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Survey and Response of different Planting Dates against Turmeric Leaf Spot Disease caused by *Colletotrichum capsici*

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ABSTRACT: Turmeric is one of the important spice crops in India. Though the crop is valued much socio-economically and medicinally, the yields are not realized to its potentiality due to various factors *viz.*, subsistence farming, popular varieties being susceptible to biotic and abiotic stresses and limited use of pesticides. Among the biotic factors, the turmeric leaf spot disease caused by *Colletotrichum capsici* is a limiting factor in turmeric cultivation in Karnataka. Hence, a study was undertaken to understand the prevalence of the disease in Karnataka and the influence of manipulation of the planting dates on the disease behaviour. A roving survey undertaken in Kalaburgi, Belgavi and Bagalkot districts of North Karnataka and Chamarajanagara district of South Karnataka during the year 2015-16 revealed that the disease severity (Per cent Disease Index) varied from 16.25 per cent to 70 per cent. Maximum PDI of 38.89 was observed in Chamarajanagara district whereas, it was minimum PDI (26.98) in Bagalkot district. The variety Cuddapah was susceptible with PDI ranging from 27.67 to 70.00 while the variety Alleppy was moderately resistant with PDI ranging from 17.50 to 22.50. The results on studies on the influence of different planting dates on disease development variety Cuddapah carried out at UHS Bagalkot, Karnataka, revealed that the crop sown on 1st August (late sown crop) registered maximum disease severity with PDI of 58.24 and yielded least fresh rhizome (27.41 t/ha) than the crop sown on May 1st (early sown crop) with an average PDI of 38.59 and highest fresh rhizome yield (34.07 t/ha). Such studies may be useful for taking up appropriate control measures and trace out the resistant varieties available if any and if the varieties are popular but susceptible then it is advisable to manipulate the planting dates that could identify the production period with less disease incidence.

Keywords: Survey, *Colletotrichum capsici*, dates of planting.

INTRODUCTION

Turmeric (*Curcuma longa* L.) is one of the important spice crops grown in India since time immemorial. It is an herbaceous perennial plant known as 'Indian saffron' as well as 'spice of life'. It belongs to the family *Zingiberaceae* and native to tropical south-east Asia especially India (Jansen, 1981). It is regarded as a symbol of well-being and future and is widely used in ceremonies and religious functions. It is one of the important spice crops in India grown mainly for its underground rhizome which yields yellow powder upon drying (Chattopadhyan *et al*., 2004; Nongmaithem and Rebika 2019). It is used in India and some other Asian countries in many ways such as condiment in culinary preparation, colouring agent (dye) in textiles, as food and confectionaries carminative, antiseptic and antiparasitic (Guji and Woga 2019; Ahmad *et al*., 2020). Turmeric contains essential oils up to 5% and curcumin up to 5%, a polyphenol (Pethe *et al.*, 2019).

It is extensively cultivated in China, India, Indonesia, Thailand and throughout the tropics, including tropical regions of Africa and America (Singh *et al.*, 2017). India is the world's largest producer of turmeric and accounts for 80 per cent of the world production. It occupies in an area of 3.50 lakh hectares with a production of 13.34 lakh metric tons in India. Major states producing turmeric in India are Tamil Nadu, Karnataka, Assam, Kerala, Maharashtra, Orissa and Andhra Pradesh. In Karnataka, it is grown in an area of 21.31 thousand hectares with a production of 1.31 lakh metric tons. (Anon, 2022). The major turmeric producing districts of the state are Charmarajnagar, Mysuru, Bagalkot, Belagavi, Bidar and Kalburgi.

The major production constraints in turmeric are long duration, low rhizome yield, low curcumin content of popular varieties and incidence of diseases. There is a quite substantial part of total harvest loss due to the diseases affecting the crop year after year. Among these, rhizome rot and foliar diseases are important

ones. Among the foliar diseases, the leaf spot disease of turmeric caused by *Colletotrichum capsici* is more destructive and prevalent in major turmeric growing areas and losses caused by leaf spot are always considered to be a limiting factor for yield, quality of rhizomes and often results in heavy yield losses (Devi, 2008). The symptoms appear in the beginning on the lower senescent leaves of turmeric. The spots are elliptical to oblong in shape, measuring of 2.50 to 4.00 cm long and 1.50 to 2.50 cm in wide. Two or more spots coalesce and develop into irregular patches eventually dry up giving blighted appearance. Such leaves became papery, easily torn off and drop off. Severely infected plants exhibited a burnt appearance which could be noticed easily from a distance (Rajesh, 2012). *C. capsici* has been reported to have a wide putative host range associated with symptoms of foliar blight, leaf spot diseases (Shenoy *et al.*, 2007).

