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Managing Diseases and Pests Threatening Elephant Foot Yam, the King of Tubers

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Tuber crops are globally acknowledged for providing dietary carbohydrates, proteins, and vitamins. Following cereals, root and tuber crops (including cassava, sweet potato, yams, and aroids) constitute the second largest group of cultivated species in tropical regions. These crops are crucial for both nutritional sustenance and economic stability in developing countries. Among tubers, elephant foot yam (*Amorphophallus paeoniifolius* (Dennst.)), popularly referred to as the "King of Tubers," is not only known for its culinary benefits but also has a lot of nutritive and medicinal properties. It belongs to the family Araceae. It requires an annual rainfall of 1000 to 1500mm and thrives in well-drained sandy loam soil. The temperature range for the crop is 25 to 35 °C. The crop is grown in India, Sri Lanka, Bangladesh, Southeast Asian countries Africa, etc. Among Indian states - Andhra Pradesh, West Bengal, Gujarat, Kerala, Tamil Nadu, Maharashtra, Uttar Pradesh, and Jharkhand are home to its cultivation. Its modified stem, or "corm," is boiled, baked, and fried before being eaten as a vegetable. They are also used to make pickles, a delicacy. Corms are rich in minerals and vitamins. Numerous traditional remedies for piles, asthma, dysentery, and other stomach issues are also made with corms. It's known as "food medicine."The crop is grown as a multitier crop with coconut or banana and as an intercrop with turmeric and it could give a massive yield of 50–80 t/ha (Utomo *et al.*, 2021).

Despite the various benefits this plant could offer, it is also prone to numerous diseases, and pests which may result in significant yield loss. The most important diseases and pests impacting elephant foot yam cultivation are being covered in this article.

I) DISEASES OF ELEPHANT FOOT YAM

1. Fungal diseases

A) Collar rot

The disease is caused by a soil-borne fungus *Sclerotium rolfsii.* The pathogen has wide host range of more than 500 species including vegetables and cereals. The disease is more severe in the rainy season followed by warm dry weather (Jambure *et al.*, 2020).

The organism is omnivorous, omnipresent, and polyphagous. Collar rot can cause a yield loss of 20 to 100% (Kumar *et al.*, 2023). Due to the ideal environmental circumstances for existence, this fungus grows most quickly in tropical and subtropical regions (Veena *et al.*, 2019). Water logging, poor drainage, heavy soils, high organic matter, and mechanical injury at the collar region favour the disease incidence. 2-3 months old plants are most susceptible to the disease.

Symptoms: When the pathogen penetrates the collar region, water-soaked lesions are observed on the pseudostem that are seen slightly above the collar region. Leaves from the tip starts yellowing and gradually spread to other areas which lead to a total chlorosis of the

plant. Eventually, as the collar region decays, the pseudostem shrinks and the plant collapses. All around the affected tissues, a thick, white mycelial mat of the pathogen is seen with globular, dark brown structures that resemble mustard seeds, known as sclerotia. Upon close inspection, one may also see extensive fissures in the roots as well as the roots being torn apart. The hyphae developed upward on the surface of the diseased plant and were strewn throughout the infected stem, on the surrounding soil surface, and within and outside of it. They were covered in a cottony, white mass of mycelium. Following tissue maceration, there is a disruption in water transport, which causes leaves to wilt and turn yellow (Billah *et al*, 2017).

Management:

1. Application of *Trichoderma harzianum* incorporated with FYM @ 36 t/ha (3 kg/pit) in pits at the time of planting
2. FYM, neem cake mixture (10:1) inoculated with *Trichoderma harzianum* @ 2.5 kg/t of FYM neem cake mixture (KAU POP 2024),
3. Use of disease-free planting material and treating seed corm with a slurry of cow dung, neem cake, and *Trichoderma* sp(@20g/kg seed corm)
4. Remove infected plant materials and adopt proper field sanitation
5. Provide proper drainage conditions
6. Application of organic amendments like neem cake and green leafy manures recommended

Collar rot

B) Post-harvest rot

Post-harvest rot in the yam is caused by 14 fungus and a bacteria *Erwinia carotovora*. Post-harvest rot develops from the soil and manifests itself when corms are stored following harvest. An 80% yield loss is caused by this disease (Baleba *et al*., 2024). The shelf life of corms is limited by post-harvest rot, and crop loss is contingent upon both their moisture content and metabolic rate. They are more vulnerable to infection because of the mechanical damage sustained during harvest and transportation.

