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RESEARCH PAPER

Distribution of early blight in major tomato growing areas of Dharwad district in Karnataka

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Abstract: Early blight caused by *Alternaria solani* is the most destructive and threatening disease causing yield losses up to 80 per cent resulting in a drastic reduction in the quantity and quality of fruit yield of tomato. In the present study, a roving survey was undertaken in major tomato growing taluks of Dharwad district *viz.,* Dharwad, Hubli and Kalghatgi during *kharif* (2021-22 and 2022-23), *rabi* (2021-22 and 2022-23), as well as during summer 2022 and 2023 to know the severity of the disease. The highest mean severity of early blight was recorded (47.44 and 34.35%) during *kharif* 2021-22 and *kharif* 2022-23, respectively. Whereas the least mean per cent disease severity was noticed during summer 2022 and 2023 (7.33 and 13.06%, respectively). In general, irrespective of the seasons and years, tomato fields with black soil and crop fruiting stage recorded more disease severity as compared to red soil and crop flowering stage.

Key words: *Alternaria solani*, Per cent disease index, Survey, Tomato

Introduction

Tomato (*Solanum lycopersicum* L.) belongs to the solonaceae family and rank as the second most important and widely grown vegetable crop throughout the world after potato (Pritesh and Subramanian, 2011; Hadian *et al*., 2011). Its fruit is used both fresh as well as processed and is a rich source of vitamins A, B, C, and E, as well as other important nutrients like protein, carbohydrates, fiber, fat, biotin, citric acid, oxalic acid, malic acid and antioxidants such as lycopene, that helps prevent cancer and protects against harmful free radicals. They are low in calories, have no cholesterol, contains 95.3 per cent of water and 0.07 per cent niacin and calcium that support metabolism and overall health. (Sgherri *et al*., 2008).

It is native to South America and is globally grown in 140 countries of the world. It was perhaps introduced to India by the Portuguese during 1700 (Kale and Kale, 1994). Tomato consumption is concentrated in China, India, North Africa, the Middle East, the US and Brazil with per capita consumption ranging from 61.9 to 198.9 kg (FAOSTAT, 2019). China leads in tomato production followed by India and the USA. In India, it is cultivated in an area of 840 thousand hectares with a production of 20.33 mt and with a productivity of 24.20 t/h. The major tomato growing states in the country include Andhra Pradesh, Madhya Pradesh, Karnataka, Gujarat, Odisha, West Bengal and Maharashtra. (Anon., 2022).

Tomato is grown well in a wide range of soil types, which are high in organic matter, well-drained and heavily amended with organic matter and should have good moisture retaining capacity and a pH range of 5.0-7.5. (Robert, 2005). Tomato crops are susceptible to number of diseases throughout their growing season. Among them early blight caused by *Alternaria solani* (Ellis and Martin) Jones and Grout is the most destructive and threatening in all over the world, causing yield losses up to 80 per cent (Datar and Mayee, 1981, Chandravanshi *et al*., 1994, Balanchard, 1992, Gomaa, 2001, Abdel-Sayed, 2006 and Abada *et al*., 2008) resulting in a drastic reduction in the quantity and quality of fruit yield of tomato.

The disease appears on fruit, stem and foliage of tomatoes. Initially, leaves exhibit small 1 - 2 mm black or brown lesions, which, under favourable conditions enlarge upto 10 mm in diameter typically displaying dark pigmented concentric rings, forming a distinctive “bull’s eye” type lesion and are often surrounded by yellow halo. Stems show sunken, lens-shaped lesions with a light center, featuring the typical concentric rings. Lesions may completely encircle the stem of young tomato seedlings, a stage referred as “collar rot” which may lead to reduced plant vigour or death. The symptoms on tomato fruit occurs through the calyx, displaying a leathery appearance and may have the characteristic concentric rings.

The severity of early blight has been increased at an alarming rate in the recent past, particularly in the major tomato growing parts of Dharwad district in Karnataka. In spite of its destructive nature, not much research work has been done on different aspects of the disease. Hence, the present study was undertaken considering different aspects like survey of the disease to know its severity in different districts of northern Karnataka, with this background the present study was taken up by conducting the roving survey in parts of Dharwad, district of Karnataka. The survey also provides additional insights into the soil types, irrigation practices, susceptible stages of the crop and the presence of other diseases on that particular localities.

Material and methods

In the present study, An intensive roving survey was carried out at three taluks *viz.,* Dharwad, Hubli and Kalghatgi in Dharwad district of Karnataka during October–November and January-February 2021-22 and 2022-23 and summer 2022 and

2023. During the survey individual tomato fields on the survey route were visited and observed for early blight severity, genotype grown, crop stage, crop grown condition, other diseases observed, soil type and other details were recorded. In each field, 10 plants were selected randomly from a $2m^2$ quadrat and five leaves each from bottom, middle and top were scored for severity of early blight using 0 to 5 disease scoring scale based on per cent leaf area infection as described by Pandey *et al.* (2003) through visual observations as given below.

Disease scale (0-5 grade) for early blight of tomato given by Pandey *et al.* (2003)

Scale	Percent leaf area infected
0	Free from infection.
1	< 10 % leaf area infected.
2	10-25 % leaf area infected.
3	26-50 % leaf areas infected
4	51-75 % leaf area infected
5	> 75 % leaf area infected

Further, per cent severity of each field was calculated by using the following formula of Wheeler (1969).

