



Collar rot of elephant foot yam (*Amorphophallus paeoniifolius*): pathogen biology, detection, and management strategies – A review

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Abstract

Tuber crops are increasingly recognized as important food security crops due to their resilience, adaptability, and contribution to household nutrition. Their cultivation is gaining popularity not only because of their growing acceptance for culinary use but also for the income they generate for smallholder and commercial farmers alike. Among tropical tuber crops, elephant foot yam (*Amorphophallus paeoniifolius*) stands out as both a food security crop and a remunerative cash crop, especially in tropical and subtropical regions. However, the productivity and sustainability of elephant foot yam cultivation are significantly threatened by several diseases, primarily those caused by fungi and viruses. Notably, collar rot, mosaic, and leaf blight are the major diseases affecting elephant foot yam, with collar rot being the most common and devastating. Collar rot, caused by the soil-borne fungal pathogen *Sclerotium rolfsii* Sacc., leads to severe losses by attacking all stages of crop growth. Infections at the early vegetative phase can be particularly destructive, often resulting in total crop failure. The persistence of the pathogen in the form of hardy sclerotia and its broad host range complicate its management. The integrated disease management (IDM) strategy, which involves interventions from pre-storage through post-planting stages, has emerged as the most effective approach for combating *S. rolfsii*. Cultural practices, chemical treatments, bio-control agents, and organic amendments must be used in synergy to mitigate disease pressure and ensure yield stability. This review provides a comprehensive overview of collar rot disease in elephant foot yam, discussing the biology of the pathogen, symptomatology, disease epidemiology, and the economic impact, while highlighting advances in management practices, including cultural, chemical, biological, and integrated strategies.

Keywords: Elephant foot yam, Collar rot, *Sclerotium rolfsii*, *Trichoderma*, Integrated Disease Management

Introduction

Tropical root and tuber crops are receiving increasing global attention in the context of climate change and food security (Taylor et al. 2018). Their high per-hectare productivity makes them valuable for enhancing food availability (Pushpalatha et al. 2022). Elephant foot yam (*Amorphophallus paeoniifolius* (Dennst.) Nicolson), a

member of the Araceae family, is an important crop in Southeast Asia (Kalloo, 2006). This crop offers excellent export potential from India, since it is not generally cultivated commercially in other countries. China and India are the major EFY producing countries in Asia. However, the crop is severely affected by collar rot, caused by *Sclerotium rolfsii* (Pravi et al. 2014), and mosaic disease, caused by *Dasheen mosaic virus* (DsMV) (Sivaprakasam

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et al. 1982; Kamala and Makesh Kumar, 2015). These diseases significantly reduce both yield and corm quality. The prevalence of *S. rolfsii* is serious in various states of India such as West Bengal, Jharkhand and Maharashtra (Khatua and Maiti, 1982; Mondal and Khatua, 2013; Lal et al. 2015; Jambure et al. 2020). Its soil-borne nature makes management especially challenging.

Various strategies have been employed to manage collar rot in elephant foot yam, including the use of chemical fungicides. Although earlier studies have recommended chemical measures against *Sclerotium* spp., there is a need to evaluate newly developed fungicides along with previously proven ones to identify the most effective fungitoxicants for disease control (Kumar et al., 2017; Veena et al. 2025). Given the environmental concerns, the risk of resistance development, and the rising cost of cultivation, greater emphasis is now placed on biological control. An integrated management approach, incorporating these considerations, has been developed and is currently being practiced. In this context, the present chapter summarizes literature on the pathogen's biology and the various management strategies explored for collar rot in elephant foot yam.

Economic significance of elephant foot yam

Elephant foot yam (EFY) is widely cultivated and consumed in several tropical and subtropical countries, including India, the Philippines, Malaysia, and Indonesia (Singh and Wadhwa, 2014). Often referred to as the “King of Tuber Crops,” EFY, is characterized by a crown-shaped canopy borne on a stout, single, upright pseudostem or petiole (Jata et al. 2019). It serves as an important food and cash crop due to its high production potential (50–80 t/ha), wide market acceptance, economic profitability, and nutritional and medicinal benefits (Lal et al. 2015; Kumar et al. 2017; Aswathy et al. 2018). The corms of EFY are a rich source of starch, dietary fiber, vitamins (notably B-complex), and essential minerals such as potassium, magnesium, and calcium. Additionally, they possess therapeutic properties and are traditionally used for managing piles, gastrointestinal disorders, and obesity (Laderman, 1983; Singh et al. 2011; Sreerag et al. 2014; Anil et al. 2023). Recent pharmacological evaluations have also indicated its potential antidiabetic and antioxidant properties.