Symptom: In most cases, no symptoms will be apparent. Crops with infection exhibit discoloration, rotting, and softening of the tissue. Reduce the crop's nutritional value and change in taste and flavour.

Sclerotium rot caused by the *Sclerotium rolfsii* is the most common storage disease in EFY. This fungus slowly infects the entire tuber causing total loss. ·

Black rot or *Botryodiplodia* rot caused by *Botrydiplodia theobromae* is another serious disease of EFY. Initially, its infection is confined to the tuber surface, but over a period of time, the pathogen penetrates deep inside the tuber leading to rotting and blackening of tubers in patches. ·

***Phytopthora* rot** caused by *Phytopthora colocasiae* is another severe disease of EFY but the damage is comparatively less than *Sclerotum* or *Botryodiplodia* rot. ·

***Fusarium* rot** (*Fusarium* spp.) and ***Rhizopus* rot** (*Rhizopus* spp.) also cause some damage during tuber in storage. ·

***Erwinia* rot**, caused by the bacterial pathogen, *Erwinia carotovora* has been found to cause serious damage to tubers when they are stored at higher temperatures (< 40^{o}C) with poor

ventilation. Tubers infected by *E. carotovora* turn watery and give a foul smell causing 80-100% tuber loss.

Management: To avoid storage rot, the tubers should be free from mechanical injury and pre-harvest infection. Infected tissues need to be removed with a sharp knife in such a way that no infected portion is left on the tubers. While removing the infected portion, even the healthy tissues adjourning the infected portions should be removed. The cut tubers should be immediately treated with mancozeb @ 0.2% and stored in a single layer before planting. Storage of tubers of EFY in a cool and ventilated place followed by periodic removal of damaged tubers has been found effective in the prevention of tuber rot. Pre-harvest application of carbendazim (0.1%) + streptomycin (150 ppm) at 30 days before harvest and treatment of the corms after the harvest with copper oxychloride (0.3%) + streptomycin (100 ppm) was found effective in checking the storage rot. Storing the harvested tubers in the Zero Energy Cool Chamber in heaps was found to be effective in reducing weight loss and storage rots.

Post-harvest rot

C) Leaf blight

Phytophthora colocasiae is the causal organism of this disease.

Symptoms: A small, black, roundish spot on the leaf is the initial symptom. The entire leaf dies as the spot enlarges, coalesces and becomes circular. Yellow liquid oozes from the affected regions. On unharmed corms, grey brown to dark blue lesions appear after harvest. The lesions grow quickly and coalesces. Usually, it is difficult to distinguish between diseased and undiseased. Affected corms are almost completely decayed within a few days of harvest in wet conditions.

Management: Cultural and agronomic practices such as rouging off severely infected plants, draining excess soil moisture, and application of organic amendments like neem cake , using healthy and disease free planting material can bring down the infecting in the field . Chemical fungicide like Mancozeb (2g/l) treatments at seven days interval resulted in significant disease control and higher yields.

Leaf blight

D) Anthracnose

This disease is caused by *Colletotrichum siamense*, which is a ubiquitous pathogen infecting a number of other species. The pathogen can spread through various means such as soil, air, or tubers or seed corms (Veena *et al.*, 2021).

Symptoms: Tan to dark brown spots on leaves that range in shape from round to crescent. Often, the spots combine to form large areas that wreak havoc on the leaves and eventually the entire foliage. On leaves, there were brown lesions with dark spore-producing structures.

