Biostimulatory effect of PGPR on chlorantraniliprole degradation kinetics and soil enzymatic activities

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The present study shows the potential of *Pseudomonas fluorescens*, a plant growth-promoting rhizobacterium (PGPR), towards the degradation of chlorantraniliprole in both liquid cultures and soil microcosms. In liquid culture, the bacterium showed high tolerance up to 100 mg L^{-1} and reduced pesticide concentrations up to 88.7%. Soil microcosm studies confirmed enhanced degradation when *P. fluorescens* was applied singly or along with organic amendments, particularly vermicompost, reducing the pesticide's half-life (13–18 days) compared to natural attenuation (33 days). Enzymatic assays further revealed that chlorantraniliprole negatively affects soil microbial functions under natural attenuation, while *P. fluorescens* and organic amendments mitigate these effects. Vermicompost, with its microbial richness and nutrient profile, proved effective in promoting enzymatic activities, suggesting a promising sustainable strategy for the bioremediation of chlorantraniliprole.

Keywords: Bioremediation, chlorantraniliprole, natural attenuation, PGPR, soil enzymes

synthesis[7]. It has demonstrated potential to degrade pesticides like carbofuran (85% in compost-amended soil) and thiamethoxam (67% in liquid media), as well as showing resistance to heavy metals (Cr6+, Ni2+, Cd2+, Pb2+) and pesticides (BHC, 2,4-D, Mancozeb)[8–10].

Chlorantraniliprole, a diamide insecticide acting on insect ryanodine receptors, causes dysregulation in muscle contractions[11]. It is reported with half-lives of 43.31 days in alluvial and 36.47 days in red soils[12]. Its application alters soil microbial communities and suppresses microbial biomass and enzyme activity[13,14].

The present study investigates the ability of *P. fluorescens* to degrade chlorantraniliprole under laboratory conditions (21 days) and evaluate the compatibility of *P. fluorescens* with vermicompost and vesicular arbuscular mycorrhiza (VAM) to assess potential synergistic effects. Chlorantraniliprole residues were quantified using high-performance liquid chromatography with a photodiode array detector (HPLC-PDA) to calculate degradation half-lives. Additionally, changes in soil enzymatic activities, including dehydrogenases, glucosidases, and phosphatases, were assessed under uncontaminated, naturally attenuated, and biostimulated conditions to understand the dynamics of enzymes during bioremediation.