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

Results discussion

A roving survey was undertaken during both *kharif* (October and November) and *rabi* seasons (January and February) of 2021-22 and 2022-23 as well as summer season (April and May) 2022 and 2023 to assess the severity of early blight in major tomato growing areas of Dharwad, Hubli and Kalghatgi taluks in Dharwad district of Karnataka. Along with disease severity other parameters like soil type, crop grown condition, stage of the crop, genotype grown and other diseases observed were also tabulated (Table 1, 2, 3, 4, 5 and 6).

Severity of early blight during *kharif* 2021-22

Totally 13 villages of three taluks were surveyed during *kharif* 2021-22. In Dharwad taluk the higher severity of early blight (55.30%) was recorded in Garag village followed by Kotur with severity of 50.23 per cent. while, the least disease severity (15.11%) was recorded in Narendra village of Dharwad taluk. (Table 1).

Similarly in Hhubli taluk, the maximum severity (50.18%) was recorded in Anchatgeri village whereas, the least severity (45.78 %) was recorded in Gopankop village. In Kalghatgi taluk, the maximum severity of early blight (75.43%) was recorded in Kurankoppa village followed by Dhummawad village with severity of 72.44 per cent whereas, least disease severity (20.17%) was recorded in Chalmatti village. Among the taluks surveyed in Dharwad district, the maximum mean severity (55.48%) was recorded in Kalghatgi followed by Hubli (48.27%) whereas, the least severity (45.78%) was recorded in Dharwad taluk.

Severity of early blight during *rabi* 2021-22

Totally 15 villages of three taluks *viz.,* Dharwad, Hubli and Kalghatgi was surveyed in Dharwad district during *rabi* 2021-22. In Dharwad taluk, the maximum severity of early blight (25.87%)

Table 1. Survey for severity of early blight of tomato in Dharwad district of Karnataka during *kharif* 2021-22

District	Taluk	Village	Genotype grown	Crop stage	Crop grown condition	Soil type	Per cent Disease Index (PDI)	Other diseases observed
Dharwad	Dharwad	Narendra	Sagar	Flowering	Irrigated	Red	15.11	-
		Narendra	Vaishali	Fruiting	Irrigated	Red	39.42	-
		UAS Campus	Durg	Fruiting	Irrigated	Black	42.34	-
		Lakamapur	Sagar	Fruiting	Irrigated	Black	39.60	-
		Mummigatti	Shankar	Fruiting	Irrigated	Red	36.12	
		Garag	Sushant	Fruiting	Irrigated	Red	55.30	-
		Garag	Sagar	Fruiting	Irrigated	Black	43.57	-
		Garag	Jawari - Local	Flowering	Irrigated	Black	25.30	-
		Kotur	-	Fruiting	Irrigated	Black	50.23	-
		Taluk mean	38.55					
	Hubli	Anchatgeri	Sagar	Fruiting	Irrigated	Red	50.18	
		Gopankop	Sagar	Fruiting	Irrigated	Red	45.78	Buck eye rot
		Gopankop	Sagar	Fruiting	Irrigated	Red	48.87	-
		Taluk mean	48.27					
	Kalghatgi	Chalmatti	Jawari - Local	Fruiting	Irrigated	Red	20.17	-
		Kurankoppa	Sagar	Fruiting	Irrigated	Black	75.43	-
		Kurankoppa	Sagar	Fruiting	Irrigated	Red	68.33	-
		Jammihal	Vaishali	Fruiting	Irrigated	Black	55.22	-
		Mishrikot	Sagar	Fruiting	Irrigated	Red	55.88	-
		Dhummawad	Sagar	Fruiting	Irrigated	Red	40.91	-
		Dhummawad	Jawari - Local	Fruiting	Irrigated	Black	72.44	-
		Taluk mean	55.48					
		District mean	47.44					

Table 2. Survey for severity of early blight of tomato in Dharwad district of Karnataka during *rabi* 2021-22

Taluk	Village	Genotype grown	Crop stage	Crop grown condition	Soil type	Per cent disease Index (PDI)	Other diseases observed
Dharwad	Lakamapur	Sagar	Fruiting	Irrigated	Black	20.37	-
	Narendra	Sagar	Flowering	Irrigated	Red	5.56	-
	Narendra	Sagar	Fruiting	Irrigated	Black	18.66	-
	Narendra	Sagar	Flowering	Irrigated	Red	6.45	-
	Narendra	Sagar	Fruiting	Irrigated	Black	25.87	-
	Mummigatti	Jawari	Fruiting	Irrigated	Red	17.13	-
	Garag	Sagar	Fruiting	Irrigated	Red	16.44	-
	Garag	Shankar	Fruiting	Irrigated	Red	22.53	-
	Kumbarganvi	Sagar	Flowering	Irrigated	Red	2.45	-
	Kavalgeri	Vaishali	Flowering	Irrigated	Red	8.54	-
	Kavalgeri	Jawari	Flowering	Irrigated	Red	5.32	-
			Taluk mean			13.57	
Hubli	Gopankop	Shankar	Fruiting	Irrigated	Black	21.55	-
	Palikop	Sagar	Fruiting	Irrigated	Red	10.66	-
	Unkal	Abilash	Flowering	Irrigated	Red	8.43	-
			Taluk mean			13.54	
Kalghatgi	Devalingikoppa	Shankar	Flowering	Irrigated	Red	11.40	-
	Jammihal	Sagar	Fruiting	Irrigated	Red	10.88	-
	Jammihal	Sagar	Flowering	Irrigated	Red	7.56	-
	Gambyapur	Sagar	Fruiting	Irrigated	Black	40.17	-
	Dhummawad	Sagar	Fruiting	Irrigated	Black	22.14	-
	Dhummawad	Sagar	Fruiting	Irrigated	Black	37.85	-
	Yammihatti	Shivam	Fruiting	Irrigated	Black	37.55	Powdery mildew
	Bangittigudihal	Siri	Fruiting	Irrigated	Black	38.48	-
			Taluk mean			25.75	
			District mean			17.62	

