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Original Research Article

Evaluation of Pigeonpea Germplasms for Antibiosis Mechanism of Resistance to the Pod Borer, *Helicoverpa armigera*

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

A B S T R A C T

Antibiosis mechanism of resistance was studied against pigeonpea pod borer *H. armigera* during two consecutive years by screening twenty six germplasms of pigeonpea under laboratory condition. For studying the antibiosis mechanism of resistance the first instar larva fed on the developing pods of each germplasms in replicated manner. Observations of larval weight on 7th and 12th days from release, larval period, larval mortality, pupal weight and pupal period were recorded. The germplasms BDN-2003-1, BDN-2001-9 and BDN-708 were found resistant among all the germplasms. These germplasms recorded lowest larval weight of *H. armigera* on 7th and 12th day, longer larval period, highest larval mortality upto pupation, minimum pupal weight and maximum pupal duration followed by the germplasms ICPL-84060, ICPL-87119 and PT, 0012. Among all the germplasms WRG-55, VRG-1 and BSMR-846 were significantly susceptible germplasms which recorded highest larval weight on 7th and 12th day from release of larva. Germplasm JKM-207 was the highly susceptible germplasm which recorded longer larval period, lowest per cent mortality, highest pupal weight and shortest pupal duration.

Keywords

Helicoverpa armigera, Host plant resistance, Antibiosis, Pigeonpea, Resistance mechanisms

Introduction

Pigeonpea [*Cajanus cajan* (Linnaeus) Millsp.] is cultivated in more than 25 countries of the world and grown on areas of about 4.59 million hectares in world with the production of 3.28 million tons annually. Dominant producers of this crop are the countries in the Indian subcontinent, Africa and Central America. The productivity is low in India as compared to developed nations in the world due to number of factors but the maximum extent of losses are caused due to insect pest attack. 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. *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.

Antibiosis includes the adverse effects of the physicochemical characteristics of the plants on the biology of an insect attempting to use that plant as a host. The chronic effects of antibiosis are also expressed in terms of weight and size of insects, sex ratio and proportion of insects entering into diapauses (Dhandapani and Balasubramanian, 1980; Dubey *et al.,* 1981; Jayraj, 1982). The antibiosis mechanism of resistance in pigeonpea to *H. armigera* has been identified in terms of slower larval growth, longer pupation time and reduced larval and pupal weight (Lateef *et al.,* 1981; Dodia *et al.,* 1996). Shanower *et al.,* (1997) revealed that larval mortality and prolongation of the larval period were the main components of resistance to *H. armigera.* Presence of antifeedant or poor nutritional quality of the varieties may be responsible for the antibiosis mechanism of resistance to *H. armigera* in pigeonpea (Yoshida and Shanower, 2000). Thus, identifying promising resistant germplasm to *H. armigera* an experiment was conducted to screen and evaluate an antibiosis effect of germplasms on pod borer development in pigeonpea.

Materials and Methods

Pigeonpea varieties comprising twenty six germplasms were screened in replicated trial in laboratory condition during two consecutive years for antibiosis mechanism of resistance against *H. armigera*. The study was followed at Vasantrao Naik Marathwada Agricultural University, Parbhani, Maharashtra. 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.

Antibiosis mechanism of pigeonpea germplasm to *H. armigera* were studied by rearing 10 fist instar 24 hrs starved larvae on each genotype material *i.e.,* developing pods in three replications in laboratory condition. While studying it is observed that, the larvae reared on some germplasms goes into pupation upto 14 days so larval weight measured at 7 days and 12 days after the release of larvae on the test materials. Larval duration, larval mortality, pupal weight and pupal duration were also recorded to know the effect of antibiosis on *H. armigera.* All these methods of screening were tested as per the methodology developed by the Indian Institute of Pulses Research, Kanpur. The data further analysed for determining the relative susceptibility of pigeonpea germplasms as per the methods described in "Statistical Methods for Agricultural Workers" by Panse and Sukhatme (1985).

Results and Discussion

Effect of Antibiosis of pigeonpea germplasms on *H. armigera*

Larval weight on 7th day

The relative feeding preference of *H. armigera* larvae towards different germplasms was studied under laboratory condition on pods. Results showed significant variations in development of *H. armigera* larval weight. Lower larval weight was observed in BDN-2001-9 *i.e.,* 0.082g followed by BDN-2003-1, BON -708, ICPL-84060 and ICPL-87119 range in between 0.090g to 0.100g. The second group ranged larval weight in between 0.106g to 0.126g was observed in PT-0012, BSMR-853, Bahar, WRG-53, C-11, ICPL-

332 (0.124g) and AKT-B811 (0.126g). Maximum larval weight was observed in the group JKM-207 (0.153g), BSMR-846 (0.156g) and VRG-l (0.158g). There were significant differences in the larval weight on different germplasms during second year. The lowest larval weight obtained in BDN-2003-1 *i.e.*, 0.076g followed by BDN-2001-9, BDN-708, ICPL-84060 and PT-0012. The germplasm ICPL-87119, WRG-53, Bahar, local check, BSMR-853, C-l1, ICPL-332 and AKT -8811 were showed 0.103g to 0.124g larval weight. The germplasms recorded maximum larval weight ranged from 0.129g in LRG-41 to JKM-207 (0.l53g).

