www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(9): 1386-1390

www.thepharmajournal.com
Received: 22-06-2022
Accepted: 25-07-2022

KV Shivakumar
(1) Department of Plant Pathology, College of Agriculture, University of Agricultural Sciences, Bangalore, Karnataka, India
(2) ICAR-Central Research Institute for Jute and Allied Fibres, Regional Station, Pratapgarh, Uttar Pradesh, India

YM Somasekhara
Department of Plant Pathology, College of Agriculture, University of Agricultural Sciences, Bangalore, Karnataka, India

N Nagaraju
Department of Plant Pathology, College of Agriculture, University of Agricultural Sciences, Bangalore, Karnataka, India

RL Ravikumar
Department of Plant Biotechnology, College of Agriculture, University of Agricultural Sciences, Bangalore, Karnataka, India

KT Rangaswamy
Department of Plant Biotechnology, College of Agriculture, University of Agricultural Sciences, Bangalore, Karnataka, India

NC Narsegowda
Department of Horticulture, College of Agriculture, University of Agricultural Sciences, Bangalore, Karnataka, India

Corresponding Author:
KV Shivakumar
(1) Department of Plant Pathology, College of Agriculture, University of Agricultural Sciences, Bangalore, Karnataka, India
(2) ICAR-Central Research Institute for Jute and Allied Fibres, Regional Station, Pratapgarh, Uttar Pradesh, India

Survey for the incidence of foot root disease of black pepper in Karnataka

KV Shivakumar, YM Somasekhara, N Nagaraju, RL Ravikumar, KT Rangaswamy and NC Narsegowda

Abstract
Black pepper (*Piper nigrum* L.), the "king of spices" is a traditional and historic spice crop. Among the major production constraints of black pepper, diseases play a key role. Foot rot, caused by *Phytophthora capsi*ci Leonian is one of the significant constraints for black pepper cultivation. Being a soil-borne pathogen, the fungus infects all parts of the plant. An intensive roving survey was conducted covering five major districts of Karnataka viz., Kodagu, Hassan, Chikkamagaluru, Shivamogga and Uttara Kannada. The survey of two years revealed that highest mean incidence of foot rot disease was observed in Hassan district (18.44%) followed by Uttara Kannada (17.77%) and the least mean disease incidence (11.40%) was observed in Shivamogga district. Among the taluks surveyed the highest disease incidence (20.16%) was found in the Sakleshpura taluk of Hassan district, while the lowest disease incidence (10.0%) was found in the Mudigere taluk of Chikkamagaluru district. The mean incidence of foot rot of black pepper was higher (16.38%) in 2017 growing season as compared to 14.35 percent in 2016.

Keywords: Black pepper, foot rot, *Phytophthora capsici*, survey, Karnataka

1. Introduction
Black pepper commonly known as "King of Spices" because of its strong aroma and is widely used in all major cuisines around the world. India ranks fourth in black pepper production in the world, producing about 8% of the world's black pepper. In India, pepper vines are majorly grown in hilly regions in the states of Karnataka and Kerala under high temperatures and ample rainfall making it vulnerable to many diseases. Foot rot/ quick wilt caused by *P. capsici* Leonian, is an important disease of black pepper causing a yield loss of 10-15% in other countries (Drenth and Sendall, 2004) [2]. About 12- 16% vine death has been reported in Chikmagalur and Shivamogga districts in Karnataka, India (Thomas and Naik, 2017) [8]. However, under severe epidemic conditions, the disease has been reported to affect up to 95% of the vines in individual farms in certain countries (Anandaraj *et al*., 1988) [1]. The pathogen attacks the host at growth stage and infects all parts of black pepper root, collar, stem, leaf and spike. Among these infections, collar rot and root rot cause severe and sudden mortality of the vines. Foot rot is debilitating disease, outbreak of foot rot disease occurs more frequent and death of vines can occur at anytime including very older vines (Ravindran, 2000) [4]. Field survey helps in estimation of crop loss in field conditions, identifying hotspots and disease free areas as well as to relate correlating factors for disease outbreaks. Hence extensive roving survey was conducted in the major pepper growing areas of Karnataka State.

