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Original Research Article

Antixenosis Mechanism (Multi-Choice Test) of Resistance in Pigeonpea to the Pod Borer, *Helicoverpa armigera*

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A B S T R A C T

An experiment was conducted for two consecutive years to screen twenty six germplasms of pigeonpea for their resistance/tolerance to pod borer under natural infestation in pesticides free open field. 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. Therefore, to develop insect-resistant cultivars, we studied the antixenosis mechanism of resistance to *H. armigera* in a diverse array of pigeonpea germplasms under multi-choice conditions. Antixenosis for multi-choice test was observed in case of 26 germplasms under laboratory conditions. It was observed that, all the germplasms tested were found moderate to low resistance to *H. armigera*, *none* of them was found free from infestation of the pest. The germplasms developed by the local research station Badanapur, BDN-2003-1, BDN-2001-9 and BDN-708 were found superior in case of larva found after 24 hrs from release, pod damaged and grain damaged. ICPL-84606, ICPL-332, PT-OO12, LRG-41 (donor), AKT-8811 and WRG-53 were recorded moderate resistance. BDN-2004, BDN-2009, BDN-2010 and BSMR-736 were recorded low resistance except BSMR-846. Germplasm JKM-207 recorded highest pod and grain damage by *H. armigera.*

Keywords

Helicoverpa armigera, Antixenosis, Pigeonpea, Resistance mechanisms, Multi-choice test, Pod damage.

Introduction

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is one of the major grain legumes in India after gram crop. 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 (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). Sahoo and Senapati (2000) revealed that a yield loss of 27.77 and 14.28 kg/ha was obtained for each unit increase in larval population and for every unit per cent increase in pod damage, due to the pod borer complex. To overcome these losses farmers resort to excessive use of pesticides.

A number of pigeonpea genotypes have been reported to be resistant to *H. armigera*

(Lateef and Pimbert, 1990; Sharma *et al.,* 2001). Pod damage was lowest in the short duration cultivars and highest in the long duration cultivars Rao *et al.,* (2003). Pest susceptible rating (PSR) showed that the genotype ICP 8863 suffered the highest pod damage caused by LPBs, while the lowest was in KM 124 and KM 125 (Srivastava and Mohapatra, 2002). Lateef and Pimbert (1990) screened the entire ICRISAT pigeonpea collection of more than 14,000 pigeonpea accessions for reaction against pod borer.

Several genotypes were identified which consistently suffered lower pod damage. Hence, it is important to characterize diff erent sources of resistance for expression of antixenosis component of resistance to *H. armigera* under multi-choice conditions to develop appropriate strategies to breed for resistance to this pest.

Therefore, we studied the antixenosis component of resistance to *H. armigera* in a diverse array of pigeonpea genotypes under laboratory conditions.

Materials and Methods

Twenty six pigeonpea cultivars were screened in thrice replicated trial. The germplasms were sown in field condition and tested in laboratory condition for their resistance /tolerance to various germplasms in multi-choice condition to *H. Armigera*. The screening was followed at Vasantrao Naik Marathwada Agricultural University, Parbhani. Each germplasm was sown 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. Laboratory studies were carried out at the time of pod formation when 15 to 20 days old pods appeared on pigeonpea plants for multi-choice test.

Non-preference multi-choice test

Larval count

Fifteen to twenty days old ten pods of each test materials replicated thrice including susceptible and resistant checks were placed in a circular trough (45cm diameter) the edges of which were kept in a circular fashion. Pods of different entries were placed equidistantly from the center and also the distances between pods of two entries were common i.e. 4 inch. Seventy five, 12 hrs starved 3rd instar larvae were released in the center of trough and covered with muslin cloth. The larvae were allowed to feed for 24 hrs and number of larvae was counted which alighted to different entries.

Per cent pod damage

The total pods damaged within 24 hrs by released larva in multi-choice test were counted and calculated the per cent pod damage

Per cent grain damage

The total grains in 10 pods of each variety were counted as well as damaged grains within 24 hrs by release larva in multi-choice test and on the basis of total grains and number of damaged grains per cent grain damage was calculated.