In India, EFY is primarily cultivated in states such as West Bengal, Kerala, Karnataka, Andhra Pradesh, Maharashtra, Chhattisgarh, Bihar, Jharkhand, and Odisha (Laxminarayana, 2021). It is typically grown under upland rainfed conditions, requiring well-distributed rainfall ranging from 1000 to 1500 mm throughout the cropping period (Nedunchezhiyan and Byju, 2005). Its adaptability to marginal lands and degraded soils further enhances its role in climate-resilient agriculture and sustainable rural livelihoods.

The market value of elephant foot yam in India is worth of ₹ 26,000 million (Mamatha et al. 2024). The average wholesale market price of elephant foot yam in India is approximately ₹ 53.62 per kg. However, prices vary significantly by region. For instance, in Kerala, the price is notably higher at around ₹ 75.00 kg⁻¹, reflecting strong regional demand and limited local supply. In contrast, Karnataka markets reported a lower average of ₹ 22.00 kg⁻¹, indicating a regional surplus or lower demand (Commodity online, 2025). These regional disparities are typical in the Indian agricultural market and are influenced by local cultivation, seasonal factors, and transport logistics. Elephant foot yam is a valuable crop in India because it is nutritious, profitable for farmers, and can be used in many processed food products. It is in demand both within the country and in international markets. With growing interest in value-added products like chips, flour, and pickles, elephant foot yam offers great opportunities for income and growth in the agriculture and food industries.

The disease

Collar rot is the most widespread and devastating disease affecting EFY, which not only cause substantial yield losses, but also results in postharvest rot and a lack of quality planting material for the next season (Khatua and Maiti, 1982; Mondal and Khatua, 2013; Lal et al. 2015; Jambure et al. 2020; Veena et al. 2021, 2025). Disease development is influenced by weather factors such as temperature, relative humidity, rainfall, total rainy days, and wind speed, with disease severity showing a positive correlation to these factors. The disease is more severe during the rainy season, followed by warm, dry weather (Sahoo et al. 2016). *S. rolfsii*, which causes collar rot in elephant foot yam, is both seed and soil-borne, with soil-borne inoculum playing a more significant role in creating infection and further disease development.

Symptoms of collar rot in elephant foot yam

The pathogen invades the collar region of the plant or just beneath the soil surface, leading to water-soaked lesions on the pseudostem just above the soil (Pravi et al. 2014; Veena et al. 2023; Kamalkumaran et al. 2024). Initially, these symptoms are often undetectable, but as the disease progresses, the leaves turn yellow from the tips, gradually extending to other parts of the plant and causing complete chlorosis (John et al. 2014; Sahoo et al. 2016). A characteristic sign of the pathogen is the presence of a thick, white mycelial mat with globular, dark-brown, mustard-seed-like sclerotia surrounding the affected tissues (Pravi et al. 2014; Veena et al. 2023, 2025). Under favorable conditions, this disease can cause the sudden death of the plant due to extensive rotting (Veena et al. 2023).

In infected Elephant foot yam, the initial symptoms include brown, shrunken bark on the collar region,

which later spreads to the roots, with inner tissues showing brown to black discoloration when peeled. The roots become rotten, and the leaves display yellow to pink discoloration, followed by shedding and eventual drying (Gogoi et al. 2002). As the disease advances, yellowing becomes more severe, causing the pseudostem to collapse as the plant dries out, with the leaves wilting and showing chlorosis (Kumar, 2012).

The Pathogen: *Sclerotium rolfsii* Sacc.

Collar rot in elephant foot yam is primarily caused by the soil-borne fungus *Sclerotium rolfsii* Sacc. (Khatua and Maiti, 1982; Mondal and Khatua, 2013; Lal et al. 2015; Jambure et al. 2020; Veena et al. 2025). This pathogen is known for its polyphagous, ubiquitous, and highly destructive nature, affecting a wide range of crops across tropical and subtropical regions (Kumar et al. 2017). It thrives particularly well in warm and moist environments, with optimal growth and sclerotial formation observed at 27–30°C (Veena et al. 2023).

