Abstract

Common bean (*Phaseolus vulgaris* L.) is a staple crop that is core to household nutrition and food security, especially in rural Sub-Saharan Africa where nutrition is anchored predominantly on starchy diets. The crop is also a major source of household income particularly among rural women. Unfortunately, its production is severely constrained by soil based nutrition especially low plant-available phosphorus (P) and drought. The objective of this study was therefore, to contribute to reduction of adverse effects of drought on common bean vegetative growth, N_2 fixation with associated grain yields in Uganda. Specifically, the study focused on drought as a determinant of growth, phenology, yield, biological N_2 fixation efficiency (assessed by the ureide procedure) and root architectural development despite the available phosphorus.

A field experiment was conducted under two drought conditions hereafter referred to as non-drought-stress (NDS) and drought-stress (DS), depending on the level of rainfall received in the area. The former was located at Mukono Zonal Agricultural Research and Development Institute in Mukono District (at latitude; 00° 15' 00" N and longitude; 32° 30' 00" E); and the latter at Wabinyonyi in Nakasongola District (at latitudes; 00° 57' 44.89" to 1° 40' 42.76" North and longitudes, 31° 58' 03.77" and 32° 48' 00.29" East) both of central Uganda. Non-drought-stress (ND) was characterised by rainfall of more than 400 mm season^{-1}, yet the drought-stress condition was characterised by less than 300 mm season^{-1}. Both sites were characterised by Bray 1 P <10 mg kg^{-1}. The experiment was carried out during rainy seasons of March-June and August-December 2014. Treatments included the two drought conditions, namely NDS and DS phosphorus at rates of P0, P60 and P160 kg ha^{-1} applied as TSP; and four bean genotypes, namely AFR703-1, AFR708, JESCA and MCM2001 against the control; K131. Treatments were laid out in a randomised complete block design with three replications.

Although soil Bray 1 P was insufficient (<15 mg kg^{-1}) for optimum bean plant growth, application of P had no significant *($p > 0.05$*) influence on grain yield and yield components, biological N-fixation (based on ureide analysis) and root development, suggesting that P was not a limiting factor for growth of the bean plant in either drought condition. On the other hand, the interaction effect of genotypes and drought condition was significant (p<0.001) on grain yield, with genotype AFR708 registering the highest yield (1775 kg ha^{-1}) in NDS condition. Similarly, all the genotypes tested significantly (*$p<0.05$*) out-performed the local check in terms of the N_2 fixed in the DS district. The genotypes investigated overcame drought

stress through fast growth during the vegetative phase and flowering early, with subsequent early attainment of physiological maturity in the DS district, particularly in genotypes AFR703-1 and AFR708. Further, the low P-tolerant common beans, particularly AFR703-1 and AFR708, when grown in the DS condition endured drought stress by developing numerous and long roots compared to the control genotype. These among others were considered as the adaptive mechanisms for survival of these genotypes under both low P and drought soils.

In conclusion, all the low P test common bean genotypes are consistently superior to the local check in the DS condition, in terms of agronomical responses, biological N_2 fixation and root development. It is also important to note that AFR703-1 and AFR708 genotypes combine adaptive mechanisms of greater mobilization of photosynthates to grain production, with early phenology and enhanced root development; more adventitious roots, longer tap and lateral roots, greater total roots and finer specific root length than the local check, especially when grown under DS condition. Therefore, since those genotypes out-perform the local check in most of the measured variable under DS conditions, they may be grown in both DS and NDS conditions for bolstering yields. The genotypes also can be used as breeding materials that can resist drought even better. However, there seems to be a moisture threshold at which the bean plant may not thrive, a topic warranting further studies.