Manipulating protein content in diverse populations using NIRS single seed sorting

ANDERS BORGEN[1], PHILIPP STEFFAN[2] AND SØREN RASMUSSEN[3]

Key words: populations, wheat breeding, single seed sorting, baking quality

Summary: The experiment shows that it is possible to increase protein content and baking quality in divers wheat populations by single seed sorting of the seed, and that the effect remains in the harvested crop. Selecting pure lines in a pedigree system is therefore not the only way to develop wheat with good baking quality.

Background

To increase robustness against biotic and abiotic stresses, organic population breeding wishes to maintain a high degree of diversity within crops. Therefore, alternative breeding techniques are needed to develop diverse crops with quality traits meeting high end user / market demands. We investigated if single seed selection can be used to increase protein content in bi parental wheat populations in order to develop high quality baking wheat populations.

Main chapter

Materials and methods

15 crosses were made between 12 different parents of spring wheat in 2007 and 2008. Parents of the crosses included both common red bread wheat (*Triticum aestivum*) and bread wheat with purple seed colour. Each cross was organically grown as separate populations until generations F5 or F6. In 2013, each population was sorted in 3 fractions using a single seed protein sorter based on NIRS (Near Infrared Spectrograf (IQ Grain Quality Sorter 1002, BoMill, Sweden). Fraction 1 contained the 20% of the seed with the lowest protein content, and Fraction 3 contained the seed with the 20% highest protein according to the calibration of this equipment. The middle fraction containing the remaining 60% of the seed was not used. Fraction 1 and 3 were sown in 2m2 plots without replications, and the harvested seed in generations F6 and F7 were analyzed on a Foss InfraTech 1221 for protein content and Zeleny value.

Results

The protein content in the harvested seed was 13.5% (with a range of 12.1-14.5%) across the fractions with the lowest protein content in the sowing seed, and 14.2% (13.0-16.1%) protein in the grain harvested from the fractions with the highest protein content in the sowing seed. A few crosses reacted inconsistently with the others to the seed sorting, and this may be related to the purple seed colour of some of the parents, as the equipment is only calibrated to measure protein in grains with red seed colour. Removing one of the purple wheat varieties from the analysis increased the difference in protein content to 1.0 percent point. A t-test showed the two groups to be significantly different (p=0.005). Similarly, the Zeleny value reflecting the baking quality was increased from 52.5 (32.6-69.2) in Fraction 1 compared with 59.3 (38.1-81.6) in Fraction 3 (p=0.04)

Conclusion

Our results show that it is possible to increase or decrease the protein content and Zeleny value in spring wheat populations by single seed sorting of the seed before sowing.

Protein content and baking quality of wheat grains is influenced by both genetic and environmental factors. Nevertheless, heritability of protein and Zeleny value is high enough for the effect of single seed sorting of bulk populations to carry on to the harvested grain, and might therefore be a useful tool to increase baking quality in diverse wheat populations.

The experiment shows the effect of sorting in only a single year. Repeated sorting for consecutive years may increase the effect. The test of this hypothesis is in progress along with a test of the yield effect of seed sorting.

The experiment was made with small amounts of grain grown in small plots, where border effects are likely to have had an impact of grain quality, including protein content, before sorting. It is therefore possible that the relative effect of the genetic factor would have been bigger if seed were used from a more homogeneous starting material.

[1]Agrologica, Denmark, www.agrologica.dk, borgen@agrologica.dk

[2] University of Copenhagen, Department of Plant and Environmental Sciences, Thorvaldsensvej 40, 1871 Frederiksberg, Denmark

Some populations with purple seed colour reacted differently to NIR seed sorting than grain with red seed colour, and was therefore excluded from statistical analysis. It is possible that special calibrations for the NIRS are needed for this type of purple wheat.

Acknowledgment

The experiment was made with support from the COBRA project (Agrologica) and the BIOBREED project (Uni. Copenhagen).