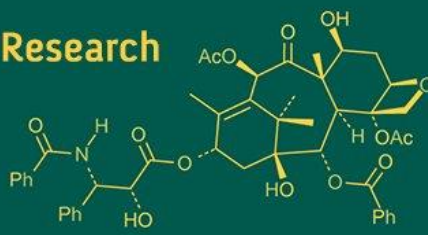


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**Jyoti Jhirwal**  
Research Scholar, Department of  
Plant Pathology, College of  
Agriculture, Agriculture  
University, Kota, Rajasthan,  
India

**Dama Ram**  
Associate Professor, Department of  
Plant Pathology, College of  
Agriculture, Agriculture  
University, Kota, Rajasthan, India

**JR Verma**  
Professor, Department of Plant  
Pathology, College of Agriculture,  
Agriculture University, Jodhpur,  
Rajasthan, India

**Durga Prasad**  
Associate Professor, Department of  
Plant Pathology, College of  
Agriculture, Agriculture  
University, Jodhpur, Rajasthan,  
India

**Manish Kumar**  
Assistant Professor, Department of  
Plant Pathology, College of  
Agriculture, Agriculture  
University, Jodhpur, Rajasthan,  
India

**KK Saini**  
Assistant Professor, Department of  
Plant Pathology, College of  
Agriculture, Agriculture  
University, Jodhpur, Rajasthan,  
India

**Avinash Pilla**  
Assistant Professor, Department of  
Agriculture, Koneru Lakshmaiah  
Education Foundation,  
Vaddeswaram, Guntur, Andhra  
Pradesh, India

**Corresponding Author:**  
**Jyoti Jhirwal**  
Research Scholar, Department of  
Plant Pathology, College of  
Agriculture, Agriculture  
University, Jodhpur, Rajasthan,  
India

## Spatial and temporal distribution of dry root rot caused by *Macrophomina phaseolina* (Tassi) Goid. in cluster bean, selected regions of Western Rajasthan

**Jyoti Jhirwal, Dama Ram, JR Verma, Durga Prasad, Manish Kumar, KK Saini and Avinash Pilla**

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### Abstract

Dry root rot, caused by the necrotrophic soil-borne fungus *Macrophomina phaseolina*, is an important constraint to cluster bean (*Cyamopsis tetragonoloba* L. Taub.) production, particularly under the hot and moisture-limited conditions of arid and semi-arid ecosystems. The present study was undertaken to assess the geographical distribution and temporal progression of dry root rot in major cluster bean-growing areas of Rajasthan. Disease surveys were conducted across 20 tehsils of Jodhpur, Bikaner, Phalodi and Nagaur districts during the Kharif seasons of 2024 and 2025. Disease severity was recorded at the field level, and precise GPS coordinates were collected to facilitate spatial documentation and mapping of disease occurrence.

Marked differences in disease distribution were observed among the surveyed districts and tehsils. Phalodi recorded the highest district-level mean percent disease index (PDI) of 24.48%, indicating a comparatively greater disease burden in the region. Among the surveyed tehsils, Bap recorded the highest localized average PDI of 28.25%. In contrast, Nagaur exhibited the lowest district-level mean PDI of 13.03%, suggesting comparatively lower disease severity during the survey period. Temporal comparison between the two cropping seasons showed that 12 out of 20 surveyed tehsils exhibited an increase in PDI during 2025 compared with 2024. The increase in disease severity across several locations indicates the continuing establishment and persistence of the pathogen in affected production areas. The spatial and temporal variation observed in the present investigation highlights the importance of location-specific disease surveillance and management strategies. The persistence of *M. phaseolina* in soil, together with favourable environmental conditions, may contribute to recurring disease development. The findings provide useful baseline information for identifying disease-prone areas and support the development of integrated management approaches involving effective biocontrol agents, improved soil-moisture management and other appropriate disease-management practices for sustainable cluster bean production in Rajasthan.

