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WATER CULTURE WILT SCREENING TECHNIQUE: A RAPID, REPEATABLE AND RELIABLE *IN VITRO* TECHNIQUE FOR ASSESSMENT OF HOST RESISTANCE IN PIGEONPEA AGAINST WILT CAUSED BY *FUSARIUM UDUM*

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ABSTRACT

Fusarium wilt, caused by *Fusarium udum*, poses a significant threat to pigeonpea (*Cajanus cajan*), which is one of the most important leguminous crops cultivated in semi-arid regions. Availability of suitable screening techniques is the key for exploiting host resistance in managing this disease. This study focuses on development of suitable, rapid, reliable and repeatable *in vitro* screening method to evaluate the host resistance in pigeonpea genotypes against *Fusarium* wilt. An *in vitro* screening method, namely water culture method was developed to identify resistant genotypes against *Fusarium udum* causing wilt in pigeonpea by screening 60 genotypes against the pathogen. These genotypes were firstly screened in wilt sick plot during *Kharif* 2024 and their response was recorded. Further assessment of the genotypes was attempted in this new technique. The age of seedlings and concentration of the pathogen culture were crucial factors and were standardised for effective expression of the disease by seedlings under suitable pathogen load. Seven days old seedlings and seven days old 10 per cent pathogen culture were found most ideal with highest disease expressions and reliability of results. Sixty pigeonpea genotypes seedlings were raised immersed in test tubes containing pathogen suspension (10 %). The observations for wilt incidence were recorded at seven days after incubation. The results of *in vitro* screening were compared with field screening. Out of 60 genotypes only two genotypes (ICP x 140203-B1 and ICP 8863) remained resistant both in field as well as water culture screening method. All the genotypes that were moderately resistant in sick plot remained moderately resistant in water culture method and additional seven genotypes (IC 405218, PT- 0012, WRG 443, PA-6, WRG 225, LRG 489 and PT-12-19-2) that were moderately resistant in field screening turned out to be susceptible under this *in vitro* assessment. The rest of 23 genotypes were found susceptible in field screening remained susceptible under *in vitro* water culture method of assessment. The experiments were repeated thrice and found highly reliable in their outcomes and helpful in employing assessment of large number of pigeonpea genotypes against *F. udum* in breeding programmes. This *in vitro* water culture method shall be employed as confirmatory test especially for preliminary screening of large number of pigeonpea genotypes for short listing potential genotypes for further field screening instead of whole material evaluation which is time, space and cost consuming. This new method provides assured and confirmed results on true behaviour of pigeonpea genotypes against *F. udum*.

Keywords **:** Pigeonpea, *Fusarium udum*, *In vitro* screening, Water culture technique

Introduction

In India, Pigeonpea (*Cajanus cajan* L. Millspaugh) ranks as the second most significant pulse crop after chickpea and the fifth most important grain legume globally (Mandal *et al.,* 2013). It contributes approximately 16% of the total pulse production in the country (Monga *et al.,* 2022). Pigeonpea exhibits remarkable drought tolerance compared to other

agricultural legumes, maintaining productivity even under annual rainfall as low as 650 mm. India ranks first in global pigeonpea production with 4.03 Mt, cultivated on 3.50 Mha area with productivity of 869 Kg/ha in 2023-24. Among the major pigeonpea-producing states, Karnataka (1.56 Mha and producing 1.25 Mt) tops in production (Anonymous, 2024), followed by Maharashtra (1.10 Mha and producing 1.90 Mt) and Uttar Pradesh (0.272 Mt.). Other states producing pigeonpea include Madhya Pradesh, Andhra Pradesh, Odisha, Bihar, Tamil Nadu, and Gujarat. In North Karnataka popularly known as pulse bowl of the state has emerged as an ideal crop for sustainable agriculture in rain-fed areas due to its numerous benefits, including low cultivation costs, high nutritional value, and resilience to drought. (Hemavathy *et al.,* 2023). However, its production is constrained by susceptibility to various diseases, insect pests, and physiological stresses. In diseases, both foliar and soil-borne diseases pose significant threats to pigeonpea cultivation. Among them, *Fusarium* wilt is a significant constraint to pigeonpea production, capable of causing yield losses of up to 100 per cent (Rohidas, 2024). The disease was first recorded by Butler in Bihar, India, and subsequently reported from other pigeonpea growing countries. The pathogen can infect the crop at any stage, ranging from the seedling phase to the pod development stage. Infected plants show gradual chlorosis, drooping and subsequent death of the plants under field conditions. Vascular discoloration and purple band on the stem extending upwards are the major symptoms of wilt in pigeonpea. Yield losses vary depending on the stage of infection, ranging from 100 per cent at the pre-podding stage to 67% at pre-harvest and 30 per cent at maturity (Reddy *et al.,* 2024). In severe cases, grain yield losses can reach up to 100 per cent.