Severe infection of the disease results in drooping of whole foliage and losses would exceed 50 per cent. Reduction in dry weight by 62.70 per cent was also reported due to foliar diseases. Heavy losses have been reported in severely diseased plants (>50 %) *i.e.* 25.83 and 62.12 per cent on fresh weight basis and 42.10 and 62.10 per cent on dry weight basis of mother and finger rhizomes respectively. Maximum losses in curcumin content (50.11 %) were found in severely diseased plants. The per cent curcumin content in rhizomes of diseased and healthy plants ranges from 2.08 to 4.17 respectively (Hudge and Ghugul 2010). The disease has been found increasing rapidly all over India over the last decade.

It is a main problem at the active vegetative growth and rhizome formation stage of turmeric. Most of the turmeric cultivars available today are susceptible to this disease, causing extensive yield losses to the turmeric production. Therefore, the survey is necessary to assess incidence and severity of the disease to determine the distribution, the status and also the reaction of the varieties/cultivars to the diseases for prioritizing the research. Such assessment studies provide the insight on the impact of geophysical and associated climatic and also edaphic variations between the regions. Previous studies conducted on the assessment of disease have given the information about the wide spread occurrence of the disease. Chidanandaswamy (2001) carried out survey in five districts of northern Karnataka for the incidence and severity of leaf spot of turmeric caused by *C. capsici* and recorded maximum disease incidence (28.00 %) in Bagalkot district. Gorawar *et al.* (2006) surveyed the disease incidence of major foliar diseases of turmeric in North Karnataka and found that the incidence of leaf spot disease caused by *C. capsici* was more prominent than leaf blight disease and was maximum in (50.00 %) in Salebiranhalli of Gulbarga district. Singh *et al*. (2016) conducted survey for the assessment of turmeric leaf spot disease incidence in Manipur. Maximum disease incidence of 57.00 and 75.84 per cent was observed in Bishnupur while the least disease incidence (48.37 and 69.72%) in Imphal West district.

Farmers in developing countries including India have very few options for the control of this disease on turmeric crop. The paradox is that the common turmeric varieties though highly susceptible to this disease, are most popular among the farmers as these varieties are high yielding ones and thus under favourable conditions the disease becomes wide spread and severe the yield gets drastically reduced. The use of fungicides is very limited because of the associated costs of these chemicals as well as handling issues and safety concerns to the users and to the environment. Hence, farmers depend largely on cultural practices such as crop rotation, intercropping and crop spacing. One of the important tools of cultural practices is manipulation in planting dates for identifying the suitable production period/s in which the crop could be sown with less favourable conditions for disease development during the production cycle. To date, there is no report on the studies on the influence of planting dates on leaf spot disease of turmeric caused by *C. capsici*. Early sown green gram crop has been reported to be less affected by *Colletotrichum truncatum*, the causal agent anthracnose disease (Kulkarni and Benagi 2012; Rajashree *et al*., 2020).

The aforesaid information on survey as well as on the response of planting dates seems to be very inadequate on turmeric leaf spot disease caused by *C. capsici*. Therefore, the study was taken up to carry out survey for the assessment of turmeric leaf spot disease in Karnataka and also the effect of different planting dates on the turmeric leaf spot disease severity.

MATERIALS AND METHODS

Survey for the assessment of turmeric leaf spot disease severity. The roving survey was undertaken to know the occurrence of turmeric leaf spot disease severity in Kalaburgi, Belgavi and Bagalkot districts of North Karnataka and Chamarajanagara district of South Karnataka during the year 2015-16 when the crop was of 5 to 6 months old. In each district two taluks and in each taluk three villages were surveyed. A total of four fields in each village were assessed for disease severity. A total of 88 fields distributed over different places were surveyed. The disease score of 0-5 scale was used for the purpose of assessing the disease severity as described by Padule and Utikar (1977).

