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Survey and estimation of chickpea wilt incidence caused by *Fusarium oxysporum* f. sp. *ciceris* in Uttarakhand

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Abstract

Chickpea (*Cicer arietinum* L.) is one of the important *rabi* pulse crop grown Uttarakhand India. The crop is nearly infected by 172 pathogens. Amongst them *Fusarium* wilt caused by *Fusarium oxysporum* f. sp. *ciceris* is one of the major diseases of chickpea causing losses to the tune of 100 percent in severe condition. A comprehensive survey was conducted to assess the prevalence and distribution of chickpea wilt disease across major chickpea-growing regions in the Garhwal and Kumaon regions of Uttarakhand. The study covered various geographic locations to evaluate disease incidence and identify areas of high vulnerability. In the Garhwal region, the highest disease incidence was recorded in Jolly Grant (14.75%) of the Doiwala block, followed by Raiwala (13.9%) and Rishikesh (13.09%). The lowest incidence was observed in Nasirabad (0.5%) in the Laksar block of Haridwar district. In the Kumaon region, Pantnagar reported the highest disease incidence (29.3%), followed by Khamiya in the Rudrapur block (28.45%), while the lowest incidence was recorded in Danthi (5.17%) in the Champawat block. These findings highlight significant spatial variations in disease incidence, influenced by regional and environmental factors. The data emphasize the need for location-specific disease management strategies to mitigate chickpea wilt disease and enhance agricultural productivity in Uttarakhand.

Keywords: Chickpea, *Fusarium oxysporum*, survey, wilt incidence, spatial distribution

Introduction

Chickpea (*Cicer arietinum* L.) ranks as the world's third most significant pulse, extensively cultivated across various subtropical and warm-temperate regions. The crop is susceptible to infection by 172 biotic stress agents, which include 67 fungal species, 3 bacterial strains, 22 viral types, and 80 nematodes, as documented in 55 countries worldwide (Nene *et al.*, 1996) [13]. Among these, wilt caused by *Fusarium oxysporum* f. sp. *ciceris* is the most destructive, widespread, and critical pathogen affecting chickpea globally (Gupta *et al.*, 1997) [3]. In India, the disease is prevalent in all chickpea-growing states, causing an estimated annual loss of 10% (Singh and Dahiya, 1973) [18]. *Fusarium* wilt leads to substantial economic losses, ranging from 10% to 40% globally (Nene *et al.*, 1984) [12]. The disease can affect the crop at any growth stage (Haware and Nene, 1980) [11], causing up to 100% loss under specific environmental conditions (Jalali and Chand, 1992) [7], particularly during the vegetative and reproductive stages (Halila and Strange, 1996) [4]. Wilt is known to induce significant yield losses, potentially reaching 100% under optimal conditions (Jalali and Chand, 1992) [7]. The incidence is highest during the flowering and pod formation stages, especially when the crop experiences abrupt temperature increases and water stress (Chaudhry *et al.*, 2007) [1]. Annual yield losses due to wilt can range from 10% to 60% under favorable conditions (Singh *et al.*, 2007). In some cases, depending on weather conditions, wilt can cause up to 90% yield loss (Venkataramanamma *et al.*, 2018) [22]. Early-stage wilt incidences are reported at 77–94%, whereas late-stage wilting ranges from 24–65% (Sunkad *et al.*, 2019) [22]. Given the substantial impact of this disease on chickpea production, the present study was conducted to assess the current status of chickpea wilt across different geographical regions of Uttarakhand.

