Supporting Information

Iron-Oxide Nanoparticle Release from Jellyfish-Based Hydrogels for Agricultural Fertilization

Environmental Science: Nano

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Table S1. *Soil properties as measured by Ben Mordechay et al., 2023 [1]. Soils were sampled from lysimeters irrigated for 20 years with tap water.*

Location	Ein Hashlosha	Saad	Nir Oz
Sand (%)	47	25	82
Silt (%)	40	48	14
Clay (%)	13	27	4
Soil organic matter (%)	2.64 ± 0.01	2.27 ± 0.07	1.04 ± 0.05
$CaCO_3$ (%)	8	16	4
Bulk density (g/cm^3)	1.27 ± 0.01	1.24 ± 0.01	1.38 ± 0.01
Cation exchange capacity (meq/100g)	16	21	11
pH	7.5	7.6	7.5

Table S2 *Zeta potential of Fe_3O_4 and $Fe(OH)_3$ NPs before and after release from JF-based hydrogel beads.*

NP type	Zeta Potential (mV)
Fe_3O_4	-9.2 ± 2.4
$Fe(OH)_3$	-11.1 ± 0.3
$Fe(OH)_3$ after release	-19.3 ± 1.1

Table S3. *Diameter of iron-containing jellyfish-based hydrogel beads ($Fe(OH)_3$@JF).*

$Fe(OH)_3$@JF bead type	Diameter (mm)
After formulation	4.9 ± 0.5
20 days in Nir Oz soil suspension	4.1 ± 0.2
20 days in Nir Oz soil suspension that was sterilized in 160 °C	4.2 ± 0.3
20 days in Nir Oz soil suspension that was submerged in 1 M $CaCl_2$	5.1 ± 0.7

Table S4. *Cation content in different soil suspensions.*

Cation Type	Ein Hashlosha	Saad	Nir Oz
Na^+ (mM)	0.67 ± 0.75	1.14 ± 0.03	1.25 ± 0.26
K^+ (mM)	0.17 ± 0.02	0.33 ± 0.04	1.79 ± 0.23
Mg^{+2} (mM)	0.57 ± 0.01	0.41 ± 0.01	0.36 ± 0.01
Ca^{+2} (mM)	1.95 ± 0.01	2.06 ± 0.02	2.88 ± 0.01

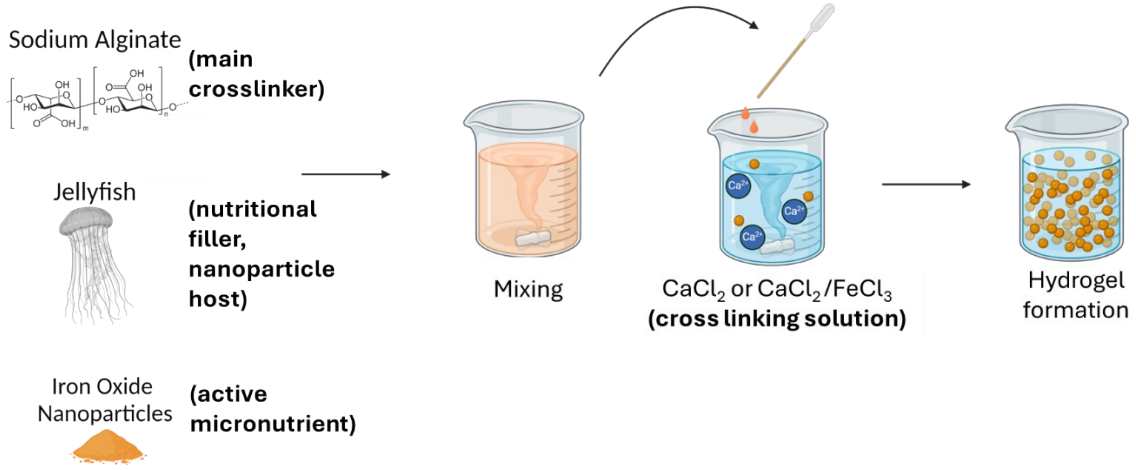

Figure S1. *Schematic illustration of the synthesis procedure and the function of each component (in bold).*

