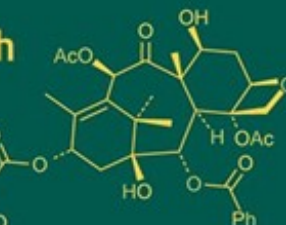


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Aishwarya Balwant Biradar
Department of Plant Pathology,
Keladi Shivappa Nayaka
University of Agricultural and
Horticultural Sciences,
Shivamogga, Karnataka, India

GN Hosagoudar
Department of Plant Pathology,
Keladi Shivappa Nayaka
University of Agricultural and
Horticultural Sciences,
Shivamogga, Karnataka, India

B Gangadhara Naik
Department of Plant Pathology,
Keladi Shivappa Nayaka
University of Agricultural and
Horticultural Sciences,
Shivamogga, Karnataka, India

K Rajashekarappa
Department of Entomology,
Keladi Shivappa Nayaka
University of Agricultural and
Horticultural Sciences,
Shivamogga, Karnataka, India

Sanjeev Jakatimath
Department of Plant Pathology,
Keladi Shivappa Nayaka
University of Agricultural and
Horticultural Sciences,
Shivamogga, Karnataka, India

M Divya
Department of Agricultural
Microbiology, Keladi Shivappa
Nayaka University of
Agricultural and Horticultural
Sciences, Shivamogga, Karnataka,
India

Corresponding Author: Aishwarya Balwant Biradar

Department of Plant
Pathology, Keladi Shivappa
Nayaka University of
Agricultural and
Horticultural Sciences,
Shivamogga, Karnataka,
India

Survey and distribution of Panama wilt disease of banana in Shivamogga district, Karnataka, India

Aishwarya Balwant Biradar¹, GN Hosagoudar², B Gangadhara Naik³, K Rajashekarappa⁴, Sanjeev Jakatimath⁵, M Divya⁶

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ABSTRACT

Panama wilt is an economically important disease of banana caused by *Fusarium oxysporum* f. sp. cubense. A roving survey was conducted during 2025 to 2026 to assess incidence and distribution of Panama wilt and to collect rhizosphere soil for isolation of potential beneficial microorganisms in seven taluks of Shivamogga district, Karnataka. Disease incidence ranged from 0.00 to 32.28 per cent, with the highest incidence recorded at Veerapura village of Bhadravathi taluk (32.28 %) and no incidence at Punaje and Jambuvalli villages. Among the taluks, Bhadravathi recorded the highest mean incidence (25.70 %), followed by Shikaripura (23.80 %) and Shivamogga (20.00 %), whereas Thirthahalli recorded the lowest incidence (7.40 %). The overall district mean incidence was 15.79 per cent. A total of 23 rhizosphere soil samples were collected from comparatively healthy banana plants in Panama wilt affected fields across seven taluks of Shivamogga district. Grand Naine (G-9), Rasthali and Elakki Bale were the major banana cultivars observed across the surveyed locations. The crop was at the pre-flowering and pre-flowering to bunch initiation stages and was cultivated under drip, basin and surface irrigation systems in red loamy, lateritic red and lateritic soils. In addition to Panama wilt, Sigatoka leaf spot and banana bunchy top were the other major diseases observed in the surveyed banana fields.

Keywords: Roving survey, Panama wilt, Disease incidence, Shivamogga

Introduction

Banana (*Musa* spp.) is one of the most important tropical, perennial monocotyledonous fruit crop, belonging to the family Musaceae. It is grown in about 120 countries, with India being the world's largest producer (FAO., 2025). The fruit is nutritionally rich in carbohydrates, B vitamins and essential minerals such as potassium, phosphorus, calcium and magnesium. Due to its high economic returns, particularly for small and marginal farmers, banana is popularly known as "Kalpataru", meaning the wish fulfilling tree, and the "apple of paradise" (Kumar, 2021) [1].