Materials and Methods

A roving survey was conducted across various chickpea-growing regions of Uttarakhand during the Rabi season of 2020-21 to estimate disease incidence and collect chickpea plants infected with wilt caused by *Fusarium oxysporum* f. sp. *ciceri*. The survey took place between December and January, corresponding to different growth stages of the chickpea crop, including flowering, pod formation, and pod development. The survey covered all chickpea-growing areas within the state. In each surveyed field, the total number of chickpea plants in two rows was counted, with wilt-suspected plants noted separately to determine the percent incidence of wilt. Approximately five wilted plants per field were carefully uprooted, placed in paper bags, labeled with relevant details, and transported to the laboratory for further analysis. The percent wilt incidence for each field surveyed was calculated using the formula provided by Mayee and Datar (1986) [9], based on the numerical data regarding the total number of chickpea plants and the wilted plants per field.

$$\text{Wilt incidence (\%)} = \frac{\text{Total number of wilted plants}}{\text{Total number of plants observed}} \times 100$$

Results and Discussion

To analyze the prevalence and distribution of chickpea wilt disease across major chickpea-growing areas, an extensive survey was conducted with a focus on geographic patterns and incidence rates. This investigation seeks to identify the spatial distribution of the disease in Uttarakhand, providing valuable insights into the environmental or regional factors that may influence its spread and severity. Understanding these variations will help identify regions with higher vulnerability and enable the development of more effective, targeted disease management strategies. The geographic coordinates and corresponding disease incidence rates of the surveyed sites are presented in Table. 1; Figure.1, offering a detailed overview of the findings.

Prevalence of chickpea wilt in Kumaon region of Uttarakhand

In the Kumaon region, a comprehensive survey was conducted across three districts: Udham Singh Nagar, Champawat, and Nainital, to assess the incidence of disease in various agricultural areas. Among the surveyed locations, Pantnagar in Udham Singh Nagar recorded the highest

disease incidence at 29.3%, indicating significant disease pressure in the area. This was closely followed by Khamiya in the Rudrapur block, with an incidence rate of 28.45%, reflecting a similar trend of high disease prevalence. Conversely, the lowest disease incidence was observed in Danthi, located in the Champawat block, with a rate of 5.17%, suggesting relatively better crop health in this region.

Prevalence of chickpea wilt in Garhwal region of Uttarakhand

In the Garhwal region, a detailed survey was carried out across three districts to study disease incidence in different chickpea-growing areas. The highest disease incidence was recorded in Jolly Grant, located in the Doiwala block, with an incidence rate of 14.75%, indicating significant disease prevalence in this area. This was followed by Raiwala and Rishikesh, which showed disease incidence rates of 13.9% and 13.09%, respectively. In contrast, the lowest disease incidence was observed in Nasirabad, situated in the Laksar block of Haridwar district, with a rate of just 0.5%, suggesting minimal disease impact. The observed variations in disease incidence across these locations underscore the need for localized disease management approaches. Such region-specific data are essential for developing targeted strategies to protect chickpea crops and improve yield potential in the Garhwal region. Studies conducted by Ghosh *et al.* (2013) during the Rabi season of 2010-2011 focused on surveying the occurrence and distribution of chickpea diseases with respect to soil type, cultivars, and seed treatments in the central and southern parts of India. The findings revealed that local cultivars were predominant in most farmers' fields, accounting for 25% to 48% of the cultivated area. Additionally, 63% of farmers practiced seed treatment with fungicides, reporting chickpea wilt disease incidence ranging from 9.7% to 13.8%. Nikam *et al.* (2011) [14] conducted a survey on chickpea wilt in the Tashils of Latur district and reported an average wilt incidence of 12.26%, with the highest incidence observed in AUSA (15.4%). Variations in wilt incidence and the widespread nature of the disease have also been documented by earlier researchers, including Nema and Khare (1973) [11], Trapero-Casas and Jimenez-Diaz (1985) [21], Jalali and Chand (1992) [7], Navas-Cortes *et al.* (2000) [10], Reddy (2002) [15], Jadhav *et al.* (2006) [6], Sontakke *et al.* (2020), Shrivastava and Mahajan (2021) [16].