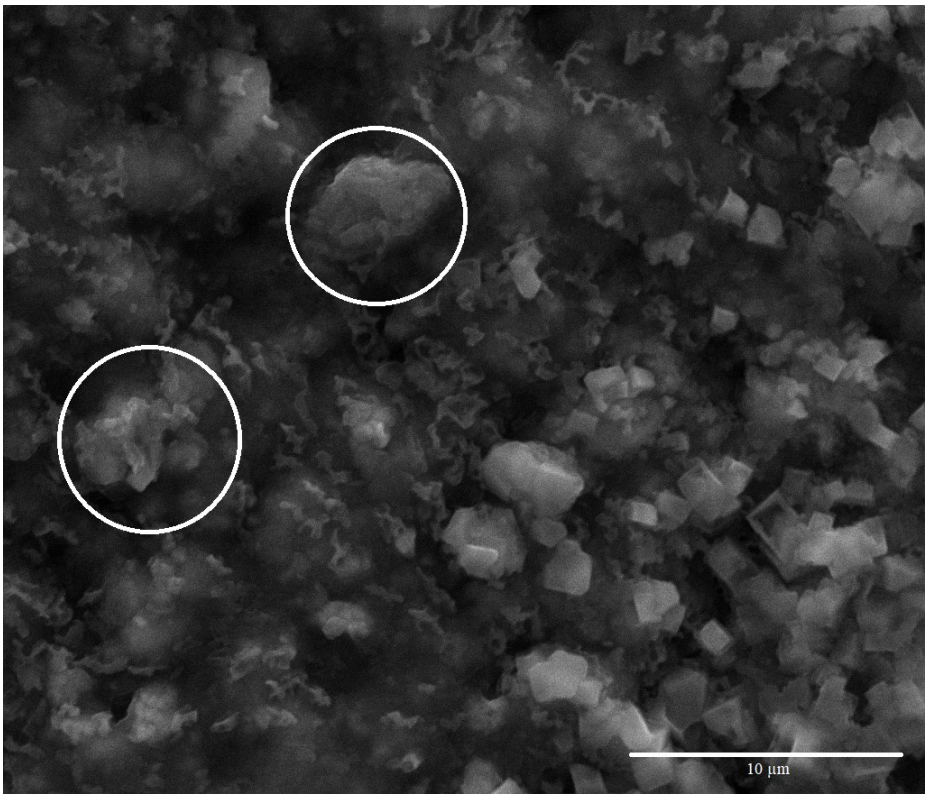

Figure S2. *Environmental scanning electron micrograph (ESEM) of a dried $Fe(OH)_3$@JF bead cross section. The circled area highlights aggregates of iron nanoparticles (NPs).*