During 2024-25, India recorded banana cultivation over an area of 901.51 thousand hectares, with a total production of 38,321.83 thousand metric tonnes (MT) and an average productivity of 42.51 MT ha⁻¹. Among the major banana producing states, Andhra Pradesh ranked first in production, followed by Maharashtra, Gujarat and Tamil Nadu, while Karnataka ranked fifth with a production of 1,220.48 thousand MT (IndiaStat, 2025) [2]. At the district level, Chamarajanagar ranked first in banana production, followed by Mysore, while Shivamogga ranked third with a production of 95,775 tonnes from 9,463 hectares, highlighting the importance of Shivamogga as a major banana growing district in the state (DES, 2023) [3].

Banana production is constrained by several biotic and abiotic stresses, among which Panama wilt caused by *F. oxysporum* f. sp. cubense (Foc) is a major economically important disease. Archith *et al.* (2021) [4] recorded Panama wilt incidence ranging from 0 to 60.57 per cent across major banana growing districts of Karnataka. Tropical Race 4 (TR4) is the most virulent race affecting Cavendish bananas, while Subtropical Race 4 (STR4) has been reported in Ney Poovan banana in Mysuru, Karnataka (Thangavelu *et al.*, 2024) [5]. The pathogen infects roots and colonizes vascular tissues, causing leaf yellowing, wilting, vascular browning, pseudostem splitting, plant death and reduced bunch size and yield (Shukla *et al.*, 2019) [6]. Foc spreads through infected rhizomes, infested soil, irrigation water and contaminated tools and can persist in soil for up to 30 years, making disease management challenging (Dita *et al.*, 2010) [7].

Shivamogga is an important banana growing district of Karnataka, where variations in soil type, crop stage, irrigation and field conditions may influence Panama wilt incidence. However, location specific information on its incidence and distribution, along with the potential of rhizosphere soil from comparatively healthy plants as a source of beneficial microorganisms, remains limited. Therefore, the present study was undertaken to assess Panama wilt incidence and distribution across banana growing areas of Shivamogga district and to collect rhizosphere soil for isolation of potential beneficial microorganisms.

Material and Methods

An intensive roving survey was conducted during 2025 to 2026 in major banana growing areas of Shivamogga district, Karnataka, covering seven taluks, namely Shivamogga, Sagara, Hosanagara, Shikaripura, Soraba, Bhadravathi and Thirthahalli. Three to four villages were selected from each taluk, and fields were systematically inspected for characteristic symptoms of Panama wilt. Representative diseased root and rhizome samples were collected for pathogen isola-

tion. Rhizosphere soil was collected from comparatively healthy banana plants growing in Panama wilt affected fields at a depth of 10 to 20 cm from the active root zone for isolation of potential beneficial microorganisms. The samples were labelled with location, date and variety and transported to the laboratory. Disease incidence was calculated based on the number of infected plants in relation to the total number of plants observed in the field using the following formula given by Wheeler (1969) [8].

Disease Incidence =

Number of plants infected

Total number of plants observed

× 100

The proforma used for the survey included information on village, taluk, district, GPS coordinates, crop stage, mode of irrigation, soil type, banana variety, other diseases observed and disease incidence.

Table 1. Details of surveyed taluks and villages for the incidence of Panama wilt of banana during 2025

District	Taluks	Villages
Shivamogga	Shivamogga	Laxmipura
		Tuppur
		Kunehosur
		Sominakoppa
	Sagara	Nedaravalli
		Gilalagundi
		Mankodu
		Kodige
	Hosanagara	Punaje
		Kachigebailu
		Thadasanahalli
		Mugalikoppa
	Shikaripura	Hulaginakoppa
		Chikkasavi
		Kummuru
		Hanchinallu
	Soraba	Holehannur
		Veerapura
		Hosamane
		Beguvalli
	Bhadravathi	Jambuvalli
		Kudumallige
		Nellisara