Statistical analysis

The data obtained from the laboratory experiment was done by completely randomized 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

Multi-choice test

Larval count

Under multi-choice test, three replications with 75 larvae each were release on randomly arranged 10 pods from each germplasm and observations were recorded on next day after 24 hrs from release (Table 1). Lowest number of larvae 1.33 was recorded in BDN-2001-9 and BDN-2003-1 followed by BDN-708 and ICPL-332 with 1.66 larvae each. All these varieties recorded significantly less larvae over all the remaining germplasms. The local check BSMR-853 and ICPL-84060 were recorded 2.00 larvae, which were at par with PT-0012 and WRG- 53 on which 2.33 larvae were observed followed by LRG-41, BDN- 2004, AKT-8811, PT-909 and PT-332. The highest larvae were observed in JKM-207 (4.66). Significant differences were recorded on larval count in multi-choice test during second year. The result revealed that: the lowest number of larva 1.00 was observed in BDN-2003-1. The local check, BAMR-853, ICPL-84060, BDN-708, BDN-2001-9, Bahar, PT-OO 12 and ICPL-332 recorded equal number of larvae i.e., 1.66 on next day from the release of larvae and followed by LRG-41, AKT-8811 and WRG-53 with 2.00 larvae each followed by PT-11-39-1, ICPL-87119 and PT-909 with 2.33 larvae each, which were at par with each other. The highest number of larvae was observed on the germplasms JKM-207 (6.00).

Pooled data of two year revealed significant differences. BDN-2003-1 recorded lowest larvae (1.1 7) followed by BDN-200 1-9 (1.50), BDN-70B (1.66) and ICPL-332 (1.66), which were at par with each other and significantly superior over all the germplasms. The germplasm ICPL-84060 was at par with local check BSMR-853 and recorded equal number of larvae 1.83 followed by PT-0012 (2.00), which were at par with each other. Maximum number of larvae was observed in JKM-207 (5.33).

The present investigation is in the support of Rathod *et al.*, (2014) screened 10 varieties of pigeonpea for resistance against pod borers, it was observed that BSMR-853 was found the least susceptible (1.39 larvae/ plant) and it was at par with variety AGT-2 (1.61 larvae/plant). The varieties ICPL-87119 was found highly susceptible with 5.63 larvae per plant.

Per cent pod damage

The pod damage was significantly lower in the germplasrn BDN-2003-1 (16.66%) followed by WRG-53 (20.00%), which were at par with each other in first year. The germplasms ICPL-84060, BDN-708 and AKT-8811 were recorded equal damage (23.33%) followed by ICPL-332 (26.66%), BDN-2001-9, LRG-41 and Bahar (30.00%) and these were at par with each other. The local check BSMR-853 and PT- 0012 were recorded 33.33 per cent pod damage followed by PT-909 (36.66%), BDN-2004 (40.00%) and PT-11-39-1 (40.00%). The highest per cent pod damage was observed in JKM-207 (73.33%) followed by VRG-l (66.66%) in their order.

In second year, minimum per cent pod damage was observed in BDN-708 (13.33%) and was significantly less than all the germplasms followed by ICPL-84060, BDN-2003-1 and AKT-8811 recorded 16.66 per cent pod damage each. The germplasms, ICPL-332 and LRG-41 were recorded 20.00 per cent pod damage followed by BDN-

2001-9, Bahar, PT-909 and local check BSMR-853 with 26.66 per cent pod damage. Maximum per cent pod damage (60.00%) was observed in JKM-207 followed by VRG-l (53.33%).

Two years pooled data on per cent pod damage in multi-choice test of table 1 revealed that maximum per cent pod damage was observed in JKM-207 (66.67%) followed by VRG-l (60.00%). The lowest, 16.67 per cent pod damage was observed in BDN-2003-1 followed by BDN-708 (18.33%), ICPL-84060 (20.00%), AKT-88l1 (20.00%) and WRG-53 (20.00%), which were at par with each other and recorded significantly superior pod damage over all the germplasms. BSMR-853, the local check was recorded 30.00 per cent pod damage followed by PT-0012 (31.67%), PT-909 (31.67%), PT-11-39-1 (35.00%) and BDN-2004 (36.67%) which was at par with each other and significantly superior over remaining all the germplasms.

