Evolutionary Breeding of Wheat for Low Input Systems

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Introduction

A major limitation in low input systems is the lack of appropriate crop genotypes. Substantial reductions in inputs expose crop plants to major increases in the diversity and variability of production environments. Individual wheat varieties, particularly those selected for high input production, are often unable to cope with such environmental variation. Under such conditions, genetically variable host populations are more likely to be both higher yielding and more stable in output.

Materials and Methods

•Elm Farm Research Centre, with the John Innes Centre, have developed 6 populations based on historically successful wheat varieties.

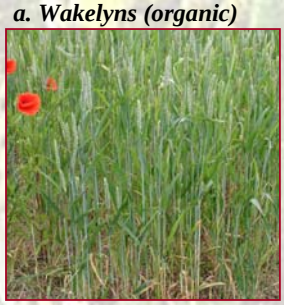
•The populations were derived from all possible combinations of 9 high yield parents (36 crosses), or 12 high quality parents (66 crosses), or intercrosses from all 21 parents (210 crosses).

• Each of these bulk populations was subdivided into those that did, or did not, contain a range of male sterile crosses (33) developed from naturally occurring male sterile parents crossed with the other varieties.

•The first field exposure of the populations was in 2003/04 in the F3 generation (see Results and Table 1). The populations and their parents were sown at four sites (2 organic and 2 conventional) in the UK.

•Measurements of crop growth and development were taken throughout the season, the crops harvested and post-harvest yield and quality assessments made.

a. Wakelyns (organic)



b. Metfield (conventional)

Yield/Quality Composite Populations at Wakelyns Agroforestry (a.) and Metfield Hall Farm (b.) showing the differences in density and leaf colour (photographs taken June 2004).

First Field Season Results

•For the characters assessed, the extent of the variation in the Composite Cross Populations (CCPs) was no greater than that of the mean of the parents. However, the diversity within each range was far greater in the CCPs.

•Organic yields were 30% of those at conventional sites (averaging 2.5 and 7.7 t/ha respectively, $P<0.001$), Table 1. The difference in yield between organic and conventional systems was considerably greater than that within each system.

•As expected, harvest indices for yield CCPs were higher than for quality CCPs.

•The dynamics of genetic variation was evident from a tendency to a skewed distribution towards tallness in the CCPs.

•The genetic variation in the CCPs, together with their slightly improved performance even in their first year in the field, provides a positive indication for the future progress of this material in relation to the objectives of the project.

	Grain yield (t/ha at 15% moisture)				
System	**Population type**	**Parental range**	**Parental midpoint**	**CCP**	**CCP male sterile**
Organic	**Yield**	0.9-5.5	3.2	2.5	2.6
	Quality	0.6-3.9	2.2	2.3	2.2
	Yield/Quality	0.6-5.5	2.9	2.9	2.2
Conventional	**Yield**	3.9-11.6	7.8	7.8	8.9
	Quality	3.3-10.6	7	7.8	7.7
	Yield/Quality	3.3-11.6	7.5	7.7	7.8

Table 1. Baseline yield data for parents and composite cross populations (CCPs) at the end of the first field season.

Practical development

There are perceived problems of utilisation and ownership of wheat populations. However, it is useful to note that appropriate procedures are established for dealing with rye populations.

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