Proceedings of the Asian Pigeonpea Pathologists Group Meeting and Monitoring Tour

International Crops Research Institute for the Semi-Arid Tropics
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Abstract

A joint Indian Institute of Pulses Research (IIPR)-International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) meeting of pigeonpea pathologists from Asia was organized at ICRISAT Asia Center, 20-25 Nov 1995, to discuss the results of collaborative trials conducted during the past 5 years, and to develop future program of work to study pathogenic variability in wilt, sterility mosaic, and phytophthora blight pathogens. Eleven pathologists from India, Myanmar, Nepal, and Scotland participated in the meeting.

Past results from Asia were reviewed. Future work plans to study variability in the three pathogens in relation to inoculation techniques, differential lines, locations, and observations to be recorded were finalized.

Proceedings

of the

Asian Pigeonpea Pathologists Group Meeting and Monitoring Tour

20-25 Nov 1995

ICRISAT Asia Center

Edited by

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ICAR

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Preface

Pigeonpea, an important component of cropping systems in rainfed agriculture, suffers from some serious disease problems. The major ones are fusarium wilt, sterility mosaic, and phytophthora blight in South and Southeast Asia, fusarium wilt in southern and eastern Africa, and witches' broom in the Caribbean and Central America. As the crop is mostly cultivated by smallholder resource-poor farmers with marginal inputs, ICRISAT's strategy to manage these diseases has been through the development and use of stable, multiple disease resistant cultivars. To achieve this objective, ICRISAT has been organizing multilocational disease nurseries in collaboration with NARS in Asia and Africa for the past 20 years. In view of the ICRISAT Medium Term Plan Research Agenda (1995-98), it was felt necessary to organize a meeting of collaborating pigeonpea pathologists to discuss past results and develop future work plans. A joint Indian Institute of Pulses Research-ICRISAT Asian Pigeonpea Pathologists meeting was organized at ICRISAT Asia Center from 20 to 25 November 1995. It is expected that through this process, a well-focused plan of work will emerge with specific responsibilities for ICRISAT and NARS, to determine pathogenic variability in major pathogens and to identify stable resistance sources to them.

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Background

The Indian Council of Agricultural Research (ICAR) and ICRISAT have been organizing multilocational disease nurseries since 1977 to identify pigeonpea lines resistant to wilt, sterility mosaic (SM), phytophthora blight (PB), and multiple diseases. Some of these nurseries have also been tested in Kenya, Malawi, Myanmar, and Nepal. In this system, lines identified as resistant at individual locations are put together and tested in disease screening nurseries at different locations. Four nurseries, one each for wilt, SM, PB, and multiple diseases were organized. The screening methodology and rating scales to be followed, and the entries and locations to be tested were discussed and finalized at the Kharif Pulses Workshops of the All India Coordinated Pulses Improvement Project (AICPIP). The results were also presented and discussed in these meetings. As a result of these cooperative trials, a few lines resistant to individual and multiple diseases were identified. Some examples are ICP 8863 and ICP 9174 for wilt; ICP 7035, ICP 10976 for SM; and KPBR 80-2-1 for PB. ICP 9174 was also found resistant to SM. KPBR 80-2-1 showed promise against wilt and SM. A few resistant cultivars were also released, e.g., ICP 8863 as Maruti in India, and ICP 9145 as Nandola Wa Sawasawa in Malawi. These trials also pointed to the possibility of the existence of strains in these pathogens. Since 1990, specific multilocational trials involving a set of differential lines to determine the variability in SM and wilt pathogens were organized. In view of the achievements of this collaborative work, it was felt desirable to organize a meeting to facilitate a review of the past work and to develop future work plans.

Objectives

The objectives of the meeting were:

- To discuss the results of the ICAR-ICRISAT collaborative multilocational disease nurseries on identification of resistance to wilt, SM, and PB diseases during the past 5 years (1990-95).
- To discuss the results of cooperative trials on the variability in pigeonpea wilt, SM, and PB pathogens conducted during 1990-95.
- To determine inoculation methodology, rating scales, and to finalize differentials and locations for future experiments.
- To monitor disease resistance and pathogenic variability trials at ICRISAT Asia Center (IAC), Patancheru, Andhra Pradesh; University of Agricultural Sciences (UAS), Gulbarga, Karnataka; Mahatma Phule Krishi Vidya Peeth (MPKV), Rahuri, Maharashtra; and Marathwada Agricultural University (MAU), Badnapur, Maharashtra.

Review of Past Work (1990-95)

India (ICAR-ICRISAT Collaboration)

In recent years, there have been significant shifts in pigeonpea cultivation in India. The area under pigeonpea in the states of Bihar, Haryana, Madhya Pradesh, Punjab, and Uttar Pradesh has declined. The area in Andhra Pradesh, Gujarat, Karnataka, Orissa, and Maharashtra has increased. The present area under pigeonpea in Maharashtra is 1 000 000 ha and in Karnataka it is 415 000 ha. The area under short-duration pigeonpea, particularly in the states of Haryana, Maharashtra, Punjab, and western Uttar Pradesh is increasing. There has also been some change in the disease scenario. Sterility mosaic, which was traditionally confined to the northeastern and southern states of India, has also spread to central parts of the country. With the introduction of short-duration pigeonpeas (SDPS), phytophthora blight, which was not a serious problem in the traditional medium-duration and late-duration types, has assumed importance. In recent years, quite a few lines with resistance to wilt and SM have been developed. But only a few cultivars such as ICP 8863 (Maruti) have become popular with the farmers. Adoption of SM-resistant or wilt- and SM-resistant cultivars (e.g., ICPL 87119) is yet to happen.

Fusarium wilt

- A few lines such as ICP 8859, ICP 8861, ICP 8863, ICPL 87119, and GPS 3 with stable resistance to wilt across the locations were identified (Tables 1,2,3). These lines showed resistance or moderate resistance at nine locations over 3-5 years. These are recommended as donor parents for wilt resistance breeding programs.
- Disease incidence in the lines generally increased over the seasons in certain locations, such as Rahuri. The reasons for this are not very clear. Increase in inoculum density could be one of the reasons.

- Variation in the reaction of the lines across the locations was observed (Table 4). The reactions of the lines at Badnapur, Gulbarga, Rahuri, and Patancheru were somewhat similar. The reactions at Kanpur, Dholi, and Varanasi were different from one another and from the previous locations, indicating the possible existence of four strains in the wilt pathogen *Fusarium udum.*
- Cultivars such as BDN 1, BDN 2, and C 11, which showed resistance in peninsular India earlier, seemed to have lost their resistance (Table 4). Increase in inoculum density in farmers' fields due to the shift from the sorghum/pigeonpea intercropping system to sole pigeonpea is considered to be one of the reasons for such a loss of resistance. Change in the virulence of the pathogen F. *udum* could be the other reason.