Disease Severity Scale	Per cent leaf area covered by disease
0	0
1	1-15
2	16-25
3	26-50
4	51-75
5	>76

Finally, the Per cent Disease Index (PDI) was calculated by using following formula proposed by Wheeler (1969).

$$\text{Per cent Disease Index (PDI)} = \frac{\text{Sum of the individual disease ratings}}{\text{Number of fruits or leaves observed} \times \text{Maximum disease grade}} \times 100$$

Effect of different dates of planting on turmeric leaf spot disease. A field experiment was conducted to understand the response of different dates of planting on disease severity. For this purpose, susceptible turmeric variety Cuddapah was used. The experiment was conducted at Haveli farm, UHS, Bagalkot during 2015-16. The experiment was laid out in randomised block design with 7 treatments and 3 replications. There were 7 different planting dates with a gap of 15 days from 1st May to till 1st August 2015. The plot size of 2.7 m × 2.1m with spacing of 45 cm × 30 cm was maintained for each replication. All the required recommended cultivation practices were carried out as per the package of practices of UHS, Bagalkot. For recording the disease severity, five plants were selected randomly in each replication of individual treatment and observation on severity of the disease on the foliage was recorded by using 0-5 scale and Per cent Disease Index (PDI) was worked out by using following formula proposed by Wheeler (1969) as mentioned above. Finally the per cent disease control over control was calculated.

RESULTS AND DISCUSSION

Survey for the assessment of turmeric leaf spot disease severity. Results on the survey (Table 1, 2 and Fig. 1) revealed that the varieties grown in farmers' field were found to be Salem, Cuddapah and Alleppy highlighting the popularity of the varieties.

Table 1: Survey for the turmeric leaf spot disease severity in major turmeric growing districts of Karnataka during 2015-16.

Sr. No.	District	Taluk	Place	Varieties	No. of fields surveyed	Per cent Disease Index
I.	Bagalkot	Jamakhandi	Banhatti	Cuddapah	4	32.50
			Chimad	Salem	4	16.25
			Hosur	Salem	3	21.67
			Jagadal	Salem	3	25.00
			Navalagi	Salem	2	22.50
		Mudhol	Malali	Salem	4	38.75
			Malapur	Salem	2	32.50
			Sirola	Salem	6	26.67
			Mean			**26.98**
II.	Belagavi	Athani	Avarkoda	Cuddapah	6	33.33
			Chikoda	Cuddapah	4	36.25
			Mugalkod	Salem	3	26.67
			Sankunatti	Cuddapah	3	26.67
		Raybhag	Harugeri	Salem	3	26.67
			Koliguda	Cuddapah	4	31.25
			Yebaratti	Cuddapah	2	32.50
			Mean			**30.48**
III.	Kalaburgi	Chincholi	Chincholi	Cuddapah	4	30.00
			Degalmadi	Salem	2	32.50
			Edalayi	Cuddapah	3	41.67
			Inoli	Salem	2	17.50
			Sulepeta	Cuddapah	2	32.50
			Mean			**30.83**
IV.	Chamarajanagara	Chamarajanagara	Baydamula	Alleppy	2	20.00
			Dolipur	Alleppy	6	22.50
			Hardanahalli	Alleppy	4	17.50
		Gundlupete	Hundi	Cuddapah	3	66.67
			Vijaypur	Cuddapah	3	36.67
			Madalli	Cuddapah	4	70.00
			Mean			**38.89**

Table 2: Variety wise disease severity observed during survey on turmeric leaf spot.

