E-ISSN: 2618-0618
P-ISSN: 2618-060X

NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; SP-8(9): 23-26
Received: 19-06-2025
Accepted: 21-07-2025

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Spatial distribution of onion twister disease in major onion-growing regions of Karnataka

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DOI: https://www.doi.org/10.33545/2618060X.2025.v8.i9Sa.3710

Abstract
Roving survey was conducted to assess the incidence of onion twister disease in major growing districts of Karnataka during 2022-23 and 2023-24 covering seven districts in the first year and five districts in the second, with systematic field sampling and disease scoring using a 0-5 scale. Per cent Disease Index (PDI) was calculated and GPS coordinates of each field were recorded for spatial mapping. During 2022-23, mean PDI ranged from 18.28 per cent in Dharwad to 45.14 per cent in Chitradurga, with major hotspots identified in Chitradurga and Chikkamagaluru. In 2023-24, disease incidence declined markedly, with average PDI across districts reduced to 6.69 per cent, indicating improved crop management and favorable climatic conditions. Spatial distribution maps highlighted significant variability in disease occurrence across taluks. Results underscore the importance of continuous surveillance and adoption of integrated management strategies.

Keywords: Onion, twister disease, Percent Disease Index (PDI) and GPS mapping

Introduction
Onion (*Allium cepa* L.) is one of the oldest cultivated vegetable crops, with its name derived from the Latin word *unio*, meaning “one” or “unity,” referring to the formation of a single bulb (Brewster, 2008) [3]. Believed to have originated in Central Asia, particularly in present-day Iran and Afghanistan, onion has spread worldwide and is now cultivated in more than 170 countries (Griffiths *et al*., 2002) [7]. Globally, it ranks second in area and production among vegetables, occupying nearly 5 million hectares with over 100 million tons of production annually (FAOSTAT, 2023) [6]. India is the second largest producer after China, contributing nearly one-fifth of global output, with Maharashtra, Karnataka, Madhya Pradesh, Gujarat and Rajasthan being the leading onion growing states (NHRDF, 2022) [11]. The crop is consumed both as a fresh vegetable and as a spice, owing to its pungency, flavor and wide use in culinary preparations (Brewster, 2008) [3]. In addition to its dietary role, onion is valued for medicinal properties such as antimicrobial, antioxidant, anti-inflammatory and cholesterol lowering activities, attributed mainly to its bioactive compounds like quercetin and organosulfur compounds (Gupta and Prakash, 2014; Teshika *et al*., 2019) [8, 15]. Onion also holds socio-economic significance by generating employment in production, processing, storage and export chains (FAO, 2020) [5]. With its dual importance in nutrition and health care, onion is considered indispensable in daily human diet across cultures.

Onion productivity is constrained by a wide range of biotic and abiotic stresses that limit its yield potential and cultivation efficiency. Among abiotic factors, onion is highly sensitive to drought, waterlogging, heat and photoperiod variations, which adversely affect bulb development and storability (Brewster, 2008) [3]. Biotic stresses include several destructive fungal pathogens such as *Alternaria porri* (Purple blotch), *Peronospora destructor* (Downy mildew), *Stemphylium vesicarium* (Stemphylium blight), *Fusarium oxysporum* f. sp. *cepae* (Basal rot), *Colletotrichum gloeosporioides* (Anthracnose/Twister), and Bacterial and Viral infections that together cause significant yield losses (Dutta *et al*., 2022) [4]. Among these, twister disease, also known as the anthracnose-twister complex, has emerged as a major

constraint in onion production. The disease is characterized by leaf twisting, curling, neck elongation, abnormal sprouting, slender bulbs and eventual bulb rot, severely affecting both yield and market quality (Patil, 2013; Dutta *et al*., 2022) [12, 4]. The primary causal agent is *Colletotrichum sp.*, although associations with *Fusarium* spp.*Sclerotium* sp. and also root-knot nematodes have also been reported (Sonawane *et al*., 2022) [14]. Yield losses due to twister disease vary widely, ranging from 20-60 per cent in India to complete crop failure under epidemic conditions worldwide (Barad, 2022) [2]. Favorable conditions such as high humidity, frequent rains, and warm temperatures during the *Kharif* season often led to severe outbreaks, underscoring the importance of systematic surveys and effective management strategies. Thus, present study aimed to document the twister disease in onion growing areas in Karnataka.

