A detailed survey to assess guava wilt incidence in Prayagraj and Kaushambi district, Uttar Pradesh, India

Abstract

An intensive survey was conducted in the Prayagraj region of Uttar Pradesh during September, 2023 – January, 2024 to assess the incidence of guava wilt. The study covered seven blocks in Prayagraj and five in Kaushambi, with three villages selected from each block. Local farmers were interviewed to gather data on orchard conditions and guava wilt incidence. Results showed that guava wilt affected all surveyed villages, with incidences ranging from 15.6% to 41.43% and as the causal organism of guava wilt four morphologically different *Fusarium oxysporum* f. sp. *psidii* were isolated and observed under microscope.. The average incidence was 29.26%, with higher rates in Kaushambi (31.50%) compared to Prayagraj (27.03%). The most affected blocks were Kaushambi (37.25%) and Meja (34.04%). Additionally, it was found that 72.22% of farmers were untrained in guava cultivation. The most common guava varieties were Allahabad Safeda (25%) and Allahabad Surkha (19.44%), which had the highest wilt incidences of 28.72% and 31.23%, respectively where L-49 and Pant Prabhat showed least wilt incidence of 25.02% and 24.29%, respectively. The orchards in the surveyed locations ranged from 6 to 22 years old, with most being older than 10 years.

Key words: *Fusarium* sp.,*Guava*, *Kaushambi*, *Prayagraj*, *Survey*, *Wilt*

1. Introduction

Guava (*Psidium guajava* L.), is a widely cultivated tropical fruit, ranking as the fourth most important fruit crop in India. It is grown over approximately 315 thousand hectares in India, producing about 45.16 million metric tons annually. Uttar Pradesh is the leading state in guava production, with Madhya Pradesh and Bihar following. In Uttar Pradesh alone, guava is cultivated across 29 thousand hectares, yielding 9.83 million metric tons. The Prayagraj district in Uttar Pradesh is particularly noted for its high-quality guava, gaining recognition both nationally and internationally (NHB, Ministry of Agriculture and Farmers Welfare, Govt. of India, 2021-2022). Plant diseases significantly impact global agriculture, causing widespread damage. Phytopathogens causing these diseases can endure extreme conditions and resist various treatments. Guava wilt is a notably destructive disease affecting guava cultivation in major growing regions (Dwivedi and Dwivedi, 2020). This disease poses a serious issue in India due to its considerable economic effects on guava production (Shukla *et al*., 2019). First reported in Taiwan in 1926 (Hsieh *et al*., 1976) and observed in India in Allahabad in 1935 (Jhooty *et al*., 1984), severe cases were later documented in Lucknow by Das Gupta and Rai (1947) and in West Bengal by Chattapadhyay and Sengupta in 1955. The disease also spread to Baruipur in 24 Parganas and Midnapur (Gupta *et al*., 2010). Guava wilt, a severe soil-borne illness, is challenging to control once symptoms manifest and involves multiple pathogens, including *Fusarium oxysporum* f. sp. *psidii* and *F. solani* (Singh *et al*., 2021). Estimates of economic losses due to wilt are currently unavailable, but in India, it can cause production losses ranging from 5% to 60%, particularly in Uttar Pradesh, Bihar, and Uttarakhand, where conditions are favourable for the disease (Yadav *et al*., 2018). Consequently, many farmers are switching to different crops (Naz *et al*., 2013). Symptoms usually appear after the rainy season, around October-November, affecting small fruit and causing branches to produce underdeveloped, hard, and stony fruit. Wilt progression can occur within fifteen days but may extend over a year (Misra *et al*., 2015). Black streaks on finer roots are visible when it is split opened, indicating *Fusarium oxysporum* f. sp. *psidii* infection (Srivastava *et al*., 2011). The bark becomes brittle and detaches from the cortex, with the stem and root areas showing discoloration and damage. Wilt affects both young and mature trees, as well as new seedlings and grafts, and can be categorized into slow and quick wilting, with quick wilt causing total wilting in 15 to 60 days, while partial wilt affects only some branches (Gupta *et al*., 2010).