Being a soil-borne disease, its management through chemical control is largely ineffective. Developing wilt-resistant varieties remains the most economical and environmentally sustainable approach to mitigating the impact of this disease. Although numerous biocontrol agents have demonstrated effectiveness *in vitro*, their large-scale commercial application remains challenging due to issues of limited availability and quality assurance. In this context, host resistance emerges as the most promising strategy for disease management. It is widely regarded as a cost-effective, durable, and environmentally sustainable approach for controlling diseases especially soil borne diseases.To identify resistance in pigeonpea against *Fusarium* wilt, *in vivo* screening is done under epiphytotic conditions in wilt sick plots. This technique helps in identifying resistant genotypes or entries, but it is limited to only one crop cycle per year. Additionally, any genotypes or entries that show resistance must undergo further confirmation over one or two more cycles before they can be released for commercial cultivation or used in breeding programs. Given these challenges in identifying resistant genotypes of pigeonpea against *Fusarium* wilt, an effort was made to develop*in vitro* screening techniques which enables screening of a large number of entries in a shorter time and within limited space with reliable and repeatable results.

Materials and Methods

Screening of pigeonpea against *Fusarium udum* in wilt in sick plot (*in vivo*): Field screening (i*n vivo*) screening of 60 pigeonpea genotypes along with susceptible check ICP 2376 and resistant check ICP 8863 was carried out wilt sick plot maintained at ZARS, Kalaburagi during 2024 *Kharif* season. The entries were sown in two rows of 5m with spacing of 60×20cm in three replications. Other agronomical practices were followed as per package of practices. Observations for wilt incidence were recorded at seven-day intervals, starting from 30 days after sowing up to 180 days. Based on the observations taken the disease incidence was calculated and the genotypes were categorized as resistant, moderately resistant or susceptible by using the disease rating scale of AICRP on *Kharif* Pulses.

Wilt incidence (%)	Reaction
0.00-10.00	Resistant
10.10-30.00	Moderately resistant
>30.00	Susceptible

(Annual Report AICRP on Pigeonpea, 2023)

Screening of pigeonpea against *Fusarium udum* in water culture method (*in vitro*)

Preparation of pathogen culture: The wilt infected pigeonpea stem were used for isolation of pure culture of *Fusarium udum* on Potato Dextrose Agar (PDA) media. After its growth on PDA medium, it was confirmed following Koch's postulates and based on culture and colony characters. Pure pathogen culture maintained on PDA was used for multiplication. A mycelial disc of 5 mm was placed in 250 ml flasks holding sterilized 100 ml Potato Dextrose Broth (PDB) under aseptic conditions. After 7 days of incubation at 28 °C, mycelial mats grown were carefully separated in clean and sterilised 500 ml beakers. After the separation of mycelial mats in a sterilized beaker, the mats were crushed for a brief (1 min) in a warring blender and uniform suspension formed was used for screening studies.

Standardization of pigeonpea seedlings age: Pigeonpea seeds of ICP 2376 susceptible to *Fusarium udum* were surface sterilized for one minute with 0.1 per cent mercuric chloride solution and rinsed three times in sterile water. Seeds were sown in plastic cups containing sterilized sand and watered regularly to maintain moisture in sand. The seedlings of 7, 10, 12 & 15 days old after germination were carefully removed from plastic cups to avoid root damage. They were cleaned with water to remove any sand adhered and used for inoculation and subsequent incubation.

Standardization of *Fusarium udum* concentration for screening: The seven days old *Fusarium udum* culture grown on potato dextrose broth at 28 °C was used for the study. The mycelial mat grown was carefully separated in clean and sterilised 500 ml beakers. It was macerated for a brief (1 min) in warring blender and uniform suspension was prepared. The inoculum was diluted to different concentrations *i.e.,* 5 per cent, 10 per cent and 20 per cent by adding sterilized water. Each inoculum was placed separately aseptically in sterilised test tubes (50ml) at 10 ml for each tube. Three set of 20 tubes (50 ml) were prepared for each concentration. Seven days old pigeonpea seedlings of ICP 2376 were placed in these tubes at the rate of two seedlings per tube in such way that roots are submerged in to inoculum suspension and shoots facing outside the tube with the help of cotton plug.

Screening of pigeonpea genotypes against *Fusarium udum* in water culture: Sixty pigeonpea genotypes were used for *in vitro* screening through water culture method against *F.udum*. Seedlings of each genotype were raised separately in plastic cup containing sterilised sand. After seven days, these seedlings were removed from the cup, sand adhering to roots was removed and cleaned with sterile water. Test tubes (50 ml) were sterilized and filled with approximately 10 ml of inoculum suspension (10 %). For each genotype 10 test tubes were prepared with three replications. For each tube two seedlings of seven days old were used. The seedlings were placed in such a way that roots were submerged in to inoculum suspension and held straight in the tube with the help of a cotton plug without damaging the stem portion and leaves facing outside the tube towards outer environment.