2. Materials and Methods
The intensive roving survey was conducted to record the incidence of foot rot of black pepper caused by *Phytophthora capsici* Leonian during June to July, 2016 and 2017 in five districts of Karnataka, *viz*. Kodagu, Hassan, Shivamogga, Chikkamagaluru and Uttara Kannada. In each districts, one to four taluks were surveyed. In each taluk, two to five villages were selected. In each village fifty vines were randomly selected to record percent disease incidence. During the survey other observations such as variety grown and most commonly used fungicides to manage the disease were also collected.
The percent disease incidence was calculated by using the following formula proposed by Wheeler (1969) [10].

$$\text{Per cent disease incidence} = \frac{\text{Number of vines infected}}{\text{Total number of vines observed}} \times 100$$

3. Results and Discussion

3.1 Symptomatology

During the survey the foot rot disease incidence was observed from all locations surveyed. The infection was observed on all parts of the vine. In general, the infection first appears on tender shoot tips or leaves of runner shoots arising from the base of the black pepper vines spreading on the ground. Infection on the leaves start as water soaked lesions and rapidly expands into large brown spots with a fimbriate margin. The leaf spots may remain uniformly dark or they may show concentric zonation with a grayish centre (Fig. 1). Tender leaves are more susceptible than mature leaves. Infection on the spikes resulted in spike shedding. Infection is noticed on tender to woody stems as dark wet spots and later rotting sets in causing die back symptoms. Foliar infection leads to varying degrees of defoliation depending on the severity of the disease (Fig. 2).

Fig 1: Typical water soaked lesion on black pepper leaves

Fig 2: Black pepper vine showing defoliation symptoms

Collar and root infection are fatal and the infected vine dies in 10-20 days and hence the often locally used term quick wilt". Collar and root infection go unnoticed until foliar yellowing is noticed. Infection start as wet slimy dark patch on the collar (foot) and rotting occurs as the disease progresses. Vascular discolorations of the affected stem beyond the point of infection have been reported. The collar infection progresses upwards and downwards. The collar infected vine show foliar yellowing, flaccidity of leaves, defoliation and breaking of stem at the nodal region and spike shedding and complete death symptoms (Fig. 3). Similar type of symptom expression was observed in the previous studies viz., Shashidhara (2007) [6], Vijaya (2008) [9] and Shobha *et al*., (2019) [7].

Fig 3: Black pepper vine showing complete wilting

3.2 Survey on the incidence of foot rot disease of black pepper

A survey was conducted to record the incidence of foot rot disease of black pepper in major growing districts of Karnataka, India viz., Kodagu, Hassan, Chikkamagaluru, Shivamogga and Uttara Kannada during monsoon season of 2016 and 2017. During the survey observations on percent disease incidence, variety, and commonly used fungicide for foot rot disease control were recorded.

Foot rot/quick wilt disease was observed in all of the investigated locations during the 2016 monsoon season. Bannuru village in Chikkamagaluru district recorded the highest disease incidence of 23.56 percent, while Devangi village in Shivamogga district had the lowest disease incidence (5.7%) (Table 1a). The taluks with the highest foot rot incidence (16.72%) was recorded in Sakleshpur taluk, and the lowest disease incidence (8.15%) was in Shivamogga district's Thirthahalli taluk. The highest mean foot rot incidence was found in Uttara Kannada district (18.62%), followed by Hassan (16.72%), Kodagu (13.30%), and Shivamogga (9.99%) among the examined districts (Table 2).

During, 2017, Yeslur village in Hassan district showed highest disease incidence of 24.33 percent, while Haralimata village in Shivamogga district had the lowest disease incidence of 6.60 percent (Table 1b). The highest disease incidence (20.16%) was found in the Sakleshpur taluk of Hassan district, while the lowest disease incidence (10.0%) was found in the Mudigere taluk of Chikkamagaluru district (Table 2).

The maximum mean incidence of foot rot disease was observed in Hassan district (18.44%) followed by Uttara Kannada (17.77%), and the least mean disease incidence (11.40%) was observed in Shivamogga district. The mean incidence of foot rot of black pepper was higher (16.38%) in 2017 growing season as compared to 14.35 percent in 2016 monsoon season (Table 2). Foot rot disease caused by *P. capsici* was found in all the pepper growing regions investigated, according to the results of a roving study conducted in five districts. However, disease incidence of greater than 25 percent was not reported in any of the surveyed years, which could be attributed to lower rainfall during the monsoon season in both years. In this study,

Hassan district had the highest disease incidence, whereas Shivamogga district had the lowest and the likely reason could be related to increased rainfall intensity, fewer varietal diversity, and most farmers' reliance on single site systemic fungicides for disease control in Hassan district. In this study, it was also discovered that pepper orchards with copper-based fungicides administered as a preventative step had lower disease incidence. According to Saju George *et al*, (2015) [5] the incidence of foot rot disease was 16.8, 12.88 and 9.92 percent in Virajpet, Madikeri and Somwarpet taluks, respectively. Losses owing to a high prevalence of foot rot have been observed in the Karnataka districts of Dakshina Kannada, Shivamogga, and Hassan (Jahagirdar, 1998) [3]. The findings were also consistent with claims that the taluks of Thirthahalli and Koppa in the Shivamogga and Chikmagalur districts, respectively, had the lowest disease incidence (Thomas and Naik, 2017) [8].

