

Spatial Distribution and Disease Incidence of Guava Wilt in the Prayagraj Region: Block and Village Survey Across Prayagraj and Kaushambi

Abstract

A comprehensive roving survey was conducted in the Prayagraj and Kaushambi districts of Uttar Pradesh, India, both prominent guava-producing regions. The survey, which included 30 villages, revealed widespread guava wilt with incidence rates ranging from 19.04% to 37.93%, averaging 30.19% across the region. Three forms of wilt these are quick, slow, and partial were identified. Kaushambi district had a higher incidence rate (31.56%) compared to Prayagraj district (28.82%). Indarapur village in Kaushambi recorded the highest wilt incidence (37.93%). The survey also found that 66.67% of farmers lacked formal training in guava cultivation, contributing to poor disease management. Guava wilt was most prevalent in older orchards (10+ years) and primarily affected the Allahabad Safeda variety, which had the highest wilt incidence (33.64%). In contrast, the Pant Prabhat variety exhibited the lowest wilt incidence (22.95%). The causal pathogen, *Fusarium oxysporum* f. sp. *psidii*, was isolated from diseased plants. Three fungal isolates displayed variations in colony morphology, growth, and sporulation. Microconidia were non-septate and kidney-shaped, while macroconidia were thin-walled and typically 2-3 septate. Two isolates also produced chlamydospores. This study highlights the need for enhanced farmer training and the potential for cultivating wilt-tolerant varieties to mitigate the spread of the disease in the region.

Key Words: *Agricultural Practices, Fusarium oxysporum* f. sp. *psidii*, *Guava Varieties, Guava Wilt Disease Incidence, Kaushambi, Prayagraj, Wilt Management.*

1. Introduction:

Guava (*Psidium guajava* L.) is an important fruit crop in tropical and subtropical regions, including India, where it is cultivated across nearly all states (Misra, 2006). Native to Mexico, Central America, the Caribbean, and northern South America (Amusa *et al.*, 2005), guava is a small tree belonging to the Myrtaceae family, with a chromosome number of $2n=22$ (Singh, 2001). In India, guava is grown extensively, with Uttar Pradesh being the leading producer, contributing 22.93% of the nation's output (Tractor Junction, 2023). Despite its nutritional significance these are rich in vitamins A and C, dietary fiber, potassium, and antioxidants, guava cultivation faces a significant challenge from guava wilt disease (Parvez *et al.*, 2018; Mitra *et al.*, 1996). Guava wilt is the most destructive disease affecting this crop, primarily caused by soil-borne pathogens such as *Fusarium oxysporum* f. sp. *psidii* (Prasad *et al.*, 1996). First reported in Taiwan in 1926 and later in India in 1935 from Allahabad (Singh and Lal, 1953), guava wilt has become a persistent issue, particularly in major guava-producing regions like Uttar Pradesh. The disease is characterized by symptoms such as wilting leaves, chlorosis, poor fruit development, and root decay, ultimately leading to tree death (Singh *et al.*, 2021).

Several factors, including soil type, climate, and cultural practices, influence disease development (Hakim *et al.*, 2021). Managing guava wilt is challenging due to its complex etiology and its association with multiple pathogens, including *Fusarium* species, *Macrophomina*, and *Rhizoctonia* (Srivastava *et al.*, 2021).

2. Materials and methods:

A comprehensive survey was conducted in Prayagraj, Uttar Pradesh, from October 2023 to February 2024 to evaluate guava wilt prevalence. This study targeted key guava-growing blocks in Prayagraj and Kaushambi districts, covering ten blocks in total, five from each district (Table 1). Three villages from each block were selected for in-depth investigation. Farmers in these villages were interviewed with open-ended questionnaires, and discussions were held with local farmers, experts, and gram panchayat officials. This approach provided a detailed overview of guava cultivation practices and the impact of guava wilt. The survey explored factors such as orchard size, guava varieties, orchard age, and challenges like pest and disease problems. It also assessed whether farmers had received any formal training or guidance on guava cultivation and disease management. Disease prevalence was calculated using the formula from Madden and Hughes (1995).

$$\text{Plant Disease Incidence (PDI)} = \frac{\text{Number of Infected Plants}}{\text{Total Number of Plants Observed}} \times 100$$

To identify the causative pathogens, guava plant root samples with wilt symptoms were collected from each orchard. The infected root segments (2-3 mm) were sterilized using 0.1% sodium hypochlorite solution for 10-20 seconds, then washed in sterilized distilled water. These segments were placed on Potato Dextrose Agar (PDA) medium and incubated at $25 \pm 2^\circ\text{C}$. Pathogen identification was based on the cultural and morphological characteristics of the fungus observed on the media, following keys from Nelson *et al.* (1983). Microscopic examination of fungal structures was performed using micrometry. This approach effectively reveals the extent of guava wilt and the involved pathogens, providing essential insights for developing targeted management strategies.