Results

The survey revealed that Panama wilt incidence varied from 0.00 to 32.28 per cent among the villages surveyed (Table 1). The highest incidence was recorded in Veerapura village of Bhadravathi taluk (32.28 %), followed by Thadasanahalli of Shikaripura taluk (27.18 %) and Hosamane of Bhadravathi taluk (24.82 %), whereas no disease incidence was observed in Punaje of Hosanagara taluk and Jambuvalli of Thirthahalli taluk. Among the taluks, Bhadravathi recorded the highest mean disease incidence (25.70 %), followed by Shikaripura (23.80 %), Shivamogga (20.00 %), Soraba (14.20 %), Hosanagara (10.80 %), Sagara (8.60 %) and Thirthahalli (7.40 %), with an overall district mean of 15.79 per cent (Table 2; Fig. 1, Plate 1). In Bhadravathi taluk, the highest disease incidence was recorded in Veerapura village (32.28 %), followed by Hosamane (24.82 %), whereas the lowest disease incidence was observed in Holehannur vil-

lage (20.00 %). In Shikaripura taluk, the highest disease incidence was recorded in Thadasanahalli village (27.18 %), followed by Mugalikoppa (23.23 %), whereas the lowest disease incidence was observed in Hulaginakoppa village (20.99 %). In Shivamogga taluk, the highest disease incidence was recorded in Laxmipura village (23.48 %), followed by Kunehosur (20.47 %), Sominakoppa (18.23 %) and Tuppur (17.82 %) (Table 1). In Soraba taluk, the highest disease incidence was recorded in Chikkasavi village (16.88 %), followed by Hanchinallu (14.19 %), whereas the lowest disease incidence was observed in Kummuru vil-

lage (11.53 %). In Hosanagara taluk, the highest disease incidence was observed in Kodige village (19.18 %), followed by Kachigebailu (13.22 %), while no disease incidence was observed in Punaje village. In Sagara taluk, the highest disease incidence was recorded in Mankodu village (10.49 %), followed by Gilalagundi (8.83 %), whereas the lowest disease incidence was observed in Nedaravalli vil-

lage (6.48 %). In Thirthahalli taluk, Kudumallige village recorded the highest disease incidence (10.98 %), followed by Beguvalli (10.38 %) and Nellisara (8.24 %), while no disease incidence was observed in Jambuvalli village (Table 1).

During the survey, 23 rhizosphere soil samples were collected from comparatively healthy banana plants growing in Panama wilt affected banana fields across seven taluks of Shivamogga district. Grand Naine (G-9), Rasthali and Elakki Bale were the major banana cultivars observed across the surveyed locations. The crop was at the pre-flowering and pre-flowering to bunch initiation stages and was cultivated under drip, basin and surface irrigation systems in red loamy, lateritic red and lateritic soils. In addition to Panama wilt, Sigatoka leaf spot and banana bunchy top were the other major diseases observed in the surveyed banana fields (Table 1).

Discussion

The survey revealed that Panama wilt incidence ranged from 0.00 to 32.28 per cent across the villages surveyed. Among the seven taluks, Bhadravathi recorded the highest mean disease incidence (25.70 %), followed by Shikaripura (23.80 %), Shivamogga (20.00 %), Soraba (14.20 %), Hosanagara (10.80 %), Sagara (8.60 %) and Thirthahalli (7.40 %), with an overall district mean of 15.79 per cent. These findings are in agreement with Archith *et al.* (2021) [4], who reported Panama wilt incidence ranging from 6.54 to 25.47 per cent in Karnataka, with the highest mean incidence recorded in Mysuru district. Similar observations were also reported by Rachana (2024) [9], who recorded the highest wilt incidence of 40.63 per cent in Kollegala taluk and the lowest incidence of 23.35 per cent in Hanur taluk of Chamaraajanagar district.

During the study, on the influence of soil type on Panama wilt incidence of banana, higher disease incidence was observed in plantations grown on red loamy soils compared to lateritic and lateritic red soils. Similar observations were reported by Archith *et al.* (2021) [4], who recorded higher Panama wilt incidence (up to 25.47 %) in banana-growing regions of Karnataka where red loamy soils predominated.

Red loamy soils, owing to their favourable physical properties, good aeration and moisture retentive capacity, support the survival, growth and infection of *F. oxysporum* f. sp. *cubense*, resulting in higher disease incidence. In contrast, lateritic and lateritic red soils, because of their comparatively better drainage and less favourable conditions for pathogen establishment, recorded comparatively lower disease incidence.