The seedlings were kept in 12-hour light and 12-hour dark at 28^0 C temperature conditions. Observations were taken on number of plants wilted on tenth day after incubation and categorized using the AICRP on *Kharif* Pulses Pigeonpea scale.

Results and Discussion

Screening of pigeonpea genotypes in wilt sick plot:

In the present study during the *Kharif* season of 2023-24, 60 pigeonpea (*Cajanus cajan*) genotypes were evaluated for resistance to *Fusarium* wilt (*Fusarium udum*) in sick plot. Diseased plants expressed symptoms starting from 30 days after sowing as in an earlier study also symptoms of pigeonpea wilting were observed four weeks after sowing in a wilt-sick plot (Nene *et al.,* 1979). Few entries expressed late like Rajkule *et al*. (1989) reported symptoms expression at 50 days after sowing, which continued and increased up to maturity.

Drooping, loss of leaf turgidity, leaf yellowing, and mild interveinal clearing were the typical signs of *Fusarium* wilt observed in wilted plants in the wilt-sick plot. During the flowering and podding stages, both partial and total wilting was noticed in some plants among the entries. Purple banding was clearly visible on the stem, extending from a few centimeters to more than a meter above the ground. When the stem of an infected plant was longitudinally split open, vascular discoloration ranging from brown to black was evident (Fig. 1)

The wilt symptoms observed in the wilt-sick plot aligned with the description provided by Butler (1908), who noted gradual or sudden withering and drying of green parts in pigeonpea plants infected with the wilt-causing pathogen. Similar symptoms have been reported by several researchers (Chaube, 1968; Nene *et al.,* 1979; Upadhyay and Rai, 1989; Reddy *et al.,* 2012). According to Pandey *et al*. (1997), vascular browning is attributed to the accumulation of phenolic compounds in response to infection by the wilt-causing pathogen.

The presence of *Fusarium udum* in susceptible plants was characterized by the presence of mycelia and conidia in the xylem vessels, plugging of some vessels, disintegration of xylem parenchyma cells in the infected area, and the formation of cavities due to heavy colonization in the pith, cortex, and vascular bundles (Mwangombe, 2001). Reddy *et al*. (1996) observed that in all pigeonpea cultivars, plants wilted only when the extent of browning and blackening reached the mid-stem and above. In contrast, in resistant cultivars, the browning and blackening were confined to the collar region.

The genotypes used for in this study were categorized based on the mean percent disease incidence (PDI), which ranged from 7.47 per cent to 86.83 per cent. Out of the 62 genotypes screened, four genotypes (ICP X 140203-B-1, TDRG 272, ICP 8863,

and GRG-811) were found to be resistant. Among these, ICP X 140203-B-1 had the least disease incidence with 7.47 per cent wilt, followed by TDRG 272 (8.2 %), ICP 8863 (9.09 %) and GRG-811 (9.75 %).

A total of 41 genotypes were recorded as moderately resistant with the disease incidence ranging between 10.01 and 30 per cent, while the remaining 17 genotypes were categorized as susceptible with a disease incidence above 30 per cent. Among these, the susceptible check ICP 2376 recorded 89.30 per cent disease incidence. The resistant check ICP 8863 recorded a disease incidence of 9.09 per cent (Fig. 2). Based on the wilt incidence, these genotypes were classified into three groups (Table 1 and Fig. 3).

The evaluation of pigeonpea genotypes for *Fusarium wilt* tolerance has been a major focus of research in pigeonpea. Similar to the present findings, Bisht *et al*. (2022) reported six resistant genotypes and seven moderately resistant genotypes with a disease incidence ranging between 21 and 40 per cent. One genotype, PARAS, exhibited severe susceptibility with an 80 per cent disease incidence, while four genotypes showed moderate susceptibility with a PDI ranging from 41 to 60 per cent.

More recently, Reddy *et al*. (2023) conducted a large-scale evaluation of 172 pigeonpea germplasm lines. Among these, 21 lines exhibited resistance with a PDI of 0–10 per cent, 45 lines showed moderate resistance (11–30 % PDI) and the remaining 106 lines displayed susceptibility, with disease incidences exceeding 30 per cent. Significant genetic variability in disease tolerance among pigeonpea germplasm underscores the potential for selecting and incorporating resistant lines into breeding programs to improve resilience against *Fusarium wilt*. Such efforts not only enhance yield stability but also contribute to sustainable pigeonpea production in wilt-prone regions. From the present findings and previous reports, it is evident that high level of resistance in pigeonpea against *Fusarium udum* exists and shall be identified through rigorous screening under high disease pressure *in vivo*.