The fungus was first described by Rolfs (1892) as the causal agent of tomato blight in Florida and later named *S. rolfsii* by Saccardo in 1911. In India, Shaw and Ajrekar (1915) initially isolated *Rhizoctonia destruens* Tassi from rotting potatoes, but later studies confirmed the pathogen to be *S. rolfsii* (Raj et al. 2009; Kamalkumaran et al. 2024). *Sclerotium rolfsii* has an exceptionally wide host range, infecting over 500 plant species across 100 families, including important crops like groundnut, green bean, lima bean, onion, garden bean, potato, sweet potato, and watermelon (Aycok, 1959; John et al. 2015). In crops, it causes a variety of symptoms such as stem rot, collar rot, seed rot, southern blight, pseudostem rot, and wilt (Arunasri et al. 2011; Chidanand and Sumangala, 2020), leading to substantial yield losses-up to 25% seedling mortality in groundnut and 30% crop loss in tomato (Kumar et al. 2017).

Morphology and cultural characteristics of the pathogen

On media like potato dextrose agar (PDA), *S. rolfsii* produces fast-growing, white, cottony to compact colonies with fluffy mycelia. The hyphae are initially hyaline, thin-walled, and sparsely septate (Kulkarni and Ahmed, 1947; Sharma et al. 2002). Mature mycelia initiate the formation of sclerotia, small, round, hard structures (0.5–2.7 mm in diameter) that begin as white tufts and gradually darken to off-white, light brown, and finally dark brown (Veena et al. 2023; Meena et al. 2023). Sclerotial formation typically occurs 4–15 days after inoculation (Pravi et al. 2014). The number and size of sclerotia vary significantly among isolates (Ansari and Agnihotri, 2000), with 5 to 30 sclerotia per cm² reported.

Detection and diagnosis of the pathogen

Timely and accurate detection of *S. rolfsii* is crucial for disease risk assessment, allowing for timely preventative actions and preventing the long-distance transmission of the pathogen through infected planting material. Historically, pathogen identification relied on culture-based morphological characteristics and biochemical approaches. However, these methods are often laborious, time-consuming, and require extensive taxonomic knowledge, complicating timely disease management decisions (Pravi et al. 2015). Molecular approaches, particularly PCR-based methods and DNA hybridization techniques, have emerged as powerful tools for rapid, sensitive, and accurate detection of *S. rolfsii*. These molecular assays enable the detection of *S. rolfsii* in naturally infected soil and planting materials, including symptomless tubers. PCR-based detection of *S. rolfsii* is based on amplifying specific regions of its ribosomal DNA (rDNA), particularly the Internal Transcribed Spacer (ITS) region, which contains both conserved and variable sequences and has a high gene copy number for sensitive detection. A species-specific PCR primer pair (SCR-F/SCR-R), designed based on the internal transcribed spacer (ITS) region of rDNA, could amplify a 540-bp product exclusively from *S. rolfsii* DNA, without amplifying DNA from EFY or other common plant pathogenic fungi (Jeeva et al. 2010; Pravi et al. 2015). This specific PCR assay can detect as little as 6 pg/ml of pure fungal DNA (Jeeva et al. 2010). The method could detect *S. rolfsii* in symptomless tuber samples as early as 12 hours post-inoculation, which is vital for preventing disease progression and spread.

Disease epidemiology and predisposing factors

The primary inoculum source in the field is the long-surviving sclerotia, which remain viable in soil for extended periods (Veena et al. 2023). The pathogen prefers low soil moisture for survival, showing maximum saprophytic activity at 20-40% soil moisture, which declines at 60-70% (Kumar et al. 2017). Environmental conditions that favor disease development include warm, humid climates, heavy rainfall, poor drainage, and mechanical injuries from intercultural operations or insect attacks (Veena et al. 2025; Kumari et al. 2013).

The disease typically appears during the later growth stages, although infections can occur at any stage. The risk intensifies in heavy clay soils with water stagnation (Pravi et al. 2015). Repeated cultivation of *Amorphophallus* in the same field has also been reported to increase disease incidence (Jeeva et al. 2020). Additional contributing factors include high organic matter, damage by implements and fertilizers, and injuries caused by insect pests. Injuries to collar region during intercultural operations and poor drainage increase the susceptibility (Misra and Nedunchezhiyan, 2008).