Table 3. Survey for severity of early blight of tomato in Dharwad district of Karnataka during summer 2022

Taluk	Village	Genotype grown	Crop stage	Crop grown condition	Soil type	Per cent Disease index (PDI)	Other diseases observed
Dharwad	Narendra	Sagar	Fruiting	Irrigated	Black	8.36	Leaf curl
	Narendra	Sagar	Fruiting	Irrigated	Red	4.56	Leaf curl
	Garag	Sagar	Flowering	Irrigated	Black	5.76	-
	Garag	Shankar	Fruiting	Irrigated	Red	3.76	Leaf curl
	Belur	Sagar	Fruiting	Irrigated	Red	4.18	Leaf curl
	Kotabagi	Sagar	Fruiting	Irrigated	Black	9.24	Leaf curl
			Taluk mean			5.97	
Hubli	Anchatgeri	Jawari-Local	Flowering	Irrigated	Red	12.48	-
	Gopankop	Sagar	Fruiting	Irrigated	Red	5.17	Leaf curl
	Taluk mean	8.82					
Kalghatgi	Dhummawad	Sagar	Fruiting	Irrigated	Black	8.42	Leaf curl
	Godyal	Jawari - Local	Fruiting	Irrigated	Red	7.73	Leaf curl
	Mishrikot	-	Fruiting	Irrigated	Red	5.53	-
			Taluk mean			7.23	
			District mean			7.33	

was recorded in Narendra followed by Garag village with severity of 22.53 per cent. The least severity (2.45%) was recorded in Kumbarganvi. Similarly in Hubli taluk, the maximum severity of early blight (21.55%) was recorded in Gopankop followed by Palikop with the severity of 10.66 per cent. The least severity (8.43%) was recorded in Unkal village. In Kalghatgi taluk maximum severity of early blight (40.17%) was recorded in Gambyapur followed by Bangittigudihal village with severity of 38.48 per cent. The least severity (7.56%) was recorded in Jammihal. Among the taluks surveyed in Dharwad district, the maximum mean disease severity (25.75%) was recorded in Kalghatgi and the least mean disease severity (13.54%) was recorded in Hubli (Table 2).

Severity of early blight during summer 2022

Totally nine villages of three taluks *viz.,* Dharwad, Hubli and Kalghatgi was surveyed in Dharwad district during summer 2022. In Dharwad taluk, the maximum severity of early blight (9.24%) was recorded in Kotabagi followed by Narendra village with severity of 8.36 per cent. The least severity (3.76%) was

Table 4. Survey for severity of early blight of tomato in Dharwad district of Karnataka during *kharif* 2022-23

District	Taluk	Village	Genotype grown	Crop stage	Crop grown condition	Soil type	Per cent Disease Index (PDI)	Other diseases observed
Dharwad	Dharwad	Yettinagudda	Durg	Fruiting	Irrigated	Black	48.16	-
		Lakamapur	Sagar	Flowering	Rainfed	Black	22.12	-
		Narendra	Naina	Fruiting	Irrigated	Black	45.34	-
		Narendra	Sarathi	Fruiting	Irrigated	Black	53.30	-
		Narendra	Shankar	Flowering	Irrigated	Black	22.37	-
		Narendra	Sagar	Flowering	Irrigated	Black	18.59	-
		Narendra	Sitara	Fruiting	Irrigated	Red	40.81	-
		Narendra	Naina	Fruiting	Irrigated	Black	44.45	-
		Kotur	Shankar	Flowering	Irrigated	Black	21.38	-
		Mummigatti	Sagar	Fruiting	Irrigated	Red	35.86	-
		Garag	Sagar	Flowering	Irrigated	Black	20.66	-
		Garag	Sagar	Fruiting	Irrigated	Black	27.19	Bacterial speck on fruit
		Hangarki	Vaishali	Flowering	Irrigated	Black	28.67	
		Kotabagi	Sagar	Fruiting	Irrigated	Black	22.72	Leaf curl
		Kotabagi	Sagar	Fruiting	Irrigated	Black	32.51	Leaf curl
		Kallur	Sagar	Flowering	Irrigated	Black	12.17	-
		Kallur	Sagar	Flowering	Irrigated	Black	20.48	-
		Mugali	Naina	Flowering	Irrigated	Black	8.87	-
		Mugali	Naina	Fruiting	Irrigated	Black	44.25	-
		Mugali	Naina	Fruiting	Irrigated	Black	45.33	-
		Madanabhavi	Naina	Fruiting	Irrigated	Black	43.27	-
		Madanabhavi	Naina	Fruiting	Irrigated	Red	55.61	-
		Tadakod	Sagar	Fruiting	Irrigated	Red	42.15	-
		Kumbarganvi	Sagar	Fruiting	Irrigated	Red	40.27	-
				Taluk mean			33.19	
Dharwad	Hubli	Anchatgeri	Jawari	Fruiting	Irrigated	Red	35.63	-
		Sulla	Sagar	Fruiting	Irrigated	Red	25.48	-
		Bhandiwad	Sagar	Fruiting	Irrigated	Red	30.55	-
		Bhandiwad	Sagar	Fruiting	Irrigated	Black	47.13	-
		Gopankop	Sagar	Fruiting	Irrigated	Black	44.32	-
		Gopankop	Sagar	Fruiting	Irrigated	Black	40.76	-
				Taluk mean			37.31	
	Kalghatgi	Jodalli	Jawari	Fruiting	Irrigated	Red	24.17	-
		Neerasagar	Sagar	Fruiting	Irrigated	Black	23.43	-
		Dhummawad	Sagar	Fruiting	Irrigated	Red	28.72	-
		Dhummawad	Naina	Flowering	Irrigated	Red	20.83	-
		Dhummawad	Sagar	Fruiting	Irrigated	Red	40.78	-
		Dhummawad	Sagar	Fruiting	Irrigated	Black	38.85	Leaf curl
		Gambyapur	Sagar	Fruiting	Irrigated	Red	39.13	-
		Jammihal	Naina	Fruiting	Irrigated	Black	40.57	-
		Kadankoppa	Namdhari	Fruiting	Irrigated	Black	45.63	-
		Godyal	Naina	Fruiting	Irrigated	Black	30.11	-
		Godyal	Sagar	Flowering	Irrigated	Black	22.46	-
		Godyal	Vaishali	Fruiting	Irrigated	Red	44.54	-
		Bangittigodihal	Sagar	Fruiting	Irrigated	Black	43.70	-
		Bangittigodihal	Sagar	Fruiting	Irrigated	Black	43.12	-
		Bangittigodihal	Sagar	Fruiting	Irrigated	Red	35.74	-
		Shivanagar	Sagar	Fruiting	Irrigated	Red	33.48	-
		Shivanagar	Vaishali	Flowering	Irrigated	Black	20.58	-
		Shivanagar	Vaishali	Flowering	Irrigated	Black	10.37	-
				Taluk mean			32.57	
				District mean			34.35	

