Supporting Information

Magnetic virus-like nanoparticles in *N. Benthamiana* plants – a new paradigm for environmental and agronomic biotechnological research

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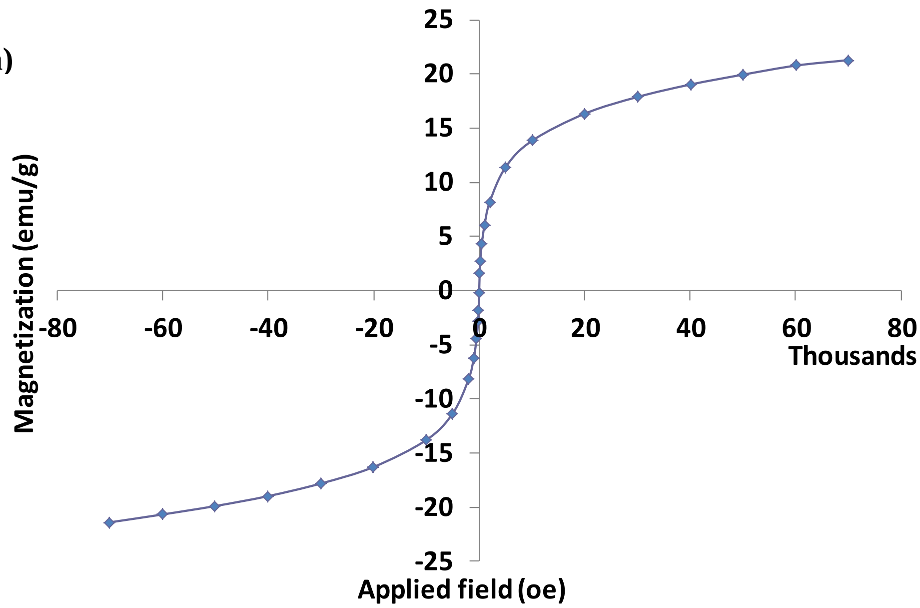
1. Magnetic properties of the HOOC-PEG-PL coated cubic iron oxide NPs

Figure S1a shows the magnetization curve of 18.6 nm NPs at 250K. The lack of hysteresis and the "S" shape of the curve are typical of superparamagnetic systems above the blocking temperature. Figure S1b presents field cooling (FC) and zero field cooling (ZFC) curves. The onset of hysteretic behavior, a proxy for estimating the blocking temperature, can be observed at about 250K.[2]

a)


25
20
15
10
5
0
-5
-10
-15
-20
-25
-80
-60
-40
-20
0
20
40
60
80
Thousands
Magnetization (emu/g)
Applied field (oe)

b)

