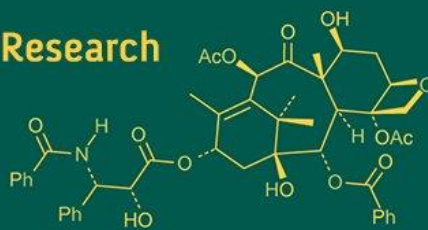


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Incidence of slow decline disease and distribution of associated pathogens in major black pepper-growing taluks of Shivamogga district, Karnataka, India

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Abstract

A roving survey was conducted during 2025-26 in the major black pepper-growing taluks of Shivamogga district, Karnataka, namely Thirthahalli, Hosanagara, Sagara and Shivamogga to assess the incidence and distribution of slow decline disease and its associated pathogens. Affected vines showed yellowing, chlorosis, gradual defoliation, reduced vigour, poor spike production, wilting and progressive drying. Root examination revealed root-knot galls, reddish-brown to dark-brown lesions, cortical necrosis and feeder-root decay. Disease incidence ranged from 10.00 to 26.00 per cent, with the highest incidence at Nellisara (26%) and the lowest at Gilalagundi (10%). Thirthahalli recorded the highest taluk mean incidence (22.75%), followed by Hosanagara (21.00%), Sagara (14.25%) and Shivamogga (12.00%). *Meloidogyne incognita* was detected in 15 of the 16 villages surveyed, with populations of 20-52 J₂ per 200 cc soil, whereas *Radopholus similis* showed a restricted distribution with populations of 3-15 nematodes per 5 g feeder roots. *Fusarium solani* was isolated from all 16 villages. The findings indicate that slow decline in the surveyed plantations is associated predominantly with *M. incognita* and *F. solani*, with *R. similis* occurring as a comparatively restricted component of the disease complex.

Keywords: Black pepper, slow decline, *Meloidogyne incognita*, *Radopholus similis*, *Fusarium solani*

Introduction

Black pepper (*Piper nigrum* L.), popularly known as the “King of Spices”, is an important spice crop cultivated extensively in the tropical regions of India. Karnataka is one of the major black pepper-producing states, with Shivamogga being an important production region. The crop is affected by several biotic stresses, among which slow decline is an important soil- and root-associated disease complex that progressively reduces vine vigour, productivity and longevity (Thangaselvabal *et al.*, 2008) ^[1]; (Anandaraj and Sarma, 2003) ^[2]. Slow decline, also known as slow wilt or yellows disease, is associated mainly with the interaction of the plant-parasitic nematodes *Meloidogyne incognita* and *Radopholus similis* with soil-borne fungal pathogens, particularly *Fusarium solani*. Affected vines generally exhibit yellowing, gradual leaf shedding, reduced growth, poor spike production, wilting, defoliation and progressive drying. Root systems show characteristic root-knot galls, reddish-brown to dark-brown lesions, cortical necrosis and feeder-root decay. Nematode feeding and migration cause root injury and physiological stress, which may facilitate fungal colonization and intensify disease development (Mustika, 1990) ^[3]; (Anandaraj and Sarma, 2003) ^[2]. Although slow decline has been reported from different black pepper-growing regions of India, recent information on its incidence and the distribution of associated pathogens in Shivamogga district is limited. Differences in agro-climatic conditions, soil properties, plantation practices and pathogen populations may influence disease occurrence and severity among locations. Therefore, the present investigation was undertaken to assess the incidence and distribution of slow decline disease in major black pepper-growing taluks of Shivamogga district, Karnataka, and to determine the occurrence and population levels of *M. incognita*, *R. similis* and *F. solani* in affected plantations.

