FACULTY OF
BIOSCIENCE ENGINEERING

RESEARCH GROUP ON CEREALS, RHEOLOGY AND FEED TECHNOLOGY

T. Hellemans, K. Dewitte, I. De Leyn, G. Haesaert, and M. Eeckhout

BAKING QUALITY OF WINTER WHEAT (*TRITICUM AESTIVUM* L.) IS INFLUENCED BY FRACTIONATION OF NITROGEN FERTILIZATION

Introduction

Nitrogen fertilization is one of the most broadly applied crop husbandry practices to obtain an enhanced wheat quality including both grain yield as well as protein content and composition [1]. However, its impact is majorly dependent on environmental (e.g. climate, soil type, etc.) and genotypic (e.g. nitrogen use efficiency) factors. Additionally, splitting of N applications is believed to mainly influence protein composition and thus dough functional properties. Despite abundant research on these interactions, studies often only cover single quality attributes thereby overlooking relevant trade-offs between protein and starch related properties.

Materials and methods

Five winter wheat cultivars were subjected to six different nitrogen fertilization treatments (combination of the suggested, reduced or elevated N-rate, applied in three or four fractions) in a field trial conducted in Flanders (Belgium) (**Fig 1**). After determining yielding properties and kernel characteristics, samples were ground to wholemeal and refined flour of which compositional attributes were analyzed. Farinograph and Alveograph were used to gain insight in the dough rheological properties. Starch pasting behavior (with enzyme inhibition) was studied using an Anton Paar MCR 102 rheometer. Baking trials were conducted to obtain an insight in the end-product quality as defined by loaf volume, oven spring, gas cell distribution, crumb color and texture (in function of time). Effects of fertilizer treatment and genotype were studied by means of (M)ANOVA and LDA while PLSR with VIP-scoring was used to relate composition to end-product quality.

Fig 1 Aerial photo of two of the four replicates in the field trial located in Merelbeke, Belgium

Conclusions

Mainly the splitting of N applications showed to have an effect on protein composition and end-product quality. However, differences between treatments were many times smaller compared to genotypic variation. Besides protein *composition*, starch pasting parameters breakdown and peak viscosity showed to be equally important for predicting end-product quality. Importance of breeding to obtain specific compositional traits (besides yield) may be more advantageous compared to more intensive fertilization practices. However, the effects of environmental conditions on its efficiency have to be investigated further.

Contact

@ t.hellemans@ugent.be

linkedin.com/in/hellemanst

0000-0002-8870-9932

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Grain yield and protein content

Grain yield was found not to be influenced significantly by splitting or total applied N, unlike grain protein content which increased by 0.26% by applying a fourth fraction of N (**Fig 2**). Both parameters were significantly affected by the genotype ($p<0.001$). Grain protein contents ranged from 10.4%/dm to 12.9%/dm for cv. 'RGT Mondio' and cv. 'Evina', respectively whereas for flour, cv. 'Cellule' had the lowest content (9.9%/dm).

PCA analysis with two principal components, explaining 50.5% of the total variation, revealed the relation between growth parameters and relative extraction rates on one hand and yielding properties and protein content on the other hand (**Fig 3**). Plant length and kernel morphology (area, width) showed strong correlations with the grain protein content. Yield, however, showed a strong negative correlation with SPAD-values during anthesis (Zadoks GS 60). Remarkably, no correlation between yield and grain protein content could be observed, nor a significant correlation was found for test weight and yield.

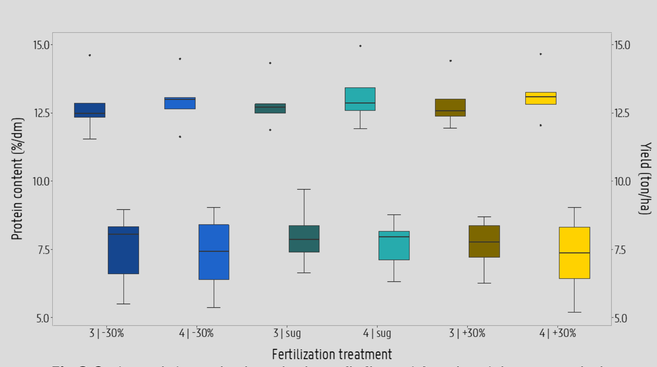

Fig 2 Grain protein content on dry base (left y-axis) and moisture corrected yield (right y-axis) per fertilization treatment

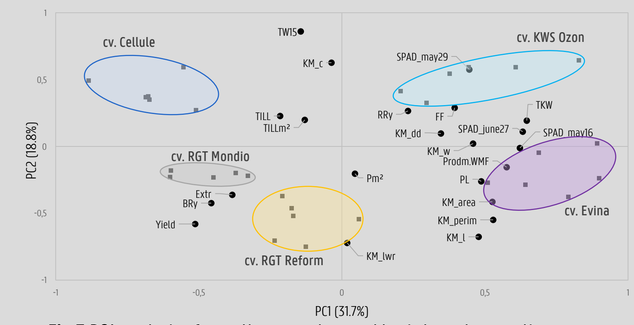

Fig 3 PCA analysis of growth parameters and basic kernel properties

Protein and starch functionality

Dough characteristics are considered to reveal differences in protein functionality and thus, composition. Farinograph softening was the sole parameter influenced by N splitting ($p<0.001$) while water absorption (WA), dough development time and stability were only significantly affected by the genotype (**Fig 4**). Moreover, flour protein content and wet gluten content (Glutomatic) showed no correlation with the WA. Alveograph parameters P, L and W also showed to be altered by both genotype ($p<0.001$) and N splitting ($p<0.05$), as well as by the interactions between treatment and genotype.

