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Genotypic variation in early root vigor among vegetatively propagated tropical grasses

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Introduction

- Grasses of *Urochloa* spp. and *Megathyrsus maximus* are gaining relevance in cattle production system systems in Sub-Saharan Africa (SSA). Currently, pre-breeding and breeding programs for *Urochloa* spp. and *M. maximus* are conducted by the Alliance of Bioversity & CIAT (ABC) for different market segments in SSA.
- Participatory evaluation of grasses previously identified ease of vegetative propagation as an important trait for farmers in Kenya and Rwanda; and a factor that facilitates farmer to farmer dissemination of novel grasses in small-scale, economically challenged farming. Also, previous research revealed genotypic differences and the morpho-physiologically "reasons" behind the ease of vegetative propagation among *Urochloa* spp. and *M. maximus* grasses.
- Early root vigor was identified as a main factor affecting ease of vegetative propagation. This is an essential trait for adequate uptake of water and nutrients and competition with weeds, which in turn will be reflected in a healthy forage stand.
- Given the relevance of vegetative propagation for farmers there is a need to identify and develop *Urochloa* spp. and *M. maximus* grasses that are fit for such purpose. The objective of this work was thereby to screen genotypes of *Urochloa* spp. and *M. maximus* from pre-breeding and breeding pipelines of ABC for their ease of vegetative establishment based on early root vigor.

Methodology

The experiment was carried out at the ABC Campus in Palmira, Colombia, in a glass greenhouse, with an average temperature of 31.3/23.8 °C (day/night) and relative humidity of 62.9/82.9 %. The evaluation was carried out with 31 genotypes: 13 from *M. maximus*, 15 from *Urochloa* sp., 2 *Vetiveria zizanioides* and 1 *Cenchrus ciliaris*.

The propagation material consisted of a vegetative propagule, a completely randomized experimental design with three replicates was used, the experimental unit consisted of one plant.

The plant material was placed in a hydroponic system, the pH was maintained between 6.0-6.1, nutrient solution with the following composition was added: NO_3 70.4 ppm; NH_4 9.76 ppm; CaO 75.8 ppm; P_2O_5 37.52 ppm; K_2O 82.8 ppm; Mg 19.2 ppm; S 11.39 ppm; Fe 0.62 ppm; Cu 0.03 ppm; Zn 0.09 ppm; Mn 0.26 ppm; Mo 0.001 ppm; B 0.39 ppm and Co 0.0001. The plants were maintained for 21 days. Root traits were evaluated by scanning the roots with the Epson 1200 scanner and analyzing them with the RhizoVision Explorer.

Results

The genotypes with the largest root diameter were CIAT:26970, Br02:1794 and CIAT:26895 (> 0.4 mm), while the genotypes CIAT:606, CIAT:6868, CIAT:16049 and CIAT:6299 had an average root diameter < 0.26 mm. CIAT:26970 and CIAT:26895 are accessions of *V. zizanioides*, which allows inferring about the ability of the species to develop thick roots from an early stage of plant establishment (Fig. 1).

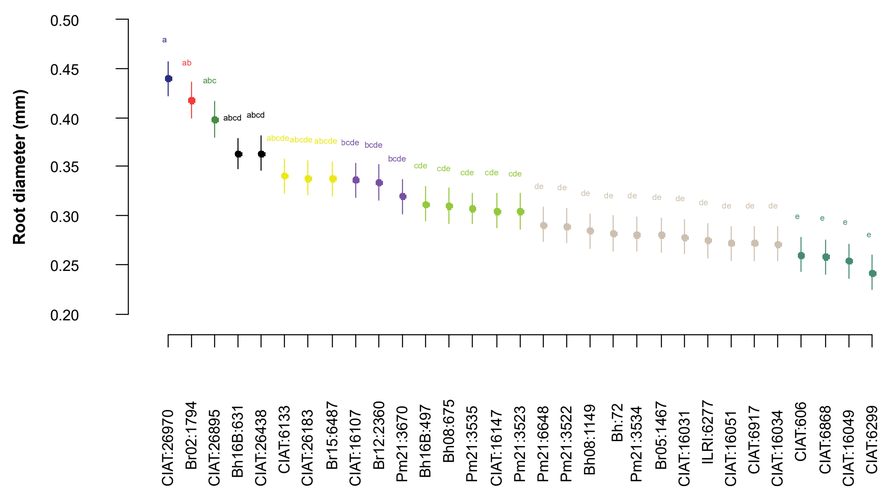

Figure 1. Root diameter of tropical grasses genotypes grown in hydroponic system. The values indicate the mean ± SE (n=3). Different letters indicate significant difference according to LSD test ($p < 0.05$, Fisher's LSD test).

CIAT:16049, Pm21:3523, Pm21:3670 and Pm21:3535 were the genotypes that had the highest number of roots (> 2600). CIAT:16049 is an accession of *M. maximus*, although this is one of the genotypes with smaller root diameter (Fig. 1), it presents the greatest number of roots, indicating that it is a material that invests more energy in the development of new roots and not in increasing thickness of existing roots. The Pm21 materials are hybrids of *M. maximus* developed by the Alliance's Tropical Forages Breeding Program. These hybrids are characterized by presenting root systems with too many roots (Fig. 2).