2. Materials and methods

An extensive roving survey was carried out in the Prayagraj region of Uttar Pradesh during September, 2023- January, 2024 to evaluate the prevalence of guava wilt. The survey focused on key guava-producing blocks in Prayagraj and Kaushambi, selecting three villages from each block. In total, the survey encompassed seven blocks in Prayagraj and five blocks in Kaushambi (Table 1). Local farmers in the chosen villages were interviewed using open-ended questionnaires, and discussions were held with representative farmers, experts, and officials from the gram panchayats to gather a well-rounded perspective. This thorough approach aimed to provide a detailed understanding of guava wilt and its effects on the agricultural community. Farmers were asked about various aspects of their orchards, including the total area, the guava varieties grown, and the year the orchard was established. They were also questioned about any difficulties encountered, such as pest issues or disease outbreaks, and whether they had received formal training or guidance on guava cultivation and disease management. This comprehensive data collection helped in understanding the factors influencing guava production and the spread of guava wilt in the region. The disease incidence was calculated using the formula from Madden and Hughes (1995).

$$\text{Plant disease incidence (PDI)} = \frac{\text{Number of infected plants}}{\text{Total number of plants observed}} \times 100$$

Samples of guava plant roots showing the typical symptoms of wilt disease was collected randomly from each guava orchards. Small pieces (2-3mm) of infected roots was cut with the help of sterilized scalpel to isolate the pathogen and was sterilized by using 0.1% sodium hypo chloride (NaOCl) solution for 10-20 sec, then the bits was repeatedly washed in sterilized distilled water. Then the bits was transferred to PDA medium under aseptic condition and incubated at 25 ± 2˚C (Yadav *et al*., 2018). The identification of the isolated pathogens was based on the cultural and morphological characteristics of their reproductive and vegetative structures developed on media, using identification keys from Nelson *et al*. (1983) and the measurement of the microscopic structures of the isolated fungal pathogens were done by micrometry.

3. Results

The survey revealed that guava wilt was found in all guava-growing villages in the Prayagraj region, with incidence ranging from 15.6% to 41.43%. The average disease incidence rate was 29.26%, where Kaushambi district had higher wilt incidence (31.50%) than Prayagraj district (27.03%).The detailed data on wilt incidence in Prayagraj region is depicted in the Table 1.

3.1 Guava wilt incidence in Kaushambi district:

In Kaushambi district, guava wilt was most prevalent in Sipai village, Kaushambi block, with an incidence of 41.43%. The next highest was 37.33% in Biroli village, Mooratganj block. Faridpur Salem, Chail block, had the lowest incidence at 24.29%. Within Mooratganj block, Biroli had the highest incidence (37.33%) and Balkaranpur the lowest (28.75%). In Newada block, the highest incidence was in Govindpur (31.25%), and the lowest was in Alampur (26.67%). In Kada block, Braulia had the highest incidence (33.57%), followed by Chak Saini (27.14%) and Aladinpur (28.5%).

3.2 Guava wilt incidence in Prayagraj district:

In Prayagraj district, the highest guava wilt incidence was recorded in Meja block (34.04%) and Chaka block (29.86%). Among surveyed villages, Amora, Meja block had the highest incidence at 40.00%, followed by Chaka at 37.50%. The lowest incidence was found in Dadri village, Chaka block, at 15.6%. In Phulpur block, Fatehpur Chakiya had the highest incidence (32.22%), with Jamuwadih and Dewariya at 25.00% and 27.14%, respectively. Karchana block saw its highest incidence in Karchana-Karailghat (28.57%), followed by Barauli (26.23%) and Dabhaon (24.70%). In Handia block, Bahoranpur had the highest incidence (28.67%), with Dulapur and Chakiya Rampur at 23.57% and 21.18%. In Dhanupur block, Babupur Sathar had the highest incidence (32.85%), followed by Chak Madhukar (22.50%) and Chak Daulat (21.50%).

Table 1. Survey of Prayagraj region to record the disease incidence of guava wilt

