Root system morphology of sorghum genotypes contrasting for phosphorus efficiency

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The acid soil complex in the tropics includes low pH, toxic levels of Al, low availability associated with high adsorption of phosphorus (P), and a generalized low level of plant nutrients. This soil acidity complex often creates a chemical barrier to root growth and development, decreasing root contact with soil nutrients and water, resulting in even greater water and nutrient stress. Forty-eight percent of the potentially arable land of the world is acidic. Sixty-four percent of the agriculture land of tropical South America, 32% of the land of tropical Asia, and 10% of the land in Central America, the Caribbean and Mexico are acidic. The acid savannas or "Cerrado" of Brazil covers an area of 205 million hectares of which 175 million are in central Brazil. Approximately 112 million hectares are considered adequate for agriculture production.

The strategy of eliminating the constraint imposed by low P availability in acid soils with corrective applications of P is limited technically due to the high rates of P fertilizer required and the high P fixing capacity of the soil. A combination of soil management practices, including liming in association with corrective levels of P, and use of crop cultivars developed for these acid soils conditions is a solution encountered for sustainable crop production in these areas. Tolerant plants can develop root systems in this chemical barrier explore a greater volume of soil, thus increasing the supply of soil nutrients and water. The identification and understanding of the alteration of the rhizosphere environment, mechanisms of acquisition and mechanisms of utilization of soil P can facilitate the genetic manipulation of these parameters. Genetic variability for both P use efficiency and P responsiveness has been identified at Embrapa Maize and Sorghum. (Schaffert et al. 2001). Among sorghum BR005 has been described as a P efficient line at low levels of soil P, BR007 has been described as a P responsive line, whereas SC283 has been described as P efficient at low levels of soil P, but was not responsive to additional P.

This study was conducted to evaluate the effect of phosphorus (P) stress on morphological characteristics of root systems of sorghum genotypes previously characterized for P efficiency in field trials using grain production as the key parameter. The sorghum lines ATF 41, inefficient and nonresponsive, BR 007, BR 005, and SC383 were used. Selected seedlings of the four lines were transplanted in suspension transparent plastic files lined with blue Anchor germination blotter paper. The suspension files were placed in 40L plastic boxes containing 5L of a 5.5 pH nutrient solution (Clark, modified by Magnavaca, 1982) with no P or 0,129 mM P. The root system was photographed daily for 10 days with a digital camera and the images were processed using SIARCS software (Embrapa/CNPDIA) to determine total root length. On the 10th day the roots of the four sorghum genotypes were evaluated for the development of root hair density and root hair length at the two P levels.

The root length development for the four genotypes is shown in Fig. 1. BR007 had the greatest overall root length after 10 days of evaluation without P stress, confirming its responsiveness to P. The P efficient genotypes, SC283 and BR005 had greater root development under P stress after six days, whereas the responsive genotype had greater root length without P stress. The P efficient genotype, SC283, developed both a higher root hair density and longer root hairs under P stress than the other genotypes (Fig. 2 and 3). This preliminary study indicates that there is genetic variability between the lines studied for both root length and rood hair development in P stress conditions. This methodology should be useful in determining useful parameters for selection for P efficiency in plant improvement programs.

