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Spatial Distribution and Incidence of Dry Root Rot of Pigeonpea Caused by *Rhizoctonia bataticola* (Taub.) Butler and Stem Canker Caused by *Macrophomina phaseolina* (Tassi) Goid]

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ABSTRACT: Pigeonpea is one of the protein rich legume crops grown in India. The production and productivity were very less due to losses caused by dry root tot and stem canker diseases from flowering to harvesting stage. The disease dry root rot caused by *R. bataticola* and stem canker caused by *Macrophomina phaseolina* is a seed borne as well as soil borne necrotic fungal pathogens infecting more than 284 plant species including monocot and dicots throughout the world. It is the most destructive disease and causes severe yield loss in major pigeonpea growing areas of North-Eastern Karnataka. Keeping this in view, a comprehensive and systematic survey was conducted by using GPS coordinates during the months of October-November 2018 in the farmer's field at Kalaburgi, Raichur, Yadgir and Bidar districts to know the status of incidence of dry root rot and severity of stem canker disease. The obtained results revealed that mean maximum dry root rot incidence was noticed in Kalaburgi district (24.20 %) followed by Raichur (20.62 %) and least in Yadgir (9.14 %) and mean maximum *Macrophomina* stem canker severity was observed in Kalaburagi district (29.72 %) followed by Bidar district (21.09 %) and the least was in Raichur district (4.97 %). GIS map was constructed by using GPS coordinates.

Keywords: dry root rot, *Macrophomina phaseolina*, Pigeonpea, *Rhizoctonia bataticola*, stem Canker.

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is a diploid (2*n* =2*x* =22) legume crop species and a member of *Phaseoleae*. It is commonly known astur orredgramor arhar, is important legume crops grown in tropics and subtropics. It is grown by farmers in almost all states of India. It helps in restoring soil fertility by fixing atmospheric nitrogen and has the ability to solubilize fixed phosphorus (Ae *et al*., 1990). The heavy shedding of leaves adds considerable organic matter to the soil system. Pigeonpea has multiple number of uses such as green tender seeds as vegetables, stem and roots of pigeonpea as fuel wood, However its main use as dhal.

Pigeonpea is one of the protein rich legume crops grown in tropical and subtropical regions of the world. It is the second most important pulse crops of India after chickpea, the country's total area, production and productivity were 4.22 Million hectares, 3.75 Million tonnes and 885 kg per hectare respectively. The state-wise trend shows that Maharashtra ranked first both in area and production (29.40 per cent (%) and 31.25 %) followed by Karnataka (22.48 % and 19.02 %). The highest yield was recorded by Bihar (1702 kg per hectare) followed by Gujarat (1156 kg per hectare) and Madhya pradesh (1133 kg per hectare). The lowest yield observed in the state of Andhra Pradesh (377 kg per hectare) followed by Telangana (568 kg per hectare) and Chattisgarh (650 kg per hectare) (Anon, 2020).

Under favourable conditions, dry root rot and stem canker diseases will infects quickly and cause annual estimated yield loss up to 10-100 per cent (Smita, *et al.*, 2015). Recently under field conditions the dry root rot and stem canker diseases were noticed in pigeonpea as major proportion in the farmer holdings, which has significant and devastating effect on plant survivality rate and yield with the present scenario of higher temperature due to global warming, this disease is gaining utmost importance in field. Even though many studies have been conducted earlier but in last 2-3 years this disease is appearing in major proportion and recent information is lacking. By considering this the present study was conducted to survey for the prevalence of dry root rot and stem canker diseases of pigeonpea during October - November, 2018 in major pigeonpea growing areas of North Eastern Karnataka by using GPS coordinates for exact results.

MATERIALS AND METHODS

A comprehensive and systematic survey was conducted by using GPS coordinates for occurrence of dry root rot and stem canker diseases of pigeonpea during the months of October - November, 2018 in major

pigeonpea growing areas of North Eastern Karnataka to know the status of incidence of dry root rot and severity of stem canker of pigeonpea at field level. Four districts were surveyed (Raichur, Kalaburgi, Yadgir and Bidar districts). In each district three major pigeonpea growing taluks were selected with three villages and in each village four fields were surveyed and then their incidence and severity was assessed by counting the number of plants showing symptoms.

