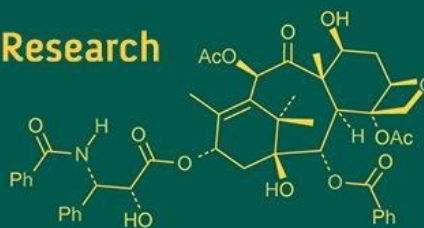


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Survey for the severity of early blight of tomato in central dry and southern transition zones of Karnataka

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Abstract

Tomato (*Solanum lycopersicum* L.) belongs to the family Solanaceae and is commonly called “Poor man’s apple” because of its nutritional value and consumer affordable price. It is a rich source of vitamin viz., A, C, riboflavin and thiamine, along with essential minerals such as potassium (K), phosphorus (P), magnesium (Mg) and iron (Fe). However, tomato cultivation is significantly hindered as the crop suffers from various biotic and abiotic stresses. Among them, early blight caused by the fungus *Alternaria solani* is considered to be one of the most serious and destructive disease reducing tomato production across the world. Considering the importance of crop and the losses caused by the pathogen, this study had been conducted to check the disease severity in different parts of central dry and southern transition zones of Karnataka. During the survey in central dry and southern transition zones of Karnataka in 2024 revealed that crop cultivation in parts of southern transition zone consisting of Shivamogga and Chikkamagaluru districts had showed highest per cent disease severity of 34.62 per cent, whereas, parts of central dry zone consisting of Davanagere and Chitradurga districts had showed 34.14 per cent. Among 23 tomato fields evaluated, 12 fields contained red soil showed highest mean per cent disease severity of 36.49 per cent, 7 fields contain black soil showed mean PDI of 31.98 per cent and 4 fields contain sandy loam soil showed mean PDI of 29.22 per cent. While studying the influence of growth stage of the crop on disease severity of early blight of tomato, highest mean per cent disease severity of 35.91 per cent was recorded in harvesting stage followed by fruiting stage (34.65%) and flowering stage (33.30%) and least severity was recorded in seedling stage (31.31%).

Keywords: Early blight, disease severity, survey, *Alternaria solani* and tomato

Introduction

Tomato (*Solanum lycopersicum* L.) belongs to the family Solanaceae and it is also known as *pomo d’oro* (golden apple) in Italian, *pomme d’amour* (love apple) in French and “Poor man’s apple” because of its nutritional, medicinal properties and consumer affordable price. The name “tomato” is derived from the Spanish word *tomate*, which comes from the Nahuatl word *tomatl*, meaning “swelling fruit” (Harper, 2024) [1]. The wild species are known to be originated in the Andes Mountains of South America, mainly in Peru and Ecuador and are domesticated in pre-Columbian Mexico (Mutschler *et al.*, 2006) [2].

With a global production of 186.82 million tonnes and an average yield of 36.97 tonnes per hectare (FAOSTAT, 2022) [3] tomatoes are predominantly grown in China, which accounts for 36 per cent of global production, followed by India with 11 per cent (FAOSTAT, 2023) [3]. In India, during the year 2023-24 tomato was grown over an area of 8,53,990 ha with an annual production of 21,323,220 MT and productivity of 24.97 MT per ha. Madhya Pradesh is the largest tomato producing state with an area of 1,19,670 ha under cultivation and 34,98,260 MT production which alone accounts for 16 per cent of total production. The other major tomato growing states are Andhra Pradesh, Karnataka, Gujarat, Odisha, West Bengal, Maharashtra, Tamil Nadu, Bihar and Chhattisgarh. Andhra Pradesh had highest productivity of 45.00 MT per ha. In Karnataka, tomato crop is grown on 62,430 ha area with a production of 20,07,330 MT and productivity of 32.15 MT per ha (Anon., 2024) [6]. The major tomato growing districts of Karnataka are Kolar, Belagavi, Chikkaballapura, Haveri, Chikkamagaluru and Bengaluru rural. Kolar is the leading producer in Karnataka (Anon., 2021) [5].

