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A novel controlled environment culture system for studying soybean response to soil water deficit

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Responses of crop plants to soil water deficits are often studied in controlled environments using plants growing in small pots, with soil water controlled using either manual or automated gravimetric methods. Advantages of such small pot systems include: maintenance of relatively homogeneous soil water content throughout the rooting zone, potential for precise control of the application and onset of drought treatments, and the opportunity to impose a wide range of precisely defined drought severities. However, such systems are generally inappropriate for studying effects of root morphology on access to soil water, since the root system easily explores the entire soil volume, and soil water profiles in small pots do not emulate those encountered in the field. In such small pot gravimetric systems, plants with more leaf area deplete the soil water more rapidly, and so experience a more rapid onset of soil water deficits. Very frequent watering is used to avoid differences and synchronise water deficit development during dry-down. When using gravimetric methods, changes in plant fresh weights are not easily distinguished from changes in soil water content; this reduces the accuracy of volumetric soil water content estimates. To overcome these shortfalls, a non-gravimetric method of imposing drought in a novel culture system has been devised, using a 1 m rooting column filled with sand-amended clay loam field soil to allow for field-like rooting depths that can be studied during and after the experiment. This novel method is being tested for its ability to quickly, precisely and cheaply impose drought stress treatments in soybean by continuously controlling volumetric soil water content in the rooting zone.