Table 1 : Grouping of pigeonpea genotypes in to different categories based on their response to *F. udum* causing wilt under *in vivo* conditions

Reaction	Wilt incidence	Genotypes	Total number of genotypes
Resistant	0-10%	ICP x 140203-B-1. TDRG 272, GRG-811, ICP 8863	4
Moderately resistant	10.1-30%	GRG 152, NAM 2217, Phule Tur, ICPL 87, NAM 2314, NAM 2284, NAM 314, NAM 2282, NAM 88, IC 74013, IC 405218, IC 73898, IC 73995, IC 73975, IC 73952, WRG 93, PT-0012, WRGE 150, CRG 18004, BDN -2019-29, WRG 443, SKNP 2122, NTL1127, SKNP 2107, NAAM 88, PA-6, WRG 225, LRG 489, PT-12-19-2, KRG-33, ICP x 140213- B-3, EC 843239, NAM 2329, ICP x 140217-B-1, NAM 2292, NAM 2151, NAM 2085, WRGE x ICP 15028, IC73959, IC 73969, IC 73961	41
Susceptible	>30%	TS-3R, CORG 9701, ICP x 140196-B-1, IC73885, IC 73058, PA 714, BAUPP 19-11, AL 2362, NUPPC-68, ICAKTM 19424, MIRA, IPAE 22-1, PAU 881, PT-11-16, RKVP 1165, ICP x 140188-B-3, ICP 2376	17

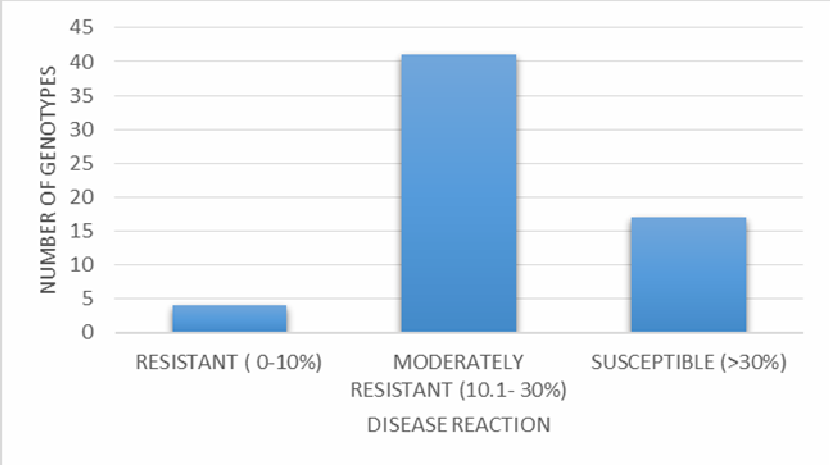


Fig. 3 : Frequency distribution of pigeonpea genotypes based on their response to *F. udum* under *in vivo* screening in sick plots.

Screening of pigeonpea genotypes through water culture method

Age of pigeonpea seedlings: Among the different aged seedlings tested, seven day old seedlings showed 100 per cent survivability. As the age of seedlings progressed, they had less survivability and posed high risk of handling due to lanky growth and bending while placing in tubes. The elongated stems made these seedlings fragile and unsuitable for the test. The seven days old seedlings had an average height of 15-16 cm and were found to be most suitable for use in water culture technique. They had shorter, sturdier stems, which minimized bending and breakage during handling.

Inoculum concentration for water screening technique: Seven-day-old seedlings (ICP 8863 and ICP 2376) raised in plastic cups filled with sterilized sand were uprooted and transferred to sterilized test tubes with inoculum suspensions at different concentrations (5 %, 10 % and 20 %) of seven days old *F. udum* broth. These thes tubes were placed in stands and kept under 12 hour light and 12 hour dark conditions (Fig. 4). No symptoms of *F. udum* infection were observed in both ICP 2376 and ICP 8863 at the lowest concentration of five per cent until ten days after incubation of seedlings. At 10 per cent concentration of *F. udum* inoculum, disease symptoms began to manifest on the pigeonpea seedlings of ICP 2376 by the fifth day after incubation, whereas in ICP 8863 no symptom were seen even after 10 days of incubation (Fig 5). At 20 per cent concentration of *F. udum* inoculum.100 per cent mortality was observed in ICP 8863. Based on the observed results, it was concluded that a 10 per cent *F. udum* inoculum concentration is optimal for screening pigeonpea genotypes against *Fusarium* wilt. This concentration provides balanced pathogen pressure that is sufficient to assess resistance levels without overwhelming the plants, making it ideal for reliable screening.

