Supplementary material

The singular molecular conformation of humic acids in solution influences their ability to enhance root hydraulic conductivity and plant growth.

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Humic acid MW characterization:

DOSY H1 NMR was performed to calculate the MW distribution of HA. A Nuclear Magnetic Resonance Bruker AVANCE AV-500 (500 MHz) was utilized using a 1H-broadband inverse probe. Spectrum was acquired by 128 scans with 2 ms pulses, with 100-200 ms diffusion time. Diffusion coefficients were calculated by using MestReC 4.7.0.0.© 2005 software.

Diffusion coefficients were calculated as follow:

$$I = I_0 \exp\left[- D_f (\Delta - \delta/3 - \tau/2)(g\gamma\delta)^2\right]$$

where I is resonance spectrum intensity, I_0 is resonance spectrum intensity without gradient pulse, is diffusion time, g y are gradient pulse amplitude and time respectively, pulses delay, H gyromagnetic radius: 26571 and D_f diffusion coefficient. Gradient intensity follows a decay line and mono exponential non-linear curve fit was applied for each DOSY spectrum peak,

$$f(x) = B \exp(-x\ F)$$

where F is the diffusion coefficient.

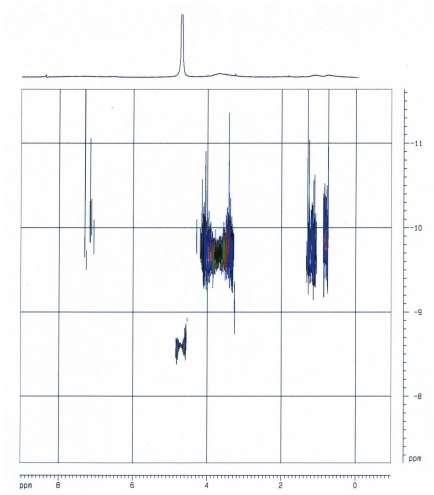
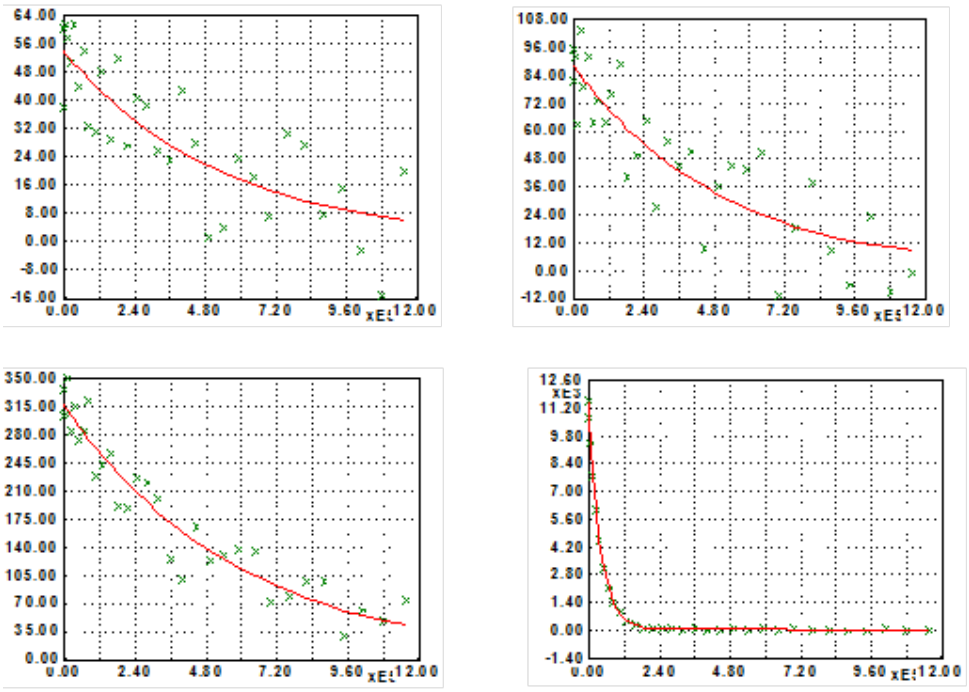