The pooled data of two year on an antibiosis effect of pigeonpea germplasms on larval weight recorded that the lowest larval weight 0.083g observed in BDN-2001-9 followed by BDN-2003-1, BDN-708, ICPL-84060, lCPL-87119 and PT-0012, which ranged larval weight from 0.083g to 0.102g which were significantly superior over other germplasms and local check, BSMR-853. Local check BSMR-853 and WRG-53 were recorded moderate larval weight of 0.114g followed by Bahar, C-11, ICPL-332, AKT-8811, PT-332, BDN-2009, AKT-9929, LRG-41, PT-909, PT-11-39-1 and BDN-2004. The remaining germplasms recorded maximum larval weight than control check which ranged from 0.143g in WRG-55 to 0.155g in VRG-l.

Larval weight on 12th day

In the first year, on 12th day from emergence the maximum larval weight was observed in BDN-2003-1 (0.203g) followed by BDN-200 1-9 (0.209g) and BDN-708 (0.217g) and recorded significantly superior result over remaining all other germplasms. The germplasm ICPL-84060 (0.246g), ICPL-87119 (0.2S5g) and PT-0012 (0.268g) were at par with local check BSMR-853 (0.260g). Remaining all the germplasms were ranged larval weight between 0.27Sg in WRG-53 to 0.410g in BSMR-736. During second year BDN-2001-9 recorded significantly lowest larval weight 0.179g which was at par with BDN-2003-1 (0.183g) and BDN-708 (0.192g) followed by ICPL-84060 (0.208g) and ICPL-87119 (0.228g). The local check, BSMR-853 recorded the larval weight, 0.283g and was at par with PT-0012, WRG-53 and Bahar (Table 1).

Pooled data of both the year recorded same trend of result as of the first year on larval weight recorded on 12th day from release of newly hatched larva. The overall result on an antibiosis effect of pigeonpea germplasms on larval weight of *H. armigera* revealed that the germplasm BDN-2003-1, BDN-2001-9 and BDN-708 were recorded lowest larval weight and significantly superior over local check BSMR-853. The local check BSMR-853 showed at par difference with the germplasm ICPL-84060, ICPL-87119 and PT-0012 and same kind of results coated by the previous workers. The effect of antibiosis is also expressed in terms of weight and size of insects and proportion of insects entering into diapause (Dhandapani and Balasubramanian, 1980; Dubey *et al.*, 1981 and Jayraj, 1982). Dodia and Patel (1994) reported that a significant decline in the larval and pupal weights and longer duration in both the stages were observed for larvae fed on developing pods of resistant varieties, ICPL-270 and ICPL-84060 as compared to those fed on the susceptible variety BDN-2 (Sison and Shanowar 1994; Dodia *et al.*, 1996).

Larval period

The observations on larval period of *H. armigera* were recorded to study the antibiosis mechanism of resistance and the

results recorded in first year, showed significant variation in larval period. The longer developmental period was observed in germplasm BDN-2001-9 (20.56 days) and BDN-708 (20.33 days) followed by BDN-2003-1 and ICPL-84060. Germplasms PT-0012 and ICPL-87119 were recorded longer time over local check BSMR-853 and WRG-53. Remaining all treatments ranged larval period from 17.66 days in Bahar to 11.13 days in JKM-207. During second year, BDN-2003-1 (22.66 days) was recorded significantly higher larval period followed by BDN-2001-9 and ICPL-84060. Germplasm BDN-708 and PT-0012 recorded higher larval duration over ICPL-87119 and BSMR-853. The lowest larval period was observed in JKM-207 (12.33 days) (Table 2).