District	Block	Village	Disease Incidence (%)	Block Average (%)	District Average (%)	Grand Average (%)
Prayagraj	Chaka	Mehba Patti	36.50		**27.03**	**29.26**
		Dadri, Chakderanand	15.60			
		Chaka	37.50	29.86		
	Phulpur	Fatehpur Chakiya	32.22			
		Jamuwadih	25.00			
		Dewariya	20.28	25.83		
	Meja	Amora	**40.00**			
		Dohariya	27.14			
		Pataria	35.00	**34.04**		
	Karchana	Karchana-Karailghat	28.57			
		Dabhaon	24.70			
		Barauli	26.23	26.50		
	Pratapur	Bariyari	28.50			
		Baghapur	22.00			
		Chak Todar	18.12	22.87		
	Handia	Chakiya Rampur	21.18			
		Dulapur	23.57			
		Bahoranpur	28.67	24.47		
	Dhanupur	Babupur Sathar	32.85			
		Chak Madhukar	22.50			
		Chak Daulat	21.50	25.61		
Kaushambi	Kaushambi	Sipai	**41.43**		**31.50**	
		Chak Ahmadipur	31.58			
		Gointha	38.75	**37.25**		
	Chail	Nauwapur	31.43			
		Faridpur Salem	24.29			
		Kathra	32.31	29.34		
	Mooratganj	Ashokpur	28.89			
		Balkaranpur	28.75			
		Biroli	37.33	31.65		
	Newada	Alampur	26.67			
		Bariyawan	30.71			

		Govindpur	31.25	29.54		
	Kada	Aladinpur	28.50			
		Braulia	33.57			
		Chak Saini	27.14	29.73		

*****The list of the blocks and villages were sourced from Allahabad KVK (https://allahabad.kvk4.in/district-profile.php).

The survey involved one farmer from each of 36 villages in two districts. Most respondents were untrained or amateur farmers (72.22%) in guava cultivation. In Prayagraj district, 7 trained farmers represented 19.44% of the total, while Kaushambi district had only 3 trained farmers, or 8.33% of the respondents (Table 2). The variation in orchard sizes and ages across different blocks and villages within each district highlights differences in agricultural practices and possibly varying levels of resource availability and training. Detailed information on orchard sizes and ages is provided in Table 3. Orchards in Prayagraj district are, on average, larger at 1.47 acres compared to 1.36 acres in Kaushambi district. Additionally, the average age of orchards in Prayagraj is 14.14 years, while in Kaushambi, it is 12.79 years. Blocks like Meja in Prayagraj (17.66 years) and Kaushambi in Kaushambi (17.33 years) feature notably older orchards, indicating that these areas have more mature and established orchards.

Table 2. Number of trained and amateur farmers among 36 respondents

District	Number of respondents	Trained farmers	Amateur farmers
Prayagraj	21	7 (19.44%)	14
Kaushambi	15	3 (8.33%)	12

Table 3. List of area and age of the orchards which were surveyed in Prayagraj region

District	Block	Village	Total area of Orchard (Acre)	Average area of orchard (Acre)	Age of the orchard (Years)	Average age of the orchard (Years)
Prayagraj	Chaka	Mehba Patti	1.00	1.58	15	16
		Dadri, Chakderanand	2.50		13	
		Chaka	1.25		20	
	Phulpur	Fatehpur Chakiya	1.25	1.66	12	14.33
		Jamuwadih	2.0		16	
		Dewariya	1.75		15	
	Meja	Amora	1.25	1.25	20	17.66
		Dohariya	0.50		15	
		Pataria	2.00		18	
	Karchana	Karchana-Karailghat	0.50	1.33	11	11
		Dabhaon	1.50		14	
		Barauli	2.00		8	
	Pratapur	Bariyari	1.50	1.33	15	10.66
		Baghapur	1.00		6	
		Chak Todar	1.50		11	
		Chakiya Rampur	2.00		12	

	Handia	Dulapur	1.50	1.66	15	14
		Bahoranpur	1.50		15	
	Dhanupur	Babupur Sathar	1.00	1.50	18	15.33
		Chak Madhukar	2.00		13	
		Chak Daulat	1.50		15	
District average				**1.47**		**14.14**

Kaushambi	Kaushambi	Sipai	1.50	1.50	20	17.33
		Chak Ahmadipur	2.00		16	
		Gointha	1.00		16	
	Chail	Nauwapur	1.00	1.16	10	9.66
		Faridpur Salem	1.00		7	
		Kathra	1.50		12	
	Mooratganj	Ashokpur	2.00	1.33	8	9.66
		Balkaranpur	1.00		10	
		Biroli	1.00		11	
	Newada	Alampur	1.50	1.33	13	10.66
		Bariyawan	1.50		9	
		Govindpur	1.00		10	
	Kada	Aladinpur	2.00	1.50	22	16.66
		Braulia	1.50		13	
		Chak Saini	1.00		15	
District average				**1.36**		**12.79**

