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Developing a Non-Destructive Method for Assessing Root Lodging in Canola

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Outline

- Background
- Objectives
- Experiments and Key measurements
- Results
- Conclusions
- Next steps

Background

- Crop lodging is a main cause of yield loss and quality reduction; but there is no convenient method to assess it
- Lodging can be classified as stem and root lodging; but it is unclear which kind of lodging is more prevalent
- Agronomic practices and abiotic stress may have an impact on crop lodging; but it is always ignored
- Measuring root capacitance could be a quick, affordable and non-invasive method for root phenotyping
- Capacitance readings are consistent in hydroponic growth media; less reliable under field or potting soil conditions

Objectives

- Examine the relationships between root electrical capacitance and responses of genotypes to heat and drought stresses
- Develop an electrical capacitance method for estimating canola root morphological traits under soil conditions
- Determine the sensitivity of the root capacitance method for assessing crop lodging and
- The impact of agronomic practices and abiotic stress on lodging

Materials and methods:

- Controlled growth chamber study:
  - Main plot: High vs. normal T
  - Subplot: Genotypes x drought

- Field Experiments:
  - Exp. 1: Irrigation x genotype (simulation of drought)
  - Exp. 2: Planting date x genotype (simulation of heat/drought stress)
  - Exp. 3: Genotype response to preplant vs. split-N application

Key measurements:

Electrical capacitance measurement with a BK Precision 879B meter

WinRHIZO

Fine roots were scanned and quantified with WinRHIZO

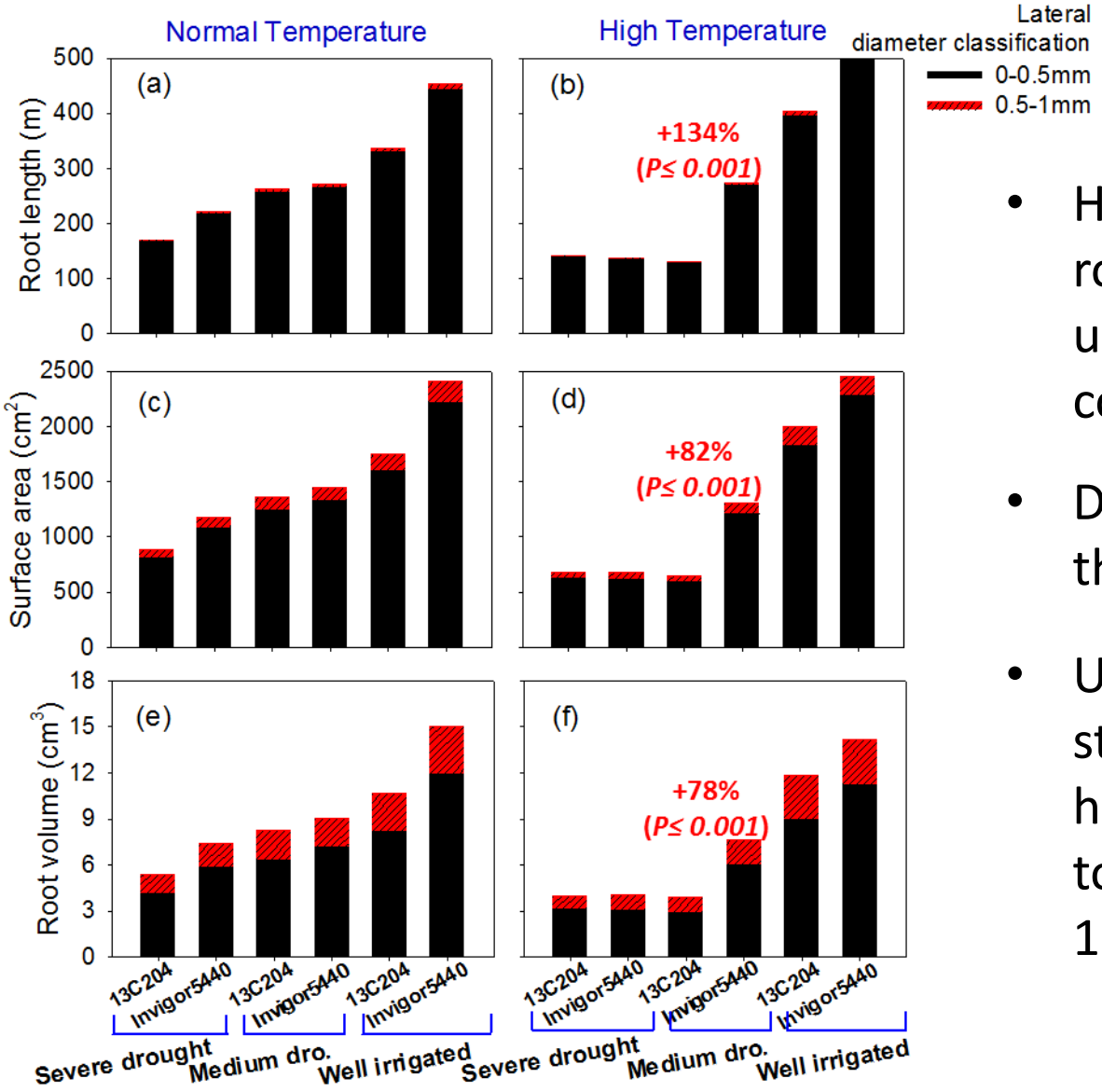
different root size that maintain unequal anchorage strength in canola