Materials and Methods

A roving survey was conducted to assess the incidence and severity of onion twister disease in the major onion-growing areas of Karnataka during the *Kharif* seasons of 2022-23 and 2023-24. In 2022-23, surveys were carried out across seven districts, *viz*., Bagalkot, Belagavi, Chikkamagaluru, Chitradurga, Dharwad, Gadag and Vijayapura, while in 2023-24, the survey was restricted to five districts, *viz*., Bagalkot, Belagavi, Dharwad, Gadag and Vijayapura. From each district, representative taluks were selected, and in every taluk, five villages were randomly chosen. In each village, two farmer fields were surveyed, and within each field, five spots of 1 m² were randomly assessed. The disease severity was recorded by visually scoring 10 plants per spot based on a 0-5 disease rating scale (0 = no symptoms, 1 = ≤10 per cent curling and chlorosis of leaves, 2 = 11-20 per cent abnormal elongation of leaves and neck, 3 = 21-40 per cent leaf sheath showing acervuli with concentric rings, 4 = 41-60 per cent elongated neck and slender bulbs with dieback symptoms, and 5 = >60 per cent severe dieback, bulb rot, and underdeveloped root system with discolored roots) as described by Ramakrishnan *et al*. (2022) [13]. The percent disease index (PDI) was calculated using McKinney's formula (1923) [10]: PDI= [Sum of all disease ratings/Total number of plants observed × Maximum disease gra de]X 100. Geographical coordinates (latitude, longitude, and altitude) of each surveyed field were recorded using a Garmin eTrex 10X GPS device. Based on the GPS data and field observations, the spatial distribution of twister disease was mapped using ArcGIS version 10.8.2 software following the methodology of Alberto *et al*. (2019) [1].

Results

The roving survey conducted during Kharif 2022-23 revealed considerable variation in the incidence and severity of twister disease of onion across the surveyed districts of Karnataka (Table 1). The mean Per cent Disease Incidence (PDI) ranged from 18.28 per cent in Dharwad to 45.14 per cent in Chitradurga, with the highest severity recorded in Hosadurga taluk of Chitradurga (61.26 ± 3.75%), followed by Hiriyuru (41.22 ± 1.75%) and Kolhar in Vijayapura (36.04 ± 3.20%). In contrast, comparatively lower incidences were observed in taluks such as Kundagol of Dharwad (8.50 ± 4.15%) and Gadag (17.28 ± 2.08%). The overall mean PDI across districts during 2022-23 was 27.57%, indicating moderate to severe levels of disease pressure in most onion-growing regions.

In contrast, the survey during Kharif 2023-24 indicated a sharp decline in disease incidence across the same regions (Table 1; Plate 2). The highest mean incidence was observed in Bagalkot district (9.63 ± 2.15%), followed by Vijayapura (10.09 ± 2.01%) and Dharwad (4.51 ± 2.31%), while Gadag district recorded the lowest incidence (2.89 ± 1.18%). Within districts, taluks such as Hunagunda (14.92 ± 3.15%) and Mudhol (12.53 ± 2.35%) in Bagalkot, along with Basavana Bagevadi (13.60 ± 1.25%) in Vijayapura, emerged as localized hotspots during 2023-24. The overall mean PDI across districts was restricted to 6.69%, which is significantly lower compared to the preceding year.

The disease distribution maps (Fig. 1 and 2) clearly depicted the spatial variability of twister disease across taluks and districts during both years of survey. The maps further confirmed that Chitradurga, Chikkamagaluru, and Vijayapura were major hotspots during 2022-23, whereas in 2023-24 the disease was largely confined to Bagalkot and parts of Vijayapura. The marked reduction in disease incidence during 2023-24 may be attributed to variability in climatic factors, adoption of improved crop management practices, or a natural decline in pathogen inoculum load. Together, these findings underscore the dynamic nature of twister disease distribution and highlight the need for continuous monitoring and adaptive management strategies to safeguard onion production in Karnataka.

Discussion

The present survey conducted across major onion-growing regions of Karnataka during Kharif 2022-23 and 2023-24 revealed considerable spatio-temporal variability in the incidence and severity of twister disease. A consistent decline in mean Per cent Disease Index (PDI) across most districts between the two years suggests the combined influence of favourable weather conditions, effective disease monitoring, and improved crop management practices. Significant reductions in Bagalkot, Belagavi, Dharwad, Gadag, and Vijayapura districts point towards increased awareness and adoption of integrated disease management (IDM) strategies such as timely fungicide sprays, crop rotation with non-hosts, and better irrigation scheduling. Since twister disease is known to intensify under prolonged humid and rainy conditions, the relatively lower rainfall during 2023-24 may have further contributed to disease suppression.