recorded in Garag. Similarly in Hubli taluk, the maximum severity of early blight (12.48%) was recorded in Achatgeri and the least severity (5.17%) was recorded in Gopankop village. In Kalghatgi taluk the maximum severity of early blight (8.42%) was recorded in Dhummawad followed by Godyal village with severity of 7.73 per cent. The least severity (5.53%) was recorded in Mishrikot. Among the taluks surveyed in Dharwad district, the maximum mean disease severity (8.82%) was recorded in Hubli

Table 5. Survey for severity of early blight of tomato in Dharwad district of Karnataka during *rabi* 2022-23

Taluk	Village	Genotype grown	Crop stage	Crop grown condition	Soil type	Per cent disease Index (PDI)	Other diseases observed
Dharwad	Narendra	Sagar	Flowering	Irrigated	Red	3.22	Leaf curl
	Narendra	Sagar	Fruiting	Irrigated	Red	22.44	-
	Mugali	Jawari- Local	Fruiting	Irrigated	Red	28.47	-
	Belur	Sagar	Fruiting	Irrigated	Red	13.32	Leaf curl
	Mulamuttl	Sagar	Fruiting	Irrigated	Red	17.62	Leaf curl
	Mulamuttal	Miku	Fruiting	Irrigated	Red	22.86	-
	Garag	Sagar	Fruiting	Irrigated	Red	28.33	-
	Garag	Kirthi	Fruiting	Irrigated	Black	18.38	Leaf curl
	Kurabagatti	Sagar	Flowering	Irrigated	Red	10.15	-
	Yettinagudda	-	Fruiting	Irrigated	Black	27.06	Leaf curl
			Taluk mean			19.18	
Hubli	Bhandiwad	Sagar	Fruiting	Irrigated	Red	12.53	-
	Sulla	Sagar	Fruiting	Irrigated	Red	10.27	-
	Palikop	Sagar	Fruiting	Irrigated	Red	14.56	-
	Palikop	Sagar	Fruiting	Irrigated	Red	18.34	-
	Gopankop	Sagar	Fruiting	Irrigated	Red	16.65	-
			Taluk mean			14.47	
Kasghattki	Dhummawad	Sagar	Fruiting	Irrigated	Black	18.46	-
	Dhummawad	Sagar	Flowering	Irrigated	Red	10.27	-
	Kurankoppa	Sagar	Flowering	Irrigated	Black	9.54	-
	Kurankoppa	Sagar	Fruiting	Irrigated	Black	10.12	-
	Godyal	Sagar	Fruiting	Irrigated	Red	24.30	-
	Bangittigudihal	Sagar	Fruiting	Irrigated	Red	22.76	-
	Jammihal	Sagar	Fruiting	Irrigated	Red	16.67	-
			Taluk mean			16.01	
			District mean			16.55	

Table 6. Survey for severity of early blight of tomato in Dharwad district of Karnataka during summer 2023