Simulated stem lodging test: three point bending test

Simulated root lodging test

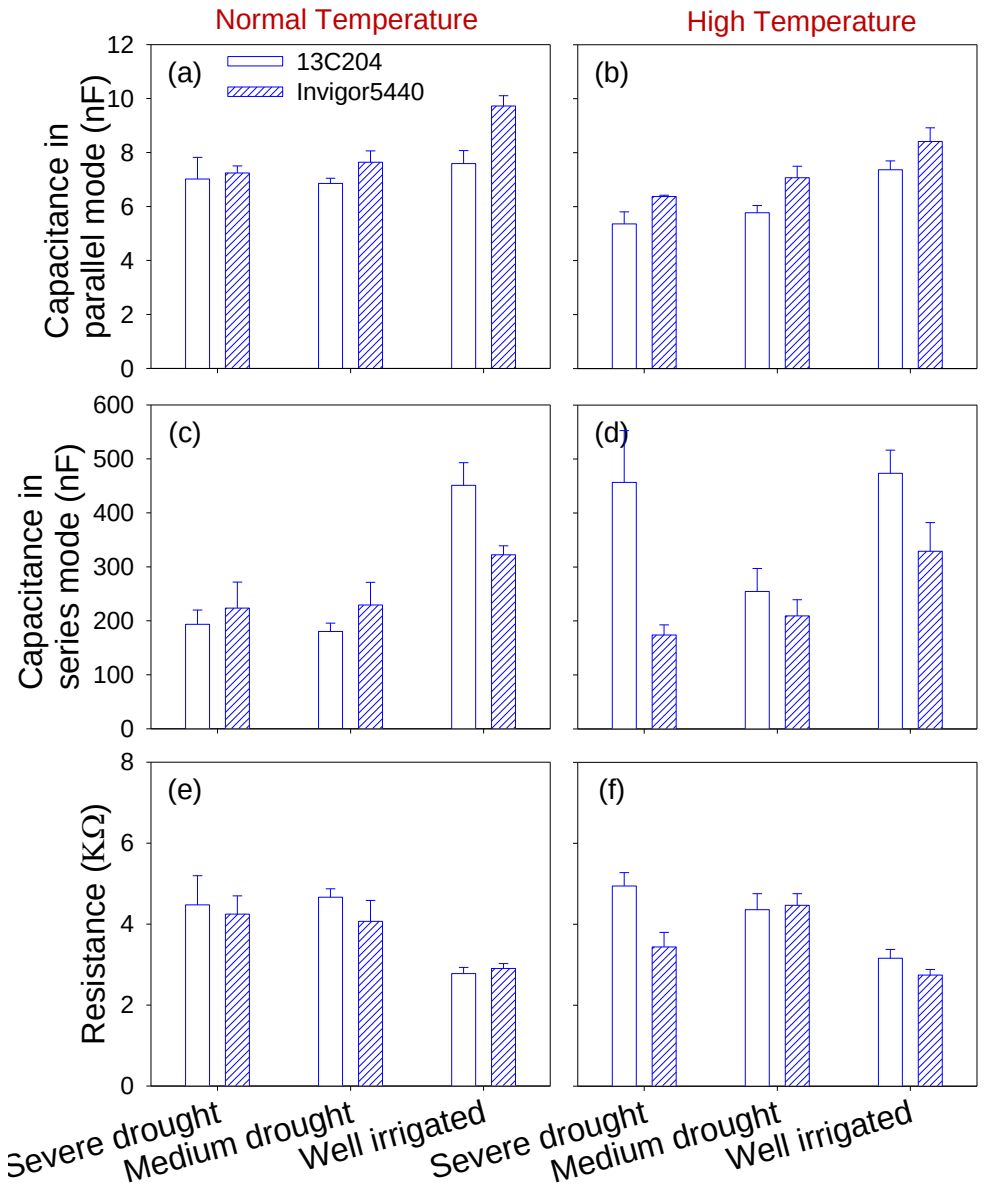
Source: Mecmesin corporation

RESULTS



Lateral root diameter classification analysis

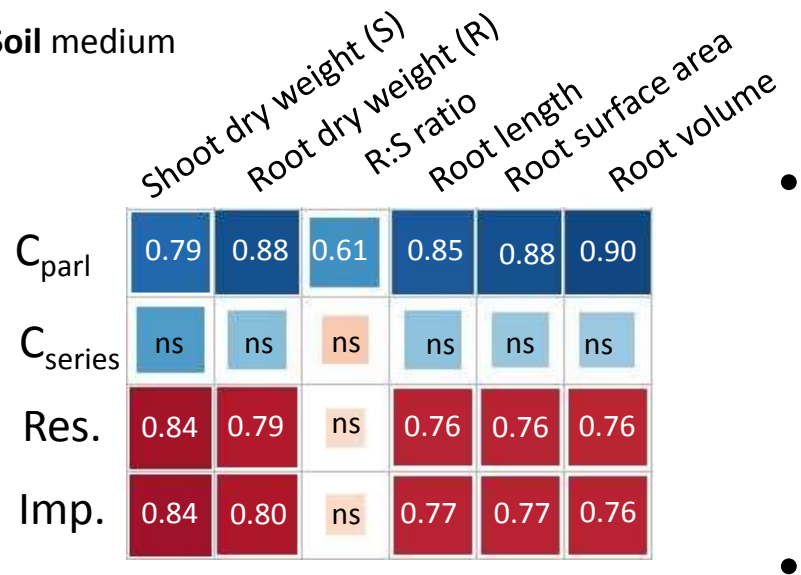
- High T decreased lateral root morphological traits under water-limited conditions
- Drought stress reduced all those lateral root traits
- Under moderate water stress, 5440 had 78% higher root volume and up to 134% length more than 13C204.