Two year pooled data on larval period revealed that the longest larval period was observed in BDN-2003-1 (21.32 days) followed by BDN-2001-9 (21.19 days) and BDN-708 (21.17 days). ICPL-84060 recorded 20.35 days larval period followed by PT-0012, ICPL-87119. The local check BSMR-853 recorded significantly higher period *i.e.,* 19.18 days. The minimum larval period was observed in JKM-207 (11.74 days). The overall results showed that BDN-2001-9, BDN-2003-1, BDN-708, ICPL-84060, PT-0012 and ICPL-87119 were recorded highest larval period than local check, BSMR-853 and significantly superior over all the germplasms. Minimum larval period observed in JKM-207 germplasm. Prolonged larval duration also indicates antibiosis component of resistance as reported by Dodia and Patel (1994). Sison and Shanower (1994) reported that a significant decline in the larval and pupal weights and longer duration in both the stages were observed for larvae fed on developing pods of resistant varieties ICPL-270 and ICPL-84060 as compared to those fed on the susceptible variety BDN-2, same result also reported by Dodia *et al.,* 1996.

Per cent larval mortality

During the study the larval mortality was recorded until pupation. The highest per cent mortality in first year was observed in BDN-2003-1 (65.67%), which was at par with BDN-708 (64.33%), BDN-2001-9 (64.00%) and ICPL-84060 (64.00%) followed by ICPL-332, PT-0012, Bahar and WRG-53 in the range of 62.67 per cent to 61.00 per cent. The local check, BSMR-853 was recorded 59.33 per cent larval mortality and was at par with AKT-8811 (59.00%) and LRG-41 (57.33%). Remaining all germplasms recorded larval mortality in the range of 55.67 per cent to 45.00 per cent. The Lowest larval mortality was observed in JKM-207 (45.00%). During second year maximum larval mortality was observed in BDN-2001-9 (68.67%) followed by BDN -2003-1 (68.00%) and BDN-708 (67.00%) followed by ICPL-84060 (65.33%) and ICPL-332 (64.00%). PT-0012, Bahar, WRG-55 and LRG-41 were showed at par difference with local check BSMR-853 (59.67%).

The pooled data of two year showed maximum larval mortality 66.84 per cent in BDN-2003-1 followed by BDN-2001-9 (66.34%), BDN-708 (65.67%) and ICPL-84060 (64.67%), which showed at par result and significantly superior over ICPL-332, PT-0012 and Bahar. Germplasm WRG-53, AKT-8811 and LRG-41 were at par with local check BSMR-853 (59.50%). Minimum larval mortality was observed in JKM-207 (46.50%). Mortality of early instars is good indicator of antibiosis mechanisms of resistance against insect pests (Painter, 1951; Slandky, 1982). Shanower *et al.*, (1997) revealed that: larval mortality was the main component of resistance to *H. armigera* in pigeonpea.

Pupal weight

Antibiosis effect on pupal weight was recorded and significant differences in the development of pupae were noticed. Lowest pupal weight was observed in BDN-2001-9 *i.e.*, 0.130g which was at par with BDN-2003-1 (0.135g), ICPL-87119 (0.143g) and BDN-708 (0.146g). Local check BSMR-853 recorded 0.167g pupal weight and at par with ICPL-84060 (0.l80g) and LRG-41 (0.169g). The highest pupal weight observed in JKM-207 (0.253g) which was at par with BSMR-846, VRG-l and BDN-2010. There were significant differences recorded in second year, on pupal weight. BDN-2003-1 recorded lowest pupal weight (0.104g) followed by BDN-2001-9, BDN-708 and ICPL-84060. Local check, BSMR-853 showed at par results with LRG-41, ICPL-87119 and PT-0012. Germplasm BSMR-846 recorded highest pupal weight *i.e.*, 0.226g and was at par with JKM-207, VRG-1, BDN-2010, BSMR-736 and WRG-51.

Pooled data of two year recorded significant result. Least pupal weight observed in BDN-2003-1 *i.e.*, 0.119g followed by BDN-2001-9, BDN-708 and ICPL-84060, which were at par with each other and showed highly adverse effect on pupal development. Another group, which revealed adverse effect on pupal weight was ICPL-87119, local check BSMR-853, LRG-41, PT-0012 and WRG-53, which recorded pupal weight in the range of 0.114g to 0.165g. Germplasm JKM-207 recorded highest pupal weight 0.238g followed by BSMR-846, BDN-2010, WRG-8l and BSMR- 846.

Pupal period

The data pertaining to the pupal period in first year revealed that highest pupal period of 24.47 days observed in BDN-2001-9 followed by BDN-2003-1 (24.32), which was significantly superior over C-l1 and BDN-708. The germplasm ICPL-84060 recorded pupal period of 23.53 days followed by ICPL-332, PT-0012, WRG-53 and Bahar. The local check, BSMR-853 recorded 22.20 days pupal period followed by LRG-41 (22.00). Germplasm JKM-207 recorded very short pupal period *i.e.*, 9.80 days followed by BSMR-846 (10.13).

