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Integrated Management of Rhizome Rot and Wilt Disease Complex of Ginger (*Zingiber officinale*) – A Review

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ABSTRACT

This review article focuses on integrated management options for ginger diseases, especially rhizome rot and wilt. We compiled the results of several strategies, including chemical treatments, cultural practices, soil solarization, organic additions, and biological management for rhizome rot and wilt disease complex of ginger. Effective approaches includes (i) raise the temperature by soil solarization, (ii) additions of soil amendments like wood sawdust, oil cakes, neem cakes that prevent soil pathogen and simultaneously improve soil health, (iii) cultural techniques such as soil selection, crop rotation and intercropping, (iv) biological control using *Trichoderma* species is another useful method to lower infestation and increase ginger yield, and (v) use of chemical control measures such as Ridomil MZ, Metalaxyl, and Streptomycin. The above-listed aspects can be integrated to develop integrated management strategies that aid in developing a treatment strategy for management for rhizome rot and wilt disease complex of ginger.

Keywords Ginger wilt complex, Rhizome rot, Soil solarization, Biological control agents, Chemical, Cultural management.

INTRODUCTION

Ginger is one of the most important and widely used spices worldwide. Valued for its medicinal properties, it played an important role in primary health care in ancient India and China. In European medicine, ginger was a component of many pharmaceutical preparations and was also among the most highly valued of all mild carminatives. India is the largest producer of ginger among the countries where it is commercially cultivated and contributes about 50% of the total production in the world (Shanmugavelu *et al.* 2002). About 80.71 thousand hectares of land are devoted to ginger cultivation, with a total production of 284.22 thousand metric tons (Shanmugavelu *et al.* 2002). Diseases are important production constraints for ginger and are often associated with fungi like *Fusarium moniliforme,* bacteria like *Ralstonia solanacearum,* and nematodes like *Pratylenchus* and *Meloidogyne* spp. (Sharma *et al*. 2017). This review paper deals with the different strategies available for the integrated management of diseases of ginger, with a special emphasis on rhizome rot and wilt complex diseases.

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Soil solarization and organic amendment

Soil solarization is one of the methods for managing soil-borne diseases by increasing the soil temperature by trapping the energy from the sun. The advantage of this method is that it does not require the application of chemicals, which are expensive and simultaneously pollute the soil. However, this method is only suitable in warm and sunny places. To standardize the techniques to manage the disease, numerous studies have been done on soil solarization throughout the globe. It was found that in the field inoculated with *Pythium myriotylum* and *Fusarium solani* and solarized for 20 days, the disease intensity was lower in solarized plots as compared to non-solarized plots (Mathur *et al.* 2002). Similarly, the ginger seed rhizomes solarized in polyethylene bags for 30 minutes and treated with *Trichoderma harzianum* 50g l-1 as seed treatment and soil application showed a high percentage of germination (90.13%), a low incidence of disease, and the highest yield (Kumar Raja *et al.* 2012).

Similarly, soil amendments are a practice to improve the soil's physical, chemical, and biological properties by applying living, dead, and decomposing tissues to the topsoil. This method not only helps to improve soil properties but also helps to check for soil-borne diseases. Soil amendments with the cakes made from *Azadirachta indica, Calophyllum inophyllum,* or *Pongamia glabracan* reduce ginger rhizome rot caused by *Pythium aphanidermatum* and *Fusarium solani* (Thakore *et al*. 1987). A similar observation was also reported in the incidence of rhizome rot by *Pythium* sp. Soil amendments with cashew shells, wood sawdust (WSD), pine needles, oak leaves, straw grass, neem cake, and farmyard manure (straw grass) also gave good results (Mathur *et al.* 1992). This suppressive ability of oil cakes is due to residual oil (Rajpurohit 1995). The incorporation of poultry manure, sawdust, and urea has been reported to manage *Meloidogyne incognita* (Stirling 1989).

Cultural management

Cultural practices such as the selection of well-drained soils, intercultural operations, intercropping, for planting also play an important role in managing the soft rot of the rhizome and the bacterial wilt of ginger. Seed rhizomes are to be selected from the disease-free field since the disease is also seed-borne. The nematodes can be controlled by treating infested rhizomes with hot water (51 °C) for 10 minutes and solarizing ginger beds for 40 days. Besides these, practices like crop rotation and intercropping are important to lower the incidence of ginger rhizome rot. Crop rotation with non-host crops reduces the disease by reducing the population load of the pathogens in soil (Yonzone *et al.* 2023). A lower incidence of rot was recorded in the areas where ginger and paddy were rotated in the paddy field (Kim *et al.* 1996). The marigold-ginger inter-cropping system showed a significant effect in managing the *R. solanacearum* population, reducing the disease incidence and increasing the yield (Yonzone *et al.* 2022). It is also reported that cabbage-based crop rotation helps in reducing the pathogen population during the determining stage of infection.

