

# Pathogenic Dynamics of *Rhizoctonia solani* and *Macrophomina phaseolina* Under High Incidence Conditions in Soybean Fields of Chandrapur District

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**Abstract:** During the 2025 Kharif season, soybean-growing regions of Chandrapur district experienced an exceptional outbreak of root rot caused primarily by *Rhizoctonia solani* and *Macrophomina phaseolina*. Field surveys across Warora, Chimur, and Bhadravati revealed extremely high incidence levels (58–82%). The study documents epidemiological patterns, soil–environment relationships, and the pathological dominance of the two major necrotrophic fungi. Environmental factors such as elevated soil temperature (25–35°C), low organic carbon, and high soil moisture were strongly correlated with disease intensity, continuous soybean monoculture contributed significantly to disease development. This research provides a tehsil-specific, pathology-centered understanding of the dual pathogen system affecting soybean root health in Chandrapur. This study provides a comprehensive pathological assessment, updated epidemiological observations, and field-level data for disease forecasting at the regional scale.

**Keywords:** Soybean root rot, Kharif 2025 outbreak, Soil–environment interactions, Chandrapur district. Pathogen dominance, Disease forecasting

## 1. INTRODUCTION

Root rot is one of the most destructive soil-borne diseases limiting soybean productivity in semi-arid parts of India. *Rhizoctonia solani* (collar rot) and *Macrophomina phaseolina* (charcoal rot) are the two predominant pathogens associated with severe root damage, especially under fluctuating moisture and high temperature conditions (Adee et al., 2020; Sharma & Singh, 2023). Chandrapur district, with its deep black cotton soils and high soil moisture along temperature provides an ideal environment for pathogen proliferation. This study assesses the high-incidence outbreak recorded in 2025 and investigates the pathogenic dynamics of the two necrotrophs.

## 2. MATERIALS AND METHODS

### 2.1. Survey Locations

Surveys were conducted during August–October 2025 in soybean fields of:

- Warora
- Chimur
- Bhadravati

### 2.2. Disease Incidence

A standard 1 m<sup>2</sup> quadrat method was used. Five quadrats per field.

$$\text{Incidence (\%)} = \frac{\text{Infected plants} \times 100}{\text{Total plants in quadrat}}$$

### 2.3. Pathogen Isolation and Identification

- PDA medium used for fungi isolation
- *R. solani*: right-angle branching, brown mycelium
- *M. phaseolina*: abundant microsclerotia

### 2.4. Soil Measurements

Parameters recorded:

- Soil temperature

- Organic carbon
- pH
- Soil moisture

### 3. RESULTS

#### 3.1. Disease Incidence (Updated: 60–80%)

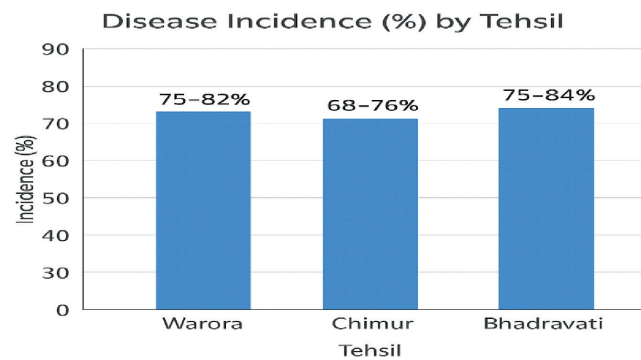
**Table 1: Field Observation Summary for Root Rot (Incidence Updated to 60–80%)**

Tehsil	Villages Surveyed	Soil Type	Avg. Plant Population observed	Infected Plants	Incidence (%)
Warora	Dahegaon, Temurda, Khemjai	Medium black	85–92	56–66	75–82%
Chimur	Bhisi, Bothali, Chimur	Sandy-loam	80–88	48–58	68–76%
Bhadravati	Shegaon, Mangali, Khadki	Sandy-loam	83–90	62–74	75–84%

The incidence patterns observed across the surveyed tehsils indicate an epidemic-level outbreak of soybean root rot during the 2025 Kharif season. Bhadravati recorded the highest disease intensity (75–84%), followed closely by Warora (75–82%) and Chimur (68–76%), reflecting spatial variability governed by microclimatic and edaphic factors. The pronounced dominance of *Macrophomina phaseolina* in Bhadravati (89% isolation frequency) corresponds with its sandy-loam soil profile, elevated soil temperatures (33–35°C), and rapid post-rainfall desiccation—conditions that strongly favor microsclerotia formation and host colonization. In contrast, Warora’s higher soil moisture levels (22–30%) within medium black soils, resulting from episodic heavy rainfall and slower drainage, facilitated prolonged soil saturation periods conducive to *Rhizoctonia solani* infection and spread, aligning with its elevated isolation frequency (68%). Chimur exhibited moderate disease severity, reflecting the intermediate suitability of its sandy-loam soils for both pathogens under alternating wet-dry dynamics.