Figure S1. DOSY H1 NMR Spectrum from HA 100 mg L^{-1}



Dosy H1 NMR Peaks	D_f	MW
1.20 ppm	2,26 E -10	2163
2.14 ppm	1.14 E -10	9482
3.75 ppm	7.50 E -11	23422
D_2O	2.00 E -09	19

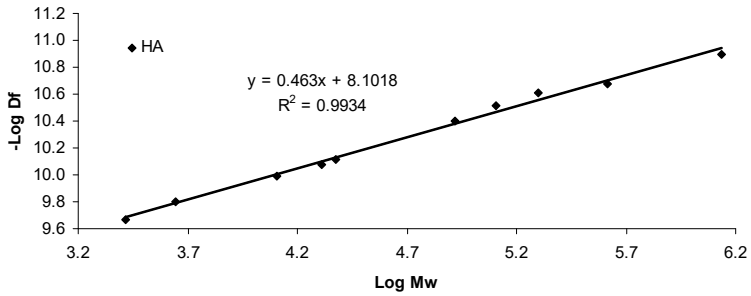
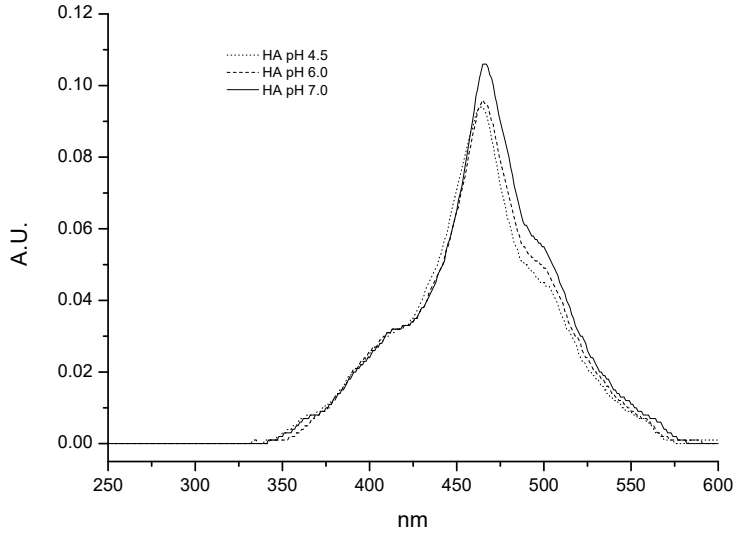
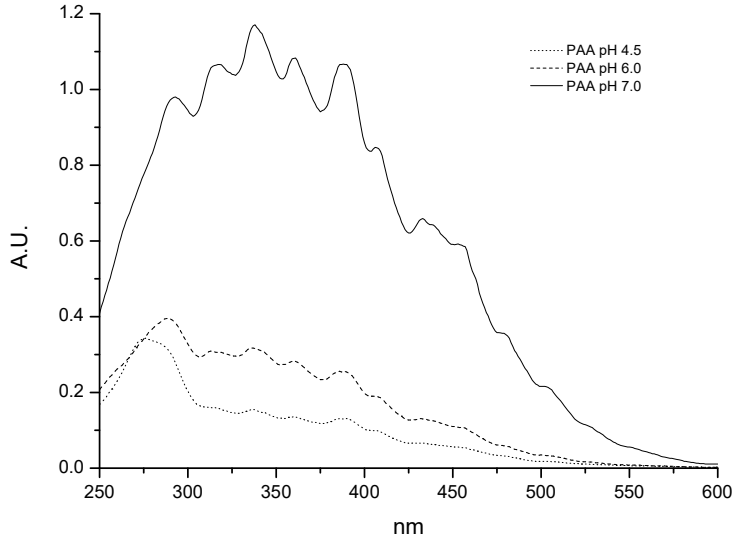


Figure S2: Decay line, D_f and Molecular Weight (MW) calculated from HA 100 mg L^{-1}. MW was calculated by interpolation using D_f from Cameron et al. 1972: Cameron, R. S., Thornton, B. K., Swift, R. S., Posner, A. M., Molecular weight and shape of humic acid from sedimentation and diffusion measurements on fractionated extracts. *European Journal of Soil Science* **197,** 23, 394-408.

