

Adaptation of winter beets to low temperature

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Introduction

It is expected that winter sugar beets sown in early autumn produce higher yields than spring sown sugar beets because of enhanced light interception. To achieve these yields, winter sugar beets have to survive frost periods during the winter. It is known that other species improve their winter hardiness by the accumulation of frost protecting substances. Furthermore, there are plants such as rape which require an optimal growth stage to survive extremely low temperatures.

The aim of the study is to identify the adaptation mechanisms which lead to an improved winter hardiness of winter sugar beets.

Material and Methods

- Field trials 2009/10 and 2010/11
- 3 locations (Göttingen, Kiel, Harz)
- sowing date: August
- 5 sugar beet hybrids
- 3 harvest dates (Oct., Dec., Mar.)
- Determination of survival rate after winter and concentration of potential frost protecting substances



Winter beet crop with snow cover, December 2010

Results

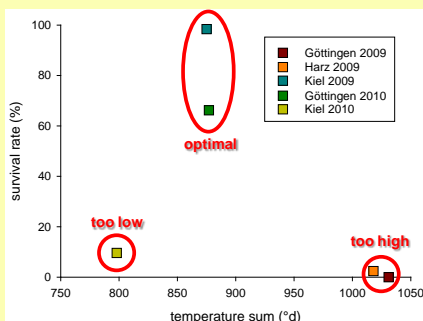


Fig. 1: Survival rate of sugar beets as affected by temperature sum; field trials, mean of 5 sugar beet hybrids, temperature sum at harvest date December

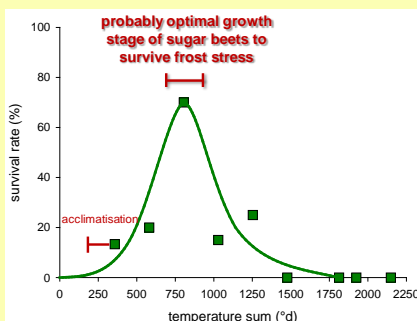


Fig. 2: Survival rate of sugar beets as affected by temperature sum; mean of 3 greenhouse experiments, frost stress -7°C after 14 days of acclimatization at 4°C

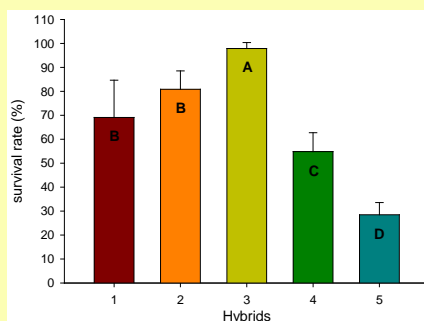


Fig. 3: Survival rate of 5 sugar beet hybrids; field trial, harvest April, different letters indicates significant differences between hybrids at $p < 0.5$, Göttingen, 2011

Tab. 1: Correlation of change before winter of different parameters with the survival rate; field trial, harvest October and December, Göttingen, 2011

Spearman correlation	Survival rate	
	root	leaves
Potassium	-0,5	0,8
Sodium	0,3	0,2
Raffinose	0,7	-0,2
Sucrose	-0,6	-0,9*
Betaine	-0,9*	0,4
Glutamine	0,0	0,3

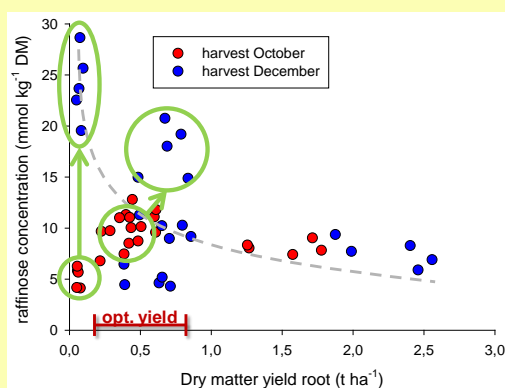


Fig. 4: Raffinose concentration in the root during the ontogenesis of sugar beet; mean of 5 sugar beet hybrids, harvest date October and December, 3 locations, 2 years



Winter beets, January 2012

Conclusions

- Results indicate an optimal growth stage to survive frost periods which is reached between 750°d and 900°d
- Differences in the survival rate indicate genetic variation in winter hardiness among winter sugar beet hybrids
- Correlation of survival rate with different substances indicate an accumulation of potential frost protecting substances
- During ontogenesis all beet compounds decrease, but there are substances which had an untypical course → raffinose may be a substance which is accumulated at low temperatures to improve winter hardiness
- The results lead to better understanding of winter hardiness of winter sugar beets. Further studies are required to verify these results.