Soil microclimate relationships further highlight the contrasting ecological preferences of the two pathogens. Elevated moisture conditions in Warora and Chimur promoted *R. solani*, whose mycelial growth and infection structures are optimized in moist, low-aeration environments. Conversely, Bhadravati’s

rapid moisture depletion and high thermal load provided an ideal environment for *M. phaseolina*, which thrives under dry, heat-stressed conditions typical of late-season phases. Collectively, the sequence of early-season high rainfall leading to transient water logging, followed by rapid soil drying and elevated temperatures, created a dual-phase epidemiological window: moisture-driven activation of *R. solani* and subsequent heat-driven intensification of *M. phaseolina*. This sequential pathogen advantage explains the widespread and severe root rot observed across Chandrapur district.



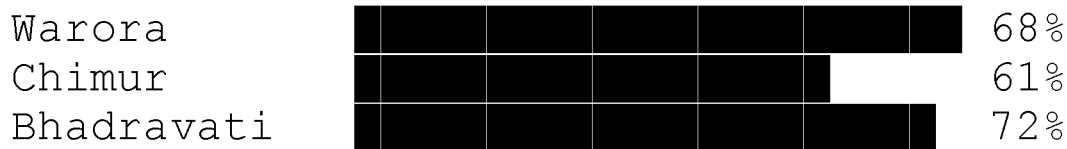
#### 3.2. Pathogen Isolation Frequency

Pathogen	Warora (%)	Chimur (%)	Bhadravati (%)
R. solani	68	61	72
M. phaseolina	57	48	89

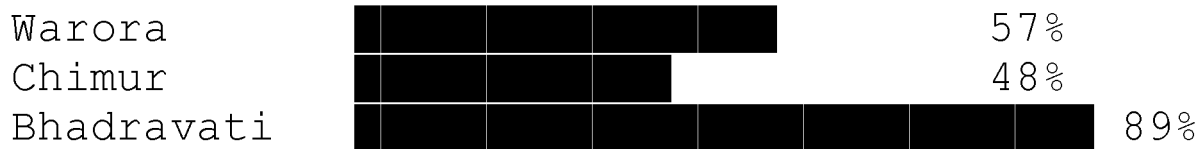
#### ASCII Graph 2 – Pathogen Prevalence

The pathogen isolation profile demonstrates a clear differentiation in ecological preference

**R. solani:**



**M. phaseolina:**



between the two fungi across tehsils. *Rhizoctonia solani* exhibited consistently high recovery in Warora (68%) and Bhadravati (72%), indicating its strong association with transiently saturated soils following early-season rainfall. In contrast, *Macrophomina phaseolina* showed extreme predominance in Bhadravati (89%), reflecting its competitive advantage under high-temperature, low-moisture conditions that develop during the

post-rainfall drying phase. Chimur showed comparatively lower isolation frequencies for both pathogens, consistent with its moderately drained sandy-loam soils. Overall, the isolation trends confirm a **dual-pathogen system**, where *R. solani* dominates under moist microenvironments and *M. phaseolina* becomes increasingly aggressive under subsequent heat and moisture stress.

