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Prevalence of Phytophthora Blight of Pigeonpea in the Deccan Plateau of India

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Phytophthora blight (PB), caused by *Phytophthora drechsleri* f. sp. *cajani* is the third potentially important disease of pigeonpea in the Deccan Plateau (DP) of India after wilt and sterility mosaic. In the rainy-season of 2005, an outbreak of PB was seen throughout DP. To quantify the incidence and spread of the disease, a systematic survey was conducted in the major pigeonpea growing regions of DP during the crop season 2005. Attempts were made to determine the effect of cropping systems on the PB development and identify resistant cultivars, if any, grown by farmers and on research farms. Widespread incidence of PB was recorded on improved, and or local cultivars grown in different intercropping systems. Majority of improved cultivars grown at research farms were found susceptible to PB (>10% disease incidence). Pigeonpea intercropped with groundnut, black gram and coriander had less disease incidence (≤10%). Three wilt and SM resistant pigeonpea cultivars KPL 96053, ICPL 99044, and ICPL 93179 were found resistant (<10%) to PB as well. However, their resistance to PB needs confirmation under optimum disease development environments.

Keywords **:** cropping system, *Phytophthora drechsleri*, pigeonpea, resistance

Pigeonpea (*Cajanus cajan* (L.) Millspaugh) is a major grain legume crop of the tropics and subtropics. Globally, it is grown in about 4.58 million ha with a production of 3.27 million tonnes. Asia is the sole contributor and India alone accounts for over 77% of area and 81% production (FAO, 2005). In India, pigeonpea is the second most important food legume crop after chickpea. It is a multipurpose crop, being grown not only for grain but also for fuel and fodder (Nene and Sheila, 1990). It is grown under a wide range of cropping systems on the Deccan Plateau (DP) in India (Reddy et al., 1998).

Pigeonpea is susceptible to many diseases and insect pests but only a few of them are of economic importance (Nene et al., 1996; Vishwa Dhar et al., 2004). After wilt (caused by *Fusarium udum*) and sterility mosaic (Pigeonpea Sterility Mosaic Virus), Phytophthora blight (PB) caused by *Phytophthora drechsleri* Tucker f. sp. *cajani* is the third potentially important disease of pigeonpea in India (Kannaiyan et al., 1984). However, it is the most important production constraint in north-eastern India (Mishra and Shukla, 1987; Chauhan et al., 2002). Cloudy weather accompanied by intermittent rains and moderate temperatures of 25±1°C during seedling stage favour PB infection and development. Characteristic symptoms of the disease are water-soaked lesions on the leaves and slightly sunken lesions on stems and petioles. Lesions girdle the stem and the foliage dries up (Vishwa Dhar et al., 2005).

During the 2005 rainy season, continuous rains (about 460 mm) were experienced from 15 June to 15 July throughout DP (Fig. 1). Periodical monitoring of pigeonpea crop at research farm of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India indicated the occurrence of PB. It is in this context, an on-farm survey was planned to assess the incidence of PB in pigeonpea grown research farms and farmers' fields in major pigeonpea growing states in DP of India. The objectives of the survey were to quantify the incidence and spread of PB in DP; assess the levels of resistance and/or susceptibility to PB in the cultivars grown in farmers' fields and research stations; and determine the effect of cropping systems on PB incidence.

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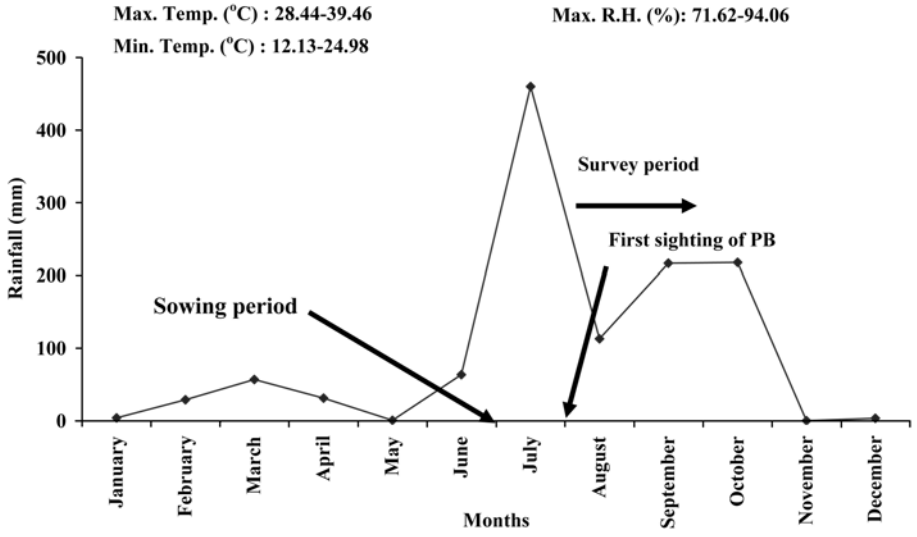

Fig. 1. Mean monthly rainfall (mm) in 2005.

