A New Encapsulation Technology for Plant Growth Promoting Rhizobacteria: A Tool for Agricultural Sustainability

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Background/Objectives. Climate change is having widespread impacts on agriculture by causing major changes in temperature, precipitation, and soil ecosystem. These changes lead increases in biotic and abiotic stresses that may be detrimental to agriculture production, such as pests, pathogens, nutrient deficiencies, salinity and drought. One green and relatively cheap way of helping sustainable agriculture is the presence of plant growth promoting rhizobacteria (PGPR). PGPR colonize roots of the plants and enhance plant health and improve productivity via inducing phosphate solubilization, nitrogen fixation, siderophore and phytohormone production. To address the shortcomings of traditional PGBR inoculant delivery system, various encapsulation technologies have been developed to encapsulate bacterial inoculants. Due to requirement for inoculation of high densities of viable beneficial PGPR into the soil, the most effective and economic way of PGPR delivery is their direct on-seed application. However, one of the major challenges is maintenance of stability and viability of PGPR during seed application and storage Additional challenge is controlled release of PGPR at the exact time of seed germination and colonization of the rhizosphere when the plant is the most vulnerable to adverse environmental conditions. Hence, the objective of this study was to study performance and efficacy of the novel encapsulation technology, superhydrophobic wax encapsulation (SWEL) for controlled release of *Bradyrhizobium diazoefficiens* USDA 110 when applied to the soybean seeds.

Approach/Activities. To test controlled release, survival, and efficacy of SWEL encapsulated strain USDA 110 in relation to the germination, nodulation, and growth of soybeans, a controlled greenhouse experiment was set up. The experimental design involved sterile and nonsterile soil sets with 20 replications of six treatments. The seeds were treated with chemical seed coating (CSC) with Flo Rite 1706 (BASF). The treatments included un-inoculated controls (soil and seed controls), seeds with strain USDA 110 encapsulated in SWEL (CSC and non-CSC coated) and unencapsulated (“free”) strain USDA 110 treatment. The soybean plants were harvested 48 days after sowing at vegetative growth stage V6-V7 and evaluated for root and shoot length, root, and shoot dry weight, trifoliate number, root nodules. Genomic DNA was extracted from soil samples and nodules for 16S rRNA amplicon sequencing to study microbial community structure and digital PCR to monitor *strain* USDA 110.

Results/Lessons Learned. The study showed that in the absence of *B. diazoefficiens* strain USDA 110 in the soil (sterile soil), the strain USDA 110 with SWEL has been released into the soil/plant and triggered nodule formation for soybean plants. The SWEL technology promoted survival of this rhizobacteria during the seed germination and nodule formation processes. The highest abundance of the strain USDA 110 was observed in the nodules of CSC coated soybean seeds with SWEL compared to other treatments. The overall data indicates that SWEL technology can be used as a vehicle for introduction of PGPBs into seeds as well as a platform for retaining their stability and viability by protecting PGPB from the abiotic stress of the environment.