The survey of 36 orchards also revealed that Allahabad Safeda (25%) and Allahabad Surkha (19.44%) were the most commonly grown guava varieties. They were followed by L-49 (13.88%), Lalit (11.11%), Bengal Safeda (8.33%), Dhareedar (5.55%), Banarasi (5.55%), Chittidar (2.77%), Pant Prabhat (2.77%), and Arka Mridula (2.77%). The highest wilt incidence was observed in Allahabad Surkha at 31.23%, closely followed by Allahabad Safeda at 30.82%. Dhareedar had a wilt incidence of 29.19%, with Chittidar and Arka Mridula both at 28.5%. Lalit, Bengal Safeda, and Banarasi had slightly lower wilt incidences of 25.98%, 25.69%, and 25.11%, respectively. L-49 also showed a wilt incidence of 25.11%, while Pant Prabhat had the lowest at 24.29%. Detailed data on these varieties is provided in Table 4.

Table 4. List of different varieties of guava cultivated in Prayagraj region along with their the wilt incidence (%)

Guava varieties	Frequency (%)	Wilt incidence (%)
Allahabad Surkha	19.44	31.23
Allahabad Safeda	25.00	30.82
Dhareedar	5.55	29.19
Arka Mridula	2.77	28.57
Chittidar	2.77	28.50
Lalit	11.11	25.98
Bengal Safeda	8.33	25.69
Banarasi	5.55	25.11
L-49	13.88	25.02
Pant Prabhat	2.77	24.29

During the present investigation the wilt causing fungi has been isolated from roots of wilted guava plants. The causal organism of guava wilt was identified as *Fusarium oxysporum* f.sp *psidii*. The identification was confirmed by comparing the morphological characters of the pathogen with the identification key of Nelson *et al*. (1983) and the dimensions of different morphological structures of the isolated *Fusarium* sp. are depicted in Table 5 and illustrated in the Plates 1 and 2. A total of four isolates were purified as they differ in colony colour, growth pattern and size of different morphological structures. The colony diameter of the pathogen ranged from 46-73 mm on the 7^{th} day of inoculation in PDA medium. The mycelia of the isolates were delicate, white to creamy brown and orange, tinge pink or purple tinge, margins slightly lobed or smooth on PDA medium. The isolates produced pale to dark violet or dark magenta pigment. Numerous microconidia and macroconidia were observed in case of all the 4 isolates. Microconidia formed singly, oval to reniform and without any septation. Conidiogenous cells bearing micro- and macroconidia were monophialides type. The size of microconidia ranged from 6.8 - 14.5 in length and 2.25 - 4.75 µm in breath. Macroconidia were falcate to almost straight, usually 2- 3 septet, rarely four to 5-septed, thin walled, both ends almost pointed, notched basal cell, apical cell short and in some cases slightly curved. The size of the macroconidia ranged from 20.94 - 38.75 and 5.65 - 6.85 µm (Length/breath). Out of 4 isolates 3 produced chlamydospores on culture media (Table 5). Chlamydospores were thick walled, terminal or intercalary, globose, smooth or wrinkled, generally single celled (5.85 - 9.5 µm) produced in hyphae. Chlamydospores were also found in two celled or in cluster and in chain form.

Table 5. Morphological characters of the isolates

Source of Isolates	Isolate No.	Micro-conidia length/breath (µm)	Macro-conidia length/breath (µm)	Colony colour	Chlamydospore (+/-)

Chaka, UP, Allahabad Safeda	Fop 1 (Plate 1 A-B)	6.80-8.35/2.25	20.94-31.32/5.65	Tinge pink or purple tinge, with violate or purple pigmentation	+
Mehba Patti, UP, Allahabad Safeda	Fop 2 (Plate 1 C-D)	7.35-9.50/3.50	22.28-27.39/6.23	Creamy to pale orange with slight violate pigmentation	+
Kaushambi, UP, Allahabad Surkha	Fop 3 (Plate 1 E-F)	6.90-14.50/4.75	30.37-38.75/6.85	Creamy yellowish to light brown cottony growth	+
Phulpur, UP, L-49	Fop 4 (Plate 1 G-H)	7.65-9.25/2.85	24.48-30.56/6.00	Whitish smooth and cottony growth	-

Note: Dimensions were obtained from average of ten readings in each case.

