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Symbiotic Functioning, Photosynthetic Induction and Characterisation of Rhizobia Associated with Groundnut, Jack Bean and Soybean from Eswatini

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Abstract : Legumes are a major source of biological nitrogen, and therefore play a crucial role in maintaining soil productivity in smallholder agriculture in southern Africa. Through their ability to fix atmospheric nitrogen in root nodules, legumes are a better option for sustainable nitrogen supply in cropping systems than chemical fertilisers. For decades, farmers have been highly receptive to the use of rhizobial inoculants as a source of nitrogen due mainly to the availability of elite rhizobial strains at a much lower compared to chemical fertilisers. To improve the efficiency of the legume-rhizobia symbiosis in African soils would require the use of highly effective rhizobia capable of nodulating a wide range of host plants. This study assessed the morphogenetic diversity, photosynthetic functioning and relative symbiotic effectiveness (RSE) of groundnut, jack bean and soybean microsymbionts in Eswatini soils as a first step to identifying superior isolates for inoculant production. According to the manufacturer's instructions, rhizobial isolates were cultured in yeast-mannitol (YM) broth until the late log phase and the bacterial genomic DNA was extracted using GenElute bacterial genomic DNA kit. The extracted DNA was subjected to enterobacterial repetitive intergenic consensus-PCR (ERIC-PCR) and a dendrogram constructed from the band patterns to assess rhizobial diversity. To assess the N2-fixing efficiency of the authenticated rhizobia, photosynthetic rates (A), stomatal conductance (gs), and transpiration rates (E) were measured at flowering for plants inoculated with the test isolates. The plants were then harvested for nodulation assessment and measurement of plant growth as shoot biomass. The results of ERIC-PCR fingerprinting revealed the presence of high genetic diversity among the microsymbionts nodulating each of the three test legumes, with many of them showing less than 70% ERIC-PCR relatedness. The dendrogram generated from ERIC-PCR profiles grouped the groundnut isolates into 5 major clusters, while the jack bean and soybean isolates were grouped into 6 and 7 major clusters, respectively. Furthermore, the isolates also elicited variable nodule number per plant, nodule dry matter, shoot biomass and photosynthetic rates in their respective host plants under glasshouse conditions. Of the groundnut isolates tested, 38% recorded high relative symbiotic effectiveness (RSE >80), while 55% of the jack bean isolates and 93% of the soybean isolates recorded high RSE (>80) compared to the commercial Bradyrhizobium strains. About 13%, 27% and 83% of the top N_2-fixing groundnut, jack bean and soybean isolates, respectively, elicited much higher relative symbiotic efficiency (RSE) than the commercial strain, suggesting their potential for use in inoculant production after field testing. There was a tendency for both low and high N_2-fixing isolates to group together in the dendrogram from ERIC-PCR profiles, which suggests that RSE can differ significantly among closely related microsymbionts.

Keywords : genetic diversity, relative symbiotic effectiveness, inoculant, N_2-fixing
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