METER
ENVIRONMENT

EXAMINING PLANT STRESS USING WATER POTENTIAL AND HYDRAULIC CONDUCTIVITY

Many scientists rely on water potential alone to measure plant water stress. Leo Rivera, a METER soil scientist, relates a greenhouse case where a two-pronged approach, using hydraulic conductivity as well as water potential, made those measurements much more powerful:

Soil moisture release curves give you incredible detail about water movement, enabling you to understand not only that plants are stressed, but WHY they are not getting the water they need. Recently, we ran into a mystery where this method was useful. Growers at a Georgia nursery noticed that plants growing in a particular soilless substrate were beginning to show signs of stress at about -10 kPa water potential, which is still *really* wet. They wanted to know why.

HYPROP

We decided to create the unsaturated hydraulic conductivity and soil moisture release curves for the substrate (using the Wind Schindler technique [HYPROP lab instrument]) and found that it had a dual porosity curve: essentially, a curve with a "stair step" in it. The source of the "stair step" can be explained by considering the substrate, which was made up of bark mixed with some other fine organic materials. In the bark material there were a lot of large and small pores, but no medium-sized pores (this is called a "gap-graded" pore size distribution). This gap in the pore size distribution reduced the unsaturated hydraulic conductivity and caused the stress. Even though there was available water in the soil, it couldn't flow to the plant roots.

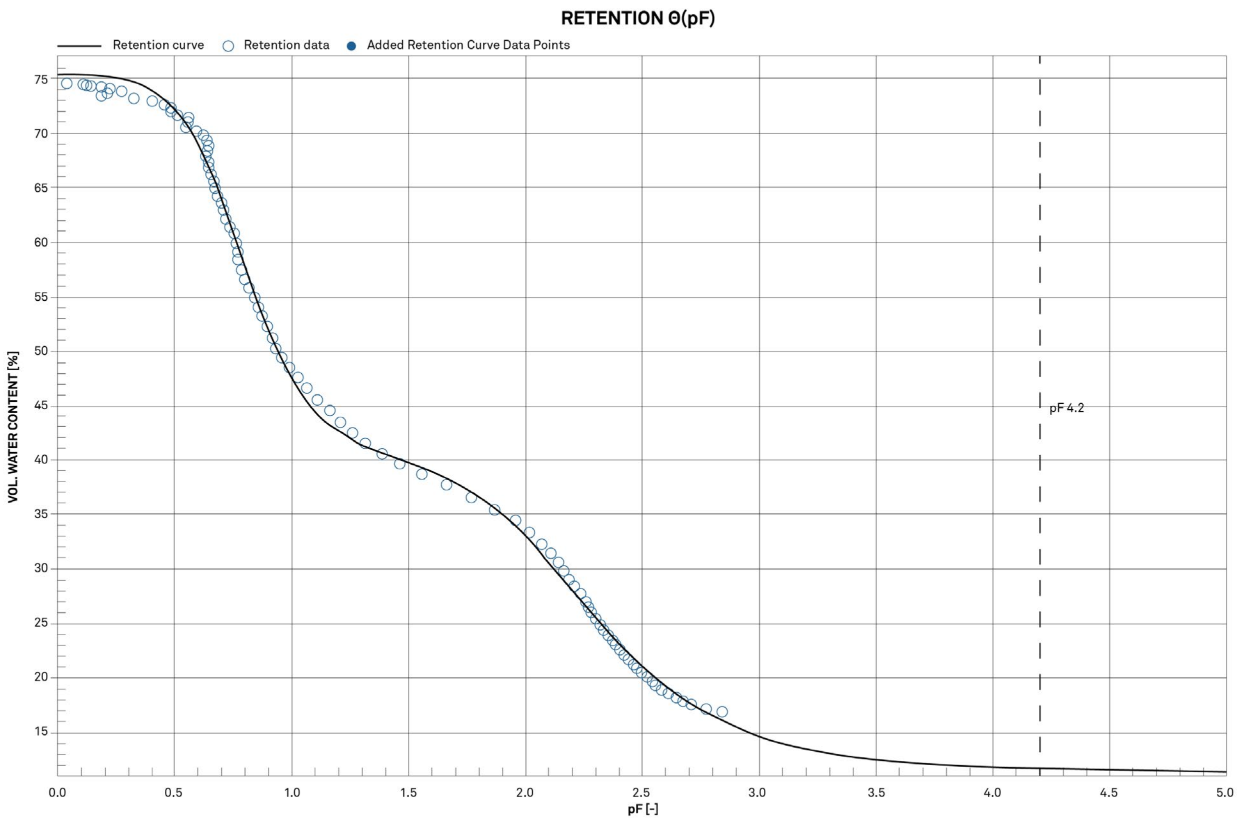

Figure 1. A dual porosity moisture release curve: essentially, a curve with a "stair step" in it. The source of the "stair step" is caused by a "gap-graded" pore size distribution.

That would have been pretty hard to understand without detailed hydraulic conductivity and soil moisture release curves—curves with more detail than most traditional techniques can provide. Our measurements showed that unsaturated hydraulic conductivity can have a major effect on how available water is to plants. Our theory about the soilless substrate was that as the roots were taking up water, they dried the soil around them pretty quickly. In a typical mineral soil, the continuous pore size distribution would allow water to flow along a water potential gradient from the surrounding area to the soil adjacent to the roots. In the bark, the roots dried the area around them in the same way, but the gap in pore size distribution created low hydraulic conductivity and prevented water from moving into the soil adjacent to the roots. This caused plants to start stressing even though the substrate was still quite wet.

We were pretty excited about this discovery. It shows that water potential, though critical, may not always tell the whole story. Using technology to measure the full soil moisture release curve (METER HYPROP) *and* the hydraulic conductivity in one continuous test, we discovered the real reason plants were wilting even when surrounded by water. In the past, it took three or four different instruments and several months to take these measurements. We can now do it in a week. For more information about creating these kinds of curves, check out the app guide: "Tools and Tips for Measuring the Full Soil Moisture Release Curve. "

Discover the HYPROP