ABSTRACT

Organic farming is gaining popularity as agronomically and environmentally sound soil management strategy with the potential to enhance soil microbial diversity and fertility, environmental quality and sustainable crop production. However, the role of bradyrhizobia and arbuscular mycorrhizal fungi (AMF) in organic farming systems is poorly understood. Field experiments were carried out to evaluate the effects of organic farming and bradyrhizobia inoculation on soybean nodulation, AMF root colonization, growth, production and yield quality. Greenhouse and laboratory experiments sought to determine the effects of bradyrhizobia and/or AMF inoculation and dual inoculation in promoting root colonization and nodulation, determine soil mycorrhizal inoculum potential (MIP), evaluate the abundance and effectiveness of native bradyrhizobia and determine the morphological and genetic diversity of native bradyrhizobia isolates under different farm management practices. Field experimental treatments included native bradyrhizobia, commercial Bradyrhizobiun japonicum, a mixture of native and commercial Bradyrhizobium japonicum and control. Promiscuous soybeans varieties SB 19 and SC squire as well as non-promiscuous Gazelle were used as test plants. All field experiments were carried out in split-split plot design. In the greenhouse, AMF and bradyrhizobia were inoculated and dual inoculated on SC squire soybeans. The AMF inoculants used were Funneliformis mosseae and Rhizophagus irregularis while bacteria involved commercial bradyrhizobia and native bradyrhizobia. Greenhouse experiments were set out using completely randomized design. The native bradyrhizobia were isolated and characterized. Deoxyribonucleic acid (DNA) from nodule isolates was extracted using Gene Jet DNA extraction kit. Polymerase chain reaction (PCR) targeting 16S rDNA gene was carried out using universal primers P5-R and P3-F. Polymerase chain reaction product purification and sequencing was carried out in MacrogenNetherlands. Sequencing was done using the same primers. Non molecular data obtained was analyzed using analysis of variance (ANOVA). Means that were significantly different at $p< 0.05$ were separated using Tukey's HSD test. Field experiment results demonstrated significant improvement of soybean nodule dry weight (NDW), shoot dry weight (SDW) and seed dry weight (SEDW) due to inoculation. Bradyrhizobia inoculation increased soybean seed yields by between 29-59% of its potential yield. Remarkably, organic farming significantly ($p=0.001$) out-performed conventional systems in SDW, NDW, SEDW and AMF root colonization. Moreover, seed nutrient significantly differed in organic and conventional farming where, seed nitrogen, phosphorus, potassium and organic carbon were higher in organic farming. Soybean varieties differed significantly on SDW, NDW and SEDW, where SC squire performed better compared to SB 19 and Gazelle. Greenhouse results showed bradyrhizobia and AMF dual inoculation significantly enhanced AMF root colonization, NDW and SDW compared with individual bradyrhizobia, AMF or control. Moreover, organic farming significantly ($p=0.001$) increased SDW, NDW and AMF root colonization compared to conventional farming. Organic farming had a significant effect ($p = 0.001$) on soil MIP. Based on molecular analysis, isolates were bradyrhizobia and matched with Bradyrhizobium japonicum among other species. There was little or no genetic differentiation of isolates with the highest molecular variation (91.12%) within the populations and 8.88 % among populations. The results demonstrate the importance of organic farming and dual inoculation in sustainable crop production. The highly potential native bradyrhizobia isolates (GRPc and GRPk) and exotic AMF should be xix popularized and commercially ultilized by farmers to alleviate declining soil fertility and increase food production with minimum expenses.