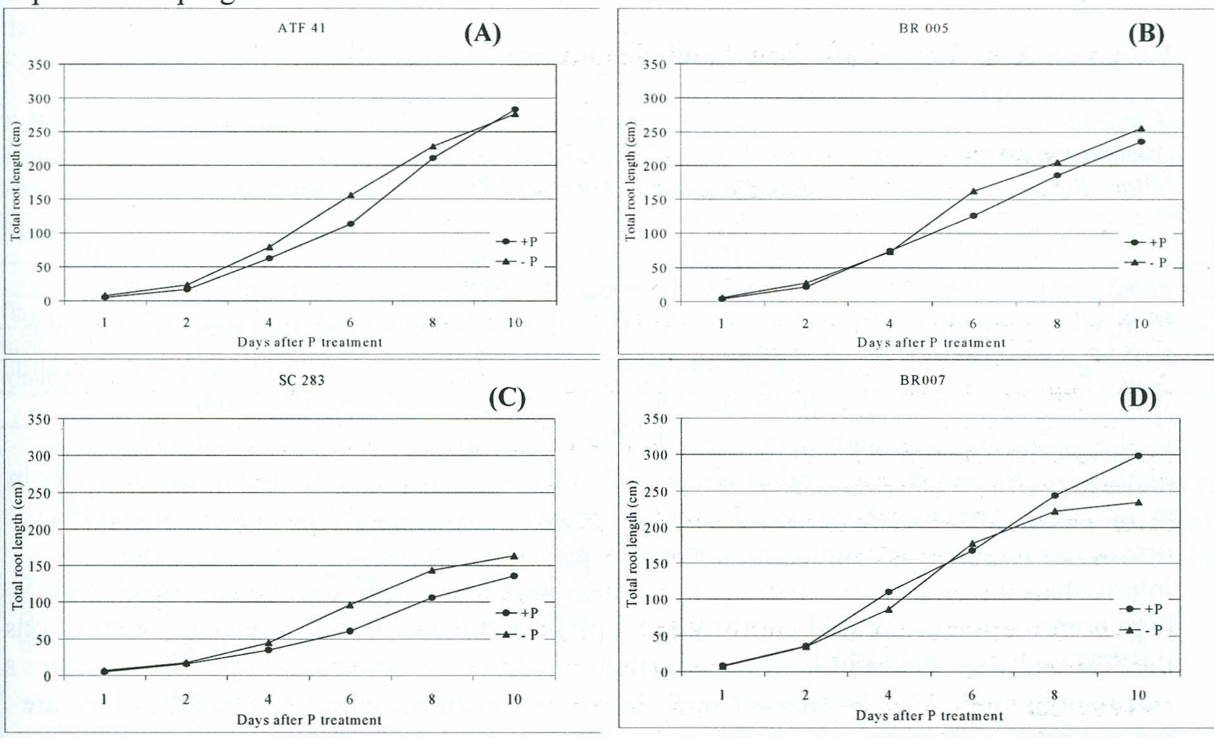

Fig 1. Average root length of the sorghum genotypes (A) ATF 41, (B) BR 005, (C) SC 283, (D) BR 007 at two P levels.

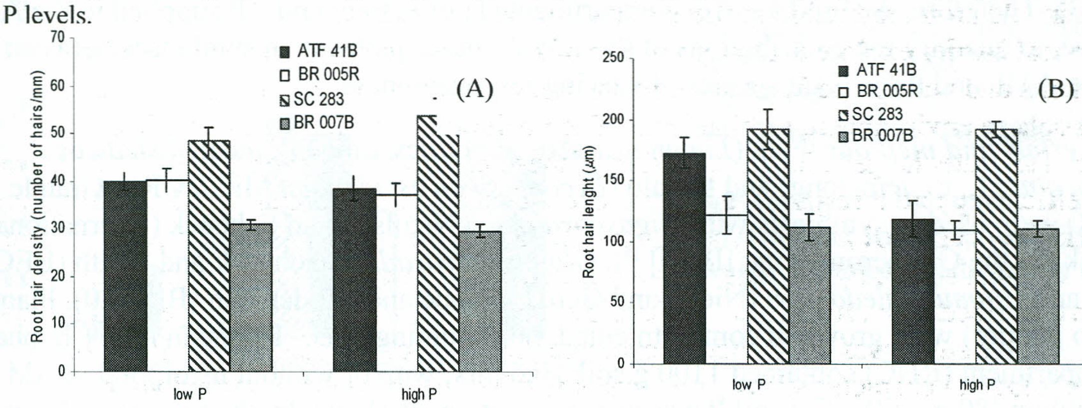

Fig 2. Density (A) and length (B) of root hairs of the P efficient genotypes, BR 005R and SC283 and the P inefficient genotypes, ATF 41B and BR007.

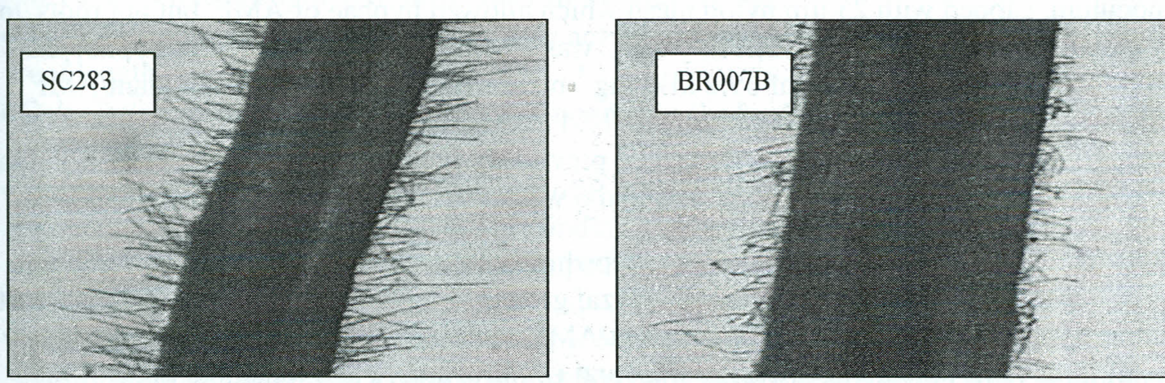

Fig. 3. Root hair development of the P efficient sorghum genotypes SC283 and the P inefficient genotype BR007 in P stress.

R.E. Schaffert, V.M.C. Alves, G.V.E. Pitta, AFC Bahia, and F.G. Santos (2001) *W.J. Horst et al. (Eds.) Plant Nutrition-Food Security and sustainabilityof Agro-ecosystems, Kluwer AP,* 72-73.