Abstract

Water deficit due to unreliable rainwater supply and P depletion are by far the most prevalent abiotic stresses limiting common bean production in sub-Saharan Africa. Intervention into these factors is increasingly through the use of varieties with adaptation potential, as an alternative to many costly recommended technologies such as irrigation and use of fertilisers. Although bean varieties that are tolerant to low soil P exist at research stations associated with CIAT, their performance when predisposed to concurrent water deficit-low P conditions is yet to be evaluated. It is particularly important that the possible mechanisms for adapting to the joint stresses are understood in order to enable resource disadvantaged farmers to leverage their low capital investments. This study therefore, assessed the low soil P tolerant common bean genotypes of morphological and physiological responses to water deficit conditions.

To determine the plant leaf physiological and morphological responses of low soil P tolerant beans to water deficit, a controlled experiment was conducted in a screen house. The treatments included three bean genotypes, namely AFR703-1 and AFR708 (low soil P tolerant), and K131 (check); two water levels, namely water deficit (WD) and well-watered (WW) as the control; and three levels of phosphorus (0, 6 and 16 mg P kg^{-1} of soil). Treatments were laid out in a completely randomised design.

A field study was also carried out to evaluate the plant phenology and root development as adaptive responses to soil water deficit. The field experiment was conducted during two rainy seasons (March-June and August-December, 2014) at two sites in central Uganda, namely the Mukono Zonal Agricultural Research and Development Institute in Mukono District; and at Wabinyonyi in Nakasongola District. The Mukono site receives rainfall of more than 400 mm $season^{-1}$ thus considered as the well-watered environment (WWE) while Wabinyonyi, receives less than 300 mm $season^{-1}$ thus considered as the water deficit environment (WDE). Phosphorus was applied as triple superphosphate (TSP) at rates of 0, 12 and 32 kg P ha^{-1}, while the two test materials used in the screen house were also used in the field experiment on top of JESCA, and MCM5001 genotypes. Treatments were laid out in a randomised complete block design with three replications.

Water deficit significantly compromised the RWC, biomass production and grain yield of all low soil P tolerant common beans. However, AFR703-1 genotype maintained its inherent RWC under WD condition compared to under WW condition. Application of P mitigated the WD effects in low soil P tolerant common beans, particularly in AFR708 which was more

susceptible to WD conditions. AFR708 responded to P application under WD conditions to the level of WW conditions.

Genotypes AFR703-1 and AFR708 adapted to WD by reducing their number of days to flower, and seed filling. Consequently, they matured 4 to 16 days earlier in the WDE than the WWE. The low soil P tolerant genotypes, especially the AFR genotypes and MCM5001 had significantly ($p < 0.05$) more adventitious roots, longer tap and lateral roots, greater total roots and finer specific root length than the check.