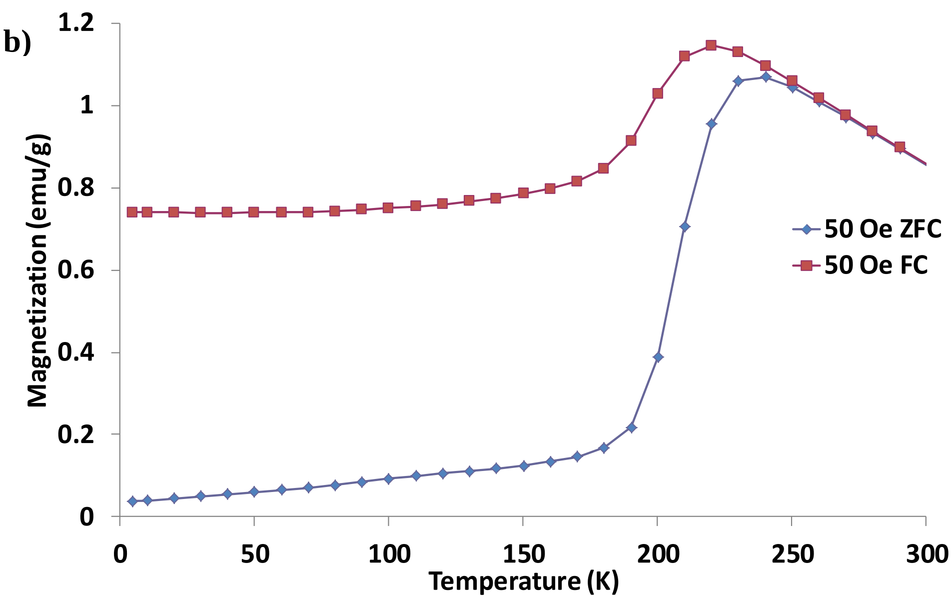
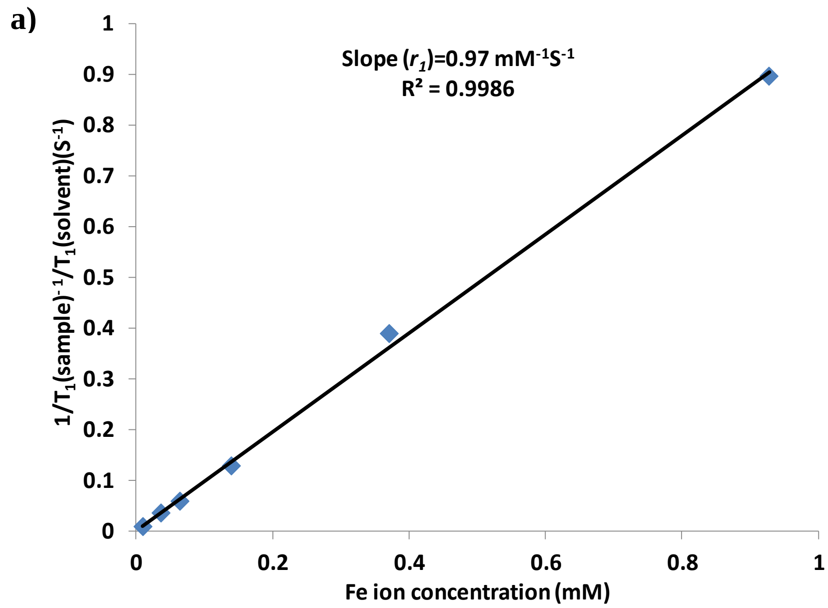

1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
Magnetization (emu/g)
Temperature (K)
50 Oe ZFC
50 Oe FC

Figure S1. (a) Magnetization curve of 18.6 nm cubic iron oxide NPs obtained at 250 K. (b) ZFC and FC curves of 18.6 nm cubic iron oxide NPs.

2. Relaxivity data of the HOOC-PEG-PL coated cubic iron oxide NPs



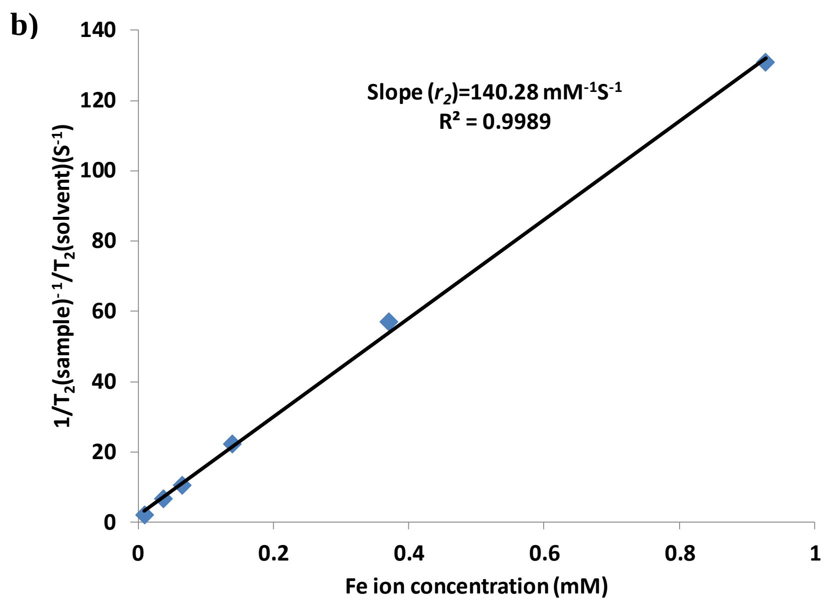


Figure S2. Plots of inverse relaxation times (a) ($1/T_{1(samples)}$-$1/T_{1(solvent)}$) and (b) ($1/T_{2(samples)}$-$1/T_{2(solvent)}$) as a function of iron concentration. The slopes correspond to (a) the longitudinal r_1 and (b) the transverse r_2 relaxivities, respectively.