**Keywords:** Dry root rot; *Macrophomina phaseolina*; Disease distribution; Disease severity; Disease surveillance; Biocontrol

### 1. Introduction

Cluster bean (*Cyamopsis tetragonoloba* L. Taub.), or guar, is a drought-hardy legume vital to the agrarian economy of Rajasthan, India. While its seeds are processed globally for industrial guar gum, the crop faces substantial yield risks from soil-borne pathogens. Under the high-temperature and low-moisture regimes characteristic of western Rajasthan, Dry Root Rot (DRR), caused by *Macrophomina phaseolina*, has emerged as a primary constraint on crop productivity. Cluster bean is an annual, herbaceous, self-pollinated crop with a chromosome number of  $2n = 14$ , attaining a height of about 0.5 to 1.0 m or more with elongated oval shaped stem (Hymowitz and Upadhy, 1963) <sup>[11]</sup>. India is the leading producer and exporter of guar, accounting for more than 80% of global production (Agricultural Statistics at a Glance, 2018–2019). Rajasthan is the major cluster bean-producing state, contributing nearly 90% of the country's cultivated area, followed by Gujarat and Haryana (Sharma, 2014) <sup>[10]</sup>. In 2025, cluster bean covered 26.50 lakh ha in Rajasthan, producing 17.64 lakh tonnes with a productivity of 666 kg ha<sup>-1</sup> (Department of Agriculture, Government of Rajasthan, 2025). The major producing districts include Barmer, Bikaner, Churu, Jodhpur, Nagaur, Jaisalmer, Jhunjhunu, Sikar and Sri Ganganagar.

Unlike foliar blights, DRR targets the host's subterranean root architecture. The fungus produces dark, resilient survival structures called microsclerotia, which persist in sandy soils for multiple seasons. Onset typically accelerates post-flowering during periods of high ambient temperature (above 35°C) and sudden moisture deficits. The pathogen colonizes the vascular tissue, leading to root xylem clogging, sudden wilting, shredded taproots, and plant death. The distribution of DRR is strongly influenced by physical soil properties, sand content, and irrigation availability. Sub-district variations in soil management can lead to localized differences in disease severity. This study systematically profiles dry root rot PDI across 20 cluster bean growing tehsils. By matching GPS coordinates with field data from 2024 and 2025, this research maps high-risk zones to help target regional soil-health and disease-mitigation strategies.

## 2. Materials and Methods

A systematic survey was conducted in the major cluster bean-growing districts of Rajasthan, namely Bikaner, Jodhpur, Phalodi, Nagaur and Barmer, during the *Kharif* seasons of 2024 and 2025 to assess the occurrence and severity of dry root rot. Five tehsils were selected from each district, and three representative farmers' fields were surveyed in each selected tehsil. In each field, five sampling spots of 1 m<sup>2</sup> area each were selected randomly along a diagonal transect to obtain a representative assessment of disease occurrence. The numbers of healthy and diseased plants were counted separately at each sampling spot. The percentage disease incidence was calculated using the formula described by Mayee and Datar (1986) [6]:

$$\text{Per cent disease incidence (\%)} = (\text{Total number of infected plants} / \text{Total number of plants}) \times 100$$

For pathogen isolation and subsequent laboratory studies, cluster bean plants showing typical symptoms of dry root rot were collected from different farmers' fields. Diseased plants were carefully uprooted along with the root and collar portions to retain the symptomatic tissues and associated pathogen structures. Typical symptoms observed in the field included yellowing and wilting of foliage followed by progressive drying of the plant. The underground portions generally exhibited brown to black discoloration and rotting of the roots and collar region, with the presence of numerous small black sclerotial bodies characteristic of *Macrophomina phaseolina* (Tassi) Goid.

The collected diseased specimens, including the affected root and collar portions, were placed individually in clean, labelled polythene bags. Each sample was labelled with relevant information such as location, tehsil, district and date of collection. The samples were collected and brought to the Department of Plant Pathology, College of Agriculture, Agriculture University, Jodhpur, for isolation, identification and further pathogenicity studies of the associated pathogen.