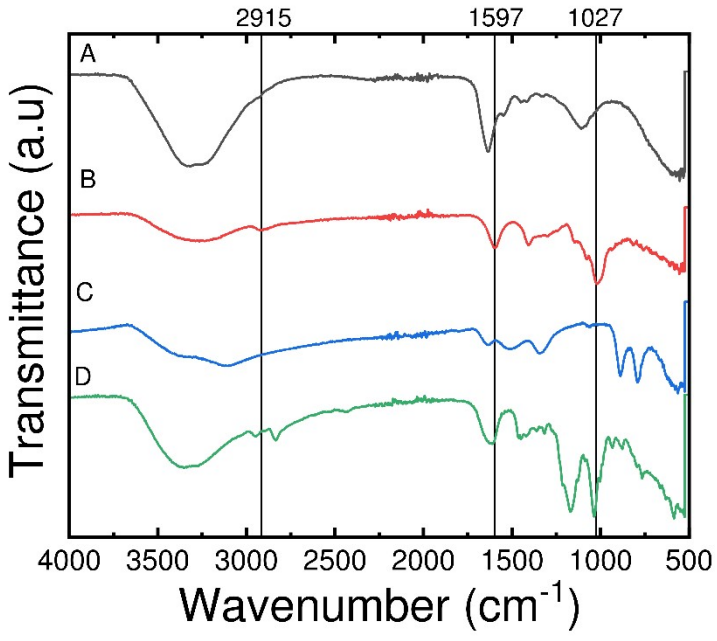

Figure S3. *FTIR spectra of (A) Jellyfish, (B) Sodium alginate, (C) $Fe(OH)_3$ nanoparticles, and (D) $Fe(OH)_3$ nanoparticles after release from hydrogels.*

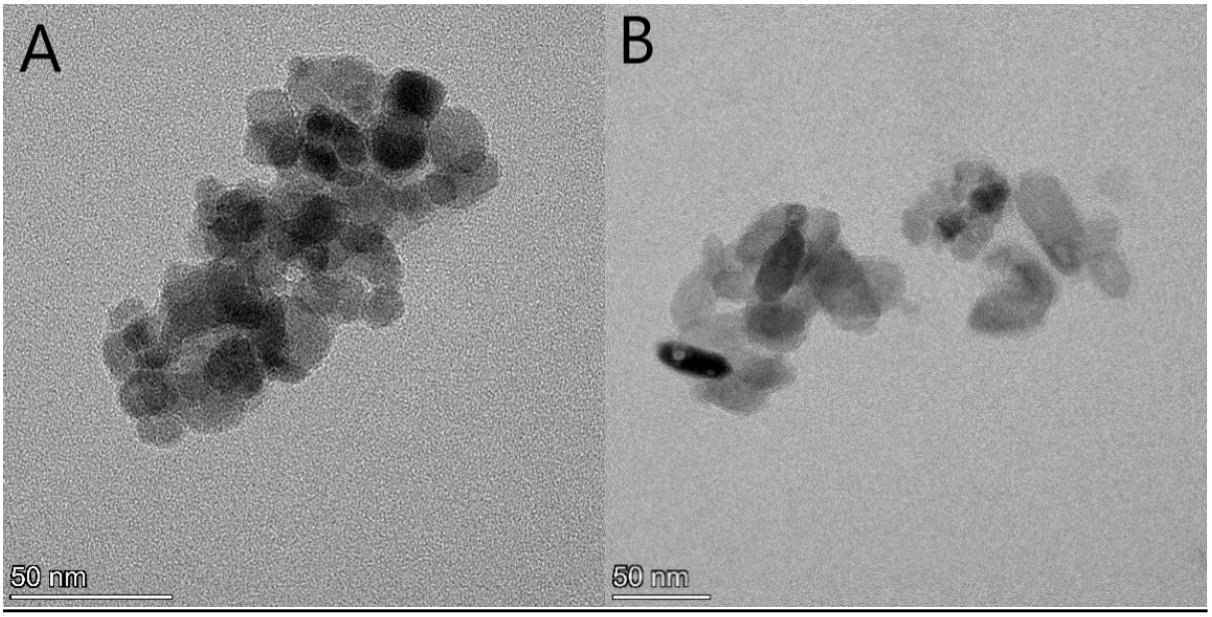

Figure S4. *Transmission electron microscope (TEM) images of (A) Fe_3O_4 NPs and (B) $Fe(OH)_3$ NPs.*