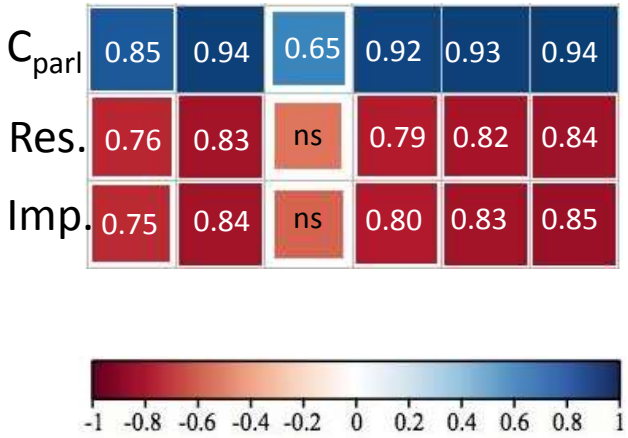
- Clearly, capacitance in parallel mode detected genotypic differences in response to stress

Electrical measurements under 1 KHz test frequency in soil medium

A **Soil** medium

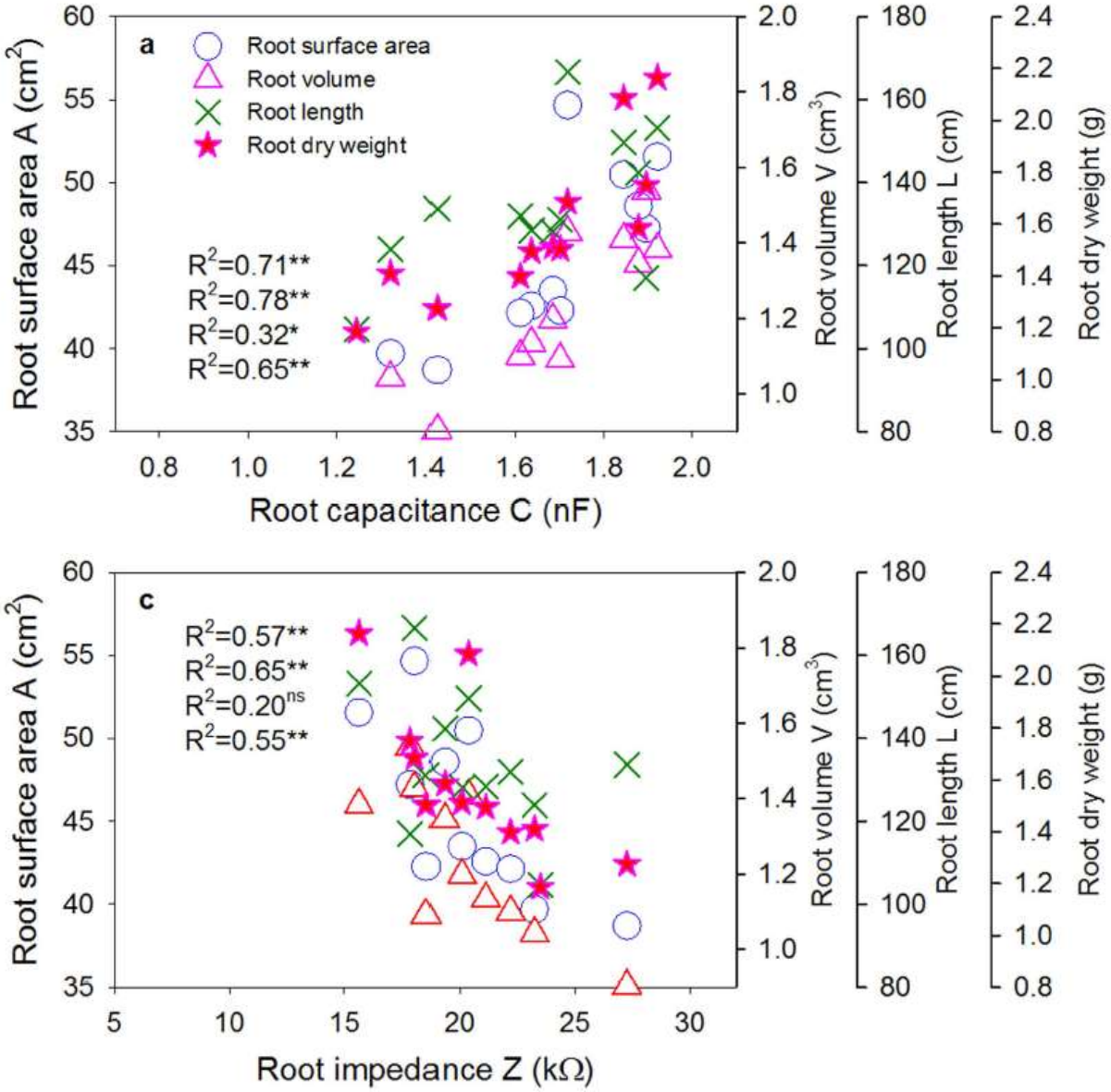