Sterility mosaic

- A few lines such as ICP 7035, ICP 8862, ICP 10976, ICPL 86065, and ICPL 87101 with stable resistance across the locations were identified (Tables 5 and 6). These were resistant or moderately resistant in as many as eight locations for 2-3 seasons.
- Variation in the reaction of lines over the seasons at the same location was observed. The reasons for such variation are not well understood.
- Variation in the reaction of lines across the locations was observed (Table 7). The isolates from India can be tentatively categorized into six groups. The Patancheru isolate represents Group A, Varanasi and Kumargunj isolates represent Group B, Pudukottai isolate represents Group C, Dholi and Kanpur isolates represent Group D, Badnapur isolate represents Group E and Pantnagar isolate represents Group F.
- Ring spot symptoms were observed at some locations such as Patancheru and not at Dholi, Pantnagar, and Varanasi (Table 8), indicating a variation in the strains at these locations. Based on symptom expression of a set of pigeonpea lines, the isolates from different locations in India seem to fall under five groups.
- There is a need to refine the disease scoring system for identification of variants of SM.

Phytophthora blight

- No pigeonpea line was found resistant across the locations in India. KPBR 80-2-1 was resistant/tolerant at most of the locations (Table 9). It is also tolerant to wilt and sterility mosaic.
- The northern Indian isolates were found to be more aggressive than the southern Indian isolates (Table 9).
- ICP 8610 and KPBR 80-2-1 showed differential reaction to blight (Table 9).
- Leaf blight symptoms are more commonly observed now than before.

Nepal

Pigeonpea is the second most important legume crop in Nepal. It accounts for 12% in area and 11% in production of grain legumes. Data show that 39% of area and production comes from the central development region, and 30% from mid- and far-western development regions, which contributed a higher share in area and production a few years ago. The popularity of pigeonpea has increased over the years and the area and production has doubled in 1992/93 compared with that in 1991/92 (Table 10). Ninety-nine percent of the pigeonpea area is concentrated in the terai region. Increased area and production of pigeonpea is a clear trend (Table 11).

Pigeonpea is infected by several diseases in different parts of the country. The productivity of pigeonpea in 1992/93 was 708 kg ha^{-1}, whereas the potential production of improved varieties is more than 2 t ha^{-1}, as observed in the experimental plot. There are many reasons for the low yield. Diseases are one of the major constraints to higher pigeonpea production in Nepal. A list of pigeonpea diseases in Nepal is given in Table 12.

Sterility mosaic

Sterility mosaic is a major disease of pigeonpea in Nepal. In epidemic years, yield loss up to 100% was found in eastern, western, and mid-western parts of the country. Primary emphasis is therefore given to select and develop resistant varieties.

Pathological work consists mainly of varietal screening against major diseases to identify sources of resistance as well as to assist breeders in the selection of disease-resistant/tolerant genotypes. Sterility mosaic disease nurseries were initiated in 1987/88. Since then, 172 genotypes in 1987/88, 62 in 1988/89, 70 in 1989/90, 41 and 21 in national and ICAR/1CRISAT nursery in 1990/91 at Rampur and Nepalgunj, 84 in 1991/92 and 41 in 1993/94 were screened for resistance to SM (Table 13).

In 1987/88, out of the 172 genotypes screened, 10 were found to be resistant (1-3 score on 1-9 scale): ICP 7035, ICPL 87, ICPL 366, ICPL 86012, PR 5114, PR 5151, PR 5146-1, PR 5147, Bahar, and Rampur local.

In 1988/89, out of the 62 genotypes screened, 27 were found to be resistant (1-3 score). Among them were some genotypes which were resistant in 1987/88. The resistant genotypes in the 1987/88 and 1988/89 screenings are: ICP 7035, ICPL 87, ICPL 366, ICPL 86012, PR 5114, PR 5151, Bahar, and Rampur local In 1989/90, out of the 70 genotypes tested, ICP 7035 and ICPL 8324 were found to be immune, and 21 were resistant with less than 10% SM.

In 1990/91, in the national nursery comprising 41 medium- and short-duration pigeonpeas, the genotypes ICPL 146, ICPL 87101, ICPL 86012, ICPL 87113, RS 1, RS 3, RS 4, and Rampur local showed less than 20% SM. From the ICAR/ICRISAT collaborative SM disease nursery, six lines: ICPL 366, ICP 7035, ICP 7867, ICP 8094, ICP 8862, and ICPL 83072 showed less than 10% SM at Rampur and Nepalgunj. Similarly in 1991/92, out of the 84 pigeonpea genotypes screened, 15 showed less than 10% SM.

In 1993/94, out of 41 screened, eight genotypes: ICPL 4, ICPL 146, ICPL 84032, ICPL 85010, ICPL 87101, ICPL 87105, RR 1, and RS 3 showed less than 10% SM. These lines showed only mild mosaic symptom at Rampur.

Wilt

The other important disease of pigeonpea in Nepal is wilt (F. *udum).* This disease is prevalent in all the pigeonpea-growing areas of Nepal and is severe in some fields (up to 90% wilt). Pigeonpea wilt was high in Banke district, and in a few sites of the Sarlahi district in 1993/94. The improved as well as local varieties were susceptible to wilt. A wilt-sick plot was developed at Nawalpur in the Sarlahi district to facilitate screening of genotypes.

Macrophomina stem canker

Macrophomina stem canker appears to be severe in some years. The promising genotype, ICPL 366, recorded maximum stem canker (over 50%). In other promising genotypes, PR 5147 and PR 5164, more than 20% plants were infected by stem canker at Nawalpur in 1990/91. The incidence of stem canker was low in 1993/94. Variability among different varieties existed. One line, RGO 311, was scored 3 (1-9 scale). Three lines, ICP 7035, PR 5106, and PR 5122 were scored 4 (moderately resistant), while many exotic lines showed high susceptibility.

The other diseases, which are listed in Table 12, affected the crop in certain years without causing any economic damage.

Myanmar

Agriculture plays a major role in the economy of the Union of Myanmar. At present, Myanmar has a population of about 42 million. To support the ever-increasing demands of the population, planned agriculture was inevitably introduced. Since Myanmar has a planned economy, coordinated national, divisional, township and village-tract, agricultural plans are made by Myanmar Agriculture Service (MAS) on behalf of the government.

