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Screening of BC_4F_1, BC_5F_1 and F_1 Generations for *Fusarium* Wilt and SMD Diseases Reaction in Pigeonpea [*Cajanus cajan* (L) Millsp.]

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ABSTRACT

The efforts were made to evaluate BC_5F_1, BC_4F_1 and 12 F_1 generations of pigeonpea against two deadly diseases, Fusarium wilt (FW) and sterility mosaic virus (SMD) causing considerable yield losses to the crop. A minimum range of variability in the crosses was observed with respect to the reaction against FW and SMD diseases. The crosses (ICPA-2101-4 × ICPB-2101-4) × ICPB-2101-4, (ICPA-2161-5 × ICPB-2161-5) × ICPB-2161-5 and (ICPA-2043 × Maruti) x Maruti of above generations recorded moderately resistant (MR) and resistant (R) reaction against FW and SMD respectively. This paper reports information for significant use to the breeders and plant pathologists by physical elimination of diseased ones at the early stage, particularly for development of resistant hybrid or variety in pigeonpea.

Key words: *Pigeonpea, Fusarium wilt, Sterility mosaic disease, Backcross, Disease reaction.*

INTRODUCTION

Pigeonpea (*Cajanus cajan* (L) Millspaugh) is a short lived perennial shrub traditionally cultivated as an annual crop in developing countries. Based on the vast natural genetic variability in local germplasm and the presence of numerous wild Relatives[1], concluded that India is probably primary centre of origin. Globally, pigeonpea is cultivated on 4.92 million hectares (M ha) with an annual production of 3.65 million tons and productivity of 898 kg/ha[2]. India is a major pigeonpea producer in the world with a It plays an important role in food security, balanced diet subsistence agriculture because of its diverse usage in food, fodder, soil contribution of 75–80 per cent. In India, pigeonpea is cultivated in an area of 3.75 m ha with production of 2.46 million tons and productivity of 656 kg/ha[3]. In Karnataka, pigeonpea occupies second place in area (0.65 m ha) and ranks second in production (0.26 m tons) with a productivity of 406 kg/ ha[3]. Gulbarga is very important potential district in the country for extensive cultivation of pigeonpea and hence known as 'pulses bowl' of Karnataka. It is also grown in Bidar, Bijapur, Dharwad, Raichur, Bellary and Belgaum districts of northern Karnataka. conservation, integrated farming systems and symbiotic nitrogen fixation[4].

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Lower productivity of pigeonpea in India is attributed to factors such as biotic (e.g., *Fusarium* wilt, sterility mosaic and pod borers) and abiotic (e.g., drought, salinity and water-logging) stresses. Among the biotic stresses, *Fusarium* wilt and sterility mosaic diseases are considered to be the most important diseases of pigeonpea in India. *Fusarium* wilt (FW), caused by *Fusarium udum* Butler, is the major constraint for limiting pigeonpea production in all pigeonpea growing regions[5,6]. The disease symptoms usually appear when plants are at the pre- flowering and podding stage (100% loss), at maturity (67%), and at pre-harvest stage (30% loss) but sometimes symptoms also appear in 1–2 month-old plants. The FW incidence increases in the ratoon and perennial crops[7] and causes serious yield losses in susceptible cultivars. The another disease sterility mosaic disease (SMD), often referred to as "Green Plague", as the affected plants are green with excessive vegetative growth but with no flowers or pods, under congenial conditions spreads rapidly leading to severe epidemics[8]. SMD infection at an early stage (<45-day-old plants) results in a 95–100% loss in yield[9]. The disease is confined to Asia and apart from India it has been reported from Nepal, Bangladesh and Myanmar, Thailand and Sri Lanka[10]. SMD is caused by Pigeonpea Sterility mosaic virus and is transmitted by an eriophyid mite (*Aceria cajani*)[11]. The loss in yield is greater by SMD disease than the *Fusarium* wilt and even other biotic stresses.Control of Sterility Mosaic Disease (SMD) and *Fusarium* wilt (FW) by chemical methods though effective, is not feasible economically and non eco- friendly[12]. Breeding resistant varieties is considered to be one of the most effective and economic methods of reducing crop losses and has received top priority. There are only few sources of resistance reported to FW and SMD[13,14]. This paper reveals about the priority research for the development of *Fusarium* wilt and SMD resistant cultivar by using back cross and F_1 generations in pigeonpea as a source of resistance to both FW and SMD.