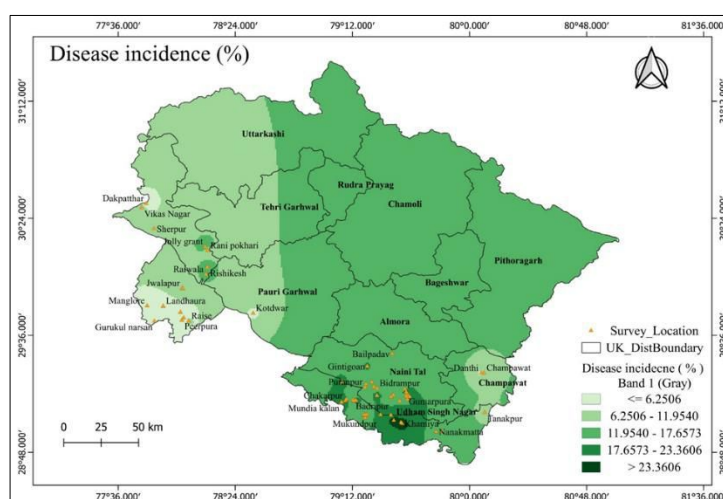


Fig 1: Surveyed locations of chickpea growing area infected with fusarium wilt in Uttarakhand.

Table 1: Survey Details of Uttarakhand: Locations, Coordinates, and Disease Incidence

