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**Supplementary Figure 1.** Mineralogical composition of the Fe-Mn nodules used in the study. (a) X-ray diffraction pattern (XRD; PANalytical X’Pert Pro diffractometer); (b) Spatial distribution of Fe and Mn in the nodule obtained by micro X-ray fluorescence spectrometry (µ-XRF; Bruker M4 TORNADO).



**Supplementary Figure 2.** Effect of different doses of dolomite (3% w/w and 20% w/w) on (a) shoot dry weight (DW) and (b) shoot length of ryegrass grown on Histosol (0-5 cm) from Apatity (Kola Peninsula, Russia) contaminated by the atmospheric emissions froma nickel-copper (Ni/Cu) smelter. Means and standard deviations are shown (n = 4). Untreated soil is also shown for comparison. Asterisks indicate a statistically significant difference between different doses of dolomite with respect to shoot length (p < 0.05). All-purpose fertilizer was added in all cases at a rate of 0.4 g fertilizer per 1 kg substrate.



**Supplementary Figure 3.** Shoot length of *Lolium perenne* as a function of growth time in the soil under study. Results are shown for the following iron-based treatments in a biochar matrix: A: untreated soil; C: dolomite (3%) + ZVI nanoparticles/biochar composite (4%); F: dolomite (3%) + biochar (2%) + Fe-Mn-nodules (2%); H: dolomite (3%) + biochar (2%) + iron powder (2%). The remainder of the treatments are not shown to simplify the figure and improve clarity and understanding.

**Supplementary Table 1.** Effect of different doses of dolomite (3% w/w and 20% w/w) on the concentration of exchangeable fractions of metals in the soil under study.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Dolomite dose | Co, mg kg-1 | Cu, mg kg-1 | Mn, mg kg-1 | Ni, mg kg-1 | Zn, mg kg-1 |
| 3% | 0.80±0.15 | 11 ± 1.0 | 9.3 ± 1.8 | 17 ± 2.9 | 0.60 ± 0.01 |
| 20% | 0.30 ± 0.05\* | 12 ± 0.60 | 4.8 ± 1.1\* | 6.7 ± 0.58\* | 0.40 ± 0.12\* |

The concentrations of exchangeable Cd were below the detection limit. An asterisk indicates a statistically significant difference between dolomite doses.

**Supplementary Table 2.** Effect of different doses of dolomite (3% w/w and 20% w/w) on foliar metal concentrations of ryegrass grown on the soil under study. The values of pH (in 0.01 N KNO3) were 5.8 and 7.2, respectively. Toxicity thresholds for foliar metal concentrations are shown for comparison.

|  |  |  |  |
| --- | --- | --- | --- |
| Metal | Foliar concentration, mg kg-1 | Toxicity threshold,mg kg-1 | Reference |
|  | Dolomite 3% | Dolomite 20% |  |  |
| Cd | 0.12 ± 0.04 | 0.13 ± 0.11 | 15 | Davis et al. (1978) |
| Co | 4.5 ± 0.78 | 5.4 ± 1.1 | 6.0 | Davis et al. (1978) |
| Cu | 29 ± 6.4 | 54 ±12 | 39 | Verdejo et al. (2015) |
| Mn | 129±32 | 413 ± 105 | >400 | Reuter and Robinson (1997) |
| Ni | 110 ± 18 | 62 ± 8.1 | 80 | Reuter and Robinson (1997) |
| Zn | 35 ± 9.7 | 17 ± 4.0 | 560 | Smilde (1981) |