The overall results indicated varietal performance in pod damage and are discussed in the light of earlier findings of earlier research workers. In present study not a single germplasm was completely free from the infestation of *H. annigera.* The result supported by Patel and Patel (1990). The levels of resistance to *H. armigera* in the germplasms accessions are low to moderate (Lateef 1985; 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-1 1 (51 % borer damaged pods). C-l1 was having 17.2 per cent pod damage due to *H. arrnigera*, 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). Minja *et al.,* (1999) reported pod borers damaged seeds in all genotypes. 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; Rao and Mohammad, 1999; Venkateswarlu and Singh, 1999). Medium duration variety C-l1 was recorded 54.09 per cent pod damage and early maturing variety showed maximum damage 57.07 per cent, reported by Sahoo and Senapati (2001). Cultivars C-l1, ICPL-87119, WRG-47 and WRG-53 showed more damage due to pests compared to the other cultivars, BSMR-846, AKT-9726 was reported by Surana *et al.*, (2002). Sharma *et al.*, (2003) revealed that all the genotypes tested showed low level of resistance.

Grains per pod

Average number of grains found in 10 pods of different germplasms was in the range of 21.83 to 36.83 grains of an average 2.18 to 3.68 grains per pod.

Per cent grain damage

There was significant difference in per cent grain damage during first year (Table 2). The lowest, 14.06 per cent grain damage was observed in BDN-2003-1 and was showed highly significant difference over all the germplasms followed by WRG-53 (21.17%), BDN-708 (22.34%) and ICPL-84060 (24.98%), which were at par with each other. The germplasm AKT-8811 recorded 28.13 per cent grain damage and at par with ICPL-332 (28.86%), BDN-2001-9 (30.43%) and Bahar (31.98%) these varieties showed significant difference over LRG-41 (33.33%), PT-OO 12 (35.87%), local check, BSMR-853 (36.58%) and PT-909 (37.50%) and at par with each other.

Table.1 No of larva, pod damaged and per cent pod damaged by *H. armigera* to different germplasms in multi-choice test

Sr. No.	Germplasm	Observations recorded after 24 hrs from the release of larva								
		No. of Larva found			Damaged pods			Per cent pod damaged		
