PHOSPHORUS TOLERANCE IN COMMON BEAN AS AFFECTED BY ROOT ARCHITECTURE

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Bean production in Africa is typically under low soil P conditions and is estimated to reduce productivity in sub-Saharan Africa by 355,000 t yr^{-1} (Wortmann *et al.*, forthcoming). Lynch and van Beem (1993) found bean varietal differences for the weight, length and rates of root growth and elongation, and in the number of basal and lateral roots. A P efficient genotype had a vigorous, highly branched root system with numerous basal roots while a P inefficient genotype had a smaller, less branched root system. Yan *et al.* (1995a) found that P efficient genotypes had more root weight and length than inefficient genotypes. Knowledge of the role of root architecture in acquisition of scarce P could improve the efficiency of efforts such as the BILFA (Bean Improvement for Low Fertility in Africa; Wortmann *et al.*, 1995) to select for greater low P tolerance in bean germplasm.

Root characteristics were determined in a screenhouse study in Uganda. Ten low P tolerant and three well-adapted susceptible genotypes were studied; their capacity for P acquisition under low soil P field conditions had been previously determined. Seed was sown into a mixture of soil and lake sand contained in black polyethylene tubes of 22.5 cm diameter, and either 50 or 75 cm length. N, P and K fertilizers were added to ensure adequate supply of these nutrients. Seedlings in the shorter tubes were harvested at eight days after sowing; and those in longer tubes were harvested at 14 or 21 DAS. Tubes were cut open and seedlings carefully removed. One seedling was selected for observation.

Genotypes differed for several root characteristics: number of lateral roots; basal root, lateral root plus tap root, and total root weight; length of basal roots and of the longest lateral root; and ratio of shoot to root weight (Table 1). Genotypic differences for number of basal roots and tap root length were not significant. The susceptible, large seeded genotypes had greater total basal root length and total root length, and were major determinants of coefficients of correlation for these traits. When the correlation analysis was limited to small seeded genotypes, P acquisition was positively related to total basal root length (r=0.65) and total root length (r=0.51). Increased lateral root growth was negatively related to P uptake (Table 2).

P tolerant genotypes can be grouped into three categories: UBR(92)13, BAT 85 and UBR(92)05 presumably benefit from more extensive root systems; P acquisition appears to be moderately associated with root characteristics for MLB 45-89A, UBR(92)12, ACC 433, UBR(92)29 and MMS 243; and the tolerance of UBR(92)26 and XAN 76 appears to be independent of the measured root characteristics.

Genotypes differed for most root characteristics measured, but only length of basal roots was related to P uptake under low P field conditions in the small seeded varieties; but length of lateral roots was negatively correlated with uptake. These results should be verified by comparing the total length of basal roots of several other small seeded low P tolerant lines with susceptible lines; such a comparison should be done amongst large seeded types as well. Preliminary screening of bean genotypes for capture efficiency of scarce P might be done by selection based on total basal root length at the seedling stage, but comparisons should be within seed size categories.

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Table 1. Root characteristics of 11 small-seeded bean genotypes grown in soil:sand mixture in a screenhouse (averages of samples taken at 8, 14, 21 days after planting).

Genotype	Total basal root length (cm)	Total root length (cm)	P uptake by 10 plants at R8 (g)
UBR(92)05	161.9	201.8	0.32
UBR(92)09	113.6	146.4	0.29
UBR(92)12	120.9	170.0	0.25
UBR(92)13	160.1	202.2	0.34
UBR(92)29	137.9	174.7	0.40
BAT 85	173.8	211.0	0.36
MMS 243	135.2	174.3	0.31
MLB-45-89A	136.3	169.5	0.34
XAN 76	127.6	166.4	0.33
ACC 433	123.9	170.0	0.25
MCM 5001	155.3	154.6	0.24