Tomato cultivation is constrained by different biotic and abiotic factors which have impeding effects on its production and productivity. Keeping abiotic factors apart, among different biotic factors, diseases are the most significant, which have a direct impact on the yield and quality of tomato fruits. There have been reports of more than two hundred diseases infecting tomatoes in the world (Atherton and Rudich, 1986) [7]. Among them, the early blight disease caused by *Alternaria solani* is regarded as the most crucial and catastrophic disease occurring worldwide (Praveen *et al.*, 2019) [9]. *Alternaria solani* is both airborne and soil-inhabiting and is accountable for producing symptoms like early blight, collar rot and fruit rot of tomato (Datar and Mayee, 1981) [8]. It produces conidia with transverse and longitudinal septa, multinucleate and dark-colored (melanised) cells. This melanin guards the pathogen against harmful environmental conditions, such as resistance to microorganisms and hydrolytic enzymes (Rotem, 1994) [10]. This study was formulated to the survey and document

the disease severity in central dry and southern transition zones of Karnataka.

2. Material and methods

An intensive roving survey was conducted in the parts of tomato growing areas of central dry and southern transition zones of Karnataka to know the severity of early blight of tomato. Davanagere, Chitradurga, Shivamogga and Chikkamagaluru these are the districts where surveys have been conducted and assess the severity of early blight disease of tomato. In each district two taluks, in every taluk 2 to 3 villages, were selected and inspected for disease symptoms in tomato plants. During the survey, diseased plant samples of tomato showing the typical symptoms of early blight were collected in polythene covers from the field and brought to the laboratory and utilized for further studies. The disease severity was observed by using 0-5 scale (Mayee and Datar, 1986) [11] described as below,

Description of disease scale (0-5)

Scale	Description
0	No symptoms on the leaf
1	0-5 per cent leaf area infected and covered by spot, no spot on petiole and branches
2	6-20 per cent leaf area infected and covered by spot and some spots on petiole
3	21-40 per cent leaf area infected and covered by spot, spots also seen on petiole and branches
4	41-70 per cent leaf area infected and covered by spot, spots also seen on petiole, branches and stem
5	> 70 per cent leaf area infected and covered by spot, spot also seen on petiole, branch, stem and fruit

Per cent Disease Index (PDI) was calculated by using the following formula given by Wheeler (1969) [12].

$$\text{PDI (\%)} = \frac{\text{Sum of individual ratings}}{\text{No. of plants examined} \times \text{Maximum disease grade}} \times 100$$

The proforma used for the survey includes the information's viz., village, taluk, district, GPS coordinates, stage of the crop, mode of irrigation, soil type, other diseases observed and per cent disease severity or index (PDI).

3.2.1 Details of surveyed districts for the severity of early blight of tomato during 2024

Districts	Taluks	Villages
Davanagere	Nyamathi	Machagondanahalli
		Veerapura
		Kudrekonda
	Honnali	Sunkadakatte
		Konayakanahalli
		Chinnikatte
Chitradurga	Chitradurga	Thopuramalige
		Doddasiddavanahalli
		Aimangala
	Hiriyur	Hiriyur
		Beeranahalli
		Metikurke
Shivamogga	Shivamogga	Pilali
		Beeranakere
		Navule
	Bhadravathi	Kommanalu
		Bannikere
		Kadadakatte
Chikkamagaluru	Tarikere	Masarahalli
		Karehalli
		Jannapura
	Chikkamagaluru	Srinivasapura
		Kurichikkanahalli

3. Results: An intensive roving survey was conducted during 2024 to assess the severity of early blight disease of tomato in parts of central dry and southern transition zones of Karnataka. In central dry zone, Davanagere and Chitradurga districts were surveyed and in southern transition zone, Shivamogga and Chikkamagaluru districts were surveyed. The data on per cent disease index, age of the plant, soil type, other diseases observed along with the latitude and longitude are presented in Table 1.

The survey results revealed that the early blight disease severity ranged between 23.44 to 48.67 per cent among all four districts (Table 1, Plate 1). Maximum per cent disease severity was observed in Machagondanahalli (48.67%) village of Nyamathi taluk of Davanagere district followed by Kurichikkanahalli (42.65%) village of Chikkamagaluru taluk, Chikkamagaluru district and Konayakanahalli (41.73%) village of Honnali taluk, Davanagere district. Whereas least disease severity of 23.44 per cent was observed in Karehalli village of Tarikere taluk, Chikkamagaluru district followed by Beeranakere (25.12%) village of Shivamogga taluk, Shivamogga district.

In Davanagere district, maximum mean per cent disease severity was observed in Nyamathi taluk (40.44%) followed by Honnali taluk (32.67%) (Table 2, Figure 1, Plate 1). Machagondanahalli village of Nyamathi taluk showed highest disease severity of 48.67 per cent and minimum disease severity was observed in Sunkadakatte village (25.31%) of Honnali taluk (Table 1).

