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Assessment of Vascular Wilt and Dry Root Rot of Pigeonpea in Tamil Nadu

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Abstract: *Roving survey was conducted in nine major pigeonpea growing districts of Tamil Nadu during the period Sep-Dec 2013 and 2014 to assess the severity of root rot and vascular wilt of pigeonpea (Cajanus cajan L. Millsp). Pigeonpea is grown both as a pure crop and intercrop under Tamil Nadu conditions. The results of the survey revealed that the incidence of root rot was higher during 2013 and 2014 (14.9 and 13.5% respectively) compared to that of wilt (8.8% and 9.2% respectively). The highest incidence of root rot (42%) was observed in Pallipalayam village of Erode district in 2013. The prevalence of wilt was severe in Kanthili village of Vellore district showing an incidence of 43% followed by Kaniampady(40%) in 2013. In general, both root rot and vascular wilt was found to be widespread in all the pigeonpea growing areas. The soil-borne pathogens viz.,Fusarium udum, Fusarium oxysporum, Fusarium solani, Rhizoctonia bataticola, Sclerotium rolfsii and Lasidiplodia sp. were found to be associated with pigeonpea in Tamil Nadu.*

Key words: *Survey, wilt, root rot,disease incidence*

INTRODUCTION

Pigeonpea (*Cajanus cajan* L. Millsp) is an important pulse crop of semi-arid tropics and subtropics grown for its grain legume and as a source of fodder and fuel. It enhances the soil fertility through nitrogen fixation in the root nodules and improves the soil structure. A long duration crop of pigeonpea can fix up to 200 kg N /ha and the residual effect for nextcrop remains 40 kg N/ha. It finds an important place in the rain-fed farming systems in developing countries because of its ability to tolerate drought and utilise residual moisture during dry season. In the Indian subcontinent, it serves as an important dietary protein to a large section of the people especially the vegetarians and the poor. Pigeonpea represents about 5% of world legume production (Hillocks *et al*., 2000) and more than 70% is being produced in India. In India, pigeonpea is grown in an area of 4.01 million hectare with a production of 2.65million tonnes bringing an average yield of 656 kg/ha (Directorate of Economics and Statistics, 2011-12). Pigeonpea is grown in Tamil Nadu in an area of 0.04 million hectare with a production of 0.03 million tonnes giving a productivity of 750 kg/ha. There is a large gap between the potential yield (2,500 kg/ha) and on farm yield and among the several factors contributing to this yield gap are the abiotic and biotic constraints. According to Nene *et al*., (1996), pigeonpea crop is attacked by 210 pathogens of which 83 are fungi. Soil borne diseases *viz*; root rot incited by *M. phaseolina (R. bataicola)* and vascular wilt caused by *F. udum* are the major constraints in reducing the yield in pigeonpea. Under favorable environmental conditions these diseases spread very quickly and develop in a heavy proportion causing huge economic losses ranging from 10-100 per cent.

The pigeonpea wilt disease was first recorded by Butler (1906) in India. Although the disease is more prevalent in India, East Africa and Malawi where yield losses of over 50% are common, it also occurs in Bangladesh, Grenada, Indonesia, Mauritius, Mynmar, Nepal, Nevis, Venezuela, Trinidad, and Tobago (Kannaiyan *et al*., 1984; Reddy *et al*., 1993; Marley and Hillocks, 1996). The disease is found in all pigeonpea growing areas but incidences are high in the eastern areas (Hillock and Songa, 1993). The incidence of the disease has been reported from 30-60 per cent at flowering and crop maturity stages (Kannaiyan and Nene, 1981). Chhetry and Devi (2014) reported 43-59 per cent wilt incidence in pigeonpea in the state of

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Manipur under organic farming conditions. The yield loss caused by *Fusarium* wilt in pigeonpea is about 470,000 tonnes of grain in India and 30,000tonnes of grain in Africa (Joshi *et al*., 2001). Recently, *Macrophomina phaseolina* (Tassi) Goid. has emerged as one of the important pathogen of different agricultural crops including pigeonpea (Kaur *et al*., 2012). Dry root rot of pigeonpea caused by *M. phaseolina* is a major problem especially when an off-season summer crop is taken particularly in black soil (Nene *et al*., 1979). The pathogenposes greater problem in pigeonpea cultivation and causes considerable loss (Bajpal *et al*., 1999).

