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A comprehensive survey of leaf blight severity in sorghum caused by *Exserohilum turcicum* in Northern Karnataka

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Abstract
Sorghum (*Sorghum bicolor* (L) Moench) is a vital cereal crop cultivated worldwide and faces severe challenges from various diseases and pests. This study aimed to identify hotspots of leaf blight in the major sorghum-growing regions of northern Karnataka during the *Kharif* and *Rabi* seasons of 2023-24A roving survey was conducted to assess the prevalence, severity, and incidence of the disease across five districts *viz.,* Dharwad, Gadag, Haveri, Belagavi, and Ballari during *Kharif* and four districts *viz.*, Dharwad, Gadag, Haveri and Belagavi during *Rabi* 2023-24 and their respective villages. The mean PDI of sorghum leaf blight among different districts surveyed during *Kharif* is 26.81 percent. Gadag district showed highest disease severity of 28.52 percent while Ballari showed least disease severity (18.41%). During *Rabi* mean PDI of leaf blight recorded is 24.95 percent wherein Gadag district showed highest disease severity (25.64%) and Haveri showed least disease severity (21.19%) where sorghum was grown both under irrigated and rainfed conditions. Gadag district emerged as a hotspot, exhibiting the highest disease severity in both seasons. Local varieties were found to be more susceptible to leaf blight compared to hybrid cultivars. The microclimatic conditions during *Kharif*, which favoured disease development, contributed to the higher disease severity observed in this season. These findings highlight the urgent need for effective disease management strategies, such as the development and deployment of resistant varieties, to mitigate the impact of leaf blight on sorghum production in northern Karnataka.

Keywords: Survey, severity, leaf blight, sorghum, *Kharif, Rabi*

Introduction

Sorghum (*Sorghum bicolor* (L) Moench) is an important cereal crop, ranking as the fifth most important crop globally, following maize (*Zea mays* L.), wheat (*Triticum aestivum* L.), rice (*Oryza sativa* L.) and barley (*Hordeum vulgare* L.) [Akram *et al*. (2007) [2], FAO., 2018, Rashwan *et al.*,2021] [23]. Archaeological evidence suggests that this crop originated in Africa, with its earliest cultivation taking place in northeastern Africa, near the Egyptian-Sudanese border, approximately 5,000 to 8,000 years ago [Kazungu *et al.* (2023) [13], Winchell *et al*. (2017) [29], Venkateswaran *et al*. (2019)] [27]. It is also known as "guinea corn" (Lucy *et al*., 2012) or "great millet". As of 2023, the United States ranks first in global sorghum production, accounting for approximately 13% of the total worldwide output. Following the U.S. are Nigeria (11%), Sudan (8%), Mexico (8%), and Ethiopia (7%) [Khalifia *et al.* (2023), Mundia *et al*., 2019] [14, 20]. India contributes around 8 percent of global production and stands third in terms of area after Sudan and Nigeria. Sorghum is grown in India with an area of 4.82 m ha, producing 4.60 m t with a productivity of 991 kg/ha. The Sorghum belt in Karnataka, located in the central region of the state, extends up to the northern part where sorghum is grown for both grains and fodder. Maharashtra is the top producer of sorghum, accounts for 26 percent of the total production followed by Karnataka, Rajasthan and Andhra Pradesh accounting for 25 percent, 14 percent and 7 percent of the production respectively. Covering an area of 10.41 lakh hectares, Karnataka yields 10.45 lakh tonnes of sorghum with productivity rate of 974 kg/ha (FAO).

Grain sorghum is a drought and heat-tolerant crop compared to other cereals, making it a promising option as climate variability and extreme weather events like drought and heat stress become more frequent worldwide (Chadalavada *et al*., 2021, Hoosain *et al*., 2022) [6, 12]. Recent years have witnessed increased research interest in sorghum, driven by its growing significance as a crucial food and feed crop. Additionally, its potential as a biofuel source in arid regions has attracted significant investment and development efforts (Habyarimana *et al*., 2022) [10].

This crop is susceptible to various fungal diseases, among which leaf blight, caused by *Exserohilum turcicum* (Pass.) Leonard and Suggs [Telomorph = *Setosphaeria turcica*], is particularly noteworthy. Leaf blight is a significant fungal disease affecting sorghum worldwide, particularly in warm and humid environments. Previously regarded as a minor disease, it has now escalated to a major concern in India (Adhikari *et al*., 2021, Nieuwoudt *et al*., 2018, Haasbroek *et al*., 2014) [1, 21, 9]. Under moist field conditions with temperatures ranging from 18 to 27°C, lesions on the plant expand and merge, leading to a reduction in the host's photosynthetic capacity (Levy and Cohen 1983) [18]. Secondary infections occur when conidia, produced on the surface of necrotic lesions, are dispersed to the upper canopy by wind and rain (Carson 1995; Ullstrup and Miles 1957) [5, 25]. This disease adversely impacts photosynthesis and can lead to a substantial reduction in grain yield with losses reaching up to 50 percent in susceptible genotypes, as reported by and. A survey on fungal foliar and panicle diseases in smallholder Sorghum cropping systems in different agro-ecologies of lower eastern Kenya concluded that sorghum plants were infected with six foliar fungal diseases *viz.*, anthracnose, leaf blight, rust, rough leaf spot, *Alternaria* leaf spot, downy mildew, and covered kernel smut. A survey was conducted in the districts of Guntur and Prakasam of Andhra Pradesh to determine the severity of sorghum leaf blight (Kumar *et al.,* 2010) [16]. The Markapuram mandal has the highest mean disease index (35.14%) and the Muppalla mandal has the lowest PDI of 26.80. In addition, it was noted that the Nested ANOVA performed at two hierarchical levels supported the important contribution of mandalas within districts to the severity of leaf blight disease. Ogolla and his co-workers 2023 conducted a study on sorghum leaf blight in Tarakan Nithi County found significant variation in disease incidence and severity across villages. Kithaga and Nkairini had the highest incidence (74.45% and 55.93%), while Gatuntu and Gituntu had the lowest (12.22%). Understanding the severity and frequency of leaf blight in the primary sorghum-cultivating districts of northern Karnataka is crucial. This knowledge enables the identification of disease hotspots and facilitates the development of resistant varieties, an effective strategy for disease control in sorghum.

