What Lies Beneath: The Importance of Studying Roots Non-Destructively with Minirhizotron Systems

Roots—“the hidden half of the plant body”\(^1\) — have the power to reveal critical information about the overall health and behavior of plants. Roots take in water and nutrients, and provide a supportive foundation to the exposed aboveground portion of plants.\(^2\) Just as leaves shrivel and wilt when they are water-deprived, roots also respond to changes in environment, developing fine root hairs to penetrate tough soils as they search for water during drought, and increasing in biomass with elevation gain.\(^3\)

Plant roots have been the subject of intensive investigation for decades, yet they have remained largely unstudied by plant scientists. One reason for this is that roots are buried in soil, which physically obstructs the observation of their growth and performance. Scientists who have chosen to study roots have had to get creative with trenching techniques, soil core sampling, anatomical root drawings, and pin boards.\(^4,5\) Many of these methods are still valuably employed in belowground research, yet their destructive nature impedes the ability to truly understand roots, and their impact on and response to their environment.

In the early 1900s, rhizotrons—underground, glass-walled laboratories—were developed to non-destructively study soil and the plants and animals living within it. Rhizotrons enabled scientists to observe roots in-situ (living in place) over many seasons. Since then they have been constructed around the world, with famous examples at the Kew Gardens in England and at Treborth Botanic Garden in Bangor.\(^6\)

Later, in 1937, G.H. Bates published “A Device for the Observation of Root Growth in the Soil,” in which he proposed the first miniature rhizotron: a series of “root windows” mounted in a walled chamber. This system allowed Bates to study living roots non-destructively—without the large investment of time and resources needed to construct a full-scale rhizotron laboratory.

Today, scientists observe roots in-situ with modernized minirhizotrons, like the CI-600 In-Situ Root Imager and CI-602 Narrow Gauge Root Imager from CID Bio-Science. These systems are made up of durable, transparent tubes installed in the ground and a cylindrical imaging device which is lowered into the tubes to collect high-resolution images and track root growth season to season. The CI-600 and CI-602 can be used with upwards of 100 tubes in a single site, and come with analysis software (RootSnap!) that allows users to quickly measure root length, area, volume, diameter & branching angle.

In a world faced with overpopulation, food scarcity, and climate change, understanding root development has never been more important. Scientists have and continue to conduct exciting belowground research with minirhizotrons around the world to help us adapt to these challenges. Agronomists study how drought impacts fine root turnover in new crop varieties, foresters estimate fine root dynamics,\(^7\) ecologists measure the effects on mycorrhizal fungi in ecological restoration,\(^8\) and environmental scientists observe root and shoot responses to better understand nutrient applications.\(^9\)
Minirhizotrons aren’t just a tool for scientists. Crop consultants, agricultural researchers, and farmers are beginning to use minirhizotrons to understand the effectiveness of fertilizers and nutrient applications, measure and plan for the impacts of drought, monitor for root pathogens, estimate crop yield based on root density, and better understand whole-plant health in general.

Read more on how CID Bio-Science’s root imaging systems are being used in research and agriculture around the world by visiting our applications page, or reading our blog.

To learn more about how our CI-600 and CI-602 work, visit our Root Measurement product page, or contact us directly to speak with an Application Scientist about how a minirhizotron might fit into your research!

**Citations**


