Root Traits for Enhanced Nitrogen and Water Acquisition in Maize

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Improved water and N acquisition by maize would be useful in both rich and poor nations. A hypothetical ideotype ('steep, cheap, and deep') is presented to optimize water and N acquisition by maize root systems. The overall premise is that soil resource acquisition is optimized by the coincidence of root foraging and resource availability in time and space. Since water and nitrate enter deeper soil strata over time and are initially depleted in surface soil strata, root systems with rapid exploitation of deep soil would optimize water and N capture in most maize production environments. Specific phenes that may contribute to rooting depth in maize include 1) a large diameter primary root with few but long laterals and tolerance of cold soil temperatures, 2) many seminal roots with shallow growth angles, small diameter, many laterals, and long root hairs, or as an alternative, an intermediate number of seminal roots with steep growth angles, large diameter, and few laterals coupled with abundant lateral branching of the initial crown roots, 3) an intermediate number of crown roots with steep growth angles, and few but long laterals, 4) one whorl of brace roots of high occupancy, having a growth angle that is slightly shallower than the growth angle for crown roots, with few but long laterals, 5) low cortical respiratory burden created by abundant cortical aerenchyma, large cortical cell size, an optimal number of cells per cortical file, and accelerated cortical senescence, 6) unresponsiveness of lateral branching to localized resource availability, and 7) low Km and high Vmax for nitrate uptake. Some elements of this ideotype have experimental support, others are hypothetical. In this presentation I will summarize experimental support for this ideotype and recent advances in phenotyping platforms for relevant traits.