The main crop grown in Myanmar is rice, which occupies 6.4 million ha each year. It has been possible to increase rice exports while diversifying production. Next to rice, pulses are the main crops for local consumption and for export. Presently in Myanmar, chickpea, mungbean, urdbean, blackgram, cowpea, soybean, and pigeonpea are grown for export revenue. The development and release of crop cultivars with higher-yielding potential, resistant to biotic and abiotic stresses, coupled with efficient management practices, could help ensure sustainable crop production in the future. It is important to control pests and diseases for advances in crop production and quality, and to stabilize agricultural production.

Pigeonpea in Myanmar

Pulses are grown in the entire country. During 1994/95, these were sown on 1 720 000 ha, with a total production for the year amounting to 1 169 000 t, giving a national average yield of 0.68 t ha^{-1}. In 1995, MAS plans to grow 2 200 000 ha of pulses, and the expected production is 1 545 000 t (Table 14).

Out of the total area of pulses during 1995, pigeonpea is grown on 320000 ha to produce 219 000 t (Table 15). Pigeonpea is grown in seven states and divisions: Kachin State, Shan State, Sagaing Division, Mandalay Division, Magwe Division, Ayeyarwady Division, and Bago Division (Fig. 1, Table 16). The major pigeonpea varieties in Myanmar are Yezin 1 (HPA-1), Shwedingar, five-seeded varieties (local varieties), ICPL 87, and ICPL 151.

Pigeonpea disease situation

Diseases are apparently not serious in Myanmar. A few diseases such as fusarium wilt, dry root rot, anthracnose, leaf spot, and SM were found every year. Screening for resistance to SM was conducted in Mahlaing Farm, Mandalay Division in 1990. Fourteen test lines were used for screening. While sowing test lines, rows of a susceptible cultivar (ICP 8863) were sown after every two rows of test cultivars to serve as indicator rows for disease spread. ICPL 84031 and ICP 8094 were found to be highly resistant; ICP 8798 and ICPL 86005 were resistant. Two lines, ICP 8862 and ICP 7234, showed less than 15% SM (Table 17). Field observations showed that Shwedingar was susceptible to SM at the Central Agricultural Research Institute (CARI), Yezin, in 1993. Yield losses occurred up to 100%.

Collaboration with ICRISAT

Collaboration between MAS and ICRISAT was initiated in 1986. Under the agreement, ICRISAT supplies crop seed and MAS agrees to test for yield, pests, and diseases. There is a prospect of expanding this collaboration in future.

Tables

Table 1. Pigeonpea germplasm lines/cultivars with stable resistance to fusarium wilt (3-5 years), identified through the ICAR-ICRISAT Uniform Trial for Pigeonpea Wilt Resistance (IIUTPWR), 1990/91 to 1994/95.

	Reaction at different locations[1]								
Line/cultivar	1	2	3	4	5	6	7	8	9
ICP 8859	MR2	R	R	R	R	MR	R	MR	R
ICP 8861	MR	MR	MR	MR	MR	MR	MR	MR	MR
ICP 8863	R	R	R	R	R	R	R	R	R
ICPL87119	R	R	R	R	MR	R	R	MR	MR
GPS 3	R	R	R	R	MR	R	R	MR	MR
GPS 26-6	R	R	R	R	R	R	R	MR	MR
GPS 30	R	R	R	R	R	R	R	R	R
GPS 33	R	R	MR	R	MR	R	R	MR	MR
GPS 36	R	R	MR	R	R	R	R	R	R
GPS 52	R	R	MR	R	R	R	R	R	R
GODU	MR	R	MR	MR	R	R	R	MR	R
Sehore 21	MR	R	MR	R	MR	MR	R	MR	R
Sujata 1-2	MR	R	R	MR	R	MR	R	MR	R

1. 1 = Badnapur, 2 = Gulbarga, 3 = Rahuri, 4 = Patancheru, 5 = Kanpur, 6 = Dholi, 7 = Pudukottai, 8 = Ranchi, 9 = Sehore.
2. R = 0-10% wilt, MR = 11-30% wilt.

Table 2. Pigeonpea lines/cultivars with broadbased resistance to fusarium wilt (1-2 years), identified through the ICAR-ICRISAT Uniform Trial for Pigeonpea Wilt Resistance (IIUTPWR), 1990/91 to 1994/95.

	Reaction at different locations[1]								
Line/cultivar	1	2	3	4	5	6	7	8	9
ICPL 89048[2]	R3	R	MR	MR	R	MR	MR	R	R
ICPL 89049[2]	R	R	MR	R	MR	MR	MR	R	R
BSMR 214	R	R	R	MR	MR	MR	R	R	R
BWR 190	MR	R	R	R	NT	R	NT	MR	R
BWR 254	R	R	R	R	NT	R	NT	MR	R
BWR 370	R	R	R	MR	NT	R	NT	R	R
BWR 369	MR	R	R	MR	NT	R	NT	R	MR

1. 1 = Badnapur, 2 = Gulbarga, 3 = Rahuri, 4 = Patancheru, 5 = Kanpur, 6 = Dholi, 7 = Pudukottai, 8 = Ranchi, 9 = Sehore.
2. Data for 3 years
3. R = 0-10% wilt, MR - 11-30% wilt, NT = Not tested.

Table 3. Pigeonpea lines/cultivars with broadbased resistance to fusarium wilt, identified in the Indian National Program, 1990/91 to 1994/95.

Line/cultivar	Duration of lines	Reaction at different locations[1]							
		1	2	3	4	5	6	7	8
GAUP 9001	Medium early	MR[2]	MR	MR	R	MR	R	NT	NT
Kanpur L.	Medium late	MR	NT	R	R	R	R	R	NT
ICPL 89044	Medium late	R	MR	MR	MR	MR	R	R	NT
ICPL 87057	Medium late	R	MR	MR	MR	MR	R	R	NT
SPMA 8	Medium late	MR	MR	MR	R	MR	MR	MR	MR
DPPA 84 8-3	Medium late	MR	MR	MR	R	MR	R	R	NT
DPPA 85-2	Medium late	R	R	MR	R	MR	R	MR	MR
DPPA 85-10	Medium late	MR	MR	R	R	MR	R	MR	MR
DPPA 85-13	Medium late	MR	R	R	R	R	R	MR	MR
DPPA 85-14	Medium late	R	R	MR	R	R	R	MR	MR
DPPA 85-15	Medium late	R	MR	MR	R	MR	R	R	MR
DPPA 85-16	Medium late	MR	MR	R	R	MR	R	MR	MR
DPA 92-1	Late	MR	MR	MR	MR	MR	MR	MR	NT

1. 1 = Badnapur, 2 = Gulbarga, 3 = Rahuri, 4 = Patancheru, 5 = Dholi, 6 = Kanpur, 7 = Sehore, 8 = Bangalore.
2. R = 0-10% wilt, MR = 11-30% wilt, NT = Not tested.