## 3. Results and Discussion:

A field survey was conducted during the *Kharif* seasons of 2024 and 2025 to determine the distribution and temporal variation of dry root rot of cluster bean caused by *Macrophomina phaseolina* in five major cluster bean-growing districts of Rajasthan, namely Jodhpur, Bikaner, Phalodi, Nagaur and Barmer. Disease severity was recorded

at the selected locations and expressed as per cent disease index (PDI). The geographical coordinates of the surveyed locations were also recorded to facilitate spatial documentation of disease occurrence and depicted in the figure 1. Considerable variation in disease severity was observed among districts and tehsils (Table 1). The district average PDI was highest in Phalodi (24.48%), followed by Jodhpur (19.93%), Barmer (18.30%) and Bikaner (17.30%), whereas the lowest district average PDI was recorded in Nagaur (13.03%). In Jodhpur district, the average PDI across the surveyed tehsils ranged from 18.29 to 21.52%. The highest average PDI was recorded at Osian (21.52%), followed by Bhopalgarh (20.48%), Jodhpur (20.97%), Bilara (18.40%) and Shergarh (18.29%). The district-level average PDI was 19.93%. Comparison between the two survey years showed an increase in PDI at Jodhpur, Bilara and Bhopalgarh, whereas a slight decline was observed at Osian and Shergarh. In Bikaner district, the average PDI varied from 15.93 to 18.73%. The highest disease severity was recorded at Nokha (18.73%), followed by Khajuwala (18.00%), Bikaner (17.25%), Lunkaransar (16.60%) and Dungargarh (15.93%). The district average PDI was 17.30%. Disease severity increased at Nokha, Lunkaransar and Dungargarh from 2024 to 2025, whereas a slight reduction was observed at Bikaner and Khajuwala.

Phalodi showed the highest overall disease severity among the surveyed districts, with a district average PDI of 24.48%. The average PDI ranged from 21.75% at Aau to 28.25% at Bap. Bap recorded the highest location-specific average PDI in the entire survey, with values of 28.50 and 28.00% during 2024 and 2025, respectively. Setrawa recorded 25.98%, Lohawat 23.24% and Dechu 23.20%. The district therefore represented a prominent disease-prone area in the present survey. In Nagaur, disease severity was comparatively lower, with a district average PDI of 13.03%. The average PDI among the surveyed tehsils ranged from 11.75 to 14.10%, with Khinwsar recording the highest value (14.10%), followed by Nagaur (13.75%), Merta (13.53%), Jayal (12.00%) and Degana (11.75%). Thus, Nagaur exhibited the lowest overall disease severity among the surveyed districts. In Barmer, the district average PDI was 18.30%, with values ranging from 16.35% at Barmer tehsil to 20.83% at Chohtan. Chohtan recorded the highest disease severity, followed by Gadra Road (18.59%), Ramsar (17.75%), Shiv (17.98%) and Barmer (16.35%). Disease severity increased during 2025 at all five surveyed locations in Barmer. Overall, comparison between the two survey years indicated considerable location-specific variation in disease progression. Several tehsils showed an increase in PDI during 2025, whereas others exhibited either a marginal reduction or relatively stable disease severity. The results demonstrate a distinct geographical pattern of dry root rot occurrence across the surveyed cluster bean-growing regions of Rajasthan. The survey demonstrated substantial spatial variation in dry root rot severity across the cluster bean-growing regions of western Rajasthan. Phalodi recorded the highest district mean PDI (24.48%), with Bap showing the highest tehsil-level average (28.25%), whereas Nagaur recorded the lowest district mean PDI (13.03%). The relatively high disease severity in the surveyed arid regions may be associated with the warm and moisture-deficient conditions favourable for *M. phaseolina* infection and disease development (Singh *et al.*, 2024). The increase in disease severity at several locations between 2024 and 2025 may reflect the persistence of *M. phaseolina* in soil and crop residues through microsclerotia, although seasonal environmental and crop-management factors can also

influence disease expression (Kumar *et al.*, 2023) <sup>[5]</sup>. The identification of disease-prone locations emphasizes the need for targeted disease surveillance and integrated management. Recent studies have demonstrated the potential of *Trichoderma* spp. and other biological approaches for reducing *M. phaseolina*-associated diseases (Degani *et al.*, 2023; Bleckwedel *et al.*, 2024; Anupriya *et al.*, 2024) <sup>[3, 2, 1]</sup>.