2. Material and Methods

A roving survey was conducted during 2025-26 in the major black pepper-growing taluks of Shivamogga district, Karnataka, namely Thirthahalli, Hosanagara, Sagara and Shivamogga. Black pepper plantations in the selected taluks were surveyed and vines exhibiting typical symptoms of slow decline including yellowing, chlorosis, gradual defoliation, reduced vine vigour, wilting, poor spike production, root decay and progressive vine decline were identified. The root systems of symptomatic vines were examined for root-knot galls associated with *M. incognita* and characteristic lesions, necrotic patches and cortical cavities associated with *R. similis*. Information on village, GPS coordinates, cultivar, galling intensity, pathogen occurrence and disease incidence was recorded during the survey. The total number of vines observed and the number of vines showing slow decline symptoms were recorded for each plantation. Disease incidence was calculated using the formula described by Wheeler (1969)

$$\text{Per cent disease incidence (\%)} = \frac{\text{Number of plants showing wilting symptoms}}{\text{Total number of plants observed}} \times 100$$

The intensity of root galling caused by *M. incognita* was assessed using the 0-5 galling scale described by Taylor and Sasser (1978) [5], as detailed below.

Description of root-knot galling scale (0-5)

Grade	Number of galls per plant
0	No galls
1	One to two
2	Three to ten
3	11-30
4	31-100
5	More than 100

Rhizosphere soil and feeder-root samples collected from symptomatic vines were examined for the occurrence and population of *M. incognita* and *R. similis*. The population of *M. incognita* was expressed as the number of second-stage juveniles (J₂) per 200 cc of rhizosphere soil, whereas the population of *R. similis* was expressed as the number of nematodes per 5 g of feeder roots. Nematodes were extracted from soil samples using the Cobb's sieving and decanting method followed by the modified Baermann funnel technique. The extracted nematodes were examined under a compound microscope and identified based on their morphological characteristics using standard taxonomic keys.

3. Results

The roving survey conducted during 2025-26 revealed the occurrence of slow decline disease in all four surveyed taluks of Shivamogga district. Disease incidence varied from 10.00 to 26.00 per cent among the surveyed villages (Table 1, Plate 1). The highest incidence was recorded at Nellisara (26%) followed by Hodagina Makki (25%) while the lowest incidence was recorded at Gilalagundi (10%). At the taluk level, Thirthahalli recorded the highest mean disease incidence (22.75%) followed by Hosanagara (21.00%), Sagara (14.25%) and Shivamogga (12.00%) (Table 1, Table 2).

Affected vines exhibited characteristic symptoms including yellowing, chlorosis, gradual defoliation, reduced vine vigour, poor spike production, wilting and progressive drying. Examination of the root systems revealed root-knot galls, reddish-brown to dark-brown lesions, cortical necrosis and feeder-root decay (Plate 1).

M. incognita was detected in 15 of the 16 villages surveyed and recorded populations ranging from 20 to 52 J₂ per 200 cc of rhizosphere soil. The highest population was observed at Hodagina Makki (52 J₂/200 cc soil). *R. similis* showed a comparatively restricted distribution with populations ranging from 3 to 15 nematodes per 5 g of feeder roots. The highest population was recorded at Hodagina Makki (15 nematodes/5 g roots). *F. solani* was isolated from all 16 villages surveyed (Table 1).

The distribution of associated pathogens varied among the surveyed villages. *M. incognita*, *R. similis* and *F. solani* occurred together in several locations, whereas some locations showed only *F. solani* or a combination of *F. solani* with one of the nematode species (Table 1). The highest root-knot index for *M. incognita* was 3 and was recorded at Hodagina Makki (Table 1).

At the taluk level, Thirthahalli recorded the highest mean root-knot index (2.00) followed by Hosanagara (1.75), Sagara (1.25) and Shivamogga (1.00). The mean population of *M. incognita* was highest in Hosanagara (39.25 J₂/200 cc soil) followed by Thirthahalli (37.25 J₂/200 cc soil), Sagara (26.33 J₂/200 cc soil) and Shivamogga (24.50 J₂/200 cc soil). The mean population of *R. similis* was highest in Thirthahalli (11.67 nematodes/5 g roots) followed by Hosanagara (8.00 nematodes/5 g roots), Sagara (4.50 nematodes/5 g roots) and Shivamogga (3.00 nematodes/5 g roots). *F. solani* was recorded in all four taluks. Mean disease incidence was highest in Thirthahalli (22.75%) followed by Hosanagara (21.00%), Sagara (14.25%) and Shivamogga (12.00%) (Table 2).