Table 4. Reaction of pigeonpea differential lines to fusarium wilt at different locations in India, 1993/95.

Differential line	Wilt incidence at different locations (%)																	
	Badnapur (3)[1]		Gulbarga (4)		Rahuri (3)		Patancheru (2)		Kanpur (4)		Dholi (4)		Varanasi (1)		Pudukottai (4)		Sehore (2)	
ICP 8858	10	R[2]	7	R	30	MR	7	R	69	HS	19	MR	17	MR	4	R	12	MR
ICP 8859	11	R	10	R	30	MR	10	R	2	R	15	MR	4	R	5	R	11	MR
ICP 8862	31	MR	11	MR	33	MR	22	MR	46	S	38	S	26	MR	12	MR	18	MR
ICP 8863	3	R	2	R	12	MR	10	R	10	R	7	R	10	R	1	R	18	MR
ICP 9145	28	MR	6	R	18	MR	27	MR	26	MR	19	MR	35	S	15	MR	17	MR
ICP 9174	4	R	9	R	12	MR	5	R	5	R	14	R	1	R	3	R	19	MR
C 11	52	S	41	S	84	HS	66	HS	50	S	22	MR	74	HS	2	R	6	R
BDN 1	85	HS	57	S	99	HS	72	HS	20	MR	43	S	84	HS	19	MR	29	MR
BDN 2	68	HS	49	S	95	HS	81	HS	31	MR	23	MR	7	R	21	MR	10	R
LRG 30 (S)	88	HS	97	HS	79	HS	92	HS	83	HS	87	HS	100	HS	10	R	19	MR
ICP 2376 (S)	99	HS	100	HS	100	HS	93	HS	83	HS	73	HS	100	HS	63	HS	71	HS
Pathotype	1		1		1		1		2		3		4		Low disease incidence		Low disease incidence	

1. Figures in parentheses are years tested.
2. R = 0–10% wilt, MR = 11–30%; S = 31–60%; HS =61–100%.

Table 5. Pigeonpea accessions/lines with broadbased and stable resistance to sterility mosaic (2-3 years), identified through ICAR-ICRISAT Uniform Trial for Pigeonpea Sterility Mosaic Resistance (IIUTPSMR), 1990/91 to 1994/95.

	Reaction at different locations[1]							
Accession/line	1	2	3	4	5	6	7	8
ICP 6997	R2	R	R	S	MR	R	MR	R
ICP 7035	R	R	R	S/MR	MR/R	R	R	R
ICP 7234	R	R	R	MR	MR	R	S	MR
ICP 8094	R	R	R	R	MR	MR	S	R
ICP 8862	R	R	MR	R	R	R	R	R
ICP 10976	S/R	R	R	MR	MR	R	R	R
ICPL 86065	R	R	R	R	MR	R	R	R
ICPL 87101	R	R	R	R	MR	R	R	R
ICPL 87108	MR	R	S	MR	S	R	MR	R
ICPL 88025	R	MR	MR	R	S	-	MR	R
ICPL 91018	R	R	R	MR	S	S	MR	R

1.1 = Badnapur, 2 = Rahuri, 3 = ICRISAT, 4 = Kanpur, 5 = Dholi, 6 = Varanasi, 7 = Kumarganj, 8 = Pudukottai.

2. R = Resistant (0-10% incidence), MR = Moderately resistant (11-30%), S = Susceptible (31-60%), HS = Highly susceptible (61-100%).

Table 6. Pigeonpea lines with broadbased resistance to sterility mosaic identified in the Indian National Program, 1990/91 to 1994/95.

Line	Duration of lines	Reaction at different locations[1]							
		1	2	3	4	5	6	7	8
Pusa B 14	Medium early	R[2]	R	R	S	MR	R	R	MR
Pusa B 17	Medium early	R	R	MR	MR	MR	R	R	R
DPPA 85-2	Late	R	R	S	R	S	R	R	R
DPPA 85-7	Late	R	R	MR	MR	S	R	R	MR
DPPA 85-8	Late	R	R	R	S	R	R	R	R
DPPA 85-11	Late	R	MR	MR	MR	R	R	R	R
DPPA 85-12	Late	MR	MR	MR	S	MR	S	R	R
DPPA 85-13	Late	MR	MR	R	S	R	MR	R	MR
NDA 91-2	Late	R	R	R	S	NT	MR	R	R
NDA 93-2	Late	R	R	R	S	NT	MR	S	R
Pusa B 19	Late	R	R	R	S	R	R	R	R
Pusa B 21	Late	R	R	R	S	R	R	R	R
Pusa B 26	Late	R	R	R	R	S	R	R	R
KA 32-1	Late	R	R	R	MR	R	R	R	R
KA 32-2	Late	R	R	R	S	S	R	MR	MR
DA 11	Late	R	R	R	R	R	R	R	R
Bahar	Late	MR	R	R	S	R	R	R	R

1. 1 = Badnapur, 2 = Rahuri, 3 = Kanpur, 4 = Dholi, 5 = Pantnagar, 6 = Varanasi, 7 = Patancheru, 8 = Pudukottai.
2. R = 0-10% wilt, MR = 11-30% wilt, S = Susceptible (31-60%), HS = Highly susceptible (61-100%), NT = Not tested.

Table 7. Reaction of pigeonpea differential lines to sterility mosaic (SM) at different locations in India, 1990/91 to 1994/95.