Inoculation of seedlings with pathogen and incubation through water culture method: After confirming the exact concentration of *F. udum* inoculum to be used for *in vitro* screening of pigeonpea, seven-day-old seedlings of 60 pigeonpea genotypes were subjected to screening against *F. udum* through water culture method (Fig 6). The screening results revealed that among the 60 genotypes tested, two genotypes, ICP x 140203-B1 and the resistant check ICP 8863, were found to be resistant, with disease incidences of 8.33 per cent and 1.67 per cent, respectively, 37 were found to be moderately resistant with disease incidences ranging from 10 per cent to 30 per cent. 23 genotypes showed susceptible reactions with disease incidences exceeding 30 per cent. Based on the percentage of disease incidence in the genotypes, they were classified into resistant, moderately resistant and susceptible categories (Table 2, Fig. 7)

When Parmar and Kartira (2015) employed the same method for screening pigeonpea genotypes, they observed no wilt incidence in the genotype ICP 8863, while five genotypes exhibited moderate to high disease incidence. Mishra and Dhar (2005) utilized the water culture method to identify the virulent strain of the pathogen, employing three isolates to screen against the genotype BAHAR. The results indicated that among the three isolates, two demonstrated 60 per cent wilt incidence, while one isolate exhibited 40 per cent wilt incidence.

Table 2: Grouping of pigeonpea genotypes in to different categories based on their response to *F. udum* under *in vitro* water culture technique

Reaction	Wilt incidence	Genotypes	Total no. of genotypes
Resistant	0-10.00 %	ICP x 140203-B-1, ICP 8863	2
Moderately resistant	10.1-30.00 %	GRG-811, GRG 152, NAM 2217, TDRG 272, Phule tur, ICPL-87, NAM 2314, NAM 2284, NAM 314, NAM 2282, NAM 88, IC 74013, IC 73898, IC 73995, IC73975, IC 73952, WRG 93, WRGE 150, CRG 18004, BDN 2019-29, SKNP 2122, NTL 1127, NAAM 88, PA 6,SKNP 2107, KRG 33, ICP x 140213 B-3,ICP x 140217- B-1,EC 843239, NAM 2329,NAM 2292, NAM 2151,NAM 2085, WRGE x ICP 15028, IC 73959, IC 73969, IC 73961	37
Susceptible	>30.00 %	ICP 2376, TS-3R, CORG 9701, ICPx 140196 B-1, IC73885, IC 73058, IC 405218, PT 0012, ICAKTM 19424, MIRA, WRG 443, PA 714, BAUP 19-7, AL2362, NUPPC -6B, PAU 881,IPAE 22-1, PT-11-16, PA 6, WRGE 255, LRG 489,RKVP 1165, PT-12-19-2, ICPx 140188- B-3	23

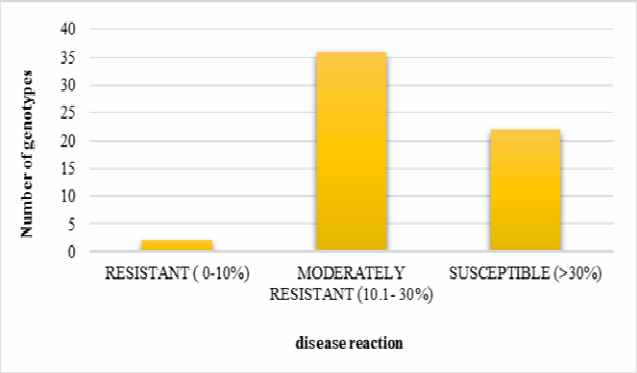


Fig. 7 : Frequency distribution of pigeonpea genotypes based on their response to *F. udum* under *in vitro* through water culture method

Comparison of *in vitro* and *in vivo* screening methods for validation: Of the 60 pigeonpea genotypes, including resistant and susceptible checks, four genotypes (ICP x 140203- B1, GRG 811, TDRG 272 and ICP 8863) were found to be resistant in field screening, but only two genotypes (ICP x 140203- B1 and ICP 8863) were found resistant in water culture method. The genotypes that showed moderately resistant reaction in the field showed the same reaction in water culture method also. Additionally, seven genotypes (IC 405218, PT- 0012, WRG 443, PA-6, WRG 225, LRG 489 and PT-12-19-2) that were moderately resistant in sick plots showed susceptibility reaction in water culture method. However, 23 genotypes that were susceptible in the field showed susceptible reaction in water culture method.

With these observations, it is evident that along with *in viv*o screening, which is basically done in sick plots for the identification of cultivars resistant to soil-borne diseases, *in vitro* screening can also be employed for early and quick assessment in short space. The water culture technique developed in this study performed extremely perfect with high precision. It can be employed as a preliminary assessment before the *in vivo* sick plot and cater to the needs of screening large number of pigeonpea genotypes against *Fusarium udum* in breeding programmes. There was little discrepancy between field resistance and *in vitro* resistance observed among the genotypes, which can be attributed to the fundamental differences in environmental conditions and pathogen interactions. The behavior of the pathogen in the field is influenced by environmental factors, such as temperature, humidity and soil composition, which may influence the aggressiveness or ability of the pathogen to infect the host. It is possible that a genotype may escape pathogen infection due to inherent variability in the pathogen population across different spots within the sick plot.

