

COMPARISONS OF CULTIVAR DIFFERENCES IN ROOT GROWTH MEASURED UNDER FIELD CONDITIONS, CONTAINERS, AND HYDROPONIC CULTURE

Jeffrey W. White, Consuelo Montes R. and German A. Llano R.
CIAT, Bean Physiology, Apt. Aereo 6713, Cali, Colombia

Previous studies on adaptation to water deficits under conditions at CIAT indicated that differences among genotypes reflected desiccation postponement through greater soil moisture extraction (Sponchiado et al., 1988). Differences were attributable to genes acting in the root system and affected many traits including carbon isotope discrimination (White et al., 1990). Since field screening for root traits is difficult, two approaches using container systems were examined for screening cultivars for differences in root growth.

One system consisted of growing single plants in 3.5 l containers using a 50:50 soil-sand mix with a competitor plant of line BAT 477 or A 70. Pots were irrigated to field capacity at transplanting, after which they were irrigated daily for 15 days with the equivalent of 50% of the previous days evapotranspiration. For the final 7 days, irrigation was withheld, pots being harvested on day 30 for determination of leaf area and shoot and root dry weights. The competitors were included to accentuate expression of differences in root genotype.

The second system was to grow plants in a hydroponic system. Fifty plants were grown in a single 100 l tank containing a medium intended to provide complete nutrients and no osmotic stress. Germinated seeds were transplanted to the tank at 5 d, and plants were sampled at 8 d. Although this system represents a large deviation from field conditions with water stress, the potential rapidity of evaluations made it of interest.

For both systems, the 10 genotypes evaluated were the same as those described in White et al. (1990) where root length density (RLD) was correlated ($r = 0.77$, $p < 0.01$) for contrasting soils at CIAT-Palmira (deep, fertile Mollisol) and CIAT-Quilichao (shallow, acid Oxisol). Thus, the field RLD data were used to evaluate effectiveness of the two systems.

In the competition study, total plant weights of the 10 genotypes and the competitors were negatively correlated ($r = -0.75$, $p < 0.02$), confirming the presence of competitor-accentuated differences in plant growth. Overall differences in root dry weights were found. No interaction between use of BAT 477 or A 70 as a competitor was detected, so means across competitors were used in subsequent analyses. Relative growth of shoots of the test genotype and the competitor was negatively associated ($r^2 = 0.41$, $p < 0.05$) with RLD (Fig. 1A), suggesting that genotypes with good root development may have relatively less shoot growth.

In the hydroponic studies, differences in root fresh weight were found in the second trial, and root weight was correlated with field RLD (Fig. 1B). The first trial gave no differences among genotypes, although root growth was twice as great. These contrasting results were unexpected, particularly under the supposed controlled conditions of hydroponic culture, so possible reasons for the inconsistency are being sought.

These results suggest that simple container systems can be used to detect differences among cultivars which reflect differences in traits of importance under field conditions. However, further refinements are needed, and other approaches merit consideration.

References

- Sponchiado, B.N., J.W. White, J.A. Castillo and P.G. Jones. 1989. Root growth of four common bean cultivars in relation to drought tolerance in environments with contrasting soil types. *Exp.Agric.* 25:249-257.
- White, J.W., J.A. Castillo and J. Ehleringer. 1990. Associations between productivity, root growth and carbon isotope discrimination in *Phaseolus vulgaris* under water deficit. *Aust. J. Plant Physiol.* 17:189-198.
- White, J.W. and J.A. Castillo. 1989. Relative effect of root and shoot genotypes on yield of common bean under drought stress. *Crop Sci.* 29:360-362.

Figure 1. Comparison of mean root length density at two locations for ten cultivars in relation to A) growth of shoot of test genotype to competitor shoots and B) root fresh weight of 8 day old plants in hydroponic culture.

