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SHORT RESEARCH ARTICLE

Identification of sources of resistance to *Fusarium* wilt and sterility mosaic diseases in pigeonpea [*Cajanus cajan* (L.) Millsp.]

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Abstract

The experiment was conducted to screen a set of 100 genotypes of pigeonpea (*Cajanus cajan* L.) for resistance to *Fusarium* wilt and sterility mosaic disease during 2021-2022 using root dip technique and the leaf stapling method, respectively. Based on percent disease incidence of *Fusarium*, seven genotypes were classified as resistant. Seventeen genotypes showed resistant reaction against sterility mosaic disease. Combined resistance for both diseases was recorded in six genotypes namely, ICPL 15023, ICPL 15063, ICPL 19467, ICPL 19482, ICPL 19489, and ICPL 19499. These resistant lines can be utilized directly as useful donor source in pigeonpea hybridization programs to improve resistance.

Keywords: *Fusarium* wilt, sterility mosaic disease, percent disease incidence, combined resistance

Pigeonpea [*Cajanus cajan* (L.) Millspaugh] is one of the major multipurpose grain legume crops of Asia and Africa's tropics and subtropics, with India being the top contributor of pigeonpea to the global food market (Dutta *et al.* 2011). Pigeonpea is an often cross-pollinated perennial shrub and is also grown as an annual crop contributing 70% of global output with good production potential in the country. However, severe abiotic and biotic stresses limit its yield (Verma *et al*. 2022). Among the various biotic stresses, *Fusarium* wilt (FW) and pigeonpea sterility mosaic disease (SMD) are major constraints that cause an annual loss of US$113 million (Kannaiyan and Nene 1981). *Fusarium* wilt is an important soil-borne and externally seed-borne fungal disease caused by *Fusarium udum* Butler. The pathogen enters the host through the root system, which causes wilting of plants from the seedling stage to the pre-pod and pre-harvest stage with an estimated total yield loss of 29.60 to 99.90% (Kannaiyan and Nene 1981). The characteristic symptoms of *Fusarium* wilt disease include yellowing, drooping of leaves, partial wilting, vascular discoloration, and a purple band extending upwards on the stem from the base of the plant (Pande *et al.* 2013). Another important biotic stress is sterility mosaic disease (SMD) also called "Green Plague" which is caused by pigeonpea sterility mosaic virus (PPSMV) belonging to the emara virus group. The PPSMV is transmitted by the sole vector Eriophyid mite *Aceria cajani* Channabasavanna in a semi-persistent manner (Kulkarni *et al.* 2002). It is known to cause 95 to 100% yield loss if infection occurs in early stages and 26 to 97% loss after 45 days depending on the disease severity with an annual estimated loss of US$282 million (Kannaiyan *et al.* 1984). The disease starts from the early growth stage of the plants with observable dark green mosaics on leaves, sometimes ring

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spots, reduced leaf size, excessive vegetative growth, severe stunting, and sterility which make plants appear as bushy and pale in the field (Pande et al. 2012). Management of these major diseases in pigeonpea through chemical, biological, cultural, and mechanical methods is not sustainable because of the evolution of pathotypes, increased cost of production, and these methods are not commercially viable (Saxena et al. 2012). Among several management strategies, host-plant resistance is a very important approach which is the most feasible and cost-effective option available for the management of these diseases (Sayiprathap et al. 2022).

Considering the importance of pigeonpea in our production system, the present investigation was carried out to screen a set of 100 germplasm lines (Table 1) procured from International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad along with the checks, ICPL87119 and ICP8863, each repeated ten times between the genotypes and BRG3 as a local check. The genotypes were screened against *Fusarium* wilt and SMD under greenhouse conditions using the root dip technique (Pande et al. 2012) and leaf stapling technique (Nene et al. 1981), respectively. The genotypes were screened along with the resistant check BRG3 for both diseases and susceptible checks ICP2376 for FW and ICP8863 for SMD during *summer* 2022 and *kharif* 2021, respectively. The disease symptoms were recorded at seven days intervals for FW and at 15 days intervals for SMD up to 60 days for both diseases. per cent disease incidence (PDI) was calculated at each interval using the scale mentioned by Pande et al. (2012) and Singh et al. (2003) for FW and SMD, respectively, and using the formula.