Table 1a: Survey on incidence of foot rot in major black pepper growing districts of Karnataka during 2016

District	Taluk	Location	Varieties	Commonly used fungicides by farmers	Disease Incidence (%)	Mean Disease Incidence (%)
Kodagu	Virajpet	Gonikoppal	Panniyur	Metalaxyl+Mancozeb, BM	10.5	13.87
		Ponnampete	Panniyur	Metalaxyl+Mancozeb, Potassium Phosphonate,	18.8	
		Thitimati	Panniyur	Dimethomorph, Metalaxyl+Mancozeb	11.8	
		Bittangala	Panniyur	Metalaxyl+Mancozeb, Potassium Phosphonate	14.4	
	Madikeri	Hakathuru	Panniyur	Metalaxyl+Mancozeb	14.1	14.00
		Moornadu	Panniyur	Dimethomorph, COC	12.3	
		Hosakeri	Panniyur	Potassium Phosphonate	15.6	
	Somwarpet	Kodlipete	Panniyur	Potassium Phosphonate	15.6	12.03
		Chettalli	Panniyur	COC, Dimethomorph	11.6	
		Shanivarashantte	Panniyur	Metalaxyl+Mancozeb, Fosetyl-Al	8.9	
Hassan	Sakleshpur	Yeslur	Panniyur-1	Fosetyl-Al, Metalaxyl+Mancozeb	18.5	16.72
		Hettur	Panniyur-1	Potassium Phosphonate, Metalaxyl+Mancozeb	13.8	
		Hanbal	Panniyur-1	Metalaxyl+Mancozeb	14.3	
		Matasagara	Karimunda	Fosetyl-Al,	20.3	
Shivamogga	Thirthahalli	Salgadi	Panniyur	COC	10.8	8.15
		Devangi	Panniyur	Metalaxyl+Mancozeb	5.7	
		Melige	Karimunda	Metalaxyl+Mancozeb	8.6	
		Shedgar	Karimunda	Metalaxyl+Mancozeb	7.5	
	Sagara	Chikkamathur	Sreekara	Metalaxyl+Mancozeb, Fosetyl-Al	11.5	11.83
		Gantinakoppa	Panniyur	Fosetyl-AL, Dimethomorph	10.8	
		Hiremane	Panniyur	Potassium Phosphonate	13.2	

District	Taluk	Location	Varieties	Commonly used fungicides by farmers	Disease Incidence (%)	Mean Disease Incidence (%)
Chikkamagaluru	Mudigere	Gonibidu	Panniyur	Metalaxyl+Mancozeb	10.00	12.30
		Devarunda	Panniyur	Potassium Phosphonate	12.76	
		Hosahalli	Panniyur	Metalaxyl+Mancozeb	11.67	
		Kudregundi	Karimunda	Metalaxyl+Mancozeb	18.90	
		Ujjire	Panchami	Metalaxyl+Mancozeb	8.17	
	Chikkamagaluru	Aldur	Panniyur	Metalaxyl+Mancozeb	7.89	15.27
		Allampura	Panniyur	Fosetyl-AL, Dimethomorph	18.40	
		Bannuru	Panniyur	Metalaxyl+Mancozeb, Dimethomorph	23.56	
		Govindapura	Panniyur	Metalaxyl+Mancozeb	11.23	
	Sringeri	Hosakoppa	Subakara	Metalaxyl+Mancozeb, Potassium Phosphonate	13.20	11.72
		Bettagere	Panniyur	Metalaxyl+Mancozeb, Dimethomorph	8.50	
		Ginikalu	Panniyur	Metalaxyl+Mancozeb	15.21	
		Halanduru	Karimunda	Metalaxyl+Mancozeb	10.0	
	Koppa	Devarahalli	Karimunda	Dimethomorph, Fosetyl-Al	10.8	13.20
		Bhuvanakote	Panniyur	Metalaxyl+Mancozeb	17.3	
		Kagodu	Panniyur	Metalaxyl+Mancozeb	11.5	
Uttara Kannada	Sirsi	Banavasi	Panniyur	Metalaxyl+Mancozeb,	21.54	19.78
		Vadla	Panniyur	Metalaxyl+Mancozeb, COC	17.80	
		Kalangi	Panniyur	Dimethomorph,	20.0	
	Siddapura	Balekoppa	Panniyur	Metalaxyl+Mancozeb, Fosetyl-AL	13.24	17.46
		Keregadde	Karimunda	COC, Fosetyl-AL	20.5	
		Sampgod	Panniyur	Metalaxyl+Mancozeb, Dimethomorph,	18.65	

