Effects of different sources of N on pearl millet growth and yield in P-limited environments of West Africa

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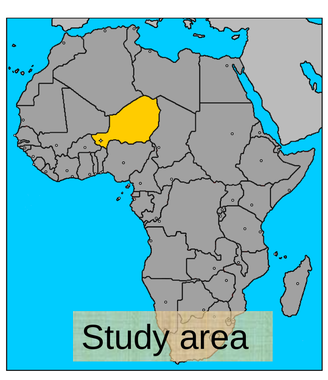
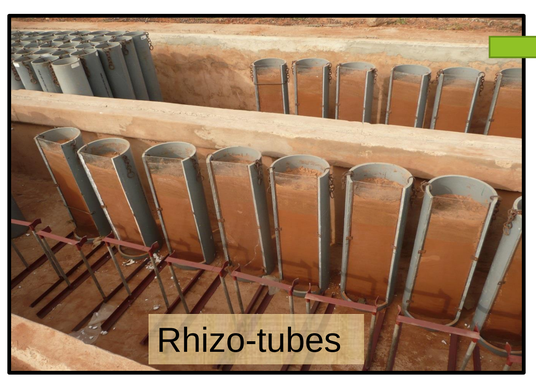
Introduction & Methods

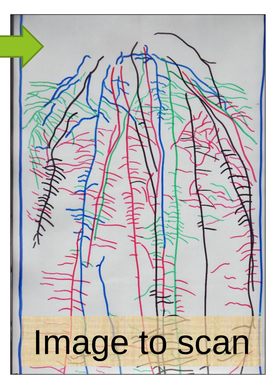
Pearl millet (*Pennisetum glaucum* L.) is the major food crop in West African Sahel and largely contributes to food security of 50 millions people. Its adaptation to soil phosphorus (P) deficiency at early seedling stages is crucial for final yield. Plant-based strategies, such as long roots, and efficient P fertilizer application are fundamental, being P resources limited.
Pot trials indicated that the addition of NH_4^+ to P can stimulate early root growth more than other N sources, but there is no information regarding root length at different timings in field-like conditions.

Objective: Analyse root length, plant growth, yield and water use under application of two different N sources: NH_4^+ and NO_3^-

Twenty-four lysimeters ("Rhizo-tubes") were cut, rearranged with a longitudinal plexiglass surface and filled with P-deficient sandy soil (BrayP1=3.3). Millet plants from a genotype known as tolerant to low soil P were grown until yield at ICRISAT station, Niger.
Three treatments were applied at sowing: 1) +P, 2) +P+NH_4 and 3) +P+NO_3^-, with 8 repetitions. Roots were hand marked on a plastic removable surface on the plexiglass, scanned and length analysed through WinRhizo. We measured: root length at 2, 3, 4 and 5 weeks after sowing (WAS, different colours), plant growth, final yield and water use (=transpiration, twice a week).







Results & Discussion

- Total root length at 5 WAS correlated with total root dry matter (DM) (r=0.7, Fig. 1).
- Throughout the season, the root system developed more in treatment (Trt) 3 than in Trt 2 and 1 (Fig. 2), probably due to higher solubility of NO_3^-. But, at early stage (2 and 4 WAS), roots in the topsoil (upper 20 cm) of Trt 2 were longer than roots in Trt 3 and 1 (at 4 WAS: 129.3 cm, 83.6 cm and 54.3 cm, respectively).
- Plants in Trt 3 produced the highest vegetative dry matter (Fig. 3). In contrast, plants in Trt 2 presented the highest reproductive dry matter (P=0.05), in agreement with their 6 days earlier flowering (from 43 to 49 days, not shown) as compared to Trt 3.
- Water use efficiency was higher for Trt 2 as compared to Trt 1 and 3 (Fig. 4), despite plants in Trt 2 and Trt 3 used similar amounts of water (not shown).

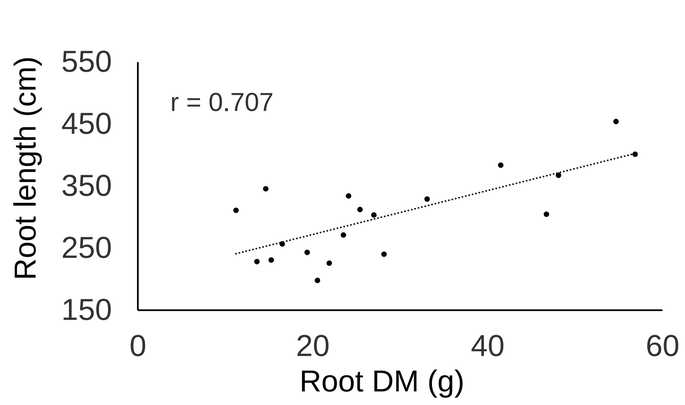


Figure 1. Relationship between total root length at 5 WAS and root dry matter at maturity of pearl millet plants grown in Rhizo-tubes in Niger.