3. Dynamic light scattering measurements of the VNPs based on HOOC-PEG-PL coated cubic iron oxide NPs

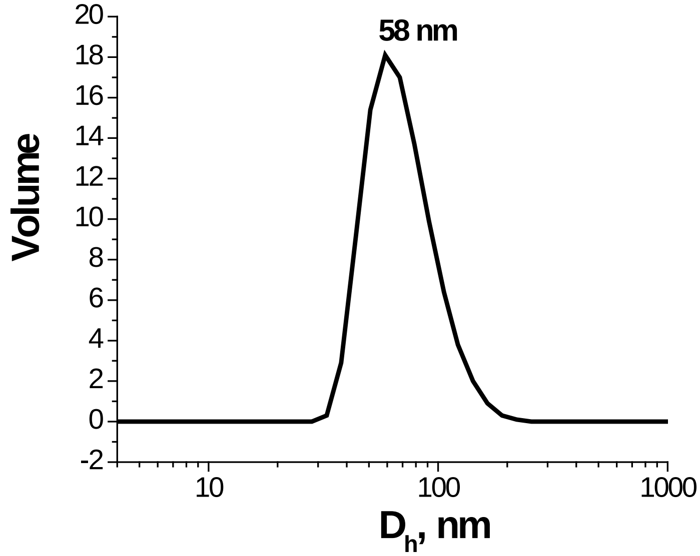


Figure S3. DLS data of VNPs formed by self-assembling of BMV proteins around 18.6 nm cubic NPs coated with HOOC-PEG-PL.

4. Iron oxide NP and VNP transit in plants

Figure S4. Infiltration of the leaf blade with a syringe.

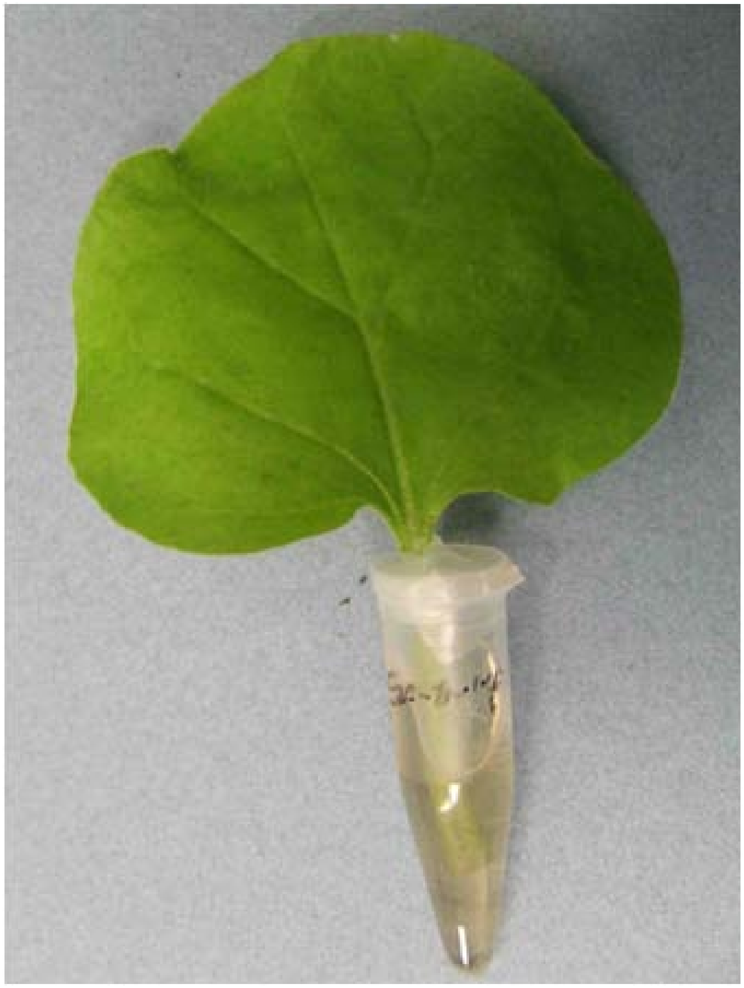


Figure S5. Cut-off leaf in the VNP feeding solution.