Materials and Methods

Areas surveyed and data collection. Survey was conducted between second week of August and first week of September 2005 in the three major pigeonpea growing states (Andhra Pradesh, Karnataka and Maharashtra) in DP, India. Stops were made after every 10-20 km en-route depending on the frequency of the crop. A total 190 farmers' fields in three states (29 fields in Andhra Pradesh, 60 in Karnataka and 101 in Maharashtra) in DP, India were surveyed for PB incidence (Fig. 2).

The crop was in active vegetative growth stage (45-75 days) during the survey. A Global positioning system (GPS) based proforma was developed to collect information on disease incidence, soil type, cultivars grown, cropping systems adopted by the farmers. PB incidence was recorded both on improved and local cultivars grown by the farmers.

Disease incidence. Three (1 × 1 m) quadret were randomly

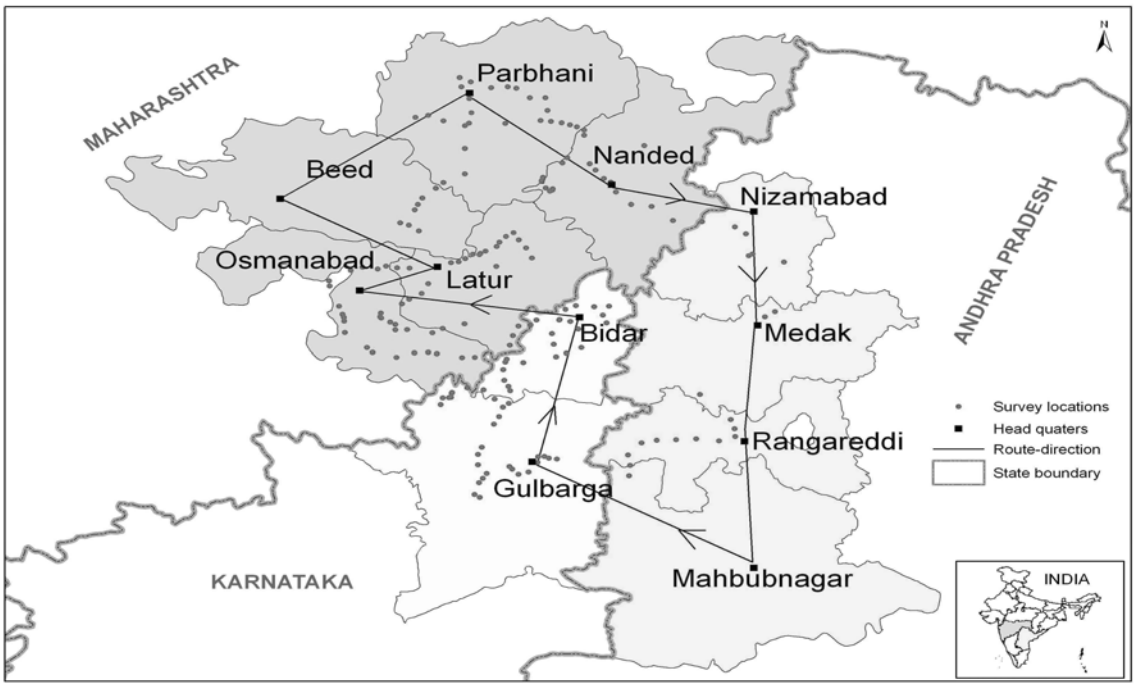

Fig. 2. Surveyed locations, district head quarters and survey route followed during pigeonpea survey in Deccan Plateau, India, 2005.

selected in each field in all of the three states surveyed and infected plants were counted in each quadret. Based on infected and total number of plants, percentage of PB incidence was calculated as follows:

$$\text{PB incidence (\%)} = \frac{\text{Number of PB infected plants}}{\text{Total number of plants}} \times 100$$

Disease incidence of individual fields was used for calculating the mean incidence of each district and the district average was used to calculate the mean incidence of the state. These averages indicate relative prevalence of PB during the year.

Results

Disease incidence in DP. Majority of the farmers grew both improved and local cultivars. Generally PB incidence was more on improved cultivars (11.9-26.5%) than on local or traditional cultivars (5.0-9.3%). Among improved cultivars grown by farmers, ICP 8863 (Maruti) had the least PB incidence (11.9%) followed by 20.3 % in BDN-2, 22.6% in BDN-7 and 26.5% in BDN-1 (Table 1).

