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Screening of Pigeonpea Germplasms for Ovipositional Preference and Tolerance Mechanism of Resistance to the Pod Borer, *Helicoverpa armigera*

Jayashri D. Ughade[1*], M. B. Sarkate[2] and S. S. Gosalwad[2]

[1]Vasantrao Naik College of Agricultural Biotechnology (Dr. PDKV), Yavatmal 445 001, Maharashtra, India
[2]Vasantrao Naik Marathwada Agricultural University, Parbhani 431 402, Maharashtra, India
**Corresponding author*

Keywords

Helicoverpa armigera, Antixenosis, Tolerance, Pigeonpea, Resistance mechanisms, Ovipositional preference

A B S T R A C T

Screening of twenty six germplasms of pigeonpea was studying during two consecutive years for their ovipositional preference and tolerance mechanism to *Helicoverpa armigera* under laboratory condition. The noctuid pod borer, *Helicoverpa armigera*, is one of the most important pests of pigeonpea, and plant resistance is an important component for minimizing the extent of losses caused by this pest. We studied the ovipositional response (antixenosis mechanism) under multi-choice conditions and tolerance mechanism of resistance to *H. armigera* in a field condition in a diverse array of pigeonpea genotypes. Ovipositional preference of 26 germplasms was observed in laboratory under multi-choice condition. The result was in the range of 8.17 to 16.66 eggs per germplasm. However, the lowest egg laying by *H. armigera* was recorded in BDN-2001-9 followed by local check BDN-2003-1. The germplasm ICPL-84060, BDN-708 and LRG-41 also recorded moderate resistance. Maximum egg laying was observed in VRG-1. In present study not a single germplasm was observed completely free from pod infestation of *H. armigera*. Tolerance study recorded moderate pod damage among all the germplasms tested. Lowest pod damage was recorded in BDN-2003-1 followed by BDN-2001-9, BDN-70S, ICPL-84060, ICPL-332 and PT-0012.

Introduction

Pigeonpea [*Cajanus cajan* (Linnaeus) Millsp.] is one of the important legume crops due to its nutritional and industrial values. Its productivity has remained static over the past several decades because of heavy damage by insect pests. More than 200 insect species feed on this crop, of which the pod borer, *Helicoverpa armigera* (Hubner) (Lep., Noctuidae) is the most damaging pests worldwide. At times, it causes complete crop loss (Yelshetty and Sidde Gowda, 1998; Shanower *et al.*, 1999). *H. armigera* has been reported to cause loss of US$ 325 million annually (ICRISAT, 1992). *Helicoverpa armigera* damage is particularly severe in the medium- maturity cultivars grown in India. In pigeonpea, one larva per plant reduces 4.95 green pods, 7.03 dry pods and 18.01 grain per plant (Meenakshi Sundaram and Gujar, 1998). Excessive use of chemical insecticides for the control of this pest not only causes the economical burden on farmers but also produces the harmful side effects on the environment as well as human beings. Therefore, use of resistant varieties is advocated in integrated pest management due to its economy, wide adaptability and environmental safety. A number of pigeonpea genotypes have been reported to be resistant to *H. armigera* (Lateef and Pimbert, 1990; Sharma *et al.*, 2001).

Ovipositional response is one of the important components of resistance to *H. armigera* in pigeonpea (Sharma *et al.*, 2001). Most of the eggs in pigeonpea are laid on flowers, flowers buds, pods and sparingly on the leaves (mostly during the vegetative phase). More eggs were recorded on floral parts and new pods when compared with that on the foliage, and the larval density was more on top leaves, flowers and pods compared with the middle and lower parts. Sison *et al.*, (1993) recorded maximum oviposition on the susceptible check, ICPL 87 under multi-choice conditions.

Hence, it is important to characterize diff erent sources of resistance for expression of antixenosis component of resistance to *H. armigera* under ovipositional preference to develop appropriate strategies to breed for resistance to this pest.

The expression of tolerance is determined by inherent genetic capability to outgrow an insect infestation or to recover and add new plant growth after the recovery from the insect damage. The levels of resistance to *H. armigera* in the germplasm accessions were low to moderate. This has necessitated the need for selecting genotypes with greater ability to tolerable or recovers from the pod damage (Lateef, 1985; Lal *et al.*, 1986).