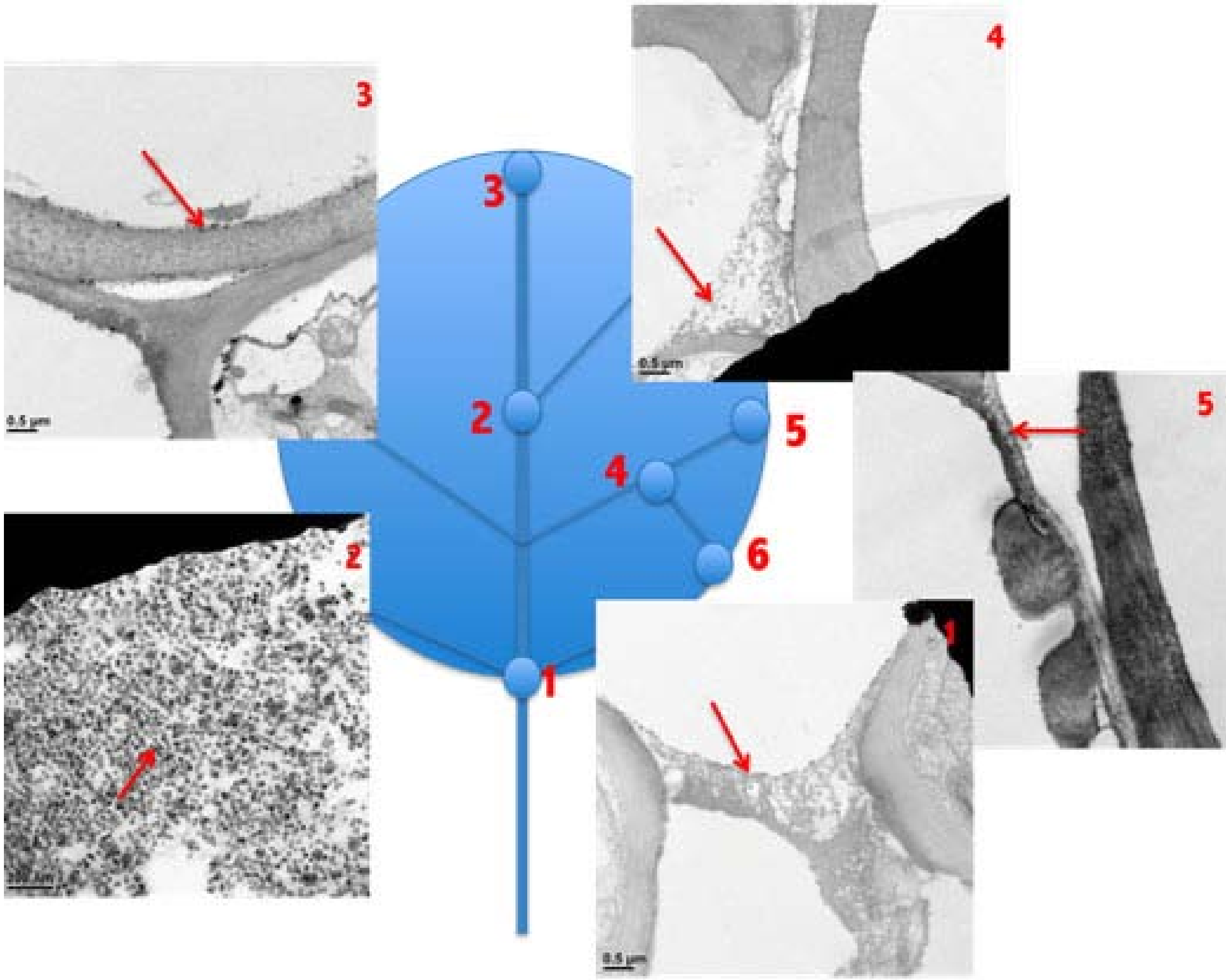


Figure S6. TEM images of the cross-sections of the leaf in the indicated positions populated with VNPs. Both primary (positions 1, 2, and 3) and secondary (positions 4 and 5) veins contain VNPs, while in tertiary veins (position 6) the VNPs are rarely found. The VNP populations are indicated by red arrows in the TEM images.