Sr. No.	Variety	Total number of fields surveyed	PDI range	Mean PDI
1.	Cuddapah	42	26.67 to 70.00	39.17
2.	Salem	34	16.25 to 38.75	26.06
3.	Allepy	12	17.50 to 22.50	20.00

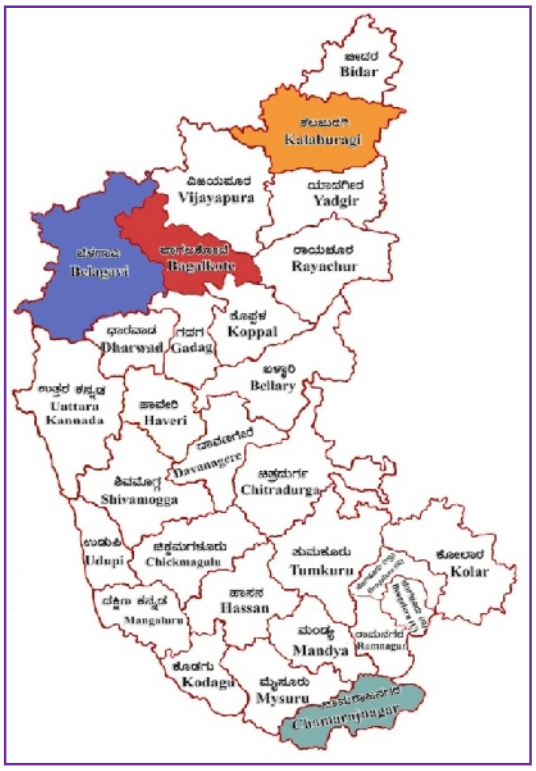

Fig. 1. Karnataka map showing the major turmeric growing districts that were assessed for the turmeric leaf spot disease severity.

The Per cent Disease Index (PDI) ranged from 16.25 to 70.00. Among the four districts surveyed, maximum disease severity (38.89 mean PDI) was noticed in Chamarajanagara district of South Karnataka while the least (26.98 mean PDI) was observed in Bagalkot district. In Bagalkot district the PDI ranged from 16.25 to 38.75. Least disease severity (16.25 PDI) was recorded in Chimad village of Jamakhandi taluk whereas, Malali village in Mudhol taluk recorded highest disease severity (38.75 PDI). In Belagavi district, the PDI ranged from 26.67 to 36.25. PDI was almost uniform in both the taluks of Belagavi district. However, maximum PDI of 36.25 was noticed in Chikoda village of Athani taluk. In Kalaburgi district, only one taluk (Chincholi) was surveyed as the cultivation of turmeric in other parts of the district was very less. In Chincholi taluk, PDI ranged from 17.50 to 41.67. In this taluk, highest disease severity (41.67 PDI) in Edalavi village and the least (17.50 PDI) was noticed in Inoli village. In Chamarajanagara district, the PDI ranged from 17.50 to 70.00. Among the taluks, Chamarajanagara taluk registered least PDI ranging from 17.50 to 22.50 whereas in Gundlapete taluk the disease was severe and ranged from 36.67 to 70.00 PDI. The Hardanahalli village of Chamarajanagara taluk registered least disease severity (PDI of 17.50) while maximum disease severity (70.00 PDI) was noticed in Madalli village of Gundlupete taluk. Gorawar *et al.* (2006) reported that among the major foliar diseases of turmeric in North Karnataka the incidence of leaf spot disease was higher than that of leaf blight caused by *Alternaria alternata*. They also reported that the incidence of leaf blight was greatest in Ranna belagali (66.60 %) of Bagalkot followed by in Salebiranhalli (50.00 %) of Gulbarga district. Turmeric leaf spot caused by *C. capsici* (Syd.) is fatal in the September crop when the temperature is high (25-30°C) and it does not normally occur in post-rainy-season crop, except under unusual rains as reported (Nene, *et al.*, 1996).

The present survey coincided with the rainfall and high relative humidity barring a few assessed fields that might have led to the relatively increased disease incidence. In one of the studies it was found that the rainfall influenced the anthracnose disease in chilli depending on the amount, duration, intensity and pattern of rainfall during the crop cycle (Ying, 1987). Anamika and Nath (2014) found increased fruit rot (anthracnose) disease in chilli due to prevalence of high humidity and moderate temperature which suit the growth and reproduction of the fungus *Colletotrichum capsici*.

