Public Abstract
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The capability of roots to mine the soil for available water is essential for survival and productivity, especially under water-limited conditions. The formation and elongation of lateral roots is an important process determining the architecture of the root system, and is highly plastic in response to soil drying. In plants, organ growth is initiated, maintained, and regulated through meristematic tissues. However, in some contexts, meristems are genetically encoded to stop the production of new cells, resulting in determinate growth.

To explore the effects of water deficit on lateral root determinacy, we implemented a system allowing photosynthetically active growth in a near-stable water stress environment. The suitability of several commonly used growth media was assessed for use in controlled water stress experiments, and conditions allowing comparisons of maize genotypes of inherently different size, and transpiration regimes, over a narrow range of precise and reproducible stress are detailed. Two inbred lines (B73 and FR697) with divergent lateral root responses to water stress were assessed. Genotypic differences specific to lateral root growth from the primary root system were observed over a series of mild water deficits. The total lateral root length of B73 plants, as well as the average length and diameter of first-order lateral roots, were unresponsive to the levels of water stress tested. In contrast, the total lateral root length of inbred FR697 plants was 27% greater when grown at a mild level of stress, and first-order lateral roots were 30% longer. Furthermore, FR697 first-order lateral roots were 26% wider than well-watered controls, resulting in a 96% increase in volume. Neither genotype showed a significant difference in lateral root length at slightly more intense levels of stress compared to their respective well-watered controls. The sensitivity of genotype specific responses over this narrow range shows the need to study mild water stress conditions using a high-resolution series of water stress levels.

First-order laterals of the water-deficit tolerant maize cultivar FR697 displayed an ability to delay the determinacy program when grown under a mild water deficit. Maximum root elongation rates were maintained for nearly 2.5 days longer, and were still at nearly half of maximum rates when well-watered laterals approached their determinate length. Maintenance of lateral root elongation resulted from sustained rates of cell flux and meristem activity. In addition, kinematic (spatio-temporal growth) analysis revealed that reductions in tissue expansion rates with aging were delayed by more than two days in the longitudinal, radial and tangential planes. This study reveals that large genotypic differences exist relating to the interaction of water deficit with the developmental determinacy of maize lateral roots.