

Table S1. Analysis of variance (p values) of nutrients concentration in plant tissues

Source of variation	Shoot conc.					Grain conc.					Root conc.				
	P	Zn	Fe	Mn	Cu	P	Zn	Fe	Mn	Cu	P	Zn	Fe	Mn	Cu
HS rate	0.000	0.039	0.579	0.000	0.440	0.001	0.001	0.028	0.000	0.012	0.574	0.011	0.000	0.000	0.130
Growth medium	0.129	0.384	0.099	0.000	0.437	0.001	0.000	0.000	0.127	0.216	0.048	0.070	0.043	0.000	0.283
Zn dose	0.901	0.005	0.499	0.441	0.431	0.799	0.000	0.758	0.153	0.467	0.947	0.604	0.112	0.409	0.057
HS*Medium	0.760	0.621	0.254	0.000	0.465	0.734	0.096	0.012	0.000	0.549	0.289	0.586	0.028	0.092	0.120
Zn*Medium	0.909	0.705	0.939	0.685	0.766	0.682	0.792	0.550	0.489	0.376	0.405	0.173	0.642	0.901	0.170
HS*Zn	0.729	0.083	0.376	0.064	0.608	0.301	0.094	0.325	0.764	0.899	0.820	0.261	0.646	0.392	0.505
HS*Zn*Medium	0.046	0.005	0.005	0.049	0.042	0.002	0.343	0.122	0.121	0.126	0.950	0.312	0.185	0.853	0.184

Table S2. Effect of the interaction between factors (growth medium type, Zn doses and humic substances rate) on studied variables

