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Survey for the severity of sorghum Turcium leaf blight in Guntur and Prakasam districts of Andhra Pradesh

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Abstract
Sorghum is a drought tolerant cereal which is globally cultivated and has been nourishing millions of people across the globe. However, losses in grain and fodder yield due to fungal diseases are becoming a major constraint for sorghum production. Of all the foliar pathogens infecting sorghum, turcicum leaf blight (TLB) has been a major threat to all crop stages, deteriorating photosynthetic area with consecutive grain losses. Due to rainfall irregularities and inadequate water availability sorghum cultivation is gradually becoming a climate change adaptation strategy in Guntur and Prakasam districts of Andhra Pradesh. Hence, a roving survey was undertaken during the *rabi* 2018-19 to assess the TLB severity in six major sorghum mandals of these areas. The highest mean disease index was noticed in Markapuram mandal (35.14%) succeeded by Komarolu and Rajupalem mandals with the mean PDI of 28.26% and 27.78% respectively. However, the least PDI was recorded in Muppalla mandal (26.80%) followed by Santamagulur (27.01%) and Bapatla mandals (27.08%). Besides this, it was also observed that the Nested ANOVA carried out at two hierarchical levels confirmed the significant role of districts and mandals within districts on TLB disease severity.

Keywords: Sorghum, survey, turcicum leaf blight, disease severity

1. Introduction
Sorghum, a camel crop is the fifth most cultivated cereal globally in diverse environmental conditions due to its highest water use efficiency (Dogget, 1988) [2]. It is a nutrient powerhouse providing food security for the poor, particularly in semi-arid tropics. Being used as a grain, fodder and poultry feed, sorghum has wide industrial applications which include the production of flour, glucose, citric acid, jaggery, and even bio-fuel. Out of the global sorghum production of 59.34 Million Tonnes (M T), 8.08% (*i.e.* 4.8 MT) was contributed by India making it the fifth-largest producer (FAOSTAT, 2018). Andhra Pradesh in India is one among the major sorghum producing states with estimated annual production and productivity of 0.300 MT and 2146 kg ha^{-1}, respectively (Indiastat, 2017-18). Kurnool, Anantapur, Kadapa, Guntur, and Prakasam districts of Andhra Pradesh are the leading producers cultivating sorghum in both *kharif* (rainy) and *rabi* (post-rainy) seasons with superior quality grain being produced in *rabi* (Kleih *et al*., 2007) [7].

Owing to the present erratic climate, irregular rainfall, and inadequate water facilities, sorghum cultivation has been an alternative contingent strategy with a proportionate increase in its production area. However, sorghum yields are often reported to be low and inconsistent involving intricate biotic and abiotic factors (Ogeto *et al*., 2013) [10]. Among the fungal pathogens that concomitantly infect susceptible sorghum cultivars, turcicum leaf blight (TLB) caused by *Exserohilum turcicum* is of global importance due to its wide adaptability pertaining heavy grain losses in both sorghum and maize farms (Reddy *et al*., 2013; Manu *et al*., 2018) [15, 8]. Grain yield losses of up to 50% may occur in susceptible cultivars when TLB infection occurs at pre-flowering stage (Frederiksen, 1980) [4]. Despite being a polycyclic foliar hemi-biotroph infecting all the crop stages, yield losses due to TLB are predisposed by host-pathotype combinations in a particular environment. In recent times, the farmers in Guntur and Prakasam districts are switching to sorghum cultivation. As the research on TLB disease in these regions is meager, a survey was conducted to assess the present status of the disease, its distribution, and severity in major sorghum growing mandals.

2. Material and Methods

A roving survey was conducted during *rabi* 2018-19 to assess the disease severity of sorghum turcicum blight in major sorghum growing mandals of Guntur and Prakasam districts of Andhra Pradesh. Relying on preceding crop statistics of sorghum, three mandals from respective districts and two villages from each mandal were chosen for survey (Fig. 1). Four fields from each village were surveyed during soft dough stage. In each field, disease severity was recorded in five square meters, one each from four corners (excluding the border rows) and one from the center. Top four leaves showing the typical leaf blight symptoms were scored using the scale given by Thakur *et al.* (2007) [1] (Table 1 & Fig. 2). Based on disease severity data, the percent disease index (PDI) at different places was calculated from the formula given by Wheeler (1969) [18].

