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## Ajith CR

Ph.D. Scholar, Department of Plant Pathology, College of Agriculture, Dharwad, University of Agricultural Sciences, Dharwad, Karnataka, India

## Ashtaputre SA

Professor, Department of Plant Pathology, Institute of Organic Farming, University of Agricultural Sciences, Dharwad, Karnataka, India

## Rao MSL

Principle Scientist and Head, AICRP on Groundnut, Main Agricultural Research Station, Dharwad, Karnataka, India

## Corresponding Author:

### Ajith CR

Ph.D. Scholar, Department of Plant Pathology, College of Agriculture, Dharwad, University of Agricultural Sciences, Dharwad, Karnataka, India

## Seasonal distribution of leaf blight of sunflower (*Helianthus annuus* L.) caused by *Alternaria helianthi* (Hansf.) Tubaki and Nishihara in major sunflower growing regions of northern Karnataka

Ajith CR, Ashtaputre SA and Rao MSL

### Abstract

Sunflower (*Helianthus annuus* L.) annual, herbaceous oilseed crop grown in tropical, sub-tropical and warm temperate regions. Leaf blight of sunflower caused by *Alternaria helianthi* (Hansf.) Tubaki and Nishihara is the major disease causing significant seed and oil yield loss. An intensive roving survey was conducted to know the severity of leaf blight of sunflower, in different areas of northern Karnataka namely Gadag, Bagalkote, Belagavi, Vijayapura, Bellary and Haveri during *Kharif*- 2022 and *Rabi*-2022-23. During *Kharif* season, Mundaragi and Sindagi taluka of Gadag and Vijayapura districts, respectively recorded highest and lowest mean disease severity of 55.84 and 20.76 per cent, respectively, while during *rabi*, Bellary taluka of Bellary and Raibhag taluka of Belagavi district had highest and lowest leaf blight severity of 18.01 and 9.02 per cent, respectively. Among districts, Gadag and Vijayapura had highest mean leaf blight severity (51.28 and 16.01%, respectively) during *kharif* and *rabi* seasons, respectively.

**Keywords:** Sunflower, *Alternaria*, leaf blight, per cent disease index, severity, district, taluka, village

### 1. Introduction

Sunflower (*Helianthus annuus* L.) is an annual, herbaceous oilseed crop grows to a height of 5 feet belongs to the family Asteraceae (Mahadevaswamy *et al.*, 2016) <sup>[11]</sup>. The crop is native to Southern UAS and Mexico which ranks third among oilseed crop after groundnut and soybean. Initially it was grown as ornamental crop but later domesticated as to oilseed crop owing to its economic utility (Bains *et al.*, 1996) <sup>[3]</sup>. India ranks thirteenth position in sunflower production with 0.40 mha cultivation area with production of 0.22 mt and productivity of 0.83  $\text{tha}^{-1}$  (Indiaagrstat, 2022, world agricultural production, 2022) <sup>[23]</sup>. Karnataka is the largest producer of sunflower in India which accounts for 0.24 mha area, 0.13 mt production with 0.34  $\text{tha}^{-1}$  productivity (Indiaagrstat, 2022) <sup>[23]</sup>. Seeds are the economic part which are used for oil extraction, consumed raw, roasted, used for cattle and poultry feed and indifferent manufacture industries like paints, varnishes, margarines, cosmetics, shortenings, vegetable ghee etc. (Indumathi, 2011) <sup>[6]</sup>. Sunflower oil has high nutritive value and used for cooking and salads (Joksimovic *et al.*, 2008) <sup>[8]</sup>.

From last few years' area under sunflower cultivation has reduced drastically owing loss caused by different biotic and abiotic stresses, with a major share owned by diseases (Akash *et al.*, 2020) <sup>[1]</sup>.

Among several diseases which are severely affecting sunflower, leaf blight caused by *Alternaria* sp. is the major one which leading to severe yield loss depending on the stage of infection and severity of disease. The species of *Alternaria*, *A. helianthi* (Hansf.) Tubaki and Nishihara is the host specific species affecting sunflower and its wild descents. The pathogen attacks crop early in the crop growth at seedling stage only, with initial symptoms seen on old bottom leaves which further spreads to middle and upper young leaves. Initially minute yellow chlorotic spots seen on old leaves, which turn brown necrotic circular spots. These brown spots will be having yellow halo with light grey centers and concentric rings which are not that much conspicuous. As disease progresses, the spots enlarge in size, become irregular, coalesce with other lesions and cause blighting of leaves. Under severe disease conditions, complete leaf become blighted, curl and dry. Symptoms also seen on leaf petiole and stem which are elongated and dark brown or black in colour and on parts of capitulum *viz.*, ray florets, receptacle and bracts, spots were light brown to brown and elliptical in shape (Patel *et al.*,

2010; Prasad *et al.*, 2020) [15, 17]. Under severe epi-phytotic seed infection is noticed. Reduction in plant vigour, stem girth, head diameter, number of seeds per head, seed test weight, oil content and overall seed yield are the resultant of disease which accounts for 27-80 per cent seed yield loss, up to 34 per cent oil loss (Shankergoud *et al.*, 2006; Berglund, 2009, Mukhtar, 2011) [18, 4, 14] and 23-32 per cent germination failure (Prasad *et al.*, 2020) [17].