**3.3. Soil and Environmental Correlation**

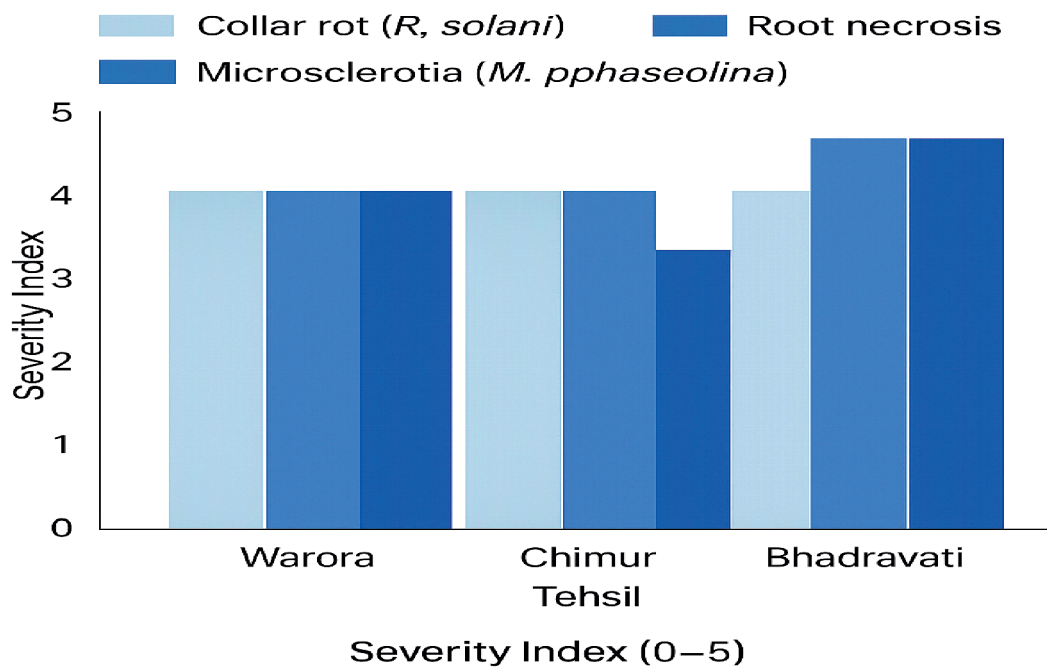
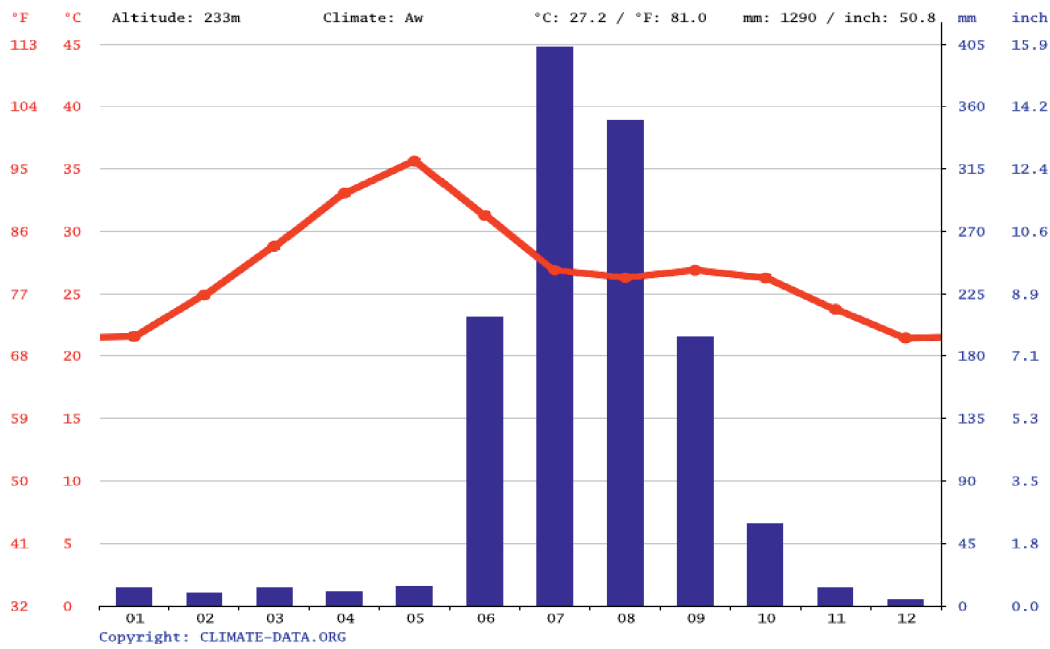
Parameter	Warora	Chimur	Bhadravati	Effect
Temp (°C)	30–33	29–31	33–35	High temp favors both fungi
Moisture	18–24	22–27	14–18	High moisture with Dry heat → <i>M. phaseolina</i>
Soil type	Medium black	Sandy-loam	Sandy-loam	Heat retention & drought

