Microalgae and Phototrophic Purple Bacteria for Nutrient Recovery from Agri-Industrial Effluents; Influences on Plant Growth, Rhizosphere Bacteria, and Putative C & N Cycling Genes

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Microalgae (MA) and purple phototrophic bacteria (PPB) have the ability to remove and recover nutrients from digestate (anaerobic digestion effluent) and pre-settled pig manure that can be utilized as a bio-fertilizer. The objective of this study was to compare the effect of biologically recovered nutrients from MA and PPB in relation to plant growth and soil biological processes involved in nitrogen & carbon cycling. To this end, a glasshouse experiment was conducted with MA and PPB as biofertilizers for growing a common pasture ryegrass (Lolium rigidum Gaudin.) with two destructive harvests (45 and 60 days after emergence). To evaluate the rhizosphere bacterial community we used barcoded PCR-amplified bacterial 16S rRNA genes, for paired end sequencing on the Illumina Mi-Seq. Additionally, we used Phylogenetic Investigation of Communities by Reconstruction of Unobserved States (PICRUSt) analysis for the detection of putative functional genes associated with nitrogen (N) cycling and soil carbon (C) cycling. There was a significant enhancement of plant growth when applying PPB to soil, which was comparable with the effects of chemical fertilizers. Comparison of rhizosphere bacteria between two harvests revealed an increase in the relative abundance of most gram-negative bacteria. There was also an increase in nitrogen cycling (nitrogen fixation, nitrification and denitrification) and carbon (starch, hemicellulose, cellulose, chitin and lignin) degrading genes in the rhizosphere of microalgae treatments during the second harvest. These data indicate that biologically recovered nutrients from waste resources can be used effectively as a fertilizer resulting in enhanced C and N cycling capacities in the rhizosphere.