Then the per cent disease incidence of dry root rot and severity of stem canker was calculated by using the formulas given below Tables 1 and 2.

A. Rating scale

In order to find out the resistant genotype of pigeonpea, test lines were scored at flowering stage based on the scales 1-3 (dry root rot), 1-5 (stem canker) as mentioned below:

Table 1: Disease rating scale for dry root rot of pigeonpea (Annon, 2016).

Per cent disease incidence	Disease reaction
0-10 (%) incidence	Resistant
11 -30 (%) incidence	Moderately resistant
30 (%) incidence	Susceptible

Table 2: Disease rating scale for Macrophomina stem canker disease of pigeonpea (Modified from Agarwal, 2003).

Grade	Symptoms	Reaction
1	1-10 % incidence (1-5 lesions/plant)	Resistant
2	10-25 % incidence (10-15 lesions/plant)	Moderately resistant
3	25-50 % incidence (15-20 lesions/plant)	Moderately Susceptible
4	50-75 % incidence (20-25 lesions/plant)	Susceptible
5	>75 % incidence (>25 lesions/plant and drying of pod loaded secondary branches	Highly susceptible

B. Collection and isolation of the pathogenic isolate

The comprehensive field survey was conducted during October- November, 2018, a large number of dry root rot infected pigeonpea roots and stem canker infected pigeonpea stems were collected from different places *viz*., Kalaburgi, Raichur, Bidar and Yadgir districts. These samples were subjected for standard tissue isolation procedure. The pigeonpea roots which are showing typical bark peeling and disintegrated roots and pigeonpea stems showing spindle shaped lesions were cut into small pieces/bits measuring about 2 mm and those bits are surface sterilized in ($HgCl_2$- 0.1%) for about one minute and washed repeatedly twice in sterile distilled water to remove the traces of $HgCl_2$ before transferring them to sterile potato dextrose agar (PDA) plates under aseptic conditions. The plates were incubated at temperature of 28± 2 ^{o}C and observed for growth of fungi. Thus the pure culture of the fungi (*Rhizoctonia bataticola* & *Macrophomina phaseolina*) was obtained by hyphal tip isolation method.

Artificial inoculation of the pathogens was conducted out to prove the pathogenicity of fungus (*Rhizoctonia bataticola*) by sick pot technique and cellophane tape method under glass house conditions for Pathogen (*Macrophomina phaseolina*) on susceptible cultivar TS3R.

RESULTS AND DISCUSSION

A. Symptoms of dry root rot in the field

Fungus existed in two forms, one saprophytic (*R. bataticola*) where the fungus mainly produces microsclerotia and another pathogen is (*M. phaseolina*) which mainly produces pycnidia. The pathogenic stage of the fungus is non-host specific and attacks broad range of economically important crops such as common beans, maize, soybean, mung bean and urdbean *etc*., (Dhingra and Sinclair, 1978a).

In pigeonpea field, the onset of the dry root rot disease appears as scattered drying of leaves and entire plants. Affected plants are generally straw coloured, but in some cases the lower leaves and affected stems shows brown discolouration. The tap root system appears black, rotten and devoid of most of the lateral, terminal and fine roots. The dead root becomes quite brittle and shows bark shredding. Dark and minute sclerotial bodies can be seen on the roots exposed or inside the wood. When the dry stem of the collar region of infected plant is split vertically, sparse mycelium or very minute sclerotia can be seen in the pith of the root system (Nene *et al.*, 1991).

In pigeonpea field, the onset of stem canker disease appears as symptoms ranged from restricted spindle-shaped lesions on the stems of the plants, to extended lesions causing drying of the whole stem and plant. Similarly, the stems of diseased plants showed spindle-shaped lesions with light gray centres and brown margins at the point of infection. Dropping of the pod-loaded (pod bearing branches) secondary branches is common in the upper part of the affected plants. Scoring for severerity of the disease was done at podding stage (after flowering) on the basis of symptoms on stem and branches (Anon., 1982).