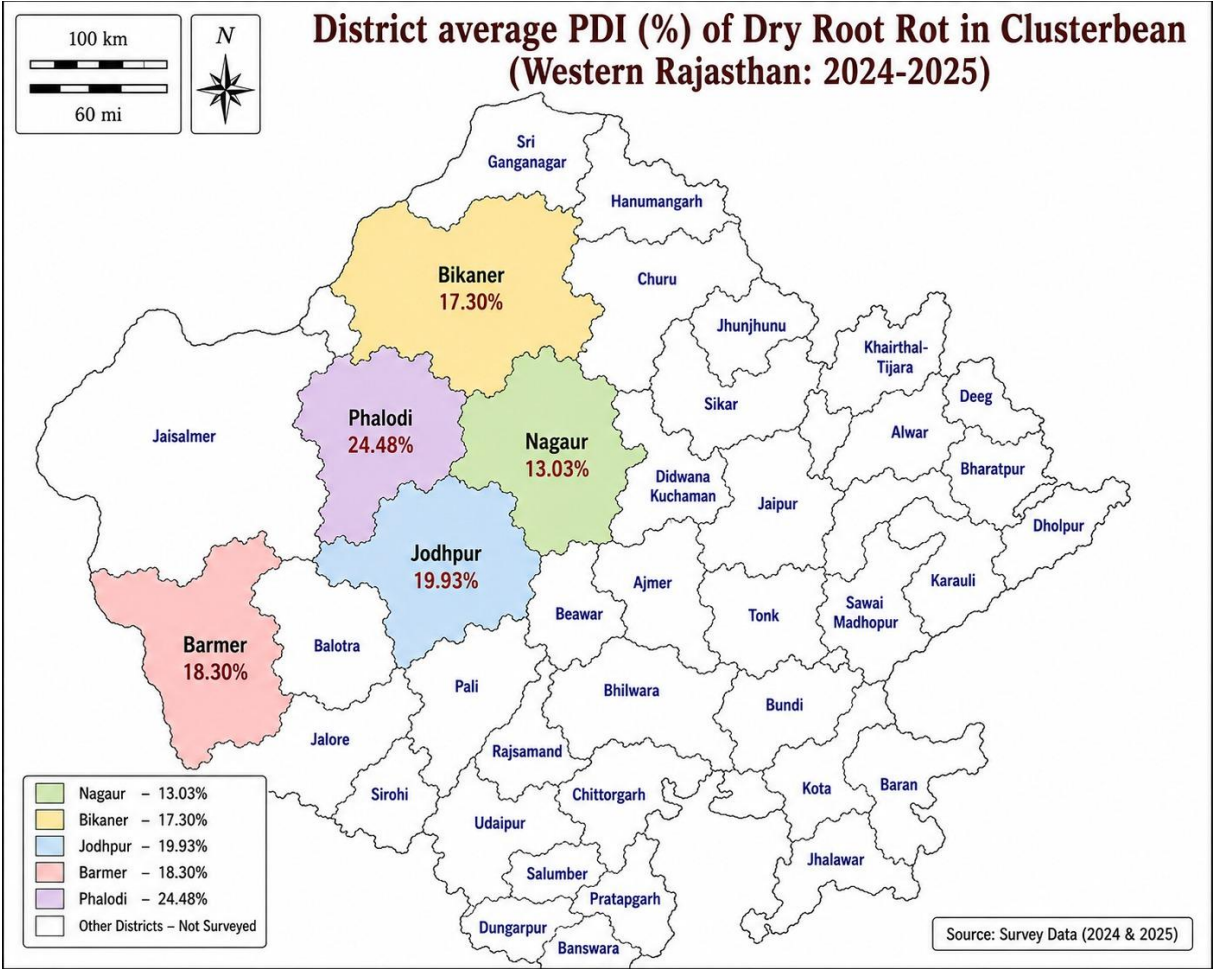


**Fig 1:** Study area map showing the surveyed districts of Rajasthan for the assessment of dry root rot in cluster bean.

