



# Anthracnose in Beans: A Growing Challenge for Farmers and Its Management Strategies

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## Introduction

French bean (*Phaseolus vulgaris* L.) and Dolichos bean (*Lablab purpureus* L.) are important leguminous crops cultivated widely in India for their nutritional and economic value. However, their productivity is severely affected by anthracnose caused by *Colletotrichum* spp., one of the most destructive fungal diseases of legumes. The disease is widely prevalent in tropical and subtropical regions and causes significant yield and quality losses worldwide. The changing climatic conditions favor rapid pathogen multiplication and dissemination, thereby increasing disease severity (Law et al. 2025). In India, anthracnose outbreaks are common in regions with prolonged rainfall, high humidity, and moderate temperatures favorable for pathogen development. Increasing fungicide resistance and limited availability of resistant cultivars have further complicated disease management. Recent advances in molecular diagnostics and fungal taxonomy have improved understanding of *Colletotrichum* diversity and epidemiology, supporting the development of integrated disease management strategies.

## Economic Importance

Anthracnose is one of the most economically important diseases of beans, causing significant losses in yield, seed quality, and marketability. The pathogen infects leaves, stems, pods, and seeds, resulting in reduced pod development, seed viability, and yield losses exceeding 50% under favorable conditions. Seed discoloration, shriveling, and poor germination further reduce commercial value. Seed-borne transmission and repeated epidemics increase disease spread and production costs due to frequent fungicide applications. In India, climatic variability, monocropping, susceptible cultivars, and excessive fungicide use have further intensified disease severity, threatening sustainable pulse production.

## Causal Agents

Anthracnose of beans is caused by several species of the genus *Colletotrichum*, a taxonomically complex group of phytopathogenic fungi exhibiting high morphological and genetic variability. Species within this genus differ in virulence, host

specificity, ecological adaptation, and fungicide sensitivity, and multiple species may co-infect a single host, complicating disease diagnosis and management (Zakaria, 2025). Traditional identification based on colony characteristics and conidial morphology is often unreliable due to overlapping phenotypic traits influenced by environmental conditions (Yu et al., 2024). Therefore, molecular tools such as Internal Transcribed Spacer (ITS) sequencing and Multi-Locus Sequence Typing (MLST) are widely used for accurate species identification and phylogenetic analysis. Recent studies have identified *Colletotrichum gloeosporioides*, *C. truncatum*, and *C. siamense* as the predominant species associated with bean anthracnose.

### Symptomatology

Anthrachnose symptoms appear on all aerial parts of the plant including leaves, stems, pods, and seeds. Initial symptoms consist of small, water-soaked lesions that enlarge into dark brown to black sunken necrotic spots. Under high humidity, pink to salmon-colored conidial masses develop on infected tissues. Leaf infection causes necrosis, chlorosis, curling, and premature defoliation, while stem lesions become elongated and sunken. Pods develop dark sunken lesions that reduce market quality and act as secondary inoculum sources. Infected seeds become shriveled and discolored, resulting in poor germination and weak seedlings. Severe infection leads to extensive tissue necrosis, poor pod filling, premature senescence, and substantial yield loss.

### Epidemiology

Occurrence of the disease is strongly influenced by environmental factors such as temperature,

relative humidity, rainfall, and leaf wetness duration. Warm and humid conditions favor conidial germination, appressorium formation, host penetration, and disease establishment, while frequent rainfall and dense crop canopy enhance pathogen sporulation and dissemination. The pathogen survives in infected seeds, crop residues, and alternative host tissues, serving as primary inoculum sources, whereas secondary spread occurs through rain splash, irrigation water, contaminated implements, and human activities. Agronomic practices such as continuous monocropping, poor field sanitation, dense planting, and overhead irrigation further increase disease incidence and severity. In recent years, climatic fluctuations associated with increased humidity and erratic rainfall has intensified anthracnose outbreaks in major bean-growing regions of India. Additionally, coexistence of multiple *Colletotrichum* species exhibiting variable pathogenicity and fungicide sensitivity further complicates disease epidemiology and management.