MATERIALS AND METHODS

The experiment was conducted at Agricultural Research Station, Kalaburagi during *Kharif* 2009-2010.The parental material for the present study was obtained from the germplasm collection maintained at Agricultural Research Station, Kalaburagi and ICRISAT, Hyderabad are presented in Table 1 and Table 2. The disease scoring was made for *Fusarium* wilt and SMD diseases in BC_4F_1, BC_5F_1 and 12 F_1's. These populations were sown in single rows of 5 m length with spacing of 90 x 30 cm. The disease reaction was screened under natural epiphytotic condition (normal field), because the seeds generated are few and precious. A 9 point scale divided into five categories is used and adopted by AICRP on Pigeonpea for easy scoring (Table. 3) for both FW and SMD. Interpretation of scale is as follows: 1-Immune, 3-Resistant, 5-Moderately Resistant, 7-Moderately susceptible and 9-Susceptible. The scored values were converted in to per cent infection by using the formula for both FW and SMD.

$$\text{Per cent Disease Index (PDI)} = \frac{\text{Number of infected plants}}{\text{Total Number of plants}} \times 100$$

RESULTS AND DISCUSSION

The data recorded on FW and SMD in BC_4F_1, BC_5F_1 and the 12 F_1's populations were screened under natural epiphytotic condition (Table 4 and Table 5). The back cross population comprised of two groups, the first group BC_5F_1 consists of four crosses obtained from ICPA-2101 × ICPB-2101. A minimum range of variability in the crosses was observed with respect to the reaction against wilt and SMD. Out of the four crosses observed, one cross (ICPA-2101-4 × ICPB-2101-4) × ICPB-2101-4 showed 5 rating while other two crosses showed 3 rating scale and

recorded 16.6 per cent reaction considered as moderately resistant followed by 6.6 per cent and 3.3 per cent are considered as resistant to wilt based on rating scale used and for SMD no reaction was observed hence all are considered as resistant to sterility mosaic virus disease. The second group BC_4F_1 consists of 6 crosses obtained from ICPA-2161 × ICPB-2161. Out of the six crosses, interestingly one cross (ICPA-2161-5 × ICPB-21611-5) × ICPB-2161-5 showed 3 rating scale and recorded 3.3 per cent for the wilt, while the cross (ICPA2161-4 × ICPB-2161-4) × ICPB-2161-4 showed 3 rating and recorded 5.7 per cent for SMD reaction and which are considered as resistant. Among the 12 F_1's screened the only one cross (ICPA-2043 × Maruti) × Maruti recorded 3 rating scale and showed 3.7 per cent reaction against wilt and for SMD 7 crosses recorded 3 rating scale with the variability ranged from 2.8-4.7 per cent was observed for reaction against the sterility mosaic disease and all are considered as resistant. A minimum range of variability in all the crosses was observed with respect to the reaction against wilt and SMD disease.The above identified *Fusarium* wilt and SMD resistant lines from natural epiphytotic condition (normal field) can further be tested under wilt sick plot and SMD infested nursery (leaf staple method). To develop a resistant hybrid or variety along with crucial yield parameter for the benefit of farming community. Hence, no such reports were available. However, the recent reports for FW and SMD by different researchers followed wilt sick plot and leaf staple screening methods to identify resistant sources against above diseases. Researchers[15,16,17] were identified wilt resistant accessions after screening a pigeonpea mini-core collection/accessions/germplasm lines, respectively. Whereas, for SMD disease, resistance sources were identified by[15,16,18].

Table 1: List of parental materials used in BC_4F_1 and BC_5F_1

Sl. No.	Parents	Source	Generation	Per cent male sterility
		Female parent		
1.	ICPA-2101	BP 13A	BC_4F_1	32
2.	ICPA-2161	BP 13A	BC_3F_1	42
		Male parent		
1.	ICPB-2101	BP 13A	--	--
2.	ICPB-2161	BP 13A	--	--

Table 2: List of stable CMS lines and restorers used in Backcrossing programme

Sl. No.	Parents	Source	Pedigree
		Female parents	
1.	ICPA-2043	ICRISAT, Hyderabad	*Cajanus cajanifolius* (A_4- Cytoplasm)
2.	ICPA-2078	ICRISAT, Hyderabad	*Cajanus cajanifolius* (A_4- Cytoplasm), BP 13[a]
3.	GT-288A	S.K. Nagar, Gujarat	*Cajanus scarabaeoides* (A_2- Cytoplasm)
		Male parents	
1.	Maruti	ARS, Gulbarga	Selection from germplasm
2.	Gullyal Red	ARS, Gulbarga	Local germplasm collection from Gulbarga
3.	WRP-1	ARS, Gulbarga	GS-1 x Maruti
4.	TS-3	ARS, Gulbarga	ICP-87051 x PT-221
5.	TS-3R	ARS, Gulbarga	TS-3 x Maruti
6.	BRG-3	UAS, GKVK Bangalore	OGUK 3 x ICP 7036