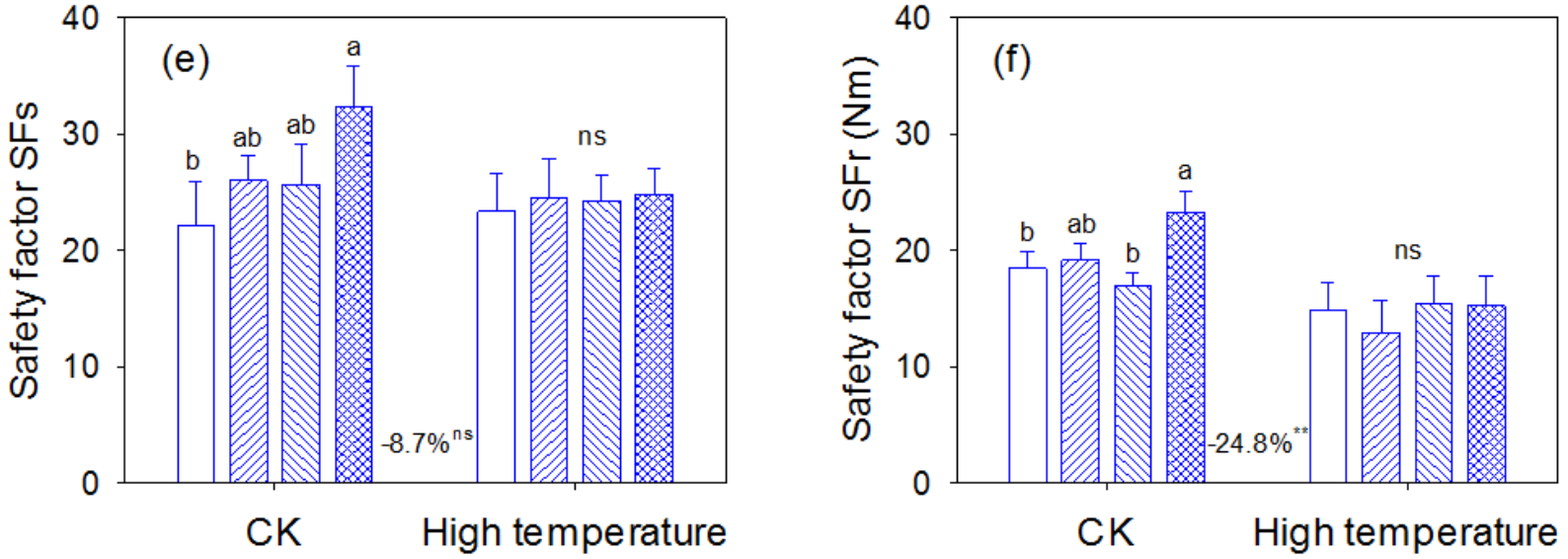
B **Water** medium



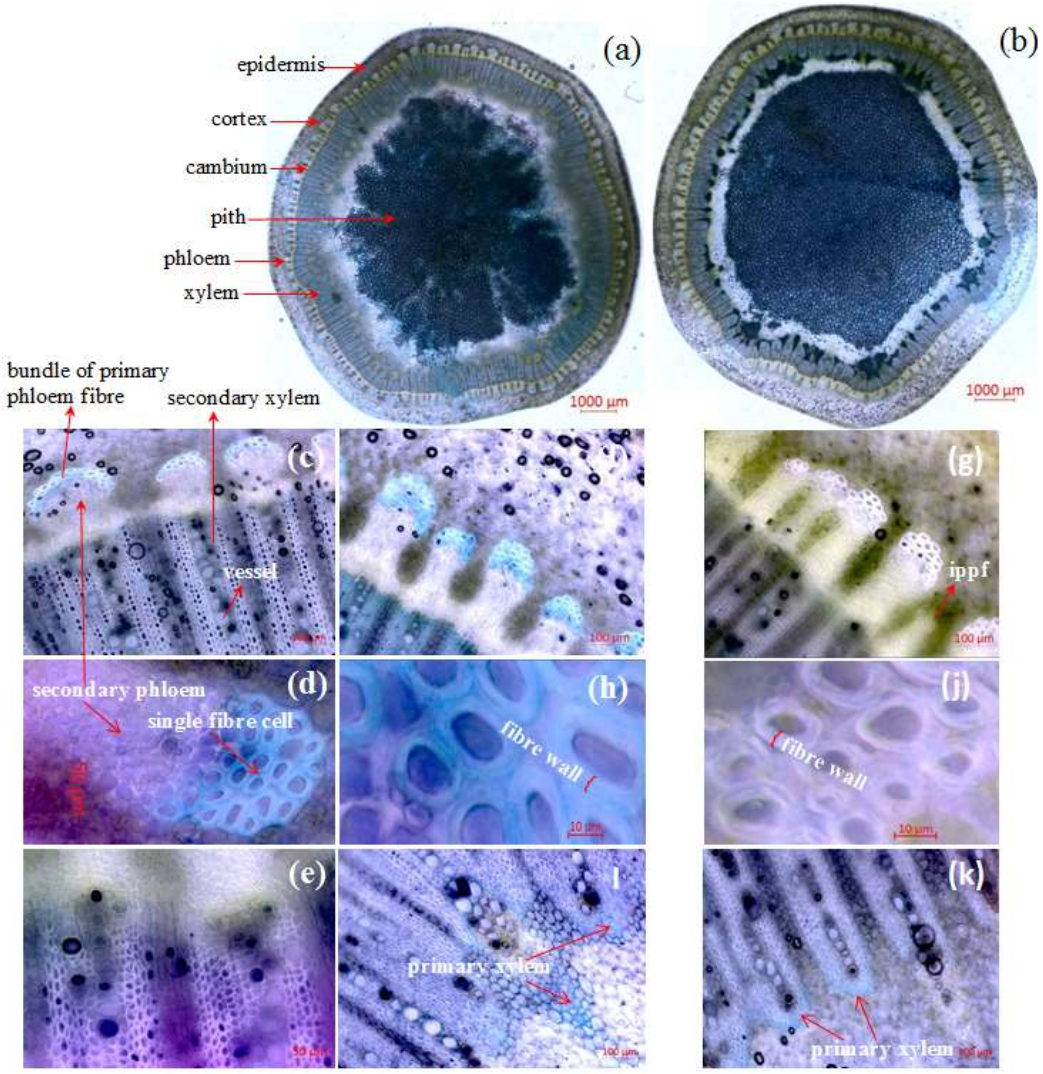
- Root capacitance in parallel mode (C_{parl}, but not in C_{series}) highly correlated with most root traits
- Root impedance showed similar and significant correlation with root related traits, except for R:S ratio
- The correlation was comparable between water and soil medium

The strong relationship of root traits with electrical capacitance and impedance was further evidenced under field condition experiments