The pathogen is a saprophyte, survive in infected crop debris in field and some amount of seed borne nature is also reported (Jeffrey *et al.*, 1984) [7]. Leaf blight of sunflower is favored by continued humid/wet weather with minimum 4 hour's dew period (Kaur *et al.*, 1991) [9]. Daily and mean temperatures of 30 °C and 25 °C, respectively (Timmer *et al.*, 2003; Prasad *et al.*, 2009) [19, 16]. The pathogen conidia spread with wind, germinate at wide temperatures (Godoy and Fernandes, 1985) [5] and penetrates through epidermis directly or through wounds and stomata (Allen *et al.*, 1983) [2].

It's very much crucial to understand the distribution and severity of pathogen and disease in different regions of sunflower cultivation in different cultivation seasons before going for any of the research work related to it. A very little work has been done regarding distribution of sunflower leaf blight in northern parts of Karnataka covering only few major locations to acquaint the disease. Considering the importance of crop and disease, present study was undertaken to conduct survey in major sunflower growing regions of northern Karnataka for severity of leaf blight of sunflower during *Kharif- 2022* and *Rabi- 2022-23*.

$$\text{Per cent disease index} = \frac{\text{Summation of all numerical ratings}}{\text{Total no. of leaves observed} \times \text{maximum rating of scale}} \times 100$$

**Table 1:** Disease scoring scale (0-9 grade) for leaf blight of sunflower (Mayee and Datar, 1986) [12]

Percent leaf area infected	Score
Zero	0
Less than 1%	1
1-10%	3
11-25%	5
26-50%	7
More than 50%	9

### 3. Results and Discussion

An intensive survey was conducted in six major sunflower growing regions of northern Karnataka including Gadag, Vijayapura, Bagalkote, Belagavi, Bellary and Haveri during *Kharif 2022* and *Rabi 2022-23*. The data obtained from survey (Table 2 and Table 3, Figure 1 and Figure 2) revealed that leaf blight was common in all the growing locations with a significant variation in severity between different locations, seasons, hybrids cultivated, soil type and growth stage of the crop.

#### 3.1 Severity of leaf blight of sunflower during *Kharif 2022*

During *Kharif 2022*, a total of 50 villages in 17 talukas of 6 districts were surveyed where a district mean disease severity ranges of 29.09- 51.28 per cent was noticed with lowest mean disease severity noticed in Vijayapura district (29.09%) followed by Bagalkote (34.94%), while the highest mean leaf blight severity was recorded in Gadag district followed by Belagavi (51.28 and 48.19%, respectively). Among different talukas, Mundaragi taluka of Gadag district and Hagaribommanalli taluka of Bellary district recorded highest

### 2. Materials and Methods

Intensive roving survey was carried out in sunflower growing areas of Bagalkote, Belagavi, Gadag, Haveri, Bellary and Vijayapura districts of Karnataka during August-September 2022 and December-January 2022-23. The individual fields were visited and observations were recorded as per the following format.

The proforma used for survey of severity of leaf blight of sunflower is as follows

Sl. No.	Particulars
1	District
2	Taluka
3	Village
4	Soil type
5	Type of cultivation (Rain-fed/irrigated)
6	Growth stage of the crop during survey
7	Genotype/ hybrid cultivated
8	Acreage
9	Disease score
10	Prevalence of other diseases and insect pests

In each field, 10 plants were selected randomly from 5 random rows and 2 leaves each from bottom, middle and top of the crop canopy were observed and scored for severity of leaf blight disease using 0-9 disease scoring scale given by Mayee and Datar (1986) [12].

The average disease intensity (per cent disease index) of each field was worked out by using following formula given by Wheeler (1969) [22].

mean per cent disease index of 55.84 and 55.19, respectively, while Sindagi taluka of Vijayapura district had lowest mean per cent disease index of 20.76. Among different villages, sunflower fields in Alabur village of Hagaribommanahalli taluka, Bellary district showed highest disease severity of 80.74 per cent which was followed by 75.43 per cent disease severity in Bommanjogi village of Vijayapura taluka and district. Sunflower crop in Sarawad village of Vijayapura taluka and

Byakod village of Sindagi taluka in Vijayapura district had lowest per cent disease severity of 4.44 and 6.66 per cent.

In Gadag district, three talukas and eight villages were surveyed which recorded 51.28 per cent district mean leaf blight severity. Among talukas, Mundaragi recorded highest mean PDI of 55.84 with disease severity range of 43.63-72.22 per cent followed by 49.07 per cent in Shirahatti and Nargund taluka (48.93%). In Mundaragi taluka, sunflower fields in Dambala village and Kadampura village recorded highest and lowest disease severity (72.22 and 43.63%, respectively). However, in Shirahatti taluka, Akkigunda and Gojanur are the villages which had highest and lowest disease severity of 50.13 and 48 per cent, respectively. Similarly, in Nargund taluka, Erekipa and Uruvinakoppa villages recorded highest and lowest disease severity of 52.23 and 45.62 per cent, respectively.

