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Pigenonpea *Cajanus cajan* (L.) Millsp. Entries Selection against Pod Fly *Melanagromyza obtusa* Mulloch

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Abstract

Pigeonpea, *Cajanus cajan* (L.) Millsp., is one of the most significant tropical food legumes that caters to the protein needs of people. Though more than 300 insect species are known to cause damage to pigeonpea, the pod borer complexes are the major threat to pigeonpea growers as they infest during the reproductive stage. Among the pod fly, *Melanagromyza obtusa* Mulloch, causes 10-80% of the damage and its hidden behaviour makes management difficult. The pod fly infests the pigeonpea during the maturity stage and the damage is visible at the time of harvest. The damaged seeds are inappropriate for dietary and seed purposes. The experiments to screen 70 pigeonpea entries were carried out to find out the resistant source against *M. obtusa* and Co8 pigeonpea used as standard checks. The responses of 70 entries were as follows: one resistant, nine moderately resistant, six tolerant, seven equal to check, 14 moderately susceptible, 31 susceptible and two highly susceptible. The pigeonpea entry, IC 525468, demonstrated resistance with a pest severity index of 54.67 and a grade of 3. The entries ACP 1225, CRG 5, IC-525514, ICPL-84031, ICPL-86020, ICPL-90028, ICPL-91018, ICPL-91045, ICPR-2447 and UPAS-120 showed moderate resistance. The pest severity index ranged from 25.21 to 48.49 for moderately resistant entries and from 6.21 to 22.86 for those equal to the check. The resistant and moderate resistant can be employed in breeding programs for creating resistant varieties against pod fly.

Keywords: Breeding programme, Pigeonpea, Pod fly, Screening, Tolerant entries

Introduction

The pigeonpea is grown widely in South and Southeast Asia. India produces 4.29 metric tonnes with a productivity of 967 kg ha^{-1} (FAOSTAT, 2022). The abiotic and biotic factors are the major yield impeding parameters in pigeonpea (Vaibhav *et al.*, 2021). Despite the fact that pigeonpea records over 300 insect species, only 66 of these are known to inflict economic damage on the crop (Rolania *et al.*, 2021). The insect pests capable of causing damage during the reproductive phase are the major yield reducers in pigeonpea (Muchhadiya *et al.*, 2024). The insect pests that cause damage during the reproductive phase of pigeonpea include the gram pod borer *Helicoverpa armigera* Hubner, spotted pod borer *Maruca vitrata* Fabricius and plume moth *Exelastis atomosa*. Walsingham, blue butterfly *Lampides boeticus* Linneaus and pod fly *Malanagromyza obtusa* Mulloch are the insects causing damage during the reproductive phase of pigeonpea (Saxena *et al.*, 2018). Among these, the increasing incidence of *M. obtusa* poses a major threat to pigeonpea cultivation. The pod fly is capable of causing 10-80% damage to the grains (Kumar *et al.*, 2016; Saxena *et al.*, 2018).

The pod fly's concealed behavior and the overlapping blooms in long-duration pigeonpeas help them sustain their infestation for a longer period (Sharma *et al.*, 2010).

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The pod fly lays eggs on the immature pods and emerging maggots feed on the seeds initially by scrapping and later forming galleries. The infested seeds are unsuitable for seed and consumption. The farmers mostly apply insecticides for the pod borer complex management and they seldom give importance to the pod fly. Despite the effectiveness of many insecticide compounds, timely application is crucial for effective management (Sreekanth *et al.*, 2020). The availability of susceptible host stages for a longer period necessitates a greater number of insecticide applications for its effective usage. Hence, the alternate management strategies are inevitable for the management of pod fly.

The use of resistant varieties is a viable alternative to manage pod fly infestations (Gandhi *et al.*, 2017). As the pod fly cause damage to the mature pods and the concealed behaviour necessitates resistance inside the plant rather than applying insecticides. The responses of pigeonpea accessions vary depending on the climatic conditions and insect incidence. Identifying resistant sources in pigeonpea is made challenging by the irregular blooming patterns and fluctuations in pod fly populations (Singh and Singh, 1990). We carried out the present investigations to identify resistant sources from the available pigeonpea accessions. The identification of resistant sources will be useful to incorporate these sources in breeding programs.