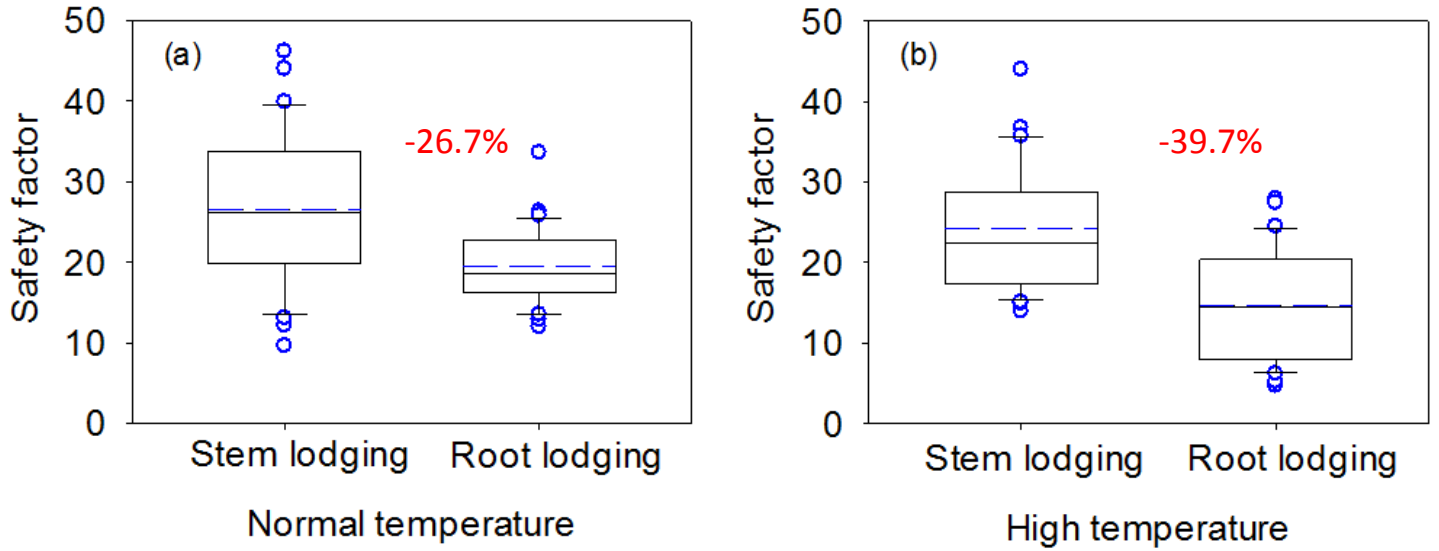


High temperature significantly reduced root safety factor by 24.8 %; but only reduced stem safety factor slightly