Among two talukas surveyed in Belagavi district, Ramdurg recorded highest mean leaf blight severity and Raibhag recorded lowest disease severity (50.02 and 46.36%, respectively with a district mean of 48.19 per cent. In Ramdurg taluka, sunflower fields in Batakurki village and Mudnur village had highest and least disease severity (59.72

and 42.69%, respectively), while in Raibhag taluka, Nasalapura and Maradi villages showed highest and lowest leaf blight severity (53.22 and 37.64%, respectively).

Similarly, in Bagalkote, five talukas were surveyed which recorded district mean leaf blight severity of 34.94 per cent with lowest taluka mean disease severity in Bagalkote taluka followed by Mudhol taluka (27.72 and 32.36%, respectively) and highest mean value in Bilagi and Jamkhandi talukas (40.62 and 40.42%, respectively). In Bagalkote taluka, among villages Kajjidoni and Udagatti recorded 25.19 and 30.25 per cent leaf blight severity, respectively, whereas in Mudhol taluka Varchagal and Byadaraaralikatti villages had 27.30 and 37.54 per cent leaf blight severity. In the same way, sunflower fields in Anagwadi and Nagaral villages of Bilagi taluka shown 33.76 and 47.47 per cent disease severity. In Hunagund taluka and Jamkhandi taluka villages namely Konnur and Timmapura (54.22 and 14.22%, respectively) and Kunchanur and Kumbarhal villages (45.62 and 34.89%, respectively) recorded highest and lowest leaf blight severity, respectively.

Sunflower fields in different villages of Vijayapura, Sindagi and Indi talukas were surveyed in Vijayapura district which recorded mean disease severity of 35.55, 20.76 and 30.97 per cent, respectively with a district mean of 29.09 per cent. In Vijayapura taluka, Sarawad and Bommanjogi villages had lowest and highest disease severity (4.44 and 75.43 %, respectively), similarly in Sindagi taluka Byakod and Sindagi rural villages had lowest and highest leaf blight severity (6.66 and 35.10 %, respectively) where in both least severity case crop was at vegetative state (45 days old). However, in Indi taluka, Gotyal and Atharga villages recorded 29.23 and 32.71 per cent disease index.

In the same way sunflower fields in two talukas viz., Hoapet and Hagaribommanahalli were visited in Bellary district. In Hospet taluka Nagalapura and Kamalapur shown least and highest leaf blight severity (24.44 and 32.52%, respectively) with a taluka mean of 27.73 per cent, while Hagaribommanahalli taluka recorded 55.19 per cent mean leaf blight

severity with least severity in Kogali village and highest in Alabur village (39.62 and 80.74%, respectively) with a district mean of 41.46 per cent.

During survey in Haveri district, Ranebennur and Haveri taluka sunflower fields were visited and found that leaf blight severity ranged between 10.18 to 52.62 per cent, where least disease severity was observed in Honnatti village (10.18%) of Ranebennur while highest disease severity was recorded in Hosalli village (52.62%) of Haveri taluka. The talukas had a mean leaf blight severity of 45.78 and 42.58 per cent in Haveri and Ranebennur talukas, respectively with a district mean of 44.18 per cent.