Conclusion

The water culture method developed and standardized in the present investigation has demonstrated it accuracy, reliability and repeatability in comparison with conventional field screening methods for *Fusarium* wilt resistance in pigeonpea. This method provide a rapid and efficient approach for screening large pigeonpea populations against the pathogen, significantly reducing the time required for the evaluation process while maintaining consistency. The results obtained from this method can be further validated through field trials, ensuring the confirmation of true resistance behavior among the selected genotypes. These validated resistant genotypes hold potential for integration into resistance breeding programs and subsequent commercial cultivation.

Table 3: Comparison of wilt incidence and disease reaction in pigeonpea genotypes screened against *F. udum* through different techniques

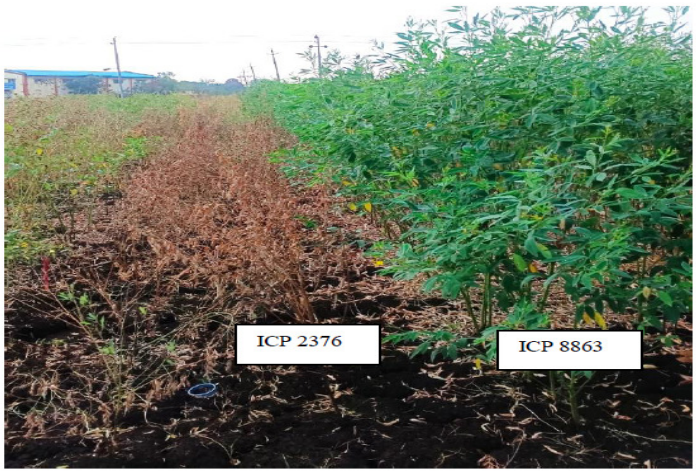
Sl No.	Genotypes	Screening methods			
		Field screening		Water culture	
		PDI (%)	Reaction	PDI (%)	Reaction
1	ICP x 140203- B1	7.47	R	8.33	R
2	GRG 811	9.75	R	18.34	MR
3	GRG 152	15.24	MR	21.67	MR
4	TS-3R	47.70	S	68.33	S
5	NAM 2217	19.69	MR	18.43	MR
6	TDRG 272	8.20	R	21.67	MR
7	CORG 9701	41.88	S	33.33	S
8	PHULE TUR	21.11	MR	16.65	MR
9	ICPL 87	25.86	MR	21.67	MR
10	ICP x 140196-B-1	36.11	S	36..67	S
11	NAM 2314	18.70	MR	23.33	MR
12	NAM 2284	21.93	MR	16.66	MR

Sl No.	Genotypes	Screening methods			
		Field screening		Water culture	
		PDI (%)	Reaction	PDI (%)	Reaction
13	NAM 314	22.37	MR	22.67	MR
14	NAM 2282	23.71	MR	26.67	MR
15	NAM-88	20.15	MR	31.67	MR
16	IC 73885	48.60	S	49.67	S
17	IC 73058	45.37	S	46.67	S
18	IC74013	20.76	MR	18.33	MR
19	IC 405218	34.68	MR	36.67	S
20	IC 73898	25.47	MR	28.33	MR
21	IC 73995	22.62	MR	25.00	MR
22	IC73975	18.45	MR	26.67	MR
23	IC 73952	24.17	MR	28.67	MR
24	WRG 93	18.26	MR	20.43	MR
25	PT -0012	34.62	MR	46.57	S
26	WRGE -150	18.99	MR	28.33	MR
27	CRG 18004	25.16	MR	21.67	MR
28	BDN -2019-29	17.41	MR	18.33	MR
29	ICAKTM 19424	48.55	S	48.53	S
30	MIRA	60.15	S	60.67	S
31	WGR 443	33.45	MR	46.54	S
32	SKNP 2122	25.98	MR	21.67	MR
33	PA 714	51.56	S	45.00	S
34	BAUPP 19 -11	43.42	S	56.67	S
35	NTL 1127	14.36	MR	28.23	MR
36	AL 2362	48.5	S	66.67	S
37	NUPPC -68	48.61	S	58.43	S
38	SKNP 2107	28.63	MR	25.22	MR
39	IPAE 22-1	49.72	S	56.65	S
40	PAU 881	69.3	S	52.33	S
41	NAAM 88	23.81	MR	21.44	MR
42	PT 11- 16	53.76	S	70.00	S
43	PA -6	34.76	MR	36.67	S
44	WRG 225	30.53	MR	58.55	S
45	LRG 489	20.05	MR	61.67	S
46	RKVP 1165	73.99	S	60	S
47	PT 12- 19 -2	16.78	MR	55.33	S
48	KRG 33	21.00	MR	28.45	MR
49	ICP x 140213- B-3	26.19	MR	28.64	MR
50	ICP x 140188-B-3	31.11	S	36.67	S
51	EC 843239	16.27	MR	23.33	MR
52	NAM 2329	27.20	MR	25.00	MR
53	ICP x 140217 B-1	14.58	MR	20.00	MR
54	NAM 2292	27.08	MR	31.60	MR
55	NAM 2151	23.05	MR	31.45	MR
56	NAM 2085	24.11	MR	28.98	MR
57	WRGE x ICP 15028	18.11	MR	20.00	MR
58	IC 73959	21.88	MR	18.43	MR
59	IC 73969	25.08	MR	28.33	MR
60	IC 73961	15.03	MR	23.33	MR
61	ICP 8863 (R.C)	9.09	R	1.67	R
62	ICP 2376 (S.C)	89.30	S	81.67	S

a. Discolouration of vascular bundles b. Partial wilting of pigeonpea plant c. Purple banding on the infected stem

