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Characterizing root morphological traits and crop lodging of canola genotypes in response to nitrogen supply strategies

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Introduction

- Lodging is a common problem to cause yield loss, deterioration in seed quality and difficult to harvest in canola (*Brassica napus* L.) crop production (Wu et al., 2018). Lodging risk would become more severe with increasing yield potentials under high N supply conditions (Ma et al., 2012), and due to frequent wind storms under climate change scenario (Wu and Ma, 2016).
- Optimising the timing and rates of N application is of critical importance to control lodging, improve NUE and producers' profitability as well as environmental sustainability. This is because split-N application could enhance the basal stem breaking strength, reduce root anchorage failure, and increase yields in canola and oat (Wu and Ma, 2016, 2019), and suppress unproductive tillers in wheat.
- The objectives of this study were to (1) determine the impact of N application on lodging risk factors and crop yields in canola, and (2) identify the prevalent type of lodging (stem or root lodging) as the target for future cultivar improvement.

Materials & methods

- We tested the responses of two canola hybrids to 8 combinations of N timing and rates (0, 50, 100, 150, 200, and 50+50, 50+150 kg N ha^{-1}) in a factorial experiment, arranged in a RCB design with 4 replications.
- At maturity, sampled stems underwent a three point bending test (Fig. 1A), while root lodging test (Fig. 1B) and electrical capacitance (Fig. 1C) were evaluated. Morphological and anatomical traits, and yield were determined.
- The safety factors (SF) against stem buckling (stem lodging, SFs) and against anchorage failure (root lodging, SFr) were calculated.

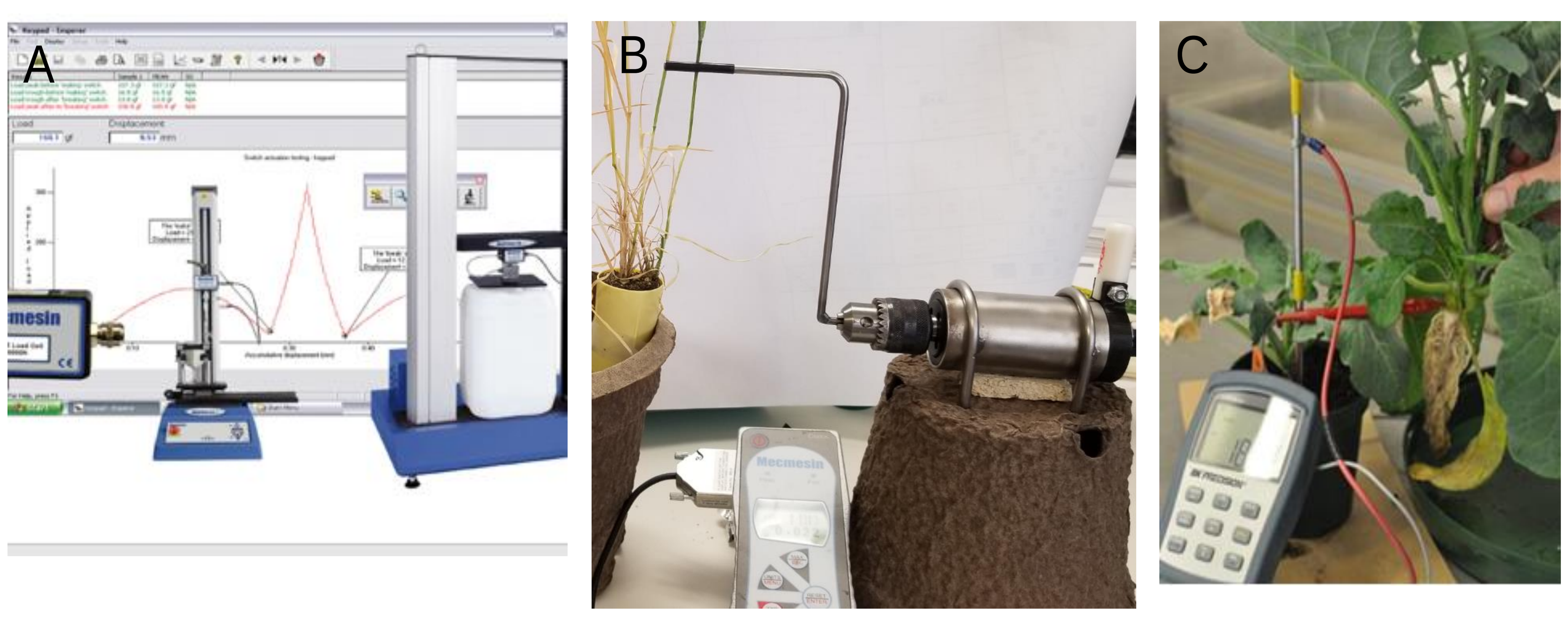

Fig.1. Illustration of (A) 3-point bending test, (B) Root lodging test, and (C) EC test.

Results & discussion

- Grain yields positively responded to rate of N application, with greater yields for split-N application than for preplant application (Table 1).

Table 1. Canola yield (kg ha^{-1}) as affected by N supply strategies.