Materials and Methods

The experiment to identify entries showing resistance to pod fly damage was conducted at the Research Farm, Department of Pulses, Tamil Nadu Agricultural University, Coimbatore (11.02345° N; 76.92934° E), over a six-month period in *kharif* 2022. We screened about 70 entries collected from different research stations and localities against pod fly infestation. Each entry was planted in two rows, each 4 meters long and replicated twice with a 60 cm × 30 cm spacing. The recommended farming practices of the Tamil Nadu Agricultural University were used for all entries. After sowing, the crops were initially irrigated, followed by mostly relying on rainfed conditions. Irrigation was provided as needed during the pod maturity stage to encourage the growth of plants. During the initial stage of the crop, Imidacloprid @ 0.5 ml l^{-1} was applied to minimize the leafhopper *Emposaca fabea* incidence. We manually removed the webbings of the spotted pod borer and hand-picked larvae of the gram pod borer to reduce damage. Insecticides were not applied to prevent *M. obtusa* infestation in the crop. The ruling variety Co8 was used as a standard check to work out the pest severity index.

The pod fly damage in pigeonpea entries was recorded at pod maturity stage (Patange *et al.*, 2017). From each entry, 30 pods were randomly collected to assess the pod fly damage. The total number of grains and pod fly-infested grains were counted under laboratory conditions. Pod-fly-damaged seeds are identified by the presence of galleries, damage the seed coat and shriveled grains with feeding damage. The pod bug-damaged seeds were not considered damaged seeds. The pod and grain damage were calculated as follows:

$$\text{Pod damage (\%)} = \frac{\text{Number of damaged pods} \times 100}{\text{Total number of pods}}$$

$$\text{Grain damage (\%)} = \frac{\text{Number of damaged grains} \times 100}{\text{Total number of grains}}$$

The pod fly damage in test entries were compared with the damage in the standard check (Co8) as detailed below (Abott, 1925).

$$\text{Pest Resistance (\%)} = \frac{(\text{Pod fly damage of standard check} - \text{Pod fly damage of test entry}) \times 100}{\text{Pod fly damage of standard check}}$$

The following description (Table 1) explains how the pest resistance percentage was transformed into a 1-9 rating.

Table 1: Pest resistance ratings based on the pod borers' percent damage, as depicted by Uma Devi (2017)

Pest Resistance (%)	Pest Resistance Rating (PRR)	Description
100	1	Immune
75 to 99	2	Highly Resistant
50 to 75	3	Resistant
25 to 50	4	Moderately Resistant
10 to 25	5	Tolerant
-10 to 10	6	Equal to Check
-25 to -10	7	Moderately Susceptible
-50 to -25	8	Susceptible
Less than -50	9	Highly Susceptible

Results and Discussion

The resistant level of 70 pigeonpea entries collected from different research institutes was evaluated against pod fly *M. obtusa*. The cultivated variety Co8 was used as a standard check to compare the resistance level of pigeonpea entries. The resistant response of 70 pigeonpea entries is presented in table 2. Though variation was observed in pod fly damage in the tested entries, all the entries were infested by the pod fly. The IC 525468 pigeonpea entry demonstrated a resistant response with a PSI of 54.67 and a resistant grade of 3. Rana *et al*. (2017) screened 20 pigeonpea entries and found that ICP 6996 was least susceptible. The entries ICPL 88034 and ICPL 2438 were highly susceptible, with pest severity indexes of -57.41 and -54.47, respectively.

The entries ACP 1225, CRG 5, IC-525514, ICPL-84031, ICPL-86020, ICPL-90028, ICPL-91018, ICPL-91045, ICPR-2447 and UPAS-120 were moderately resistant with pest severity indexes of 37.05, 45.13, 48.49, 35.46, 25.21, 39.44, 38.72 and 35.46, respectively. The entries ARG 102, C 11, ICP 7234, ICPL 87, ICPL 525588, PA 128 and TAT 93-47 recorded pest severity indexes of -6.21, -4.38, -8.48, -22.86, -1.51, -4.63 and -9.7 and fall in the equal to check category. The performance of these entries was comparable to the standard check Co 8