Fig. 1 : Typical symptoms of *Fusarium* wilt caused by *F. udum*

Susceptible check- ICP 2376 Resistant check – ICP 8863



Field view of screening of pigeonpea genotypes in sickplot against *Fusarium* wilt

Fig. 2 : *In vivo* screening of pigeonpea genotypes in wilt sickplots against *Fusarium* wilt

Fig. 4 : Experimental set up for *in vitro* screening of pigeonpea seedlings against *Fusarium* wilt through water culture method

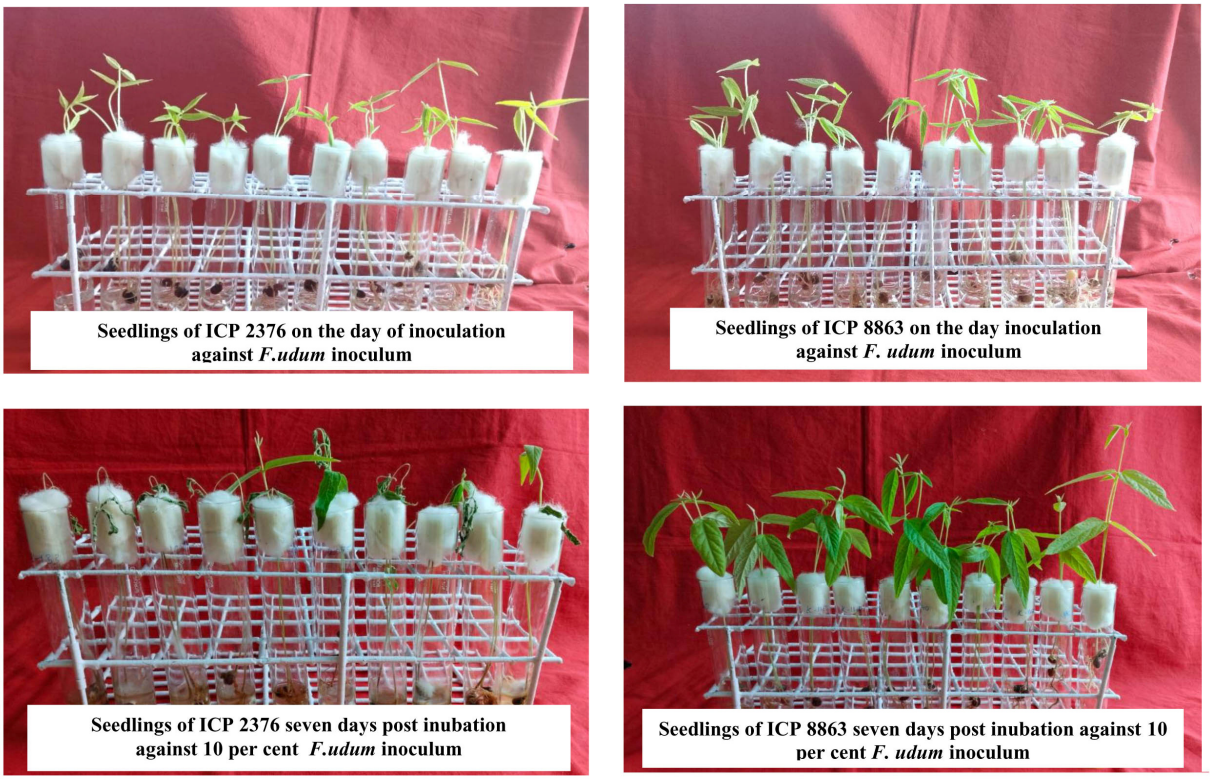


Fig. 5 : Comparison of seedling response in ICP 8863 and ICP 2376 on the day of inoculation and seven days post incubation with 10 per cent inoculum concentration of *F. udum.*

Fig. 6 : *In vitro* screening of pigeonpea genotypes against *Fusarium* wilt through water culture method

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References

Anonymous (2024). India stat, area, yield and production for the year 2024-25. https,//www. ndiastat.com.

Ashitha, S.G., Ramappa, H.K. and Gowri, R. (2016). Evaluation of pigeonpea genotypes against *Fusarium* wilt under artificial inoculation conditions. *Indian Phytopathol.*, ***69***(4), 381-385.