		Ist year	IInd year	Pool-ed	Ist year	IInd year	Pool-ed	Ist year	IInd year	Pooled
1	WRG-55	3.66	4.66	4.16	5.66	4.33	5.00	56.66 (48.83)*	43.33 (41.16)*	50.00 (44.98)*
2	ICPL-87119	3.66	2.33	3.00	4.66	3.00	3.83	46.66 (43.08)	30.00 (33.21)	38.33 (38.24)
3	BDN-2010	3.66	4.66	4.16	5.33	4.66	5.00	53.33 (46.90)	46.66 (43.08)	50.00 (44.98)
4	JKM-207	4.66	6.00	5.33	7.33	6.00	6.67	73.33 (58.90)	60.00 (50.77)	66.67 (54.73)
5	VRG-1	3.66	5.00	4.33	6.66	5.33	6.00	66.66 (64.73}	53.33 (46.90)	60.00 (50.75)
6	C-11	3.33	3.00	3.17	4.33	3.66	4.00	43.33 (41.16)	36.66 (37.26)	40.00 (39.21)
7	ICPL-84060	2.00	1.66	1.83	2.33	1.66	2.00	23.33 (28.87)	16.66 (24.10)	20.00 (26.53)
8	BDN-708	1.66	1.66	1.66	2.33	1.33	1.82	23.33 (28.87)	13.33 (21.40)	18.33 (25.34)
9	BDN-2001-9	1.33	1.66	1.50	3.00	2.66	2.83	30.00 (33.21)	26.66 (31,09)	28.33 (32.15)
10	AKT-9929	3.00	2.66	2.83	5.00	4.33	4.67	50.00 (45.00)	43.33 (41. 16)	46.67(43.08)
11	BDN-2003-1	1.33	1.00	1.17	1.66	1.66	1.66	16.66 (24.07)	16.66 (24.10)	16.67 (24.07)
12	PT-332	2.66	3.00	2.83	4.33	3.00	3.67	43.33 (41. 16)	30.00 (33.21)	36.67 (37.26)
13	Bahar	3.00	1.66	2.33	3.00	2.66	2.83	30.00 (33.21)	26.66 (31,09)	28.33 (32.15)
14	PT-0012	2.33	1.66	2.00	3.33	3.00	3.16	33.33 (35.25)	30.00 (33.21)	31.67 (34.23)
15	ICPL-332	1.66	1.66	1.66	2.66	2.00	2.33	26.66 (31.08)	20.00 (26.56)	23.33 (28.87)
16	BSMR-736	4.66	4.66	4,66	6.00	5.00	5.50	60.00 (50.77)	50.00 (45.00)	55.00 (47.87)
17	BSMR-846	4.00	4.66	4.33	5.00	4.33	4.67	50.00 (45.00)	43.33 (41.16)	46.67 (43.08)
18	PT-909	2.66	2.33	2.50	3.66	2.66	3.16	36.66 (37.23)	26.66 (31.09)	31.67 (34.23)
19	WRG-53	2.33	2.00	1.16	2.00	2.00	2.00	20.00 (26.56)	20,00 (26.56)	20.00 (26.56)
20	AKT-8811	2.66	2.00	2.33	2.33	1.66	1.99	23.33 (28.87)	16.66 (24.10)	20.00 (26.56)
21	WRG-51	3.66	4.33	3.99	5.33	4.33	4.83	53.33 (46.90)	43.33 (41.16)	48.33 (44.04)
22	LRG-41	2.66	2.00	2.33	3.00	2.00	2.50	30.00 (33.21)	20.00 (26.56)	25.00 (30.00)
23	BDN-2009	3.00	3.33	3.16	4.66	3.66	4.16	46.66 (43.08)	36.66 (37.26)	41.66 (40.31)
24	BDN-2004	2.66	3.66	3.16	4.00	3.33	3.67	40.00 (39.23)	33.33 (35.24)	36.67 (37.26)
25	PT-11-39-1	3.00	2.33	2.67	4.00	3.00	3.50	40.00 (39.23)	30.00 (33.21)	35.00 (36.27)
26	BSMR-853	2.00	1.66	1.83	3.33	2.66	3.00	33.33 (35.25)	26.66 (31.09)	30.00 (33.19)
	SE ±	0.079	0.078	0.097	0.079	0.072	0.086	1.593	0.523	1.483
	CD at 5%	0.218	0.215	0.282	0.219	0.200	0.237	4.408	1.454	4.314

