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Organic Fertilizers Mitigate Microplastics Toxicity in Agricultural Soil

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Abstract : Massive global plastic production, combined with poor degradation and recycling, leads to significant environmental pollution from microplastics, whose effects on plants in the soil remain understudied. Besides, effective mitigation strategies and their impact on ammonia (NH_3) emissions under varying fertilizer management practices remains sketchy. Therefore, the objectives of the study were (i) to determine the impact of organic fertilizers on the toxicity of microplastics in sorghum and physicochemical characteristics of microplastics-contaminated soil and (ii) to assess the impacts of these fertilizers on NH_3 emissions from this soil. A field experiment was conducted using sorghum as a test crop. Treatments were: (i) Control (C), (ii) Microplastics (MP), (iii) Inorganic fertilizer (IF), (iv) MPIF, (v) Farmyard manure (FM), (vi) MPFM, (vii) Biochar (BC), and (viii) MPBC, arranged in a randomized complete block design (RCBD) with three replicates. Microplastics of polyvinyl chloride (PVC) were applied at a rate of 1.5 tons ha^{-1}, and all fertilizers were applied at the recommended dose of 90 kg N ha^{-1}. Soil sampling was done before sowing and after harvesting the sorghum, with samples analyzed for chemical properties and microbial biomass. Crop growth and yield attributes were measured. In a parallel pot experiment, NH_3 emissions were measured using passive flux samplers over 72 hours following the application of treatments similar to those used in the field experiment. Application of MPFM, MPBC and MPIF reduced soil mineral nitrogen by 8, 20 and 38% compared to their sole treatments, respectively. Microbial biomass carbon (MBC) was reduced by 19, 25 and 59% in MPIF, MPBC and MPFM as compared to their sole application, respectively. Similarly, the respective reduction in microbial biomass nitrogen (MBN) was 10, 27 and 66%. The toxicity of microplastics was mitigated by MPFM and MPBC, each with only a 5% reduction in grain yield of sorghum relative to their sole treatments. The differences in nitrogen uptake between BC vs. MPBC, FM vs. MPFM, and IF vs. MPIF were 8, 10, and 12 kg N ha^{-1}, respectively, indicating that organic fertilizers mitigate microplastic toxicity in the soil. NH_3 emission was reduced by 5, 11 and 20% after application of MPFM, MPBC and MPIF than their sole treatments, respectively. The study concludes that organic fertilizers such as FM and BC can effectively mitigate the toxicity of microplastics in soil, leading to improved crop growth and yield.

Keywords : microplastics, soil characteristics, crop n uptake, biochar, NH_3 emissions
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