Table 1b: Survey on incidence of foot rot in major black pepper growing districts of Karnataka during 2017

District	Taluk	Location	Varieties	Commonly used fungicides by farmers	Disease Incidence (%)	Mean Disease Incidence (%)
Kodagu	Virajpet	Gonikoppal	Panniyur	Metalaxyl+Mancozeb, BM	15.6	16.98
		Ponnampete	Panniyur	Metalaxyl+Mancozeb, Potassium Phosphonate,	22.1	
		Siddapura	Panniyur	Metalaxyl+Mancozeb	19.35	
		Ammathi	Panniyur	Potassium Phosphonate	10.89	
	Madikeri	Galibidu	Panniyur	Metalaxyl+Mancozeb	18.00	20.87
		Madenadu	Panniyur	Metalaxyl+Mancozeb	23.40	
		Moornadu	Panniyur	Metalaxyl+Mancozeb	21.22	
	Somwarpet	Kodlipete	Panniyur	Potassium Phosphonate	19.11	19.25
		Attur	Panniyur	COC	21.31	
		Chettalli	Panniyur	Metalaxyl+Mancozeb, Potassium Phosphonate,	17.33	
Hassan	Sakleshpur	Yeslur	Paniyur-1	Fosetyl-Al, Dimethomorph	24.33	20.16
		Hettur	Panniyur	Potassium Phosphonate	19.16	
		Bage	Panniyur	Dimethomorph, Metalaxyl+Mancozeb	15.60	
		Belagodu	Karimunda	Dimethomorph,	21.55	
Shivamogga	Thirthahalli	Salgadi	Pournami	Metalaxyl+Mancozeb	12.11	12.46
		Holekoppa	Panniyur	Metalaxyl+Mancozeb	15.65	
		Haralimata	Panniyur	COC	6.60	
		Munduvalli	Panniyur	Metalaxyl+Mancozeb	15.50	
	Sagara	Anandapura	Panniyur	Metalaxyl+Mancozeb, Fosetyl-Al	17.24	13.19
		Kalmane	Panniyur	Metalaxyl+Mancozeb, Dimethomorph	13.33	
		Mullakere	Panniyur	Fosetyl-Al	9.0	

District	Taluk	Location	Varieties	Commonly used fungicides by farmers	Disease Incidence (%)	Mean Disease Incidence (%)
Chikkamagaluru	Mudigere	Gonibidu	Panniyur	Metalaxyl+Mancozeb	17.8	10.0
		Hosahalli	Panniyur	Metalaxyl+Mancozeb	13.6	
		Balur	Panniyur	Metalaxyl+Mancozeb, Dimethomorph	5.9	
		Bettegere	Karimunda	Metalaxyl+Mancozeb, COC	8.5	
		Angadi	Panniyur	Metalaxyl+Mancozeb,	4.2	
	Chikkamagaluru	Aldur	Panniyur	Metalaxyl+Mancozeb	23.4	16.6
		Masagali	Panniyur	Dimethomorph	15.4	
		Narasipura	Karimunda	Fosetyl-Al	10.8	
		Sadarahalli	Panniyur	Dimethomorph, Fosetyl-Al	16.9	
	Sringeri	Dharekopa	Karimunda	Metalaxyl+Mancozeb	11.2	13.97
		Ginikal	Karimunda	Metalaxyl+Mancozeb, Fosetyl-Al	15.6	
		Kavadi	Panniyur	Potassium Phosphonate	18.6	
		Melukoppa	Panniyur	Dimethomorph	10.5	
	Koppa	Hattikodige	Panniyur	Metalaxyl+Mancozeb	8.6	11.23
		Devarahalli	Karimunda	Metalaxyl+Mancozeb	15.6	
		Kagodu	Panniyur	Metalaxyl+Mancozeb	9.5	
Uttara Kannada	Sirsi	Banavasi	Panniyur	Dimethomorph, Fosetyl-Al	17.8	17.57
		Kanve	Panniyur	Fosetyl-Al	20.3	
		Kerekoppa	Panniyur	Metalaxyl+Mancozeb	14.6	
	Siddapura	Balekoppa	Panniyur	Dimethomorph, Fosetyl-Al	10.5	16.3
		Gakttikai	Panniyur	Potassium Phosphonate	18.2	
		Doddamane	Panniyur	Fosetyl-Al	20.5	

