CI-600 / CI-602
Minirhizotron Systems

WHITE PAPER

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 Banger.[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,[10] 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

1. Lux, A., Rost, T. 2012. Plant root research: the past, the present and the future. Annals of Botany 2012, 110(2): 201-204. doi: 10.1093/aob/mcs156
2. Judd, L., Jackson, B., Fonteno, W. Advancements in Root Growth Measurement Technologies and Observation Capabilities for Container-Grown Plants. Plants 2015, 4(3), 369-392; doi: 10.3390/plants4030369
3. Kobiela, B., Biondini, M. & Sedivec, K. Comparing root and shoot responses to nutrient additions and mowing in a restored semi-arid grassland. Plant Ecology 2016, 217: 303. doi:10.1007/s11258-016-0571-3
4. Rewald, B., Ephrath, J. Minirhizotron Techniques. The Hidden Half, Fourth Edition 2013, 42-1-41-16. doi: 10.1201/b14550-50
5. McMichael, B., Zak, J. The Role of Rhizotrons and Minirhizotrons in Evaluating the Dynamics of Rhizoplane-Rhizosphere Microflora. Microbial Activity in the Rhizosphere 2006, 7 (Soil Biology): 71-87. doi: 10.1007/3-540-29420-1_5
6. Busch, J., Mendelssohn, I., Lorenzen, B., Brix, H., Miao, S. A rhizotron to study root growth under flooded conditions tested with two wetland Cyperaceae. Flora - Morphology, Distribution, Functional Ecology of Plants 2006, 201 (6): 429-439. doi: 10.1016/j.flora.2005.08.007
7. Han, S., Yun, S., Lee, J. et al. Estimating the production and mortality of fine roots using minirhizotrons in a Pinus densifloraforest in Gwangneung, Korea. Journal of Forestry Research 2016, 27: 1029. doi: 10.1007/s11676-016-0221-6
8. Li, S., Bi, Y., Kong, W. et al. Effects of arbuscular mycorrhizal fungi on ecological restoration in coal mining areas. Russian Journal of Ecolology 2015, 46: 431. doi: 10.1134/S1067413615050173
9. Kobiela, B., Biondini, M. & Sedivec, K. Comparing root and shoot responses to nutrient additions and mowing in a restored semi-arid grassland. Plant Ecology 2016, 217: 303. doi: 10.1007/s11258-016-0571-3
10. Fageria, N., Moreira, A. The role of mineral nutrition on root growth of crop plants. Advances in Agronomy 2011, 110: 251-331. doi: 10.1016/B978-0-12-385531-2.00004-9

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