

Rise and Fall: Understanding Genetic Progress for Lodging Resistance in Elite Spring Wheat



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Introduction

Lodging, an irreversible displacement of crops from their upright position, reduces wheat grain yield and quality. Its causes are complex, involving the interaction between genotype, environmental factors including abiotic and biotic stresses and crop management. There is a lack of robust selection tools available for breeders to accurately assess and select for lodging resistance as natural lodging (under field conditions) occurrence is not consistent in every crop cycle. A model of the lodging process has been used for estimating ideotype parameters of a lodging proof wheat plant (**Figure 1**) in absence of natural lodging.

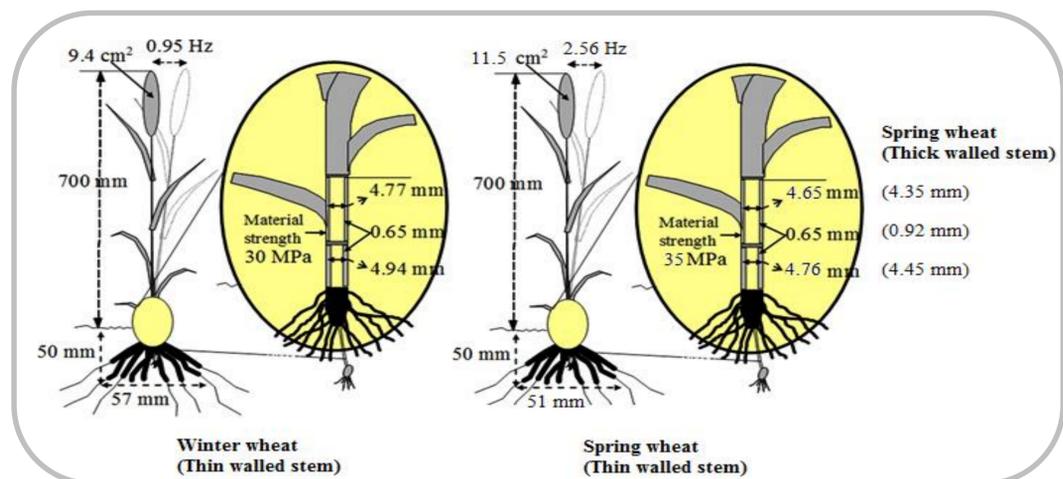


Figure 1. Lodging-proof ideotypes for winter and spring wheat

Objective

To assess the genetic change in the lodging response of elite spring wheat germplasm developed at CIMMYT between 2003 and 2016 to determine if increased lodging resistance was indirectly selected along with progress for grain yield over time

Methods

A set of wheat lines from the 23 -38 ESWYTs (Elite Spring Wheat Yield Trial) from 2003-2016 were evaluated under optimum conditions during 2019, 2020 and 2021 at Campo Experimental Norman E. Borlaug (CENEB) in the Yaqui Valley, Mexico (**Figure 2 a, b, c**). We optimized a set of novel mechanistic methods to assess components of lodging resistance including stem and root anchorage properties under field conditions (**Figure 2 d, e, f**).