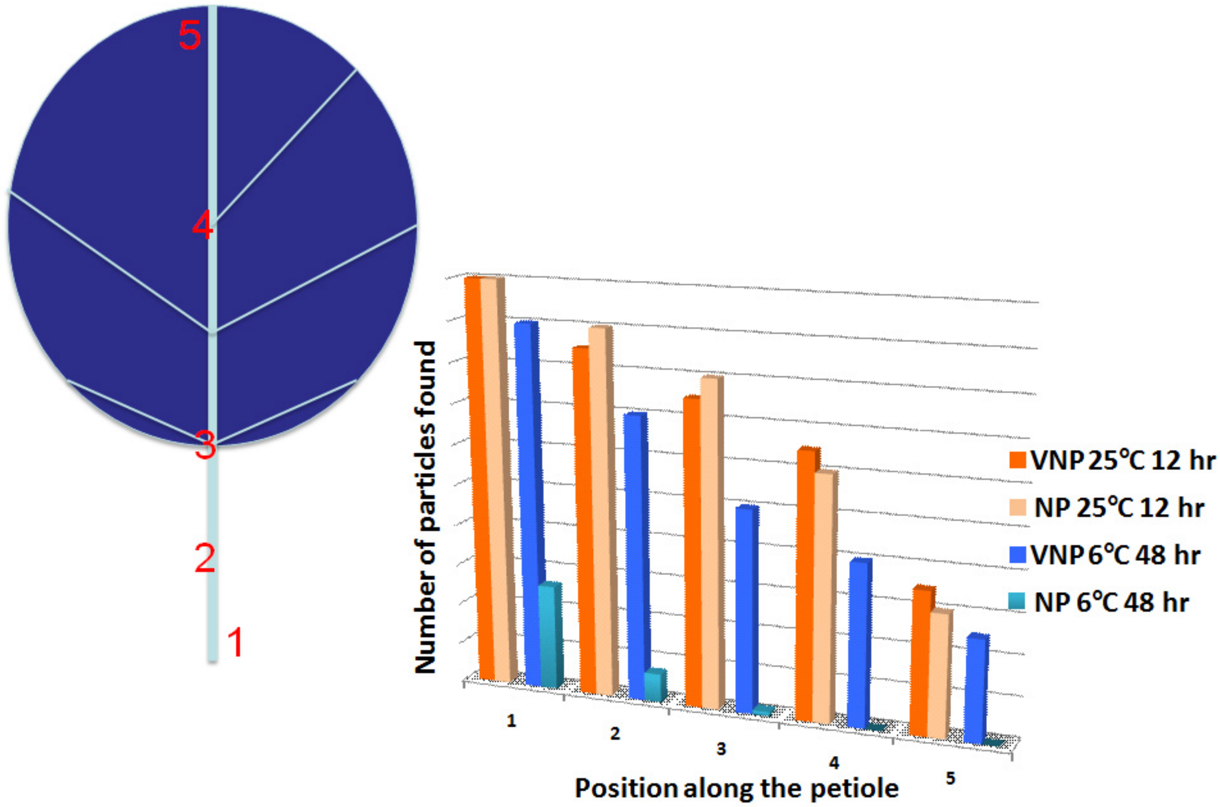


Figure S7. Schematic of a leaf with five positions along the petiole (left) and charts showing amount of iron oxide NPs and VNPs found in different positions of the petiole at 25 and 6°C (right).

1. Huang, X.; Bronstein, L. M.; Retrum, J. R.; Dufort, C.; Tsvetkova, I.; Aniagyei, S.; Stein, B.; Stucky, G.; McKenna, B.; Remmes, N.; Baxter, B.; Kao, C. C.; Dragnea, B., *Nano Lett.* **2007,** *7* (8), 2407-2416.
2. Talapin, D. V.; Shevchenko, E. V.; Weller, H., Synthesis and Characterization of Magnetic Nanoparticles. In *Nanoparticles*, Schmid, G., Ed. Wiley-VCH: Weinheim, 2004; pp 199-230.