While studying the influence of crop stage on Panama wilt incidence, higher disease incidence was observed in plantations at the pre-flowering stage to pre-flowering to bunch initiation stage. Similar observations were reported by Vanitha *et al.* (2025) [10], who observed Panama wilt incidence among banana fields, with greater disease incidence in pre-flowering to bunch initiation to maturation stage. As the crop advances in age, *F. oxysporum* f. sp. *cubense* progressively colonizes the vascular tissues, resulting in blockage of xylem vessels, reduced translocation of water and nutrients and the subsequent expression of characteristic wilt symptoms, thereby increasing disease incidence.

While studying the influence of banana cultivars on Panama wilt incidence, higher disease incidence was observed in Grand Naine (G-9) compared to other cultivars surveyed. Similar observations were reported by Rana *et al.* (2020) [11], who recorded severe disease incidence of 72.5 and 75.0 per cent in Grand Naine (Cavendish group), and attributed the higher incidence due to continuous monoculture of banana and the use of infected suckers as planting material, which facilitated the introduction and establishment of *F. oxysporum* f. sp. *cubense* (Foc). Archith (2021) [12] reported a severe Panama wilt incidence of up to 60 per cent in Rasthali variety and attributed the high disease incidence to continuous monocropping, which favoured the progressive persistence of *F. oxysporum* f. sp. *cubense* inoculum in the soil.

Table 1. Survey for Panama wilt disease incidence in Shivamogga district of Karnataka during 2025-26

GPS coordinates		Soil types	Varieties	Stage of the crop	Mode of irrigation	Other diseases observed	Disease Incidence (%)
Latitude	Longitude						
13.8879°	75.7379°	Red loamy soil	Grand Naine (G-9)	Pre-flowering to bunch initiation	Basin irrigation	Sigatoka leaf spot, Bunchy top	23.48
14.0819°	75.3134°	Red loamy soil	Elakki Bale	Pre-flowering	Drip irrigation	Sigatoka leaf spot, Bunchy top	17.82
14.0849°	75.3030°	Red loamy soil	Rasthali	Pre-flowering to bunch initiation	Surface irrigation	Sigatoka leaf spot	20.47
13.9951°	75.4687°	Red loamy soil	Rasthali	Pre-flowering	Basin irrigation	Sigatoka leaf spot, Bunchy top	18.23
							20.00
14.11960°	75.13414°	Lateritic red soil	Elakki Bale	Pre-flowering	Drip irrigation	Sigatoka leaf spot, Bunchy top	6.48
14.07583°	75.26651°	Lateritic red soil	Elakki Bale	Pre-flowering	Basin irrigation	Sigatoka leaf spot	8.83
14.17442°	75.04568°	Lateritic red soil	Rasthali	Pre-flowering to bunch initiation	Basin irrigation	Sigatoka leaf spot, Bunchy top	10.49
							8.60
13.71761°	75.35928°	Lateritic soil	Rasthali	Pre-flowering to bunch initiation	Surface irrigation	Sigatoka leaf spot	19.18
13.96258°	75.09319°	Lateritic soil	Elakki Bale	Pre-flowering	Drip irrigation	Bunchy top	00
13.97276°	75.104001°	Lateritic soil	Rasthali	Pre-flowering	Basin irrigation	Sigatoka leaf spot, Bunchy top	13.22
							10.80
14.47806°	75.32087°	Red loamy soil	Grand Naine (G-9)	Pre-flowering	Surface irrigation	Sigatoka leaf spot, Bunchy top	27.18
14.3908°	75.29224°	Red loamy soil	Rasthali	Pre-flowering to bunch initiation	Basin irrigation	Sigatoka leaf spot	23.23

(continued on next page)

