Evolutionary wheat makes the grade

EFRC’s strategy of ‘evolutionary, or population, breeding’ challenges current pedigree line breeding approaches.

Composite Cross Populations (CCPs) are the collective progeny of multiple crosses of pure line cultivars. Such populations can be adaptable to different and changing environments over seasons.

For this project, three CCPs were produced from:
1.) parent varieties selected for good milling potential - Quality (Q) CCP;
2.) parent varieties selected for high yield (Y) potential - YCCP; and
3.) both sets of parent varieties - YQCCP.

The three CCPs are further divided into those without or with plants with heritable male sterility (ms), which facilitates cross-fertilisation amongst plants.

Evolution of winter wheat is continuing at Elm Farm Research Centre at four sites (two organic and two non-organic) in the East and West of England. Results from last season’s trials (2004-05) give an insight into the potential of novel breeding methods and diverse populations in sustainable systems. Data from 2004’s harvest were reported in Bulletin 76.

Establishment of CCPs and mixtures (relative to the parent cultivars) was greater in the organic systems than in the non-organic systems, which may suggest that the CCPs were better able to deal with the greater environmental variability at the organic sites. For establishment in non-organic systems, the yield and yield-quality CCPs had a significantly higher establishment than their equivalent physical mixtures.

Grain yields were considerably higher in the trials of 2005 than in trials of 2004 (7.9 and 5.1 t/ha @ 15% mc respectively, p < 0.001), a trend that was reflected across the country (Source: HGCA). However, the effect was much larger, relatively, in the organic systems than in the non-organic systems (Table 1).

Table 1. Grain yields (t/ha @ 15% mc) for organic and non-organic systems in 2004/05 and 2003/04, and % change across years.

<table>
<thead>
<tr>
<th>System</th>
<th>2003/04</th>
<th>2004/05</th>
<th>% change across years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-organic</td>
<td>7.9</td>
<td>10.0</td>
<td>127</td>
</tr>
<tr>
<td>Organic</td>
<td>2.6</td>
<td>6.0</td>
<td>228</td>
</tr>
</tbody>
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In both organic and non-organic systems, CCPs tended to produce a greater grain yield than the means of their parent cultivars. This was more strongly evident at the organic sites – an early indication of the yield potential of the CCPs for organic management?

In both organic and non-organic systems the grain yield of the yield CCPs was significantly higher than that of the quality (e.g. Table 2).
Comparing organic and non-organic sites, there was a clear difference in relative performance of the modern varieties, in the sense that they produced high yields under non-organic conditions but relatively poor yields under organic conditions.

Importantly, the CCPs exhibited a greater stability of yield across organic sites compared with their parents and, encouragingly, to their physical mixtures. However, this effect was not evident under non-organic conditions.

Table 2. Mean yield, HI, Protein concentration and Hagberg Falling Number of CCPs at organic trial sites, 2004/05 (l.s.d. = least significant difference- any differences greater than this are significant).

<table>
<thead>
<tr>
<th>Organic CCP</th>
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<th>l.s.d.</th>
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<tbody>
<tr>
<td>Yield (t/ha @15% mc)</td>
<td>6.1</td>
<td>5.6</td>
<td>6.3</td>
<td>0.46</td>
</tr>
<tr>
<td>HI (Harvest Index)</td>
<td>0.52</td>
<td>0.48</td>
<td>0.51</td>
<td>0.025</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>11.4</td>
<td>12.1</td>
<td>11.5</td>
<td>1.21</td>
</tr>
<tr>
<td>Hagberg Falling Number (s)</td>
<td>159</td>
<td>189</td>
<td>183</td>
<td>20</td>
</tr>
</tbody>
</table>

In both organic and non-organic systems, the harvest indices of yield CCPs (YCCPs) were greatest, followed by YQ and Q CCPs. (Table2).

Quality data (HFN and % protein) were as expected (QCCP > YCCP), with no compromise in quality from composite cross populations. The same trends were also evident for thousand grain weights (TGW) at organic and non-organic sites.

Seed borne diseases were generally at low levels. There were significant differences between systems, with lower Microdochium nivale levels on organic sites and lower ergot levels on non-organic sites.

This selected sample of the large volume of data for the trial season 2004/5 suggests that the composite cross populations are continuing to evolve under natural selection. Two more years of trials will investigate this possible trend.

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