These results align with earlier findings by Sonawane *et al*. (2022) [14], who reported a decline in disease severity from 20.17-54.59 per cent in 2020 to 12.00-35.00 per cent in 2021 across major onion-growing districts of Maharashtra, attributing the variation primarily to rainfall patterns. Similarly, Manthesha *et al*. (2022) [9] highlighted spatial and temporal differences in the Kalyan Karnataka region, underscoring the critical role of weather fluctuations and management practices in disease development.

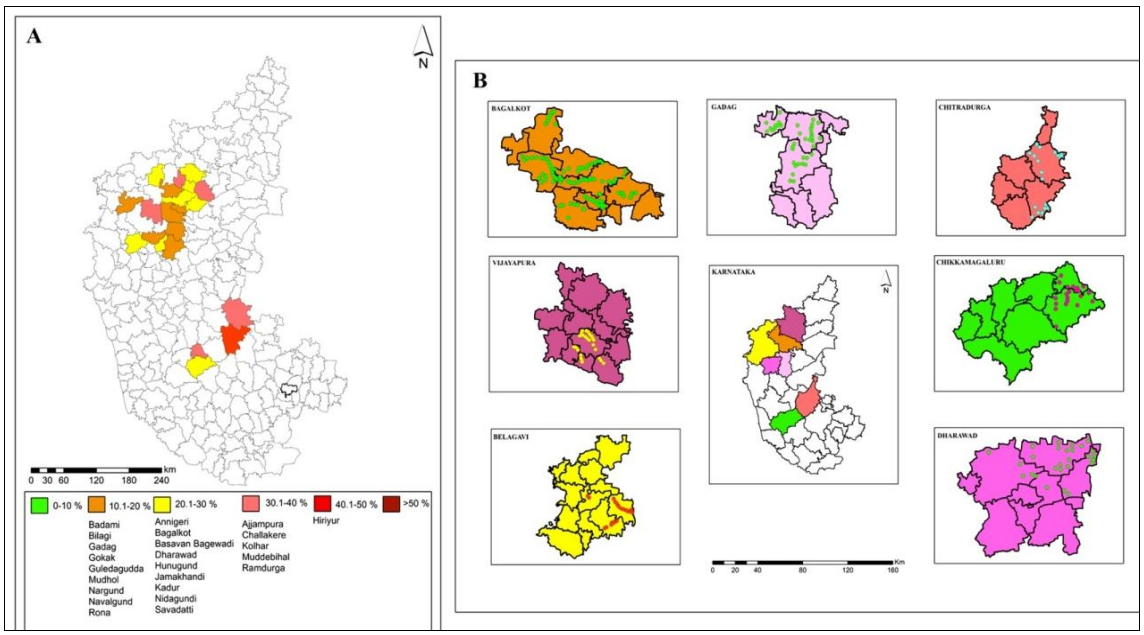
Despite the overall reduction in disease pressure, Chitradurga and Chikkamagaluru districts remained persistent hotspots. This may be due to favourable microclimatic conditions that supported disease development or comparatively lower adoption of IDM practices. Such findings highlight the importance of targeted surveillance and region-specific management strategies.

Looking forward, integrating real-time weather data, pathogen population dynamics, and varietal susceptibility into predictive disease models could enhance early warning systems for twister disease. Sustained surveillance, capacity-building of farmers, and promotion of resistant cultivars will be crucial for long-term disease management and safeguarding onion production in Karnataka.

Table 1: Distribution of twister disease of onion in Karnataka during 2022-23 and 2023-24