Table 1: Survey for the incidence of slow decline disease in major black pepper-growing taluks of Shivamogga district, Karnataka during 2025-26

District	Taluks	Villages	GPS coordinates		Variety	RKI (0-5)	<i>M. incognita</i> (J ₂ /200 cc soil)	<i>R. similis</i> (No./5 g roots)	<i>F. solani</i>	Disease incidence (%)
			Latitude	Longitude						
Shivamogga	Thirthahalli	Beguvalli	13.704600°	75.402400°	Panniyur-1	2	35	8	+	24
		Nellisara	13.732500°	75.270700°	Panniyur-1	2	38	12	+	26
		Jambuvalli	13.719556°	75.418316°	Panniyur-1	1	24	0	+	16
		Hodagina Makki	13.606800°	75.307900°	Panniyur-1	3	52	15	+	25
		Mean				2.00	37.25	11.67		22.75
	Hosanagara	Kodige	13.717611°	75.359287°	Panniyur-1	2	45	6	+	22
		Punaje	13.962732°	75.092935°	Panniyur-1	1	30	0	+	18
		Yedehalli	13.739089°	75.382532°	Panniyur-1	2	42	10	+	23

		Masthikatte	13.737222°	75.027778°	Panniyur-1	2	40	8	+	21
		Mean				1.75	39.25	8.00		21.00
		Yalavarsi	14.167900°	75.040900°	Panniyur-1	1	25	4	+	15
	Sagara	Gilalagundi	14.075835°	75.266514°	Karimunda	1	0	0	+	10
		Mankodu	14.174465°	75.045687°	Panniyur-1	1	22	0	+	14
		Keladi	14.224100°	75.016400°	Karimunda	2	32	5	+	18
		Mean				1.25	26.33	4.50		14.25
	Shivamogga	ZAHRS, Shivamogga	13.975982°	75.573679°	Panniyur-1	1	28	0	+	12
		Kudli	13.870628°	75.555815°	Karimunda	1	26	0	+	12
		Gajanur	13.839000°	75.527000°	Panniyur-1	1	20	3	+	13
		Agasavalli	13.908550°	75.525470°	Panniyur-1	1	24	0	+	11
		Mean				1.00	24.50	3.00		12.00

RKI: Root-knot Index; “+” indicates presence of *Fusarium solani*

Table 2: Taluk-wise mean of root-knot index (RKI), nematode population, occurrence of *Fusarium solani* and disease incidence of slow decline disease of black pepper in Shivamogga district

Sl. No.	Taluks	Root-knot Index (RKI) (0-5)	<i>M. incognita</i> population (J2/200 cc soil)	<i>R. similis</i> population (No./5 g roots)	<i>F. solani</i> occurrence	Mean disease incidence (%)
1	Thirthahalli	2.00	37.25	11.67	Present	22.75
2	Hosanagara	1.75	39.25	8.00	Present	21.00
3	Sagara	1.25	26.33	4.50	Present	14.25
4	Shivamogga	1.00	24.50	3.00	Present	12.00

(A-B) Black pepper vines showing symptoms of slow decline; (C) symptomatic roots exhibiting root-knot galls, reddish-brown to dark-brown lesions and feeder-root decay



Plate 1: Field and root symptoms of slow decline disease of black pepper in Shivamogga district