Cropping system and soil type. Pigeonpea crop was grown by the farmers in different cropping systems in all the surveyed states. It was cultivated both on alfisols and vertisols.

In Andhra Pradesh, it was grown from sole crop to intercrop with black gram [*Vigna mungo* (L.) Hepper], green gram [*Vigna radiata* (L.) Wilcz.)], soy bean [*Glycine max* (L.) Merr.], cow pea [*Vigna unquiculata* (L.) Walp.], however, predominant cropping system was pigeonpea intercropped with sorghum [*Sorghum bicolor* (L.) Moench.]/

Table 1. Incidence of Phytophthora blight in commonly grown improved local cultivars of pigeonpea in the Deccan Plateau of India during 2005 rainy season.

Cultivar	Average PB incidence (%)[a]	Distribution
Improved		
ICP 8863[b]	11.9	Andhra Pradesh, Karnataka and Maharashtra
LRG-30	12.3	Andhra Pradesh
BSMR-853	15.5	Maharashtra and Karnataka
BSMR-736	18.3	Maharashtra and Karnataka
BDN-2	20.3	Maharashtra
BDN-7	22.6	Maharashtra
BDN-1	26.5	Maharashtra
Local		
Pandri Tur	5.0	Maharashtra
Benur Local	8.9	Karnataka
Gulyal Local	9.2	Karnataka and Maharashtra
Black Tur	9.3	Karnataka and Maharashtra
Local[c]	19.6	Andhra Pradesh, Karnataka and Maharashtra

[a][Resistant (≤10%), Moderately resistant (10.1-20.0%), Moderately susceptible (20.1-40.0%), and Susceptible (40.1-100%)]
[b]Released as Maruti, covering >75% area in the states of Andhra Pradesh, Karnataka and Maharashtra on the survey route.
[c]Traditional cultivars of mixed identity selected and grown by farmers.

Table 2. Incidence of Phytophthora blight on pigeonpea grown in intercropping systems in the Deccan Plateau of India during 2005 rainy season

Intercropping system	Soil type[a]	Distribution[b]	PB incidence (%)[c]
Pigeonpea + Groundnut	Alfisol	Karnataka	8.0
Pigeonpea + Black gram	Alfisol and Vertisol	Andhra Pradesh, Karnataka and Maharashtra	9.4
Pigeonpea + Coriander	Vertisol	Maharashtra	10.0
Pigeonpea + Sesamum	Alfisol and Vertisol	Karnataka	12.8
Pigeonpea + Pearl millet	Alfisol and Vertisol	Karnataka and Maharashtra	14.5
Pigeonpea + Green gram	Alfisol and Vertisol	Andhra Pradesh, Karnataka and Maharashtra	15.4
Pigeonpea + Maize	Alfisol and Vertisol	Andhra Pradesh	16.1
Pigeonpea + Soybean	Alfisol and Vertisol	Andhra Pradesh, Karnataka and Maharashtra	16.8
Pigeonpea + Cotton	Vertisol	Maharashtra	17.2
Pigeonpea + Sorghum	Alfisol and Vertisol	Andhra Pradesh, Karnataka and Maharashtra	20.6
Pigeonpea + Turmeric	Vertisol	Maharashtra	21.4
Pigeonpea + Citrus	Alfisol and Vertisol	Maharashtra	22.6
Pigeonpea + Cowpea	Alfisol	Andhra Pradesh	37.3
Sole crop	Alfisol and Vertisol	Andhra Pradesh, Karnataka and Maharashtra	15.8

[a]Major area in the state either under alfisols or vertisols.
[b]Based on total number of fields sown under a particular cropping system across three states.
[c][Resistant (≤10%), Moderately resistant (10.1-20.0%), Moderately susceptible (20.1-40.0%), and Susceptible (40.1-100%)]

maize [*Zea mays*]. In Karnataka, in addition to the above mentioned cropping systems it was also intercropped with groundnut [*Arachis hypogea* L.], sesamum [*Sesamum indicum*] and predominantly with sorghum/pearl millet [*Pennisetum glacum* (L.) R. Br.]. Pigeonpea was found predominantly intercropped with cotton [*Gossypium* spp.], coriander [*Coriander sativum* L.], pearl millet, sorghum, turmeric [*Curcuma longa*] and citrus [*Citrus spp.*] in Maharashtra.