Fluorescence spectroscopy





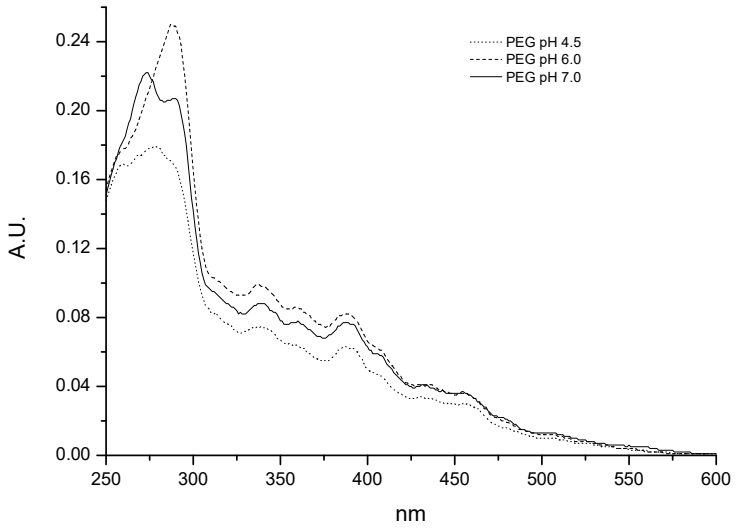


Figure S3. Synchronous fluorescence spectra for HA, PAA and PEG as a function of pH. Synchronous spectra were recorded between 250–600 nm wavelengths, with a 5-nm slit width on both monochromators. The scan speed of spectra 120 nm min^{-1} and resolution 0.5 nm.

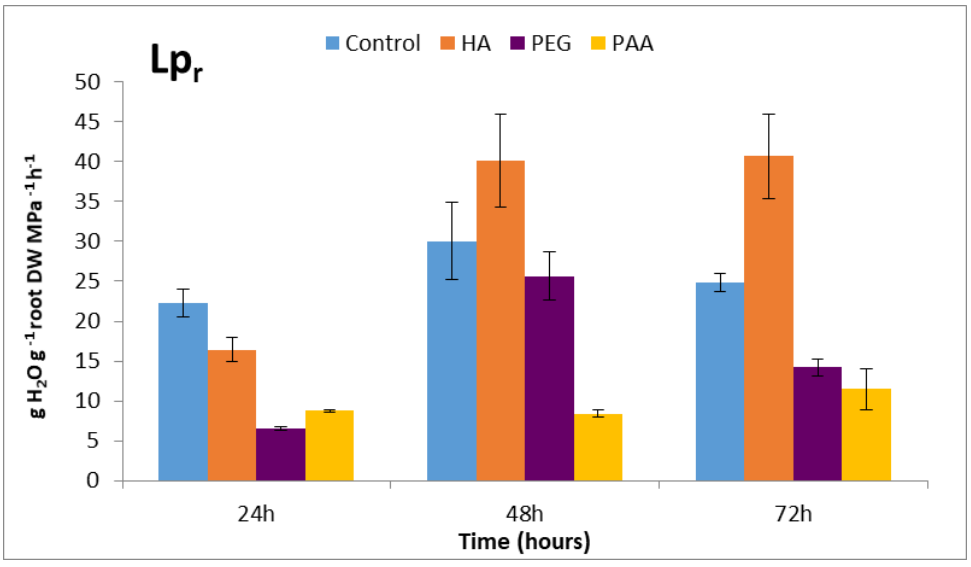


Figure S4: Lpr ± standard error (n=5). Time evolution of Lpr for the treated plants. Measurements were carried out after 24, 48 and 72 hours of treatment. Experiments were repeated three times.