Management strategies

Effective management of collar rot in elephant foot yam is particularly challenging due to the polyphagous nature of *S. rolfssii* and the long-term viability of its sclerotia in soil (Kamalkumaran et al. 2024). As the pathogen cannot be effectively controlled through a single method, an integrated disease management (IDM) approach is essential (Veena et al. 2025).

Cultural and physical measures

Cultural and physical practices are critical in preventing disease onset and minimizing inoculum build-up in the soil (Veena et al. 2023). Recommended practices include, use of disease-free corms for planting to avoid introducing the pathogen into new fields, removal and destruction of infected plants to prevent further spread, improved field drainage to avoid water stagnation, which creates favorable conditions for the pathogen, deep summer ploughing to expose or bury sclerotia, thus reducing their viability, mulching with paddy straw or organic wastes helps maintain soil health and suppresses sclerotia germination. Crop rotation with non-host crops (e.g., cereals or legumes) has been shown to reduce disease incidence. Avoidance of mechanical injuries during intercultural operations, especially to the collar region, is vital since wounds serve as primary entry points for infection (Veena et al. 2025). These preventive strategies form the first line of defense and are especially important in areas where the pathogen is endemic.

Host resistance

Although the development of resistant cultivars is considered one of the most sustainable approaches to disease management, commercially grown elephant foot yam varieties remain largely susceptible to *Sclerotium rolfssii* (Veena et al. 2023, 2025). Significant progress has been made in identifying resistant lines through field screening. Jambure et al. (2020) evaluated sixteen genotypes and reported that EFY DPL-2, EFY DPL-3, and BCA-4 exhibited notable resistance to collar rot up to 120 days after planting. To ensure long-term protection, it is imperative to initiate breeding programs aimed at integrating resistance traits into high-yielding, farmer-preferred cultivars. The application of modern molecular tools, including marker-assisted selection (MAS) and genome-wide association studies (GWAS), has shown promise in accelerating resistance breeding in tuber crops and could be effectively leveraged for elephant foot yam improvement.

Chemical measures

Collar rot symptoms typically manifest 4-5 months after planting, with a sudden surge in incidence often observed following intercultural operations. Therefore, timely fungicide drenching or application of bio-

agents immediately after such operations is crucial for effective disease suppression (Veena et al. 2025). The use of chemical fungicides is being increasingly restricted due to environmental and health concerns. However, certain fungicides have proven effective under field and laboratory conditions. Pre-plant treatment of corms is an essential step in minimizing primary inoculum. Corms treated three days before planting with a combination fungicide, mancozeb + carbendazim (like Sprint, Saaf) @0.2% has been found effective. Additionally, dipping corms in Carbendazim 12% + Mancozeb 63% WP for 10 minutes before storage significantly reduces the risk of infection during early crop stages (Veena et al. 2023, 2025). Post-intercultural drenching with mancozeb + carbendazim @0.2% is advised for disease suppression. Infected plants should be carefully removed, followed by an additional protective drenching of nearby plants to contain the spread of the pathogen (Veena et al. 2023, 2025).

Field experiments have demonstrated the effectiveness of combined corm and soil treatments. A corm dip + soil drench with hexaconazole @ 0.1% + 0.1% resulted in minimum disease severity (15.16%), maximum disease control (73.29%), and highest corm yield (59.5 t/ha) (Lal et al. 2015). In another study conducted by Gogoi et al. (2002), the soil drenching with Captan recorded the lowest disease incidence (12.9%). Notably, corm + soil treatment with Captan performed comparably to corm + soil treatment with *Trichoderma harzianum*. However, combining *T. harzianum* with Captan led to inhibition of the bioagent, suggesting the need for caution in mixed applications. In all treatments, the population density of *S. rolfssii* was significantly reduced compared to the untreated control. Eight fungicides (Indofil M-45, Bavistin, Blitox, Vitavax Power, Kavach, Curzet, Krilaxyl MZ) used in a study reduced sclerotial germination. Vitavax Power (Carboxin 37.5% + Thiram 37.5% WP) totally inhibited sclerotial germination. Kavach (Chlorothalonil 75%) and Krilaxyl MZ (Metalaxyl 8% + Mancozeb 64%) reduced germination upto 95% (Mondal and Khatua, 2013).