Biological management

Biocontrol is one of the components of the integrated management of plant diseases. They help to manage diseases by enhancing plant growth through different mechanisms (Bhattacharyya and Jha 2012). The benefits of the biocontrol method are that it is non-polluting, biodegradable, has a selective mode of action, is difficult for pathogens to develop resistance against, is unlikely to harm other beneficial microorganisms or humans, and generally improves soil health and the sustainability of agriculture. Numerous studies have been done using bioagents to manage ginger diseases in different parts of the globe. Bioagents are also able to reduce disease through plant-mediated induced resistance, which is systemically activated and extends up to above-ground plant parts. This type of induced disease resistance is often referred to as rhizobacteria-mediated induced systemic resistance (Van Loon *et al.* 1998). *Trichoderma harzianum* and *Trichoderma viride* were found to be potential antagonists against *Pythium aphanidermatum* in dual cultures. Pot experiments established the efficacy of *T. harzianum* for the control of rhizome rot in (Shanmugam *et al.* 2000). The establishment of *Trichoderma harzianum, Trichoderma aureoviride, Gliocladium virens,* and *Trichoderma viride* in the ginger rhizosphere and rhizoplane, correlates with the reduction of the disease and the significant increase in yield (Jayasekhar *et al.* 2001 and Ram *et al*. 2000). Furthermore, it has been found that the *Trichoderma viride* produces non-volatile substances, which inhibited the growth of the rhizome rot pathogens *Pythium myriotylum* and *Fusarium solani* by 70% and 10%, respectively (Rathore *et al.* 1992).

Chemical control

Several chemicals are used to manage plant diseases. In ginger, different chemicals, singly or in combinations, were evaluated to manage the disease. It was found that the combined soil application of bleaching powder (15 kg ha^{-1}), lime (10 q ha^{-1}), and mustard cake (10 q ha^{-1}) before planting tomatoes reduced the wilt disease incidence caused by *R. solanacearum* to 17% (Chowdhury *et al.* 2000). A fungicide like Ridomil MZ and an insecticide like Phorate were found to be effective in reducing disease intensity and increasing sprouting and yield (Mathur *et al.* 2002). Similarly, other fungicides like Metalaxyl (Jayasekhar *et al*. 2001). Thiophanante-methyl, Carbendazim (Kumar Raj *et al.* 1989). Captan, Captafol, and Mancozeb, Chlorothalonil, Mercuric chloride (Sharma and Dohroo 1982), wettable, and ceresan effective. Several workers combined the chemicals to develop suitable management strategies. Disease development in pre-inoculated and naturally infected rhizomes of ginger was significantly inhibited by Metalaxyl, Matalaxyl and Copper oxychloride, and Echlomezol (Choi *et al*.1996). Antibiotics are used to treat bacterial infections. Antibiotics were evaluated against the bacterial wilt of ginger, and it has been found that Streptomycin and Streptopenicillin (Singh *et al.* 2000) and Terramycin were effective in managing the disease (Ray *et al.* 2005).

CONCLUSION

Integrated management of diseases involves a combination of different management strategies, like cultural, chemical, and biological. Several works have been evaluated for the management of ginger diseases throughout the world. Intercropping ginger with crops like marigold, paddy, and capsicum is very effective in managing the disease. It may be due to these crops acting as trap crops or non-host crops, resulting in a decrease in inoculum density in the soil. Another method that is also reported as promising is the solarization of soil by trapping the energy from the sun. This method also helps to reduce the pathogen in the soil by increasing the soil temperature, making the soil unsuitable for its survival. The amendment of soil with organic matter and bio-agents is equally effective. This method not only helps to check for soil-borne diseases but also improves the soil's properties. Finally, fungicides like Ridomil MZ, Mancozeb, Metalaxyl, Oxadixyl, Propamocarb, Ethazole, Captan, Captafol, Chlorothalonil, Copper oxychloride, and Echlomezol have been tested and found effective. The diseases of ginger have been a major threat to its cultivation. Integrated management strategies combining the above-stated components will help formulate a management strategy for ginger disease.

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