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Soft rot disease management in ginger (Zingiber officinale) for enhancing its marketing value: A review

Akshit Kukreti

Himmotthan Society, Dehradun, Uttarakhand

Introduction

Ginger (*Zingiber officinale* Roscoe) is a perennial monocot herb from the Zingiberaceae family, which comprises 47 genera and 1,400 species (Hogarth, 2000). Other notable spices within this family include turmeric (*Curcuma longa*), cardamom (*Elettaria* sp.), mioga (*Zingiber mioga*), and galangal (*Alpinia galanga*). While the entire family, including ginger, is thought to have originated in Asia or specifically India, the exact origin remains uncertain (Singletary, 2010;). Ginger is now cultivated globally in subtropical and tropical regions, where it plays a crucial role in agricultural economies (Kavitha and Thomas, 2008). India, China, and Indonesia are among the primary producers of fresh ginger rhizomes, though its flavor and pungency can vary based on several factors, including soil type, season, climate, cultivation practices, and postharvest processes (Singletary, 2010; Le *et al.*, 2014). Despite the wide cultivation of ginger, genetic diversity within *Z. officinale* is considered limited.

In India, ginger is cultivated across nearly all states, including Uttarakhand, where it is primarily grown by small and marginal farmers who rely on it for their livelihood. It is cultivated in nearly every district of Uttarakhand. Despite being a high-value cash crop, ginger's productivity remains low, likely due to the continuous use of degenerated seed rhizomes, which are highly susceptible to various diseases, insect pests, and nematodes. The major ginger producing districts are Tehri Garhwal, Pauri Garhwal, Dehradun, Rudraprayag, Uttarakashi and Haridwar in Garhwal region while Nanital, Almora, Udham Singh Nagar, Bageshwar, Pithoragarh, Champawat and Chamoli in Kumaon region (Avinash *et al.*, 2018). The usable part of the plant is the underground rhizome, which can be consumed fresh or processed into various forms such as dried, powdered, salted, paste, or extracted as ginger oil or oleoresin (Kizhakkayil and Sasikumar, 2011).

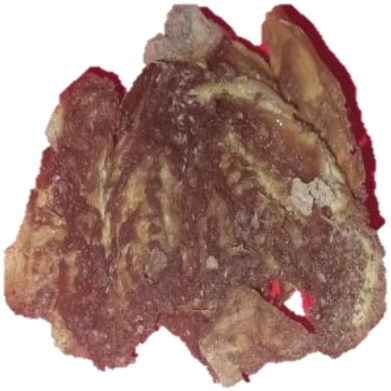
Ginger rhizomes are rich in carbohydrates, proteins, fats, fiber, water, and essential oils. Beyond its culinary and nutritional value, ginger has been used in traditional Asian medicine for centuries to treat ailments like headaches, nausea, colds, and arthritis. Recent research has shown its potential in reducing the risk of certain

cancers, diabetes, high blood pressure, and its anti-inflammatory effects (Krell and Stebbing, 2012; Avinash *et al.,* 2018). The objective of this review is to present a comprehensive overview of a significant disease affecting cultivated ginger, known as “soft rot”, which is prevalent in all regions where ginger is grown. Despite the name implying a single causative pathogen, soft rot is induced by multiple species within the genus *Pythium* (Stramenopila: Oomycota).

Pythium Soft rot of ginger (PSR) symptoms

- It first appears on the above-ground parts of the ginger plant, specifically at the rhizome-stem junction (collar), as watery, brown lesions.
- These lesions enlarge and merge, leading to stem rot and collapse.
- On leaves, the initial symptoms due to basal infection begin with yellowing at the tips of older leaves, which gradually spreads downwards along the leaf margins, eventually affecting the entire leaf blade and sheath.
- As older leaves wilt and show necrosis, younger leaves also start to exhibit similar symptoms, leading to the eventual death of the entire plant.
- Diseased stems can be easily detached from the rhizomes due to the loss of structural integrity.
- If the infection is mild, the plants may survive but will remain stunted and unproductive.
- Infected rhizomes appear brown, water-soaked, soft, and rotten, decaying over time.
- Roots emerging from the infected rhizome areas also show softening and rotting.

Fig. 1: Disease symptoms in the field (Source: Vafa *et al.*, 2021 and Bhatt *et al.*, 2021)



Water-soaked and brown coloured area on rhizome

Diseased rhizome (fungal growth)

Favourable condition:

- A warm and humid climate predisposes the plants to infection at sprouting stage.
- The spread of the disease is typical of soil bome diseases.
- For germination of *Pythium* spp, like *P. aphanidermatum*, the optimum temperature is 34°C.

Disease cycle:

- The pathogen perpetuates through diseased rhizomes as well as through oospores present in the soil.
- The infected plant debris remaining in the field serves as primary source of infection
- Oospores have also been detected in the scales of stored rhizomes.
- Secondary infection spreads through zoospores