Treatment (kg N ha^{-1})	2013	2014	2015
0	2336 d	2855 c	2255 e
50	3102 c	3424 b	2973 d
100	3420 ab	3569 ab	3535 bc
150	3212 bc	3560 ab	3490 c
200	3294 abc	3508 b	3733 ab
50+50	3508 a	3366 b	3633 bc
50+100	3438 a	3900 a	3751 ab
50+150	3327 ab	3704 ab	3908 a

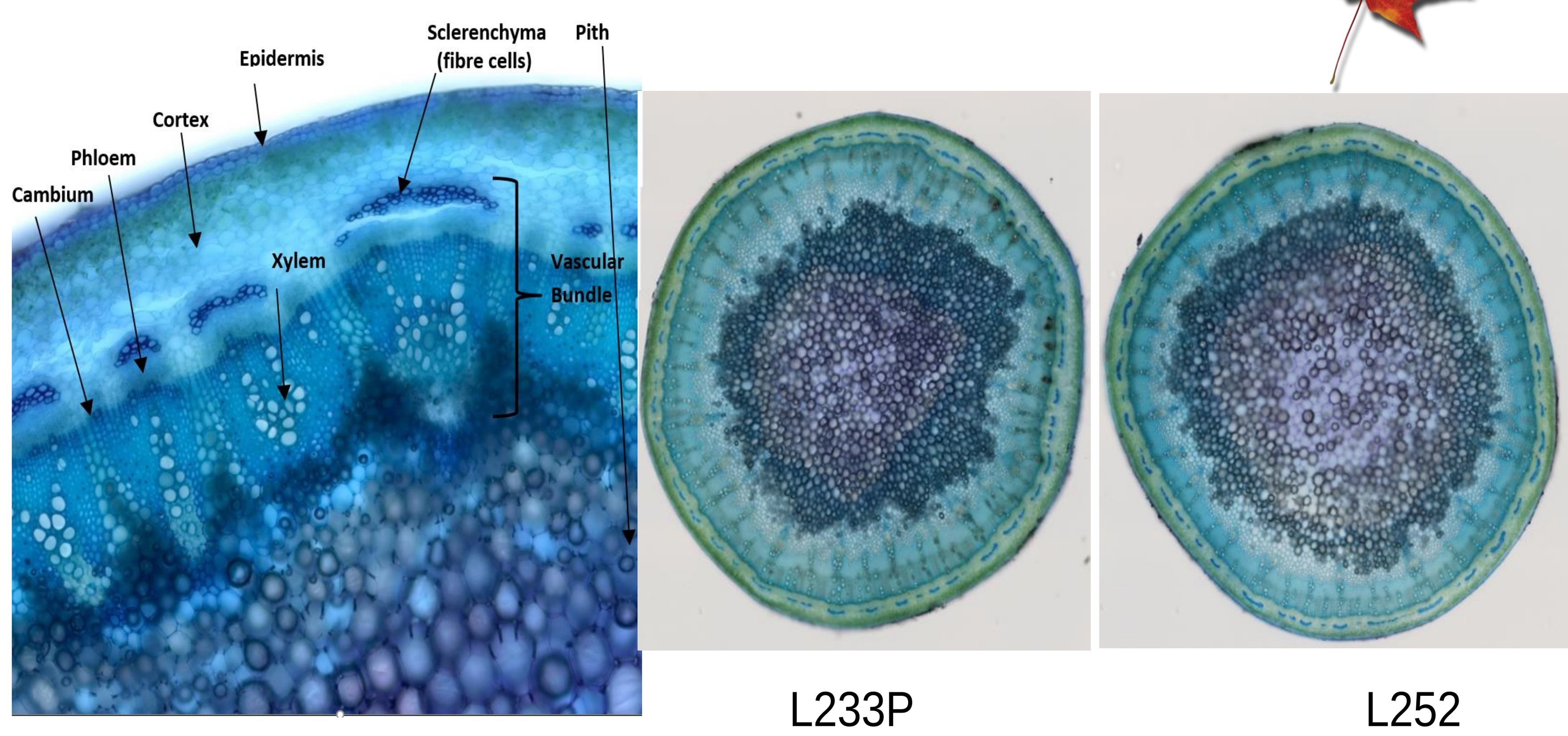

Fig. 2. Illustration of basal stem anatomical traits measured for SF calculation, and the structure of InVigor L233P vs. InVigor L252.

- Canola hybrids differed largely in the risk of lodging, due to differences in their anatomic traits (Fig. 2).
- Risk of lodging, especially root lodging increased with increasing N application rates, due to alteration of basal stem anatomical structure.
- The split-N application strategy reduced the risk of crop lodging, through improved anchorage strength (S_p) and root lodging safety factor (SF_r).
- Electronic capacitance (EC) was positively correlated with yield, and with root length, surface area and volume. These traits played a significant role in nutrient absorption and water uptake, as well as the anchorage strength.
- Smaller SFr against root lodging, compared with SFs against stem lodging across all treatments implied that root lodging was more prevalent than stem lodging in canola.

Conclusions

- N management strategy significantly influenced plant lodging resistance and seed yield of canola.
- Enhancing the root lodging resistance (increasing S_p and SF_r) was more important than enhancing the stem lodging resistance (in terms of S_s and SF_s).
- To minimize the risks of lodging while sustain high yield performance, farmers should adopt appropriate crop management practices, such as adoption of in-season fertilizer management and selecting varieties with strong S_p.
- Root EC appears to be a good indicator for selecting genotypes with both strong Sp and high yield potential in breeding programs.

Selected references

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Acknowledgements

This project was financially supported, in part, by the Canadian Agricultural Partnership of improving canola NUE project through the CRDA between AAFC and Canola Council of Canada, and with Eastern Canada Oilseed Development Alliance. We gratefully acknowledge the excellent assistance of L. Evenson, A. Quesnel, and S. Patterson of AAFC. Thanks are extended to Dr. S. Miller, research scientist, and D. Chabot, technician at the Microscope Service Unit of AAFC for helping us during the assessment of root anatomic traits.

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