### Integrated Disease Management

Effective management of bean anthracnose caused by *Colletotrichum* spp. requires an integrated disease management (IDM) approach involving cultural, biological, chemical, and host resistance strategies. Since the pathogen is predominantly seed-borne and survives in infected crop debris, use of certified disease-free seeds and seed treatment with carbendazim 50 WP at 2 g/kg seed, thiophanate methyl 70 WP at 2-2.5 g/kg seed, or carbendazim + mancozeb (2:1) at 3 g/kg seed effectively reduces primary inoculum and improves seedling establishment. Biological seed treatment with *Trichoderma harzianum*, *T. viride* (4-10 g/kg seed), or *Pseudomonas fluorescens* (10 g/kg seed) further

suppresses pathogen establishment. Cultural practices such as removal of infected crop residues, crop rotation for 2-3 years, deep summer plowing (20-25 cm), proper drainage, and optimum spacing (45x15 cm for French bean and 60x30 cm for Dolichos bean) help minimize inoculum buildup and canopy humidity. Drip irrigation is preferred over overhead irrigation as it reduces splash-mediated dispersal of conidia and disease spread.

Chemical fungicides continue to play a crucial role in anthracnose management, particularly under favorable environmental conditions for disease development. Preventive foliar sprays with mancozeb 75 WP at 2.5 g/litre water or chlorothalonil 75 WP at 2 g/litre applied at 10-15 day intervals effectively reduce disease initiation. Systemic fungicides belonging to triazole and strobilurin groups provide effective suppression of *Colletotrichum* spp. Sprays of propiconazole 25 EC at 1 ml/litre, hexaconazole 5 EC at 1 ml/litre, difenoconazole 25 EC at 0.5 ml/litre, azoxystrobin 23 SC at 1 ml/litre, or pyraclostrobin 20 WG at 0.75 g/litre have shown significant reduction in lesion development and disease severity. Combination fungicides such as azoxystrobin + difenoconazole at 1 ml/litre or trifloxystrobin + tebuconazole at 0.5–0.75 g/litre are highly effective under severe disease pressure.

Fungicidal sprays should be initiated immediately after the appearance of initial symptoms and repeated at 10–12 day intervals depending on disease severity and environmental conditions, using a spray volume of 500–700 litre/ha for effective canopy coverage. However, continuous and indiscriminate fungicide use may promote development of fungicide-resistant pathogen populations; therefore, fungicides

should be rotated based on their mode of action following FRAC guidelines.

Biological control agents offer environmentally sustainable alternatives for disease suppression, wherein soil application of *Trichoderma harzianum* or *T. viride* enriched FYM (2.5 kg bioagent mixed with 50 kg FYM/ha) effectively reduces soil- and residue-borne inoculum, while foliar sprays of *Pseudomonas fluorescens* at 0.5% (5 g/litre) or *Bacillus subtilis* at 5-10 ml/litre suppress pathogen growth through mycoparasitism, antibiosis, competition, and induction of systemic resistance. Development and cultivation of resistant cultivars remain the most economical and eco-friendly approach for long-term anthracnose management; therefore, continuous screening of indigenous germplasm and incorporation of resistant genotypes into breeding programs are essential. Overall, integration of disease-free seeds, crop sanitation, optimum spacing, biological agents, resistant cultivars, and judicious fungicide application provides the most effective and sustainable strategy for anthracnose management in beans.

## Conclusion

Anthracnose caused by *Colletotrichum* spp. continues to be a serious threat to French bean and Dolichos bean production due to its widespread occurrence, high destructive potential, and impact on yield and seed quality. The increasing diversity of *Colletotrichum* species, changing climatic conditions, and emergence of fungicide resistance have further complicated disease management. Adoption of an integrated disease management approach involving disease-free seeds, cultural practices, biological control agents, resistant cultivars, and judicious fungicide application is essential for

effective and sustainable disease suppression. Continuous research on pathogen diversity, molecular characterization, fungicide sensitivity, and host resistance, along with farmer awareness and improved disease surveillance, will be crucial for minimizing anthracnose incidence and ensuring sustainable pulse production in India.

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