



Genotype and environment affect the grain quality and yield of winter oats (*Avena sativa* L.)

Catherine J. Howarth, Pilar M.J. Martinez-Martin, Alexander A. Cowan, Irene M. Griffiths, Ruth Sanderson, Susan J. Lister, Tim Langdon, Sarah Clarke, Nick Fradgley, and Athole H. Marshall

Foods 2021, **10** (10): 2356; <https://www.mdpi.com/2304-8158/10/10/2356>

Contact: Catherine Howarth, cnh@aber.ac.uk

Summary:

Plant breeders aim to develop improved crop varieties that are adapted to produce high yields of quality grain over a wide range of environments, with the adaptability of a variety usually tested by the degree of interaction with different environments under which it is planted. Analysis of the genotype x environment interaction on grain yield and quality is, therefore, essential in variety evaluation and to understand the adaptability and stability of varieties for different environments. The extent to which quality and yield of plant varieties are influenced by environment is important for their successful uptake by end users, particularly as climatic fluctuations are now resulting in environments that are highly variable from one growing season to another. Maintaining grain quality under a variable climate is critical for human nutrition, end-use functional properties, and commodity value.

In this study, the genotype-by-environment interaction of milling quality and yield was studied using four winter oat varieties in multi-locational trials over four years in the UK. Significant differences across 22 environments were found between physical grain quality and composition traits as well as grain yield, with the environment having a significant effect on all of the traits measured. Grain yield was closely related to grain number per metre squared (m^{-2}), whereas milling quality traits were related to grain size attributes. Considerable genotype by environment interaction was obtained for all grain quality traits. Stability analysis revealed that the variety ‘Mascani’ was the least sensitive to the environment for all milling quality traits measured, whereas the variety ‘Balado’ was the most sensitive. Examination of environmental conditions at specific within-year stages of crop development indicated that both temperature and rainfall during grain development were correlated with grain yield and β -glucan content and with the ease of removing the hull (hullability). The effect of environment on grain quality traits related to milling efficiency and feed value is crucial for the milling, food, and feed sectors when it comes to predicting the performance of different varieties in different environments.

Breeding programs face a huge challenge in addressing the complexity of factors affecting quality and quantity of yield, and in striking a balance between the two to maximize the value of the crop to the producer. For example, in this study, grain yield was negatively correlated with the hullability of the grain, demonstrating the difficulty in improving both traits simultaneously. Breeders also need to identify genotypes with superior performance that are stable across a



range of environments. The greatest challenge is to combine grain yield with all milling quality traits in a single variety, whilst minimizing GEI of any individual trait. Of the varieties tested here, Mascani was the most stable for all the milling quality traits measured (groat content, hullability, hectoliter weight) and also had the highest mean values for those traits.