Differential line	SM incidence at different locations (%)															
	Patancheru (2)[1]		Varanasi (3)		Kumarganj (2)		Pudukottai (2)		Dholi (5)		Kanpur (5)		Badnapur (2)		Pantnagar (1)	
ICP 2376	0	R[2]	35	S	34	S	75	HS	86	HS	65	HS	57	S	100	HS
ICP 7035	0	R	0	R	4	R	0	R	25	MR	39	S	4	R	75	HS
ICP 8862	2	R	3	R	5	R	6	R	9	R	22	MR	17	MR	34	S
ICP 10976	10	R	8	R	4	R	4	R	28	MR	15	MR	54	S	78	HS
ICP 11164	6	R	14	MR	19	MR	41	S	67	HS	47	S	14	MR		NT
ICP 7197	0	R	10	R	5	R	1	R	54	S	7	R	43	S	56	S
ICP 10960	43	S	7	R	9	R	1	R	28	MR	25	MR	13	MR		NT
ICP 8863	100	HS	88	HS	91	HS	85	HS	89	HS	75	HS	62	R	100	HS
BDN 1	100	HS	71	HS	100	HS	83	HS	91	HS	83	HS	100	HS	100	HS
Tentative grouping	A		B		B		C		D		D		E		F	

1. Figures in parentheses are years tested.
2. R = Resistant (0–10%), MR = Moderately resistant (11–30%); S = Susceptible (31–60%); HS = Highly susceptible (61–100%).

Table 8. Reaction (type of symptom) of pigeonpea differential lines to sterility mosaic (SM) at different locations in India, 1990/91 to 1994/95.

Differential line	Badnapur (2)[1]	Patancheru (2)	Kumarganj (2)	Pudukottai (2)	Dholi (5)	Kanpur (5)	Pantnagar (1)	Varanasi (3)	Gwalior (Ref)
ICP 2376	SM,MM,RS[2]	R(RS)	SM	SM,MM	SM,MM	SM,MM	SM,MM,	MM	R
ICP 7035	SM,MM,R	R	MM(R)	R	SM,MM(R)	SM,MM,R	MM	R	R
ICP 8862	SM,MM,RS,R	SM,R	MM(R)	SM,MM,R	SM,MM,R	SM,MM,R	MM	R,MM	R
ICP 10976	SM,MM(RS)[3]	SM,MM(RS)	MM(R)	R	SM,MM(R)	SM,MM	MM	MM	R
ICP 11164	SM,MM(R)	SM,MM(R)	SM(RS)	SM,MM,RS(R)	SM,MM	SM,MM	NR	MM	R
ICP 7197	SM,MM(RS)	R	MM	R,RS(SM)	SM,MM(R)	MM,R(RS)	NR	R,MM	R
ICP 10960	SM,MM(R)	SM,MM(R)	SM,MM	MM,R(SM)	SM,MM	SM,MM,R	NR	R,MM	R
BDN 1	SM	SM	SM	SM,MM	SM	SM	SM	SM	-
ICP 8863	SM,MM	SM	SM	SM,MM,RS	SM,MM	SM,MM	SM	SM	S
C 11	SM,MM	SM	SM	SM,MM	SM,MM	SM,MM	SM	SM,MM	-
LRG 30	NT	SM	SM	SM,MM	SM,MM	SM	SM	SM,MM	-
Tentative grouping	Vr.2	Vr.2	Vr.3	Vr.3	Vr.4	Vr.5	?[4]	?	?Vr.1

1. Figures in parentheses are years tested.
2. SM = Severe mosaic, MM = Mild mosaic, RS = Ring spot, R = No apparent symptoms, NT = Not tested.
3. Letters in parentheses indicate the reaction of the lines in earlier study by Reddy et al. 1993 (Indian Phytopathology 46(3):206-212).
4. ? = Not grouped.

Table 9. Percentage of phytophthora blight incidence in pigeonpea lines at different locations in India, 1990-94.

Line	Baroda	Patan-cheru	New Delhi	Kanpur	Pant-nagar	Sehore	Varanasi
ICP 8564	38	18	28	29	73	30	25
ICP 8610	19	21	100	48	51	16	25
ICP 8692	8	29	90	31	68	10	35
ICP 8921	19	48	78	71	95	0	35
ICP 9046	6	47	70	46	40	7	55
ICP 9252	33	18	68	43	60	11	95
ICP 12749	13	40	55	26	73	20	100
ICPL 84023	63	66	63	78	100	24	80
KPBR 80-2-1	12	20	0	56	22	18	20
ICPX 800284	-[1]	30	55	49	90	21	55
ICPX 860095	-	15	23	26	50	4	25
ICPX 860114	-	29	63	51	52	19	100
ICPX 860115	-	25	23	73	71	15	55
ICP 2376	65	96	65	50	69	33	67
ICP 7119	100	100	100	69	100	98	100

1 - = Not tested.

Table 10. Area ('000 ha) and production ('000 t) of pigeonpea in Nepal, 1992/93.

	Pigeonpea	
Development region	Area	Production
Eastern region	16.1	11.2
Central region	5.5	3.8
Western region	7.0	5.1
Midwestern region	8.6	6.3
Far-western region	3.6	2.5
Total	40.8	28.9

Table 11. Area, production, and productivity of pigeonpea in Nepal, 1988/89 to 1992/93.

Crop	1988/89	1989/90	1990/91	1991/92	1992/93	Change per annum
Area (ha)	17900	18800	17930	17520	40800	1863.83
Production (t)	12200	13200	12030	11310	28900	3
Productivity (kg ha^{-1})	681	705	671	646	708	-6.18

Table 12. List of pigeonpea diseases in Nepal.

Disease	Causal organism	Economic importance
Sterility mosaic	Unknown etiology. Transmitted by Eriyophyid mite *Aceria cajani.*	Major
Wilt	*Fusarium udum* Butler	Major
Macrophomina stem canker	*Macrophomina phaseolina* [(Tassi) Goid]	Major
Phytophthora blight	*Phytophthora drechsleri* f.sp. *cajani* (Pal et al.) (Kannaiyan et al.)	Minor
Powdery mildew	*Leveillula tauric* Lev.	Minor
Phyllosticta leaf spot	*Phyllosticta cajani* Syd.	Minor
Root rot	*Fusarium* sp.	Minor
Yellow mosaic	Mungbean yellow mosaic virus	Minor

Table 13. Summary of sterility mosaic screening nursery from 1987 to 1993/94 in Nepal.

Year	Genotypes screened (no.)	Resistant lines
1987/88	172	ICP 7035, ICPL 87, ICPL 366, ICPL 86012, PR 5114, PR 5151, PR 5146-1, PR 5147, Bahar, and Rampur Local.
1988/89	62	ICP 7035, ICPL 87, ICPL 366, ICPL 86012, PR 5114, PR 5151, Bahar, and Rampur Local
1989/90	70	ICPL 7035 and ICPL 8324
1990/91	41	ICP 146, ICPL 87101, ICPL 86012, ICPL 87113, RS 1, RS 3, RS 4, and Rampur Local
	21 (ICAR/ ICRISAT nursery)	ICPL 366, ICP 7035, ICP 7867, ICP 8094, ICP 8862, and ICPL 83072
1991/92	84	15 genotypes
1993/94	41	ICPL 4, ICP 146, ICPL 84032, ICPL 85010, ICPL 87101, ICPL 87105, RR 1, and RS 3

Table 14. Area (ha) and production (t) of pulses in Myanmar, crop year 1994/95 to 1995/96.