The extent of damage during the podding stage can be reduced by selecting genotypes that flower and mature before or after the peak abundance of *H. armigera* and suffer low damage than those flowering during the periods of greatest insect abundance (Srivastava and Srivastava, 1989). Therefore, we studied the antixenosis component i.e. ovipositional response and tolerance mechanism of resistance by counting per cent pod damage at maturity to *H. armigera* in a diverse array of pigeonpea genotypes under laboratory conditions and carried out the correlation.

Materials and Methods

To study the relative susceptibility of pigeonpea germplasms twenty six pigeonpea cultivars were selected to grow in field condition for screening the tolerance mechanism at the time of maturity as well as screened in replicated trial under laboratory condition for their resistance to ovipositional preference and choice to various germplasms in multi-choice condition to *H. armigera*.

The screening was followed at Vasantrao Naik Marathwada Agricultural University, Parbhani, Maharashtra in two consecutive years.

Each germplasm was sow on the farm of Department of Entomology in two rows of each 10 m length with a spacing 60 cm x 30 cm by dibbling method. All the recommended agronomic practices were adopted to raise the crop.

Oviposition preference

Laboratory studies were carried out at the time of 50 per cent flowering for ovipositional preference under multi-choice condition. Three tender pigeonpea twigs of 45 cm long inflorescence per germplasm were collected from twenty six germplasms from the field and these twigs were kept in conical flask filled with water and the mouth of the conical flask plugged with cotton in the cage made up of using muslin cloth. Five pairs of moths were released on these twigs. Numbers of eggs laid by female moths were counted after 72 hrs from release of moths for two consecutive years.

Tolerance mechanism

At the time of pod maturity (before harvest) five plants were selected from each germplasm and total number of healthy and damaged pods in 45 cm long inflorescence of each germplasm were counted and per cent pod damage were worked out.

Statistical analysis

The data obtained from the laboratory experiment was done by completely randomized design and the data obtained from field was analysed by randomized block design as per the methods described in "Statistical Methods for Agricultural Workers" by Panse and Sukhatme (1985) for determining the relative susceptibility of pigeonpea germplasms.

Appropriate standard error (S.E.) and critical differences (C.D.) at 5% level were worked out as and when necessary and used for data interpretation.

Results and Discussion

Ovipositional preference

Results presented in Table 1 reveals that none of the germplasms was found free from egg laying of the pest. The mean number of *H. armigera* eggs laid ranged from 8.33 to 24.00 eggs per 45 cm inflorescence on different pigeonpea germplasms during first year. Among the twenty six germplasms under test, LRG-41 was recorded the lowest egg laying which was at par with ICPL-332, AKT-8811, BSMR-853, PT-0012, WRG-53 and Bahar, recorded eggs in the range of 9.00 to 11.00 per germplasm, whereas significantly more eggs were laid in remaining germplasms which ranged from 13.00 eggs on PT-909 to 24.00 eggs on PT-332. During the second year BDN-2001-9 recorded lowest egg laying of *H. armigera* i.e. 9.33 eggs which were at par with BDN-2003-1 and ICPL-84060 followed by germplasm BDN-708, ICPL-332 and AKT-8811 and recorded significantly low egg laying in the range of 9.66 to 11.00. Remaining all the germplasms recorded eggs in the ranged of 11.66 to 17.66 eggs per germplasms. VRG-1 recorded highest egg laying by *H. armigera*.

The overall pooled result of two consecutive years showed statistically significant ovipositional preference of *H. armigera* in laboratory in range of 8.17 to 16.66 eggs per germplasms. The lowest egg laying by *H. armigera* was recorded in BDN-2001-9 which was at par with local check BDN-2003-1 and superior over all the germplasms. The germplasms ICPL-84060, BDN-708 and LRG-41 also recorded comparatively low to moderate eggs and they were at par with ICPL-332, AKT-8811 and local check BSMR-853. Maximum egg laying was observed in VRG-1.

Several workers, Fitt (1986); Courtney and Kibota (1990) have suggested that the preference for a particular host by *H. armigera* is shown by laying more eggs. Pigeonpea genotypes showing resistance to *H. armigera* under field conditions exhibited oviposition non- preference under laboratory conditions (ICRISAT, 1991). Sison *et al.*, (1993) reported that ICPL 87 was preferred much for oviposition both under no-choice and multi-choice conditions. Thus, the results obtained through present investigations are more or less in accordance with earlier reports.