The pigeonpea wilt pathogen was first described as *F. udum* from India (Butler, 1910). The perfect state of *F. udum* was discovered by Rai andUpadhyaya (1979) on wilted and dead pigeonpea plants near Varanasi in Uttar Pradesh, India, and identified it as a new species of *Gibberella*. Several distinct isolates of *Fusarium* spp. were isolated from wilted pigeonpea plants (Padwick, 1939). Other species of *Fusarium* reported associated with pigeonpea wilt are *F. vasinfectum* (Mundkur, 1938), *F. oxysporum* (Mukiibi, 1976) and *F. accuminatum, F. equiseti, F. merismoides,F. semitectum* and *F. solani* (Reddy *et al*., 1990). *Fusarium* is mainly soil borne as well as seed borne and also it is a facultative saprophyte. It can survive in the soil upto six years in the absence of susceptible host. *Macrophomina* is primarily soil and seed-borne fungal pathogen that incites the disease by producing microsclerotia/pycnidia (Pun *et al*., 1998). It has a wide host range, infecting about 500 cultivated and wild plant species from more than 100 families around the world (Mihail & Taylor, 1995).

Recently the outbreak of wilt and root rot was noticed in pigeonpea in major proportion in the farmers holdings which has significant impact on plant population and yield. With the current scenario of increasing temperature due to global warming, these diseases are gaining significance in hitherto less severe areas. The present investigation was undertaken to assess the severity of root rot and wilt of pigeonpea in various districts of Tamil Nadu.

MATERIALS AND METHODS

Disease Survey

An intensive roving survey was conducted in the major pigeonpea growing districts of Tamil Nadu *viz*., Coimbatore, Erode, Salem, Dharmapuri, Krishnagiri, Vellore, Theni, Namakkal, and Thiruvannamalai (Fig. 1) during the period from September through

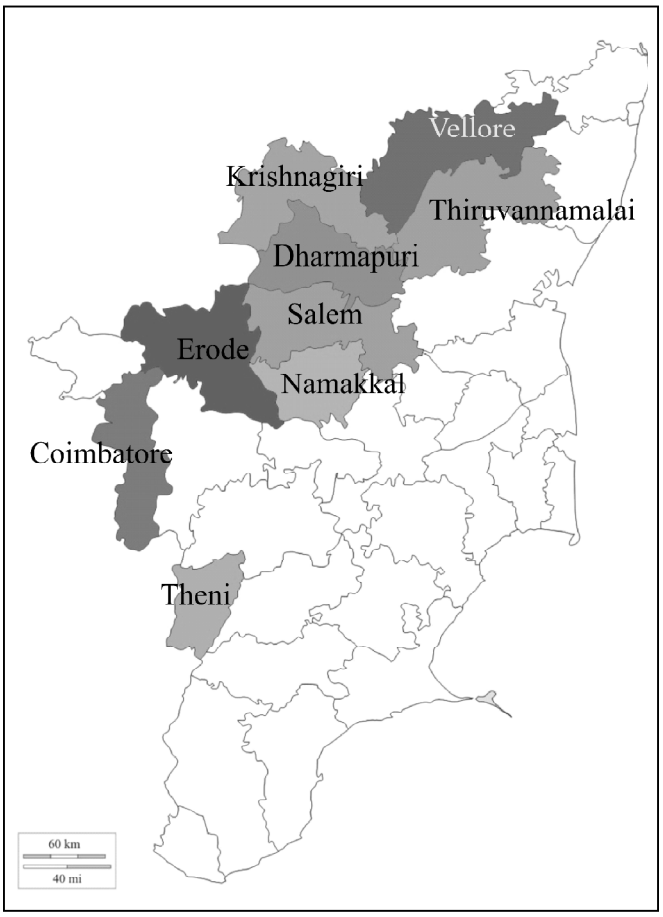

Figure 1: Districts surveyed for root rot and wilt of pigeonpea in Tamil Nadu

Decemberduring the years 2013 and 2014. The nine pigeonpea growing districts were traversed and observations were recorded in fields after every 10-20 km. Stops were less frequent in areas where pigeonpea was sparsely grown. The major soil-borne diseases were *Fusarium* wilt and *Macrophomina* root rot. Their incidence was assessed by counting the number of plants showing symptoms in three representative 75-100 plants randomly chosen in each field. The percentage incidence at each location in a district was used for calculating the district average and district averages in turn were used for calculating the state average. The per cent disease incidence was calculated using the formula,

$$Percent\ disease\ incidence = \frac{No.of\ plants\ showing\ wilting\ /\ root\ rot\ symptoms}{Total\ no.of\ plants\ observed} \times 100$$

Isolation of the pathogens and pathogenicity

Samples of infected plants were collected from each field and used for isolation of the pathogen. Isolation was made from collar and stem region in the case of

Fusarium udum and root and collar region were used for isolating *Rhizoctonia bataticola*. The tissues were washed in running tap water, cut into small bits of 5- to 10-mm, surface sterilized with 0.1 per cent mercuric chloride for 30 seconds, blotted dry on sterile filter paper and plated on Potato Dextrose Agar (PDA) medium. The plates were incubated at 25-27°C for two to three days and fungal growth was transferred to PDA slants by hyphal tip method.