Medium	Zn dose	HS rate	β -GLU ($\mu\text{g g}^{-1} \text{h}^{-1}$)	pH	Olsen P (mg kg^{-1})	Shoot conc. (mg kg^{-1})					Grain conc. P (g kg^{-1})	Total P uptake (mg plant^{-1})
						P	Zn	Fe	Mn	Cu		
Calcareous	Z1	HS0	2.02 $\pm$ 0.38	8.39 $\pm$ 0.03	9.15 $\pm$ 0.54	313 $\pm$ 23.7	21.6 $\pm$ 6.38	39.8 $\pm$ 15.0	12.4 $\pm$ 2.38	1.86 $\pm$ 0.60	2.60 $\pm$ 0.13	2.37 $\pm$ 0.19
		HS1	1.45 $\pm$ 0.19	8.41 $\pm$ 0.06	7.93 $\pm$ 0.95	263 $\pm$ 65.9	27.1 $\pm$ 3.92	44.9 $\pm$ 26.8	18.4 $\pm$ 3.80	2.49 $\pm$ 0.59	2.74 $\pm$ 0.33	2.25 $\pm$ 0.45
		HS2	2.05 $\pm$ 0.40	8.56 $\pm$ 0.06	9.77 $\pm$ 0.48	225 $\pm$ 23.6	29.1 $\pm$ 4.22	48.4 $\pm$ 23.9	22.0 $\pm$ 1.02	2.72 $\pm$ 0.53	2.45 $\pm$ 0.12	2.00 $\pm$ 0.10
		HS3	1.20 $\pm$ 0.28	8.49 $\pm$ 0.06	7.75 $\pm$ 0.89	201 $\pm$ 8.89	21.3 $\pm$ 4.97	50.9 $\pm$ 7.28	44.3 $\pm$ 10.4	2.45 $\pm$ 0.27	2.36 $\pm$ 0.16	1.75 $\pm$ 0.20
	Z2	HS0	2.49 $\pm$ 0.42	8.36 $\pm$ 0.07	8.99 $\pm$ 0.90	330 $\pm$ 67.1	33.6 $\pm$ 1.89	57.1 $\pm$ 17.7	16.1 $\pm$ 3.86	2.94 $\pm$ 0.21	3.39 $\pm$ 0.60	2.81 $\pm$ 0.26
		HS1	1.88 $\pm$ 0.30	8.41 $\pm$ 0.04	10.10 $\pm$ 1.02	224 $\pm$ 27.7	28.1 $\pm$ 7.38	38.7 $\pm$ 12.4	18.4 $\pm$ 5.39	2.40 $\pm$ 0.40	2.23 $\pm$ 0.17	1.99 $\pm$ 0.03
		HS2	2.76 $\pm$ 1.21	8.40 $\pm$ 0.07	9.42 $\pm$ 1.43	258 $\pm$ 96.0	23.1 $\pm$ 5.72	46.9 $\pm$ 32.2	24.2 $\pm$ 8.64	2.10 $\pm$ 0.56	2.93 $\pm$ 0.58	2.10 $\pm$ 0.44
		HS3	1.27 $\pm$ 0.23	8.63 $\pm$ 0.07	7.41 $\pm$ 0.59	190 $\pm$ 19.8	25.6 $\pm$ 3.23	82.7 $\pm$ 60.4	40.7 $\pm$ 8.90	2.71 $\pm$ 0.68	2.36 $\pm$ 0.15	1.56 $\pm$ 0.23
	Z3	HS0	1.91 $\pm$ 0.17	8.45 $\pm$ 0.01	9.69 $\pm$ 1.58	255 $\pm$ 90.5	33.7 $\pm$ 5.37	51.3 $\pm$ 19.7	16.5 $\pm$ 2.89	2.18 $\pm$ 0.34	2.56 $\pm$ 0.43	2.05 $\pm$ 0.08
		HS1	2.29 $\pm$ 0.64	8.40 $\pm$ 0.04	7.73 $\pm$ 0.97	252 $\pm$ 49.8	27 $\pm$ 5.37	29.1 $\pm$ 3.66	23.8 $\pm$ 4.82	2.14 $\pm$ 0.37	2.69 $\pm$ 0.20	2.49 $\pm$ 0.23
		HS2	2.30 $\pm$ 0.99	8.60 $\pm$ 0.09	8.70 $\pm$ 1.12	233 $\pm$ 37.4	22.1 $\pm$ 3.71	50.6 $\pm$ 12.8	16.1 $\pm$ 2.54	2.65 $\pm$ 0.35	2.57 $\pm$ 0.16	2.17 $\pm$ 0.25
		HS3	1.49 $\pm$ 0.24	8.59 $\pm$ 0.05	6.89 $\pm$ 0.54	206 $\pm$ 43.4	31.9 $\pm$ 2.41	49.8 $\pm$ 14.7	36.8 $\pm$ 6.46	2.53 $\pm$ 0.46	2.34 $\pm$ 0.10	1.63 $\pm$ 0.18