Materials and Methods

The principal aim of this project is to investigate the prevalence, severity and incidence of leaf blight in the major sorghum-growing regions of five northern Karnataka districts *viz.*, Dharwad, Gadag, Haveri, Belagavi and Ballari during *Kharif* 2023-24 and four districts *viz.*, Dharwad, Gadag, Haveri and Belagavi during *Rabi* 2023-24 and their respective villages.

Sampling strategy

A stratified sampling structure was employed to collect leaf blight triggered by *E. turcicum* infected sorghum leaves from fields in five districts of northern Karnataka *viz.*, Dharwad, Gadag, Haveri, Belagavi and Ballari during *Kharif* 2023-24 and *Rabi* 2023-24 and their respective villages. At least two farmer's fields were visited from each taluk among the respective districts. Almost in each field, 5-6 samples consisting of leaf blight symptoms were taken. The crop stage at which samples of diseased leaves were collected during the flowering/grain filling stage from farmers' fields during 2023-24 *Kharif* and 2023-24 *Rabi* growing seasons and used for the more advanced studies. All the collected samples during the survey were sterilized by using 70 percent ethanol to vanquish saprophytic invasion, swilled in distilled water, dried on the workbench at room temperature and stocked up at 4°C until requisite. Among the 65 samples collected during survey, 30 samples were from *Kharif* 2023-24 and 35 samples were from *Rabi* 2023-24.

For the study, 10 plants were randomly selected from each farmer's field and the severity or intensity of the disease was determined using a leaf chart based on the lower, middle and upper leaves of each plant.

Disease assessment

The incidence of leaf blight disease in each field was evaluated by calculating the proportion of plant symptoms. In each field 40-50 plants having TLB symptoms in the middle of each plot were randomly selected, observed and recorded from each field, allowing for calculation of the proportion of affected plants as a percentage of the plant population. The severity of TLB or the Percent Disease Index (PDI) was calculated by following the 1-9 Scale for leaf blight (Thakur *et al*., 2007) [24] as detailed in Table 1.

Further, the scale was converted into Percent Disease Index (PDI) by using formula given by Wheeler (1969) [28].

$$\text{Percent Disease Index (PDI)} = \frac{\text{Sum of the individual disease ratings}}{\text{Number of leaves assessed} \times \text{Maximum grade}} \times 100$$

Table 1: Scale (1-9) used for scoring leaf blight severity of sorghum

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

Results and Discussion

A roving survey in Northern Karnataka in sorghum growing regions showed significant variability in leaf blight severity due to differing ecological conditions, cropping practices and inoculum levels. The survey focused on mapping the disease index to pinpoint endemic areas and revealed the incidence of disease varied from place to place, season to season and stage to stage. Leaf blight of sorghum was prevalent in all surveyed agro-ecologies in *Kharif* 2023-24 cropping season at varying levels.

Among the five districts during *Kharif* highest disease pressure was observed in Gadag (28.52%) followed by Belagavi (23.82%), Haveri (23.25%), Dharwad (22.05%) and Ballari (18.41%) (Table 2). The percent disease severity of leaf blight among the surveyed villages during ranged between 14.45 percent (Garag of Dharwad district) to 51.12 percent (Dundur of Gadag district). The mean percent disease severity of sorghum leaf blight among different districts and talukas was 26.81 and 28.87 percent respectively. The mean percent disease severity of leaf blight of sorghum among different talukas ranged between 18.34 percent (Hukkeri) and 38.97 percent (Mundaragi). The condition in Gadag district revealed the highest disease severity of 51.12 percent disease severity in Dundur of Gadag taluk followed by Hulkoti of Hulkoti taluk (42.23%) both at grain filling stage. Kadampur and Mundaragi villages of Mundaragi taluk recorded 45.60 and 28.98 percent at flowering and grain filling stage, likewise, Bagewadi of same taluk showed 32.30 percent disease at grain formation stage. Belahatti of Shirhatti taluk recorded the disease severity of 41.20 percent at the grain filling stage (Fig 1). In Ballari district, the disease severity was lowest of 18.41 percent at Ballari (ARS) of Ballari taluk at panicle initiation stage. In addition to leaf blight, other diseases like rust, downy mildew, grain mold, smut, and charcoal rot were recorded. Disease severity was higher under irrigated conditions due to microclimatic factors. Factors such as cultural practices, location, crop growth stage, and meteorological conditions (temperature, humidity, rainfall) also influenced disease severity. At Belagavi district, eight villages were surveyed. Among them, highest severity of leaf blight was seen in Anigol of Bailhongal taluk *i.e.,* 31.14 percent at flowering stage followed by Buralatti of Athani taluk (27.89%) at soft dough stage and Arabhavi of Gokak taluk (25.45%) at panicle initiation stage. Least severity was recorded in Chikanandi of Gokak taluk recorded (16.70%) at boot leaf stage, Murkibhavi and Kenganur of Bailhongal taluk (23.32 and 18.01%) during boot leaf and soft dough stage. Raxi of Hukkeri taluk recorded least disease severity *i.e.*, 17.62 percent during panicle initiation stage, whereas Hukkeri village of same taluk recorded 18.89 percent during boot leaf stage. At Haveri district, Holeitagi of Haveri taluk showed highest disease severity (26.67%) at the grain filling stage. Taredahalli recorded 22.23 percent disease severity followed by Tangol of same taluk recorded 21.22 percent both at the grain filling stage. Guttala of Haveri taluk recorded least disease severity *i.e.,* 17.78 percent at flowering stage.

