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LDPE and PP Microplastic-Induced Growth Inhibition in Common Bean (*Phaseolus Vulgaris* L.) Growth and Soil Alterations

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Abstract

Microplastic (MP) contamination in agricultural soil imposes a global concern, yet the comparative effects of different polymer types and environments remain underexplored. This study aimed to assess the impact of two common MP types, Low-Density Polyethylene (LDPE) and Polypropylene (PP), on the growth of common bean (*Phaseolus vulgaris* L.) and soil physicochemical parameters. Two independent experiments were conducted using two different local soil sources, incorporating 0% (control), 1%, 3%, and, 5% w/w of dry soil with LDPE and, PP MPs (≤1,000µm and, ≤2,000µm particles). The experimental soil for both was confirmed to be MP-free via Fourier-transform infrared spectroscopy before treatment. Plant growth was monitored for 45 days after sowing seeds. Vine length was recorded daily, while the number of leaves and stem diameter were recorded weekly. Soil moisture content, conductivity, and pH were measured after 45 days of sowing. A regression model/two-way ANOVA followed by a Tukey pairwise comparison test and descriptive statistics were deployed for data analysis. The results revealed a highly significant (p<0.001) and concentration-dependent negative impact on plant growth across both MP types, where plants were most affected at 5% w/w concentration. Both treatments caused substantial reductions in all three growth parameters over the 6-week period. Maximum growth reduction occurred in the number of leaves (up to 56.52% reduction), followed by vine length (up to 44.45% reduction), and stem diameter (up to 25.76% reduction). Vine length and number of leaves showed a reduction in the consistent range of 13-45% and 18-57%, respectively, across the concentration gradient. The observed effects under these elevated MP levels reflect stress-test conditions designed to identify the potential phytotoxicity risk of both MP types. Similar effects were observed on soil physicochemical properties. Both MP amendments caused a concentration-dependent lowering of soil conductivity and reduction of soil moisture content. Soil pH showed a slight alkaline shift with increasing LDPE-MP concentration, whereas a slight acidification occurred with PP-MP. These findings support that both common microplastic types pose a phytotoxicity risk to common bean growth and alter the soil properties. Despite the short experimental duration, the results offer early warning evidence of phytotoxicity risks that may emerge under repeated or long-term MP accumulation in agricultural soils, such as those arising from the progressive degradation of plastic mulches. Given that these findings are influenced by variables such as polymer type, soil particle size, future studies should address these interactions to understand the MP effect on agroecosystems.

Keywords: *Microplastics, Plant growth, Phytotoxicity, Soil contamination*