$$PDI\ (\%) = \frac{sum\ of\ individual\ disease\ ratings}{No.\ of\ observations\ assessed\ \times Maximum\ disease\ rating} \times 100$$

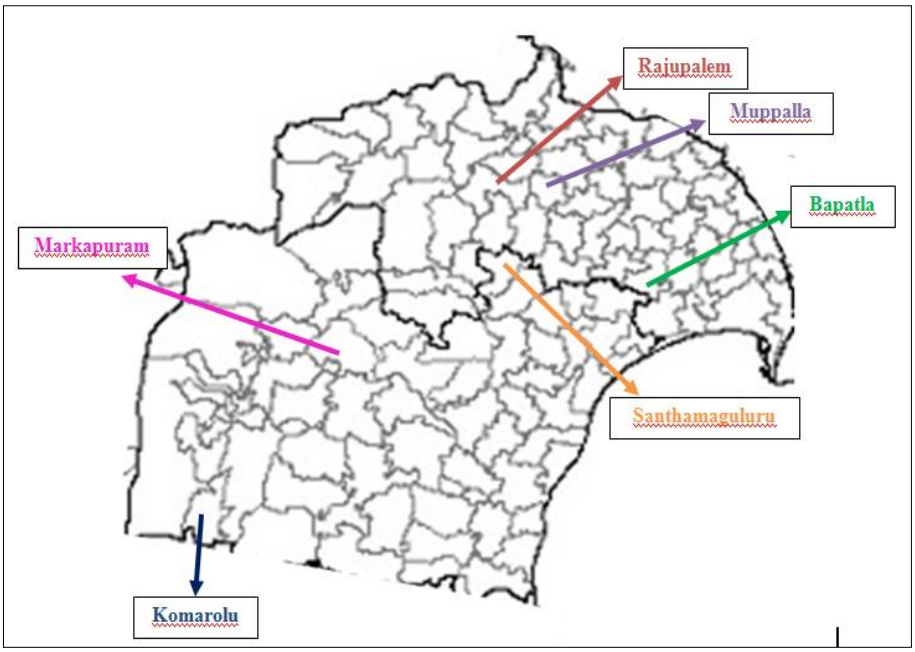

Fig 1: Map of Guntur and Prakasam districts showing the mandals selected for survey during *rabi* 2018-19.

Table 1: Disease severity scale for turcicum leaf blight in sorghum

Severity rating	Symptom and lesion types (on top four leaves)
1	0 to <1% leaf area with mild yellow flecks
2	1-5% leaf area covered with hypersensitive small lesions
3	6-10% leaf area covered with hypersensitive small lesions
4	11-20% leaf area covered with small necrotic lesions
5	21-30% area covered with small necrotic coalescing lesions
6	31-40% area covered with large coalescing necrotic lesions
7	41-50% leaf area covered with large coalescing necrotic lesions
8	51-75% leaf area covered with large coalescing necrotic lesions
9	76-100% leaf area covered with large coalescing necrotic lesions

Fig 2: Disease scale observed during the survey of sorghum turcicum leaf blight in Guntur and Prakasam districts

2.1 Data analysis

Disease severity data was used to compute analysis of variance (ANOVA) using Microsoft Excel 2007 (v12.0) (Microsoft Corporation, Washington). The disease severity

readings observed in each field were subjected to nested ANOVA, performed using MINITAB 19.2020.1 (Minitab Inc, Pennsylvania, USA) at two levels of hierarchy in which the sampling was done (districts and mandals with in districts) to determine the impact of districts and mandals within districts on TLB disease severity.

3. Results and Discussion

The TLB disease was prevalent in all the villages surveyed with severity ranging from 25.42 to 35.14%. Maximum PDI was observed in Markapuram village (35.14%) followed by Kothapalli (35.00%) and Komarolu (30.42%) villages of Prakasam district with no significant difference. Whereas, the least PDI was observed in Bollavaram village (25.42%) which was statistically on par with Devinutala (25.56%), Rajupalem (27.50%), Reddigudem (28.06%), Irukupalem (28.19%), Bapatla (28.61%) villages of Guntur district and Edamakallu (26.11%), Elchur (26.11%), Santamagulur (27.92%) villages of Prakasam district respectively (Table 2).