Taluk	Village	Genotype grown	Crop stage	Crop grown condition	Soil type	Per cent Disease Index (PDI)	Other diseases observed
Dharwad	Garag	Sagar	Flowering	Irrigated	Red	0.00	Leaf curl
	Garag	Sagar	Fruiting	Irrigated	Red	17.35	Leaf curl
	Garag	Pooja	Fruiting	Irrigated	Red	4.67	Leaf curl
	Garag	Shankar	Fruiting	Irrigated	Red	3.82	Leaf curl
	Madanabhavi	Sagar	Flowering	Irrigated	Red	4.34	Leaf curl
	Kotabagi	Shivang	Fruiting	Irrigated	Red	13.25	Leaf curl
	Kurabagatti	Sagar	Fruiting	Irrigated	Red	12.65	Leaf curl+ powdery mildew
	Agasanahalli	Sagar	Fruiting	Irrigated	Red	32.44	Leaf curl+ powdery mildew
	Agasanahalli	Sagar	Flowering	Irrigated	Red	2.13	Powdery mildew
	Dubbanamardi	Sagar	Flowering	Irrigated	Red	2.17	Leaf curl+ powdery mildew
	Dubbanamardi	Abhilash	Fruiting	Irrigated	Red	14.23	Leaf curl+ powdery mildew
	Dubbanamardi	SVTD 8323	Fruiting	Irrigated	Red	16.54	Leaf curl+ powdery mildew
	Yettinagudda	GPBT 8	Fruiting	Irrigated	Black	25.66	Leaf curl
	UAS Campus	DMT 5	Fruiting	Irrigated	Black	30.18	Leaf curl
	UAS Campus	DMT 3	Fruiting	Irrigated	Black	32.40	Leaf curl
	UAS Campus	DMT 1	Fruiting	Irrigated	Black	24.36	Leaf curl
	UAS Campus	DMT 2	Fruiting	Irrigated	Black	27.16	-
	Taluk mean	15.36					
Hubli	Anchatgeri	Jawari	Fruiting	Irrigated	Red	20.66	Leaf curl
	Gopankop	Sagar	Flowering	Irrigated	Red	02.34	-
			Taluk mean			11.50	
Kalghatgi	Bangittigudihal	Sagar	Fruiting	Irrigated	Red	24.78	Leaf curl+ powdery mildew
	Dhummawad	Sahoo	Fruiting	Irrigated	Red	12.22	Powdery mildew
	Chalmatti	Sagar	Flowering	Irrigated	Red	0.00	-
			Taluk mean			12.33	
			District mean			13.06	

and the least mean disease severity (5.97%) was recorded in Dharwad (Table 3).

Severity of early blight during *kharif* 2022-23

Totally 26 villages of three taluks, *viz.,* Dharwad, Hubli and Kalghatgi were surveyed in Dharwad district during *kharif* 2022-23. In Dharwad taluk, the higher severity of early blight (55.61%) was recorded in Madanabhavi followed by Narendra village with severity of 53.30 per cent. Least severity (8.87%) was recorded in Mugali. Similarly in Hubli taluk, the maximum severity of early blight (47.13%) was recorded in Bhandiwad followed by Gopankop with the severity of 44.32 per cent. The least severity (25.48%) was recorded in Sulla village. The maximum severity of early blight (45.63%) was recorded in Kadankoppa followed by Godyal village with severity of 44.54 per cent. The least severity (10.37%) was recorded in Shivanagar in Kalghatgi taluk. Among the taluks surveyed in Dharwad district, the maximum mean disease severity of early blight (37.31%) was recorded in Hubli and the least severity was recorded in Kalghatgi (32.57%) (Table 4).

Severity of early blight in Dharwad district during *rabi* 2022-23

Totally 16 villages of three taluks *viz.,* Dharwad, Hubli and Kalghatgi of Dharwad district was surveyed during *rabi* 2022-23. In Dharwad taluk, the maximum severity of early blight (28.47%) was recorded in Mugali followed by Garag village with severity of 28.33 per cent. least severity (3.22%) was recorded in Narendra. Similarly in Hubli taluk, the maximum severity of early blight (18.34%) was recorded in Palikop followed by Gopankop with the severity of 16.65 per cent and least severity (10.27%) was recorded in Sulla village. In Kalghatgi taluk the maximum severity of early blight (24.30%) was recorded in Godyal followed by Bangittigudihal village with severity of 22.76 per cent. The least severity (9.54%) was recorded in Kurankoppa. Among the taluks surveyed in Dharwad district, the maximum mean disease severity (21.00%) was recorded in Dharwad and the least mean disease severity (14.47%) was recorded in Hubli (Table 5).

Severity of early blight in Dharwad district during summer 2023

Totally 12 villages of three taluks *viz.,* Dharwad, Hubli and Kalghatgi of Dharwad district was surveyed during summer 2023. In Dharwad taluk, the maximum severity of early blight (32.44 %) was recorded in Agasanahalli followed by Yettinagudda village with severity of 25.66 per cent and no incidence (0.00 %) was recorded in Garag. Similarly in Hubli taluk, the maximum severity of early blight (20.66 %) was recorded in Anchatgeri and the least severity (2.34 %) was recorded in Gopankop village. In Kalghatgi taluk the maximum severity of early blight (24.78 %) was recorded in Bangittigudihal followed by Dhummawad village with severity of 12.22 per cent and no incidence (0.00 %) was recorded in Chalmatti. Among the taluks surveyed in Dharwad district, the maximum mean disease severity (15.36 %) was recorded in Dharwad and the least mean disease severity (11.50 %) was recorded in Hubli. Table 6

In general early blight of tomato was found widespread in all the surveyed locations of Dharwad district. Crop grown during *kharif* recorded higher disease severity (40.89%) compared to *rabi* (17.08 %) and summer (10.19 %) Table 7.

During the survey apart from the early blight, other diseases were observed as well. Buck eye rot, leaf curl and bacterial speck on fruit were noticed in certain fields during *kharif* season. Leaf curl was also observed during *rabi* seasons while, powdery mildew and sever leaf curl infestation were noticed during the summer seasons in Dharwad district (Table 1 to 6).

