Phenotyping root development in pearl millet, an orphan cereal from arid regions

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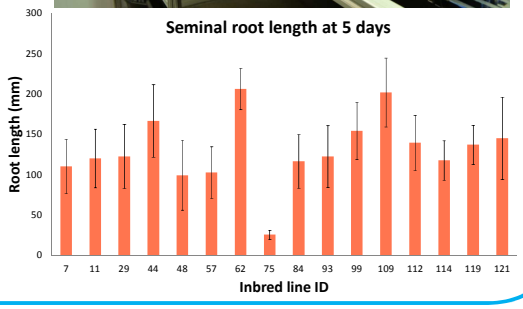
Introduction

Food security is a major challenge for the 21st century, especially in Sub-Saharan Africa, the region with the highest prevalence of undernourishment. Pearl millet is a subsistence cereal crop that plays an important role for food security in tropical arid and semi-arid regions. Root architecture contributes to pearl millet adaptation to drought and poor soils and could be a target for selection. We tested different root phenotyping systems to characterize pearl millet root development and to find genomic regions involved in this process that could be targets for selection.

High throughput 2D phenotyping

Phenotyping experiment was performed on a set of 16 pearl millet inbred lines (IL) chosen from a pool of 82 IL to maximize genetic diversity. The plants (360 plants/experiment) were grown on vertical Anchor blue germination paper moistened with Hoagland solution. A picture of the root system was taken every two days during five days. Root length and branching were extracted using RootNav (1). Various root traits such as seminal root growth showed a high variability between lines. This system was suitable for high-throughput phenotyping of early pearl millet root development (up to 5 days after germination).

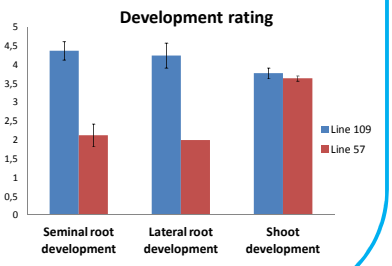
As early seminal root growth is an important trait for early plant establishment and since it was highly diverse and heritable in our experiment, we will use the same phenotyping system to characterize a set of 120 pearl millet IL. This will form the basis for a genome wide association study to identify genomic regions controlling early seminal root growth in pearl millet.



High resolution 2D phenotyping

We used rhizotron system (2) to grow 16 plants belonging to two contrasted inbred lines during nine days. This system allowed a more detailed and longer analysis of root system development on a limited number of plants. Our results confirmed the differences in root development observed for a shorter period on the high-throughput paper system while shoot development was similar.

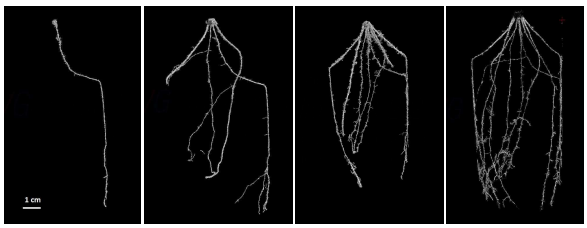
We will use this system to find rules governing the development of the root systems of these two lines. This will allow us to quantitatively compare the two lines and to produce a *in silico* model of pearl millet root system.



3D phenotyping

In order to study the 3D-architecture of pearl millet root system in soil, we used X-ray micro-computed tomography. 16 plants were grown under well-watered or drought conditions and the root system was scanned regularly during two weeks. The root systems were manually segmented in each scan.

We will use these data to compare the volume of soil explored for each plant over time, and its regulation by drought stress.



Extracted root system of a well-watered plant scanned at different time points (DAG: days after germination)

References

(1) Pound, M. P. *et al,* 2013, *Plant Physiology*
(2) Neufeld, H. S. *et al*, 1989, *Plant and Soil*

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