In second year, maximum pupal period was observed in BDN-2003-1 *i.e.*, 22.00 days followed by C-l1 (21.87) were at par with each other and significantly superior over BDN-2001-9 (21.73) followed by BDN-708 (20.86). Germplasm ICPL-84060 recorded pupal period 20.20 days and at par with PT-0012 (20.13) and ICPL-332 (20.00) followed by WRG-53 (19.93), Bahar (19.66) and local check BSMR-853(19.40). Very short pupal period 9.09 days was observed in JKM-207 followed by VRG-l (10.13) and BSMR-846 (10.26).

The two year pooled data revealed that BDN-2003-1 recorded maximum pupal period of 23.16 days and at par with BDN-2001-9 (23.10) and C-l1 (22.94) followed by BDN-708 (22.20) and ICPL-84060 (21.87). The germplasm PT'-0012 (21.56), ICPL-332 and WRG-83 (21.38) recorded moderate resistance over Bahar (21.11) followed by local check BSMR-853 (20.79) and LRG-41 (20.58) (Table 3).

The very short pupal period was recorded in JKM-207 (9.42). The present investigation are in the lightning of earlier researchers reports who also suggested significant decline in the larval and pupal weights and longer duration in both the stages were observed for larvae fed on developing pods of resistant varieties ICPL-270 and ICPL-84060 as compared to those fed on the susceptible variety BDN-2 (Sison and Shanower, 1994; Dodia *et al.*, 1996).

Table.1 Antibiosis effect of pigeonpea germplasms on larval weight of *H. armigera*

Sr. No.	Germplasm	Larval wt. on 7th day (g)			Larval wt. on 12th day (g)		
		1st Year	2nd Year	Pooled	1st Year	2nd Year	Pooled
1	WRG-55	0.144	0.142	0.143	0.374	0.317	0.345
2	ICPL-87119	0.100	0.103	0.101	0.255	0.225	0.240
3	BDN-2010	0.150	0.148	0.149	0.392	0.330	0.361
4	JKM-207	0.153	0.153	0.153	0.396	0.311	0.353
5	VRG-1	0.158	0.153	0.155	0.400	0.346	0.373
6	C-11	0.123	0.119	0.121	0.284	0.256	0.270
7	ICPL-84060	0.096	0.089	0.092	0.246	0.208	0.227
8	BDN-708	0.091	0.083	0.087	0.217	0.292	0.204
9	BDN-2001-9	0.082	0.079	0.080	0.209	0.179	0.194
10	AKT-9929	0.134	0.130	0.123	0.325	0.289	0.307
11	BDN-2003-1	0.090	0.076	0.083	0.203	0.187	0.193
12	PT-332	0.130	0.130	0.130	0.300	0.270	0.285
13	Bahar	0.117	0.113	0.115	0.279	0.255	0.267
14	PT-0012	0.106	0.099	0.102	0.268	0.242	0.255
15	ICPL-332	0.124	0.121	0.122	0.302	0.277	0.289
16	BSMR-736	0.147	0.141	0.144	0.386	0.330	0.358
17	BSMR-846	0.156	0.151	0.153	0.410	0.340	0.375
18	PT-909	0.135	0.134	0.134	0.315	0.277	0.296
19	WRG-53	0.119	0.110	0.114	0.275	0.246	0.260
20	AKT-8811	0.126	0.124	0.125	0.292	0.267	0.279
21	WRG-51	0.148	0.144	0.015	0.392	0.332	0.362
22	LRG-41	0.137	0.129	0.133	0.336	0.298	0.317
23	BDN-2009	0.134	0.129	0.131	0.319	0.283	0.301
24	BDN-2004	0.141	0.137	0.139	0.363	0.324	0.343
25	PT-11-39-1	0.138	0.135	0.136	0.351	0.310	0.330
26	BSMR-853	0.113	0.116	0.114	0.260	0.235	0.247
	SE ±	0.007	0.009	0.009	0.008	0.008	0.009
	CD at 5%	0.020	0.025	0.025	0.022	0.021	0.024

Table.2 Antibiosis effect of pigeonpea germplasms on larval period and larval mortality of *H. armigera*