Bisht, C., Verma, S.K., Gaur, A.K., Chauhan, C., Deep, H., Karn, A. and Sharma, R.K. (2022). Characterization of Elite Genotypes for *Fusarium* Wilt Resistance in Pigeonpea [*Cajanus cajan* (L.) Millspaugh]. *Legum. Res.*, **45**(1), 116-121.

Butler, E.J. (1908). Selection of pigeonpea for wilt disease. *Agric. J. India,* **3**, 182-183.

Chaube, H.S. (1968). Combating diseases of arhar and gram. *Indian Farmers Digest,* 1, 26.

Hemavathy, T.A., Anantharaju, P., Kavitha, S. and Dhanushkodi (2023). Investigation of pigeonpea (*Cajanus cajan* (L.) Millspaugh) germplasms for drought tolerance dynamics. *J. Pharm. Innov.,* **12**(6), 1064-1067.

Kashyap, G.S., Lohithaswa, H.C., Banakara, S., Sowmya, M.S., Padmaja, A.S., Keshavareddy, G., Mallikarjuna, M.G. and Gangashetty, P.I. (2023). Identification of sources of resistance to *Fusarium* wilt and sterility mosaic diseases in pigeonpea [*Cajanus cajan* (L.) Millsp.]. *Indian J. Genet.,* **83**(2), 278-281.

Kshirsagar (2023). "Studies on genetic diversity of pigeonpea (*Cajanus cajan*) fermplasm in response to *Fusarium* wilt tolerance." PhD Thesis, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani.

Mishra, S. and Dhar, V. (2005). Efficient method of inoculation by *Fusarium udum*, the incitant of pigeonpea wilt. *Indian Phytopathol.*, **58**(3), 332-334.

Monga, S., Rana, R.K. and Pandit, A. (2022). Impact of government initiatives on total factor productivity of pigeon pea cultivation in India. *Indian J. Agric. Res,* ***56***(4) ,489-495.

Mwangombe, A.W., Kiprop, E.K., Baudoin, J.P., Kimani, P.M. and Mergeai, G. (2001). Histology of resistant and susceptible pigeonpea infected with *Fusarium udum*. *African Crop Sci. Conf. Proc.,* **5**, 123-128.

Nene, Y.L., Kannaiyan, J., Haware, M.P. and Reddy, M.V. (1979). Proc. Consultants group discussion

on the resistance of Soil-borne diseases of legumes, ICRISAT, **34**, 3-39.

Pandey, R.N., Pawar, S.E. and Bhatia, C.R. (1997). Interaction between *Fusarium udum* and wilt susceptible and resistant pigeonpea genotypes, Fungal growth and histopathology. *Indian Phytopathol.,* **50**(1), 53- 58.

Parmar, M.B. and Kathiria, K.B. (2015). Evaluation of pigeonpea genotypes for resistance to *Fusarium* wilt. *Plant Arch.*, **15**(2), 1013-1015.

Parmar, M.B. and Kathiria, K.B. (2015). Evaluation of pigeonpea genotypes for resistance to *Fusarium* wilt. *Plant Arch.*, **15**(2), 1013-1015.

Rajkule, P.N., Goyal, S.N. and Vala, D.G. (1989). Screening of pigeonpea varieties against *Fusarium* wilt. *Int. pigeonpea Newsl*., **9**, 24-25.

Reddy, B.D., Kumar, B., Reddy, M.S., Krishna, K.S., Karthik, S. and Kumar, R. (2023). Identification of elite pigeonpea genotypes against *Fusarium* wilt and sterility mosaic disease through AMMI and GGE biplot analysis. *Legum. Res. I. J.,* **46**(1),104-111

Reddy, B.D., Kumar, B., Sahni, S., Yashaswini, G., Karthik, S., Reddy, M.S., Kumar, R., Mukherjee, U. and Krishna, K.S. (2024). Harnessing the power of native biocontrol agents against wilt disease of Pigeonpea incited by *Fusarium udum*. *Scientific Reports*, ***14***(1), 12500.

Reddy, M.V., Raju, T.N, Sharma, S.B., Nene, Y.L., Mcdonald, D., Pande, S. and Sharma, M. (2012). Handbook of Pigeonpea Diseases (Revised). *Inf. Bull*. No. **42**. Patancheru, A. P. India, ICRISAT. 32(9),64.

Reddy, M.V., Raju, T.N. And Nene, Y.L. (1996). Low wilt incidence in short duration pigeonpeas. *Inter. pigeonpea Newsl.,* **7**, 26-27.

Rohidas, M.Z.R. (2024). Studies on management of wilt disease of pigeonpea with bioagent and new molecule (Doctoral dissertation, mahatma phule krishi vidyapeeth).

Upadhyay, R.S. and Rai, B. (1989). Wilt disease of pigeonpea and its causal organism *Fusarium udum*. In, Perspective of Phytopathology (Eds. Agnihotri, V. P., Singh, U. Wollenweber, H. W., 1913, Studies on *Fusarium* problem. *Phytopathology*, **3**, 24.