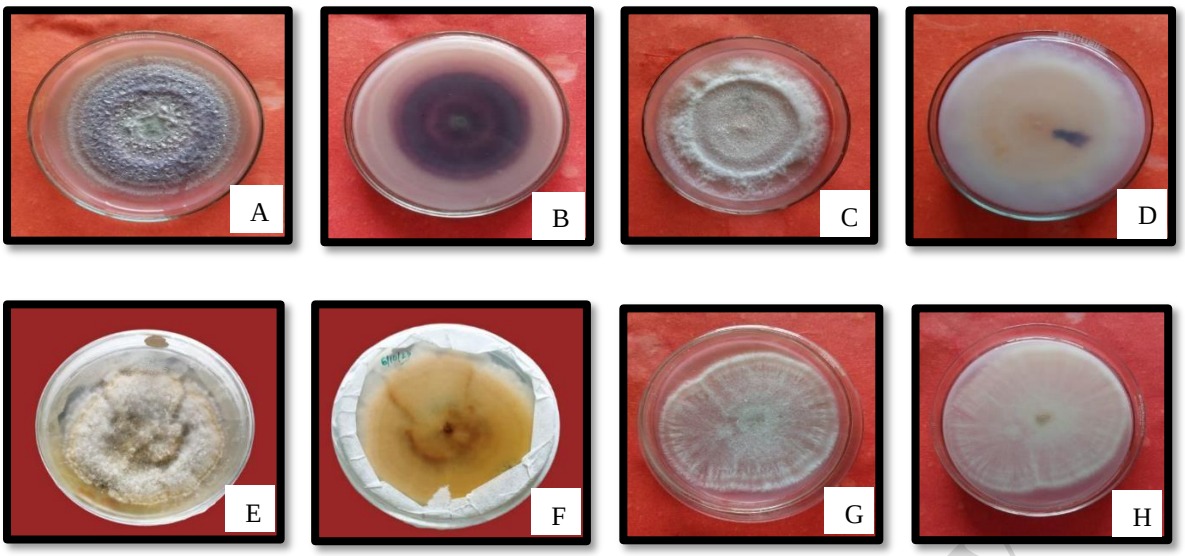

Plate 1: A) Fop1 front view B) Fop1 back view C) Fop2 front view D) Fop2 back view E) Fop3 front view F) Fop3 back view G) Fop4 front view H) Fop4 back view