In Chitradurga district, maximum mean per cent disease severity was observed in Hiriyur taluk (33.39%) followed by Chitradurga taluk (30.09%) (Table 2, Figure 1, Plate 1). Metikurke village of Hiriyur taluk showed highest disease severity of 38.52 per cent and minimum disease severity was observed in Aimangala village (26.13%) of Chitradurga taluk (Table 1).

In Shivamogga district, maximum mean per cent disease severity was observed in Bhadravathi taluk (38.89%) followed by Shivamogga taluk (29.22%) (Table 2, Figure 1, Plate 1). Masarahalli village of Bhadravathi taluk showed the highest disease severity of 39.21 per cent and minimum disease severity was observed in Beeranakere village (25.12%) of Shivamogga taluk (Table 1).

Table 1: Survey for the severity of early blight of tomato in parts of central dry and southern transition zones of Karnataka during the year 2024

Districts	Taluks	Villages	GPS Coordinates		Soil type	Stage of the crop	Mode of irrigation	Other diseases observed	PDI (%)
			Latitude	Longitude					
Davanagere	Nyamathi	Machagondanahalli	14.113646°	75.504842°	Red	Fruiting stage	Drip	Late blight	48.67
		Veerapura	14.110777°	75.53787°	Red	Seedling stage	Surface	Damping off, wilt	40.77
		Kudrekonda	14.13287°	75.542269°	Red	Flowering stage	Drip	Wilt, TMV	31.89
	Mean								40.44
	Honnali	Sunkadakatte	14.2177105°	75.6487907°	Red	Seedling stage	Surface	Septoria leaf spot	25.31
		Konayakanahalli	14.2559670°	75.6368646°	Red	Fruiting stage	Drip	Late blight, TYLCV	41.73
		Chinnikatte	14.120876°	75.487662°	Red	Seedling stage	Drip	Wilt, Damping off	30.97
	Mean								32.67
	District mean								36.55
Chitradurga	Chitradurga	Thopuramalige	14.190322°	76.454557°	Black	Seedling stage	Drip	TMV, Late blight	31.63
		Doddasiddavanahalli	14.189856°	76.455119°	Black	Flowering stage	Drip	Mosaic, wilt	32.52
		Aimangala	14.089608°	76.538001°	Black	Harvesting stage	Drip	Late blight	26.13
	Mean								30.09
	Hiriyur	Hiriyur	14.002841°	76.588302°	Black	Seedling stage	Drip	Septoria leaf spot	27.89
		Beeranahalli	13.954386°	76.542426°	Black	Fruiting stage	Drip	TYLCV, Wilt	32.21
		Metikurke	14.007482°	76.585546°	Black	Fruiting stage	Drip	Wilt	38.52
		Pilali	13.753643°	76.653765°	Black	Harvesting stage	Drip	Late blight	34.97
	Mean								33.39
	District mean								31.74
Shivamogga	Shivamogga	Beeranakere	14.038168°	75.572702°	Sandy loamy	Fruiting stage	Drip	Late blight	25.12
		Navule	13.97418°	75.578142°	Sandy loamy	Fruiting stage	Drip	Septoria leaf spot	27.35
		Kommanalu	14.023671°	75.591996°	Sandy loamy	Fruiting stage	Drip	Late blight, TMV	35.64
		Bannikere	14.035946°	75.602396°	Sandy loamy	Flowering stage	Drip	TYLCV	28.78
	Mean								29.22
	Bhadravathi	Kadadakatte	13.8602834°	75.6839226°	Red	Flowering stage	Drip	Late blight, TMV	38.57
		Masarahalli	13.8086368°	75.7306152°	Red	Fruiting stage	Drip	Late blight	39.21
	Mean								38.89
	District mean								34.05
Chikkamagaluru	Tarikere	Karehalli	13.630161°	75.946638°	Red	Fruiting stage	Drip	Septoria leaf spot	23.44
		Jannapura	13.675291°	75.924878°	Red	Flowering stage	Drip	TYLCV, TMV	34.75
	Mean								29.09
	Chikkamagaluru	Srinivasapura	13.412148°	75.903474°	Red	Harvesting stage	Drip	Late blight	39.91
		Kurichikkanahalli	13.381396°	75.875539°	Red	Harvesting stage	Drip	Late blight	42.65
	Mean								41.28
	District mean								35.18

GPS: Global Positioning System; PDI: Per cent Disease Index; TMV: Tomato mosaic virus; TYLCV: Tomato yellow leaf curl virus

In Chikkamagaluru district, maximum mean per cent disease severity was observed in Chikkamagaluru taluk (41.28%) followed by Tarikere taluk (29.09%) (Table 2, Figure 1, Plate 1). Kurichikkanahalli village of Chikkamagaluru taluk showed highest disease severity of 42.65 per cent and minimum disease severity was observed in Karehalli village

(23.44%) of Tarikere taluk (Table 1). Among all the taluks surveyed, Chikkamagaluru taluk of Chikkamagaluru district showed maximum disease severity (41.28%) and Tarikere taluk of the same district showed minimum disease severity (29.09%) (Table 2).