Sr.No.	Germplasm	Duration of larval period (Days)			Per cent larval mortality		
		1st Year	2nd Year	Pooled	1st Year	2nd Year	Pooled
1	WRG-55	13.46	15.60	14.54	47.33	50.00	48.67
2	ICPL-87119	18.46	20.60	19.54	53.00	55.33	54.17
3	BDN-2010	12.86	14.73	13.82	49.00	51.33	50.17
4	JKM-207	11.13	12.33	11.74	45.00	48.00	46.50
5	VRG-1	12.20	13.86	13.05	47.00	50.00	48.50
6	C-11	17.26	19.46	18.34	51.67	53.67	52.64
7	ICPL-84060	19.46	21.26	20.35	64.00	65.33	64.67
8	BDN-708	20.33	21.00	21.17	64.33	67.00	65.67
9	BDN-2001-9	20.56	21.80	21.19	64.00	68.67	66.34
10	AKT-9929	15.36	17.66	16.51	57.00	57.33	57.17
11	BDN-2003-1	20.00	22.66	21.32	65.67	68.00	66.84
12	PT-332	16.73	18.93	17.86	52.67	55.00	53.84
13	Bahar	17.66	19.80	18.74	61.33	61.67	61.50
14	PT-0012	19.00	20.86	19.94	62.00	62.33	62.17
15	ICPL-332	16.93	19.13	18.05	62.67	64.00	63.34
16	BSMR-736	13.27	15.40	14.35	48.33	51.67	50.00
17	BSMR-846	11.93	13.60	12.81	48.67	51.00	49.84
18	PT-909	14.93	16.93	15.91	55.67	56.00	55.84
19	WRG-53	17.87	20.00	18.95	61.00	60.00	60.50
20	AKT-8811	16.86	18.60	17.82	59.00	59.00	59.00
21	WRG-51	13.60	15.00	14.30	48.00	50.33	49.17
22	LRG-41	15.06	17.40	16.22	57.33	59.67	58.17
23	BDN-2009	16.53	18.53	17.53	51.00	53.33	52.17
24	BDN-2004	14.33	16.00	15.19	50.00	52.00	51.00
25	PT-11-39-1	14.66	16.27	15.48	52.33	55.00	53.67
26	BSMR-853	18.00	20.33	19.18	59.33	59.67	59.50
	SE ±	0.094	0.049	0.072	0.953	0.964	1.069
	CD at 5%	0.260	0.135	0.198	2.637	2.669	2.959

Table.3 Antibiosis effect of pigeonpea germplasms on pupal weight and pupal period duration of *H. armigera*

Sr.No.	Germplasm	Pupal weight (g)			Pupal Period Duration (Days)		
		1st Year	2nd Year	Pooled	1st Year	2nd Year	Pooled
1	WRG-55	0.221	0.202	0.211	15.26	13.13	14.29
2	ICPL-87119	0.143	0.146	0.144	16.80	15.00	15.90
3	BDN-2010	0.236	0.213	0.224	14.26	12.86	13.57
4	JKM-207	0.253	0.224	0.238	9.80	9.06	9.42
5	VRG-1	0.242	0.219	0.230	12.93	10.13	11.57
6	C-11	0.217	0.198	0.207	24.00	21.87	22.94
7	ICPL-84060	0.150	0.122	0.136	23.53	20.20	21.87
8	BDN-708	0.146	0.117	0.131	23.86	20.86	22.20
9	BDN-2001-9	0.130	0.115	0.122	24.47	21.73	23.10
10	AKT-9929	0.188	0.166	0.177	20.33	18.60	19.50
11	BDN-2003-1	0.135	0.104	0.119	24.32	22.00	23.16
12	PT-332	0.201	0.183	0.192	18.19	16.53	17.38
13	Bahar	0.190	0.175	0.182	22.53	19.66	21.11
14	PT-0012	0.173	0.149	0.161	23.06	20.13	21.56
15	ICPL-332	0.214	0.197	0.205	23.13	20.00	21.55
16	BSMR-736	0.225	0.210	0.217	16.20	14.80	15.50
17	BSMR-846	0.248	0.226	0.237	10.13	10.26	10.21
18	PT-909	0.198	0.175	0.186	18,80	16.98	17.87
19	WRG-53	0.178	0.152	0.165	22.86	19.93	21.38
20	AKT-8811	0.194	0.171	0.182	21.73	19.00	20.38
21	WRG-51	0.227	0.209	0.218	15,60	13.87	14.75
22	LRG-41	0.169	0.138	0.153	22.00	19.13	20.58
23	BDN-2009	0.221	0.199	0.210	14.13	12.66	13.38
24	BDN-2004	0.220	0.196	0.208	17.00	16.13	16.58
25	PT-11-39-1	0.214	0.182	0,198	17.46	16.60	16.80
26	BSMR-853	0.167	0.140	0.153	22.20	19.40	20.79
	SE ±	0.007	0.007	0.008	0.095	0.089	0.130
	CD at 5%	0.019	0.020	0.021	0.264	0.247	0.286

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