Table 2: Leaf blight disease severity in major sorghum growing districts of northern Karnataka during *Kharif* 2023-24

District	Taluk	Village	Hybrid/ Variety/Local	Irrigated/ Rainfed	Stage of the crop	Percent Disease Index	Other diseases observed
Dharwad	Dharwad	Govankoppa	Byahatti local	Irrigated	Grain filling stage	25.67	Rust
		Shivalli	Byahatti local	Irrigated	Hard dough stage	38.89	Grain mold, Rust
		Hebballi	Byahatti local	Irrigated	Hard dough stage	43.45	Grain mold, Rust
		Dharwad	CSH 14	Irrigated	Grain filling stage	25.11	Rust, Sooty stripe
		Garag	Nandyal local	Irrigated	Flowering stage	14.45	Rust
		Tadakod	Nandyal local	Irrigated	Flowering stage	31.12	Rust
		Taluk Mean				29.11	
	Hubbali	Byahatti	Byahatti local	Rainfed	Vegetative stage	24.45	Downy mildew
		Hebsur	Byahatti local	Irrigated	Flowering stage	28.99	Rust
		Taluk Mean				26.72	
	Navalgund	Navalii	Byahatti local	Irrigated	Grain formation stage	29.98	Rust
		Saidapur	Nandyal local	Irrigated	Grain formation stage	25.55	Rust
					Taluk Mean	22.79	
	Annigeri	Annigeri	Annigeri local	Irrigated	Flowering stage	33.34	Rust
		Taluk Mean				33.34	
		District mean				22.05	
Gadag	Gadag	Dundur	Nandyal local	Irrigated	Grain filling stage	51.12	Rust
		Taluk Mean				37.04	
	Hulkoti	Hulkoti	Nandyal local	Irrigated	Grain filling stage	42.23	Rust
		Taluk Mean				32.53	
	Mundaragi	Kadampur	Nandyal local	Irrigated	Flowering stage	45.60	Rust
		Mundaragi	Nandyal local	Irrigated	Grain filling stage	28.98	Rust
		Bagewadi	Nandyal local	Irrigated	Grain formation stage	32.30	Rust
		Taluk Mean				38.97	
	Shirhatti	Belahatti	Hybrid	Irrigated	Grain filling stage	41.20	Rust
		Taluk Mean				35.78	
		District mean				28.52	
		Tangol	Hybrid	Irrigated	Grain filling stage	21.22	Rust

Haveri	Haveri	Holeitagi	Hybrid	Irrigated	Grain filling stage	26.67	Rust
		Taredahalli	Hybrid	Irrigated	Grain filling stage	22.23	Rust
		Guttala	Hybrid	Irrigated	Flowering stage	17.78	Rust
		Taluk Mean				23.25	
		District mean				23.25	
Belagavi	Athani	Buralatti	Hybrid	Irrigated	Soft dough stage	27.89	Rust
		Taluk Mean				27.89	
	Bailhongal	Kenganur	Hybrid	Irrigated	Soft dough stage	18.01	Rust
		Anigol	Hybrid	Irrigated	Flowering stage	31.14	Rust
		Murkibhavi	Hybrid	Irrigated	Boot leaf stage	23.32	Rust
		Taluk Mean				21.11	
	Gokak	Chikananadi	Hybrid	Irrigated	Boot leaf stage	16.70	Rust
		Arabhavi	Hybrid	Irrigated	Panicle initiation stage	25.45	Rust
		Taluk Mean				21.15	
	Hukkeri	Raxi	Hybrid	Irrigated	Panicle initiation stage	17.62	Rust
		Hukkeri	Hybrid	Irrigated	Boot leaf stage	18.89	Rust
		Taluk Mean				18.34	
		District mean				23.82	
Ballari	Ballari	Ballari	Hybrid	Irrigated	Panicle initiation stage	18.41	-
		Taluk Mean				18.41	-
		District mean				18.41	
		Mean taluk				28.87	
		Mean district				26.81	

