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SALT STRESS MODULATES THE LIGNIN METABOLISM AND FERULOYLATION IN MAIZE

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LIGNIN METABOLISM, FERULIC ACID AND SALT STRESS

Lignin is synthesized by the phenylpropanoid pathway, which is involved in the synthesis of a wide range of phenolic acids in plants, such as ferulic and *p*-coumaric acids. Salinity stress has been associated with a greater deposition of lignin in vascular tissues and xylem development, representing an adaptation mechanism in resisting salinity-imposed stress. Maize is grown under a wide spectrum of soil and climatic conditions, and soil salinity is a serious threat to its production worldwide. **Objectives:** Understanding maize response to salt stress and resistance mechanism, overviewing management options may help to devise strategies for improved maize performance in saline environments. The biochemical mechanism of lignin biosynthesis and feruloylation in response to salt stress are still scant.

METHODOLOGY

Maize seeds (cv. IPR 164) were surface-sterilized with 2% sodium hypochlorite for 2 min and dark-germinated (25 °C) for three days on two sheets of moistened filter paper.

Three-day-old seedlings were cultivated in half-strength Dong's solution (pH 6.0), with or without addition of 50, 100 or 200 mM of NaCl, into a growth chamber (25 °C, 12/12 h light/dark photoperiod) for 3 days.

Fresh biomass

- Root length and weight;
- Cell viability;
- Relative water content;
- Malondialdehyde;
- Enzymatic assays;

Dry biomass

- Dry weight;
- Soluble protein;
- Soluble cinnamic acids;
- Ester-linked cinnamic acids;
- Lignin content and composition.

RESULTS

A. Growth phenotypes, biomass yield and physiological parameters

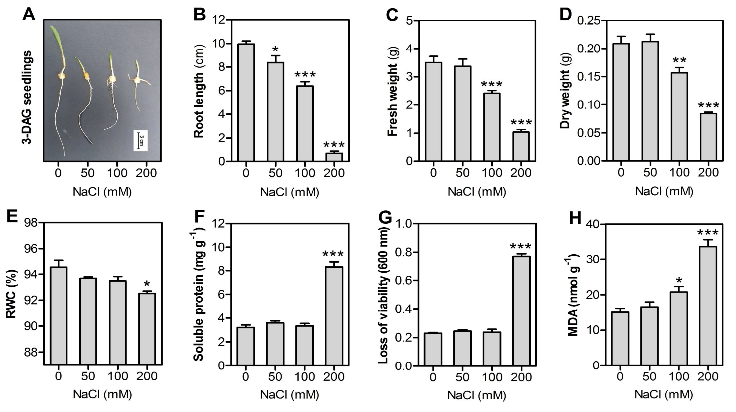

Figure 1: Effects of salt stress on maize roots. Maize seedlings (A), root length (B), fresh weight (C), dry weight (D), relative water content (E), soluble protein (F), loss of cell viability (G) and malondialdehyde (H). Error bars indicate ± SEM. *n* = 5-6; *0.05 > *P* >0.01, **0.01> *P* > 0.001, ***0.001 > *P;* Dunnett's test.

B. Ester-linked, soluble hydroxycinnamic acids and lignin content

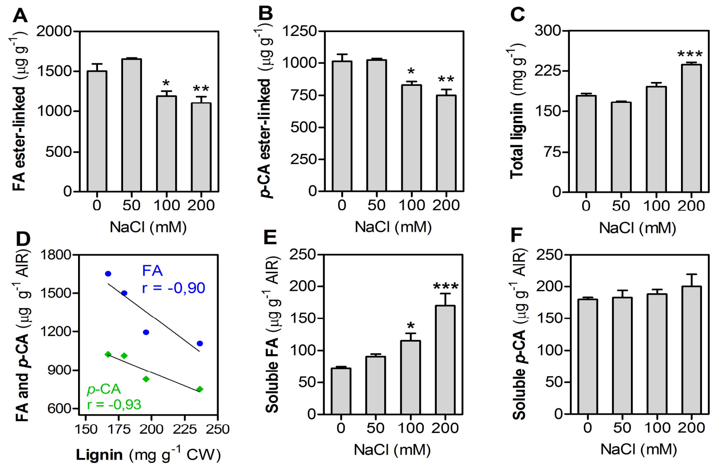

Figure 2: Hydroxycinnamic acids and total lignin. Ferulic acid ester-linked (A), *p*-coumaric acid ester-linked (B), total lignin (C), correlation between ferulic and p-coumaric acids ester-linked with lignin (D), soluble ferulic (E) and *p*-coumaric acid (F). Error bars indicate ± SEM. *n* = 5-6; *0.05 > *P* >0.01, **0.01> *P* > 0.001, ***0.001 > *P;* Dunnett's test.

C. Phenylpropanoid and monolignol pathway

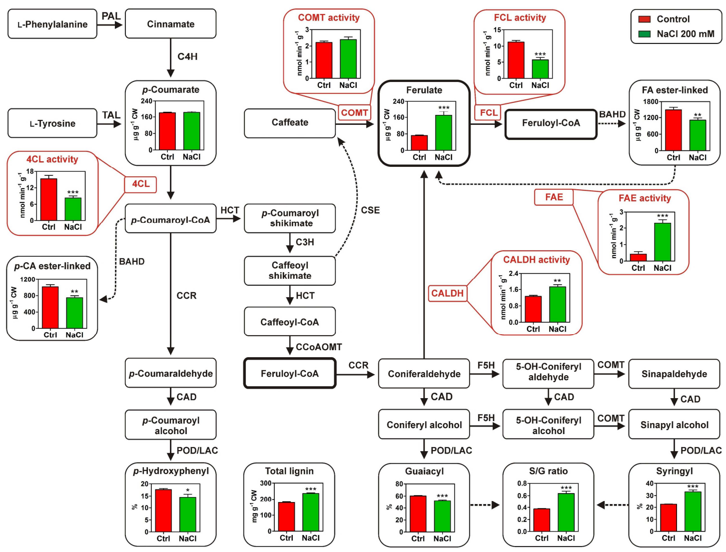

Figure 3: Phenylpropanoid and monolignol pathway under salt stress (NaCl 200 mM) in maize roots 3-DAG. Arrows with dotted lines are routes that have been suggested in the literature. 4CL, 4-coumarate: CoA ligase; BAHD, BAHD acyl-CoA transferase; CAD, cinnamyl alcohol dehydrogenase; CALDH, coniferaldehyde dehydrogenase; CCoAOMT, caffeoyl-CoA O-methyltransferase; CCR, cinnamoyl-CoA reductase; COMT, caffeic acid O-methyltransferase; CSE, caffeoyl shikimate esterase; C3H, *p*-coumarate 3-hydroxylase; C4H, cinnamate 4-hydroxylase; FAE, feruloyl esterase; FCL, feruloyl-CoA ligase; F5H, ferulate 5-hydroxylase; HCT, hydroxycinnamoyl-CoA: shikimate/quinate hydroxycinnamoyltransferase; LAC, laccase; PAL, phenylalanine ammonia-lyase; POD, peroxidase; TAL, tyrosine ammonia-lyase.

CONCLUSIONS

Our results reveal the complex way in which the phenylpropanoid pathway is involved in response to salt stress. These data suggest new potential targets for genetic improvement of plants with resistance to salt stress.

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