

Supplementary Materials

Table S1. Primer sequence

Gene	Primer	Sequence (5'→3')	Primer Length	T _m (°C)	GC (%)
ZmAHA2	F	CAGGACTTCGTCGGGATCGT	20	61.65	60
	R	GTTGTTGGTGCGTGCCTTGG	20	62.95	60
ZmHAK5	F	GATGCGTCGGAGAAAATGCC	20	59.97	55
	R	ATGCTAGGTGCAGTGTGGTC	20	60.04	55
ZmSOS1	F	ACATCATTGTTGCTTGGCGG	20	59.76	50
	R	GCAACAATAGCGGTCCCATC	20	59.34	55
ZmACS6	F	ATGGCCGGTGGTAGCAGT	18	61.01	61.11
	R	AAAGGGTCCATGTCGTAGGC	20	59.75	55
ZmADH1	F	TGGCAACTATAAGCCACGCA	20	60.04	50
	R	AGGTCGAACGCCTTGTTGAT	20	59.97	50
ZmActin	F	GGGATTGCCGATCGTATGAG	20	56.8	50
	R	GAGCCACCGATCCAGACACT	20	59.6	60

Table S2. Gene expression

Gene	PreTR		10DAT				
	NT	ST	NT	ST	ST+K+P	ST+K+S	ST+K+Si
ZmAHA2	4.5 ± 0.29	2.1 ± 0.30	2.2 ± 0.16	1.2 ± 0.12	0.8 ± 0.14	1.9 ± 0.23	2.3 ± 0.23
ZmHAK5	2.6 ± 0.18	1.3 ± 0.31	0.6 ± 0.04	1.5 ± 0.27	0.4 ± 0.08	0.5 ± 0.13	0.9 ± 0.11
ZmSOS1	0.5 ± 0.11	1.0 ± 0.18	1.3 ± 0.06	1.5 ± 0.25	0.5 ± 0.05	1.3 ± 0.13	1.0 ± 0.20
ZmACS6	4.2 ± 0.28	1.7 ± 0.18	2.3 ± 0.16	1.5 ± 0.13	0.7 ± 0.05	1.9 ± 0.13	2.3 ± 0.20
ZmADH1	0.9 ± 0.07	0.7 ± 0.06	1.5 ± 0.06	1.5 ± 0.14	0.7 ± 0.04	1.6 ± 0.14	1.8 ± 0.17

Table S3. Functional integration of analyzed genes with corresponding physiological and biochemical outcomes.

Gene	Encoded Protein/Core Biological Function	Integrated Physiological/Biochemical Outcomes in This Study
ZmAHA2	Plasma membrane H ⁺ -ATPase; generates the proton gradient for secondary active transport.	Supports the energy demand for ion transporters (SOS1, HAK5). Reduced expression in Si-treatment suggests enhanced energy efficiency.
ZmHAK5	High affinity K ⁺ transporter; crucial for K ⁺ uptake under salt stress.	Coordinated regulation with SOS1 ensures the optimal Na ⁺ /K ⁺ ratio, directly supporting systemic growth recovery.
ZmSOS1	Plasma membrane Na ⁺ /H ⁺ antiporter; mediates active Na ⁺ efflux to maintain ion homeostasis.	Downregulation in Si-treatment reflects reduced necessity for active Na ⁺ exclusion due to the physical barrier, strongly correlating with decreased oxidative damage (MDA).
ZmACS6	ACC synthase 6; rate-limiting enzyme in ethylene biosynthesis, promoting senescence.	Stabilization correlates with suppressed leaf senescence and maintained antioxidant capacity (POD, SOD), promoting biomass accumulation.
ZmADH1	Alcohol dehydrogenase 1; key marker enzyme for anaerobic fermentation.	Lowest expression in Si-treatment serves as a molecular indicator of rapid metabolic transition from hypoxia back to aerobic respiration.