Table 3: Reaction of Pigeonpea (*Cajanus cajan*) crosses to wilt and sterility mosaic disease (SMD)

Rating scale (1-9)	Per cent infection	Disease reading	*Fusarium* wilt	Sterility Mosaic Disease
1.	0	Immune	No symptoms on any plant	No symptoms on any plant
2.	10	Resistant	10 or less mortality	Symptoms on 10% of fewer plants
3.	11-20	Moderately resistant	11-20% mortality	Ring spot symptoms on most plants but disappearing with age; no sterility
4.	20-50	Moderately susceptible	20-50% mortality	Mild mosaic symptoms on most plants causing plant sterility
5.	> 50	Susceptible	51% or more mortality	Severe mosaic on most plants; almost completely sterility

Table 4: Screening for wilt and Sterility mosaic disease in $BC_4F_1$and BC_5F_1 selected plant to plant crosses

Sl. No.	Crosses	Total No. of plants	Wilted plants	Per cent wilt	SMD plants	Per cent SMD
BC_5F_1 plant to plant crosses						
1.	(ICPA-2101-3 × ICPB-2101-3) × ICPB-2101-3	30	2	6.6	--	--
2.	(ICPA-2101-4 × ICPB-2101-4) × ICPB-2101-4	30	5	16.6	--	--
3.	(ICPA-2101-9 × ICPB-2101-9) × ICPB-2101-9	32	--	--	--	--
4.	(ICPA-2101-12 × ICPB-2101-12) × ICPB-2101-12	30	1	3.3	0	0
BC_4F_1 plant to plant crosses						
1.	(ICPA-2161-4 × ICPB-2161-4) × ICPB-2161-4	35	--	--	2	5.7
2.	(ICPA-2161-5 × ICPB-2161-5) × ICPB-2161-5	30	1	3.3	--	--
3.	(ICPA-2161-6 × ICPB-2161-6) × ICPB-2161-6	34	--	--	--	--
4.	(ICPA-2161-6 × ICPB-2161-6) × ICPB-2161-7	33	--	--	--	--
5.	(ICPA-2161-6 × ICPB-2161-6) × ICPB-2161-9	33	--	--	--	--
6.	(ICPA-2161-6 × ICPB-2161-6) × ICPB-2161-10	32	--	--	--	--
7.	GS-1 (Check-wilt susceptible)	30	4	13.3	--	--
8.	Maruti (Check-SMD susceptible)	28	--	--	4	14.3

--: No disease symptoms, **SMD:** Sterility mosaic disease

Table 5: Screening for wilt and sterility mosaic disease in 12 F_1's

Sl. No.	Crosses	Total No. of plants	Wilted plants	Per cent wilt	SMD plants	Per cent SMD
1.	(GT-288A × TS-3R) × TS-3R	21	--	--	1	4.76
2.	(GT-288A × WRP-1) × WRP-1	26	--	--	1	3.85
3.	(GT-288A × MARUTI) × MARUTI	22	--	--	1	4.54
4.	(ICPA-2078 × WRP-1) × WRP-1	33	--	--	2	6.06
5.	(ICPA-2078 × TS-3R) × TS-3R	35	--	--	1	2.86
6.	(ICPA-2078 × G.RED) × G.RED	30	--	--	1	3.33
7.	(ICPA-2043 × TS-3R) × TS-3R	34	--	--	--	--
8.	(ICPA-2043 × G.RED) × G.RED	30	--	--	--	--
9.	(ICPA-2043 × WRP-1) × WRP-1	28	--	--	1	3.57
10.	(ICPA-2043 × MARUTI) × MARUTI	27	1	3.7	--	--
11.	(ICPA-2043 × TS-3) × TS-3	30	--	--	--	--
12.	(ICPA-2043 × BRG-3) × BRG-3	28	--	--	--	--
13.	GS-1 (Check-wilt susceptible)	30	4	13.3	--	--
14.	Maruti (Check-SMD susceptible)	28	--	--	4	14.3

--: No disease symptoms, **SMD:** Sterility mosaic disease

CONCLUSION

The identified resistance sources could become the pre breeding tools for the breeder to make use in disease resistance breeding programme for developing enhanced disease resistance in different elite but susceptible cultivar of pigeonpea. Further, these resistance sources can be utilized in gene pyramiding for multiple races of *Fusarium* wilt through advanced molecular technology using marker assisted backcrossing (MABC) in future.

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