Difenoconazole (Score) and hexaconazole (Contaf) demonstrated maximum mycelial growth inhibition of *S. rolfssii* even at low concentrations (3.125 ppm) in laboratory assays. Combination fungicides such as Carbendazim 12% + Mancozeb 63% and Metalaxyl + Mancozeb achieved complete inhibition at higher concentrations (1600 ppm). Conversely, Carbendazim 50% WP and Copper oxychloride were found to be less effective or nearly ineffective against *S. rolfssii* under similar test conditions (Prakash et al. 2023).

Bio-intensive management options

Biological control offers a safe and environmentally sustainable strategy for managing collar rot in elephant

foot yam (EFY), particularly given the challenges posed by pesticide resistance and the regulatory restrictions on chemical fungicides. The integration of beneficial microorganisms, especially *Trichoderma* spp. and *Bacillus* spp., has shown promise in reducing disease incidence caused by *Sclerotium rolfsii*. Biocontrol agents (BCAs) function by suppressing harmful pathogens through antagonism, competition, antibiosis, or by inducing systemic resistance in the host plant. Their application not only mitigates disease pressure but also contributes to plant growth and nutrient uptake, offering a holistic approach to crop management (Widmer, 2019; Besset-Manzoni, 2019; Harman, 2000). With the shift towards sustainable and organic farming systems, biological options are gaining relevance as alternatives to synthetic pesticides (Cook, 1985; Veena et al. 2013). The rhizosphere, being rich in microbial diversity and root exudates, offers an ideal environment for deploying such agents (Aswathy et al. 2018). The most frequently studied and applied biocontrol organisms belong to the genera *Trichoderma*, *Bacillus*, *Pseudomonas*, and *Rhizobium* (Ongena and Jacques, 2008; Lorito et al. 2010).

Trichoderma is among the most widely used fungal BCAs owing to its versatility and multiple mechanisms of action. It thrives in a range of habitats such as soil, air, and plant surfaces and is considered safe, cost-effective, and environmentally benign (Haouhach et al. 2020; Zhang et al. 2021; Wang et al. 2022; Yao et al. 2023). The key mechanisms involved with the biocontrol potential of *Trichoderma* are mycoparasitism (Linnet et al. 2018), antibiosis related with the production of extracellular enzymes (e.g., chitinases, β -1, 3-glucanases) and antibiotics to inhibit pathogens (Vinod et al. 2024), rapid colonization and competition for nutrients and space (Baby et al. 2022), enhancement of root growth and nutrient assimilation (Aswathy et al. 2018) and induced Systemic Resistance (ISR) (Vinod et al. 2024). Several *Trichoderma* isolates showed strong antagonistic activity against *S. rolfsii*, with *in vitro* inhibition ranging from 66.11% to 100% in dual culture assays (Linnet et al. 2018). In pot trials, *T. harzianum* (Tr9) significantly reduced collar rot incidence by 85.33% (John et al. 2015).

Bacillus species are widely recognized as plant growth-promoting rhizobacteria (PGPR) and effective biocontrol agents. Six species of bacillus such as *B. siamensis*, *B. amyloliquefaciens*, *B. pumilus*, *B. halotolerans*, *B. subtilis*, and *B. altitudinis* were isolated from tuber crop rhizospheres and demonstrated strong antagonistic activity against *S. rolfsii* (Aswathy et al., 2018). *B. amyloliquefaciens* and *B. subtilis* were highlighted as highly effective *in vitro*, with potent antifungal properties and growth-promoting capabilities. However, despite high lab efficacy, the field performance of *B. amyloliquefaciens* was found to be inconsistent, possibly due to environmental factors

or microbial competition in the rhizosphere (Veena et al. 2025). *Streptomyces* spp. and *Pseudomonas fluorescens* also demonstrated antagonistic potential by inhibiting mycelial growth and reducing sclerotial populations of *S. rolfsii* (Kumar et al. 2017).