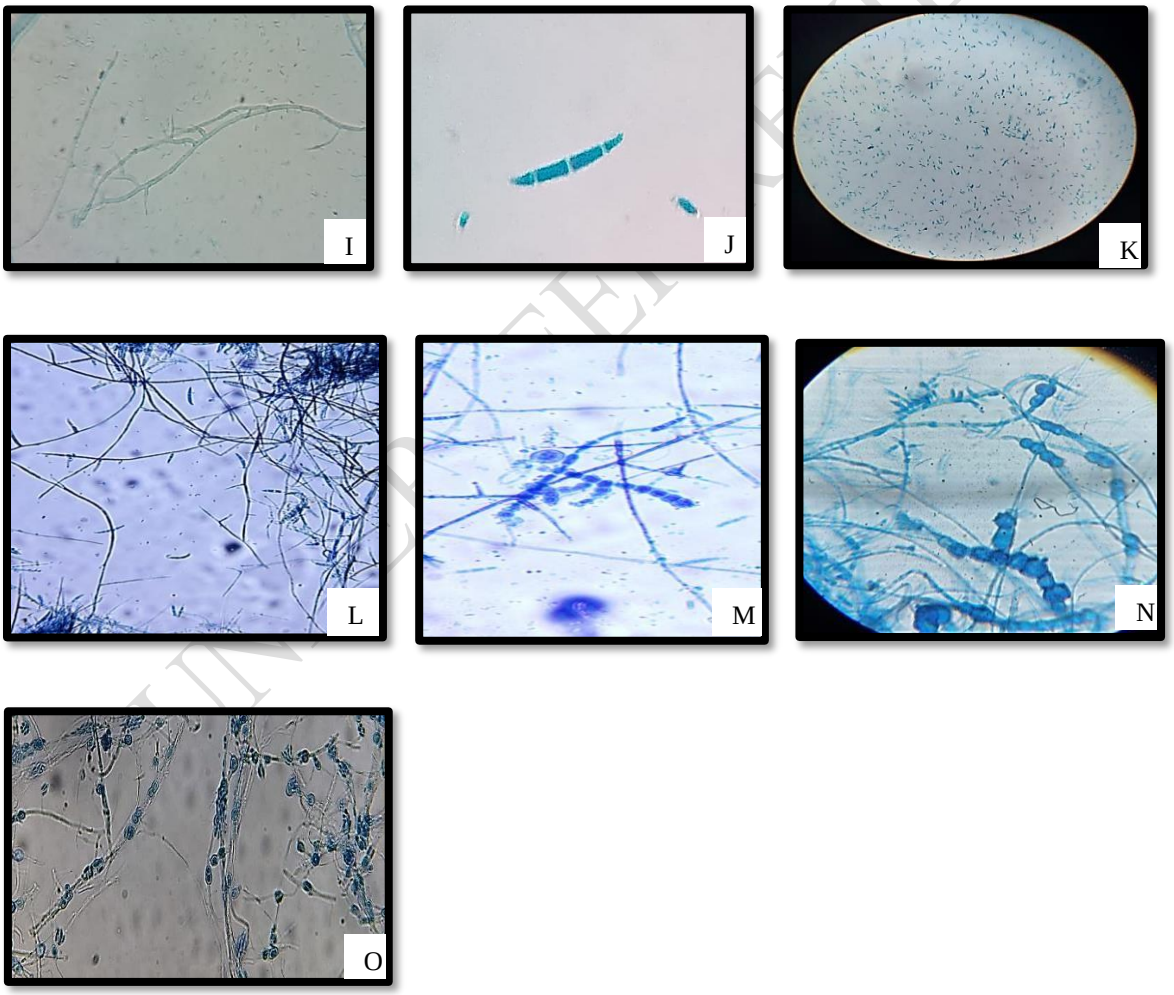

Plate 2 : Different morphological structures of *Fusarium oxysporum* f. sp. *psidii* (40x) I) phialides J) macroconidia K) microconidia L) mycelium M) chlamydospore in chain N) terminal and intercalary clustered chlamydospores O) Two celled intercalary chlamydospores

4. Discussion

The survey in Prayagraj and Kaushambi districts of Uttar Pradesh revealed widespread guava wilt, with incidence rates ranging from 15.6% to 41.43% and an average of 29.26%. These results align with earlier findings by Mathur (1956) and Misra (1987), indicating a persistent issue with guava wilt in the region. The survey also found that 72.22% of guava growers are untrained and lack effective management practices for guava wilt. This lack of training leads to various cultivation issues, with guava wilt and Fusarium fruit rot being the most common problems. Upadhyay *et al*. (2018) similarly reported that 71.25% of farmers lacked formal training, which correlates with the high wilt incidence observed. Misra *et al*. (2013) also noted guava wilt as a significant factor affecting guava marketability, reinforcing the findings of this survey. In the Prayagraj region, Allahabad Safeda was the most cultivated guava variety (25%), with a wilt incidence of 28.72%. Allahabad Surkha, known for its round, red fruits, had the highest wilt incidence at 31.23% and was grown by 19.44% of farmers. L-49, less common at 13.88%, had a lower wilt incidence of 25.02%. The Pant Prabhat variety had the lowest wilt incidence at 24.29%. Farmer interviews indicated that L-49 plants often avoided wilt infection, which is supported by the findings of Hussain *et al*. (2018) and Singh *et al*. (1977) that round varieties are more susceptible and L-49 shows some tolerance against wilt disease. The surveyed orchards, aged between 6 and 22 years, were predominantly older than 10 years. These older orchards demonstrated a greater susceptibility to guava wilt, in line with Gupta *et al*. (2010) who documented that plants over 10 years old are more likely to be affected by the disease compared to younger ones. This trend emphasizes the necessity for regular orchard renewal and the implementation of effective management practices to combat the impact of guava wilt.

5. Conclusion

In conclusion, the survey in Prayagraj and Kaushambi districts underscores the persistent issue of guava wilt, affirming findings from prior research. It indicates that the problem of guava wilt has endured with little to no significant progress over the decades. The study highlights that a significant number of guava growers lack proper training, which contributes to elevated wilt rates and other cultivation difficulties. This lack of training is consistent with earlier observations, stressing the need for better educational initiatives and enhanced management practices. The survey also reveals varying levels of wilt susceptibility among different guava varieties and indicates that older orchards are particularly vulnerable. These insights point to the necessity for regular orchard renewal and the implementation of effective management strategies to address guava wilt, thereby improving the sustainability and productivity of guava cultivation in the region.

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