Damping-off in Okra Seedlings: Current Understanding and Prospect for Sustainable Management

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Abstract

Damping-off in okra (*Abelmoschus esculentus L.*) seedlings has become a significant concern among fruit and vegetable crops, attracting increasing attention from researchers globally, including those in Nigeria and across West Africa. This study explores the scientific understanding of the disease, emphasizing its association with soil-borne fungal pathogens such as *Pythium spp.*, *Rhizoctonia solani*, *Fusarium oxysporum*, and *Macrophomina phaseolina*. These pathogens infect okra seedlings, often leading to pre- and post-emergence death of young plants, which results in poor stand establishment and economic losses. The review aims to analyze the biological and environmental factors (both biotic and abiotic) that influence the prevalence of damping-off in okra seedlings. Furthermore, it highlights the need for sustainable management approaches, including preventive and control strategies, to minimize yield loss and promote healthy crop production. The study provides an updated synthesis of current knowledge and proposes future directions toward the effective and environmentally sound management of damping-off disease in okra.

Keywords: Okra, Damping-off, Seedling, Fungal Pathogens

Introduction

Okra is an edible fruit of the flowering plant *Abelmoschus esculentus L.*, a member of the family *Malvaceae*. Although botanically classified as a fruit, it is widely prepared and consumed as a vegetable. Plants in the *Malvaceae* family are mostly herbaceous and bear showy flowers, and okra is one of the most common and economically important members of this group. In Nigeria and West Africa, okra is valued for its nutritional content, culinary versatility, and cultural importance. It is rich in vitamins, antioxidants, and bioactive compounds, and its regular consumption is believed to support digestive health and contribute to the management of conditions such as prediabetes and type-2 diabetes. These nutritional and medicinal perceptions make okra a staple in many households, contributing to its high daily demand across the region.

Okra is also a crop of major agricultural interest due to its adaptability to tropical climates and its high yield potential. It remains one of the most profitable vegetable crops for farmers in Nigeria, as it can be grown year-round and, in some cases, continues producing for more than one season. Its usefulness extends beyond food; okra pods and by-products are used in industries such as pharmaceuticals, paper production, and food processing, further increasing its economic value. The wide industrial demand for okra makes healthy seedling establishment extremely important, as the quality and quantity of harvested produce depend largely on successful early growth.

Damping-off is a major constraint to the healthy emergence of okra seedlings. It is a disease that affects germinating seeds and young seedlings, causing them to rot, collapse, or die shortly after emergence. This disease occurs even when environmental conditions such as sunlight, temperature, and soil moisture appear favourable. Damping-off in okra is primarily caused by soil-borne fungi, including *Pythium spp., Rhizoctonia solani*, *Fusarium oxysporum*, and *Macrophomina phaseolina.* These organisms survive in the soil as spores or hyphae and infect young plants by attacking the roots, stems, or cotyledons. They are heterotrophic, eukaryotic organisms involved in nutrient decomposition, but under favourable conditions, they become destructive pathogens that severely limit seedling survival.

The impact of damping-off on okra production is significant. It reduces seedling establishment, lowers yield, and leads to substantial economic losses for smallholder farmers who depend heavily on okra cultivation. Many local farmers may not recognize the early symptoms of damping-off or may attribute the losses to poor seed quality rather than pathogenic infection, which leads to repeated yearly losses.

Despite the ease with which these fungal pathogens infect okra seedlings, attention given to the disease by farmers and extension services remains limited. As a result, the crop continues to suffer from preventable yield declines. This review examines current knowledge on damping-off in okra seedlings, the pathogens responsible, and the environmental and biological factors that influence disease development. It also highlights sustainable management strategies and emphasizes the need for continuous monitoring and further research to reduce pathogen prevalence and protect okra production in the coming years.

Pathogens Associated with Damping-off in Okra

Soil-borne Pathogens

Soil-borne fungi are the primary causal agents of damping-off in okra seedlings. As the term “soil-borne” implies, these pathogens live in the soil and can persist as unicellular or multicellular structures. They are responsible for stunted growth, rotting of seedlings, and eventual death of young plants. These fungi display diverse morphologies in the soil and reproduce both sexually and asexually, though sexual reproduction is relatively rare for many of the species involved. Most are aerobic, requiring dissolved oxygen for survival, although some can tolerate temporarily low-oxygen conditions. They persist in the soil as spores, hyphae, or

sclerotia; microscopic structures capable of surviving independently until they encounter a susceptible host.

Seedlings, in their early growth stages, have underdeveloped defense mechanisms, making them highly vulnerable to infection. Similar to a newborn human adjusting to life outside the womb and building its immune system while exposed to environmental pathogens, young okra seedlings face significant challenges when confronted with these soil-borne microorganisms. Their susceptibility makes early-stage damping-off a particularly destructive disease for okra cultivation.