Bio-intensive management using *Trichoderma* and *Bacillus* species presents a viable, eco-friendly alternative to chemical fungicides for collar rot control in elephant foot yam. However, successful implementation depends on selecting locally adapted strains, ensuring compatibility with existing agro-inputs, and optimizing field application methods. Most *Trichoderma* isolates grow optimally between 25-30°C, but certain strains can tolerate temperatures up to 40°C, making them particularly suitable for tropical climates like that of EFY growing regions (Vinod et al. 2024). *T. asperellum* is compatible with commonly used fungicides such as copper oxychloride and various mancozeb combinations, including cymoxanil 8% + mancozeb 64%, and mefenoxam 4% + mancozeb 64%. However, it is incompatible with fungicides such as carbendazim 50%, hexaconazole 5%, difenoconazole 25%, and metalaxyl-M 3.3% + chlorothalonil 33.1%, which may inhibit its viability (Baby et al. 2022). The combined use of *T. harzianum* and *B. subtilis*, with or without 0.2% captan, was evaluated against collar rot. The results indicated satisfactory disease suppression, though the compatibility between BCAs and fungicides needs to be assessed carefully to avoid mutual antagonism (Gogoi et al. 2002).

Incorporation of organic amendments

The excessive and indiscriminate use of chemical pesticides in agriculture has raised significant concerns regarding their impact on human health, environmental sustainability, and the development of resistant strains of pathogens (Linnet et al. 2018; Aswathy et al. 2018). These limitations have driven a growing interest in alternative disease management strategies, particularly in organic and low-input farming systems. Organic amendments, such as vermicompost and vermiwash, offer dual benefits: enhancing soil health and suppressing soil-borne pathogens. Their application alters the soil physicochemical properties and microbial community structure, which can create an unfavorable environment for pathogens like *S. rolfsii* (Chen et al. 1987; Song et al. 2015). In addition to their direct disease-suppressive properties, organic amendments facilitate the establishment and proliferation of introduced beneficial microbes, including biocontrol agents like *Trichoderma* spp. (Chidanand and Sumangala, 2020). This synergistic interaction enhances the effectiveness of integrated disease management strategies. The beneficial action of vermicompost and vermiwash are improving soil fertility and structure, enriching the microbial population and activity in the rhizosphere, induction of systemic

resistance in plants and suppression of pathogen activity through competitive exclusion and antibiosis.

A significant reduction in collar rot incidence and a yield increase of up to 70% was observed in elephant foot yam with the combined use of vermicompost and vermiwash (Veena et al. 2011, 2013). The use of *Trichoderma* enriched organic inputs such as farmyard manure (FYM) and vermicompost has gained prominence in sustainable disease management. Field application of *Trichoderma*-enriched FYM (2.0–2.5 kg per pit at planting) or vermicompost (150 g per plant to the collar region) immediately after intercultural operations significantly reduced disease incidence. These enriched inputs not only suppress *S. rolfsii* but also improve corm vigor and overall plant health, making them an essential component of integrated collar rot management strategies (Veena et al., 2023).

Integrated disease management (IDM)

An integrated approach is essential for the effective management of collar rot in elephant foot yam (EFY). Such an approach reduces environmental risks, delays the development of resistant pathogen strains, and lowers cultivation costs (Kumar et al. 2017). While biological control agents are promising, their effectiveness is often enhanced when combined with other compatible methods, forming the basis of a robust IDM strategy (Sahni et al. 2008).

Biological control agents such as *T. harzianum* and *B. subtilis*, either alone or in combination with captan (0.2%), have shown significant efficacy in suppressing *S. rolfsii*, the causal agent of collar rot (Gogoi et al. 2002; Veena et al. 2025). The combined use of *Trichoderma* with neem cake has also been effective in reducing disease incidence (Misra and Nedunchezhiyan, 2008). Similarly, the application of *Trichoderma* enriched farmyard manure (FYM) or vermicompost at planting has been found to suppress disease effectively under field conditions (Lal et al. 2015). The enrichment of organic amendments such as FYM or vermicompost with beneficial microorganisms has proven to be a successful strategy. Studies have shown that this combination can significantly reduce collar rot incidence and improve corm yield in EFY. For instance, field trials demonstrated that the combined application of *Trichoderma* and vermicompost reduced disease severity by 73.33% to 100%, compared to untreated controls (Adi et al. 2021).