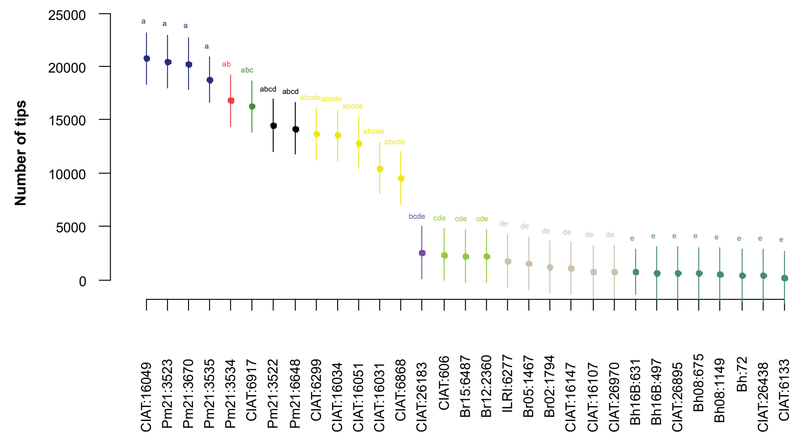

Figure 2. Number root tips of tropical grasses genotypes grown in hydroponic system. The values indicate the means ± SE (n=3). Different letters indicate significant difference according to LSD test ($p < 0.05$, Fisher's LSD test).

The genotypes Pm21:3523, Pm21:3534, Pm21:3670, Pm21:3535 and CIAT:6917 had the highest total root length (> 145 m). CIAT:6917 corresponds to an accession of *M. maximus*, indicating the capacity of the species to develop long roots and thus explore greater volume of soil. Bh materials are *U. humidicola* hybrids developed by the Breeding Program, some of these materials had the lowest total root length (Fig. 3), as well as low number of roots. Root length is a characteristic that presented high correlation (> 0.95) with the root surface area, root volume and number of roots.

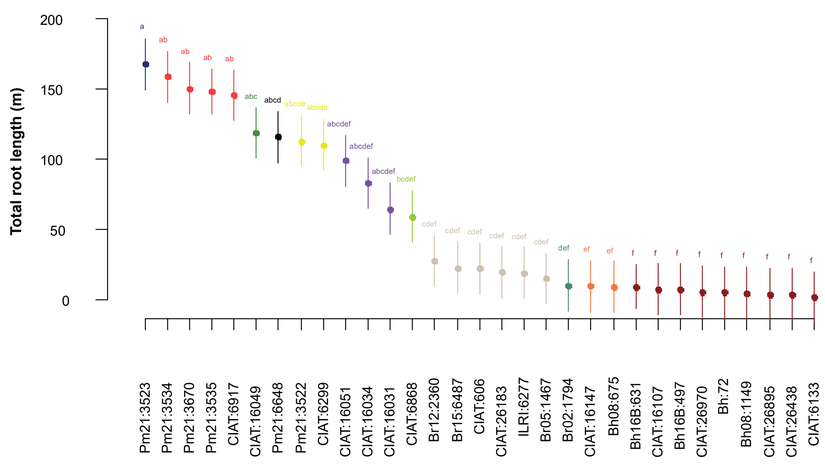

Figure 3. Total root length of tropical grasses genotypes grown in hydroponic system. The values indicate the means ± SE (n=3). Different letters indicate significant difference according to LSD test ($p < 0.05$, Fisher's LSD test).

CIAT:6917 accession and *M. maximus* hybrids developed by the Breeding Program were the genotypes that had the highest dry shoot weight, which has a high correlation (> 0.88) with root number, total root length, root volume and root surface area, being the latter an indicator of the potential that the root has to absorb nutrients from the soil and use them in the development of the plant, as we can see in these results (Fig. 4).

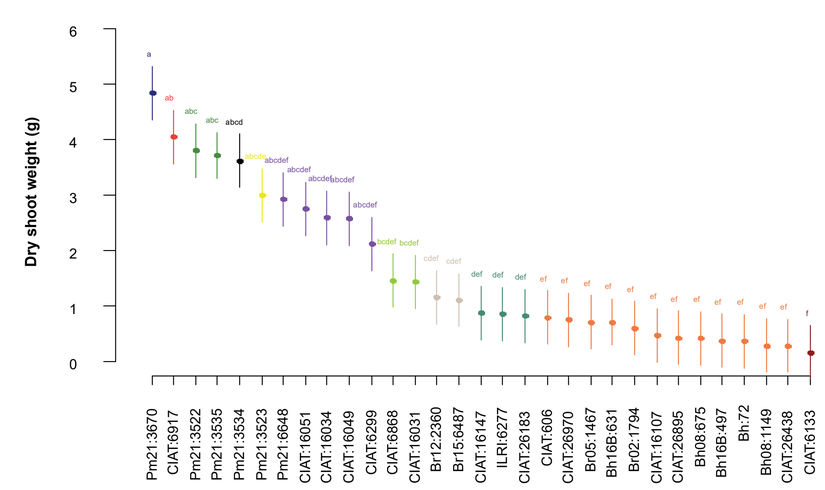

Figure 4. Dry shoot weight of tropical grasses genotypes grown in hydroponic system. The values indicate the means ± SE (n=3). Different letters indicate significant difference according to LSD test ($p < 0.05$, Fisher's LSD test).

Conclusion

Our results indicated that there is genotypic variation in early root vigor of vegetative propagules (VP), which in turn is affected by pool of total non-structural carbohydrates, number of nodes, preformed root primordia in nodes and sensitivity of epidermal cell rupture to ethylene of VP. The information generated in this study will help to further develop genotypes with greater early root vigor of vegetative propagated grasses which is an essential component for their uptake and use by small scale farmers in SSA.

Acknowledgments

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