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Breeding for stem cell wall digestibility in alfalfa

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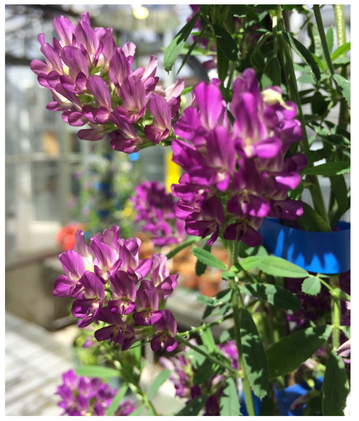


Introduction

The extensive genetic variability for cell wall (CW) digestibility in alfalfa (*Medicago sativa* L.) can be exploited for genetic improvement (Duceppe et al., 2012). However, one of the limitations is the availability of screening techniques for identification of superior genotypes.

A screening approach was developed to identify genotypes with high CW digestibility using enzyme-release glucose (ERG), i.e. glucose released from CW following enzymatic hydrolysis (Bertrand et al., 2014; Duceppe et al., 2012).

Using this screening method, our **objectives** were to evaluate:

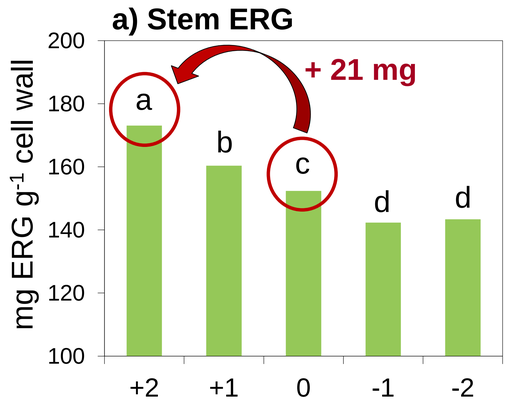
- the direct effect of a divergent phenotypic selection on stem ERG in alfalfa
- the indirect effects of this selection on plant biomass and stem water soluble carbohydrate concentration (WSC)

Materials and methods

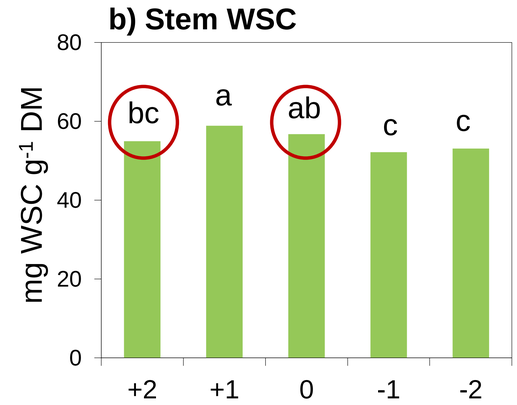
- 500 alfalfa genotypes from two genetic backgrounds (54V54 and Orca) were subjected to two cycles of divergent phenotypic selection for stem ERG concentrations
- Within each background, the 20 lowest and 20 highest ERG genotypes were selected and intercrossed to generate four populations: ERG+1 (one selection cycle), ERG+2 (two selection cycles), ERG-1 (one selection cycle), and ERG-2 (two selection cycles)
- Plants were transplanted at three sites across Québec in 2013 and were harvested at the late flowering stage in 2014 and 2015
- Plant biomass was measured and samples were analysed for stem ERG and WSC concentrations
- ERG = measured by HPLC after enzymatic hydrolysis and predicted by NIRS
- WSC = sucrose + glucose + fructose (measured by HPLC and predicted by NIRS)

Results and discussion

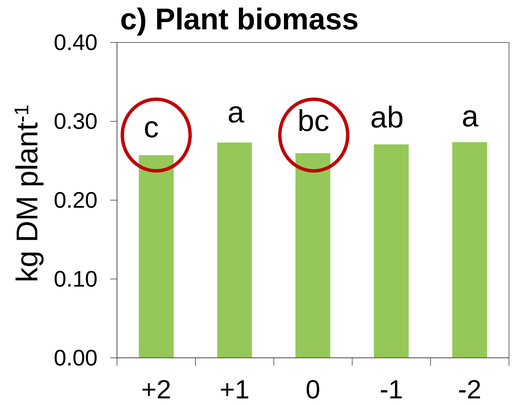
- Our method of divergent selection based on ERG concentration was highly efficient : after two cycles of selection, ERG concentration in alfalfa stem was significantly higher in ERG+2 compared to the ERG+1 and base (0) populations (Fig. 1a)
- Our method of divergent selection was specific to ERG concentration, since there were no significant differences in stem WSC concentration and in plant biomass between ERG+2 and base (0) populations (Fig. 1 b, c)



Effect	Pr > F
Cycle	***
Background	N.S.
Site x Year	***



Effect	Pr > F
Cycle	**
Background x Site x Year	***



Effect	Pr > F
Cycle	*
Background x Site	***
Site x Year	***
Background x Year	*

*Fig. 1. Mean stem ERG and WSC concentrations and plant biomass of two alfalfa cultivars (54V54 and Orca) harvested at three sites in Québec in 2014 and 2015, and subjected to two cycles of divergent phenotypic selection for ERG (+2, +2, -1, -2). Means followed by different letters are significantly different at P<0.05. Significance of the main effects and interaction is expressed as *** (p < 0.001), ** (p < 0.01), and * (p < 0.05). N.S.= not significant.*

Conclusions

- Alfalfa stem CW digestibility, based on stem ERG concentration, can be increased by genetic selection
- The increase in ERG with two cycles of selection (ERG+2) had no negative effect on plant biomass and stem WSC concentration
- Phenotypic selection based on stem ERG concentration is a very promising approach to improve alfalfa stem CW digestibility without reducing plant biomass and stem WSC concentration

References

Bertrand et al., 2014, Crop Sci. 54:2893–2902; Duceppe et al., 2012, Bioenerg. Res. 5: 904-914.

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