A validated integrated management package, tested over several years across five Indian states, involved pre-storage treatment of EFY corms by dipping them in a combination fungicide (Carbendazim 12% + Mancozeb 63% WP) for 10 minutes, followed by treatment with cow dung slurry enriched with *T. asperellum* (5 g/kg corm) three days before planting. In the field, two drenchings with the same fungicide after intercultural

operations were also applied. This integrated approach resulted in the lowest disease incidence (3.19%) and highest yield (36.70 t/ha), highlighting the importance of pre-storage treatments in reducing disease incidence by 8.0–18.0% and improving yields by 18.0–24.0% (Veena et al. 2025). Similarly, soil drenching with Vitavax (0.2%) combined with FYM enriched with *T. harzianum* reduced disease severity to 17.70%, achieved 68.13% disease control, and yielded 58.24 t/ha of corms. A combination of seed treatment with Hexaconazole 5EC (0.1%) and soil application of enriched FYM provided 64.10% disease control and yielded 59.45 t/ha. These treatments were statistically at par and superior to other treatments, which provided 35.83–53.13% disease control (Lal et al. 2015).

Cultural practices such as intercropping have also contributed to disease suppression. Intercropping the crop with turmeric or ginger in a 1:2 ratio significantly reduced collar rot severity. The disease severity was 14.99% in the sole EFY crop, whereas it decreased to 7.66% and 8.16% in the EFY + turmeric and EFY + ginger systems, respectively. This reduction is likely due to the suppressive effects of intercrop root exudates on the pathogen population in the rhizosphere (Lal et al. 2015). Botanical amendments like neem and karanj cake have also demonstrated promising results. In a two-season field trial, the application of neem and karanj cake @ 5 q/ha each provided 75.33% disease control, outperforming FYM alone, which resulted in 67.67% disease control (Lal et al., 2015). Plaster of Paris of commercial grade and some fungicides were evaluated against *S. rolfsii* and it showed strong adverse effect on mycelial growth and survival of sclerotia under field condition without producing phytotoxicity (Mondal and Khatua, 2013). These approaches highlight the potential of combining multiple organic inputs-botanicals, composts, and microbial inoculants for enhanced disease suppression and yield improvement.

Collar rot caused by *S. rolfsii* remains a major constraint in elephant foot yam cultivation, especially under warm and humid conditions conducive to pathogen proliferation (Anahosur, 2001). Future research on management of this pathogen should focus on developing resistant varieties, since all the varieties are susceptible to the pathogen. Advances in molecular biology and genomics offer scope for identifying resistance genes and understanding the host-pathogen interaction at the transcriptomic and proteomic levels (Thangavel et al. 2022). The exploration of the plant-associated microbiome, particularly beneficial endophytes and rhizosphere microbes, holds promise for developing sustainable microbial consortia for disease suppression (Raaijmakers et al. 2009). Biopriming of planting material with selected bioagents, such as *Trichoderma* spp. and *Bacillus* spp., could enhance plant immunity and improve establishment in pathogen-

infested soils (Meena et al. 2017). Furthermore, research into formulation technology will aid in commercializing effective biocontrol products for collar rot management (Singh et al. 2016). Climate-resilient management practices, coupled with decision support tools using AI and IoT for disease forecasting, represent promising frontiers in disease prediction and precision application of biocontrol agents (Prasad et al. 2021). Integrating these multidisciplinary approaches will significantly enhance the long-term control of collar rot and ensure the sustainability of elephant foot yam cultivation.

Conclusion

Elephant foot yam holds a prominent position among tropical tuber crops due to its high productivity and wide range of uses. However, pathogens affecting EFY in the field often persist during storage, leading to recurring issues with corm health. Therefore, effective management of the pathogen at all stages of crop development is essential. *S. rolfsii*, a destructive soil-borne fungal pathogen, is the primary causal agent of collar rot in elephant foot yam. A comprehensive understanding of *S. rolfsii* and its interaction with the host plant, supported by advancements in molecular diagnostics, has facilitated the development of more targeted and efficient management strategies. An integrated approach combining strategic fungicide application, through pre-storage corm dipping and post-intercultural drenching with Carbendazim + Mancozeb with bio-priming using *Trichoderma asperellum*-enriched cow dung slurry has demonstrated consistent effectiveness in reducing disease incidence and enhancing yield across diverse agro-climatic conditions. Furthermore, the use of organic amendments such as vermicompost, vermiwash, and botanical cakes, particularly when enriched with biocontrol agents like *Trichoderma* spp., offers an environmentally sustainable alternative to conventional fungicides. These integrated disease management strategies not only suppress pathogen populations but also enhance soil health and plant vigor, making them critical components in organic and sustainable agriculture systems.

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