Major Fungal and Fungus-like Pathogens

Pythium spp. are oomycetes, commonly known as water molds, which were formerly classified as fungi but are now placed under the kingdom *Stramenopila*. These pathogens are highly parasitic, attaching to germinating seedlings, causing pre-emergence and post-emergence damping-off, and ultimately leading to seedling death. They spread through soil moisture and readily infect young roots, preventing proper seed germination and establishment.

Rhizoctonia solani is a true soil-borne fungus that infects okra seedlings, attacking roots and stems, resulting in reduced seedling vigor and damped-off plants. This pathogen significantly limits okra yield in West African countries such as Nigeria.

Fusarium oxysporum and *Macrophomina phaseolina* are filamentous fungi in the phylum *Ascomycota*, class *Sordariomycetes*. They produce septate hyphae that interconnect to form mycelia. Both pathogens cause vascular wilt and charcoal rot in okra seedlings and other crop plants, reducing seedling survival and contributing to substantial yield losses.

Summary

These pathogens are widespread across Nigeria, West Africa, and Africa at large. Water bodies such as the Niger and Benue Rivers facilitate the movement and transmission of many soil-borne pathogens, complicating control efforts. The widespread presence of these organisms reduces the healthy emergence of okra seedlings, ultimately leading to lower crop yields and diminished quality of the harvested produce. Effective management strategies are therefore essential to protect early-stage seedlings and ensure sustainable okra production.

Environmental and Biological Factors Influencing Damping-off

Beyond the presence of pathogens, environmental factors play a critical role in the development of damping-off in okra seedlings. Infection outcomes result from a complex interplay between the pathogen and the host's characteristics. Abiotic factors, such as soil temperature, ambient temperature, sunlight intensity, soil pH, and fertility, significantly influence seedling susceptibility.

Many farmlands in Africa are used repeatedly for different crops, such as cocoa, yams, tomatoes, and other vegetables, before being planted with okra seedlings. Without proper soil assessment, the remaining macro- and micronutrient levels may be insufficient to support healthy seedling growth.

Macronutrients required for okra:

Nitrogen (N): Essential for chlorophyll formation and photosynthesis

Phosphorus (P): Promotes root development and flowering

Potassium (K): Supports disease resistance and water regulations

Calcium (Ca): Strengthens cell walls and membranes

Magnesium (Mg): Central atom in chlorophyll

Sulfur (S): Component of amino acids and proteins

Micronutrients required for okra:

Iron (Fe), Manganese (Mn), Zinc (Zn), Copper (Cu), Boron (B), Molybdenum (Mo), Chlorine (Cl), Nickel (Ni)

Seed quality also influences damping-off incidence. Poor-quality seeds or seeds with low vigor are more susceptible to root rot and early death. Furthermore, the presence of other microorganisms in the soil, water quality used for irrigation, soil moisture, and temperature can enhance pathogen survival and disease development.

Management and Control Strategies

Biological Control Methods

Biological control involves the use of beneficial microorganisms to suppress or eliminate pathogens responsible for damping-off. These agents include bacteria and fungi, such as *Trichoderma* species, which act as natural antagonists to pathogenic organisms.

Cultural Control Methods

Cultural methods include:

Crop rotation: Avoiding continuous planting of okra in the same soil to reduce pathogen build-up

Proper soil drainage: Ensuring the soil is well-drained to prevent waterlogging

Seedling spacing: Maintaining adequate distance between seedlings to minimize disease spread

Sustainable Control Methods

Sustainable approaches include genetically modified microorganisms (GMMs) or organisms (GMOs) to resist fungal and non-fungal pathogens. These methods enhance nutrient uptake and seedling resilience independently of environmental factors.



Figure 1: Seeds from a diseased okra pod showing pathological alterations

Cross and longitudinal sections of okra pods revealing discolored, shriveled, and partially decomposed seeds resulting from systemic or pod-invading fungal pathogens. Such seed deterioration is linked to reduced germination capacity, increased susceptibility to damping-off, and the potential spread of seed-borne diseases to new seedlings.



Figure 2: Internal rot and tissue degradation in diseased okra fruit

Longitudinal sections of okra pods displaying extensive internal breakdown of pod walls and placental tissues caused by fungal colonization. Symptoms include soft rot, discoloration, and structural collapse, characteristic of fruit infections associated with poor field sanitation, high humidity, or seed-borne fungal inoculum.

Impact of Damping-off on Okra Production

Damping-off significantly reduces germination, yield, and overall economic return. It affects seedling survival, nutritional value, and farmers' livelihoods. Future research should focus on biotechnology, genetically resistant seedlings, and monitoring tools to reduce disease prevalence.

Future Prospects and Research Needs

Advancements in AI, monitoring systems, and resistant seedlings can mitigate damping-off. Continuous monitoring and research into pathogen genetics, environmental interactions, and biological controls will improve sustainable management strategies.

Conclusion

Damping-off in okra remains a major constraint to seedling emergence and crop production in Nigeria and West Africa. Integrating biological, cultural, and technological strategies, alongside farmer education, can reduce the impact and improve sustainable okra production.

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