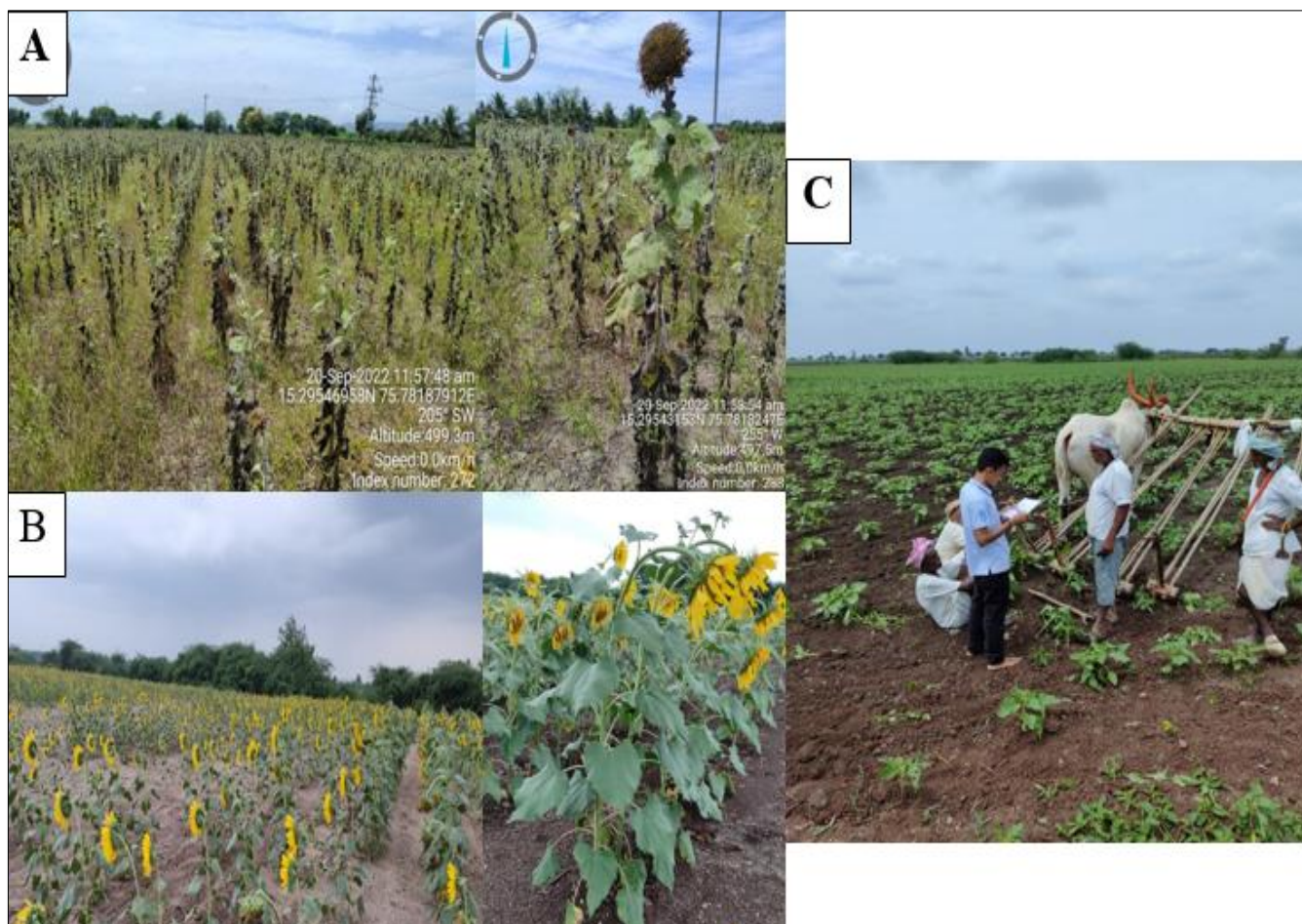
During *Kharif* survey apart from leaf blight, necrosis, powdery mildew, *Sclerotium* root rot were also observed in many villages and with respect to insect pests, head borer and Bihar hairy caterpillar are the major one which attacked sunflower crop.

### 3.2 Severity of leaf blight of sunflower during *Rabi* 2022-23

During, *Rabi*- 2022-23, in 14 talukas of 6 districts, 47 villages were visited to investigate sunflower leaf blight severity and observed that disease pressure was lower compared to *Kharif* season. Haveri and Belagavi districts had least mean leaf blight severity of 11.32 and 12.5 per cent, respectively while Vijayapura and Bellary districts had highest mean leaf blight severity of 16.01 and 13.79 per cent, respectively. Among talukas, Bellary taluka followed by Vijayapura taluka had highest disease pressure (18.01 and 17.24%, respectively), whereas, Raibhag taluka of Belagavi and Hirekerur taluka of Haveri recorded least mean disease severity (9.02 and 9.58 per cent, respectively). When look into different villages, Devara hipparagi village of Vijayapura and Vannenu village of Bellary had highest leaf blight severity (28.23 and 26.33 PDI, respectively), while Thaluru village of Sanduru taluka Bellary district and Mekali village of Raibhag taluka Belagavi district recorded least disease severity (5.87 and 6.25 per cent, respectively).



**Plate 1:** Symptoms of leaf blight of sunflower on different plant parts, A) on bottom old leaves at seedling stage of crop, B) severe leaf infection, C) on leaf petiole, D) on stem, E) infection of head, bracts and ray florets, F) infected plant, G) infection of head, H) severely affected head at maturity of crop



**Plate 2:** Severity of leaf blight of sunflower during A) *Kharif* B) *Rabi* season, C) interaction and data collection from farmers during survey

In Gadag district with mean severity of 12.98 per cent, Doni village and Neeralgi village of Gadag taluka recorded lowest and highest leaf blight severity (8.22 and 12.38%, respectively) with a taluka mean of 10.32 per cent, while in Nargund taluka with mean severity of 15.63 per cent, Lowest and highest leaf blight severity of 12.61 and 18.64 per cent was recorded in Arishinagodi and Benakanakoppa villages, respectively.

Similarly, in Bagalkote district which had mean leaf blight severity of 12.78 per cent, Badami taluka had least leaf blight severity (9.77%) followed by Mudhol (12.66%), while Hunagund and Jamkhandi talukas recorded highest of 15.14 and 13.57 per cent leaf blight severity, respectively. The sunflower fields in villages Kulgeri and Narasapura (7.45 and 12.32%, respectively) in Badami taluka, Machaknur and Melligeri villages (6.52 and 17.24%, respectively) of Mudhol taluka, Langanur and Mariguddi villages (8.34 and 20.41%, respectively) of Jamkhandi talukas and Krishnapura and Balgundi villages (10.32 and 21.87%, respectively) of Hunagund taluka recorded lowest and highest leaf blight disease severity, respectively.