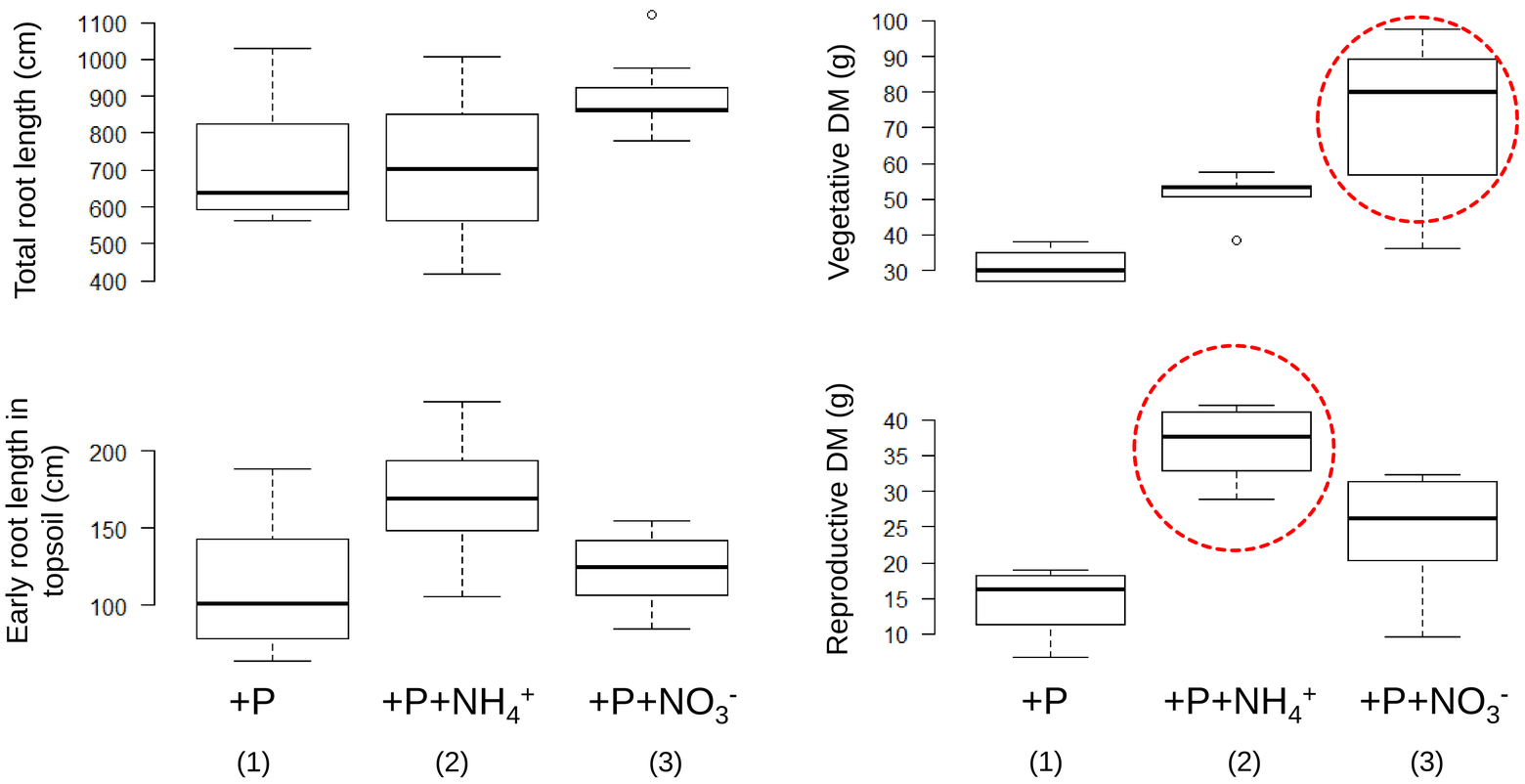


Figure 2. Total root length at 5 WAS (above) and sum of root length in the topsoil at 2 and 4 WAS (below) of pearl millet plants grown in Rhizo-tubes in Niger.

Figure 3. Total vegetative (roots + leaves + stem) (above) and reproductive (spikes) dry matter at maturity of pearl millet plants grown in Rhizo-tubes in Niger.

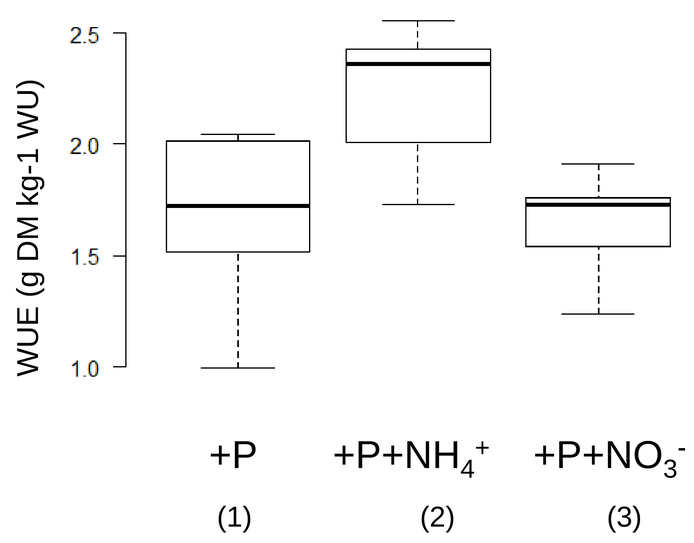


Figure 4. Water use efficiency (aboveground dry matter produced at maturity per unit of water transpired) of pearl millet plants grown in Rhizo-tubes in Niger.

Aknowledgements

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Conclusions

- Our results suggest that the choice of N source to add to P can be critical to the partitioning of vegetative versus reproductive biomass of pearl millet plants adapted to a low-P soil.
- NH_4^+ seems to improve water use efficiency, which is possibly related to the anticipated flowering of plants.
- The Rhizo-tubes methodology is a reliable tool for studying root developement under the West African Sahelian conditions.