Table 2: Taluk wise severity of early blight of tomato during 2024

Sl. No.	Districts	Taluks	Mean PDI
1.	Davanagere	Nyamathi	40.44
		Honnali	32.67
2.	Chitradurga	Chitradurga	30.09
		Hiriyur	33.39
3.	Shivamogga	Shivamogga	29.22
		Bhadravathi	38.89
4.	Chikkamagaluru	Tarikere	29.09
		Chikkamagaluru	41.28

Among the different districts surveyed, Davanagere district showed maximum disease severity (36.55%), whereas Chitradurga district showed minimum disease severity (31.74%) (Table 3). Between the two zones surveyed, the

southern transition zone showed the highest disease severity of 34.62 per cent and central dry zone showed slightly lesser disease severity of 34.14 per cent (Table 4).

Table 3: District wise severity of early blight of tomato during 2024

Sl. No.	Districts	Mean PDI
1.	Davanagere	36.55
2.	Chitradurga	31.74
3.	Shivamogga	34.05
4.	Chikkamagaluru	35.18

Table 4: Zone wise severity of early blight of tomato during 2024

Sl. No.	Zones	Mean PDI
1.	Central dry zone (Davanagere and Chitradurga)	34.14
2.	Southern transition zone (Shivamogga and Chikkamagaluru)	34.62

Along with early blight disease, some of the other diseases like late blight, damping off, wilt, septoria leaf spot, tomato mosaic virus and tomato yellow leaf curl virus were also observed. Most of the fields had drip irrigation systems except for some fields like Veerapura and Sunkadakatte.

Disease severity of early blight of tomato as influenced by soil type: During survey conducted to assess the severity

of early blight of tomato, additional data on soil types of tomato fields were also recorded to correlate the disease severity with soil. Among 23 tomato fields visited in 2024, 12 fields contained red soil and 7 fields were of black soils and 4 fields were consisting of sandy loam soil. The highest mean PDI was observed in the fields containing red soil (36.49%) followed by black soil (31.98%). Least mean PDI was seen in sandy loam soil (29.22%) (Table 5).

Table 5: Disease severity of early blight of tomato as influenced by soil type

Sl. No.	Soil	No. of fields	Mean PDI
1.	Red	12	36.49
2.	Black	07	31.98
3.	Sandy loam	04	29.22

Disease severity of early blight of tomato as influenced by growth stage of the crop: Disease severity of early blight of tomato was highly intercepted at the harvesting

stage by recording mean PDI of 35.91 followed by fruiting stage (34.65%) and flowering stage (33.30%). Least mean PDI was seen during seedling stage (31.31%) (Table 6).

Table 6: Disease severity of early blight of tomato as influenced by growth stage of the crop

Sl. No.	Stage of the crop	No. of fields	Mean PDI
1.	Seedling stage	05	31.31
2.	Flowering stage	05	33.30
3.	Fruiting stage	09	34.65
4.	Harvesting stage	04	35.91