Division	District	Block	Area	Location	Latitude	Longitude	Disease incidence (%) (2020-21)	Mean (D.I %)
Kumaon (41)	Udham Singh Nagar (19)	Bajpur (7)	Plains	Chakarpur	29°9'8.29"N	79°9'3.604"E	19.25	17.93
				Bazpur	29°9'44.405"N	79°9'33.419"E	17.52	
				Badripur	29°9'26.258"N	79°12'17.416"E	12.75	
				Ganeshpur	29°3'14.904"N	79°27'47.088"E	18.95	
				Mundia kalan	29°8'34.364"N	79°7'35.028"E	21.12	
				Vijay Rampura	29°09'10.9"N	79°13'31.3"E	22.45	
				Sheetpuri	29°09'07.1"N	79°12'37.4"E	13.45	
		Rudrapur (4)		Khamiya	28°59'51.456"N	79°32'22.516"E	28.45	25.56
				Jawahar nagar	29°0'17.072"N	79°31'28.721"E	23.25	
				Pantnagar	29°1'5.444"N	79°28'58.648"E	29.3	
		Gadarpur (5)		Chhatpur	29°1'55.33"N	79°23'30.026"E	21.24	15.27
				Chandan Nagar	29°3'25.614"N	79°23'33.757"E	14.62	
				Rambagh	29°3'23.187"N	79°17'55.838"E	18.45	
				Mukundpur	29°3'17.654"N	79°16'41.718"E	17.52	
				Barirai	29°2'12.797"N	79°17'13.34"E	14.52	
				Narayanpur	29°3'16.934"N	79°17'29.201"E	11.25	
				Nanakmatta	28°56'39.746"N	79°48'33.404"E	14.5	
		Sitarganj (3)		Bidaura	28°56'28.072"N	79°46'19.826"E	18.69	17.49
				Chikaghat	28°56'28.072"N	79°46'19.826"E	19.29	
				Mean	18.76			
	Nainital (19)	Haldwani (8)	Plains	Puranpur	29°14'42.11"N	79°17'8.916"E	11.07	16.28
				Halduchaur Dina	29°9'3.097"N	79°31'19.097"E	17.67	
				Gosaipur	29°10'42.807"N	79°27'52.441"E	13.26	
				Prempur	29°11'30.237"N	79°28'49.867"E	12.86	
				Reshambagh	29°11'14.687"N	79°22'4.752"E	19.45	
				Jwala Pokhri	29°11'34.032"N	79°34'29.223"E	16.05	
				Gaula Par	29°10'35.3"N	79°35'25.1"E	19.64	
				Dewala Malla	29°12'43.6"N	79°34'02.2"E	20.24	
		Ramnagar (6)	Plains	Gumarpura	29°11'22.87"N	79°34'1.843"E	15.83	17.32
				Kishanpur	29°9'41.67"N	79°34'33.72"E	16.43	
				Gautam gram	29°13'53.279"N	79°33'28.734"E	17.02	
				Bailpadav	29°28'22.87"N	79°28'22.87"E	17.62	
				Himmatpur	29°10'53.548"N	79°34'15.799"E	18.21	
				Ramnagar	29°23'45.7"N	79°07'38.9"E	18.81	
		Kotabagh (5)	Plains	Nayagaon	29°16'43.123"N	79°19'58.302"E	15.6	16.78
				Bhimpuri	29°15'58.069"N	79°17'36.542"E	16.19	
				Bidrampur	29°14'13.878"N	79°22'4.752"E	16.79	
				Ratanpur	29°14'48.801"N	79°20'44.432"E	17.38	
				Gintigoan	29°23'15.06"N	79°18'4.263"E	17.98	
					Mean	16.74		
	Champawat (3)	Champawat (3)	Plains Hill	Tanakpur	29°04'20.6"N	80°06'18.8"E	8.57	7.64
Champawat				29°20'30.8"N	80°05'55.0"E	9.17		
Danthi				29°20'24.2"N	80°04'43.0"E	5.17		
					Mean	7.63		
Garhwal Region (17)	Dehradun (5)	Vikas Nagar (1)	Plains	Vikas Nagar	30°28'18.4"N	77°45'37.5"E	9.25	9.80
		Doiwala (2)		Rani pokhari	30°10'40.5"N	78°12'42.8"E	9.45	
		Jolly grant		30°12'17.7"N	78°11'41.1"E	14.75		
		Rishikesh (1)		Rishikesh	30°03'55.7"N	78°12'34.5"E	13.09	
		Kalsi (1)		Dakpatthar	30°29'57.2"N	77°47'29.7"E	2.5	
					Mean	9.8		
	Pauri Garhwal (1)	Kotdwar (1)	Plains	Kotdwar	29°45'00.5"N	78°31'20.3"E	5.55	5.55
					Mean	5.55		
	Haridwar (12)	Roorkee (4)	Plains	Manglore	29°48'04.1"N	77°47'52.5"E	3.2	4.80
				Gurukul narsan	29°41'49.4"N	77°50'53.9"E	4.5	
				Sherpur	30°19'44.6"N	77°50'46.2"E	6.89	
				Landhaura	29°47'57.8"N	77°54'27.8"E	4.63	
		Bahadrabad (3)		Jwalapur	29°55'14.2"N	78°02'16.7"E	6.58	9.98
				Sarai	29°55'05.8"N	78°02'28.7"E	9.45	
				Raiwala	30°00'56.3"N	78°12'00.0"E	13.9	
		Laksar (5)		Raise	29°41'51.9"N	78°04'53.8"E	7.1	4.57
				Munda khera	29°43'10.5"N	78°02'51.1"E	4.64	
Mirzapur sadat				29°42'12.5"N	78°02'06.2"E	4.2		

			Nasirabaad	29°45'27.2"N	78°01'30.8"E	0.5	
			Peerpura	29°42'12.5"N	78°02'06.2"E	6.4	
					Mean	5.99	

Conclusion

Based on the survey conducted across chickpea-growing regions, it is evident that the prevalence and distribution of chickpea wilt disease vary significantly across different geographic areas in Uttarakhand. The study highlights regions with high disease incidence, such as Jolly Grant, Raiwala, and Rishikesh, as areas requiring immediate attention for disease management interventions. Conversely, areas like Nasirabad with minimal disease incidence present opportunities to study factors contributing to reduced disease prevalence. These findings underline the importance of understanding spatial disease patterns to develop targeted strategies for controlling chickpea wilt and minimizing its impact on crop productivity.

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