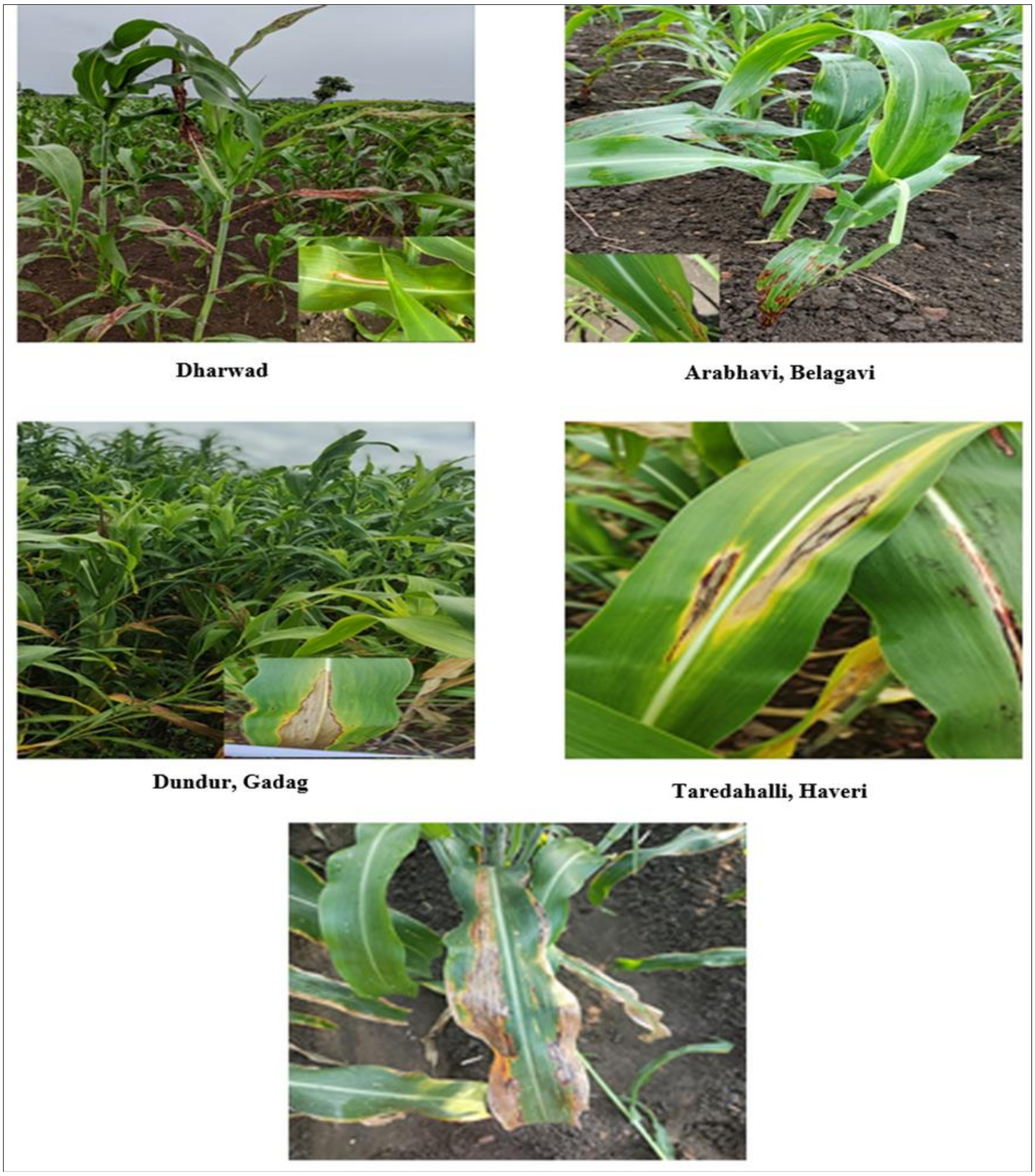

Fig 1: Survey for leaf blight severity and different district of northern Karnataka during *Kharif* 2023-2024

Garag village of Dharwad taluk *i.e.*, 14.45 percent at flowering stage whereas, highest severity was observed in Hebballi followed by Shivalli villages of Dharwad taluk *i.e.*, 43.45 and 38.89 percent at hard dough stage. Tadakod at flowering stage showed 31.12 percent of disease severity followed by Govankoppa and Dharwad of Dharwad taluk with 25.67 and 25.11 percent disease severity at grain filling stage. In Hubballi taluk Hebsur showed disease severity of 28.99 percent at flowering stage and Byahatti showed 24.45 percent at vegetative stage. In

Fig 2: Survey for the leaf blight severity at different district of northern Karnataka during *Rabi* 2023-24

Navalgund taluk Navalli showed disease severity of 29.98 percent and Saidapur showed 25.55 percent at grain formation stage. Annigeri of Annigeri taluk recorded 31.34 percent disease severity at flowering stage.

Among the four districts during *Rabi* highest disease pressure is observed in Gadag (25.64%) and Belagavi (24.25%) whereas, least was observed in Haveri (21.19%) and Dharwad (22.71%) (Table 3 and Fig 2). This could be attributed to favourable conditions such as intermittent rainfall and the optimal average temperature experienced in the Gadag district. When comparing the various talukas individually during *Rabi*, Mundaragi (32.85%) and Hubballi (31.57%) recorded the highest severity. Additionally, many farmers in Dharwad and Gadag districts have been growing susceptible varieties, such as Byahatti local, Annigeri local, Nandyal local, M 35-1 and other local types. The adequate irrigation during the crop's vegetative stage led to a heightened severity of leaf blight on sorghum in northern Karnataka during *Kharif* (Fig 3).