Later, the lesions became larger and combined to destroy the entire foliage. Because of the scorch-like look of the withered leaves and stem, the disease is also known as scorch sickness.

Anthracnose

Management: Ensure that planting corms are pathogen free. Cultural control measures such as removal of weeds that may be the alternate hots of pathogen, planting barrier crops of maize, avoiding damage to tubers at harvest and ploughing in plant residues immediately after harvest help to reduce the spread of infection. Spraying Mancozeb @2g/l is also recommended as a chemical control measure.

2. Viral diseases

A) Amorphophallus Mosaic Disease

The disease is caused by Dasheen mosaic virus (DsMv) belong to Potyvirus group (Jeeva *et al.*, 2023). Planting material is the main source of disease spread. The disease is also disseminated secondarily through non-persistent insect vectors *viz*., *Myzus persicae, Aphis gossypii*, and *Aphis craccivora*.

Mosaicosaic

Symptoms: Mosaic leaves, mottling, puckering and shoe stringing of the leaf lamina, increased lateral bud proliferation, bud separation from mother corms, and poor root growth. Compared to healthy plants, corms generated by mottled plants are significantly smaller.

Management: Since the crop is propagated vegetatively, corms from healthy plants should be used for seed purpose. Secondary spread can be reduced by rouging diseased plants and applying suitable systemic insecticides like imidacloprid @ 2-4 ml/l.

II) PESTS OF ELEPHANT FOOT YAM

Amorphophallus is affected by many pests such as aphids, spider mites, thrips, caterpillars, etc. out of which the major ones are mealy bugs.

A) Mealybug

In India, mealybug (*Rhizoecus amorphophalli*) is reported to be one of the major pests which pose a serious threat to the cultivation of elephant foot yams in the field as well as in storage. The emergence and infestation of mealybugs are primarily dependent on the prevailing climatic condition, whereas the duration of the infestation determines the severity of damage. The field infestation ranges from 6 to 45% (Palaniswami and Peter, 2008). For seed purposes, elephant foot yam is often harvested in the dry season as it reaches full maturity. During this time, the mealy bugs infect corms by entering through holes and fissures in the soil that were created after the drying of pseudostem. When the corms are left in the soil throughout the dry season for an extended period of time, the infestation will get worse.

Mealybugs prevail in the warm, humid environments. Its infestation is severe when the temperature rises beyond 30°C, and it gets worse as the humidity and temperature rises up.

The high humidity and warmth created by poor ventilation during storage may cause the entire lot of corms succumb to infestation.

Symptoms: Dirty white powdery mealy particles of mealybugs were seen covering the corm surface. Corms with severe infestations shrink due to desapping by adults and crawlers, which diminishes their quality and thus make them less marketable. This has a direct impact on sprouting and as well as it affects the yield negatively.

Management: The mealy bugs can be removed physically by rubbing the tubers with soft brush or gunny bag pieces or coir pith dipped in a suitable contact insecticide solution. For long term storage, the tubers are required to be treated with the Mancozeb @ 0.2% before storage. Use pest-free seed corms. Cowdung slurry (2 kg/l) treatment is very effective against mealybug. If cowdung is not available for large-scale seed corm treatment, one can choose chemical seed corm treatment, which involves the application of 1:1 combination of neem oil: soap mixture @ (10:4) ml/l: Imidacloprid 17.8 SL (0.6 ml/l) before storage (Nedunchezhiyan *et al.*, 2023).

Mealy bug infestation

Conclusion

Several studies on amorphophallus revealed that it is a highly remunerative, nutritive, and medicinal crop that may potentially act as a best partner as a source of food security in climate resilient agriculture. Unfortunately, it is affected byvarious diseases and pests. But these can be easily mitigated by early and accurate diagnosis,and by adopting a combination of various cultural, biological and chemical methods of plant disease and pest management techniques in the field as well as in the storage.

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