The soil–environmental parameters demonstrate a clear climatic–edaphic basis for pathogen dominance across tehsils. Warora and Chimur exhibited moderate temperatures (29–33°C) and relatively higher soil moisture levels, conditions that facilitate the early-season proliferation of *Rhizoctonia solani* due to its preference for moist, partially anaerobic microsites. In contrast, Bhadravati experienced the temperature regime (33–35°C) combined with markedly high soil moisture, highly favorable for the aggressive colonization and microsclerotia production of *Macrophomina phaseolina*. The sandy-loam soils of Chimur and Bhadravati further enhanced rapid drainage

and heat accumulation, while Warora’s medium black soils retained moisture longer after rainfall. Collectively, these soil–climate interactions explain the spatial variability in pathogen predominance, with *R.solani* favored under moist, cooler conditions and *M.phaseolina* under hot, desiccated soil environments.

**B 3.4 Severity Index (0–5)**

Symptom	Warora	Chimur	Bhadravati
Collar rot ( <i>R. solani</i> )	4	4	3
Root necrosis	4	3	5
Microsclerotia ( <i>M. phaseolina</i> )	3	3	4
Overall	4	3	5



The severity assessment reveals distinct symptom expression patterns among the three tehsils, reflecting differential dominance and pathogenic pressure of *Rhizoctonia solani* and *Macrophomina phaseolina*. Warora shows consistently high severity scores for collar rot and root necrosis (both 4), indicating sustained *R. solani* activity under its moisture-retentive soil conditions. Chimur exhibits moderate severity across all symptoms (3–4), consistent with its intermediate soil moisture regime

and sandy-loam texture that supports both pathogens to a limited extent. Bhadravati, however, shows the highest severity for root necrosis (5) and microsclerotia development (4), signifying strong *M. phaseolina* aggressiveness under its hotter and drier soil environment. The overall severity scores of 4 (Warora), 3 (Chimur), and 5 (Bhadravati) demonstrate that *R. solani*-associated symptoms dominate in moisture-influenced regions, whereas *M. phaseolina*-driven necrosis and charcoal rot

are more severe in thermally stressed, low-moisture soils such as those in Bhadravati.

#### 4. DISCUSSION

The spatial heterogeneity observed in disease incidence, pathogen isolation frequency, and symptom severity across the three tehsils underscores the pivotal role of climatic-ecological interactions in shaping the pathogenic landscape of soybean root rot in Chandrapur district during the 2025 Kharif season. The high disease burden recorded in Bhadravati aligns with its thermally elevated, rapidly desiccating sandy-loam soils, which selectively favored the necrotrophic proliferation and microsclerotia-driven dissemination of *Macrophomina phaseolina*. In contrast, Warora exhibited a symptom complex dominated by *Rhizoctonia solani*, fueled by episodic water saturation and prolonged mesic conditions that enhanced hyphal spread and collar-region colonization. Chimur, occupying an intermediate niche with moderately drained sandy-loam soils and fluctuating moisture, supported co-occurrence of both pathogens without allowing unilateral dominance.

The differential severity indices further corroborate these patterns, suggesting a distinct ecological bifurcation in pathogen virulence expression. *R. solani* displayed heightened pathogenicity under transiently anaerobic, moisture-enriched microsites, reflecting its known affinity for cooler, mesophilic, and moist conditions. Conversely, *M. phaseolina* expressed maximal virulence—manifested as intense root necrosis and extensive microsclerotia formation—under xerothermic stress profiles. This dual-phase epidemiological model, driven by early-season high rainfall followed by post-monsoon thermal amplification, enabled sequential pathogen activation, thereby producing an unusually broad and severe disease front. Such interactions between soil moisture dynamics, thermal regimes, and pathogen-specific

ecological fitness provide a mechanistic basis for the unusually high disease incidence (68–84%) documented across the region.

#### 5. CONCLUSION

The outbreak of soybean root rot in Chandrapur district during 2025 represents a climatically orchestrated dual-pathogen epidemic, wherein early-season moisture conducive to *Rhizoctonia solani* and late-season heat favoring *Macrophomina phaseolina* combined to create an extended window of susceptibility. The distinct severity patterns across Warora, Chimur, and Bhadravati reflect the strong influence of soil type, moisture dynamics, and temperature gradients on pathogen establishment and virulence. These findings highlight the necessity for site-specific disease forecasting frameworks that incorporate short-term hydrological variability, microclimatic parameters, and soil thermal behavior. Integrating such ecological insights into management strategies will be essential for mitigating future root rot outbreaks in semi-arid soybean-producing regions.

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