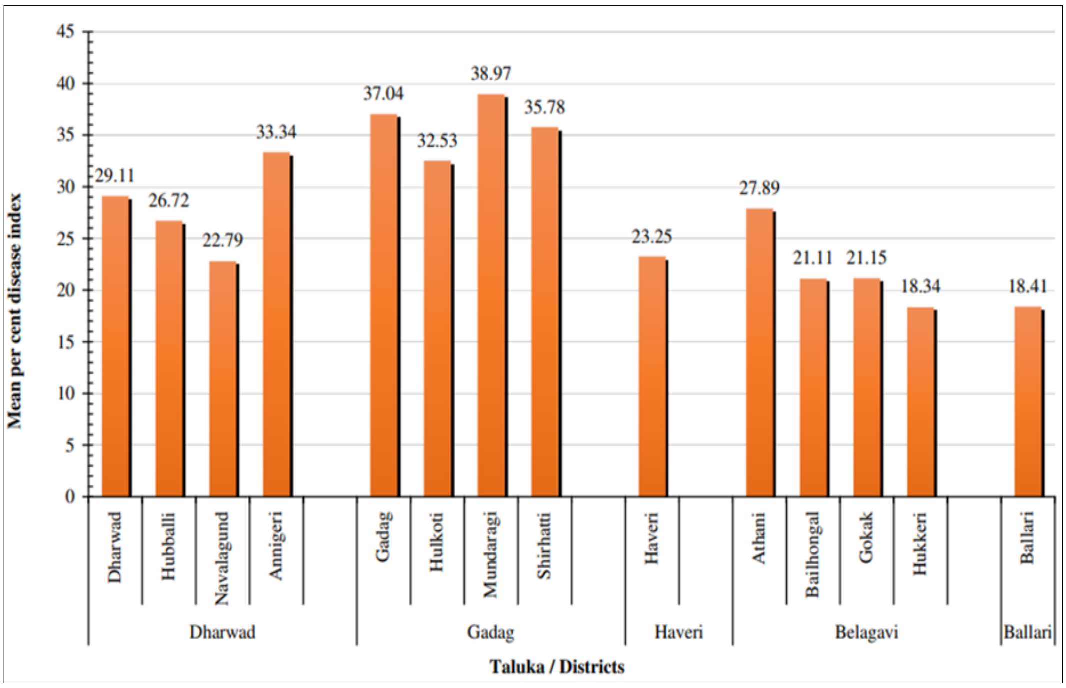

Fig 3: Districts and taluk wise severity of leaf blight of sorghum in northern Karnataka districts during *Kharif* 2023-2024

Such variations in the severity of diseases in different districts of northern Karnataka attributed to dynamic environment, genetic makeup of varieties and lack of awareness among farmers. The results are in agreement with studies conducted by (Pallavi, 2018) who linked such variations in disease severity from region to region to weather factors majorly temperature and relative humidity, cultivar/variety grown, cropping pattern and other cultural practices followed. Frequent rainfall, taking up of sorghum cultivation season after season, susceptible stage of crop and increased relative humidity might have created congenial environmental condition for disease progress to greater extent. The percent disease severity of leaf blight among the surveyed villages during *Rabi* 2023-24 ranged between 15.32 percent (Belawadi of Belagavi) and 36.70 percent (Sulla village of Dharwad). The mean percent disease severity of sorghum leaf blight among different districts and taluka is 24.95 and 26.92 percent respectively. The mean percent disease severity of leaf blight of sorghum among different talukas a during *Rabi* 2023-24 ranges between 23.78 percent (Haveri) and 32.85 percent (Mundaragi). At Haveri district the disease severity was observed lowest (20.15%) by Meundi of Haveri taluk at vegetative stage followed by Belavigi of same taluk with disease severity of 22.21 percent at soft dough stage. Neeralgi and Adavisomapur villages of Shiggaon taluk showed disease severity of 32.21 percent and 25.54 percent at flowering and boot leaf stage. In Haveri taluk Guttala and Taredahalli showed disease severity of 23.32 and 24.43 percent at soft dough stage. At Gadag district, highest disease severity recorded at Dambal of Mundaragi taluk (34.54%), followed by Mewundi of same taluk (33.17%) each at boot leaf stage and Mundaragi of Mundaragi taluk (33.09%) each at soft dough stage. Kalkeri of Nargund taluk recorded 24.45 percent disease severity. Nargund of same taluk showed least disease severity (22.23%) at soft dough stage, whereas, highest severity (32.23%) in this taluk is seen in Kurlageri at boot leaf stage of same taluk. Hombal and Lakkundi villages of Gadag taluk showed severity of 23.32 and 22.24 percent at soft dough stage. 6At Dharwad district, among the thirteen villages surveyed, lowest disease severity was observed by Hebsur of Dharwad taluk of 18.89 percent at boot leaf stage whereas highest severity was observed in Sulla (36.70%) and Byahatti (33.23%) of Hubballi taluk followed by Dharwad and Shalwadi villages of Dharwad taluk *i.e.*, 34.45 and 30.20 percent at soft dough stage. Navalgund of Navalgund taluk at soft dough stage showed 28.89 percent of disease severity followed by Hebballi of Dharwad taluk at flowering stage showed (28.83%). Hangaraki of Dharwad taluk at boot leaf stage showed 25.56 percent of disease severity followed by Arahatti (24.45%) and Garag (24.29%) villages of Dharwad taluka at soft dough and harvesting stage. Villages of Dharwad taluk *viz*., Tadakod, Shivalli, Durga colony recorded PDI of 23.34, 22.23 and 19.79 percent at flowering, soft dough and flowering stage respectively (Fig 4). Results are also in agreement with Harlapur (2005) who experienced Belagavi recorded the highest severity (55.89%) of maize leaf blight. Significant levels of the disease were also observed in Mysore (54.76%), Davanagere (53.86%), Mandya (53.85%) and Haveri (53.85%). Similar survey studies were also conducted by Khedekar *et al.* (2010) who recorded leaf blight incidence in maize in Sankeshwar (53.68%), Gokak (50.59%), Bailhongal (48.54%) and Soudatti (48.20%) talukas of Belagavi district. Gadag (45.33%) and Bagalkot districts (47.58%) also showed significant levels of turcicum leaf blight incidence.