The disease severity varied with the varieties. The PDI was ranged from 26.67 to 70.00 in Cuddapah variety, it was ranged from 16.25 to 38.75 in Salem variety while in Allepy variety the PDI ranged from17.50 to 22.50. The variety Alleppy was found to be moderately resistant while the variety Cuddapah was susceptible with disease severity was as high as 70.00 (Table 2). The varieties Alleppy, IISR Prabha and Allampuram are reported to be resistant varieties while IISR Pratibha and Salem are moderately resistant (Kadam *et al.*, 2014).

Effect of different dates of planting on turmeric leaf spot disease. The results on the effect of different sowing dates on PDI are depicted in Table 3 and in Fig. 2. There was a significant difference in the severity of leaf spot disease at different sowing dates. At 70 days after planting (DAP), maximum PDI (30.75) was noticed in the crop sown on 1st August (late sown crop) and the minimum PDI (15.57) was observed in the crop sown on 1st May followed by the crop sown on 15th May (16.43) (early sown crop) which was statistically on par with the crop sown on 1st May. This was followed by the crop sown on 1st June (18.07) and 15th June (19.75) which were statistically on par with each other.

At 100 DAP, the crop sown on 1st May (early sown crop) showed least PDI (29.07) and statistically was on par with the crop sown on 15th May (31.08). The crops sown 1st June (36.00) and 15th June (38.00) were statistically on par with each other. The maximum PDI (48.00) was registered in the crop sown on 1st August (late sown crop) followed by the crop sown on 15th July (45.00) and 1st July (43.53).

Table 3: Effect of different planting dates on turmeric leaf spot disease severity.

Sr. No.	Planting dates	Per cent Disease Index (PDI) at days after planting (DAP)					Fresh rhizome yield (t/ha)
		70 DAP	100 DAP	130 DAP	160 DAP	190 DAP	
1.	May 1st	15.57 (23.24)	29.07 (32.62)	38.00 (38.05)	49.00 (44.42)	61.33 (51.55)	34.07
2.	May 15th	16.43 (23.91)	31.08 (33.88)	41.47 (40.08)	54.13 (47.37)	65.40 (53.97)	32.02
3.	June 1st	18.07 (25.15)	36.00 (36.86)	46.00 (42.70)	59.00 (50.18)	70.20 (56.92)	31.22
4.	June 15th	19.75 (26.38)	38.00 (38.05)	49.73 (44.84)	60.33 (50.96)	73.93 (59.30)	30.80
5.	July 1st	21.67 (27.70)	43.53 (41.28)	54.13 (47.37)	63.17 (52.63)	74.33 (59.56)	28.81
6.	July 15th	25.08 (30.04)	45.00 (42.12)	58.27 (49.76)	64.20 (53.25)	76.10 (60.73)	28.04
7.	August 1st	30.75 (33.67)	48.00 (43.85)	62.20 (52.06)	69.13 (56.25)	81.13 (64.27)	27.41
	SEm±	0.58	0.60	0.63	0.68	0.67	1.14
	CD (P=0.05)	1.79	1.84	1.90	2.11	2.06	3.51
	CV (%)	3.71	2.69	2.38	2.33	2.0	6.51

Note: Figures in parenthesis are arc sine transformed values

At 130 DAP, the minimum PDI (38.00) was registered in the crop sown on 1st May (early sown crop) and was statistically superior over the crop sown on all other planting dates. This was followed by the crop sown on 15th May (41.47), 1st June (46.00), 15th June (49.73). Maximum PDI (62.20) was noticed in the crop sown on 1st August (late sown crop) followed by the crop sown on 15th July (58.27) and 1st July (54.13).

At 160 DAP, the crop sown on 1st May (early sown crop) showed least PDI (49.00) and was statistically superior over all other treatments followed by the crop sown on 15th May (54.13) and 1st June (59.00). Maximum PDI of 69.13 was noticed in the crop sown on 1st August (late sown crop) followed by the crops sown on 15th July (64.20) and 1st July (63.17).

At 190 DAP, the disease was found to be severe irrespective of different dates of sowing. However, minimum PDI (61.33) was registered in the crop sown on 1st May (early sown crop) and was statistically significant over the crops sown on different dates followed by the crop sown on 15th May with PDI of 65.40. Maximum PDI (81.13) was noticed in the crop sown on 1st August (late sown crop) followed by the crop sown on 15th July with PDI of 76.10.

