Science Societies

Belowground Cameras and Machine-Learning Analysis for Root Phenotyping

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Left panel: Intermediate wheatgrass roots imaged with a minirhizotron (left) and traced with a machine-learning program (right) to study root structure. Image by Alexandra Griffin. Right panel: Graduate researcher Alexandra Griffin images intermediate wheatgrass roots using a minirhizotron on the University of Minnesota campus in St. Paul, MN. Image by Emma Link.

Roots mediate the movement of carbon, nitrogen, and water above and below the soil. As such, many measures of agricultural sustainability are linked to crop roots, including water quality, soil carbon sequestration, water use efficiency, and more. However, measuring roots is difficult and costly, so few plant-breeding programs have integrated root phenotyping.

Researchers used in-field, belowground cameras known as minirhizotrons to collect thousands of root images of the novel perennial grain crop intermediate wheatgrass, or Kernza. They analyzed images using the open-source machine-learning software RootPainter and used these data to bridge the gap between above- and belowground traits and generate information that can be used in applied breeding, e.g., inclusion of data in genomic selection models. Results showed that grain yield was weakly positively correlated with total root length, area, and volume, and that there was moderate heritability of root traits, suggesting that there is genetic variation in root traits that could be selected for as part of a breeding program.

These findings demonstrate the potential for in-field root phenotyping and genomic selection to aid in advancing crop varieties with specific root traits important for ecosystem services.

Dig Deeper

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