In vitro Bioaugmentation of Zea mays L. via a Bacillus subtilis Seed Coating to Stimulate Allelopathic Defense Mechanisms Against Co-Germinating Ambrosia artemisiifolia

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As Ambrosia artemisiifolia, an invasive weed species, expands its global presence, it generates significant yield losses of up to 50% in Zea mays L., destabilizing economies and altering soil structure through nutrient depletion. This series of experiments harnesses the natural potential of Bacillus subtilis, a plant growth-promoting rhizobacterium, to increase allelochemical production in Zea mays L. and reduce Ambrosia artemisiifolia density in the rhizosphere through seed coatings. The initial two trials focused on analyzing the effects of a liquid Bacillus subtilis suspension combined with nutrient broth on Zea mays L. seeds, which were co-germinated with Ambrosia artemisiifolia. Conclusively, the third trial investigated the responses of Ambrosia artemisiifolia and co-germinated Zea mays L. seeds, which were coated with a sodium alginate-based seed coating containing Bacillus subtilis. ANCOVA results statistically validated ($p<0.01$) a link between the Bacillus subtilis seed coatings and the inhibition of Ambrosia artemisiifolia. Furthermore, Ambrosia artemisiifolia grown alongside Bacillus subtilis-coated Zea mays L. revealed a Mean Response Index of -0.51, indicating that the average physiological trait difference was 51% less than that of the control Ambrosia artemisiifolia. Additionally, UV-Vis spectrophotometric analysis indicated that the sodium alginate and Bacillus subtilis-coated Zea mays L. contained approximately 165% more allelochemical concentrations than the control Zea mays L., suggesting the stimulation of phenylpropanoid pathways. These conclusions suggest that sodium alginate-based seed coatings containing Bacillus subtilis provide a sustainable solution to suppressing Ambrosia artemisiifolia in agricultural regions through allelopathy.

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