Table 3: Leaf blight severity in major sorghum growing districts of northern Karnataka during *Rabi* 2023-24

District	Taluk	Village	Hybrid/Variety/Local	Irrigated/ Rainfed	Stage of the crop	Percent Disease Index	Other diseases observed
Dharwad		Garag	M-35-1	Irrigated	Harvesting stage	24.29	Rust
		Hangaraki	M-35-1	Irrigated	Boot leaf stage	25.56	Rust
		Tadakod	M-35-1	Rainfed	Flowering stage	23.31	Rust
		Pudakalakatti	Local	Rainfed	Vegetative stage	25.67	Rust
		Durga colony	Local	Rainfed	Flowering stage	19.79	Anthracnose
		Hebballi	M-35-1	Irrigated	Flowering stage	28.83	Rust
		Shivalli	M-35-1	Rainfed	Soft dough stage	22.23	Rust
		Dharwad	M-35-1	Rainfed	Soft dough stage	34.45	Rust
		Arahatti	Local	Rainfed	Soft dough stage	24.45	Rust
		Shalwadi	Local	Rainfed	Soft dough stage	30.20	Anthracnose
		Hebsur	Local	Rainfed	Boot leaf stage	18.89	Rust
		Taluk Mean				25.46	
	Hubbali	Sulla	M-35-1	Rainfed	Soft dough stage	36.70	Anthracnose
		Byahatti	M 35-1	Rainfed	Soft dough stage	33.23	Rust
		Taluk Mean				31.57	
	Navalgund	Navalgund	Local	Rainfed	Soft dough stage	28.89	Rust
		Taluk Mean				26.76	
		District Mean				22.71	
Gadag	Nargund	Nargund	Local	Rainfed	Soft dough stage	22.24	Rust
		Kalkeri	Local	Rainfed	Soft dough stage	24.47	Rust
		Kurlageri	Annigeri local	Rainfed	Boot leaf stage	32.23	Rust
		Taluk Mean				27.30	
	Gadag	Hombal	Local	Rainfed	Soft dough stage	23.32	Rust
		Lakkundi	Local	Rainfed	Soft dough stage	22.21	Rust
		Taluk Mean				24.52	
	Mundaragi	Dambal	Local	Irrigated	Boot leaf stage	34.54	Rust
		Mewundi	Local	Rainfed	Boot leaf stage	33.17	Rust, Anthracnose
		Mundaragi	Local	Rainfed	Soft dough stage	33.09	Rust, Anthracnose
					Taluk Mean	32.85	
		District Mean				25.64	
Haveri	Shiggaon	Neeralgi	Local	Irrigated	Flowering stage	32.21	Rust
		Adavisomapur	Local	Rainfed	Boot leaf stage	25.54	Rust
		Taluk Mean				25.87	
	Haveri	Meundi	Hybrid	Irrigated	Vegetative stage	20.15	Rust
		Belavigi	Hybrid	Irrigated	Soft dough stage	22.20	Rust
		Guttala	Hybrid	Irrigated	Soft dough stage	23.30	Rust
		Taredahalli	Hybrid	Irrigated	Soft dough stage	24.43	Rust
		Taluk Mean				23.78	
		District Mean				21.19	
Belagavi	Bailhongal	Belawadi	Hybrid	Irrigated	Vegetative stage	15.32	Rust
		Bailhongal	Hybrid	Irrigated	Physiological maturity stage	28.90	Rust
		Murkibhavi	Local	Rainfed	Soft dough stage	35.60	Rust, Smut
		Madanbhavi	Local	Irrigated	Soft dough stage	36.67	Rust
		Nesargi	Local	Rainfed	Soft dough stage	27.89	Rust
		Taluk Mean				28.55	
	Hukkeri	Hukkeri	Hybrid	Irrigated	Soft dough stage	16.70	Rust
		Hattargi	Local	Irrigated	Soft dough stage	31.90	Rust
		Taluk Mean				25.30	-
		District mean				26.25	
	Overall mean taluk					26.92	
	Overall mean district					24.95	

