Deep rooting ability is identified as an important trait for drought resistance in *Canavalia brasiliensis*, a forage legume

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Introduction

Canavalia brasiliensis (Figure 1), a highly drought adapted cover legume (stays green during 5 months of dry season), native from Central America; was introduced into the smallholder's traditional crop-livestock production system of the Nicaraguan hillsides to overcome soil fertility decline. Canavalia increases available forage biomass and augments milk production in the dry season (Douxchamps et al, 2008).

There is very limited knowledge on the physiological basis of adaptation of Cavavalia to either individual or combined stress factors of drought and low soil fertility. We tested the hypothesis that the superior tolerance of canavalia to long dry season under low soil fertility conditions is related to its deep rooting ability. We used a greenhouse soil tube method to quantify phenotypic differences in root development and distribution of 4 germplasm accessions of canavalia under simulated soil drying (terminal drought) combined with low fertilizer application.

Figure 1. Pod, seed, twining foliage, trifoliolate leaves and inflorescence of *Canavalia brasiliensis* Mart. ex Benth.

Materials and Methods

- A greenhouse study was conducted at CIAT-Palmira in 2009 using a mix of an Andisol (from Darien of Colombia) with river sand (2:1 w/w). Plants were grown for 35 days in plastic cylinders (80 cm long with 7.5 cm diameter) that were inserted in PVC tubes. The trial included 4 canavalia genotypes: *Canavalia brasiliensis* CIAT 17009, *Canavalia brasiliensis* CIAT 905, *Canavalia brasiliensis* CIAT 7969 and *Canavalia sp.* CIAT 21014. The trial was planted as a randomized complete block arrangement with two levels of water supply: well-watered and terminal drought stress conditions, and two levels of fertilizer application to soil: high amounts of fertilizer application and without fertilizer application.

- A number of shoot traits were measured during the experiment, including total chlorophyll content (SPAD), photosynthetic efficiency, leaf conductance and rooting depth. At harvest time (35 days after planting; 27 days with water stress treatment), leaf area, shoot biomass distribution, and root traits (root length, mean root diameter, specific root length, and root dry weight) were determined.

Results

During the plant growth and development the maximum and minimum air temperatures were 33 and 21 °C. The final soil moisture under terminal drought stress was at 8% of the field capacity.

The genotypes CIAT 7969 and CIAT 905 were outstanding in leaf area production under both fertilizer and water regimes. The genotype *Canavalia sp.* CIAT 21014 showed lower values of leaf area under both fertilizer and water regimes.

The genotype CIAT 905 showed the lower value of leaf conductance under individual drought stress conditions (high fertilizer + terminal drought) and combined low fertility and drought stress indicating the ability to regulate transpirational waterloss .

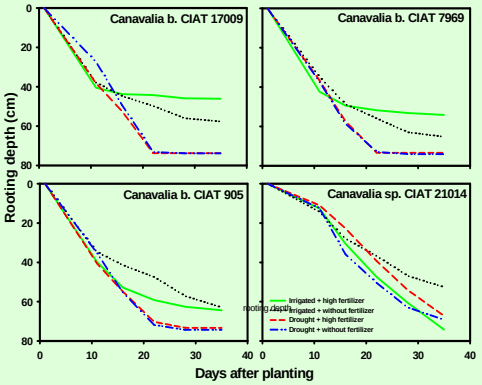

Figure 2. Influence of individual and combined stress factors of drought and low soil fertility on deep rooting of 4 Canavalia genotypes that were grown under greenhouse conditions of CIAT, Palmira

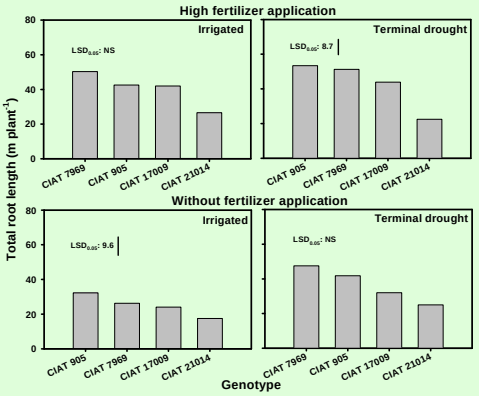

Figure 3. Influence of individual and combined stress of low soil fertility and drought on total root length of 4 Canavalia genotypes that were grown under greenhouse conditions of CIAT, Palmira

Genotypic differences were observed in deep rooting ability among treatments. All the genotypes, except CIAT 21014, showed a greater deep rooting ability under individual drought stress and combined stress of drought and low soil fertility (Figure 2). The genotypes CIAT 17009 and CIAT 7969 were outstanding in their deep rooting ability under individual low soil fertility conditions. The genotypes CIAT 17009 and CIAT 7969 showed greater ability for deep rooting under drought conditions with or without fertilizer application (Figure 2).

The genotypes CIAT 905 and CIAT 7969 were superior in root length production under individual terminal drought conditions and individual low soil fertility conditions (Figure 3). The genotypes CIAT 905 (Figure 4) and CIAT 7969 (Figure 5) were outstanding in their total root length production across soil depth under combined stress of drought and low soil fertility.

In some forage legumes such as *Stylosanthes guianensis*, drought avoidance is linked with deep rooting ability that contribute to improved acquisition of water and nutrients leading to superior dry season tolerance. Similar mechanism was observed in canavalia.

Figure 4. Influence of high fertilizer application combined with drought stress and irrigated conditions (A) and no fertilizer application combined with drought stress and irrigated conditions (B) on root development of *Canavalia* CIAT 905

Figure 5. Influence of high fertilizer application combined with drought stress and irrigated conditions (A) and no fertilizer application combined with drought stress and irrigated conditions (B) on root development of *Canavalia* CIAT 7969

Conclusions

Results from this greenhouse study indicated that drought resistance of canavalia under low soil fertility conditions is associated with deep rooting ability and vigorous fine root development to explore greater volume of soil. Two *Canavalia brasiliensis* accessions (CIAT 7969 and CIAT 905) were found outstanding in their total root length production across soil depth under combined stress factors of low soil fertility and drought.

References

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