Tolerance mechanism

The lowest pod damage was observed in the germplasm BDN-2001-9 (24.85%) followed by BDN-2003-1, ICPL-332 and PT-0012. Local check, BSMR~853 recorded 27.64 per cent pod damage followed by ICPL-84060, BDN-708, WRG-53, AKT-8811, LRG-41 and AKT-9929 ranged from 27.04 to 29.01 per cent pod damage and showed significant difference over all remaining germplasms. The highest pod damage was observed in the germplasm JKM-207 i.e. 40.27 per cent. During the second year, the highly tolerant germplasm to pod damage was BDN-2003-1 which recorded lowest pod damage of 9.80 per cent and was at par with BDN-708 and BDN-2001-9 with 10.01 and 10.21 per cent pod damage respectively (Table 2).

Second group of tolerant germplasm contains ICPL-332, PT-0012, WRG-53, LRG-41, PT-909 and AKT-8811 which ranged from 13.02 to 13.64 per cent pod damage and at par with local check BSMR-853, which recorded 13.07 per cent pod damage. Remaining all the germplasms which recorded pod damage ranged from 14.04 per cent in AKT-9929 to the comparatively susceptible germplasms 17.69 per cent damage in JKM-207.

The pooled data of both the years revealed that the lowest pod damage 17.41 per cent was recorded in the germplasm BDN-2003-1 followed by BDN-2001-9, BON-708, ICPL-84060, ICPL-332 and PT-0012 which was at par with each other considered to be the tolerant set of germplasms. The second group which showed moderate per cent pod damage ranged from 20.30 per cent to 22.02 per cent included the germplasms, local check, BSMR-853, WRG-53, Bahar, AKT-8811, LRG-41, AKT-9929 and PT-909. The remaining germplasms showed pod damage which ranged from 23.26 per cent pod damage in ICPL-87119 to 28.98 per cent pod damage in JKM-207.

In present study not a single germplasm was observed completely free from the infestation of *H. armigera*. The overall results indicated moderate pod damage among all the tested germplasms. The present investigation supported by Patel and Patel (1990) who screened 13 early and 13 midlate maturing varieties of pigeonpea against *H. armigera* but none of the entry was completely free from the infestation.

The low to moderate levels of resistance to *H. armigera* in the germplasms accessions were reported by earlier workers Lateef (1985) and Lal *et al.,* (1986). ICRISAT (1992) reported variety ICPL-332 as tolerant to the pod borer *H. armigera* and was having on an average 35 per cent borer damaged pods as against the cultivars C- 11 (51 % borer damaged pods). C-11 was having 17.2 per cent pod damage due to *H. armigera*, reported by Sahoo and Patnaik (1993) and also reported that none of the extra early genotype was free from infestation by major species of borer (Raut *et al.*, 1993; Mali and Patil, 1994).

A total of 2033 accessions of pigeonpea screened against pod borer for three years indicated that the varieties of ICRISAT showed lower levels of pod damage compared with the control variety Bahar (Lal and Rathore, 1999; Venkateswarlu and Singh, 1999). Medium duration variety C-11 was recorded 54.09 per cent pod damage reported by Sahoo and Senapati (2001). Cultivars C-11, ICPL-87119, WRG-47 and WRG-53 showed more damage due to pests compared to the other cultivars, BSMR-846, AKT-9726, reported by Surana *et al.,* (2002). Sharma *et al.,* (2003) revealed that all the genotypes tested showed low level of resistance.

Table.1 Ovipositional preference of *H. armigera* in laboratory test after 72 hrs from release of adults