Varying level of PB incidence was recorded on pigeonpea grown in different intercropping systems in the surveyed states (Table 2). There was no clear effect of intercropping and soil types (either alfisols or vertisols) on PB incidence. In general relatively more PB incidence was found in mixed/intercropped pigeonpea than in sole crop, irrespective of soil types and cropping systems. Pigeonpea intercropped with groundnut, black gram and coriander had the least PB incidence (≤10%) followed by sesamum, pearl millet, green gram, maize, soybean, cotton where PB incidence was between 10.1-20.0%. PB incidence was >20.0% when pigeonpea was intercropped with sorghum, turmeric, citrus and cowpea (Table 2).

Research farm. A total of 15 fields were surveyed for PB incidence at research farm of the ICRISAT, Patancheru, of which seven were alfisols and eight vertisols. In these fields pigeonpea was grown as a sole crop. Mean disease incidence was upto 33.9% among the pigeonpea genotypes grown in alfisols and upto 26.7% in the genotypes grown in vertisols.

Table 3. Incidence of Phytophthora blight in improved cultivars of pigeonpea, ICRISAT, Patancheru during 2005 rainy season

Cultivar	PB incidence (%)[a]	Wilt incidence (%)	SM incidence (%)
KPL 96053	6.7	0.0	0.0
ICPL 99044	9.4	0.0	0.0
ICPL 93179	9.8	1.4	0.0
ICP 8863 (Maruti)[b]	11.9	5.3	100.0
ICPL 87119 (Asha)	13.9	5.8	0.8
ICPL 96053	14.9	4.2	0.0
KPL 44	15.1	3.1	0.0
ICPL 87091	16.0	87.5	60.5
UPAS 120	23.0	67.1	35.7
ICP 7035 (Kamica)	28.0	3.2	0.0
ICPL 88039	36.1	22.6	26.5
ICPL 85063 (Lakshmi)	42.0	93.0	3.8
ICPL 332 (Abhaya)	44.6	60.8	58.5

[a][Resistant (≤10%), Moderately resistant (10.1-20.0%), Moderately susceptible (20.1-40.0%), and Susceptible (40.1-100%)]
[b]ICPL 8863 released as wilt resistant cultivar in Deccan Plateau.

Of the total 15 fields surveyed for PB incidence at ICRISAT, one of the vertisols field had wilt and sterility mosaic resistant screening activity. The PB incidence on the 13 improved cultivars grown in this field ranged between 6.7-44.6%. However, three cultivars, KPL 96053, ICPL 99044 and ICPL 93179 showed multiple resistance (≤10% disease incidence) to PB, wilt and sterility mosaic. Additionally, three lines ICPL 87119, ICPL 96053, and KPL 44 were found moderately resistant (10.1-20.0%) to PB but resistant to wilt and SM (<10%). One line ICP 7035 was found resistant to wilt and SM but susceptible to PB. Rest of the lines was found susceptible to PB (Table 3).

Discussion

Widespread incidence of PB in pigeonpea was observed in major parts of DP and it is a matter of concern. The disease incidence varied between 5.0-26.5% on various cultivars grown by the farmers'. The unpredictable heavy rains during early July and August in DP probably predisposed the pigeonpea crop to favourable conditions for PB development. High incidence of PB could be due to low levels of field topography and poor soil surface drainage that resulted in water stagnation and favoured the multiplication and spread of inoculum of *P. drechsleri.* However, it is still not clear how and where the PB pathogen survives and causes epidemics in pigeonpea grown on DP.

During this survey, the least PB incidence was found where pigeonpea was intercropped with black gram, groundnut and coriander. It is assumed that these intercrops provide good ground cover and prevent splashing of inoculum from soil to the foliage of pigeonpea. Vishwa Dhar et al. (2005) also reported that intercropping of pigeonpea with crops such as soybean, cowpea, groundnut, mungbean or urdbean could help in minimizing the disease. MV Reddy and TN Raju (1995-96 unpublished data ICRISAT, India) also observed that PB incidence was substantially reduced when short duration pigeonpea was intercropped with short leguminous crops such as black gram and groundnut. On the other hand, PB incidence was more when pigeonpea was intercropped with citrus, turmeric and sorghum indicating the effect of thick crop canopy that results in favourable microclimate for *P. drechsleri* infection, colonization and spread.

Three improved cultivars, KPL 96053, ICPL 99044 and ICPL 93179 showed multiple resistance to PB, wilt and sterility mosaic at ICRISAT. However, these improved multiple disease resistant cultivars require more testing across seasons and locations to confirm their resistance to PB, wilt and SM. Reddy et al. (1989) reported multiple disease resistant lines against wilt, SM and PB vis-à-vis need to develop cultivars with combined resistance against

these diseases. Recently, Mishra et al. (2003) also reported late maturing multiple disease resistant lines of pigeonpea against wilt, SM and PB. A detailed analysis of the factors responsible for widespread incidence of PB needs further investigations.

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