The susceptible cultivar CoRg7 was used for testing the pathogenicity. Pathogenicity of *Fusarium udum*was proven by modified root injury method (Madhukeshwara and Seshadri, 2001). Earthen pots were filled with sterilized potting mixture. In the middle of the earthen pots, 15 cm length cut pieces of PVC pipes were immersed and the soil inside was scooped out. The surface sterilized seeds of susceptible variety were sown in the pot just at the periphery of the PVC pipe all around. The pots were watered regularly. The PVC pipes were gently removed when the seedlings were 10-15 days old which exposed the entire root system of pigeonpea and facilitated infection. The gap created by removing the pipes were filled with *F.udum* on sterilized sand:maize medium at the rate of 5% w/w. Pathogenicity of isolate of *R. bataticola* was tested according to the method of Chan, 1968. Ten days old plants were inoculated by placing four grams g of *R. bataticola* multiplied on sand-maize medium around the collar region of pigeonpea plants. The plants were observed regularly for symptom development.

RESULTS AND DISCUSSION

Symptoms of wilt and root rot in the field

The characteristic symptoms of wilt are mostly seen in crops nearing the flowering/podding stage even though the infection occurs early in the seedling stage, and sometimes seen in seedling stage also (Hillocks *et al*., 2000). The affected plants dry but the leaves remain intact on the plants for a long time (Fig. 2). Purple coloured streaks can be seen on the stem. Infected plants when split open shows brown to black discolouration of the vascular bundles. Partial wilting in affected plants is common. Such partially wilted plants show a dark purple band extending from the base to several feet above ground towards wilted branches (Nene, 1980). Butler (1906) reported that wilt appears in young seedlings but highest mortality is caused at flowering. Temperatures range of 12-29°C favours the disease development in pigeonpea plants approaching physiological maturity (Mundkur, 1935). According to Kotasthane and Gupta (1981), there is a close relation between flowering period, wilt intensity and soil temperature due to which early varieties suffer less due to wilt. This may be due to efficient moisture utilization and early maturing of the plant before the expression of the symptoms.

In the case of root rot, the plants dry up completely. Root rot infected plants dry up in seedling stage as well as maturity. The affected plants can easily be pulled out of the soil and the root show bark shredding symptoms (Fig. 3). Dark to greyish pycnidia can be seen on the stem at the collar region and also on the root portion which become erumpent at maturity.

Isolation and pathogenicity

Fusarium spp. isolated from infected plants collected from the various districts varied in their cultural and morphological characters. The colonies when grown on PDA produced different growth patterns. *F.udum* produces both macroconidia and microconidia in culture. Macroconidia are sickle shaped and hyaline with 3 to 4 septa (Fig. 4a,b) and microconidia are oval, hyaline, and aseptate or with single septa. Numerous chlamydospores are produced in the medium.

R. bataticola colonies in culture range in colour from white to brown or gray and darken with age (Fig. 5a). Microsclerotia are jet black in color and appear smooth and round to oblong or irregular (Fig. 5b). The pycnidia (*M. phaseolina*) produced on plants bear simple, rod shaped conidiophores with single celled, hyaline and elliptical or oval conidia.

The Koch's postulates were proved for both the pathogens.

Prevalence of vascular wilt and root rot

Pigeonpea is cultivated in red sandy loam and black soils in different districts of Tamil Nadu, mainly intercropped with groundnut, blackgram, greengram, cowpea, turmeric, castor and vegetables. It is grown as a sole crop in some areas especially in the districts of Erode, Vellore and Krishnagiri. The percentage incidence of wilt in the individual fields ranged from zero to 43 with the state average of 8.8% and 9.2% during the years 2013 and 2014 respectively (Table 1). The highest incidence of wilt was recorded in Kanthili village of Vellore district with an incidence of 43%. The district wise mean incidence was also the highest in Vellore with 33.4% and 27.8% in 2013 and 2014. In Erode district wilt incidence was 10.1% in 2013and 16% in 2014 with other districts showing less than 10% incidence. Least incidence was noted in