3. Results:

A survey of 30 villages in Prayagraj and Kaushambi districts found guava wilt with an average incidence of 30.19%, ranging from 19.04% to 37.93%. Kaushambi had a higher rate (31.56%) than Prayagraj (28.82%). Indarapur village had the highest incidence at 37.93%. Wilt predominantly affected older orchards (10+ years) and the Allahabad Safeda variety (33.64%) more than Pant Prabhat (22.95%). *Fusarium oxysporum* f. sp. *psidii* was the pathogen identified, showing varied morphology and sporulation. The findings highlight the need for improved farmer training and wilt-resistant guava varieties.

3.1 Recorded wilt incidence in district Prayagraj:

In Prayagraj district, guava wilt was most severe in Chaka block, with an incidence of 32.10%, followed by Phulpur block at 29.44%. Among villages, Mohabatganj Uparhar had the highest disease rate at 34.95%, and Dhanuha was close behind at 34.31%. The lowest incidence in the

district was in Karchana block at 28.09%, with Birna village in Phulpur block showing the lowest rate of 19.04%. In Phulpur block, Shudhanipur had the highest wilt incidence at 30.95%, followed by Baraepur at 30.39%, and Birna at 19.04%. In Karchana block, Chakiya recorded the highest rate at 29.89%, with Mahori and Purani at 27.27% and 27.11%, respectively. Meja block had Kardaha with the highest incidence at 31.42%, followed by Pataria at 28.68% and Sukath at 26.66%. In Pratappur block, Manipur had the highest incidence at 29.03%, with Balarampur at 28.09% and Chak Todar at 27.51%.

3.2 Recorded wilt incidence in district Kaushambi:

In Kaushambi district, guava wilt was most severe in Kaushambi block, where it affected 34.06% of the plants. Newada block had a slightly lower incidence at 31.81%. The village with the highest guava wilt was Indarapur in Kaushambi block, with 37.93%. Other villages with high wilt rates included Barulia in Kada block (33.96%) and Undi in Sarsawan block (33.85%). The lowest wilt incidence was in Kada block, at 29.18%, with Aladinpur village having the lowest rate at 26.23%. In Newada block, Tarana village had the highest rate at 33.66%, while Fareedpur had the lowest at 29.52%. In Sarsawan block, Undi had the highest rate at 33.85%, followed by Bhubhi at 33.61%, and Gahani at 26.98%. In Kada block, the highest incidence was in Barulia village at 33.96%, with Chak Saini at 27.35% and Aladinpur at 26.23%. In Manjhanpur block, Mokimpur had the highest rate at 32.67%, with Pathara-kalan and Pachamba at 30.85% and 30.33%.

The survey of 30 villages in two districts revealed that most farmers were either inexperienced or untrained in guava cultivation, with 66.67% in this category. In Prayagraj district, 20% of farmers had formal training, while in Kaushambi district, only 13.33% were trained. The survey also showed differences in orchard sizes and ages between the districts. Orchards in Kaushambi are generally larger, averaging 1.20 acres, compared to 1.01 acres in Prayagraj. Orchards in Kaushambi are also a bit older, with an average age of 13.52 years, compared to 13.26 years in Prayagraj. Some areas, like Karchana in Prayagraj and Newada in Kaushambi, have particularly old orchards, indicating these farms are more established.

The variations in orchard sizes and ages across different blocks and villages within each district highlight differences in agricultural practices, resource availability, and training levels. On average, orchards in Kaushambi district are slightly larger (1.20 acres) than those in Prayagraj (1.01 acres). Additionally, the average orchard age in Kaushambi (14 years) is higher than in Prayagraj (13.26 years). Notably, some blocks like Karchana in Prayagraj (15.66 years) and Newada in Kaushambi (15.33 years) have older orchards, indicating more established cultivation practices.