	1994/95		1995/96	
Crop	Area	Production	Area	Production
Blackgram	386 000	315 000	440 000	359 000
Greengram	360 000	218 000	400 000	254 000
Soybean	65 000	52 000	111 000	100 000
Chickpea	172 000	118 000	220 000	146 000
Cowpea	45 000	22 000	80 000	74 000
Pigeonpea	257 000	162 000	320 000	219 000
Other legumes	434 000	282 000	628 000	393 000
Total	1 720 000	1 169 000	2200 000	1 545 000

Table 15. Area, yield, and production of pigeonpea in Myanmar, crop year 1991/92 to 1995/96.

Year	Area (ha)	Yield (t ha^{-1})	Production (t)
1991/92	112000	0.55	63000
1992/93	212000	0.65	139000
1993/94	228000	0.63	143000
1994/95	257000	0.63	162000
1995/96	320000	0.68	219000

Source: Myanmar Agriculture Service, Planning and Statistics Division.

Table 16. Expected sown area of pigeonpea in Nepal, 1995/96.

Place	Sown area (ha)
State	
Kachin	1600
Kayah	4000
Chin	7600
Rakhine	4800
Shan	10000
Division	
Sagaing	16000
Bago	1200
Magwe	80000
Mandalay	102800
Ayeyarwady	12000
Total	320000

Table 17. Screening for resistance to sterility mosaic of pigeonpea in Myanmar, Mahlaing Farm, Mandalay Division, 1990.

	Infected plants (%)		
Variety	R I	R II	Mean
ICP 8863	30	10	20
ICP 2376	30	0	15
ICP 87119	11	20	15
ICP 8863	60	10	35
ICP 7035	100	10	55
ICP 7867	90	60	75
ICP 8863	30	40	35
ICP 10976	60	40	50
ICP 8798	10	0	5
ICP 8863	40	20	30
ICP 8862	11	10	11
ICPL 86005	10	0	5
ICP 8863	30	20	25
ICPL 84031	0	0	0
ICPL 336	90	0	45
ICP 8863	10	30	20
ICP 7234	20	0	10
ICPL 83072	0	80	40
ICP 8863	10	40	25
ICP 8094	0	0	0
ICP 6997	20	20	20
ICP 8863	20	20	20

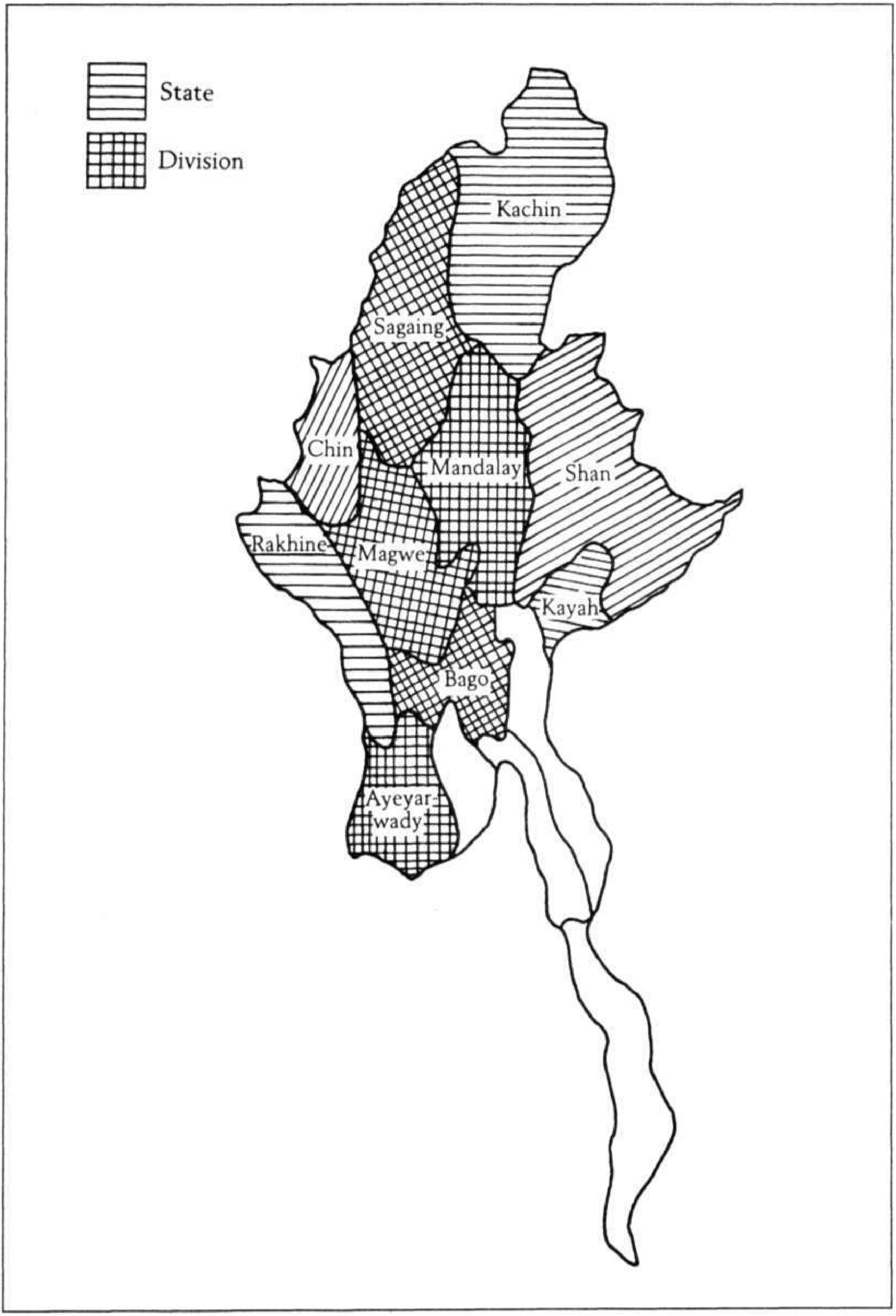

Figure 1. Pigeonpea-growing regions in Myanmar.

