Introgression of three QTLs for pre-harvest sprouting tolerance in a bread wheat line

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Introduction

Pre-harvest sprouting (PHS) is a major problem in cereal production, especially in region with relatively high rainfall before harvest. In Switzerland, a variable proportion of the harvest is downgraded from baking to feed purpose almost every year. In the worst years, such as 2007 or 2014, more than 20% of the Swiss bread wheat production was reclassified as feed wheat with a price reduction of around 13.50 €/dt.

Breeding for PHS resistance is difficult. Screening for seed dormancy or low alpha-amylase activity, using the falling number method, is time-consuming. Nevertheless, some progress has recently been achieved in improving dormancy, especially in white wheat. The use of marker-assisted selection could improve breeding efficiency if the markers and genes or quantitative trait loci (QTLs) are efficient. QTLs involved in PHS tolerance or grain dormancy have been published. Three of them were used in this project.

The following questions were investigated:

i) Are the QTLs identified on white-grained cultivars effective also in red-grained cultivars?

ii) Which QTL, or which combination of QTLs, is the most effective?

iii) How many QTLs are needed to obtain a sufficient PHS resistance?

Fig.1: Sprouting test. From left to right: CH-111.14812+4AL QTL; CH-111.14812 without QTL; CH-111.14812+3AS QTL.

Material and methods

A QTL for dormancy (QPhs.ocs-3A.1) on chromosome 3AS originating from the hard red wheat cultivar Zen (Mori *et al*. 2005) and two other QTLs on chromosome 4AL and 5BL originating from the white-grained cultivar Aus1408 (Tan *et al*. 2006) were introgressed in a sprouting susceptible hard red wheat line (CH-111.14812) through five back-crosses (5BC).

Twenty-two 5BC lines representing all possible combinations (zero, one, two or three of these QTLs) were compared with the original line regarding their PHS tolerance.

Scoring of PHS tolerance was based on counts of sprouted grains on wet spikes, as described by Kumar *et al*. (2010).

First Results

The least PHS was observed on BC lines possessing the QTL on 3AS, alone or in combination with other QTLs. The QTL on 4AL had a smaller impact than the 3AS QTL (figure 1). No clear impact was observed with the QTL on 5BL. Combining the 3AS QTL with one or two other QTLs did not improve sprouting tolerance in the CH-111.14812 wheat line (figure 2).

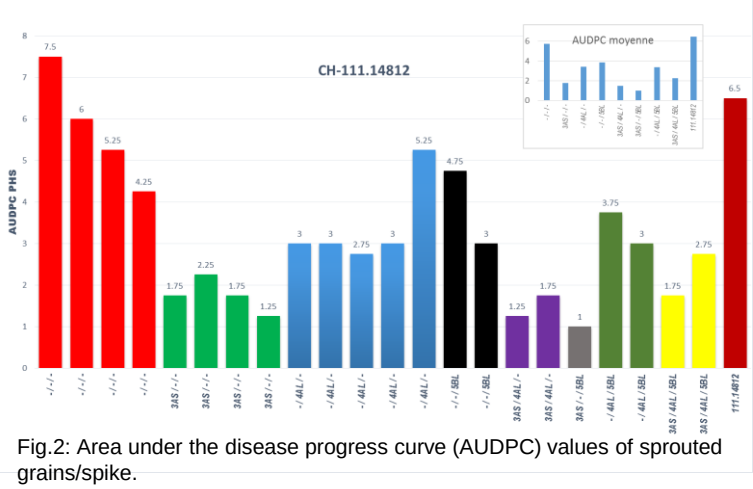

Fig.2: Area under the disease progress curve (AUDPC) values of sprouted grains/spike.

Prospective

Further tests must be done to confirm these first results. Testing these QTLs on other genetic backgrounds (other wheat cultivars) will increase confidence regarding their usefulness. The 5BC lines with the best QTL combinations (i.e., those with the least PHS) will be used for future crosses in the Swiss breeding program.

References

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Tan MK, Sharp PJ, Lu MQ, Howes H (2006) Genetics of grain dormancy in a white wheat. Aust J Agr Res 57:1157-1165