Severity of early blight of tomato as affected by seasons during 2021, 2022 and 2023

Data pertaining to the severity of early blight disease under *kharif* and *rabi* 2021-22 & 2022-23 and summer 2022 and 2023 are presented in the Table 7. Maximum mean per cent disease index (PDI) (47.44 and 34.35 PDI) was recorded in *kharif* season as compared to *rabi* season (17.62 and 16.55 PDI) and summer (7.33 and 13.06 PDI) during *kharif* and *rabi* 2021-22 & 2022-23

Table 7. Mean severity of tomato early blight at Dharwad district during survey conducted in *kharif* 2021-22, 2022-23, *rabi* 2022-23, summer 2022 and summer 2023

District	Taluk	Year 2021-22 and 2022 (Mean PDI)		
		Kharif 2021-22	*Rabi* 2021-22	Summer 2022
Dharwad	Dharwad	38.55	13.57	5.97
	Hubli	48.27	13.54	8.82
	Kalghatgi	55.48	25.75	7.23
	Mean	47.43	17.62	7.34
		Year 2022-23 and 2023 (Mean PDI)		
		Kharif 2022-23	*Rabi* 2022-23	Summer 2023
	Dharwad	33.19	19.18	15.36
	Hubli	37.31	14.47	11.50
	Kalghatgi	32.57	16.01	12.33
	Mean	34.35	16.55	13.06
		Kharif 2021-22 and 2022-23/Mean PDI	*Rabi* 2021-22 and 2022-23/ Mean PDI	Summer 2022 and 2023/ Mean PDI
	Overall mean	40.89	17.08	10.19

and summer 2022 & 2023, respectively. In general, crop grown during *kharif* recorded higher disease severity compared to *rabi* and summer season.

Severity of early blight of tomato as affected by soil type during *kharif* 2021-22 and 2022-23

Data pertaining to the severity of early blight disease under red and black soil condition during *kharif* 2021-22 and 2022-23 are presented in Table 8. Totally 40 black and 27 red soil fields were visited. Mean per cent disease index (49.17 and 34.15 PDI) was recorded in black soils, comparing to red soils (44.26 and 32.11 PDI) during *kharif* 2021-22 and 2022-23, respectively.

Severity of early blight of tomato as affected by soil type during *rabi* 2021-22 and 2022-23

Data pertaining to the severity of early blight disease under red and black soil condition during *rabi*, 2022 and 2023 are presented in Table 9. Totally 14 black soil and 30 red soil fields were visited. Mean per cent disease index (29.18 and 16.71 PDI) was recorded in black soils, comparing to red soils (10.25 and 17.22 PDI) during *rabi* 2022 and 2023, respectively.

Severity of early blight of tomato as affected by soil type during summer 2022 and 2023

Data pertaining to the severity of early blight disease under red and black soil condition during summer 2022 and 2023 are presented in Table 10. Totally nine black soil and 24 red soil fields were visited. Higher per cent disease index (7.95 and 27.95 PDI) was recorded in black soils, comparing to red soils (6.20 and 10.80 PDI) during summer 2022 and 2023, respectively. In general, irrespective of the seasons fields with black soil recorded more disease severity as compared to red soil.

Severity of early blight of tomato as affected by crop stage during *kharif* 2021-22 and 2022-23

During *kharif* 2021-22 and 2022-23 survey (Table 11) a total of 52 fields in fruiting stage and 15 in flowering stage were visited. Higher per cent disease index of early blight (49.40 and 38.77 PDI) recorded at fruiting stage was more as compared to flowering stage (20.21 and 19.21 PDI) during *kharif* 2021 and 2022, respectively, Between two *kharif* seasons, the early blight severity was more in 2021-22 as compared to 2022-23.

Severity of early blight of tomato as affected by crop stage during *rabi* 2021-22 and 2022-23

During *rabi* 2021-22 and 2022-23 survey (Table 12), 33 tomato fields in fruiting stage and 12 in flowering stage were visited. Mean per cent disease index of early blight (24.30 and 20.21 PDI) were recorded in fruiting stage of the crop as compared to flowering stage (6.96 and 8.30 PDI) during *rabi* 2021-22 and 2022-23, respectively. Between two *rabi* seasons, the early blight severity was more in 2021-22 as compared to 2022-23.

Severity of early blight of tomato as affected by crop stage during summer 2022 and 2023

Twenty five tomato fields in fruiting stage and 8 in flowering stage were visited during summer 2022 and 2023 (Table 13). Early blight (6.33 and 19.52 PDI) severity was more in fruiting stage of the crop in general as compared to flowering stage (9.12 and 1.83 PDI). Between two summer seasons, the early blight severity was more in 2023 as compared to 2022. Irrespective to the seasons fruiting stage recorded more disease when compared to flowering stage.

Survey on the severity of disease helps to gather information on the prevalence, severity, distribution of disease

Table 8. Severity of early blight of tomato as affected by soil type in Dharwad district during *kharif* 2021-22 and 2022-23

Year	Black soil		Red soil	
	No. of fields	Mean PDI	No. of fields	Mean PDI
2021-22	32	34.15	16	32.11
2022-23	8	49.16	11	44.26
Total	40		27	
Mean		41.66		38.19

PDI-Per cent Disease Index

Table 9. Severity of early blight of tomato as affected by soil type in Dharwad district during *rabi* 2021-22 and 2022-23

Year	Black soil		Red soil	
	No. of fields	Mean PDI	No. of fields	Mean PDI
2021-22	9	29.18	13	10.25
2022-23	5	16.71	17	17.22
Total	14		30	
Mean		22.95		13.73

PDI-Per cent Disease Index

Table 10. Severity of early blight of tomato as affected by soil type in Dharwad district during summer 2022 and 2023

Year	Black soil		Red soil	
	No. of fields	Mean PDI	No. of fields	Mean PDI
2022	4	7.95	7	6.20
2023	5	27.95	17	10.67
Total	9		23	
Mean		17.95		8.43

PDI-Per cent Disease Index

Table 11. Severity of early blight of tomato as affected by crop stage in Dharwad district during *kharif* 2021-22 and 2022-23