Future Work Plans

Fusarium Wilt

Inoculation techniques

For field evaluation, sick plots that have uniform wilt incidence (2500-4500 cfu g^{-1} soil) are to be used (Nene et al. 1991). Early sowing and keeping fields weed free will help in getting higher wilt incidence. While recording observations, plants that die due to phytophthora blight or macrophomina dry root rot need to be differentiated. Wilt-susceptible controls, ICP 2376 or LRG 30 or Bahar, need to be sown after every two test rows. Final observations should be recorded at 80% pod maturity stage.

For greenhouse screening, a root dip and transplantation technique is recommended (Reddy and Raju, 1993). One-week old seedlings (needle-leaf stage) raised in sterile sand in polythene bags, after dipping the roots in *F. udum* spore suspension (one 250 mL flask of inoculum diluted to 200 mL/1 x 10^6 spores mL^{-1}) are transplanted in sterilized sand-soil mixture in pots (5 plants/15 cm pot). Greenhouse temperature should be maintained at 30℃. Final observations need to be recorded 1 month after inoculation.

Differential lines

ICP 2376	-	Universally wilt susceptible
ICP 8863 (Maruti)	-	Broadbased resistance to wilt, released cultivar
ICP 9145	-	Tolerant to wilt in India but resistant in Malawi, released cultivar
ICP 8858 (Sharda)	-	Differential reaction to Indian isolates of *F. udum*
BDN 1	-	Cultivar that seems to have lost its resistance to wilt
BDN 2, C 11, NPWR 15	-	Released wilt-resistant cultivars in India

Observations to be recorded

- In the field and greenhouse: percentage of mortality
- Wilting: days after sowing (DAS)
- In the field: extent of xylem blackening
- In the greenhouse: chlorosis and stunting

Locations and scientists

Dholi-B K Sinha, Varanasi-V B Chauhan, Kanpur-Viswa Dhar/R G Choudhary, Gwalior-M P Srivastava, Rahuri-N J Bendre, Badnapur-K K Zote, Gulbarga-D Mahalinga, Bijapur-V B Bidari, ICRISAT-M V Reddy/T N Raju, Bangalore-V S Seshadri, Pudukkottai-S Natarajan, Khargone-D R Saxena, Nawalpur (Nepal)-

Sharda Joshi (C R Yadav), Nepalgunj (Nepal)-R K Neupani; Yezin, Mandalay, Magwe (Myanmar)-U Moe Hein (Daw Myint Myint San).

Experimental design and replications

Field : Randomized Block Design (RBD)
Greenhouse : Split plot: Main treatments-cultivars
Subtreatments-isolates
Replications: 3
Plot size: In the field, 50 seeds in two 5 m rows per replication
In the greenhouse, 5 seedlings per pot per replication
Repetitions: Minimum of three times

Molecular characterization of F. *udum.*

A proposal for a collaborative project with Beltsville Agricultural Research Center (Dr R D Lumsden) of the United States Department of Agriculture (USDA) with United States Aid for International Development (USAID) support has been submitted.

References

Reddy, M.V., and Raju, T.N. 1993. Pathogenic variability in pigeonpea wilt pathogen F. *udum.* Pages 32-34 *in* Plant Disease Problems in Central India (Muralidharan, K. and Reddy, C.S., eds.). Hyderabad, Andhra Pradesh, India: Directorate of Rice Research.

Nene, Y.L., Kannaiyan, J., and Reddy, M.V. 1981. Pigeonpea diseases-resistance screening techniques. Information Bulletin no. 9. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.

Sterility Mosaic

Inoculation techniques

For field evaluation, infector-hedge technique should be used (Nene et al. 1991).
For greenhouse evaluation, leaf stapling technique should be used (Reddy et al. 1993).

Differential lines

ICP 8863 - Universally SM-susceptible line
DA 11, ICP 7035 - Broadbased resistance to SM

ICP 10976	-	Ring spot reaction at some locations and mosaic symptoms at other locations
ICP 10984, ICP 11164	-	Differential reaction to Indian isolates of SM
Bahar	-	Released SM-resistant cultivar
PT 25	-	Resistant landrace

Observations to be recorded

- Incidence-Mosaic symptoms (mild and severe)
- Incidence-Ring spot symptoms
- Half row of each differential line to be detopped after observations for new flush and clear symptom development

Locations and scientists

Varanasi-V B Chauhan, Dholi-B K Sinha, Faizabad-R P Gupta, Pantnagar-Y P S Rathi, Kanpur-Vishwa Dhar/R G Choudhary, Rahuri-N J Bendre, Badnapur-K K Zote, Nagpur-Wanzari, ICRISAT-M V Reddy/T N Raju, Bangalore-V S Seshadri, Pudukkottai-S Natarajan, Rampur (Nepal)-C R Yadav (Sharda Joshi), Nawalpur (Nepal)-B P Sharma, Nepalgunj (Nepal)-R K Neupani, Yezin (Myanmar)-U Moe Hein (Daw Myint Myint San).

Experimental design and replications

Field : Randomized Block Design (RBD)

Greenhouse : Split plot: Main treatments-cultivars
Subtreatments-isolates

Replications: 3

Plot size: In the field, 50 seeds in two 5 m rows per replication
In the greenhouse, 10 seedlings per pot per replication

Repetitions: Three times

Genetic variation in *A. cajani*

A collaborative project between ICRISAT, Scottish Crop Research Institute (SCRI) (A T Jones), and Asian NARS with ODA funding for 1996/97 has been approved.

References

Reddy, M.V., Raju, T.N., Nene, Y.L., Ghanekar, A.M., Amin, K.S., Arjunan, G., Astaputre, J.V., Sinha, B.K., Muniyappa, V., Reddy, S.V., Gupta, R.P., and Kausalya Ganghadharan 1993. Variability in sterility mosaic pathogen of pigeonpea in India. Indian Phytopathology 46(3):206-212.

Nene, Y.L., Kannaiyan, J., and Reddy, M.V. 1981. Pigeonpea diseases—resistance screening techniques. Information Bulletin no.9. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.

Phytophthora Blight

Inoculation techniques

In the field, use sick plots and/or diseased debris inoculation technique. Inoculation to be done within a month after sowing (Reddy et al. 1990).

In the greenhouse, use soil-drench or foliar spray inoculation techniques. Soil drench inoculation to be done in 7-10-day old seedlings. Foliar spray inoculation to be done on 15-day-old seedlings. Cover the inoculated plants with polythene sheet for 48 h in a greenhouse at 28°C in case of foliar spray inoculation. In drench inoculation, keep the soil in pots wet by frequent irrigation (Nene et al. 1981).