Table 2: TLB disease severity in Guntur and Prakasam districts

District	Mandal	Village	Average PDI (%)	Mandal mean (%)	District mean (%)
Guntur	Bapatla	Bapatla	28.61^{b}	27.08	27.22
		Devinutala	25.56^{b}		
	Muppalla	Irukupalem	28.19^{b}	26.80	
		Bollavaram	25.42^{b}		
	Rajupalem	Rajupalem	27.50^{b}	27.78	
		Reddigudem	28.06^{b}		
Prakasam	Santamagulur	Santamagulur	27.92^{b}	27.01	30.12
		Elchur	26.11^{b}		
	Markapuram	Markapuram	35.14^{a}	35.07	
		Kothapalli	35.00^{a}		
	Komarolu	Komarolu	30.42^{ab}	28.26	
		Edamakallu	26.11^{b}		
		Mean	28.67		
		CD ($p \leq 0.05$)	5.33		
		CV (%)	12.96		

*Numerical with same alphabets are statistically on par

Percent disease index in mandals ranged from 26.80 to 35.07%. Markapuram mandal of Prakasam was noticed with the highest PDI (35.07%) followed by Komarolu mandal (28.26%) of Prakasam and Rajupalem mandal (27.78%) of Guntur districts respectively. The lowest disease severity was noticed in Muppalla mandal (26.80%) of Guntur followed by Santamagulur mandal of Prakasam (27.01%) and Bapatla mandal of Guntur (27.08%) (Table 2). The results of the present study were in agreement with the earlier survey reports of Ramathani *et al.* (2011) who reported the TLB severity of 14.8 to 37.6% in Uganda and also with the results of Reddy *et al.* (2013) [15] who reported 33% disease severity in Guntur. Reports by Nwanosike *et al.* (2015) and Ogolla *et al.* (2019) [9, 11] revealed the role of cultivar variability and host-pathotype interactions for the maximum disease severity. Varied disease incidence and severity of TLB with the time, location, and environmental conditions was reported by Ullstrup (1966) [17]. Similar observations were also made by Harlapur, 2005 and Khedekar *et al.* (2010) [5, 6] that the prevailing environmental conditions during a cropping season could be a reason for higher disease incidence.

Nested ANOVA carried out at two hierarchical levels (districts and mandals within districts) confirmed the significant role of districts and mandals within districts on TLB disease severity (Table 3).

Table 3: Nested ANOVA for turcicum blight severity on sorghum

Source	DF	SS	MS	F-Value	P-Value
District	1	100.4	100.43	7.33	0.010*
Mandal	4	304.8	76.20	5.56	0.001*
Error	4	575.2	13.69		
Total	4	980.4			

*Statistically significant differences at $p \leq 0.05$

DF degrees of freedom; SS sum of squares; MS Mean square

Relatively high disease severity of 30.12% observed in Prakasam district might be attributed to the cropping pattern and the cultural practices followed. As the majority of the area in Praksam district is rainfed, farmers cultivate fodder sorghum/bajra/blackgram during *kharif* and take up sorghum during *rabi* through broadcasting. This might be contributed to the survival of the pathogen and its multiplication under favorable microclimate. It was reported that crop spacing has an influential role in fungal disease spread through many ways which include providing congenial microclimate for inoculum proliferation, favoring abundant chances of inoculum interception with host and subsequent survival (Burdon and Chilbers, 1982; Flory and Clay, 2013) [1,3]. The present findings were in corroboration with Manu *et al.* (2018) and Ogolla *et al.* (2019) [8, 11] who observed that mono-cropped fields had more TLB disease index. Besides monocropping, majority of farmers in Prakasam were observed to implement poor management practices for TLB which could be another reason for higher disease severity.

4. Conclusions

Results from the present study revealed that the disease severity of sorghum TLB varied from one village to another in Guntur and Prakasam districts and is mostly influenced by the agronomic practices followed. TLB disease could be a major constraint for the sorghum production in Prakasam district if left without proper management. An integrated management system has to be taken up by the farmers involving the use of resistant varieties, following proper spacing, use of biocontrol agents and fungicide application which is essential to avoid economic losses due to TLB.

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