Year	Fruiting stage		Flowering stage	
	No. of fields	Mean PDI	No. of fields	Mean PDI
2021-22	17	49.40	2	20.21
2022-23	35	38.77	13	19.20
Total	52		15	
Mean		44.08		19.70

PDI-Per cent Disease Index

Table 12. Severity of early blight of tomato as affected by crop stage in Dharwad district during *rabi* 2021-22 and 2022-23

Year	Fruiting stage		Flowering stage	
	No. of fields	Mean PDI	No. of fields	Mean PDI
2021-22	14	24.30	8	6.96
2022-23	18	19.06	4	8.30
Total	32		12	
Mean		21.68		7.63

PDI-Per cent Disease Index

Table 13. Severity of early blight of tomato as affected by crop stage in Dharwad district during summer 2022 and 2023

Year	Fruiting stage		Flowering stage	
	No. of fields	Mean PDI	No. of fields	Mean PDI
2022	9	6.33	2	9.12
2023	16	19.52	6	1.83
Total	25		8	
Mean		12.92		5.48

PDI-Per cent Disease Index

and pathogen diversity in a particular agro-climatic zone. Survey and surveillance form the basis for any successful plant protection that depends on early detection of disease followed by timely adoption of management measures. With this background the present study was taken up by conducting the roving survey in parts of Dharwad district of Karnataka, where the tomato was grown predominantly for commercial purpose.

Roving survey was conducted to collect the information regarding the severity of early blight disease, its distribution in different agro climatic zones and the prevalence and diversity of the pathogen in different tomato growing taluks in Dharwad district during *kharif* (2021-22 and 2022-23), *rabi* (2021-22 and 2022-23), as well as during summer 2022 and 2023. The severity of the disease was expressed as per cent disease index. This information is necessarily needed to find out extent of damage caused by the pathogen thereby, to come out with best management strategies to overcome the disease in future. The survey also supplements the information on type of soil and irrigated/rainfed situations in which crop grown, susceptible stage of the crop, other disease prevailed on the particular locality.

The survey result revealed that the early blight was more during the year 2021-22 than 2022-23 and the disease varied from location to location, season to season and year to year. Such variation is attributed to various environmental factors like temperature, relative humidity, pattern of rainfall and even it could also be attributed to existence of variability in pathogen and cropping pattern.

Among the three tomato growing taluks surveyed for early blight severity during *kharif* (2021-22 & 2022-23), *rabi* (2021-22 & 2022-23), and also during summer 2022 and 2023, Kalghatgi recorded the highest disease severity of 55.48 per cent during *kharif* 2021-22, while the least severity (45.78 %) was recorded in Dharwad. During *kharif* 2022-23, Hubli recorded maximum mean disease severity of early blight (37.31 %), whereas Kalghatgi recorded the least severity of 32.57 per cent. During *rabi* 2021-22 the highest mean disease severity (25.75 %) was recorded in Kalghatgi, while the least mean disease severity (13.54 %) was recorded in Hubli. During *rabi* 2022-23, Dharwad recorded the maximum mean disease severity (19.18 %) and the least mean disease severity (14.47 %) was recorded in Hubli. During summer 2022 the maximum mean disease severity (8.82 %) was recorded in Hubli and the least mean disease severity (5.97 %) was recorded in Dharwad, whereas during summer 2023 the maximum mean disease severity (15.36 %) was recorded in Dharwad and the least mean disease severity (11.50 %) was recorded in Hubli. Fig. 2, 3, 4, 5, 6 and 7. Such variations in the disease severity have also been observed by Prasad (2002) who carried out a field survey in northern districts of Karnataka during *kharif* 2001 and recorded disease severity ranging from 28.60 per cent to 65.36 per cent.

Similar findings were noticed by Roopa and Yadahalli (2016) who surveyd northern districts of Karnataka *viz.*, Dharwad, Belgaum, Haveri, Gadag and Bagalkot, where the disease severity ranged from 17.30 per cent to 37.25 per cent. The highest disease severity was observed in Haveri district with 31 per cent, while Dharwad district recorded the least severity with 20.16 per cent. Similarly Mahantesh *et al*.(2017) conducted a survey in Shivamogga and Davanagere districts of Karnataka, their results indicated that the highest PDI of 47.25 was recorded in Nyamati village followed by Savalanga (46.20 PDI) and Malebennuru (45.25 PDI) villages in Davangere district. In Shivamogga district maximum PDI was recorded in Kommanal

(42.50). The minimum disease severity of 22.35 and 39.75 per cent was recorded in Avarekoppa (Shivamogga) and Kenchikoppa (Davangere), respectively. Notably, *kharif* seasons recorded higher disease severity when compared to both *rabi* and summer seasons. In general, crop grown in black soil recorded more early blight severity (41.66, 22.95 and 17.95 %) as compared to red soil (38.19, 13.73 and 8.43 %) during *kharif* and *rabi* 2021-22 & 2022-23 and summer 2022 and 2023, respectively. Moreover, early blight infection was observed to be more sever at fruiting stage (44.09, 21.68 and 12.92 %) as compared to flowering stage (19.70, 7.63 and 5.48 %) during *kharif* and *rabi* 2021-22 & 2022-23 and summer 2022 and 2023, respectively. Moreover, early blight infection was observed to be more sever at fruiting stage (44.09, 21.68 and 12.92 %) as compared to flowering stage (19.70, 7.63 and 5.48 %) during *kharif* and *rabi* 2021-22 & 2022-23 and summer 2022 and 2023, respectively.