Table 2: Response of different pigeonpea entries to pod fly infestation

Sl. No.	Entries	Total no. of grains	No. of pod fly infected grains	Percent infestation	PSI	Grade	Resistance category
1	AL-601	124	46	37.10	7.39	6	EC
2	ARG-102	113	48	42.48	-6.21	6	EC
3	C-11	60	25	41.67	-4.38	6	EC
4	ICP-7234	42.5	18.5	43.53	-8.48	6	EC
5	ICPL-87	106.5	55	51.64	-22.86	6	EC
6	ICPR-525585	44.5	18	40.45	-1.51	6	EC
7	PA-128	152	63.5	41.78	-4.63	6	EC
8	TAT-93-47	17	7.5	44.12	-9.70	6	EC
9	ICPL-2438	52	45.5	87.5	-54.47	8	HS
10	ICPL-88034	31	29	93.55	-57.41	9	HS
11	ACP-1225	43	12.5	29.07	37.05	4	MR
12	CRG-5	76.5	21	27.45	45.13	4	MR
13	IC-525514	68	19	27.94	42.59	4	MR
14	ICPL-84031	82	22	26.83	48.49	4	MR
15	ICPL-86020	106	29.5	27.83	43.15	4	MR
16	ICPL-90028	119	35	29.41	35.46	4	MR
17	ICPL-91018	88	28	31.82	25.21	4	MR
18	ICPL-91045	42	12	28.57	39.44	4	MR
19	ICPR-2447	144.5	41.5	28.72	38.72	4	MR
20	UPAS-120	42.5	12.5	29.41	35.46	4	MR
21	AL -61112	106	55.5	52.36	-23.91	7	MS
22	AL-1730	118	62	52.54	-24.18	7	MS
23	AS-36	49	26	53.06	-24.92	7	MS
24	Co-5-25	32	15	46.88	-15.01	7	MS
25	CRG-516	98	49	50.00	-20.32	7	MS
26	DPP-2-183	90	44.5	49.44	-19.42	7	MS
27	DPP-252	48	25	52.08	-23.51	7	MS
28	GRG 9407	80.5	37	45.96	-13.32	7	MS
29	IC-525490	31	16.5	53.23	-25.15	7	MS
30	IC-525519	101.5	70	68.97	-42.23	8	MS
31	ICL 88001	115.5	61	52.81	-24.57	7	MS
32	ICP-2387	47.5	25.5	53.68	-25.79	7	MS
33	ICP-92047	42	23.5	55.95	-28.80	7	MS
34	ICPR-2438	62.5	29.5	47.20	-15.59	7	MS
35	IC-525468	66	17	25.76	54.67	3	R
36	AF-28411	75.5	40.5	53.64	-25.73	8	S
37	AF-28412	122	73.5	60.25	-33.87	8	S
38	AL-1692	65	43	66.15	-39.78	8	S
39	AL-1727	70	49	70.00	-43.09	8	S
40	AL-1733	53.5	33.5	62.62	-36.37	8	S
41	AL-1736	68	44.5	65.44	-39.12	8	S
42	AL-1739	62	46.5	75.00	-46.88	8	S

Sl. No.	Entries	Total no. of grains	No. of pod fly infected grains	Percent infestation	PSI	Grade	Resistance category
43	AS-4461 A	82	49	59.76	-33.33	8	S
44	AS-46	93.5	54.5	58.29	-31.65	8	S
45	DPP-3-244	115	72	62.61	-36.37	8	S
46	GRG9302	113	62.5	55.31	-27.97	8	S
47	IC-123325	55	37.5	68.18	-41.57	8	S
48	IC-342747	61	37	60.66	-34.32	8	S
49	IC-525466	68.5	54.5	79.56	-49.93	8	S
50	IC-73895	42	25	59.52	-33.07	8	S
51	IC-74016	60.5	32.5	53.72	-25.84	8	S
52	ICP-2391	94	59	62.77	-36.53	8	S
53	ICP-245507	71	48	67.61	-41.07	8	S
54	ICP-245517	82	65	79.27	-49.74	8	S
55	ICP-245531	89	53.5	60.11	-33.72	8	S
56	ICP-245532	21	16	76.19	-47.71	8	S
57	ICP-245541	66.5	43.5	65.41	-39.10	8	S
58	ICPL-161	153.5	89	57.98	-31.29	8	S
59	ICPL-20325	26	20	76.92	-48.21	8	S
60	ICPL-83027	36.5	21.5	58.90	-32.36	8	S
61	ICPL-85010	95.5	75.5	79.06	-49.61	8	S
62	ICPL-88039	91	68	74.73	-46.68	8	S
63	ICPL-90047	28.5	20.5	71.93	-44.61	8	S
64	VBN-1	96	63	65.63	-39.29	8	S
65	CRG-9060	58.5	20	34.19	16.53	5	T
66	DPP-2-89	28.5	10	35.09	13.54	5	T
67	IC-339057	42	15	35.71	11.55	5	T
68	ICPC-149	38.5	14.5	37.66	5.78	5	T
69	ICPL-81-3	38.5	13.5	35.06	13.62	5	T
70	ICPL-88039-1	74.5	24	32.21	23.67	5	T
Check	Co8	128	51	39.84			