B. Isolation of the pathogen

R. bataticola and *M. phaseolina* isolated from infected plants collected from different major pigeonpea growing areas of North Eastern Karnataka and studied different cultural and morphological characters.

Prevalence and distribution of dry root rot and stem canker. A comprehensive and systematic survey was conducted during *kharif*, 2018 in different pigeonpea growing districts of North Eastern Karnataka which includes, Raichur, Yadgir, Kalaburagi and Bidar districts to assess the inidence of dry root rot and severity of *Macrophomina* stem canker under field conditions. GIS map was constructed by using GPS coordinates which were taken during survey. The results obtained pertaining to survey were given in Table 3.

Table 3

SI. No	District	Taluk	Village	Variety	DI (%) Dry root rot	PDI (%) Stem canker
1.	Raichur	Raichur	Yeregera	local	19.50	10.00
			Shaktinagar	Gulyal Red	28.00	11.00
			Jambaladinni	Karitogari	33.00	5.50
		Mean			26.80	8.50
		Deodurga	Deodurga	Karitogari	22.50	3.00
			Jakkaladinni	TS-3R	12.60	5.00
			Karigudda	TS-3R	17.50	1.00
		Mean			17.53	3.30
		Sirwar	Sirwar	local	9.50	3.30
			Kurdi	TS-3R	25.00	2.50
			Kavital	TS-3R	18.00	3.50
		Mean			17.50	3.10
	Mean				**20.61**	**4.96**
2.	Kalaburgi	Kalaburgi	ARS, Kalaburgi	TS-3R	35.00	65.00
			Sirasgi	TS-3R	21.50	18.00
			Bhimnal	Kattibeej	26.50	31.00
		Mean			27.76	38.00
		Aland	Padsawali	Gulyal red	27.50	20.00
			Honhalli	Kattibeeja	15.00	23.00
			Telekuni	TS-3R	37.00	56.00
		Mean			26.50	33.00
		Sedam	Handerki	TS-3R	23.33	16.50
			Neelhalli	TS-3R	12.00	18.00
			Kodla	TS-3R	20.00	20.00
		Mean			18.44	18.16
	Mean				**24.23**	**29.72**
	Bidar	Humnabad	Hudgi	TS-3R	1.00	55.00
			Kanakatta	Asha	4.5	13.55
			Hallikhed	TS-3R	15.50	10.50
3.		**Mean**			**7.00**	**26.33**
		Bidar	Mirzapur	BSMR-736	**4.00**	**15.56**
			Janawada	Maruti	**11.00**	**14.50**
			Honnadi	BSMR-736	**4.50**	**12.50**
		Mean			6.50	14.18
		Basavakalyan	Hipparga	TS-3R	14.00	23.26
			Manhalli	TS-3R	15.00	24.00
			Betbalkunda	TS-3R	16.00	21.00
		Mean			15.00	23.75
	Mean				**12.33**	**21.42**
	Yadgir	Yadgir	Gurumitkal	Maruti	12.50	11.25
			Yargal	TS-3R	12.80	15.50
			Ramsamudra	TS-3R	5.00	10.50
4.		**Mean**			10.10	12.41
		Shahapur	Bheemarayanagudi	TS-3R	6.50	15.50
			Doranahalli	Kattibeeja	6.00	12.50
			Gogi	Gulyal Red	12.00	12.00
		Mean			8.16	15.16
		Shorapur	Shorapur	TS-3R	6.50	15.50
			Kakkeri	Karitogari	9.00	12.50
			Kodekal	TS-3R	12.00	12.00
		Mean			9.16	13.33
	Mean				**9.14**	**13.63**