Sr.No.	Cultivar/variety	No. of eggs laid/45 cm long inflorescence		
		1st Year	2nd Year	Pooled
1	WRG-55	15.00 (3.94)*	17.33 (4.22)*	16.16 (4.08)*
2	ICPL-87119	13.33 (3.27)	15.66 (4.02)	14.50 (3.87)
3	BDN-2010	15.00 (3.94)	17.33 (4.22)	16.17 (4.08)
4	JKM-207	16.00 (4.06)	17.00 (4.18)	16.17 (4.08)
5	VRG-1	17.00 (4.18)	17.66 (4.26)	16.66 (4.14)
6	C-11	18.00 (4.30)	16.00 (4.06)	15.00 (3.94)
7	ICPL-84060	19.00 (4.42)	10.00 (3.24)	9.00 (3.08)
8	BDN-708	20.00 (4.53)	10.00 (3.24)	9.17 (3.11)
9	BDN-2001-9	21.00 (4.64)	9.33 (3.14)	8.17 (2.94)
10	AKT-9929	22.00 (4.74)	15.66 (4.02)	14.33 (3.85)
11	BDN-2003-1	23.00 (4.85)	9.66 (3.19)	8.50 (3.00)
12	PT-332	24.00 (4.95)	15.66 (4.02)	14.50 (3.87)
13	Bahar	11.00 (3.39)	13.00 (3.67)	12.00 (3.54)
14	PT-0012	10.33 (3.29)	11.66 (3.49)	10.83 (3.37)
15	ICPL-332	9.00 (3.08)	11.00 (3.39)	10.00 (3.24)
16	BSMR-736	14.33 (3.85)	16.33 (4.10)	15.33 (3.98)
17	BSMR-846	15.33 (3.98)	17.00 (4.18)	16.16 (4.08)
18	PT-909	13.00 (3.67)	15.00 (3.94)	14.00 (3.81)
19	WRG-53	10.66 (3.34)	12.00 (3.54)	11.33 (3.44)
20	AKT-8811	9.33 (3.14)	11.00 (3.39)	10.17 (3.27)
21	WRG-51	15.66 (4.02)	17.33 (4.22)	16.50 (4.12)
22	LRG-41	8.33 (2.97)	10.66 (3.34)	9.50 (3.16)
23	BDN-2009	14.33 (3.85)	16.00 (4.06)	15.17 (3.96)
24	BDN-2004	14.00 (3.87)	16.33 (4.10)	15.17 (3.96)
25	PT-11-39-1	13.66 (3.76)	15.33 (3.98)	14.50 (3.87)
26	BSMR-853	10.00 (3.24)	10.33 (3.29)	10.17 (3.27)
	SE ± CD at 5%	0.235 0.651	0.268 0.741	0.276 0.765

* Figures in parenthesis are sqrt χ + 0.5.

Table.2 Per cent pod damage by *H. armigera*

Sr.No.	Cultivar/variety	Per cent pod damage from 45 cm inflorescence		
		1st Year	2nd Year	Pooled
1	WRG-55	38.45 (38.31)*	16.09 (23.62)	27.27 (31.47)
2	ICPL-87119	32.38 (34.67)	14.14 (22.07)	23.26 (28.82)
3	BDN-2010	38.09 (38.10)	17.00 (24.35)	27.54 (31.64)
4	JKM-207	40.27 (39.38)	17.69 (24.84)	28.98 (32.56)
5	VRG-1	38.14 (38.13)	17.64 (24.81)	27.89 (31.86)
6	C-11	34.75 (36.12)	14.62 (22.46)	24.68 (29.77)
7	ICPL-84060	27.04 (31.32)	11.50 (19.82)	19.27 (26.02)
8	BDN-708	28.17 (32.03)	10.01 (18.44)	19.09 (25.88)
9	BDN-2001-9	24.85 (29.89)	10.21 (18.63)	17.53 (24.74)
10	AKT-9929	29.01 (32.58)	14.04 (21.98)	21.52 (27.63)
11	BDN-2003-1	25.03 (30.01)	9.80 (18.24)	17.41 (24.65)
12	PT-332	33.71 (35.49)	14.43 (22.31)	24.07 (29.36)
13	Bahar	29.78 (33.06)	12.28 (20.48)	21.03 (27.29)
14	PT-0012	26.26 (30.82)	13.08 (21.17)	19.67 (26.31)
15	ICPL-332	26.09 (30.70)	13.02 (21.13)	19.55 (26.23)
16	BSMR-736	35.09 (36.31)	16.67 (24.07)	25.88 (30.57)
17	BSMR-846	38.15 (38.14)	17.68 (24.84)	27.91 (31.89)
18	PT-909	30.42 (33.46)	13.62 (21.64)	22.02 (27.97)
19	WRG-53	28.45 (32.22)	13.19 (21.26)	20.82 (27.13)
20	AKT-8811	28.67 (32.37)	13.64 (21.65)	21.15 (27.37)
21	WRG-51	37.80 (37.97)	14.30 (22.22)	26.08 (30.70)
22	LRG-41	29.01 (32.58)	13.40 (21.47)	21.20 (27.42)
23	BDN-2009	33.77 (35.52)	16.03 (23.59)	24.90 (29.93)
24	BDN-2004	34.16 (35.76)	16.14 (23.67)	25.15 (30.09)
25	PT-11-39-1	34.98 (36.25)	14.36 (22.25)	24.67 (29.76)
26	BSMR-853	27.64 (31.70)	13.07 (21.16)	20.35 (26.70)
	SE ±	0.495	0.282	0.924
	CD at 5%	1.369	0.782	0.688

* Figures in parenthesis are Arc sin values.

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