$$Per\ cent\ \text{Disease Incidence (PDI)} = \frac{\text{No. of diseased seedlings}}{\text{Total no. of seedlings}} \times 100$$

Screening for Fusarium wilt disease

The disease symptoms observed were loss of turgidity, yellowing of leaves, drooping, and purple discoloration in vascular bundles (Fig. 1), and the disease was confirmed using tissue isolation of *Fusarium*-infected plants on the potato dextrose medium. Based on the PDI, seven genotypes (ICPL 19467, ICPL 19499, ICPL 19489, ICPL 15023, ICPL 19482, ICPL 15063, and ICPL 19538) were found resistant (0–10% PDI), and 11,13 and 72, genotypes showed moderately resistant (10.1–20% PDI), moderately susceptible (20.1–40% PDI) and susceptible (40.1-100% PDI) reaction, respectively. The analysis of variance revealed significant differences among the genotypes based on the PDI (Table 2). The frequency distribution of genotypes for disease reaction is depicted

Table 1. A list of genotypes and checks (c) used in the study

S. No.	Genotypes	S. No.	Genotypes	S. No.	Genotypes	S. No.	Genotypes	S. No.	Genotypes
1	ICPL19509	22	ICPL 19511	43	ICPL 19488	64	ICPL 19540	85	ICPL 15062
2	ICPL19480	23	ICPL 19493	44	ICPL 19520	65	ICPL 19491	86	ICPL 15023
3	ICPL 19528	24	ICPL 19483	45	ICPL 19525	66	ICPL 19523	87	ICPL 19515
4	ICPL15060	25	ICPL 19514	46	ICPL 19537	67	ICPL 19494	88	ICPL 15010
5	ICPL 16531	26	ICPL 19517	47	ICPL 19487	68	ICPL 19497	89	ICPL 19468
6	ICPL 19471	27	ICPL 15003	48	ICPL 19535	69	ICPL 19512	90	ICPL 19544
7	ICPL 19507	28	ICPL 19464	49	ICPL 19534	70	ICPL 19516	91	ICPL 19477
8	ICPL 19545	29	ICPL 19495	50	ICPL 15014	71	ICPL 19467	92	ICPL 19475
9	ICPL 19486	30	ICPL 19482	51	ICPL 19518	72	ICPL 19470	93	ICPL 19465
10	ICPL 19522	31	ICPL 19500	52	ICPL 19519	73	ICPL 19526	94	ICPL 15067
11	ICPL 19474	32	ICPL 19524	53	ICPL 19481	74	ICPL 19476	95	ICPL 19530
12	ICPL 19508	33	ICPL 15028	54	ICPL 19542	75	ICPL 19546	96	ICPL 15063
13	ICPL 19527	34	ICPL 19533	55	ICPL 19543	76	ICPL 19502	97	ICPL 19466
14	ICPL 19499	35	ICPL 19501	56	ICPL 19473	77	ICPL 15057	98	ICPL 19504
15	ICPL 19490	36	ICPL 19472	57	ICPL 19532	78	ICPL 15006	99	ICPL 19529
16	ICPL 19478	37	ICPL 15058	58	ICPL 19505	79	ICPL 15007	100	ICPL 19541
17	ICPL 19536	38	ICPL 19513	59	ICPL 15079	80	ICPL 19510	101	ICP 8863(c)
18	ICPL 19547	39	ICPL 19480	60	ICPL 19469	81	ICPL 15021	102	ICPL 87119(c)
19	ICPL 19485	40	ICPL 19484	61	ICPL 19498	82	ICPL 19479	103	BRG 3(c)
20	ICPL 19506	41	ICPL 15024	62	ICPL 19492	83	ICPL 19521		
21	ICPL 19539	42	ICPL 19503	63	ICPL 19496	84	ICPL 19538		

Table 2. Analysis of variance of CRD for the genotypes screened for *Fusarium* wilt and sterility mosaic diseases