14.41901°	75.30759°	Red loamy soil	Rasthali	Pre-flowering	Basin irrigation	Sigatoka leaf spot, Bunchy top	20.99
							23.80
14.33555°	75.21777°	Red loam to Lateritic soil	Rasthali	Pre-flowering	Basin irrigation	Sigatoka leaf spot	16.88
14.38014°	75.13240°	Red loam to Lateritic soil	Elakki Bale	Pre-flowering to bunch initiation	Drip irrigation	Sigatoka leaf spot, Bunchy top	11.53
14.38107°	75.21867°	Red loam to Lateritic soil	Rasthali	Pre-flowering	Basin irrigation	Sigatoka leaf spot, Bunchy top	14.19
							14.20
13.86710°	75.71147°	Red loamy soil	Rasthali	Pre-flowering to bunch initiation	Basin irrigation	Sigatoka leaf spot	20.00
13.88151°	75.739254°	Red loamy soil	Grand Naine (G-9)	Pre-flowering	Surface irrigation	Sigatoka leaf spot, Bunchy top	32.28
13.76597°	75.47268°	Red loamy soil	Rasthali	Pre-flowering	Basin irrigation	Sigatoka leaf spot, Bunchy top	24.82
							25.70
13.71531°	75.39577°	Lateritic soil	Rasthali	Pre-flowering	Basin irrigation	Sigatoka leaf spot, Bunchy top	10.38
13.71966°	75.41814°	Lateritic soil	Elakki Bale	Pre-flowering to bunch initiation	Drip irrigation	Sigatoka leaf	0.0
13.72502°	75.28802°	Lateritic soil	Grand Naine (G-9)	Pre-flowering	Drip irrigation	Sigatoka leaf spot, Bunchy top	10.98
13.76078°	75.47106°	Lateritic soil	Rasthali	Pre-flowering	Basin irrigation	Sigatoka leaf spot, Bunchy top	8.24
							7.40
							15.79

GPS: Global Positioning System

Table 2. Taluk wise disease incidence of Panama wilt during 2025-26

Sl. No.	District	Taluks	Mean Disease Incidence (%)
1	Shivamogga	Bhadravati	25.70
2		Shikaripura	23.80
3		Shivamogga	20.00
4		Soraba	14.20
5		Hosanagara	10.80
6		Sagara	8.60
7		Thirthahalli	7.40
District Mean			15.79

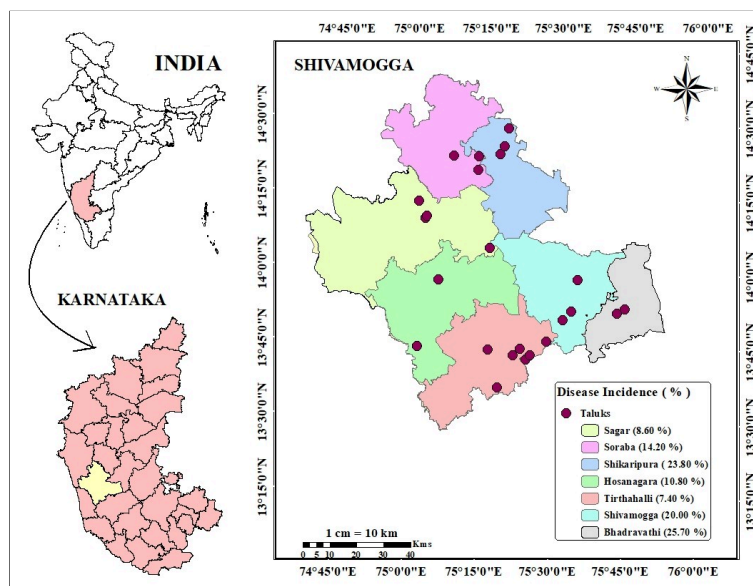


Figure 1. Surveyed locations of Panama wilt disease incidence in Shivamogga district of Karnataka during 2025-26



Plate 1. Survey for the disease incidence of Panama wilt in Shivamogga district of Karnataka during 2025-26

Conclusion

A roving survey conducted during 2025 to 2026 across seven taluks of Shivamogga district revealed Panama wilt incidence ranging from 0.00 to 32.28 per cent among the villages surveyed. The highest incidence of 32.28 per cent was recorded in Veerapura village of Bhadravathi taluk, while no disease incidence was recorded in Jambuvalli and Punaje villages. Bhadravathi recorded the highest mean Panama wilt incidence (25.70 %), followed by Shikaripura (23.80 %) and Shivamogga (20.00 %), whereas the lowest incidence was recorded in Thirthahalli (7.40 %), with an overall district mean of 15.79 per cent.

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