Table 1
Incidence of root rot and wilt in different districts of Tamil Nadu during 2013 and 2014

Sl. No.	*District*	*No. of villages traversed*	*Cropping pattern*	*Percent root rot incidence (2013)*	*Percent wilt incidence (2013)*	*Percent root rot incidence (2014)*	*Percent wilt incidence (2014)*
1.	Coimbatore	10	Pure crop & intercrop with turmeric, vegetables, blackgram	18	6.1	14.4	5.1
2.	Erode	9	Pure crop & intercrop with turmeric, groundnut, blackgram, greengram	23.1	10.1	21.4	16
3.	Salem	6	Pure crop & intercrop with groundnut	8.2	5.8	10.2	6.8
4.	Dharmapuri	3	Pure crop & intercrop with turmeric, cowpea,	13.3	4.6	16.7	5
5.	Krishnagiri	8	Pure crop & intercrop with vegetable, groundnut, cowpea, mango	10.75	9	11.1	7.4
6.	Vellore	7	Pure crop & intercrop with groundnut	11.8	33.4	11.1	27.8
7.	Thiruvannamalai	4	Pure crop & intercrop with groundnut, cowpea	11	4.5	10.3	7.3
8.	Namakkal	4	Intercrop with greengram, groundnut, sorghum	17.75	6	10.5	5.5
9.	Theni	2	Pure crop & intercrop with sorghum	20.5	1	16	1.5
Tamil Nadu Total		53		14.70	11.03	12.6	7.9

