

Public Abstract

First Name:**Ahsan**

Middle Name:**Mir**

Last Name:**Rajper**

Adviser's First Name:Ranjith

Adviser's Last Name:Udawatta

Co-Adviser's First Name:

Co-Adviser's Last Name:

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Title: **ASSESSING THE ROLE OF PROBIOTICS FOR THE ENHANCEMENT OF SOIL QUALITY UNDER COVER CROPS**

Use of agro-chemicals over the past few decades has increased land productivity, however, frequent use of agro-chemicals may result in some negative impacts on the environment and soil microbial biodiversity. Use of alternative management such as application of probiotics for soil and plants is believed to promote soil biodiversity and soil nutrient cycling. Probiotics are believed to improve plant growth, root development and production of plant growth promoting substances. The main objective of this study was to quantify the effects of SCD Probiotics (Bio-Ag) on soil quality (SQ; microbial biomass, microbial communities, enzymatic activity) in association with cover crops in field and greenhouse studies.

This research was conducted at the Natural Resources Conservation Service (NRCS) Soil Health Demonstration Farm, Chariton County, Missouri to quantify probiotic effects on soil biology and enzyme activity. Prior to 2012, the site was comprised of conventional corn (*Zea mays* L.)-soybean (*Glycine max* L.) rotation with tillage and chemical fertilizer (anhydrous) use. Soils at the study site were Armstrong loam (fine, smectitic, mesic Aquertic Hapludalfs). The treatments included: control, treatment 1 (Trt1; 60L ha⁻¹ yr⁻¹ of Bio-Ag probiotics), treatment 2 (Trt2; 90L ha⁻¹ yr⁻¹ of Bio-Ag probiotics) and treatment 3 (Trt3; 120L ha⁻¹ yr⁻¹ of Bio-Ag probiotics) with three replications. Two equal split soil applications of probiotics were applied in September 2013 and May 2014. Soil samples were collected in August 2013, September 2013 and June 2014 from 0-6cm depth. Soil microbial biomass and community structures were analyzed using phospholipid fatty acid (PLFA) analysis. Standard enzyme assays were used to analyze B-glucosidase, fluorescein diacetate hydrolase (FDA), dehydrogenase (DHA) and B-glucosaminidase activities. Total fungi biomass was highest in Trt3 followed by control, Trt1 and Trt2. Saprophytic fungi, protozoa and rhizobia biomarkers were significantly higher in Trt3 than control. Principal component analysis (PCA) revealed that PC1 and PC2 accounted for 62% of total variance. PCA also revealed that with time saprophytic fungi, protozoa and rhizobia biomass increased in Trt3 treatment. DHA ($p < 0.001$) and FDA ($p < 0.037$) were significantly higher in Trt3 than control, Trt1 and Trt2. Increasing trends in the values of soil fungal communities, rhizobia, DHA, B-glucosaminidase and FDA with probiotic concentration imply that probiotics can be used to improve SQ parameters.

A secondary study was conducted to quantify probiotic effects on hairy vetch roots and precursor-independent auxin production in soils in greenhouse study with control and treatment 3 (Trt3; 120L ha⁻¹ yr⁻¹ of Bio-Ag probiotics) treatments. Soil dilutions were plated on King's B medium selective for fluorescent pseudomonads. Fluorescent pseudomonads were significantly higher in Trt3 than control after the second probiotic application. Auxin production in soil samples was determined by high-performance liquid chromatography-Mass spectrometry (HPLC-MS/MS). Probiotics showed no effect on the precursor-independent production of auxin in soil samples. Two plant root samples (36 days old) with replicated images were also collected 7 days after the first probiotic application for scanning electron microscopy (SEM) observations. Images of SEM revealed more root hair growth and microbial colonization on hairy vetch roots treated with probiotic compared to control.

Our secondary study implied that root hair growth and fluorescent pseudomonads are increased in hairy vetch with probiotic application. However, there was no effect of probiotic on auxin content in the soils. Our results also suggest that auxin-like substances can be detected using HPLC-MS/MS method and compounds can be recovered up to 87%.