From the above results it can be observed that the disease in the beginning was minimum and started showing the increasing trend as the crop age advanced and became severe towards the fag end of the crop. The early sown crop showed less PDI than the late sown crop. Irrespective of the different dates of planting, the PDI was more at 160 DAP and 190 DAP.

The data on the fresh rhizome yield of turmeric as influenced by different dates of planting was significant. The maximum rhizome yield (34.07 t/ha) was obtained in the crop sown on 1st May (early sown crop). However, the yield obtained in the crops sown in 15th May (32.02 t/ha), 1st June (31.22 t/ha) and 15th June (30.80 t/ha) were statistically on par the yield obtained in the crop sown on 1st May. The least fresh rhizome yield (27.41 t/ha) was noticed in the crop sown on 1st August (late sown crop) followed by the crop sown on 15th July (28.01 t/ha) which were statistically on par with each other (Plate 1A and 1B).

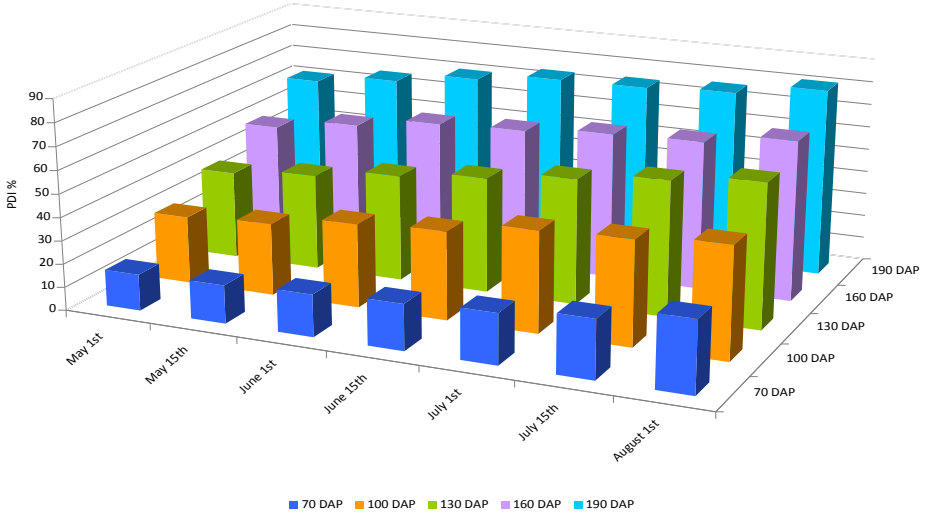

Fig. 2. Effect of different planting dates on turmeric leaf spot disease severity.

Plate 1A: General view of the experimental plot on the effect different planting dates on turmeric leaf spot disease.

May 1st Planted

August 1st Planted

May 1st Planted

August 1st Planted

Plate 1B: Effect of different planting dates on turmeric leaf spot disease; 1 B (a&b): 130 days after planting; 1B (c&d): 160 days after planting.

The present work is in agreement with the earlier works on effect of sowing dates on the incidence of anthracnose of green gram caused by *C. truncatum* where in the earlier crop sown recorded significantly less disease severity and highest grain yield than the late sown crop (Kulkarni and Benagi 2012; Rajashree *et al*., 2020). Similarly Shadap *et al.* (2013) recorded lower per cent disease intensity (*Helminthosporium* leaf spot) in May planting that also recorded highest fresh rhizome yield in ginger variety Humanabad.

CONCLUSION

The present study concludes that the anthracnose disease of turmeric is present in all the surveyed turmeric growing areas in Karnataka with varied disease intensities. Chamarajanagara district of South Karnataka was found to be more prone to the disease attack than Bagalkot district. The variety Cuddapah though popular among the farmers was susceptible to turmeric leaf spot disease than Alleppy which was moderately resistant. The early sown turmeric crop (1st May) registered least disease severity with highest fresh rhizome yield than the late sown turmeric crop (1st August). Therefore, future studies are very much essential to understand the performance of different varieties in particular the resistant ones in those localities where they either have not been popular or ignored by the farmers for many reasons.

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Conflict of Interest. None.

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