Supplementary Information

Table S1. The measured ζ-potential and calculated ψ_0 for various species in different media from previous studies.

Plants and Ref.	Treatment No.	pH	$CaCl_2$	$MgSO_4$	NaCl	KCl	$LaCl_3$	$Cu(NO_3)_2$	ζ-Potential	Calculated ψ_0 Value [b]
			mM					μM	mV	
Barley leaf protoplasts [46]	1	6.7	0.1		0.5				−48	−66
	2	6.7	0.1		6.5				−39	−59
	3	6.7	0.1		0.5	6			−39	−60
	4	6.7	0.1		0.5		0.1		−17	−7
	5	6.7	0.1		0.5		0.3		0	3
	6	6.7	0.1		0.5		1		14	12
	7	3.6	0.1		6				−2	5
	8	3.6	0.1				1		23	16
Barley leaf protoplasts [47]	9	7.6			3				−29	−105
	10	7.6			7.5				−20	−83
	11	7.6			15				−13	−67
	12	7.6			1	14			−13	−74
	13	7.6			30				−10	−52
	14	7.6	1		4.5				−10	−37
	15	7.6		1 [a]	4.5				−11	−36
	16	7.2			0.5		0.17		0	−2
	17	6.5			5		1		3	12
Barley leaf protoplasts [48]	31	7.3	0.02		6	1			−18	−72
	32	6.3	0.02		6	1			−16	−70
	33	5.2	0.02		6	1			−12	−52
	34	4	0.02		6	1			1	−11
	35	2.7	0.02		6	1			18	40

Table S1. *Cont.*

Plants and Ref.	Treatment No.	pH	$CaCl_2$	$MgSO_4$	NaCl	KCl	$LaCl_3$	$Cu(NO_3)_2$	ζ-Potential	Calculated ψ_0 Value [b]
			mM					µM	mV	
Corn root PM vesicles [49]	18	6.5			15				−24	−64
	19	6.5			65				−14	−36
	20	6.5		6	15				−8	−17
	21	6.5		6	65				−6	−14
Tabacco leaf protoplasts [50]	22	5.8			6.7	10			−28	−57
	23	5.8	1		6.7	10			−25	−33
	24	5.8	10		6.7	10			−9	−10
	25	5.8	100		6.7	10			0	8
Rauwolfia serpentina cultured cell protoplasts [51]	26	7.3	0.02		6	1			−18	−72
	27	6.3	0.02		6	1			−18	−70
	28	5.3	0.02		6	1			−17	−54
	29	4.2	0.02		6	1			−12	−18
	30	3	0.02		6	1			2	29
Wheat root protoplasts [29]	36	6	0.23	0.22 [a]	0.97	0.4			−27	−46
	37	6	0.55	0.23 [a]	1.02	0.5			−22	−40
	38	6	1.04	0.23 [a]	1.02	0.5			−19	−34
	39	6	1.52	0.23 [a]	1.04	0.5			−17	−30
	40	6	2.01	0.23 [a]	1.02	0.5			−16	−28
	41	6	2.5	0.23 [a]	1.02	0.5			−15	−25
	42	6	0.24	0.22 [a]	0.97	0.4		0.24	−26	−46
	43	6	0.24	0.22 [a]	0.97	0.4		0.98	−28	−46
	44	6	0.24	0.22 [a]	0.97	0.4		3.9	−27	−45
	45	4.5	0.24	0.22 [a]	0.38	0.5			−17	−30

Table S1. *Cont.*

Plants and Ref.	Treatment No.	pH	$CaCl_2$	$MgSO_4$	NaCl	KCl	$LaCl_3$	$Cu(NO_3)_2$	ζ-Potential	Calculated ψ_0 Value [b]
			mM					µM	mV	
Wheat root protoplasts [29]	46	5	0.24	0.22 [a]	0.47	0.5			−21	−41
	47	5.3	0.24	0.22 [a]	0.56	0.5			−23	−44
	48	5.6	0.24	0.22 [a]	0.69	0.5			−23	−45
	49	6.5	0.24	0.22 [a]	1.5	0.5			−25	−46
	50	7	0.24	0.22 [a]	1.97	0.5			−29	−46

[a] $MgCl_2$; [b] ψ_0 values were calculated based on the SGCs programme (http://www.uq.edu.au/agriculture/sgcs/).

Table S2. Estimates of coefficients for equation RL = $a + b\{1/\exp[(c\{Co^{2+}\}_0)^d + (e\{Zn^{2+}\}_0)^f]\}$ (Equation (19), Figure 7) and RL = $a + b[1 + b_1\{H^+\}_0 + b_2(\{H^+\}_0)^2]\ \{1/\exp[(c\{Co^{2+}\}_0)^d + (e\{Zn^{2+}\}_0)^f]\}$ (Equation (20), Figure 7). The coefficients c and e in Equation (18) were expanded to $c(1 + c_1\{Zn^{2+}\}_0)$ and $e(1 + e_1\{Co^{2+}\}_0)$, respectively. Activities are expressed as μM. n = 108. Data were obtained from Wang *et al.* [12]. ([a] Not significant, and CI represents confidence interval.).

Equation (19)				
Parameter	**Estimate**	**ASE**	**Parameter/ASE**	**95% CI**
a	−3.19 ns [a]	10.23	−0.31	−23.48–17.10
b	10.18 ns [a]	10.21	0.10	−10.07–30.44
b_1	2.90×10^{-4} ns [a]	3.20×10^{-4}	0.92	-3.40×10^{-4}–9.20×10^{-4}
b_2	1.38	0.35	3.90	0.68–2.08
c	4.60×10^{-4} ns [a]	4.70×10^{-4}	0.98	-4.70×10^{-4}–1.39×10^{-3}
$c1$	1.46	0.37	3.95	0.73–2.19
d				
e				
e_1				
f				
r^2			0.655	
Equation (20)				
Parameter	**Estimate**	**ASE**	**Parameter/ASE**	**95% CI**
a	2.09	0.29	7.24	1.52–2.66
b	8.28	0.48	17.37	7.34–9.23
b_1	−0.02	0.01	−10.55	−0.03–(−0.02)
b_2	1.44×10^{-4}	1.60×10^{-5}	8.89	1.12×10^{-4}–1.77×10^{-4}
c	6.80×10^{-4}	5.00×10^{-5}	14.89	5.90×10^{-4}–7.70×10^{-4}
$c1$	-1.90×10^{-5} ns [a]	3.20×10^{-4}	−0.06	-6.54×10^{-4}–6.15×10^{-4}
d	2.40	0.36	6.76	1.70–3.10
e	1.00×10^{-3}	7.00×10^{-5}	14.17	8.60×10^{-4}–1.14×10^{-3}
e_1	4.42×10^{-4}	1.99×10^{-4}	2.22	4.700×10^{-5}–8.370×10^{-4}
f	2.38	0.38	6.34	1.63–3.12
r^2			0.895	

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