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Deciphering wheat grain protein content

Gene c analysis of temporal dynamic nitrogen content resorption in flag leaves

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Introdución

Grain protein content (GPC) is a targeted trait in breeding for durum wheat since it has a strong impact in industrial transformation. However, its improvement is compromised by the complexity of its genic architecture (many QTL have been highlighted) and by a negative correlation with the yield. Nevertheless, in view of the necessity to feed more and more people, reducing the fertilizer inputs and preserving our environment, the genetic improvement of the GPC appears as a good way to maintain the product’s quality and to ensure a good production to farmers.

In response to this economical and environmental context, we propose to decipher this trait and to focus on an underlying mechanism to the elaboration of the GPC, the nitrogen remobilization in the flag leaf.

Material and Method

Phenotyping

We phenotyped 282 Rils coming from a half diallel (4 parental lines, lloyd, neodur, ixos and primadur) in a greenhouse. We used a portable near infrared spectrometer (LabSpec®) covering a wide range of wavelengths (350 to 2500 nm) to measure the flag leaves of our population during the grain filling period, from anthesis to maturity.

![Spectrometer calibration on](image)

The spectra obtained at a young flag leaf at anthesis and a dry flag leaf at maturity.

Sta tistical Analysis

For each plant, we obtained 30-40 spectra that were converted into value of nitrogen content thanks to a robust calibraion on the device ($R^2=0.93$, Ecarnot and Roumet, submitted). The curves were modelled using a non linear method based on a Gauss Newton algorithm.

![The curve obtained](image)

Variables coming from the curves and other variables measured at anthesis or at maturity.

Results

A mixed model was defined to mate the variance components and to predict the gene c values (BLUP) using the ASReml-R package (Butler et al., 2007). The block was considered as fixed and the genotype as random with the pedigree associated. The gene c correlation between two traits were mated with bivariate models as the ratio between the genetic covariance for a pair of traits and the product of their own additive variance. The phenotypic correlation between traits were mated with the Pearson coefficient between pairs of traits. The values of individual heritability were calculated as the additive variance divides by the sum of the additive and the residual variance for each trait.

![Table of heritability](image)

<table>
<thead>
<tr>
<th>Trait</th>
<th>Heritability</th>
<th>Additive Variance</th>
<th>Residual Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPC</td>
<td>0.3634</td>
<td>0.5054</td>
<td>0.1421</td>
</tr>
<tr>
<td>Nm</td>
<td>0.3953</td>
<td>0.5579</td>
<td>0.1928</td>
</tr>
<tr>
<td>Area</td>
<td>0.3502</td>
<td>0.5579</td>
<td>0.1928</td>
</tr>
<tr>
<td>Yiel</td>
<td>0.3455</td>
<td>0.5579</td>
<td>0.1928</td>
</tr>
<tr>
<td>GPW</td>
<td>0.3543</td>
<td>0.5579</td>
<td>0.1928</td>
</tr>
</tbody>
</table>

- Genitors had contrasted mean values for the studied traits (standardized values), especially ixos and primadur.
- For most of the traits, the gene c correlation was stronger than the phenotypic correlation with some exceptions.
- The values of heritability were low to moderate, some traits related to senescence presented the same order of magnitude than the one of the GPC or GPW.

Conclusion

- We used a new device for phenotyping presenting the advantage to be non destructive for the plants and allowed us to follow the remobilization of nitrogen in the flag leaf of a durum wheat population.
- The trait chosen is an underlying mechanism of the GPC elaboration. Heritabilities of its components being of the same order of magnitude than the GPC, the remobilization of nitrogen could be improved as well as the GPC but with the advantage to be combined with other underlying traits for GPC as the efficiency of nitrogen absorp tion for example.
- The use of remobilization on t0 and t1 are negatively correlated with GPC but positively with GPW. It is relevant with the negative correlation on exist ng between GPC and the yield since a late remobilization increase the yield but by a dilution effect, reduce the GPC but not the protein weight in the spike.