* Figures in parenthesis are Arc sin values.

Table.2 Damaged grains and per cent grain damaged by *H. armigera* to different germplasms in multi-choice test

Sr. No.	Cultivar/ genotype	Observations recorded after 24 hrs from the release of larva								
		Total grains in 10 pods			Damaged grains			Per cent grain damaged		
		Ist year	IInd year	Pooled	Ist year	IInd year	Pooled	Ist year	IInd year	Pooled
1	WRG-55	25.66	26.00	25.83	11.66	11.33	10.50	45.44(42. 37) *	43.57 (41.30)*	44.51 (41.84)*
2	ICPL-87119	37.66	35.66	36.66	14.33	13.00	13.67	38.05 (38.08}	36.45 (37.13)	37.25 (37.60)
3	BDN-2010	30.33	29.00	29.67	13.33	13.33	13.33	45.03 (42.14)	45.96 (42.68)	45.50 (42.40)
4	JKM-207	26.66	27.33	27.00	13.00	13.66	13.33	48.76 (44.28)	49.98 (44.98)	49.37 (44.63)
5	VRG-1	31.33	32.33	31.83	15.00	14.66	14.83	47.87 (43.77)	45.34 (42.31)	46.61 (43.05)
6	C-11	25.00	27.66	26.33	10.33	11.33	10.83	41.32 (39.99)	40.96 (39.79)	41.14 (39.88)
7	ICPL-84060	26.66	27.33	27.00	6.66	7.00	6.83	24.98 (29.97)	25.61 (30.40)	25.30 (30.17)
8	BDN-708	31.33	31.00	31.17	7.00	6.66	6.83	22.34 (28.19)	21.48 (27.60)	21.91 (27.90)
9	BDN-2001-9	30.66	30.00	30.33	9.33	9.00	9.17	30.43 (33.47)	30.00 (30.21)	30.22 (33.34)
10	AKT-9929	27.33	26.33	26.83	12.00	11.66	11.83	43.90 (41.50)	44.28 (41.71)	44.09 (41.59)
11	BDN-2003-1	21.33	22.33	21.83	3.00	3.00	3.00	14.06 (21.99)	13.43 (21.48)	13.75 (21.73)
12	PT-332	35.66	33.00	34.33	14.66	13.66	14.16	41.11 (39.87)	41.39 (40.03)	41.25 (39.95}
13	Bahar	33.33	32.00	32.67	10.66	10.33	10.50	31.98 (34.43)	32.28 (34.61)	32.13 (34.52)
14	PT-0012	30.66	31.66	31.16	11.00	11.33	11.17	35.87 (36.78)	35.78 (36.73)	35.83 (36.76)
15	ICPL-332	30.00	30.00	30.00	8.66	6,66	8.66	38.86 (32.49)	28.86 (32.49)	28.86 (32.49)
16	BSMR-736	29.33	28.66	29.00	13.33	13.00	13.17	45.44 (42.37)	45.35 (42.32)	45.40 (42.34)
17	BSMR-846	29.00	27.00	28.00	12.33	11.33	11.83	42.51 (40.69)	41.96 (40.37)	42.24 (40.52)
18	PT-909	32.00	30.66	31.00	12.00	11.66	11.83	37.50 (37.76)	38.03 (38.07)	37.77 (37.91)
19	WRG-53	33.66	32,00	32.83	7.33	6,66	7.00	21.77 (27.79)	20,81 (27,13)	21.29 (27.46)
20	AKT-8811	34.66	34.00	34.33	9.66	9.33	9.50	28.13 (32.02)	27.44 (3I.57)	27.79 (31.80)
21	WRG-51	30.33	28.33	29.33	13.33	12.66	12.99	43.94 (41.51)	44.68 (41.94)	44.31 (41.73)
22	LRG-41	21.00	20.00	20.50	7.00	6.66	6.83	33.33 (35.25)	33.30 (35.24)	33.32 (35.24)
23	BDN-2009	37.66	36.00	36.83	15.66	15.00	15.33	41.58 (40.1S)	41.66 (40.20)	41.62 (40.18)
24	BDN-2004	31.33	31.00	31.17	12.66	12.66	12.66	40.40 (39.47)	40.83 (39.71)	40.42 (39.58)
25	PT-11-39-1	29.66	28.20	28.93	11.33	11.00	11.17	38.19 (38.16)	38.96 (38.62)	38.58 (38.60)
26	BSMR-853	37.33	28.00	27.67	10.00	10.33	10.17	36.58 (37.21)	36.89 (37.39)	36.74 (37.30)
	SE ± CD at 5%	1.883 5.210	1.573 4.353	1.927 5.333	0.132 0.366	0.178 0.326	0.138 0.382	1.001 2.770	0.983 2.721	1.094 3.027

* Figures in parenthesis are Arc sin values.

Maximum per cent grain damage 48.76 per cent observed in JKM-207 followed by VRG-l (47.87%). Minimum per cent grain damage 13.43 per cent was observed in BDN-2003-1 and was superior over all germplasms in second year followed by WRG-53 (20.81%) and BDN-708 (21.48%) were at par and showed significant differences over ICPL-84060 (25.61 %), AKT-8811 (27.44%) and ICPL-332 (28.86%), which were at par with each other. BDN-2001-9 recorded 30.00 per cent grain damage, which was at par with Bahar (32.28%) and LRG-41 (33.30%) followed by PT-OO 12 (35.78%), ICPL-87119 (36.45%), local check, BSMR-853 (36.89%) and PT-909 (38.03%), they were at par with each other and significantly superior over remaining all germplasms.

The pooled data revealed the same trend of result as recorded in second year on per cent grain damage in multi-choice test. The present study also supports the finding of

Anitha *et al.,* (2006) who found lower percentage of pod damage and observed loss of grain yield < 29 per cent in genotype ICPL 332, ICPL 84060 and ICPL 187-1 as compared to 87.2 per cent in ICPL 87.

All the germplasms tested were found moderate to low resistance to *H. armigera*, none of them was found free from infestation of the pest. The germplasms developed by the local research station Badanapur, BDN-2003-1, BDN-2001-9 and BDN-708 were found superior in case of larva found after 24 hrs from release, pod damaged and grain damaged. ICPL-84606, ICPL-332, PT-OO12, LRG-41 (donor), AKT-8811 and WRG-53 were recorded moderate resistance. BDN-2004, BDN-2009, BDN-2010 and BSMR-736 were recorded low resistance. BSMR-846 recorded high damage by *H. armigera.*

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