Raibhag and Athani talukas of Belagavi recorded mean leaf blight severity of 9.02 and 15.98 per cent, with a district mean of 12.5 per cent with lowest and highest leaf blight severity in sunflower fields of Kottalgi and Aigali villages (8.65 and 15.66%, respectively) of Athani taluka and Mekali and

Chinchali villages (6.25 and 11.32%, respectively) of Raibhag taluka.

In Vijayapura district with mean leaf blight severity of 16.01 per cent lowest severity was recorded in Kannur village (7.22%) of Vijayapura taluka and Bannihatti village (8.56%) of Sindagi taluka and highest severity in Devara hipparagi (28.23%) and Rampura village (22.12%) of Vijayapura and Sindagi talukas, respectively with a taluka mean value of 14.77 and 17.24 per cent, respectively.

Similarly, sunflower fields in Nitturu village of Ranebennur taluka and Yallapur village of Hirekerur taluka of Haveri district recorded lowest leaf blight severity of 7.44 and 8.21 per cent, respectively, while Kuppelur and Chikkerur village of Ranebennur and Hirekerur talukas had highest severity (21.35 and 10.44%, respectively) in corresponding talukas. The Ranebennur taluka recorded mean severity of 13.31 per cent and Hirekerur recorded 9.32 per cent mean severity with an overall Haveri district mean of 11.32 per cent.

Bellary and Sandur talukas were visited in Bellary district during *Rabi* survey where both talukas recorded mean leaf blight severity of 18.01 and 9.58 per cent, respectively with 13.79 district mean severity. Gotur and Vannenu villages of Bellary taluka, Talur and Kodalu villages of Sandur taluka recorded lowest and highest leaf blight severity (12.33, 26.33, 5.87, 15.22%, respectively) in respective talukas.

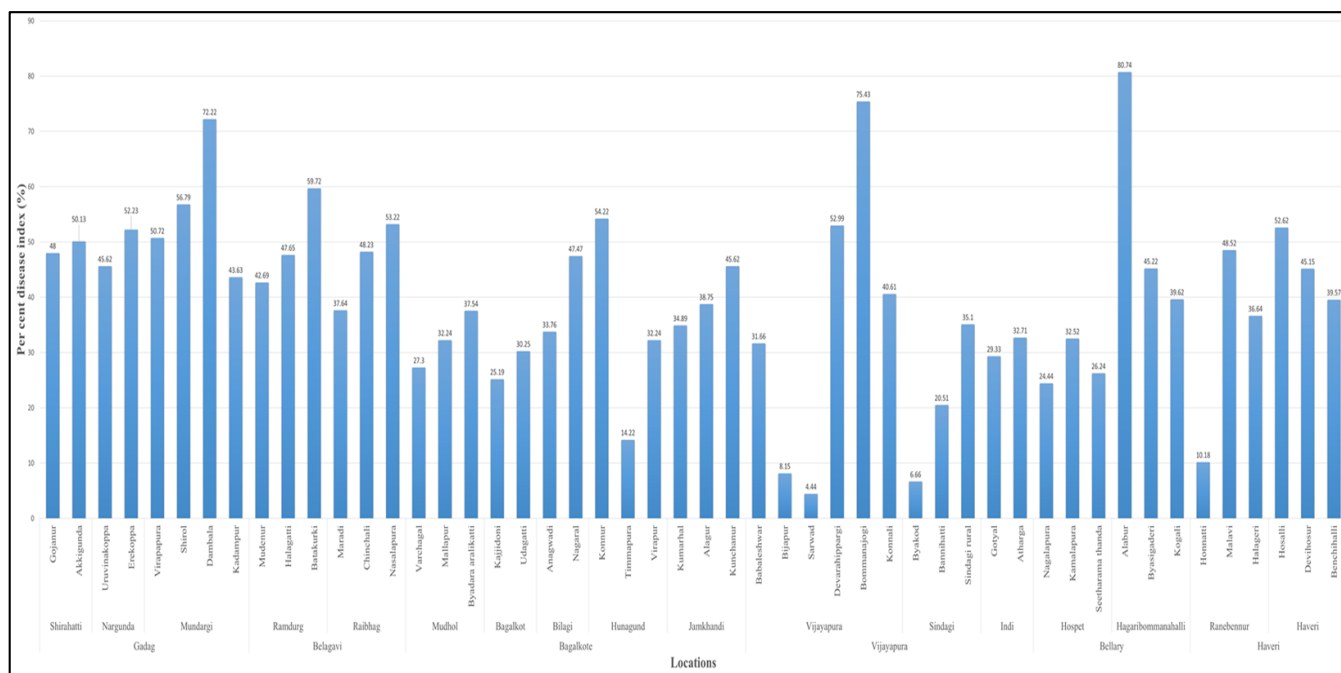


Fig 1: Severity of leaf blight of sunflower in major sunflower growing areas of northern Karnataka during Kharif-2022