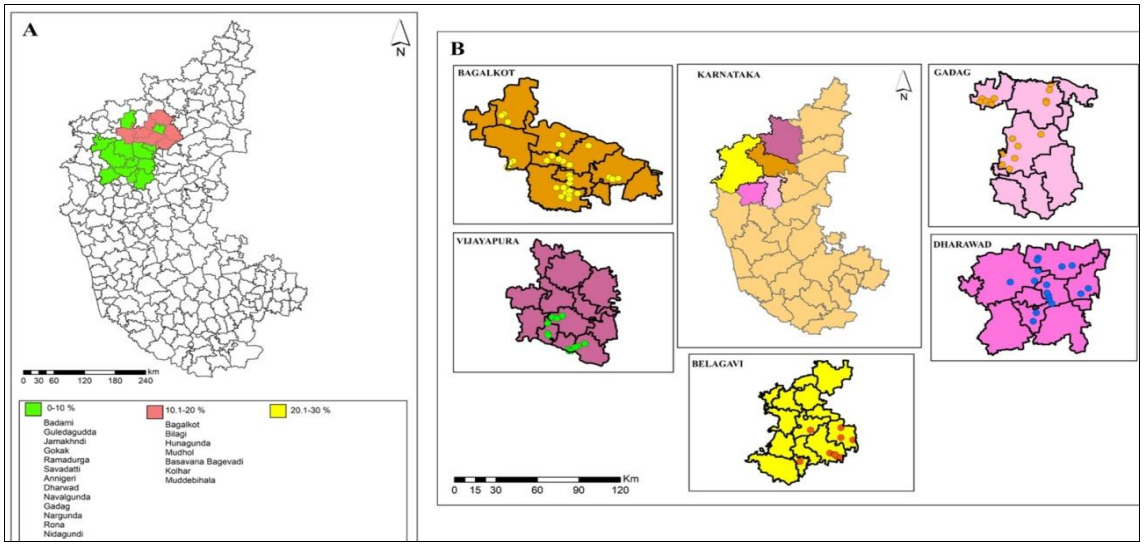
District	Taluk	PDI ± SD	
		2022-23	2023-24
Bagalkot	Badami	11.33 ± 1.00	4.90 ± 1.00
	Bagalkot	25.43 ± 1.50	11.02 ± 2.45
	Bilagi	18.84 ± 1.32	12.16 ± 1.84
	Guledagudda	19.36 ± 2.12	6.42 ± 2.73
	Hunagunda	25.57 ± 1.00	14.92 ± 3.15
	Jamakhndi	29.82 ± 1.74	5.48 ± 1.50
	Mudhol	19.26 ± 2.45	12.53 ± 2.35
	Average	21.37 ± 1.59	9.63 ± 2.15
Belagavi	Gokak	18.44 ± 1.75	4.10 ± 2.75
	Ramadurga	34.79 ± 2.40	3.83 ± 1.00
	Savadatti	23.97 ± 3.74	4.18 ± 1.40
	Average	25.73 ± 2.63	4.04 ± 1.72
Chikkamalaguru	Ajjapuru	32.99 ± 1.00	---
	Biruru	30.04 ± 3.75	---
	Kaduru	26.50 ± 1.83	---
	Average	29.84 ± 2.19	---
Chitradurga	Challakere	32.94 ± 3.20	---
	Hiriyuru	41.22 ± 1.75	---
	Hosadurga	61.26 ± 3.75	---
	Average	45.14 ± 2.90	---
Dharwad	Annigeri	23.34 ± 1.60	3.00 ± 3.47
	Dharwad	21.24 ± 2.89	4.56 ± 2.18
	Kundagol	8.50 ± 4.15	4.88 ± 1.25
	Navalgunda	20.02 ± 3.65	5.60 ± 2.35
	Average	18.28 ± 3.07	4.51 ± 2.31
Gadag	Gadag	17.28 ± 2.08	2.07 ± 1.03
	Nargunda	18.81 ± 4.15	5.10 ± 1.50
	Ron	20.70 ± 1.00	1.50 ± 1.00
	Average	18.93 ± 2.41	2.89 ± 1.18
Vijayapur	BasavanaBagevadi	18.10 ± 2.45	13.60 ± 1.25
	Kolhar	36.04 ± 3.20	13.35 ± 2.70
	Muddebihala	39.75 ± 1.76	10.52 ± 2.40
	Nidagundi	21.07 ± 1.58	2.88 ± 1.68
	Average	28.74 ± 2.25	10.09 ± 2.01

Figure captions



A. Taluka wise disease incidence map.
B. District wise disease incidence map (Dots indicates surveyed fields)

Fig 1: Disease incidence map of twister disease of onion in Karnataka during 2022-23.



A. Taluka wise disease incidence map.
B. District wise disease incidence map (Dots indicates surveyed fields)

Fig 2: Disease incidence map of twister disease of onion in Karnataka during 2023-24

Conclusion

The survey across major onion growing districts of Karnataka revealed a wide variation in twister disease incidence during 2022-23 and 2023-24. The highest disease severity was recorded in Chitradurga (45.14% PDI) and Chikkamagaluru (29.84% PDI) during 2022-23, while comparatively lower levels were noted in Dharwad (18.28%) and Gadag (18.93%). A consistent reduction in disease intensity was observed in 2023-24, with A sharp reduction in average PDI was observed during 2023-24 in Bagalkot, Belagavi, Dharwad, Gadag and Vijayapura compared to the previous year, indicating that disease severity declined considerably across these districts. The decline may be attributed to improved disease management, favorable weather conditions, and adoption of better agronomic practices. Overall, the results emphasize the dynamic nature of twister disease and the need for continuous monitoring and integrated control strategies tailored to each region.

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