The survey of 30 orchards found that Allahabad Safeda (36.20%) and Banarasi (19.76%) are the most widely cultivated guava varieties, followed by Allahabad Surkha (16.35%), Lalit (12.67%), L-49 (7.51%), Chittidar (3.74%), and Pant Prabhat (3.74%). Allahabad Safeda exhibited the highest incidence of wilt at 33.64%, with Banarasi close behind at 30.27%. L-49 had a wilt incidence of 30.20%, followed by Chittidar (28.68%) and Allahabad Surkha (27.76%). The Lalit variety had a lower incidence of wilt (25.66%), while Pant Prabhat had the lowest at 22.95%.

Table: -1. Recorded guava wilt disease incidence in Prayagraj and Kaushambi district [Each district had 5 blocks, and 3 villages from each block were selected for the survey.]

District	Block	Village	Wilt disease incidence (%)	Block Average (%)	District Average (%)	Grand Average (%)
Prayagraj	Chaka	Dhanuha	34.31%	32.10%	28.82%	
		Chaka	27.05%			
		Mohabatganj uparhar	34.95%			
	Meja	Kardaha	31.42%	28.92%		
		Sukath	26.66%			
		Pataria	28.68%			
	Karchana	Mahori	27.27%	28.09%		
		Purani	27.11%			
		Chakiya	29.89%			
	Pratappur	Chak Todar	27.51%	28.21%		
		Manipur	29.03%			
		Balrampur	28.09%			
	Phulpur	Baraepur	30.39%	26.79%		
		Shudhanipur	30.95%			
		Birna	19.04%			
Kaushambi	Kaushambi	Bindaw	32.89%	34.06%	31.56%	30.19%
		Indarapur	37.93%			
		Dugauli	31.37%			
	Newada	Fareedpur	29.52%	31.81%		
		Makhupur	32.25%			
		Tarna	33.66%			
	Sarsawan	Undi	33.85%	31.48%		
		Bhobhi	33.61%			
		Gahani	26.98%			
	Kada	Aladinpur	26.23%	29.18%		
		Barulia	33.96%			
		Chak Saini	27.35%			
	Manjhanpur	Mokimpur	32.67%	31.28%		
		Pachamba	30.33%			
		Pathara-kalan	30.85%			

Table: -2. Number of the formal training have and not among 30 orchards

District	Sum of number of respondents	Sum of trained farmers	Sum of amature amature farmers
Prayagraj	15	6 (20%)	9
Kaushambi	15	4 (13.33)	11

Table: - 3. List of the area and age of the orchards of all surveyed places

District	Block	Village	Age of the orchards (Years)	Average age of the orchards (Years)	Total area of the orchards (Acre)	Avaerage age of the orchard (Acre)
Prayagraj	Chaka	Dhanuha	13	15	1	1.33
		Chaka	17		2	
		Mohabatganj uparhar	15		1	
	Meja	Kardaha	12	11.66	0.5	0.75
		Sukath	15		0.5	
		Pataria	8		1.25	
	Karchana	Mahori	16	15.66	1.5	1
		Purani	14		0.5	
		Chakiya	17		1	
	Pratappur	Chak Todar	19	14	1.5	1.08
		Manipur	13		0.5	
		Balrampur	10		1.25	
	Phulpur	Baraepur	13	10	1	0.91
		Shudhanipur	10		1.25	
		Birna	7		0.5	
Kaushambi	Kaushambi	Bindaw	16	13.66	1.5	1.16
		Indarapur	13		1.5	
		Dugauli	12		0.5	
	Newada	Fareedpur	19	15.33	1	0.83
		Makhupur	17		0.5	
		Tarna	10		1	
	Sarsawan	Undi	15	11.33	1.25	1
		Bhobhi	11		1.25	
		Gahani	8		0.5	
Kada	Aladinpur	19	14.66	1	1.16	
	Barulia	12		0.5		
	Chak Saini	13		2		
Kaushambi	Manjhanpur	Mokimpur	17	12.66	2	1.33

	Pachamba	12		1	
	Pathara-kalan	9		1	

Table: - 4. List of the frequency and wilt disease incidence % on specific varieties of the guava

Guava varieties	Frequency (%)	Wilt incidence (%)
Allahabad Safeda	36.2	33.64
Banarasi	19.76	30.27
L-49	7.51	30.2
Chittidar	3.74	28.68
Allahabad Surkha	16.35	27.76
Lalit	12.67	25.66
Pant Prabhat	3.74	22.95

In this present study, the fungus responsible for guava wilt was identified as *Fusarium oxysporum* f. sp. *psidii* based on morphological features described by Nelson *et al.* (1983). Three isolates were purified, displaying distinct colony colors, growth patterns, and morphology. After seven days on PDA medium, colony diameters ranged from 45 to 75 mm, with mycelia colors varying from white to light brown, occasionally showing pink or purple hues.