Table 2: Year wise incidence of foot rot of black pepper in different taluk's and district's of Karnataka

District	Taluk	Mean disease incidence (%)		
		2016	2017	Pooled mean
Kodagu	Virajpet	13.87	16.98	15.42
	Madikeri	14.00	20.87	17.43
	Somwarpet	12.03	19.25	15.64
	Mean	13.30	19.03	16.16
Hassan	Sakleshpur	16.72	20.16	18.44
	Mean	16.72	20.16	18.44
Shivamogga	Thirthahalli	8.15	12.46	10.30
	Sagara	11.83	13.19	12.51
	Mean	9.99	12.82	11.40
Chikkamagaluru	Mudigere	12.3	10.0	11.15
	Chikkamagaluru	15.27	16.6	15.93
	Sringeri	11.72	13.97	12.84
	Koppa	13.2	11.23	12.21
	Mean	13.12	12.95	13.03

Uttara Kannada	Sirsi	19.78	17.57	18.67
	Siddapura	17.46	16.30	16.88
	Mean	18.62	16.93	17.77
Grand mean		14.35	16.38	15.36

4. Conclusion

Foot rot disease is continuing to be major threat for black pepper production worldwide. From this study, the higher disease incidence recorded in Hassan district (18.44%) of Karnataka and it has been found that disease is more prevalent in areas where usage of copper based fungicides is very less and dependency on systemic fungicides is more suggesting the role copper fungicides in combination with other management practices to prevent emergence of new pathogen races and destructive nature of the disease. Therefore recommended integrated management practices measures need to be followed by farmers to overcome the problem in their gardens.

5. References

1. Ananadaraj M, Jose Abraham, Balakrishnan R. Crop loss due to foot rot (‘*Phytophthora palmivora*’ MF4) disease of black pepper (*Piper nigrum* L). in Cannanore district of Kerala. Indian Phytopath. 1988;41:473-476.
2. Drenth A, Sendall B. Economic impact of *Phytophthora* diseases in Southeast Asia in Diversity and Management of Phytophthora in Southeast Asia. ACIAR; c2004. p. 10-28.
3. Jahagirdar S. Etiology and management of foot rot of black pepper (*Piper nigrum*). Ph.D. Thesis, Univ. Agric. Sci., Bangalore; c1998.
4. Ravindran PN, Botany. crop improvement of black pepper. Black Pepper (*Piper nigrum* L.), Medicinal and Aromatic Plants-Industrial Profiles; c2000.
5. Saju George, Veerendra Kumar, KV Prabhakara B. Incidence of foot rot disease of black pepper (*Piper nigrum* L.) in Kodagu District of Karnataka. Pest manage. hortic. ecsyst. 2015;21(1):115-116.
6. Shashidhara S. Studies on foot rot of black pepper caused by *Phytophthora capsici* Leonian, emend, Alizedeh and Tsao. M.Sc. (Agri.) Thesis, Univ. Agric. Sci. Dharwad, (India); c2007.
7. Shobha MS, Lakshmidevi N, Mahadeva Murthy S. Field survey, morphological and molecular characterization of *Phytophthora capsici*, causes foot rot disease of black pepper in Karnataka, India. Int. J Curr. Adv. Res. 2019;8(1):17089-17097.
8. Thomas LM, Naik BG. Evaluation of different culture media, fungicides and bio control agents on the growth of *Phytophthora capsici* Leonian. causing foot rot of black pepper *in vitro*. Chem Sci Rev Lett. 2017;6(21):279-286.
9. Vijaya P. Studies on characterization and variability of *Phytophthora* species pathogenic to black pepper (*Piper nigrum*). Ph.D. Thesis, University of Calicut, Kerala; c2008.
10. Wheeler BEJ. An Introduction to Plant Diseases, John Wiley and Sons Limited, London; c1969. p.301.