World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:15, No:01, 2021

Effect of Chemical Fertilizer on Plant Growth-Promoting Rhizobacteria in Wheat

Authors : Tessa E. Reid, Vanessa N. Kavamura, Maider Abadie, Adriana Torres-Ballesteros, Mark Pawlett, Ian M. Clark, Jim Harris, Tim Mauchline

Abstract : The deleterious effect of chemical fertilizer on rhizobacterial diversity has been well documented using 16S rRNA gene amplicon sequencing and predictive metagenomics. Biofertilization is a cost-effective and sustainable alternative; improving strategies depends on isolating beneficial soil microorganisms. Although culturing is widespread in biofertilization, it is unknown whether the composition of cultured isolates closely mirrors native beneficial rhizobacterial populations. This study aimed to determine the relative abundance of culturable plant growth-promoting rhizobacteria (PGPR) isolates within total soil DNA and how potential PGPR populations respond to chemical fertilization in a commercial wheat variety. It was hypothesized that PGPR will be reduced in fertilized relative to unfertilized wheat. Triticum aestivum cv. Cadenza seeds were sown in a nutrient depleted agricultural soil in pots treated with and without nitrogen-phosphorous-potassium (NPK) fertilizer. Rhizosphere and rhizoplane samples were collected at flowering stage (10 weeks) and analyzed by culture-independent (amplicon sequence variance (ASV) analysis of total rhizobacterial DNA) and -dependent (isolation using growth media) techniques. Rhizosphere- and rhizoplane-derived microbiota culture collections were tested for plant growth-promoting traits using functional bioassays. In general, fertilizer addition decreased the proportion of nutrient-solubilizing bacteria (nitrate, phosphate, potassium, iron and, zinc) isolated from rhizocompartments in wheat, whereas salt tolerant bacteria were not affected. A PGPR database was created from isolate 16S rRNA gene sequences and searched against total soil DNA, revealing that 1.52% of total community ASVs were identified as culturable PGPR isolates. Bioassays identified a higher proportion of PGPR in non-fertilized samples (rhizosphere (49%) and rhizoplane (91%)) compared to fertilized samples (rhizosphere (21%) and rhizoplane (19%)) which constituted approximately 1.95% and 1.25% in non-fertilized and fertilized total community DNA, respectively. The analyses of 16S rRNA genes and deduced functional profiles provide an in-depth understanding of the responses of bacterial communities to fertilizer; this study suggests that rhizobacteria, which potentially benefit plants by mobilizing insoluble nutrients in soil, are reduced by chemical fertilizer addition. This knowledge will benefit the development of more targeted biofertilization strategies.

Keywords : bacteria, fertilizer, microbiome, rhizoplane, rhizosphere
Conference Title : ICEM 2021 : International Conference on Environmental Microbiology
Conference Location : Zurich, Switzerland
Conference Dates : January 14-15, 2021