This variation may be attributed to susceptibility of genotypes as well as favorable environmental conditions such as warm temperature, high relative humidity and rainfall pattern. The elevated disease levels in Dharwad district may also be attributed due to buildup of inoculum year after year, presence of initial inoculum in the previous year crop debris in that particular locations, cultivation of same genotypes over a larger area and susceptibility of genotypes must have helped in building up of inoculum.

Conclusions

The survey conducted at three taluks in Dharwad district revealed that the early blight was prevalent in all the tomato growing areas of the district in a low to severe form.

The highest mean per cent disease severity was recorded in Kalghatgi taluk (55.48 %), while Dharwad taluk recorded minimum disease severity of 45.78 per cent during *kharif* 2021-22. During *kharif* 2022-23, Hubli recorded maximum mean disease severity of early blight (37.31 %), whereas Kalghatgi reported the least disease severity of (32.57 %). During *rabi* 2021-22, Kalghatgi recorded highest mean disease severity (25.75 %), while Hubli recorded the least mean disease severity (13.54 %). During *rabi* 2022-23 Dharwad recorded the maximum mean disease severity (19.18 %), whereas Hubli recorded the least mean disease severity (14.47 %). During summer 2022, Hubli exhibited highest mean disease severity (8.82 %), while least mean disease severity (5.97 %) was recorded in Dharwad. During summer 2023, Dharwad recorded the maximum mean disease severity (15.36 %), whereas Hubli recorded the least mean disease severity of 11.50 per cent. Notably, higher per cent disease severity was observed during *kharif* 2021-22 and 2022-23, (47.43 and 40.89, respectively) compared to *rabi* 2021-22 and 2022-23, (17.62 and 16.55, respectively) and summer season where the disease index recorded was 7.33 and 13.06 % during summer 2022 and 2023, respectively. In general, black soil recorded more early blight disease (41.66, 22.95 and 17.95 %) compared to red soil (38.19, 13.73 and 8.43 %) during *kharif* and *rabi* 2021-22 & 2022-23 and summer 2022 and 2023, respectively. Irrespective of the seasons and years, early blight was observed to be more severe at the fruiting stage than at the flowering stage. The current study provides the data on the severity and distribution of early blight in major tomato growing areas of Dharwad district and to find out the hot spots of *Alternaria solani* in different taluks of Dharwad district.

References

Abada K A, Mostafa S H and Hillal M R, 2008, Effect of some chemical salts on suppressing the infection by early blight disease of tomato. *Egyptian Journal of Applied Sciences,* 23(20): 47-58.

Abdel Sayed M H F, 2006, Pathological, physiological and molecular variations among isolates of *Alternaria solani* the causal of tomato early blight disease. *Ph. D. Thesis*, Faculty of Agriculture Cairo University, pp. 181.

Anonymous, 2022, Indiastate focused on facts. selected state-wise data area, production and productivity of tomato in India, ministry of agriculture & farmers welfare, government of India.

Balanchard D A, 1992, Colour Atlas of Tomato Diseases. Wolfe Publication Limited, Book House, London, P. 298.

Chandravanshi S S, Singh B P and Thakur M P, 1994, Persistence of different fungicides used against *Alternaria alternata* in tomato. *Indian Phytopath*ology, 47: 241-244.

Datar V V and Mayee C D, 1981, Assessment of loss in tomato yield due to early blight. *Indian Phytopathology,* 34: 191-195.

FAOSTAT, 2019, World tomato production. Food and Agriculture Organization of the United Nations, Rome, Italy. Available at: http://www.fao.org/faostate/en/#home

Gomaa A M I, 2001, Pathological studies on early blight of tomato. *M.Sc. Thesis*., Faculty of Agriculture, Cairo University.

Hadian S, Rahnama K, Jamali S and Eskandari A, 2011, Comparing neem extract with chemical control on *Fusarium oxysporum* and *Meloidogyne incognita* complex of tomato. *Advances in Environmental Biology,* 5(8): 2052-2057.

Kale P N and Kale S P, 1994, Bhajipala Utpadan (Vegetable production) Continental Publication, C.O. Pune, pp. 29-30.

Mahantesh S B, Karegowda C, Narayanaswamy H, Manu T G and Punithkumar N D, 2017, Status of tomato early blight in Shivamogga and Davanagere districts. *Journal of Pharmacognosy and Phytochemistry*, 6(5): 2317-2319.

Pandey K K, Pandey P K, Kalloo G and Banerjee M K, 2003, Resistance to early blight of tomato with respect to various parameters of disease epidemics. *Journal of General Plant Pathology,* 69: 364-371.

Prasad Y, 2002, Studies on variability, pre and post harvest management of early blight of tomato. *M.Sc(Agri.) Thesis,* University of Agricultural Sciences, Dharwad.

Pritesh P and Subramanian R B, 2011, PCR based method for testing Fusarium wilt resistance of tomato. *African Journal of Basic and Applied Sciences*, 3(5): 222-227.

Robert R W, 2005, Growing tomatoes. University of Georgia, College of Agriculture and Environmental Science Bulletin, 3(2): 487- 488.

Roopa S and Yadahalli K B, 2016, Severity and distribution of Alternaria blight disease of tomato in northern Karnataka. *Biochemical and Cellular Archives,* 16(1): 107-109.

Sgherri C Z, Kadlecova A, Pardossi F, Navari-Izzo and Izzo R, 2008, Irrigation with diluted seawater improves the nutritional value of cherry tomatoes. *Journal of Agricultural and Food Chemistry*, 56(9): 3391-3397.

Wheeler B E, 1969, An Introduction to Plant Diseases. John Willey and Sons Limited London, p. 301