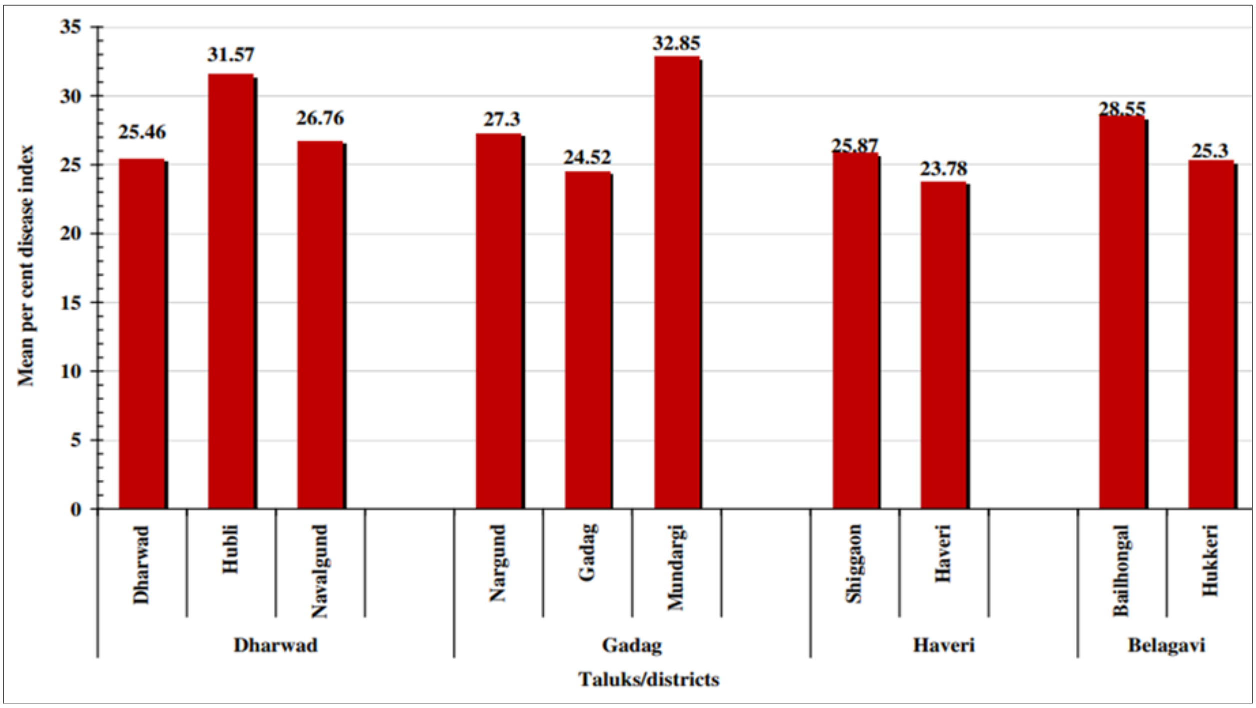

Fig 4: Districts and taluk wise severity of leaf blight of sorghum in northern Karnataka districts during *Rabi* 2023-2024

Ullstrup *et al.* (1957) [25] observed that the incidence and severity of Turcicum leaf blight (TLB) varied annually and geographically, with environmental factors playing a key role. Earlier surveys emphasized the importance of cultivar susceptibility and weather conditions in influencing the severity of the disease. Similar observations were also made by several researchers, including Gowda *et al.*, 1993, Laxminarayana and Shankarlingam (1983) [8, 17], Babu *et al.* (2004) [4] and Reddy *et al*. (2010) [16]. Favourable cropping-season weather conditions, year-round intensive maize farming, the limited genetic variety of commercial hybrids, and farmers' lack of adoption of disease management techniques are all factors contributing to the high proportion of disease occurrence. All of these elements work together to make the disease more common in certain places.

Conclusion
The mean PDI of sorghum leaf blight among different districts surveyed during *Kharif* is 26.81 percent. Gadag district showed highest disease severity of 28.52 percent while Ballari showed least disease severity (18.41%). During *Rabi* mean PDI of leaf blight recorded is 24.95 percent wherein Gadag district showed highest disease severity (25.64%) and Haveri showed least disease severity (21.19%) where sorghum was grown both under irrigated and rainfed conditions. It is observed that the disease severity was higher in sorghum crop during *Kharif* apparently due to the microclimate which favoured the development of disease. Across different locations local varieties favoured high leaf blight severity when compared to hybrids.

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References
1. Adhikari P, Mideros SX, Jamann TM. Differential regulation of maize and sorghum orthologs in response to the fungal pathogen *Exserohilum turcicum*. Front Plant Sci. 2021;12:675208.
2. Akram A, Fatima M, Ali S, Jilani G, Asghar R. Growth, yield and nutrients uptake of sorghum in response to integrated phosphorus and potassium management. Pak J Bot. 2007;39(4):1083.