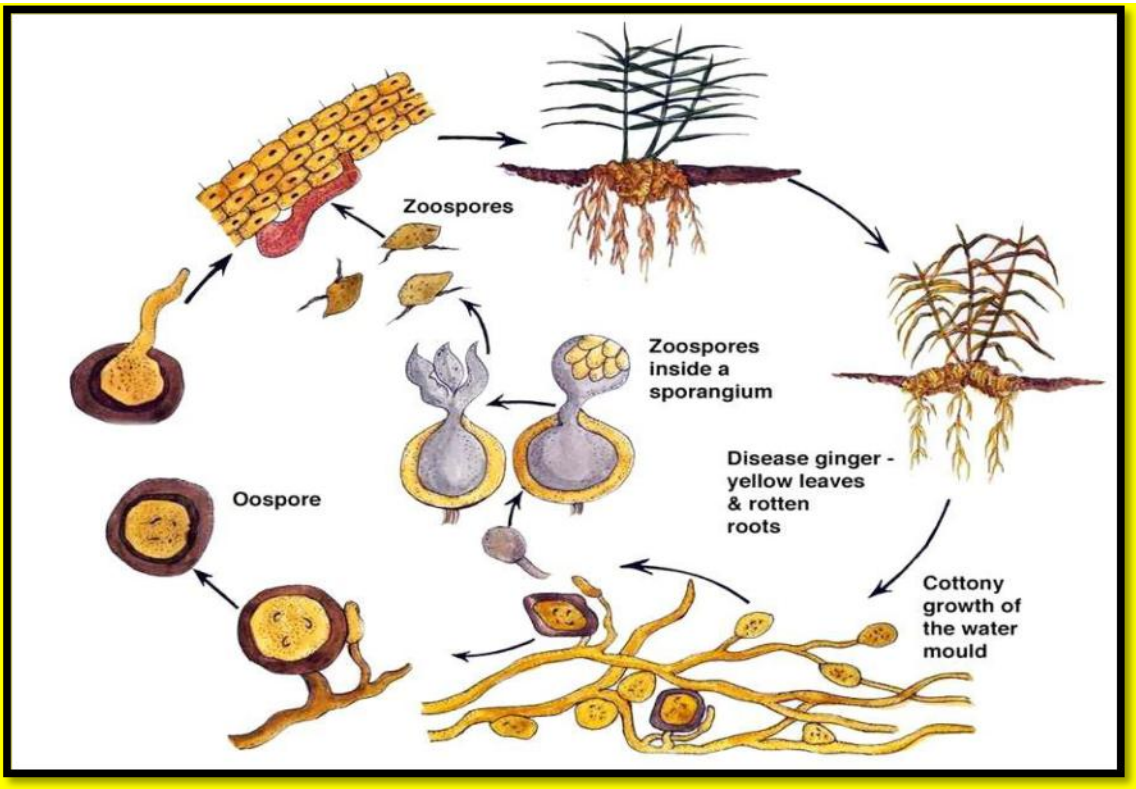


Fig. 2: Disease cycle of soft rot of ginger

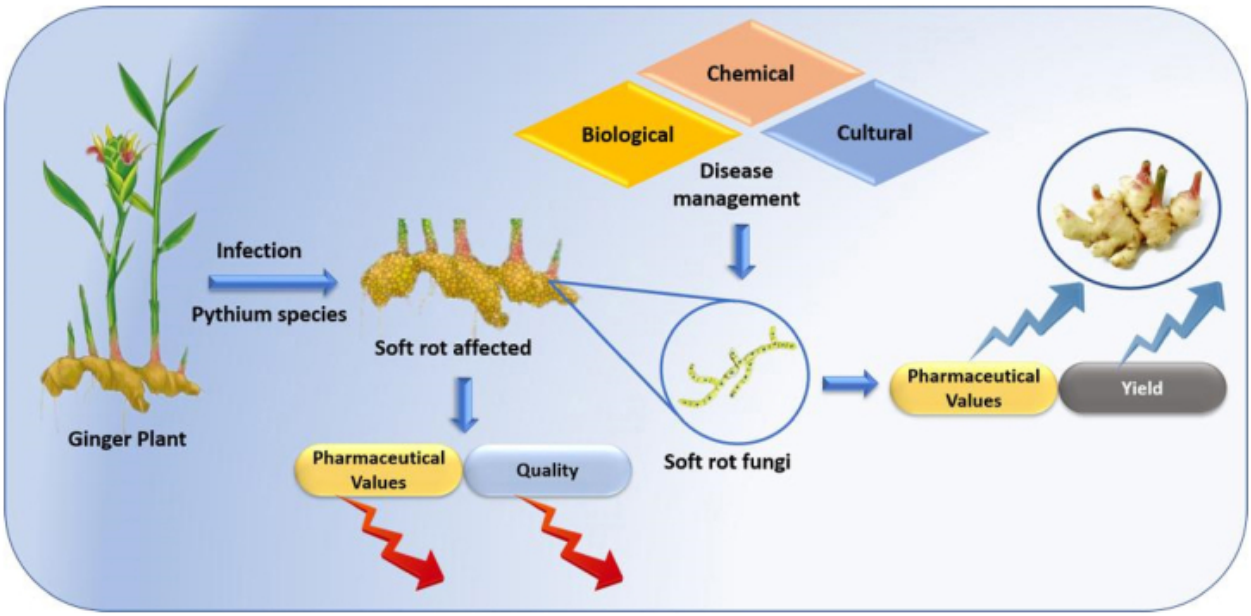


Fig. 3: Soft rot disease management in ginger (Yadav *et al.*, 2023)

Management

- To prevent disease incidence, it is essential to use disease-free seed rhizomes for planting.
- Use quality planting material i.e. Reo-degenerio, Himgiri, Suprabha, Suruchi
- To implement crop rotation with non-host crops such as maize, soybean, or leguminous crops for a minimum of 2 to 3 years was recommended to further disease management.
- Seed treated with copper oxychloride 50 WP @ 0.3% before sowing. + Bavistin 75 WP (0.1%) @ 0.3 % + Azoxystrobin 11% + Tabuconazole 18.3% was found very effective and gave a higher net return
- In addition, soil amendment practices, such as applying neem cake, (250 g/m^2), neem oil and lime, are suggested.
- Antagonistic species of *Trichoderma*, including *T. viride, T. harzianum, and T. hamatum*, are effective at inhibiting pathogenic fungi when applied at 50 g/m^2.

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