**Table 1:** Survey for the incidence of dry root rot in cluster bean growing areas of Western Rajasthan during 2024 and 2025

| District | Tehsil      | Location  |            | PDI (%) |       | Average Incidence | District Average PDI |
|----------|-------------|-----------|------------|---------|-------|-------------------|----------------------|
|          |             | Latitude  | Longitude  | 2024    | 2025  |                   |                      |
| Jodhpur  | Jodhpur     | 26.2684°N | 73.0059°E  | 20.50   | 21.43 | 20.97             | 19.93                |
|          | Bilara      | 26.1792°N | 73.7056°E  | 17.85   | 18.94 | 18.40             |                      |
|          | Bhopalgarh  | 26.6498°N | 73.4956°E  | 20.05   | 20.90 | 20.48             |                      |
|          | Osian       | 26.7245°N | 72.9047°E  | 21.80   | 21.23 | 21.52             |                      |
|          | Shergarh    | 26.3284°N | 72.2963°E  | 17.98   | 18.60 | 18.29             |                      |
| Bikaner  | Nokha       | 27.5562°N | 73.4732°E  | 17.89   | 19.56 | 18.73             | 17.30                |
|          | Lunkaransar | 28.4931°N | 73.7430°E  | 15.75   | 17.45 | 16.60             |                      |
|          | Bikaner     | 28.0176°N | 73.3150°E  | 17.80   | 16.70 | 17.25             |                      |
|          | Dungargarh  | 28.0951°N | 73.9948°E  | 15.45   | 16.40 | 15.93             |                      |
|          | Khajuwala   | 28.702°N  | 72.591°E   | 18.05   | 17.95 | 18.00             |                      |
| Phalodi  | Lohawat     | 26.9850°N | 72.5900° E | 23.50   | 22.98 | 23.24             | 24.48                |
|          | Bap         | 27.3745°N | 72.3529°E  | 28.50   | 28.00 | 28.25             |                      |
|          | Setrawa     | 26.6167°N | 72.3333°E  | 25.45   | 26.50 | 25.98             |                      |
|          | Aau         | 27.1959°N | 72.8506°E  | 21.50   | 22.00 | 21.75             |                      |
|          | Dechu       | 26.7747°N | 72.3306°E  | 23.90   | 22.50 | 23.20             |                      |
| Nagaur   | Merta       | 26.6514°N | 74.0353°E  | 11.50   | 12.00 | 11.75             | 13.03                |
|          | Degana      | 26.8951°N | 74.3222°E  | 13.50   | 14.00 | 13.75             |                      |
|          | Khinwsar    | 26.974°N  | 73.406°E   | 14.25   | 13.95 | 14.10             |                      |
|          | Jayal       | 27.2218°N | 74.1834°E  | 11.50   | 12.50 | 12.00             |                      |
|          | Nagaur      | 27.2070°N | 74.7423°E  | 13.80   | 13.68 | 13.75             |                      |
| Barmer   | Ramsar      | 25.7036°N | 71.00315°E | 17.50   | 18.00 | 17.75             | 18.30                |
|          | Chohtan     | 25.4945°N | 71.0822°E  | 20.23   | 21.43 | 20.83             |                      |
|          | Shiv        | 26.1897°N | 71.244°E   | 17.50   | 18.45 | 17.98             |                      |
|          | Barmer      | 25.7531°N | 71.4180°E  | 15.60   | 17.10 | 16.35             |                      |
|          | Gadra Road  | 25.7438°N | 70.6413°E  | 18.23   | 18.95 | 18.59             |                      |

#### 4. Conclusion

This study maps the distribution and multi-year shifts of dry root rot in cluster bean across western Rajasthan. The results identify Phalodi and its sub-district Bap as critical high-risk zones, whereas Nagaur shows lower disease susceptibility. The widespread annual increase in PDI highlights the limitations of uniform disease management guidelines. Effectively managing this soil-borne pathogen will require region-specific strategies focused on increasing soil organic matter, introducing bio-priming techniques with *Trichoderma* spp., and selecting root-rot-resistant cluster bean lines.

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