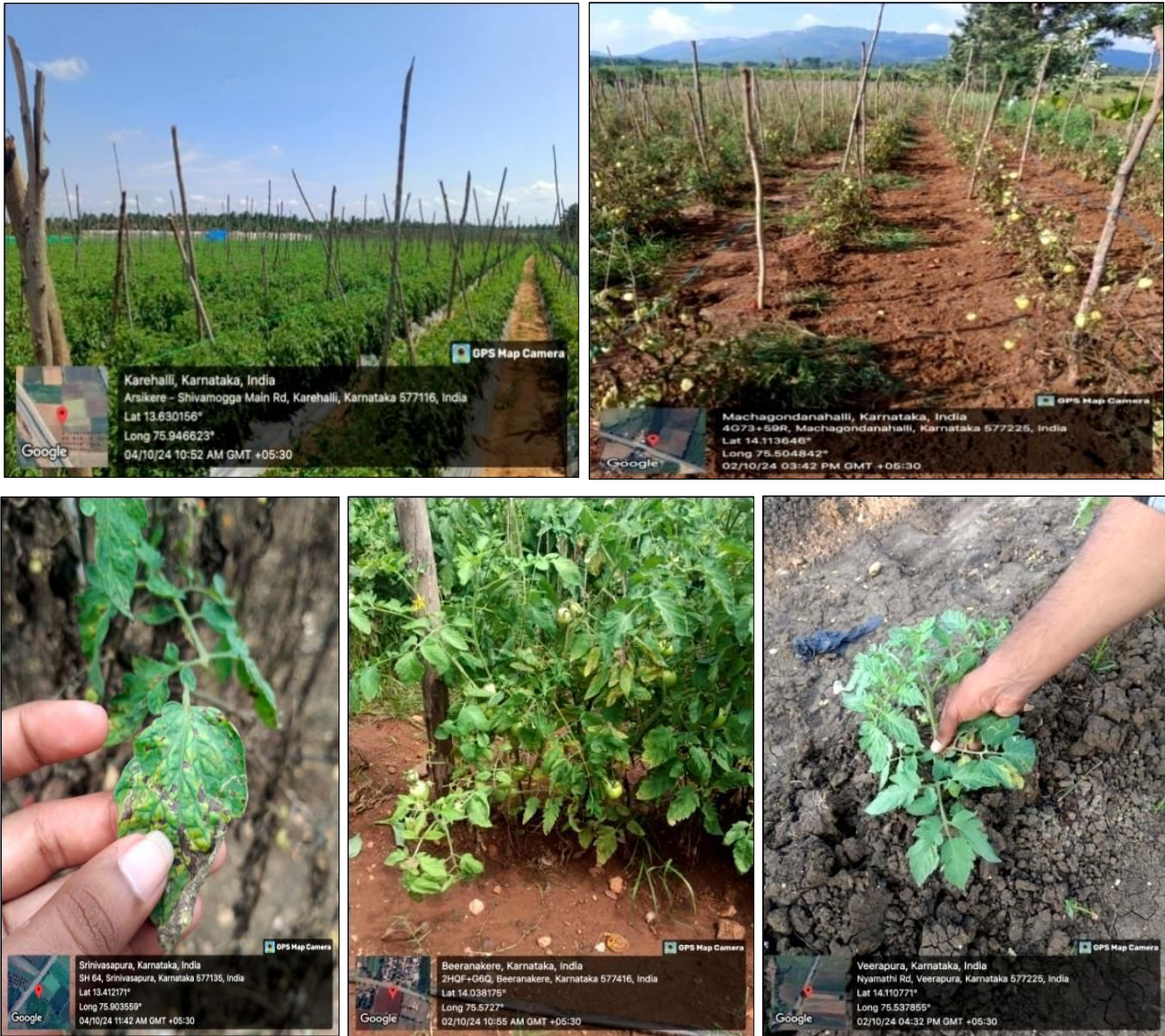


Plate 1: Survey for the severity of early blight of tomato in parts of central dry and southern transition zones of Karnataka