It is clear from the table that, the mean maximum dry root rot incidence was observed in Kalaburagi district (24.20 per cent (%)) followed by Raichur (20.62 %) and the least disease incidence was observed in Yadgir (9.14 %) followed by Bidar (9.50 %). In Kalaburagi district, the highest disease incidence was noticed in Telekuni village (37.00 %) of Aland taluk and least was in Neelhalli (12.00 %) village of Sedamtaluk. However, in Raichur district, the maximum incidence was noticed in Jambaladinni (33.00 %) village of Raichurtaluk and the least was in Sirwar (9.50 %) village of Sirwartaluk. In Bidar district, the maximum disease incidence was observed in Betbalkunda (16.00 %) village of Basavakalyan taluk and least was in Hudgi (1.00 %) village of Humnabad. In Yadgir district the maximum incidence was noticed in Yargal village (12.80 %) of Yadgirtaluk and least disease incidence was noticed in Ramasamudra (5.00 %) village of Yadgir taluk. The overall disease incidence of dry root rot was ranged from 1.00 to 37.00 % across all the districts and taluks (Table 3).

The mean maximum *Macrophomina* stem canker severity was observed in Kalaburagi district (29.72 %) followed by Bidar district (21.09 %) and the least was in Raichur district (4.97 %). In Kalaburagi district, the highest disease severity (65.00 %) was noticed in ZARS, Kalaburagi and least was in Handerki village (16.50 %) of Sedam. However, in Raichur district, the maximum severity was noticed in Shaktinagar village (11.00 %) of Raichur taluk and the least was in Kavital village (3.50 %) of Sirwartaluk. In Bidar district, the disease severity was more in Hudgi village (55.00 %) of Humnabad taluk and least was in Hallikhed village (10.50 %) of Humnabad taluk. The maximum severity of stem canker in Yadgir district was noticed in Gogi village (16.50 %) of Shahpur taluk and least was in Ramasamudra (10.50 %) village of Yadgirtaluk. The overall severity of stem canker was ranged from 1.00 to 65.00 % across all the districts and taluks covered (Table 3).