Siliceous	Z1	HS0	1.13 $\pm$ 0.08	7.8 $\pm$ 0.08	6.86 $\pm$ 1.24	324 $\pm$ 41.3	27.1 $\pm$ 2.01	60.6 $\pm$ 42.7	24.4 $\pm$ 3.89	2.76 $\pm$ 1.62	3.06 $\pm$ 0.33	3.30 $\pm$ 0.66
		HS1	1.94 $\pm$ 0.40	7.83 $\pm$ 0.01	7.34 $\pm$ 0.51	269 $\pm$ 27.7	23.5 $\pm$ 3.52	32.5 $\pm$ 8.40	16.3 $\pm$ 0.60	2.87 $\pm$ 1.14	2.89 $\pm$ 0.12	2.76 $\pm$ 0.21
		HS2	1.65 $\pm$ 0.50	7.8 $\pm$ 0.1	6.99 $\pm$ 0.28	271 $\pm$ 17.9	19.2 $\pm$ 7.22	26.6 $\pm$ 9.19	20.5 $\pm$ 6.96	1.33 $\pm$ 0.04	2.95 $\pm$ 0.31	2.57 $\pm$ 0.17
		HS3	2.51 $\pm$ 0.37	7.92 $\pm$ 0.07	5.72 $\pm$ 0.82	187 $\pm$ 18.3	20.6 $\pm$ 5.99	43.1 $\pm$ 20.4	56 $\pm$ 4.29	2.54 $\pm$ 1.01	2.44 $\pm$ 0.31	2.10 $\pm$ 0.14
	Z2	HS0	2.37 $\pm$ 0.47	7.79 $\pm$ 0.15	7.34 $\pm$ 1.10	231 $\pm$ 36.6	33.5 $\pm$ 8.26	33.6 $\pm$ 11.9	26.4 $\pm$ 6.90	2.04 $\pm$ 0.37	2.80 $\pm$ 0.27	2.92 $\pm$ 0.19
		HS1	1.92 $\pm$ 0.58	7.80 $\pm$ 0.06	7.41 $\pm$ 0.52	245 $\pm$ 19.2	18.7 $\pm$ 7.98	41.7 $\pm$ 24.5	13.6 $\pm$ 2.52	2.95 $\pm$ 1.64	2.93 $\pm$ 0.31	2.49 $\pm$ 0.17
		HS2	1.75 $\pm$ 0.38	7.75 $\pm$ 0.06	7.53 $\pm$ 1.44	267 $\pm$ 24.0	21.2 $\pm$ 5.69	149.6 $\pm$ 95.9	31.3 $\pm$ 6.20	4.00 $\pm$ 3.01	2.69 $\pm$ 0.39	2.51 $\pm$ 0.29
		HS3	2.00 $\pm$ 0.52	8.02 $\pm$ 0.03	6.65 $\pm$ 0.67	287 $\pm$ 134	31.2 $\pm$ 12.9	35.9 $\pm$ 23.9	48.3 $\pm$ 5.05	2.40 $\pm$ 1.67	3.01 $\pm$ 1.09	1.73 $\pm$ 0.31
	Z3	HS0	3.15 $\pm$ 1.44	8.01 $\pm$ 0.04	5.74 $\pm$ 0.16	350 $\pm$ 116	28.1 $\pm$ 3.99	29.2 $\pm$ 12.1	26.6 $\pm$ 5.10	1.94 $\pm$ 0.66	3.33 $\pm$ 0.67	3.56 $\pm$ 0.32
		HS1	1.80 $\pm$ 0.48	7.79 $\pm$ 0.04	7.49 $\pm$ 0.78	249 $\pm$ 26.8	28.2 $\pm$ 5.24	83.9 $\pm$ 55.5	16.5 $\pm$ 2.46	3.20 $\pm$ 1.63	2.67 $\pm$ 0.28	2.65 $\pm$ 0.14
		HS2	1.53 $\pm$ 0.27	7.79 $\pm$ 0.05	5.74 $\pm$ 0.82	276 $\pm$ 38.0	33.2 $\pm$ 6.29	28.2 $\pm$ 8.43	30.3 $\pm$ 2.20	2.33 $\pm$ 0.66	2.64 $\pm$ 0.10	2.34 $\pm$ 0.09
		HS3	2.12 $\pm$ 0.08	8.05 $\pm$ 0.01	6.11 $\pm$ 0.54	173 $\pm$ 28	26.4 $\pm$ 6.34	65.7 $\pm$ 55.2	52.4 $\pm$ 7.58	3.00 $\pm$ 1.36	2.75 $\pm$ 0.36	2.13 $\pm$ 0.24

HS: humic substances. HS rates: HS0, HS1, HS2, and HS3 = 0, 0.05, 0.1, and 0.5 g C kg⁻¹ medium, respectively. Zn rates: Z1, Z2, and Z3 = 1, 5, and 10 mg Zn kg⁻¹ medium. β -GLU: β -glucosidase activity. Total uptake: the total uptake of P by plants. The values are the means of four replicates $\pm$ SD.