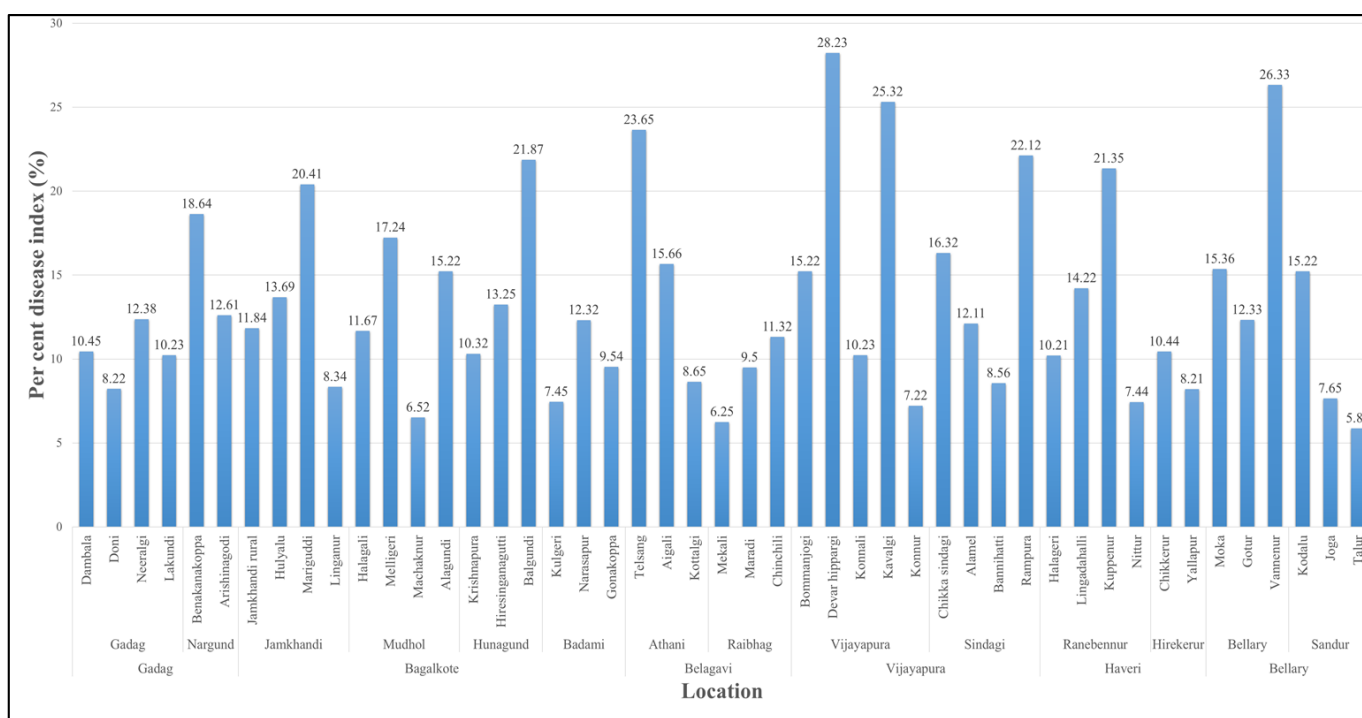


Fig 2: Severity of leaf blight of sunflower in major sunflower growing areas of northern Karnataka during Rabi-2022-23

Table 2: Severity of leaf blight of sunflower in different talukas and districts during Kharif-2022 and Rabi-2022-23

District	Taluk	Taluk mean	
		Kharif	Rabi
Gadag	Shirhatti	49.07	--
	Nargund	48.93	15.63
	Mundargi	55.84	--
	Gadag	--	10.32
Belagavi	Mean	51.28	12.98
	Ramdurga	50.02	--
	Raibag	46.36	9.02
	Athani	--	15.98
Bagalkot	Mean	48.19	12.5
	Mudhol	32.36	12.66
	Bagalkot	27.72	--

	Bilgi	40.62	--
	Hungund	33.56	15.14
	Jamkhandi	40.42	13.57
	Badami	--	9.77
	Mean	34.94	12.78
Bijapur	Bijapur	35.55	17.24
	Sindagi	20.76	14.77
	Indi	30.97	--
	Mean	29.09	16.01
Ballary	Hosapet	27.73	--
	Hagaribommanalli	55.19	--
	Ballary	--	18.01
	Sonduru	--	9.58
	Mean	41.46	13.79
Haveri	Ranebennur	42.58	13.31
	Haveri	45.78	--
	Hirekerur	--	9.32
	Mean	44.18	11.32

During *Rabi* survey necrosis and powdery mildew were commonly found in majority of the sunflower fields.

