistant genotype GDO-10 (3.73%) and moderately resistant AKO-114 (1.20%).

ix. Average fecundity/Female

Female moth transformed from the larvae of *E. vitella* reared on the fruits of highly resistant genotype GDO-15 laid on an average significantly lowest eggs (237.40 ± 9.56) per female. Increasing trend of egg laying was noticed from resistant GDO-10 (272.00 ± 7.58) and AKO-114 (281.00 ± 8.22) to susceptible Parbhani Kranti and highly susceptible Julie registered highest fecundity (331.20 ± 16.95 and 348.60 ± 17.17 eggs/female, respectively).

x. Longevity of male (days)

Longevity of adult male reared from the larvae on the fruits of GDO-15 was statistically shortest (7.80 ± 1.30 days) which was followed by resistant genotype GDO-10, AKO-114 and Parbhani Kranti with 8.20 ± 1.10, 8.80 ± 0.84 and 9.40± 0.89 days, respectively. Whereas, longevity of male was longestin susceptible genotype Julie (10.40 ± 0.55 days).

xi. Longevity of female (days)

Similar trend was observed in case of longevity of *E. vitella* adult female These results are in concurrence with the findings of Gupta (1988) [8] who reported that the per cent larval survival of *E. vitella*, adult emergence and egg laying was more in the larvae reared on the susceptible genotype than rest of the genotypes.

Similar views are also expressed by Sultani (2008) [14] who found that survival of larvae of *E. vitella* was less on highly resistant genotypes of okra in comparison to that of highly susceptible genotype. Further reported that larvae took more days to pupate on the resistant genotypes than on highly susceptible genotypes. The shorter pupal period, low pupal weight and lowest per cent adult emergence were also recorded in the resistant genotypes.

It means preferential antibiosis was noticed in highly resistant genotype as compared to susceptible ones which subsequently help to reduce the pest population in next generation.

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