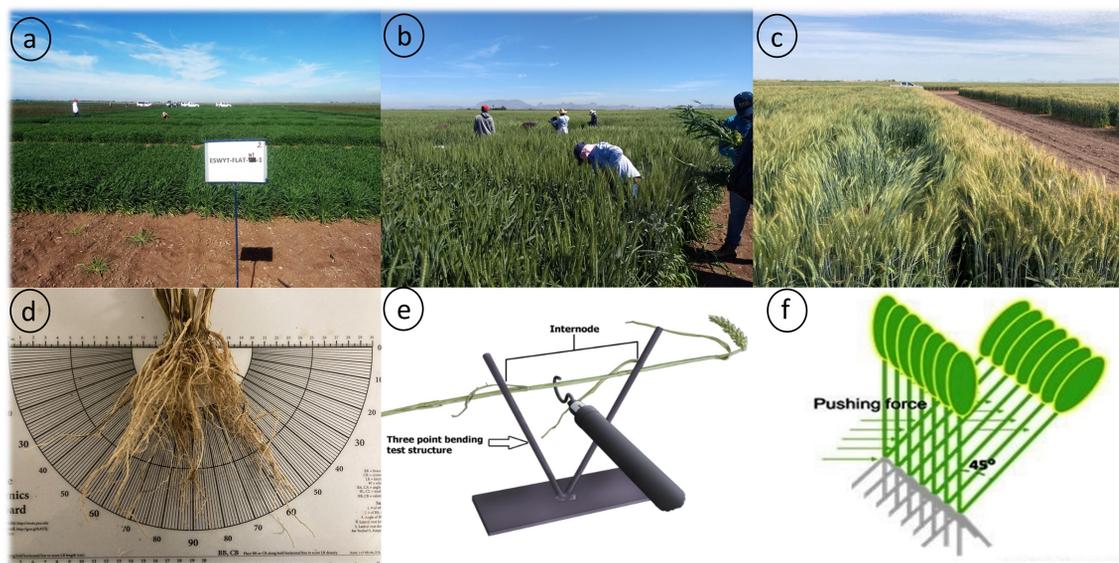
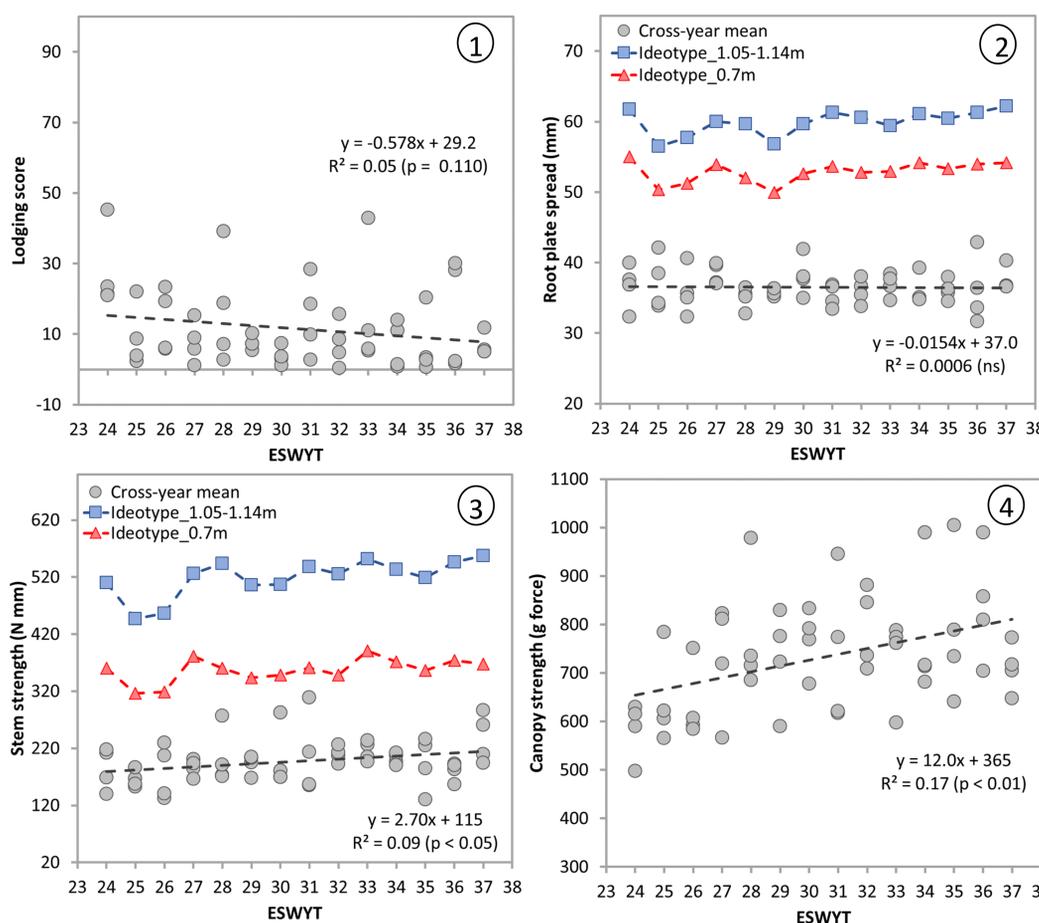


Figure 2. (a) ESWYT trials in 2019, (b) plant sampling for lodging components measurements, (c) plot affected by natural lodging (lodging score), (d) crown root dimensions (anchorage), (e) internode strength (stem mechanical resistance), and (f) canopy strength (canopy mechanical resistance)

Results

- 1 Natural lodging: measured as lodging score has decreased over time
- 2 Plant anchorage: measured as root plate spread has not changed over time
- 3 Stem mechanical resistance: measured as stem strength has increased over time.
- 4 Canopy mechanical resistance: measured as canopy strength has increased over time.



Ideotype targets (blue and red lines) have not been achieved in both plant anchorage and stem mechanical resistance

Conclusion

Theoretical optimal “lodging-proof ideotype” values indicate there is further potential to increase resistance to lodging for wheat improvement

Stem and canopy strength increases are most likely due to selection for wider stems

Selection for wider root crown root plate has not been targeted directly nor indirectly

Key stem strength components

- Stem diameter: increased over time
- Stem wall width: no change

Funded by:



References

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