An ideotype for organic wheat – is it possible?

Breeding programmes generally identify an ideal plant with given characteristics as a goal for selection: an ideotype. With the Whealbi EU project we had the opportunity to investigate what an ideotype for organic wheat would look like. ***Ambrogio Costanzo*** *summarises preliminary results of two years of trials, suggesting that the response could be more complex than it seems.*

The Green Revolution in the 1950-60s was a turning point in wheat breeding, with the formalisation of an ideal plant, with short straw and a single, big ear, as a univocal 'ideotype', as formalised by CM Donald in 1968[1]. There is currently a lot of discussion about what an ideal wheat for organic farming would look like. Many people claim that Donald's ideotype still leads the way with the magnificent and progressive fate of technology, whilst others urge the importance of getting back to older varieties. No clear solution is in sight.

As part of the EU-funded Whealbi (Wheat and barley Legacy for Breeding Improvement) project, ORC carried out a field experiment during the 2015/16 and 2016/17 seasons, at Sonning farm – University of Reading's Crops Research Unit – to compare several wheat and barley accessions in a ploughed and a shallow non-inversion organic system. With 20 different accessions, the wheat trial provided a unique opportunity to compare landraces dating back to the 17th century with heritage cultivars (pre-Green revolution), modern cultivars and elite breeding lines, to identify optimal trait architectures, i.e. an 'organic ideotype'.

Yield was found to be significantly lower in shallow non-inversion tillage plots (1.78 ± 0.08 t/ ha) compared to ploughed plots (2.32 ± 0.10 t/ ha) in the first year only (p = 0.000***) when continuous rainfall prevented any mechanical weed control. Across the two years, no 'best cultivar' could be identified. There was a yield advantage of modern cultivars and elite breeding lines over heritage cultivars across both years, but this was only significant in the ploughed, and not in the shallow non-inversion system (fig. 1). Moreover, when looking in detail at relationships among different morphological traits, yield did not appear to be linked to some of the key features of the 'Donald's ideotype', particularly short straw and high harvest index (grain/total biomass). The most consistent yield driver seemed to be ground canopy cover at the onset of stem extension, probably because of its relationship with resource capture and timely competition against weeds. Analyses on processing and nutritional grain quality will follow and provide a more comprehensive view on performance.

The conclusion cannot be a simple statement. Yield advantage can be expected from 'modern breeding' cultivars if they are locally adapted and match their growing environment well. When deviations from this occur, for example when the environment becomes limiting – as can happen e.g. when not ploughing (Fig. 1) – their advantage may be lost. Getting back to heritage varieties is not a univocal solution either, at least as far as yield is concerned. We can confirm that crops with good early ground cover are better suited to organic conditions, but we cannot neglect that the challenge is far more complex: fitting varieties into a range of growing environments whose variability cannot be artificially buffered. This requires new knowledge and new organisational, technical and possibly business models for cereal breeding.

Reference

1. CM Donald (1968) The breeding of crop ideotypes. Euphytica 17:385-403

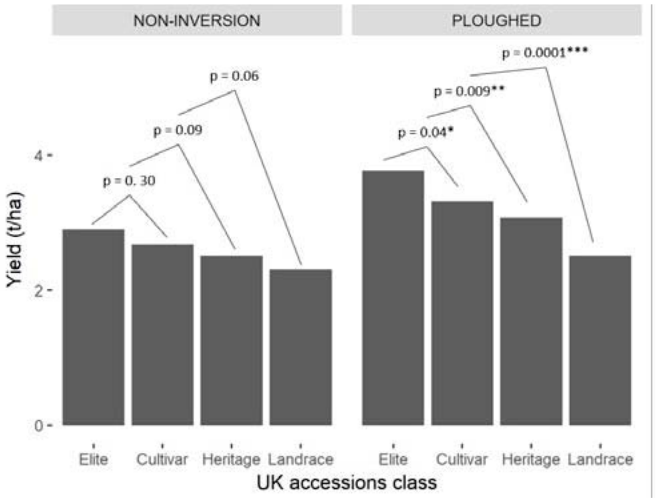

Figure 1: Average 2015/16 and 2016/17 grain yield (t/ha at 15% moisture content) of UK accessions, grouped according to different genetic classes, in the non-inversion and ploughed system. P-values of orthogonal linear contrasts are indicated.

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Organic Winter Wheat Variety Trials Network

Our experimental work testing the performance of different varieties in organic agriculture has continued as part of the LIVESEED EU project. In collaboration with Organic Arable a network of seven farmers has been established across the country from Dorset to Lincolnshire. These farmers, including Mark Lea, who is hosting NOCC this year, are growing at least three varieties on their farm at a commercial scale, managing them with their own farm equipment and taking note of key performance indicators throughout the season. We will also be assessing yield, gross margins and different quality measures as part of the UK Grain Lab. The varieties being tested this year were selected based on farmer preference and performance in breeder trials. They are Basset, Crispin, Evolution, Montana, ORC Wakelyns Population, Siskin and Spyder. All seven of these varieties are being assessed in a fully replicated plot design in our organic field trials at Sonning. In combination, this 'mother trial' and the on-farm 'baby trials', all connected to one another through a specific experimental design, will help us to understand how genes, environment and management interact to determine variety performance in conditions that more closely reflect organic and low-input farms compared to current testing protocols for the recommended list. We hope that this is just the beginning of a collaborative organic variety trial network that can provide growers with the information that they need to enable variety choice. ***Charlotte Bickler***

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