The isolates produced abundant microconidia (6.8–14.5 μm in length, 2.28–4.65 μm in width), which were oval to kidney-shaped and non-septate. Macroconidia (21.94–37.75 μm in length, 5.68–6.83 μm in width) were thin-walled, falcate to nearly straight, typically with 2–3 septa, and had pointed ends. Two isolates also produced chlamydospores (5.75–9.4 μm), which were thick-walled, terminal or intercalary, and globose, forming either singly or in clusters.

Table: - 5. Morphological characters of the isolated pathogens

Source of Isolates	Isolate No.	Microconidia length/breadth (μm)	Macroconidia length/breadth (μm)	Colony colour	Chlamydo-spore (+/-)
Chaka, U.P., Allahabad Safeda	Fop 1 (Plates 4.6, 4.7, 4.12, 4.15 and 4.17)	6.80-8.30/2.28	21.94/28.97/5.68	The fungal colony shows a dark purplish center, fading to lighter purple and then to whitish at the edges.	+

Phulpur, U.P., Allahabad Safeda	Fop 2 (Plates 4.8,4.9,4.13, 4.14 and 4.18)	7.54-9.71/3.12	24.16-31.45/5.98	The fungal colony transitions from a white center to a light brown or tan with a fuzzy texture, fading to a translucent edge.	+
Kaushambi, U.P., Banarasi	Fop 3 (Plates 4.10, 4.11, 4.13 and 4.16)	9.53-14.5/4.65	30.1437.75/6.83	Predominantly white, with a slightly denser, creamy white center, exhibiting a fluffy texture throughout.	-



Plate 1 and 2 Colony morphology of isolate Fop 1

Plate 3 Colony morphology of isolate Fop 2



Plate 4 Colony morphology

Plate 5 and 6 Colony morphology of isolate Fop 3 isolate Fop

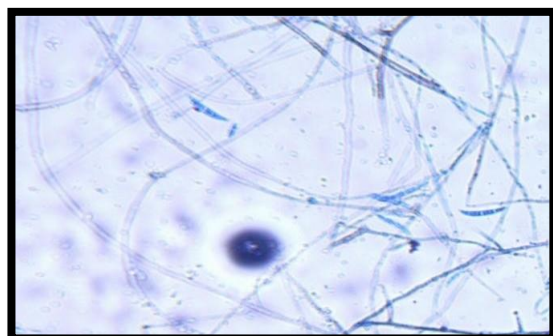


Plate 7 Phialides (10x)

Plate 8 Macroconidia with mycelium (10x)



Plate 9 Macroconidia (3 Septate) (40x)

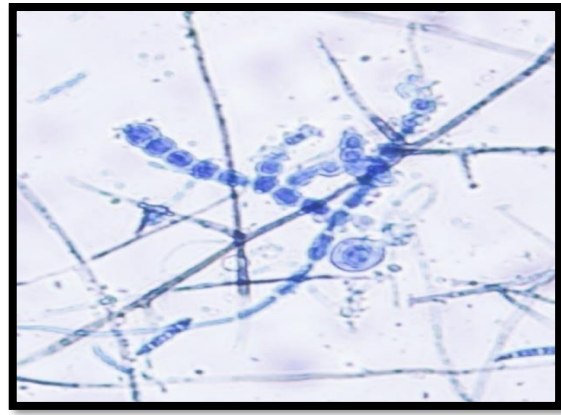


Plate 10 Chlamydospore in chain form(40x)

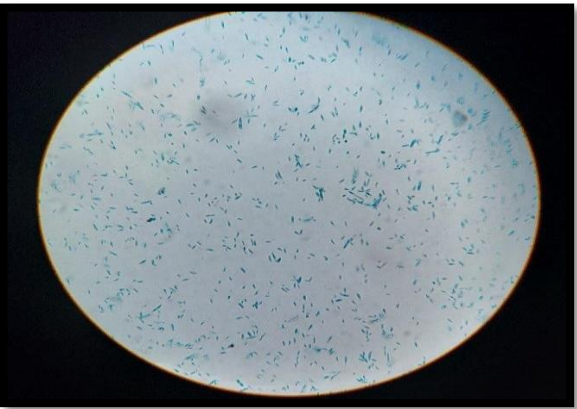


Plate 11 Micro-conidia (10x)



Plate 12 Micro-conidia and Macroconidia
(10x)