### 3.3 Severity of leaf blight of sunflower as affected by season, soil type, crop growth stage and hybrid grown

There was a considerable variation was observed with respect to leaf blight severity between different seasons, soil type, crop growth stage and hybrid grown. Among seasons i.e. *Kharif* 2022 and *Rabi* 2022-23, leaf blight was more severe during *Kharif* season (41.52% mean PDI) as compared to *Rabi* season (13.23% mean PDI) owing to favorable weather conditions for the disease.

During survey it was noted that Ganga Kaveri, ITC, Sandoz, SB 293 and PAC 334 were the sunflower hybrids commonly grown in both seasons where disease pressure was different in different hybrids in *Kharif* season (31.31- 43.06% mean PDI) while in *Rabi* season all the hybrids showed almost similar disease pressure which ranged from 8.49 to 15.33 mean leaf blight severity. The hybrid Ganga Kaveri recorded highest of 43.06 per cent mean disease severity in *Kharif* season, while

in *Rabi* it recorded 14.54 per cent mean disease severity. Other hybrids viz., Sandoz, PAC 334, ITC and SB 293 recorded 32.83, 32.29, 32.09 and 31.31 and 11.46, 15.04, 15.33 and 8.49 per cent mean leaf blight severity during *Kharif* and *Rabi* seasons, respectively.

In Both the seasons, leaf blight severity was lowest at the early stage of the crop, which drastically increased towards the crop maturity in both seasons. At vegetative stage, during *Kharif* season disease severity was 7.59 per cent while during *Rabi* it was 9.44 per cent. And in fields where crop was at flowering state, disease pressure of 32.03 and 17.09 per cent was noticed in *Kharif* and *Rabi* seasons, respectively. While in fields with crop at maturity state severe leaf blight infestation was seen during *Kharif* (47.29%) while in *Rabi* it was moderate (25.22%) but compared to other growth stages, at maturity severe infection was observed.

**Table 3:** Severity of leaf blight of sunflower as affected by different factors during *Kharif*- 2022 and *Rabi*- 2022-23

Factors	Group	Particulars	Number of fields		Mean PDI	
			<i>Kharif</i> - 2022	<i>Rabi</i> - 2022-23	<i>Kharif</i> - 2022	<i>Rabi</i> - 2022-23
Season					41.52	13.23
Genotype	I	ITC	7	6	32.09	15.33
	II	Sandoz	3	4	32.83	11.46
	III	Ganga Kaveri	7	7	43.06	14.54
	IV	SB 293	5	2	31.31	8.49
	V	PAC 334	3	3	32.29	15.04
Crop growth stage	I	Vegetative	3	25	7.59	9.44
	II	Flowering	18	19	32.03	17.09
	III	Maturity	29	3	47.29	25.22
Soil type	I	Red	29	21	39.21	11.86
	II	Black	21	26	39.26	14.87

With respect to soil type, red and black soils are the major groups where sunflower cultivated in both seasons. During *Kharif* season, sunflower crop had no difference in leaf blight severity in both soil types where 39.21 and 39.26 per cent mean disease severity in red and black soil, respectively owing to major influence of weather parameters on disease than soil type. However, in *Rabi* season, the both soil types shown different leaf blight pressure level with highest severity in black soil (14.87%) than red soil (11.86%) which might be attributed to factors like water holding capacity and irrigation. Similar results were obtained by Mesta (2009) [13] where they conducted survey on sunflower *Alternaria* blight in

Bagalkote, Vijayapura, Gulbarga, Koppal and Raichur during *Kharif* season and observed disease pressure up to 41.40 per cent with highest disease severity in Bagalkote district (50.3%), while Bagalkote taluka of hitted worse by leaf blight. Vidyashree *et al.* (2020) [21] also reported sunflower *Alternaria* blight in all surveyed locations with greater severity in Koppal and Bellary (45.34 and 40.46%, respectively) with a severity range of 13.33 to 65.60 per cent in different locations. High disease severity was attributed to congenial weather conditions which includes heavy rainfall, high relative humidity and moderate temperatures (Mesta *et al.*, 2009) [13]. Prasad *et al.*, 2009 [16] also postulated that

sunflower leaf blight is most common in wet weather with daily and mean temperatures of 30 and 25 °C. High severity of old plants than young plants was reported by Kgate *et al.* (2020)<sup>[10]</sup> where they found 100 per cent mortality with less disease pressure on 15 days old plants while, 45 days old plants showed no mortality with severe outbreak of leaf blight.

#### 4. Conclusion

Leaf blight caused by *A. helianthi* is the major disease of sunflower causing considerable economic loss to farmers under favorable and severe disease epi-phytotic. The severity of the disease was varied in different locations, seasons, growth stage of the crop, hybrid grown and in different soil types. Gadag district had higher leaf blight severity in *Kharif* while in *Rabi* Vijayapura district recorded highest leaf blight severity. Severe outbreak of leaf blight was observed in *Kharif* season under rain fed system compared to *Rabi* season which was favored by heavy rains with humid or wet weather and moderate temperatures. From the survey data it was clear that with irrigation facility, raising sunflower crop in late *Kharif* or in *Rabi* season is more beneficial to get higher yield with less severity of disease.

