A new type of plant metalloreductase maintains root growth under low phosphorus

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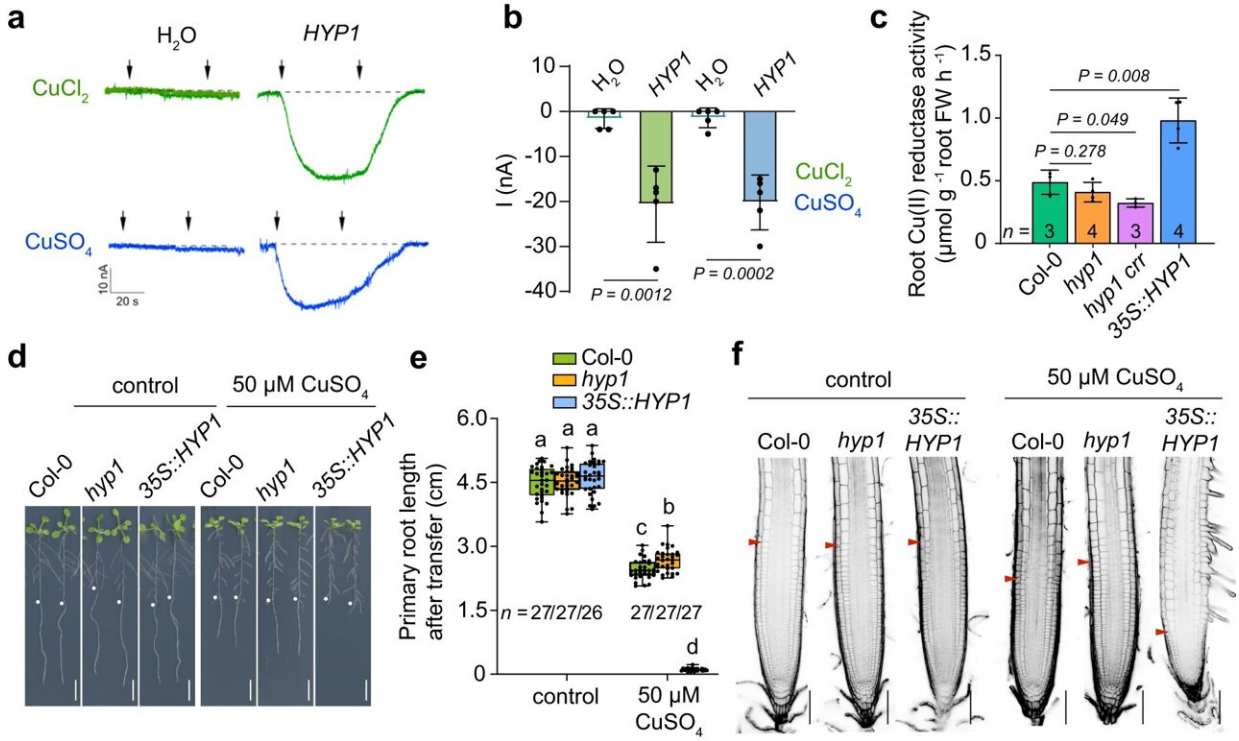

HYP1 can mediate cupric reduction activity and alter Cu sensitivity of roots. **a**, **b** Trans-plasma membrane current recordings (**a**) and calculated mean currents (**b**) in *X. laevis* oocytes injected with water (H_2O) or cRNA of *HYP1* (*HYP1*) in response to two sources of Cu(II) ($CuSO_4$ and $CuCl_2$) in standard bathing solution (pH 5.5), at a holding potential of −20 mV. The left and right arrows indicate the addition and removal of the Cu substrates, respectively. Bars represent means ± SD (n = 5 independent oocytes). P values according to two-sided Student's t-test. **c** Cu(II) reductase activity of wild-type (Col-0), *hyp1*, *hyp1 crr* and one transgenic line overexpressing *HYP1* (*35S::HYP1*). Ten-day-old seedlings grown on standard half-strength MS medium were used for the assay.

Bars represent means ± SD (n = biological replicates constituted of 6 plants each as indicated in the plot). P-values according to two-sided Student's t-test. **d–f** *HYP1* overexpression increases the sensitivity of primary roots to high Cu concentrations. Appearance of plants (**a**), primary root length (n = independent roots as indicated in the plot) (**b**) and root tip morphology (**c**). Ten-day-old seedlings were transferred to fresh medium containing 0.05 μM (control) or 50 μM $CuSO_4$ and analyzed after 6 days. For the box plots, horizontal line, median; edges of boxes, 25th (bottom) and 75th (top) percentiles; whiskers, minimum and maximum values; and dots, individual biological replicates. Different letters indicate significant differences (one-way ANOVA followed by post-hoc Tukey's test, P