Differential lines

ICP 7119 (Hy 3C)	-	Universally blight susceptible
ICP 2376	-	Resistant to P2 isolate but susceptible to P3 isolate
KPBR 80-2-1, ICP 7200	-	Field-tolerant to P3 isolate
ICPW 61, ICPW 66	-	C. *playtcarpus* accessions resistant to P2 and P3 isolates

Observations to be recorded

- Percentage of mortality
- Severity

Locations and scientists

Kanpur-Vishwa Dhar, Varanasi-V B Chauhan, Pantnagar-Y P S Rathi, New Delhi-R H Singh, Sehore-S C Agarwal, ICRISAT-M V Reddy/T N Raju, Akola-B T Raut, Baroda-K R Joshi.

Experimental design and replications

Field : Randomized Block Design (RBD)

Greenhouse : Split plot : Main treatments-cultivars
Subtreatments-isolates

Replications: 3

Plot size: In the field, 50 seeds in two 5 m rows per replication
In the greenhouse, 5 seedlings per pot per replication

Repetitions: Minimum of three times
Seedbed: Flat bed

References

Nene, Y.L., Kannaiyan, J., and Reddy, M.V. 1981. Pigeonpea diseases— resistance screening techniques. Information Bulletin no. 9. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.

Reddy, M.V., Nene, Y.L., Raju, T.N., Sheila, V.K., Nandita Sarkar, Remanandan, P., and Amin, K.S. 1990. Disease debris field inoculation technique for phytophthora blight of pigeonpea. International Pigeonpea Newsletter 12:25-26.

Monitoring Tour

- The area under pigeonpea in recent years, in the states of Karnataka and Maharashtra in India, and in Nepal and Myanmar, has shown a significant increase. The present area of pigeonpea in Karnataka is 415000 ha and 1000000 ha in Maharashtra. The area under pigeonpea in Myanmar during 1995/96 was 320 000 ha compared with 112 000 ha in 1991/92. The present area under pigeonpea in Nepal is 40 800 ha which is double that of the 1991/92 season.
- The group visited field experiments at IAC, Patancheru (Andhra Pradesh); UAS, Gulbarga (Karnataka); MPKV, Rahuri (Maharashtra); MAU, Badnapur (Maharashtra); and pigeonpea farmer's fields on the way to the above locations.
- Excellent field screening facilities for wilt, SM, and PB at IAC, for wilt at Gulbarga, wilt and sterility mosaic at Rahuri and Badnapur have been developed. Greenhouse screening facilities for PB exist at IAC.
- No serious wilt or SM problem was observed in farmers' fields in Karnataka. Wilt was a known problem in this state but large-scale adoption of the wilt-resistant cultivar Maruti seems to have reduced the problem.
- In Maharashtra, especially in the Marathwada region, wilt was a serious problem in farmers' fields. Up to 90% incidence was observed in some fields. As no wilt-resistant cultivar has been adopted in this area, there is an immediate need to introduce wilt-resistant cultivars. Cultivars such as Maruti and Asha may prove very useful and on-farm trials, in collaboration with Dr K K Zote, Senior Scientist, Pulses, MAU, Badnapur, can be planned.
- In addition to *Helicoverpa* pod borer, drought, especially in Maharashtra, was found to affect the crop. Cultivars such as ICPL 227 could do well.
- Dusting of insecticides was more common in Karnataka as this was found to be more effective than spraying.

Asian Pigeonpea Pathologists Group Meeting and Monitoring Tour

20-25 Nov 1995

Program

Mon 20 Nov

Chair J M Lenne **Rapporteur T N Raju**

0830	Introductory remarks	Y L Nene
0835	Objectives of the meeting	M V Reddy
0840	Summary of 5 year's results	Vishwa Dhar
0930	Discussion	
1030	*Tea/Coffee break*	
1100	Presentations by participants	NARS pathologists
1230	*Lunch break*	
1400-1600	• Video films on ICRISAT, sterility mosaic, and phytophthora blight; • Visit to Pathology Laboratory; observations of *Aceria cajani* and zoospores of *Phytophthora drechsleri* f. sp *cajani;* • Visit to greenhouse experiments on *Fusarium udum* and *Phytophthora drechsleri* f. sp *cajani* variability; • Field visit.	M V Reddy/T N Raju
1900	*Dinner*	

Tue 21 Nov

Chair C L L Gowda **Rapporteur M V Reddy**

0830	Finalization of future work plans
1030	*Tea/Coffee break*
1300	Hyderabad-Gulbarga

Wed 22 Nov	Gulbarga-Rahuri
Thu 23 Nov	Rahuri-Badnapur
Fri 24 Nov	Badnapur-Parbhani
Sat 25 Nov	Parbhani-Hyderabad

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About IIPR

The Indian Institute of Pulses Research (IIPR) is an apex organization carrying out basic and applied research on pulses at national level. The responsibility of the Institute is to conduct research through six divisions, Plant Breeding, Agronomy, Entomology, Extension, Physiology and Biochemistry, and Plant Pathology. IIPR is also the headquarters of the All India Co-ordinated Projects on Improvement of chickpea, pigeonpea, and MULLaRP [mungbean, urdbean, lentil, lathyrus, rajma (common bean), and peas].

IIPR's mandate is to:

- Act as a national center for basic and applied research on pulses.
- Monitor, guide, and coordinate research on pulses in the country.
- Impart training to scientists and extension workers engaged in pulses research and development.
- Foster international collaboration by exchanging views and material.

About ICRISAT

The semi-arid tropics (SAT) encompasses parts of 48 developing countries including most of India, parts of southeast Asia, a swathe across sub-Saharan Africa, much of southern and eastern Africa, and parts of Latin America. Many of these countries are among the poorest in the world. Approximately one-sixth of the world's population lives in the SAT, which is typified by unpredictable weather, limited and erratic rainfall, and nutrient-poor soils.

ICRISAT's mandate crops are sorghum, pearl millet, finger millet, chickpea, pigeonpea, and groundnut; these six crops are vital to life for the ever-increasing populations of the semi-arid tropics. ICRISAT's mission is to conduct research which can lead to enhanced sustainable production of these crops and to improved management of the limited natural resources of the SAT. ICRISAT communicates information on technologies as they are developed through workshops, networks, training, library services, and publishing.

ICRISAT was established in 1972. It is one of 16 nonprofit, research and training centers funded through the Consultative Group on International Agricultural Research (CGIAR). The CGIAR is an informal association of approximately 50 public and private sector donors; it is co-sponsored by the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and the World Bank.

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