Figure 2: wilt symptoms in field

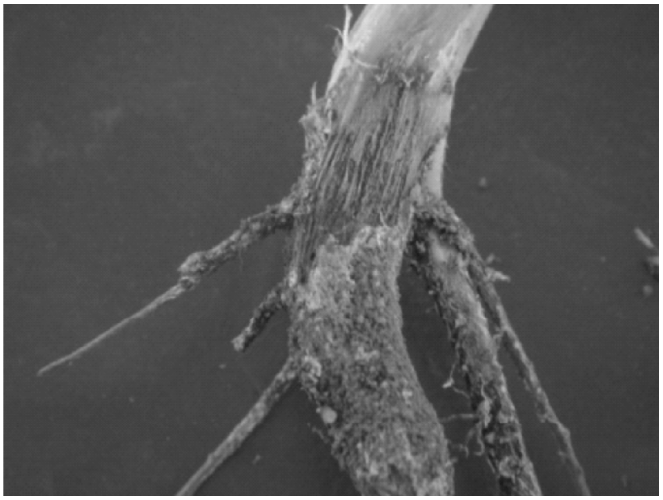

Figure 3: Bark shredding in root rot

Figure 4a: *F. udum* culture

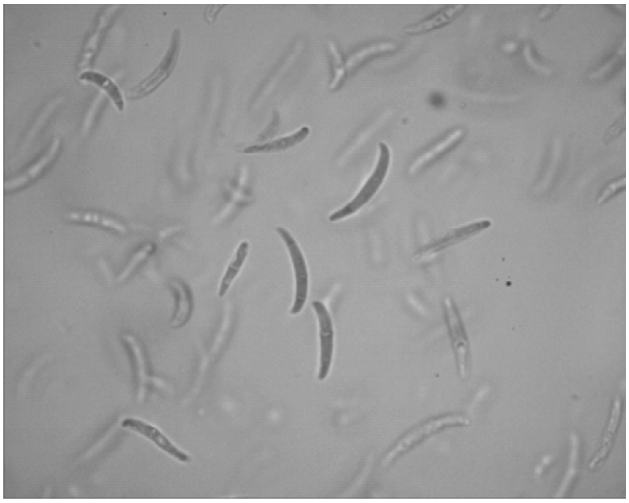

Figure 4b: Macroconidia of *F. udum*

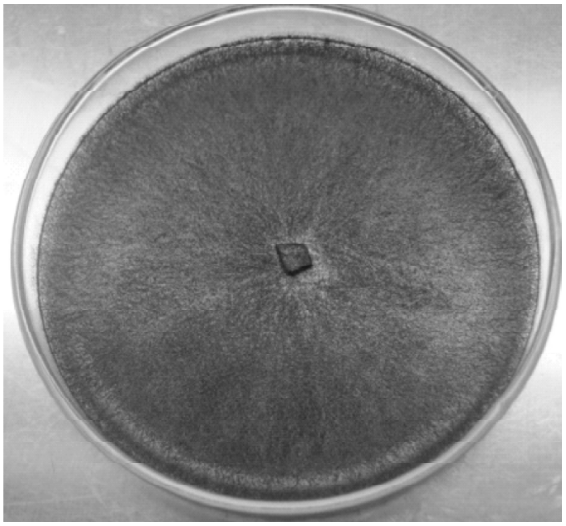

Figure 5a: Culture of *R. bataticola*

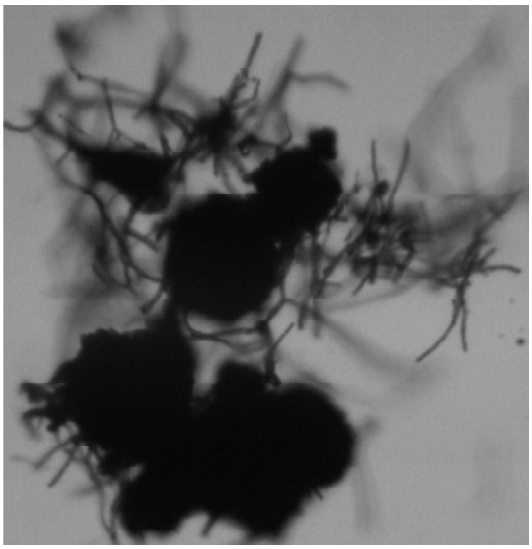

Figure 5b: Microsclerotia of R. *bataticola*

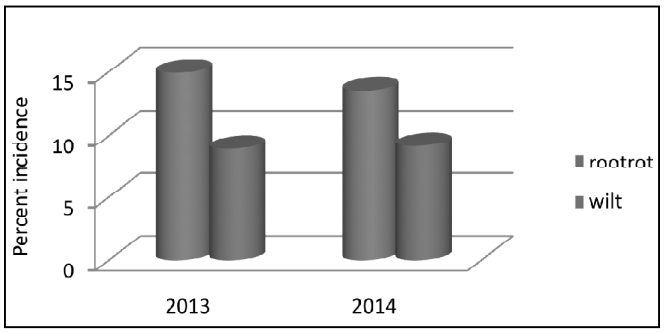

Figure 6: Average incidence of root rot and wilt in Tamil Nadu during 2013 and 2014

Theni district (1%). The state as a whole recorded 8.9% and 9.2% wilt incidence in the year 2013 and 2014 respectively (Fig. 5).

The wilt pathogen has been reported to survive in soil (McRae, 1926) and on pigeonpea seed (Haware and Kannaiyan, 1992) but major infection occurs through soil. The fungus can survive in soil in the absence of host for more than 10 years and also in weed plants. *Fusarium* wilt is favoured by low soil temperature and increasing plant maturity (Mundkur, 1935). Soil water holding capacity (30%) and soil temperatures between 20 and 30°C favours the disease (Singh and Bhargava, 1981). Presence of host and non-host seeds of legumes and cereals enhance the growth (Singh, 1974). Chhetry and Devi (2014) reported a wilt incidence of 58.77 % in early maturing and 42.74% in late maturing varieties of pigeonpea in Manipur.

The incidence of root rot was higher compared to wilt with a state average of 14.9% in 2013 and 13.5% in 2014 (Fig. 3). The highest incidence was seen in Erode district of 42% in Pallipalayam where pigeonpea was grown as a pure crop. The disease was widespread and comparatively higher root rot incidence in Erode district than other districts of Tamil Nadu. Dry root rot caused by *R. bataticola* is favoured by hot and dry weather conditions. Dry root rot is a major problem when pigeonpea is cultivated as an off-season (November-April) summer crop especially in black soil (Nene *et al*., 1979). *Macrophomina* is primarily soil and seed-borne fungal pathogen that incites disease by producing microsclerotia/pycnidia (Pun *et al*., 1998). Rain followed by prolonged dry weather predisposes the crop to this disease. *M. phaseolina* becomes aggressive during summer and at a soil temperature of 27-35°C (Yang and Navi, 2003). Kaur *et al*., (2012) conducted a survey in different regions of Varanasi and concluded higher disease incidence under the conditions of higher temperature and drought stress.The incidence and severity of*Macrophomina* stem canker of up to 70 and 55 per cent were reported in a survey from regions of eastern Uttar Pradesh in India.

In conclusion, the soil-borne pathogens *Fusarium* and *Macrophomina* are gaining importance especially in the current scenario of increasing temperature due to global warming. The present investigation has provided an insight into the severity of vascular wilt and root rot of pigeonpea in Tamil Nadu. Though various disease control strategies are being adopted, amore focussed approach on the epidemiological aspects of these diseases will be helpful in evolving durable management practices.

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