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Redistribution of Ni in soil containing polystyrene microplastics: evidence from sequential extraction

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INTRODUCTION & AIM

The co-occurrence of microplastics (MPs) and heavy metals (HMs) in soils has become an increasing environmental concern. Owing to their large specific surface area, surface charge, and hydrophobic nature, MPs can interact with co-existing contaminants and modify their environmental fate. Through the so-called Trojan effect, MPs may influence metal transport, redistribution, and bioavailability in soil systems. Although previous studies have demonstrated that metals adsorbed onto MP surfaces can be re-released into the soil environment, their impact on metal partitioning among geochemical fractions remains poorly understood. Therefore, this study evaluated the influence of polystyrene (PS) microplastics on nickel (Ni) fractionation in soil, with the hypothesis that PS promotes the redistribution of Ni toward more labile and potentially available fractions.

METHOD

A trifactorial pot experiment was established with 12 treatment groups and five replicates per treatment (Figure 1a). Soil (400 g per pot) was amended with PS (0 and 1%) and Ni (0, 50, and 500 mg kg^{-1}), and incubated in a growth chamber for 65 days. Bulk and rhizosphere soils were subsequently analyzed for Ni fractionation using the BCR sequential extraction procedure. Experimental design comprised control (**C**), polystyrene (**PS**), nickel (**Ni50** and **Ni500**), and combined PS–Ni treatments in bulk soil (S) and rhizosphere soil (R).

Figure 1. Experimental design

RESULTS & DISCUSSION

In untreated soil, Ni was mainly associated with oxidizable (F3, 41.9%) and residual (F4, 43.7%) fractions. The addition of PS promoted Ni redistribution toward the reducible fraction (F2), indicating increased potential mobility.