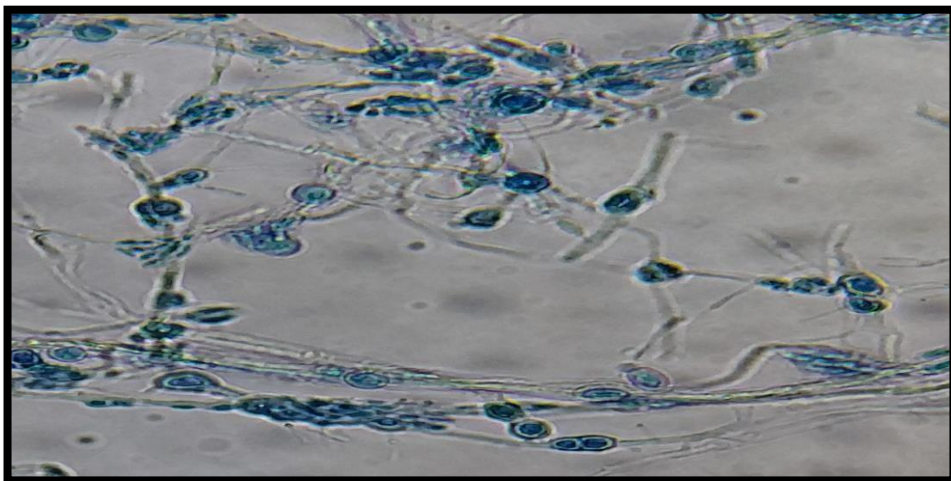


Plate 13 Two celled and intercalary chlamydospores (40x)

4. Discussion

Survey conducted across 30 villages in the Prayagraj and Kaushambi districts revealed an average guava wilt incidence of 30.19%, ranging from 19.04% to 37.93%. The incidence was higher in Kaushambi (31.56%) compared to Prayagraj (28.82%), with Indarapur village in Kaushambi recording the highest incidence at 37.93%. Older orchards (over 10 years) and the Allahabad Safeda variety (33.64%) were most affected, while the Pant Prabhat variety had the lowest wilt incidence (22.95%). The pathogen responsible, *Fusarium oxysporum* f. sp. *psidii*, was identified through morphological analysis, which showed variations in colony color, growth, and sporulation. Misra and Shukla, 2002 estimated 5%-60% loss in Lucknow area.

In Prayagraj, the most severe incidence was in Chaka block (32.10%), with Mohabatganj Uparhar having the highest village-level incidence at 34.95%. In Kaushambi, Kaushambi block had the highest overall wilt incidence (34.06%), with Indarapur village topping the list at 37.93%. Kaushambi district orchards were larger (1.20 acres) and slightly older (13.52 years) than those in Prayagraj (1.01 acres, 13.26 years), reflecting different cultivation practices and resource availability.

The survey also highlighted that most farmers lacked formal training, with only 20% of farmers in Prayagraj and 13.33% in Kaushambi receiving training in guava cultivation. The most commonly cultivated guava varieties were Allahabad Safeda (36.20%) and Banarasi (19.76%). Allahabad Safeda had the highest wilt incidence (33.64%), followed by Banarasi (30.27%) and L-49 (30.20%). Round varieties are more prone to infection, while the L-49 variety demonstrates some resistance to wilt disease (Singh *et al.*, 1977).

The identification of *Fusarium oxysporum* f. sp. *psidii* was confirmed based on morphological traits described by Nelson *et al.* (1983). Three isolates displayed distinct colony characteristics, and their microconidia measured 6.8–14.5 μm in length and 2.28 to 4.65 μm in width. Macroconidia ranged from 21.94 to 37.75 μm in length, with 2-3 septa. Two isolates also produced chlamydospores, ranging from 5.75 to 9.4 μm in size, either singly or in clusters. These findings stress the need for better farmer education and the development of wilt-resistant guava varieties.

5. Conclusion:

In conclusion, the survey revealed that the majority of orchard owners lacked formal training in guava cultivation and were not planting wilt-resistant varieties, which has likely contributed to the widespread occurrence of guava wilt in the region. Most of the orchards surveyed consisted of older trees, predominantly the Allahabad Safeda variety, with a significant proportion of trees being over 10 years old. These older plants were found to be more susceptible to the disease, highlighting the need for targeted interventions, including farmer education on proper cultivation practices and the adoption of resistant guava varieties, to mitigate the impact of guava wilt and ensure sustainable production.

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