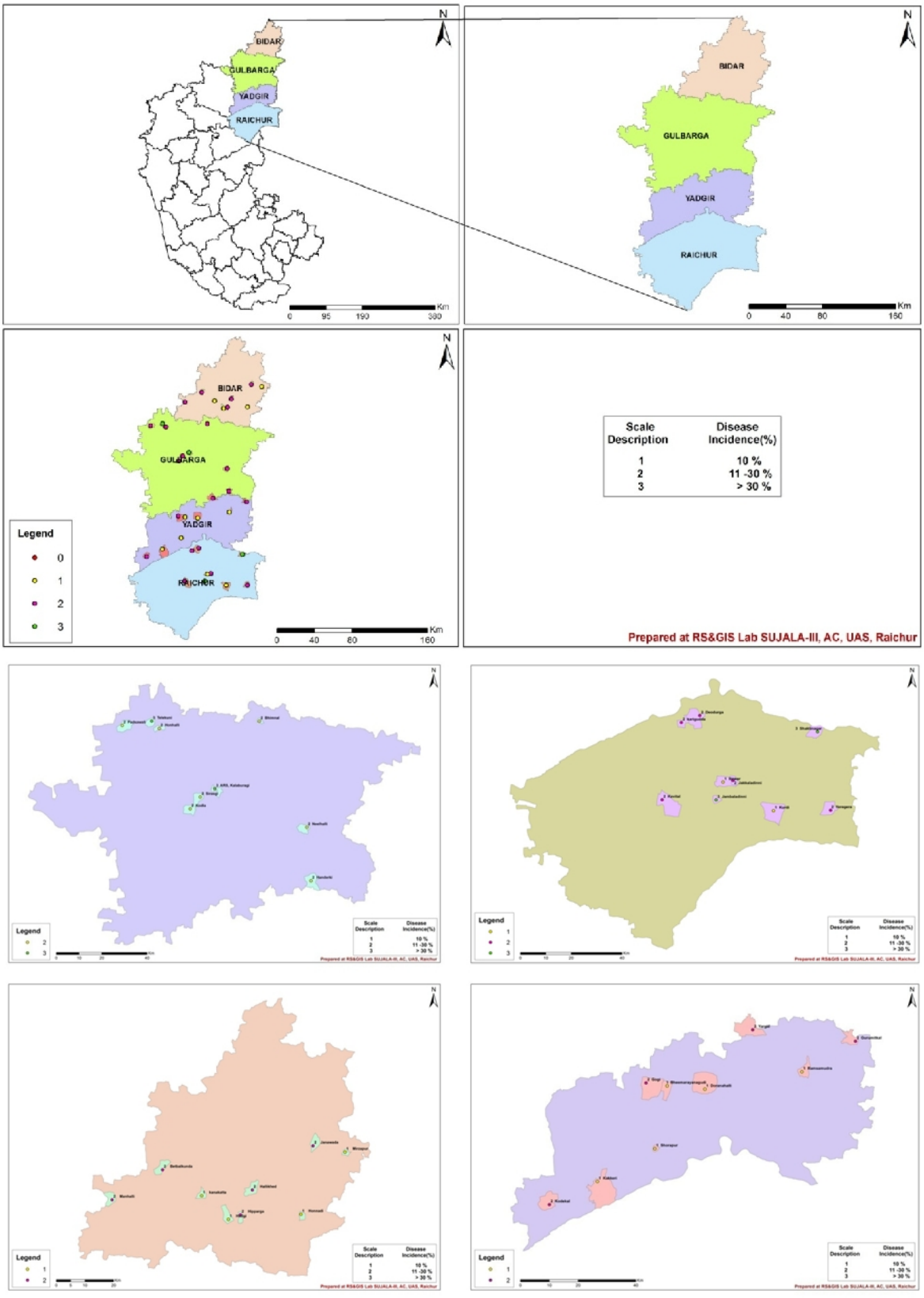
The similar kind of incidence was observed by earlier reporter Chikkannaswamy (2014) who conducted survey in the same four districts. The average temperature of 30-40^{o}C and prolonged dry spell (Rainfall 20 mm) from flowering to harvesting stage was observed in Kalaburagi during Nov-Feb 2019, which was resulted in enhanced disease. These observations are in agreement with the results of Nobel and Richardson, (1968); Bajpal *et al*., (1999).

Mono-cropping with very closer spacing and also severe drought with high temperature (35-40 ^{o}C) and very low rainfall accelerated the vulnerability of the crop and increased the aggressiveness of the pathogen. The current findings are also supported by Garrett *et al.* (2006) and Kaur *et al*., (2012). Similarly Manjunatha *et al.,* (2011) also reported severe dry root rot incidence was mainly attributed to variation in soil temperature (35-37 $^{\circ}$C) and moisture. Maruti *et al*., (2017) reported that incidence of dry root rot is mainly enhanced by severe moisture stress and prolonged dry spells at maturity stage of the crop.

