Deep Rooting in Switchgrass for Greater Nitrogen Uptake

Background

- Roots are essential for the productivity of crops, especially bioenergy feedstocks grown on marginal lands. Little is known about the physiology of switchgrass roots, how they contribute to soil resource capture, and differences among ecotypes that originate from different habitats.

Approach

- Lowland and upland switchgrass ecotypes were grown in tall mesocosms to allow deep rooting under water and/or nitrogen stress.
- Physiological parameters such as leaf photosynthesis, root respiration and deep ^{15}N nitrate capture by roots were measured for a comprehensive understanding of switchgrass adaptation. Root length was measured throughout the vertical profile using RhizoVision Explorer.

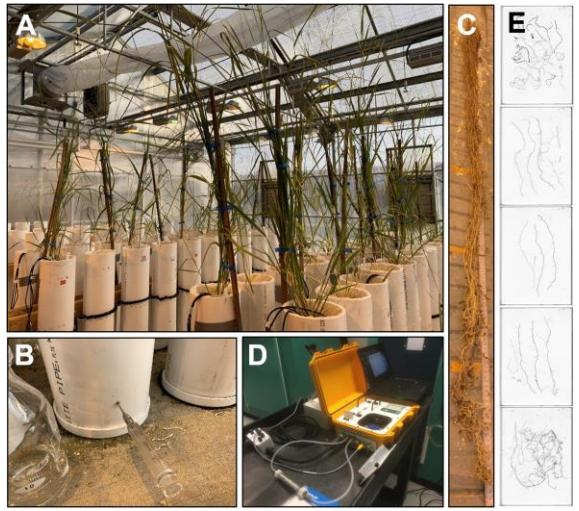
Results

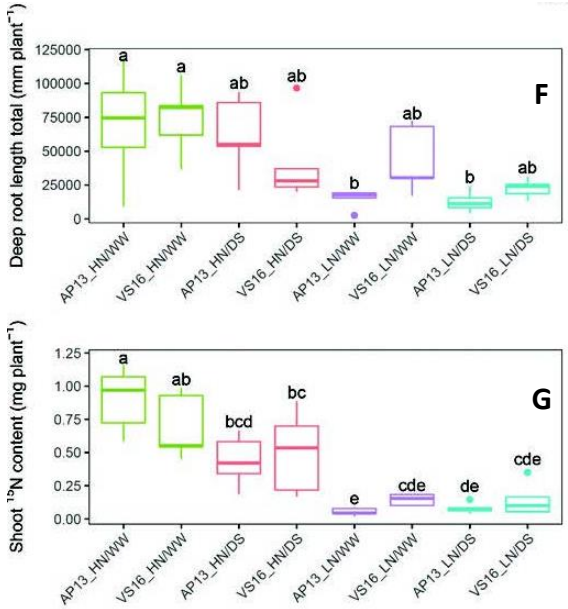
- In both ecotypes, roots respond to stress by increasing lateral rooting which allows soil exploitation with less metabolic cost.
- The abundance of roots in the bottom of the mesocosms was directly linked to the uptake of a nitrogen stable isotope from the roots into the shoots and leaves.

Significance

- This research shows wide natural genetic variation for root traits in switchgrass, their ability to respond to abiotic stress, and indicates greater lateral rooting as a valuable target for breeding.
- It confirms that deep rooting promotes nitrate capture, plant productivity and sustainability, especially as we consider growth on marginal lands with little inputs.

Larger mesocosms are a powerful way to study roots. Switchgrass tillers were planted in 5 ft tall, 6 in diameter pipes to allow roots to grow (A). A stable isotope ^{15}N was injected at the bottom a day before harvest (B). Roots were washed out of the solid media (C). Root respiration was measured with an infrared gas analyzer (D). Root structure was imaged with scanners and analyzed using the CBI-developed RhizoVision Explorer (E).





Root length in the deepest layer (F) and ^{15}N content in the shoot for the switchgrass ecotypes by treatment condition. High nitrogen: HN, low nitrogen: LN, well-watered: WW, Drought-stressed: DS. Boxes with different letters were significantly different at $P<0.05$ according to Tukey's HSD test.

Griffiths, M., et al. (2022). *Journal of Experimental Botany* 73, 967–979, doi: 10.1093/jxb/erab437.