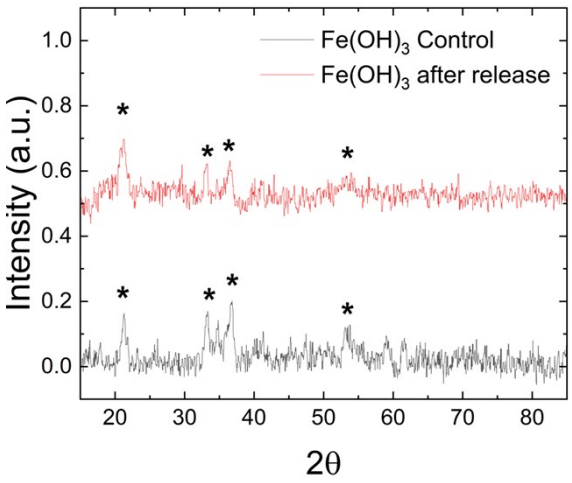

Figure S5. *X-ray diffraction (XRD) spectra of $Fe(OH)_3$ nanoparticles prior to (control) and following release from the hydrogel into soil solution. The asterisks represent expected iron hydroxide peaks present on both samples.*

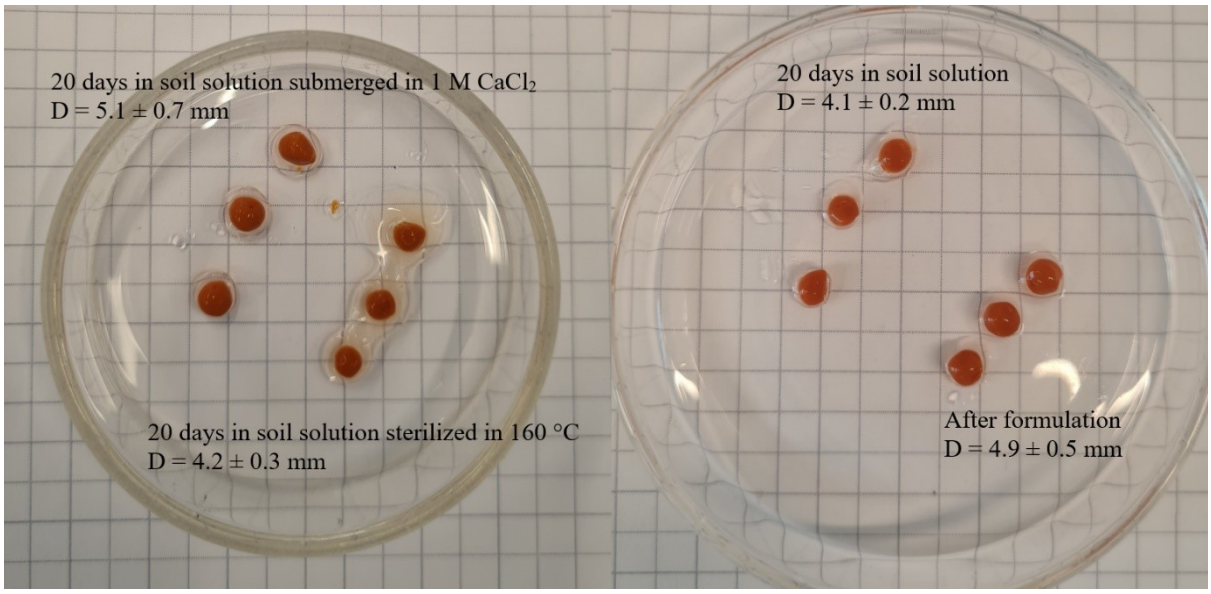

Figure S6. *Images of iron-containing jellyfish-based hydrogel beads ($Fe(OH)_3$@JF) after formulation, after 20 days in soil suspension prepared from Nir Oz soil, after 20 days in soil suspension prepared from Nir Oz soil that was sterilized in 160 °C, and after 20 days in soil suspension prepared from Nir Oz soil that was submerged in 1 M $CaCl_2$.*

References

1 E. Ben Mordechay, M. Shenker, J. Tarchitzky, V. Mordehay, Y. Elisar, Y. Maor, J. J. Ortega-Calvo, D. Hennecke, T. Polubesova and B. Chefetz, *Soil and Environmental Health*, DOI:10.1016/j.seh.2023.100036.