Public Abstract
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The nodal root system is critical for the development of the mature root system in maize (Zea mays) and other grasses. Under drought conditions, nodal root axes may need to grow through surface soil that is dry, hard, and hot. These roots are known to have a superior ability to continue elongation at low water potentials relative to other organs of the plant, but the physiology of this response has been little studied. The objective of this study was to develop an experimental system that models the field situation in which upper soil layers dry, to enable studies of nodal root growth regulation under water deficit conditions. A divided-chamber experimental system was developed to allow the growth of maize primary and seminal root systems in well-watered conditions while the nodal root system is exposed to precise conditions of low soil water potential. The divided-chamber system was used to characterize nodal root growth responses to a range of soil water potentials under steady-state and reproducible conditions. Two contrasting genotypes, selected for differences in root growth response to water stress based on a previous study of the primary root, displayed similarly sensitive growth responses to -0.3 MPa soil, but different capacities to maintain high root tip water potential corresponding with different growth responses at lower soil water potentials. Both genotypes maintained relatively high nodal root tip water potentials in -2.0 MPa soil, despite the decreased soil water potential, suggesting a stress-induced response that enhances water transport to the root tip. The difference in high tissue water potential maintenance was seen not only between the contrasting genotypes but also between the first two developmental nodes of roots. The divided-chamber system provides a powerful experimental approach to investigate the physiological mechanisms regulating nodal root growth responses to adverse soil conditions. Future studies may include measurements of hydraulic conductivity, anatomical characterization of vascular elements near the growth zone, aquaporin content and activity, and suberin deposition in response to low soil water potentials.