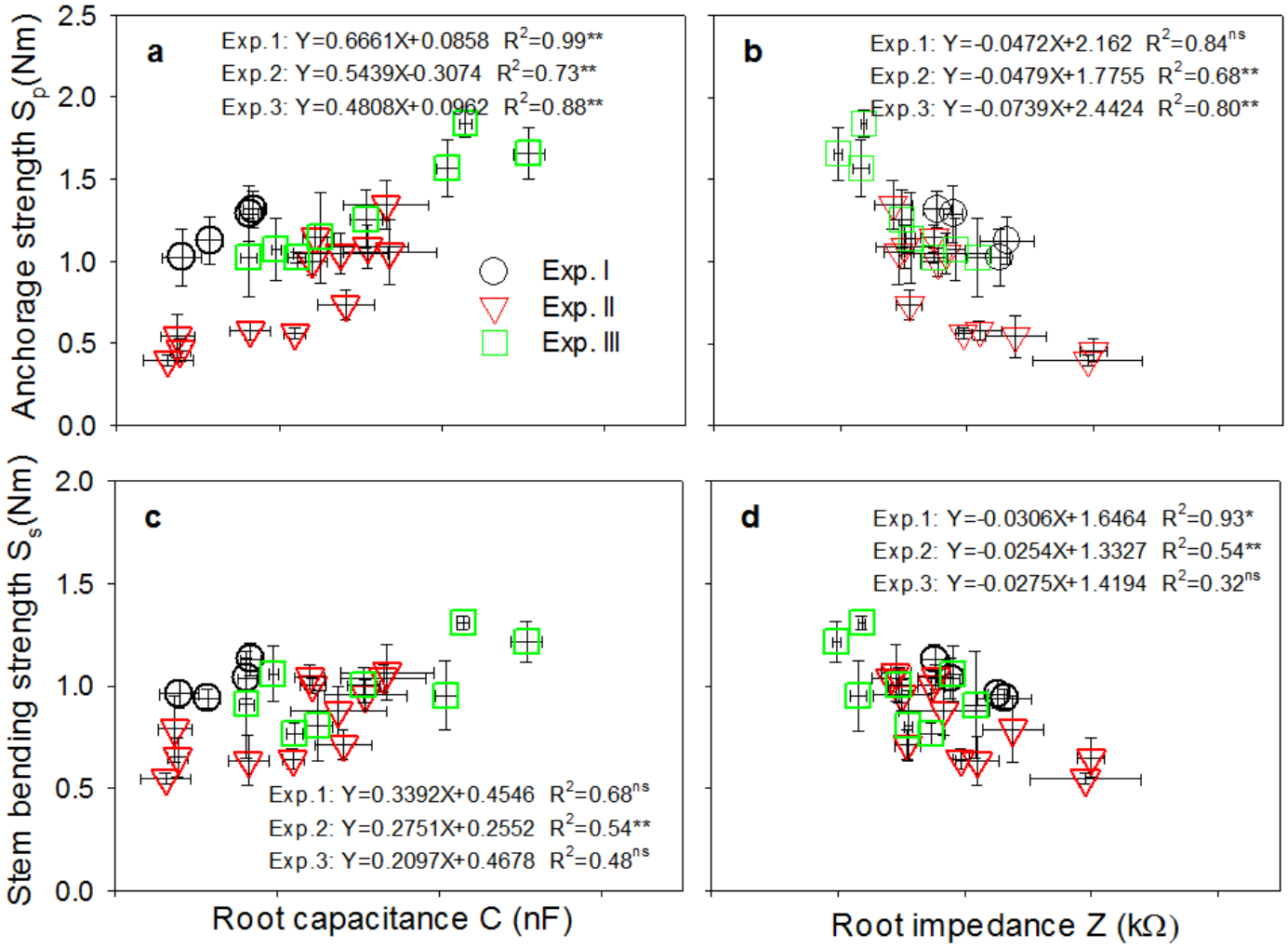
High temperature reduced vascular bundle area, xylem area, fibre bundle area and single fibre cell area

The aborted primary phloem, thinner cell wall, smaller primary xylem were evidenced in high temperature, in comparison with CK



Root lodging is more likely to occur than stem lodging as SFs > SFr

Risk of root lodging becomes more critical under high temperature



EC and impedance displayed consistent relationships with anchorage strength and stem bending strength in all three field expts

Key conclusions

- Root capacitance method able to delineating genotypes in response to abiotic stresses;
- Heat stress greatly increased the risk of root lodging;
- Lodging risk can be reduced by appropriate agronomic practices and variety selection;
- Electrical measurements as an appropriate methodology suitable for studying canola root traits;
- Root capacitance method appears to be a non–invasive technique for in situ assessment of lodging resistance.

Wu, W. and B.L. Ma. 2016. A new method for assessing plant lodging and the impact of management options on lodging in canola crop production. Scientific Reports 6:31890

Wu, W., R.W. Duncan, and B.L. Ma. 2017. Quantification of canola root morphological traits under heat and drought stresses with electrical measurements. Plant Soil (*in press*)

Next steps

- Field studies with diverse genetic background are needed to verify the results;
- Adapt the capacitance method in a breeding program for assessing lines with high yield potential and improved abiotic tolerance;
- Quantify lodging-induced yield loss and quality reductions;
- Improve crop standability, grain yield and quality with best agronomic practices, especially with the use of variety-specific nitrogen management.

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THANK YOU

ANY QUESTIONS ?