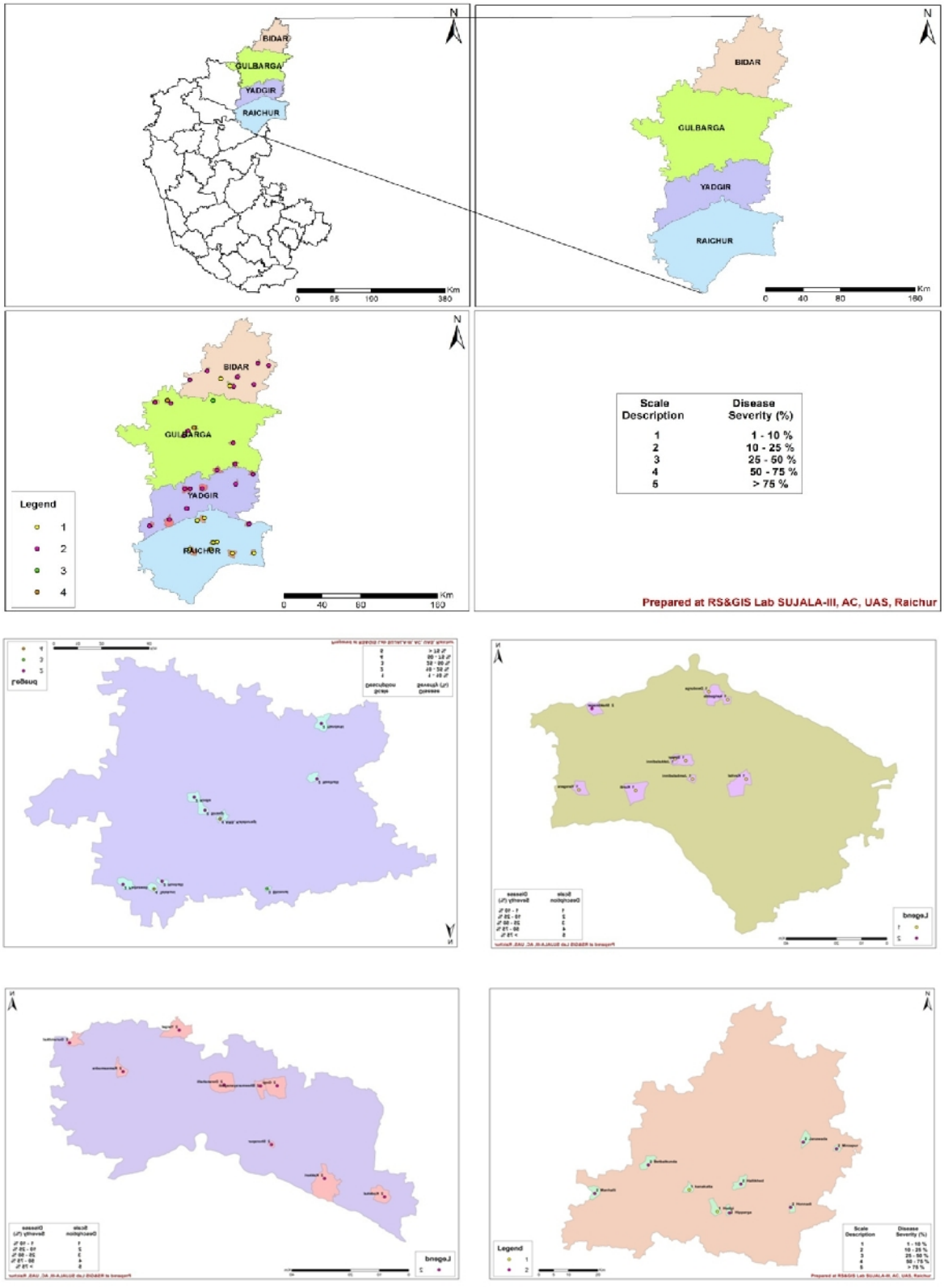
The high incidence may also be attributed to the monocropping of TS-3R variety in larger area, which might be responsible for existence of aggressive pathogen. The least incidence could be attributed to the cultivar usage of Kattibeeja variety, which might have shown resistance against the disease. Such variations in disease incidence in different locations was usually attributed to environmental or cultivar variations.

A. Infected plant showing yellowing and drying of leaves; **B.** Close view of dry root rot infected pigeonpea plant; **C&D.** Typically infected pigeonpea plant**.**

E. Different stages of symptoms of *Macrophomina* stem canker of pigeonpea.



GIS map showing spatial variation of dry root rot on pigeonpea in selected districts of North Eastern Karnataka during *kharif* 2018.



GIS map showing spatial variation of stem canker on pigeonpea in selected districts of North Eastern Karnataka during *kharif* 2018.

CONCLUSION

The maximum incidence of dry root rot of pigeonpea was 24.20 per cent in Kalaburgi and least was in Yadgir district to an extent 9.14 per cent during *kharif* 2015. The maximum severity of stem canker of pigeonpea was 29.72 per cent in Kalaburgi and least was in Raichur district to an extent 4.97 per cent during *kharif* 2015.

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