3. Assefa Y, Holman JD, Obour AK, O'Brien D, Prasad PVV. Historic Grain Sorghum Production, Value, Yield Gap, and Weather Relation Trends. Agronomy. 2024;14(11):2582.
4. Babu R, Mani VP, Pandey AK, Pant SK, Rajeshsingh Kundu S, Gupta HS. Maize Research at Vivekananda Parvatiya Krishi Anusandhan Sansthan – An Overview. Technical Bulletin, Vivekanand Parvatiya Krishi Anusandhan Sansthan, Almora. 2004;21:31.
5. Carson ML. Inheritance of latent period length in maize infected with *Exserohilum turcicum*. Plant Dis. 1995;79:581-585.
6. Chadalavada K, Kumari BR, Kumar TS. Sorghum mitigates climate variability and change on crop yield and quality. Planta. 2021;253(5):113.
7. FAO. Food and Agricultural Organization of the United Nations. Available: Faostat statistics database. Accessed on 4/3/2019.
8. Gowda KTP, Shetty HS, Gowda BJ, Sangamlal S. Incidence of turcicum leaf blight of maize in southern Karnataka. Curr Res. 1993;22(6-8):100-101.
9. Haasbroek MP, Craven M, Barnes I, Crampton BG. Microsatellite and mating type primers for the maize and sorghum pathogen, *Exserohilum turcicum*. Aust Plant Pathol. 2014;43:577-581.
10. Habyarimana E, Gorthy S, Baloch FS, Ercisli S, Chung G. Whole-genome resequencing of *Sorghum bicolor* and *S. bicolor* × *S. halepense* lines provides new insights for improving plant agroecological characteristics. Sci Rep. 2022;12(1):5556.
11. Harlapur SI. Epidemiology and management of turcicum leaf blight of maize caused by *Exserohilum turcicum* (Pass) Leonard and Suggs. PhD Thesis, Univ Agril Sci, Dharwad, Karnataka, India. 2005. p.150.
12. Hossain MS, Islam MN, Rahman MM, Mostofa MG, Khan MAR. Sorghum: A prospective crop for climatic vulnerability, food and nutritional security. J Agric Food Res. 2022;8:100300.
13. Kazungu FK, Muindi EM, Mulinge JM. Overview of sorghum (*Sorghum bicolor* L), its economic importance, ecological requirements and production constraints in Kenya. Int J Plant Soil Sci. 2023;35(1):62-71.
14. Khalifa M, Eltahir EA. Assessment of global sorghum production, tolerance, and climate risk. Front Sustain Food Syst. 2023;7:1184373.
15. Khedekar SA, Harlapur SI, Kulkarni S, Benagi VI, Deshpande VK. Survey of turcicum leaf blight of maize in Northern Karnataka. J Plant Dis Sci. 2010;5(2):249-50.
16. Kumar MP, Reddy PN, Reddy RR, Sankar AS. Management of turcicum leaf blight caused by *Exserohilum turcicum* in maize. Indian J Plant Prot. 2010;38(1):63-66.
17. Laxminarayana C, Shankarlingam S. Turcicum leaf blight of maize, techniques of scoring for resistance to important diseases of maize. Proc All India Coordinated Maize Improvement Project. 1983;16-24.
18. Levy Y, Cohen Y. Biotic and environmental factors affecting infection of sweet corn with *Exserohilum turcicum*. Phytopathology. 1983;73(5):722-725.
19. Lucy OF, Ifedayo OA. Guinea corn (*Sorghum vulgare*) leaf, a potential source of nutrients and phytochemicals. Food Public Health. 2012;2(6):228-30.
20. Mundia CW, Secchi S, Akamani K, Wang G. A regional comparison of factors affecting global sorghum production: The case of North America, Asia and Africa's Sahel. Sustainability. 2019;11(7):2135.
21. Nieuwoudt A, Human MP, Craven M, Crampton BG. Genetic differentiation in populations of *Exserohilum turcicum* from maize and sorghum in South Africa. Plant Pathol. 2018;67(7):1483-1491.
22. Pallavi HU. Studies on Turcicum Leaf Blight and Common Rust Diseases of Sweet Corn (*Zea mays* L. saccharata). Doctoral dissertation, University of Agricultural Sciences, Dharwad. 2018.
23. Rashwan AK, Yones HA, Karim N, Taha EM, Chen W. Potential processing technologies for developing sorghum-based food products: An update and comprehensive review. Trends Food Sci Technol. 2021;110:168-182.
24. Thakur RP, Reddy BV, Mathur K. Screening techniques for sorghum diseases. Information: Bulletin No. 76. International Crops Research Institute for the Semi-Arid Tropics. 2007.
25. Ullstrup AJ, Miles SE. The effects of some leaf blights of corn on grain yield. Phytopathology. 1957.
26. Ullstrup AJ. Corn diseases in the United States and their control. Agricultural Research Service, US Department of Agriculture. 1961. No. 199.
27. Venkateswaran K, Elangovan M, Sivaraj N. Origin, domestication and diffusion of *Sorghum bicolor*. In: Breeding Sorghum for Diverse End Uses. Woodhead Publishing; 2019. p.15-31.
28. Wheeler BEJ. An Introduction to Plant Diseases. The English Language Book Society and Wiley and Sons Ltd. 1969.
29. Winchell F, Stevens CJ, Murphy C, Champion L, Fuller DQ. Evidence for sorghum domestication in fourth millennium BC eastern Sudan: Spikelet morphology from ceramic impressions of the Butana Group. Curr Anthropol. 2017;58(5):673-683.