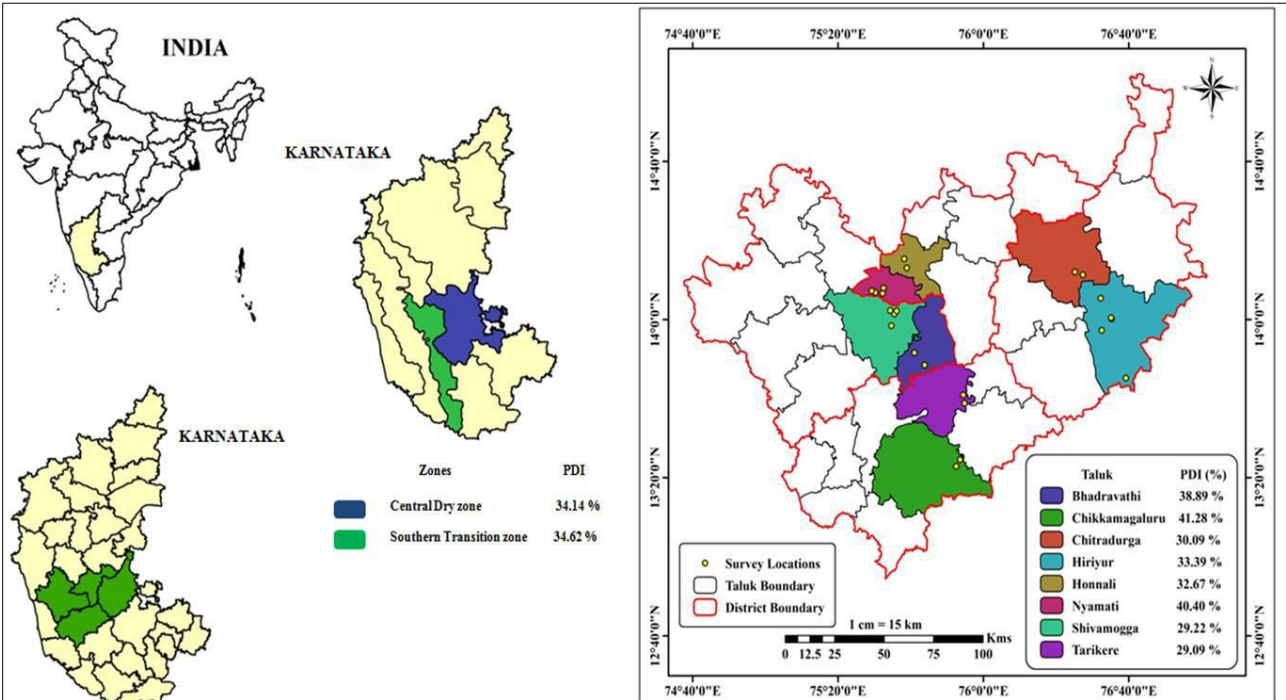


Fig 1: Surveyed locations of early blight of tomato in parts of central dry and southern transition zones of Karnataka

4. Discussion

Survey on the severity of early blight of tomato revealed the extent of the problem, which serves as a precursor for evolving the successful management strategies. The work was initiated to know the distribution of the disease in major tomato growing areas of central dry and southern transition zones of Karnataka. In the central dry zone, Davanagere and Chitradurga districts were surveyed, while in the southern transition zone, Shivamogga and Chikkamagaluru districts were surveyed.

During the survey it was observed that disease symptoms were prominent on older leaves compared to younger ones and the severity of early blight of tomato was expressed as per cent disease index (PDI). The survey also revealed the change in severity depending on location, age of the plant, management strategies adopted.

Among the two zones surveyed, the disease severity was observed almost the same in both zones. The southern transition zone recorded 34.62 per cent disease severity, whereas central dry zone recorded 34.14 per cent disease severity. But in comparison with the districts, Davanagere district from central dry zone recorded the highest mean per cent disease severity of 36.55 per cent and Chitradurga district from the same zone recorded least mean per cent disease severity of 31.74 per cent. These results are consistent with the results of Mahantesh (2016) [13], who reported the highest disease severity of 43.80 per cent in Davanagere district and least disease severity of 29.50 per cent in Shivamogga district.

During the study of influence of soil type on disease severity of early blight of tomato, highest mean PDI was observed in the fields containing red soil (36.49%) followed by black soil (31.98%). Least mean PDI was seen in sandy loam soil (29.22%). These findings are consistent with those of Stridh *et al.* (2024) [14], who reported that light soils like red soil, being low in organic matter and nutrients, predispose plants to stress and higher disease severity. In contrast, heavy soils like black soil, through moisture retentive, harbor diverse soil microbes that can suppress *Alternaria solani*, leading to comparatively lower severity.

While studying the influence of growth stage of the crop on disease severity of early blight of tomato, highest mean per cent disease severity of 35.91 per cent was recorded in harvesting stage followed by fruiting stage (34.65%) and flowering stage (33.30%) and least severity was recorded in seedling stage (31.31%). Similar results were observed by Anwar *et al.* (2024) [15], who reported increasing disease severity in tomato plants with increase in plant age *i.e.*, 28.30 per cent at 30 days, 51 per cent at 60 days and 73.10 per cent at 120 days and this is because of reduction in sugar level of plant canopy as it became older.

5. Conclusion

Among the different villages surveyed, the highest disease severity was noticed in Machagondanahalli (48.67%), whereas least per cent disease severity was recorded in Karehalli (23.44%). Davanagere district recorded the highest mean per cent disease severity (36.55%), whereas least mean per cent disease severity was recorded in Chitradurga district (31.74%). Overall southern transition zone recorded slightly higher mean per cent disease severity (34.62%) compared to central dry zone (34.14%). Red soil fields showed the highest mean PDI compared to other soils and harvesting stages of the crop had the highest mean PDI compared to other stages of the crop.

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