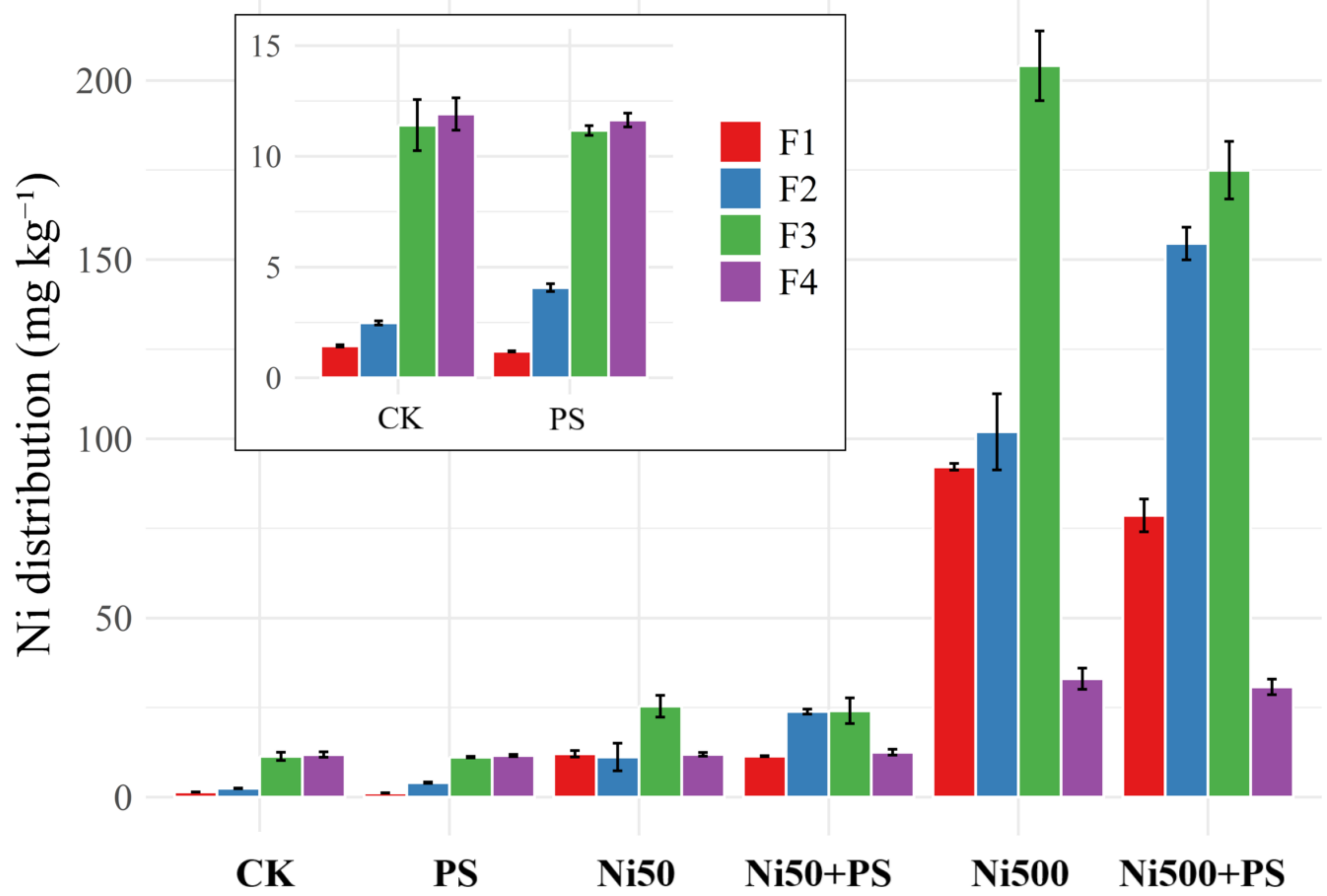

Figure 2. Concentration of Ni in BCR phases

In Ni50 soil, PS increased the proportion of Ni in F2 by 84.6%, whereas in Ni500 soil the increase was lower (31.4%), indicating a concentration-dependent response.

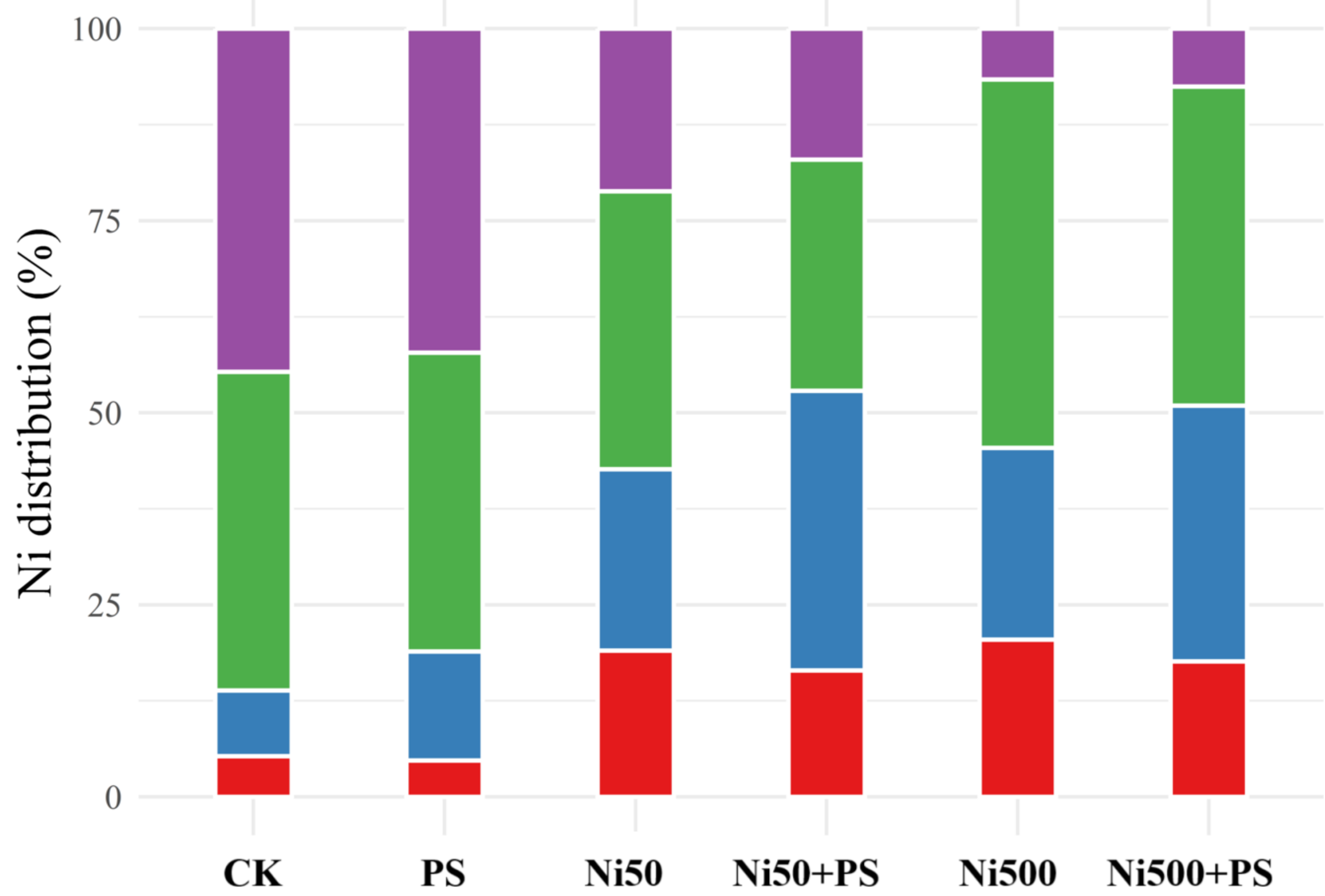

Figure 3. Percentage contribution of BCR phases

Polystyrene increased Ni partitioning into potentially available fractions by up to 81.2%.

CONCLUSION

These findings demonstrate that PS-MPs promote Ni redistribution from stable to more labile fractions, particularly under moderate contamination levels. The results highlight the importance of MP–metal interactions in controlling metal mobility in soils.