S. No.	Source of variation	Df		Mean sum of squares	
		FW	SMD	FW	SMD
1	Between groups	3	2	21891.52***	19281.9***
2	Within groups	119	118	299.29	241.59

FW – *Fusarium* wilt, SMD – Sterility Mosaic Disease

Fig. 1. a) Symptoms of *Fusarium* wilt disease – healthy plant and completely wilted plant, b) Symptoms of Sterility Mosaic disease – Healthy plant and pale plant with severe mosaics

in Fig. 2. The susceptible check ICP2376 expressed 100% disease incidence and the distribution of genotypes was skewed towards susceptibility. The results from Sharma et al. (2012) suggested that there was a high correlation (r=0.99) between the sick pot screening and screening using the root dip technique. Thus, the results suggested that the root dip technique can be used to screen many genotypes and rapidly identify the resistant genotypes under *in-vitro* conditions with limited area, time, and resources (Gowri *et al.*2016).

Screening for Sterility Mosaic Disease

The symptoms observed were mild mosaic, severe mosaic, ring spot, partial sterility, and complete sterility of plants (Fig. 1). The 17 genotypes *viz.*, ICPL 19545, ICPL 19499, ICPL 19482, ICPL 15058, ICPL 19489, ICPL 19484, ICPL 15023, ICPL 19503, ICPL 19525, ICPL 19518, ICPL 19542, ICPL 19473, ICPL 19467, ICPL 19470, ICPL 19502, ICPL 15063, and ICPL 19541were found resistant (0-10% PDI), 64 genotypes were found moderately resistant (10.1-30% PDI) and 21 genotypes showed susceptible (30.1-100% PDI) reaction. The significance of the ANOVA indicated that the genotypes differed in their disease response as presented in Table 2. The frequency distribution of genotypes based on PDI is represented in Fig. 2 indicating normal distribution. The results indicated that there was a uniform disease spread based on the symptoms observed. The findings are in accordance with the earlier reports (Pande *et al.* 2012; Sharma *et al.* 2012 and Sayiprathap *et al.* 2022) on identification of resistant genotypes from different populations.

Combined resistance to Fusarium wilt and sterility mosaic disease

The genotypes ICPL 19499, ICPL 19482, ICPL 19489, ICPL 19467, ICPL 15023, and ICPL 15063 showed combined

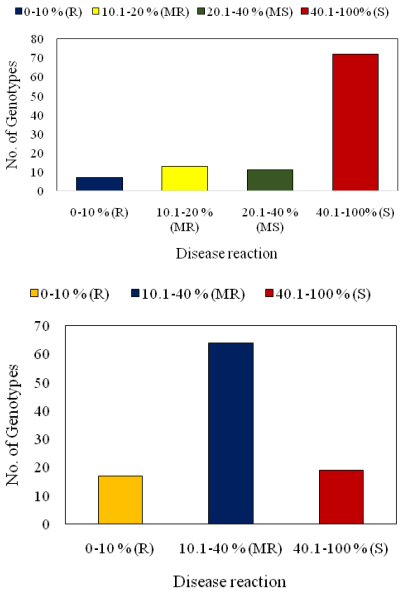

Fig. 2. Frequency distribution of per cent disease incidence on pigeonpea genotypes for a) *Fusarium* wilt disease and b) Sterility mosaic disease

resistance to both *Fusarium* wilt and Sterility mosaic disease in the current study. In addition, the genotypes ICPL 19529, ICPL 19495, ICPL 19487, ICPL 15014, ICPL 19540, ICPL 19477, and ICPL 19472 were found to be moderately resistant to both diseases. These genotypes identified as resistant to both diseases must be evaluated in field conditions for further validation of resistance and can be further utilized in the cultivar development or in hybridization programs to develop high-yielding genotypes with resistance to both diseases or in introgression studies as a source of resistance.

Authors' contribution

Conceptualization of research (HCL); Designing of the experiments (HCL); Contribution of experimental materials (HCL, PG); Execution of field/lab experiments and data collection(GSSK, HCL, SB, MSS, ASP); Analysis of data and interpretation (GSSK, HCL, MGM); Preparation of the manuscript (GSSK, SB, MSS, HCL, MGM, PG).

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