used in the present study. The early (UPAS 120), mid early (WRGE 124) and medium (SKNP 1715) were least effected by pod borers (Basha *et al.*, 2024).

The pigeonpea entries CRG 9060, DPP 2-89, IC 339057, ICPC 149, ICPL 81-3 and ICPL 88039-1 demonstrated the tolerance response against pod fly, registering PSI values of 16.53, 13.54, 11.55, 5.78, 13.62 and 23.67, respectively. Among the tested entries, 13 recorded a moderate susceptible response, with a PSI ranging from -13.32 to -42.23, respectively, while the PSI of 31 susceptible entries ranged from -25.84 to -49.93. Among 145 entries, ICP 11007, H 23, BAHAR, DA 322, GR 28, ICP 49114, ICP 11957, SMR 1693158 and BRG-10-02 resistance to *H. armigera* and *M. vitrata* (Kavitha and Vijayaraghavan, 2018).

Badabagni and Patange (2020) evaluated 20 entries against pod fly and found that BRG 2 was most susceptible. They recorded the highest incidence in BDN 2010-1 pigeonpea entry. A wide range of variations were recorded in 24 genotypes tested against pod fly and ICPL 85063 recorded the lowest damage (Khan *et al.*, 2014). Experiments conducted to evaluate 260 pigeonpea genotypes against pod fly revealed that all the entries were prone to pod fly damage. Among these, GP 75, GP 118, GP 233 and GP 253 were found least vulnerable, with pod damage varying from 3.76 to 5.24% (Moudgal *et al.*, 2009).

Among the 18 entries evaluated against pod fly, pigeonpea entries ICPL 319 and BDN 1 recorded the lowest damage, at 30.30% and the highest damage, at 81.01%. In the present investigation, the percent pod fly damage in the resistant category was 25.76 (IC 525468). These results are aligned with earlier studies that reported 30% pod damage in resistant entries. However, these findings are contrary to the results of Moudgal *et al.* (2009), where they recorded pod fly damage of 3.76 to 5.24 in the pod fly least susceptible entries. The difference in pod fly population may be the reason for infestation variation (Kavitha and Vijayaraghavan, 2020; Keval *et al.*, 2010). The percent infestation in the susceptible category varied from 55.31 to 79.56 in the present study and in the highly susceptible category, the infestation range was 87.50 to 93.55%.

According to Sharma *et al.* (2003), *Cajanus cajanifolius* (Haines) vander Maesen accessions were vulnerable to pod fly infestation, while *Cajanus scarabaeoides* (L.) Thouars accessions were resistant to pod fly damage. Romeis *et al.* (1999) revealed that the presence of trichomes in *C. scarabaeoides was* responsible for the resistance against insects. The bold seeded pigeonpea entries were more susceptible to pod fly damage (Durairaj, 1999; Minja *et al.*, 1999). Pigeonpea entries BDN 2014-1 and ATKE 11-2 recorded lowest and highest pod damage, among the 15 entries screen against pod fly (Dhande *et al.*, 2023). Through three-year screening, Chakravarty *et al.* (2016) found that PUSA-2012-1, PA 409, PA 406, AL1747 were least vulnerable (PSR = 4 to 5) and, AL 1790 and AL 1770 were highly vulnerable against pod borers. The present investigation identified one resistant entry (IC 525468) and nine moderately resistant entries. These entries may possess trichomes, bold seeds, or biochemical properties that contribute to resistance against pod fly. To determine the mechanisms underlying the resistance to pod flies, more research is necessary.

Conclusion

About 70 pigeonpea entries were examined for their response against pod fly *M. obtusa*. The pod fly damage was recorded in all the entries and one entry (IC 525468) with a pest severity index of 54.67 resisted the pod fly damage and nine entries were moderately resistant with a PSI range of 25.21-48.49, which may be used as resistant lines in breeding programs.

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