#### 5. References

1. Akash IP, Ingle ST, Choudhari RJ. Efficacy of fungicides and *Trichoderma viride* mutants against *A. helianthi* causing leaf blight of sunflower. *Journal of Pharmacognosy and Phytochemistry*. 2020;8(4):1041-1044.
2. Allen SE, Brown JF, Kochman JK. Production of inoculum and field assessment of *A. helianthi* on sunflower. *Plant Disease*. 1983;67:665-668.
3. Bains SS, Hardip S, Karanpal S, Dhima JSH, Singh K. Powdery mildew of sunflower in Punjab. *Indian Journal of Mycology and Plant Pathology*. 1996;26(1):90-92
4. Berglund DR. Extension Publication A-1331. North Dakota Agricultural Experiment Station and North Dakota State University; c2009.
5. Godoy JR, Fernandes NG. *Alternaria helianthi* (Hansf.) Tubaki & Nishihara on sunflower (*Helianthus annuus* L.): Influence of the age of the plant in susceptibility and infection of the seed. *Summa Phytopathologica*. 1985a;11:186-197.
6. Indumathi S. Integrated Disease Management of *Alternaria* Leaf Spot of Sunflower Caused by *Alternaria helianthi* (Hans F.) Tubaki and Nishihara, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad. M.Sc. thesis; c2011. p. 1-123.
7. Jeffrey KK, Lipps PE, Herr LJ. Effects of isolate virulence, plant age and crop residues on seedling blight of sunflower caused by *Alternaria helianthi*. *Phytopathology*. 1984;74(9):1107-1110.
8. Joksimovic J, Jovanka A, Marinkovic R, Jovanovi D. Genetic control of oleic and linoleic acid contents in sunflower. *Helia*. 2008;29:33-40.
9. Kaur J, Chahal SS, Aulakh KS. Differential efficiency of different methods in detection and location of seed borne fungi in sunflower. *Plant Disease Research*. 1990;5(1):53-58.
10. Kgate MB, Flett M, Truter, Aveling T. Control of *Alternaria* leaf blight caused by *Alternaria alternata* on sunflower using fungicides and *Bacillus amyloliquefaciens*. *Crop Protection*; c2020. p. 105-146.
11. Mahadevaswamy G, Vijayalakshmi G, Murali R, Gangadharanaik B. Survey for the *Alternaria* blight of sunflower in Southern transition zone of Karnataka. *Advances in Life Sciences*. 2016;5(6):2348-2351.
12. Mayee CD and Datar VV. *Phytopathometry*, Technical Bulletin 1. Marathwada Agricultural University, Parbhani; c1986. p. 146.
13. Mesta RK, Benagi VI, Shankergoud I and Megeri N. Survey for the status of *Alternaria* blight of sunflower in Northern Karnataka. *Karnataka Journal of Agricultural Sciences*. 2009;22(5):1032-1037.
14. Mukhtar I. Sunflower disease and insect pests in Pakistan: A review. *African Crop Science Journal*. 2010;17(2):109-118.
15. Patel VV, Singh CP, Mishra US. Symptomatological studies on leaf blight of sunflower caused by *A. helianthi* in Rohilkhand. *Advances in Bioresearch*. 2010;1(1):97-100.
16. Prasad MSL, Sujatha M, Rao SC. Analysis of cultural and genetic diversity in *Alternaria helianthi* and determination of pathogenic variability using wild *Helianthi* species. *Journal of Phytopathology*. 2009;157:609-617.
17. Prasad MSL, Naresh KN, Sujatha D, Usha M, Sujatha C, Sarada S, *et al.* Population structure of *Alternaria* species causing leaf blight of sunflower (*Helianthus annuus* L.) in India. *Phytoparasitica*. 2020;48:335-356.
18. Shankergoud I, Shadakshari YG, Parameshwarappa KG, Chandranath HT, Katti P, Mesta RK. Sunflower and Castor research in Karnataka - An overview, University of Agricultural Sciences, Dharwad; c2006. p. 1-41.
19. Timmer LW, Peever TL, Solel Z, Akimitsu K. *Alternaria* diseases of citrus-novel patho-systems. *Phytopathologia Medditerranea*. 2003;42:1-16.
20. Tubaki K and Nishihara N. *Alternaria helianthi* (Hansf.) Comb. Nov. *Trans. British Mycological Society*. 1969;53:147-149.
21. Vidyashree P, Yenjerappa ST, Pramesh D, Gururaj S, Vikas K. Present status of *Alternaria* leaf blight disease of sunflower in North Eastern Karnataka. *International Journal of Chemical Studies*. 2020;8(3):2906-2908.
22. Wheeler BEJ. An introduction to Plant Diseases. *Plant Diseases*; c1969. p. 374.
23. [www.indiaagristat.com](http://www.indiaagristat.com); c2022.
24. [www.worldsgricproduction.com](http://www.worldsgricproduction.com); c2022.