Both the Hagberg falling number and the peak viscosity of the starch paste after enzyme inhibition were higher for almost all wholemeal samples which received four N applications. However, in both cases, treatment effects were partly mitigated for flour samples. In general, genotype again showed to be the determining factor (**Fig 5**).

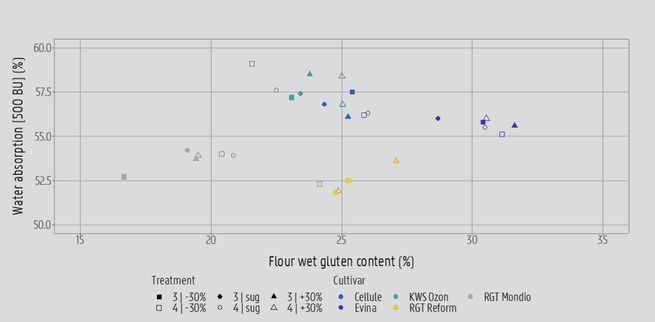

Fig 4 Farinograph water absorption at 500 BU shows no relation with the wet gluten content (Glutomatic) of the refined flour

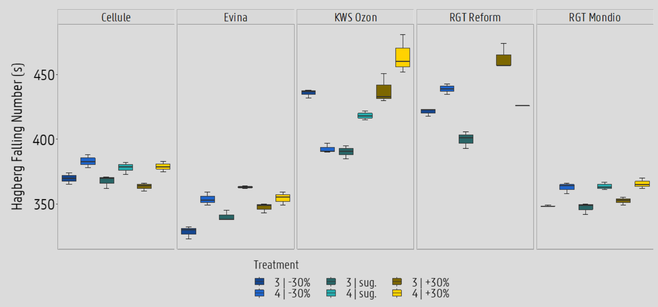

Fig 5 Genotype effects are mainly determining for the Hagberg falling number of the whole meal while splitting and dosing shows mutual interaction with genotype

End-product quality

LDA using loaf volume, oven spring, height-to-width ratio, and crumb hardness as independent variables and fertilization treatment as grouping variable was able to predict only 8 out of 29 cases correctly. This emphasized the limited differences in end-product quality as a result of the fertilization treatment. Genotype on the other hand could be predicted with 86% accuracy. Mean bread volume differed over genotypes from 957 to 1465 ml/kg flour for cv. 'KWS Ozon' and cv. 'RGT Reform', resp., whereas the increase due to a fourth N applications was only 40 ml (3.2%). Moreover, significant effects for all single factors as well as their interaction terms could be observed.

VIP-scores of a PLSR-model for the prediction of the loaf volume emphasized the importance of starch properties. Breakdown and peak viscosity were equally important compared to the water binding capacity of the wet gluten and the wet gluten content (**Fig 6**). Remarkably, the lowest score was obtained for the flour protein content.

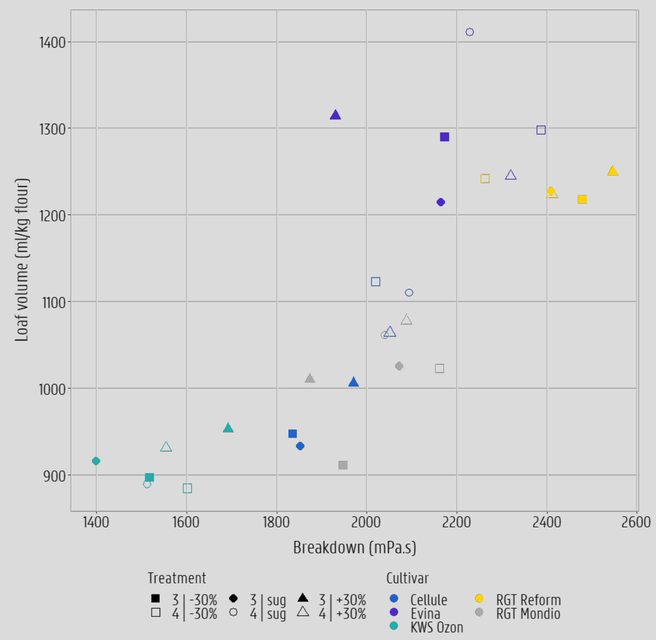

Fig 6 Correlation between flour pasting parameter breakdown (with enzyme inhibition) and loaf volume

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