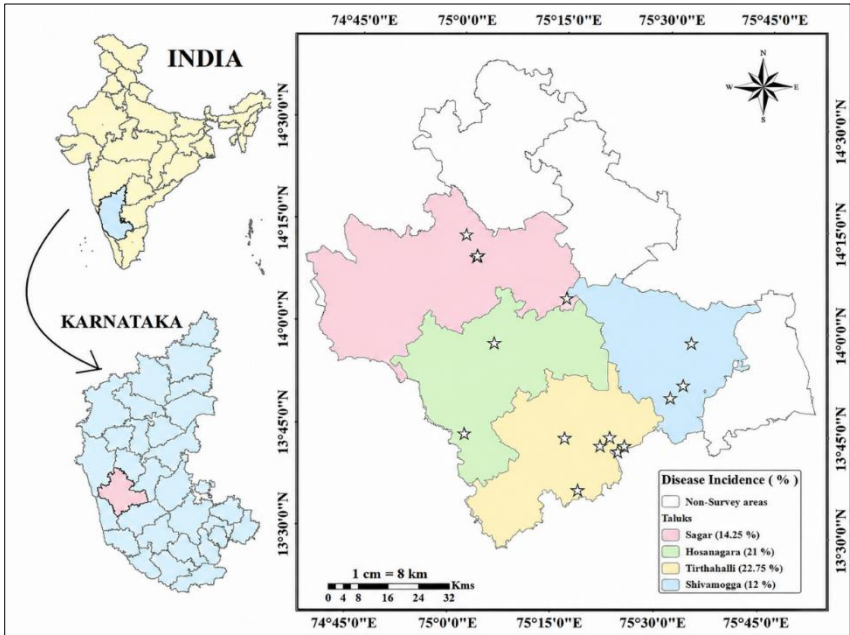


Fig 1: Surveyed locations to assess the disease incidence of slow decline of black pepper in Shivamogga district

4. Discussion

The present survey confirmed the widespread occurrence of slow decline disease in the major black pepper-growing areas of Shivamogga district. The variation in disease incidence among villages and taluks may be influenced by differences in soil moisture, drainage, plantation conditions and pathogen pressure. The symptoms observed, including yellowing, defoliation, reduced vine vigour, poor spike production, wilting and progressive drying, along with root-knot galls, necrotic lesions and feeder-root decay, were consistent with previously reported symptoms of slow decline (Anandaraj and Sarma, 2003) [2].

M. incognita was the most widely distributed nematode, occurring in 15 of the 16 villages surveyed. Its higher populations at some locations were associated with greater disease incidence and root-knot symptoms. The feeding activity of *M. incognita* damages roots and interferes with water and nutrient uptake, thereby weakening the vines. Its widespread occurrence agrees with earlier reports identifying *M. incognita* as an important component of the black pepper decline complex in Karnataka (Ashoka, 2001) [6]; (Ravindra *et al.*, 2014) [7].

R. similis showed a comparatively restricted distribution. Its occurrence along with *M. incognita* and *F. solani* at several locations suggests a possible combined contribution to root deterioration. As a migratory endoparasite, *R. similis* produces lesions and cortical damage that may facilitate colonization by soil-borne fungi. Such nematode-fungus interactions have been reported to contribute to increased root damage in black pepper (Mustika, 1990) [3].

F. solani was isolated from all 16 villages, indicating its widespread association with slow decline. Its detection at Gilalagundi in the absence of detectable nematodes indicates that fungal infection may also occur independently under certain conditions. However, the variation in pathogen combinations among villages indicates that disease expression is not governed by a single pathogen. Overall, the findings support the complex nature of slow decline involving *M. incognita*, *R. similis* and *F. solani*, with their relative contribution varying among locations.

5. Conclusion

The present survey revealed that slow decline disease is widely prevalent in the major black pepper-growing areas of Shivamogga district, with disease incidence ranging from 10.00 to 26.00 per cent.

M. incognita was the most widely distributed nematode, occurring in 15 of the 16 villages, while

R. similis showed a comparatively restricted distribution. *F. solani* was consistently associated with affected plantations and was isolated from all 16 villages. The variation in pathogen occurrence and their co-occurrence at several locations indicates the complex nature of slow decline disease. The findings provide baseline information on the current disease status and distribution of its major pathogen components in Shivamogga district and can support the development of integrated management strategies.

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Conflicts of Interest: There are no conflicts of interest among the authors.

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