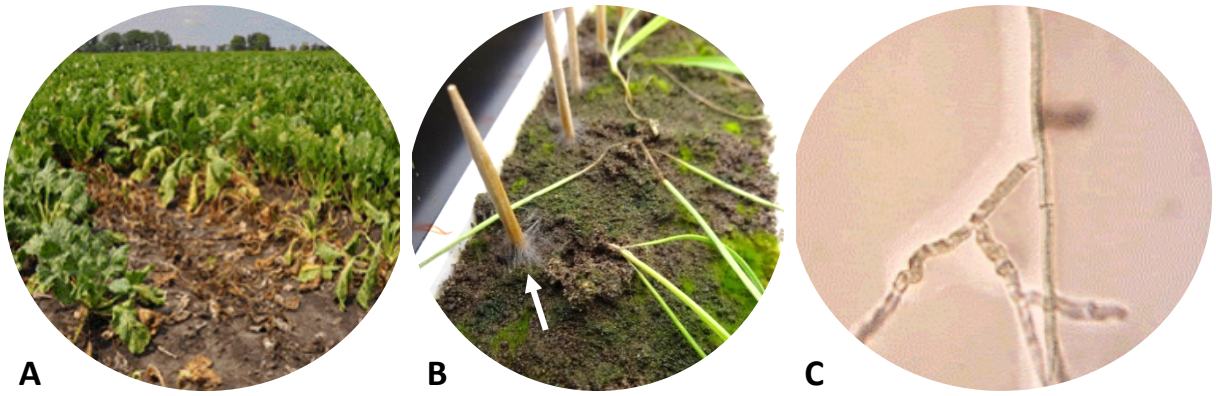
MicroRogue Rhizoc: (*Rhizoctonia solani*)

(Eline A. Ampt)



A: Bare patch disease in sugar beet fields caused by *Rhizoctonia* root rot; B: *Rhizoctonia* damping-off seedling disease with fungal hyphae (white arrow) baited on toothpicks from the soil; C: Microscopic view of the *Rhizoctonia* fungus. Hyphae are ~10 µm wide (~1/5 the width of a human hair). (Pictures A and C: Hacque and Parvin 2021, Agricultural and Biological Research).

Claim to fame: all-rounder Jekyll and Hyde fungus

Farmers who grow crops are all too familiar with soil-borne diseases of plants. These diseases are caused by microbes that live in the soil and infect roots and kill plants. Among these root pathogens are many fungi.

A famous one is Rhizoc, or to give it its scientific name, *Rhizoctonia solani*. Yet, this fungus is more versatile than you might think! For starters, this fungal species actually comprises a grouping of many different *Rhizoctonia* fungi which share many similarities, but also some differences. For example, they differ in which plant species they can infect ('host plants'). Some prefer sugar beet, others potato or wheat. Also, while many infect seeds or roots of young seedlings, some infect mature roots or tubers.

Together, these fungi cause disease in more than 200 crop species worldwide. *Rhizoctonia* fungi can be very challenging for farmers to control because they can persist in soils for a long time. This is because Rhizoc does not put all its eggs in one basket! It has some back-up strategies for times when there are few or no host plant roots available. First, it can degrade dead organic material in the soil, such as plant debris. Second, it can form resting structures called sclerotia, which can survive for years in the soil until the conditions become favorable again.

Fungal life in the soil

Rhizoc spreads through the soil via a network of hyphae: threadlike strands of fungal cells that are as thin as plastic cling wrap (~10 µm). A cool feature of Rhizoc is its ability to translocate nutrients through the hyphae. This means that when they obtain nutrients (e.g. from a plant root) with one hyphal strand, they can transport these nutrients through their hyphal network to other hyphae. These hyphae can then utilize these nutrients for further growth into the soil.

When the hyphae encounter new plant roots, they will quickly form a so-called 'infection cushion'. This is a dense aggregation of hyphae on the surface of a root. Here, infection of the root occurs and hyphae grow into the root cells. Once the nutrients from the root cells are captured by the hyphae, the cycle begins again: hyphae grow out of the root and explore the soil again until a new root is found. You can imagine that this is super easy for the fungus in

agricultural fields with a high density of a single crop species that it can infect. This results in the characteristic bare patches in such crop fields, as shown above.

Root infection process of *Rhizoctonia* fungus. A: Fungal hyphae spread in the soil to find plant roots; B: On the root surface, fungal hyphae aggregate to form an 'infection cushion'; C: Cross section of root cells. At the site of the infection cushion, the fungal hyphae secrete toxic enzymes that dissolve the root cell wall. The fungal hyphae grow into the root and kill the root cells. Pictures captured from https://youtu.be/yHVp8cpF0Io by the American Phytopathological Society. Scan the QR code to watch the full animation video.

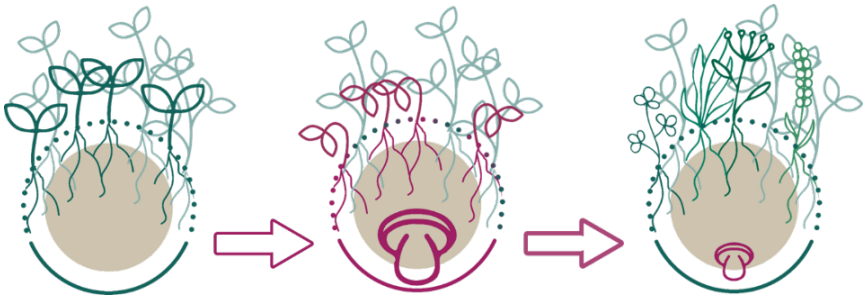
Foes or Friends in the soil?

Sounds like these *Rhizoctonia* fungi are pretty bad-ass foes in the soil, right? That is - to the plants that fall victim to them… However, *Rhizoctonia* fungi may be a 'friend' for other plants that do not become ill! For example, some *Rhizoctonia* fungi have been found to collaborate with orchids. These fungi live inside the orchid roots and collaborate with them by exchanging nutrients. Other *Rhizoctonia* fungi infect roots without hurting them and actually seem to protect these roots against infection with those *Rhizoctonia* fungi that do cause disease!

Rhizoc is a fascinating Jekyll and Hyde character:
a beastly MicroRogue but also a mighty MicroStar

The importance of Rhizoc for plant diversity

Without pathogens such as *Rhizoctonia*, the plant cover of natural landscapes would be quite boring. One or a few plant species that grow quickly would outcompete the other plants and become dominant. However, when pathogens in the soil infect and kill some of these dominant plants, space opens up for other, slower-growing, plant species to establish. Together, this allows more plant species to co-exist in an area. Plant communities with more plant species are more robust to stresses, such as drought or heat waves. And the plants often perform better, too. In other words: soil-borne plant pathogens like Rhizoc are super important to maintain natural ecosystems and increase biodiversity!



Soil-borne pathogens enhance plant diversity