Winter wheat variety performance in organic and conventional farming systems and the potential for organic plant breeding in the UK
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INTRODUCTION

Modern plant breeding has increased cereal yields through development of varieties with high response to external inputs such as mineral fertilisers and pesticides which regulate the cropping environment (Evenson and Gollin, 2003). Such varieties, however, often lack resilience in more marginal environments, including organic farming systems. As a consequence, the productivity of organic farming in the UK is limited by the lack of suitable cereal varieties. This could be resolved by utilising modern plant breeding technologies and selecting material for local adaptation to the target environment so as to develop varieties that perform well under low inputs. Evolutionary participatory plant breeding offers this opportunity.

MATERIALS AND METHODS

Variety performance trials

Nineteen modern and heritage wheat varieties were trialled in a replicated randomised complete block design on two organic and two conventional sites in England over three trial seasons from harvest years 2003 to 2005.

Organic breeding trials

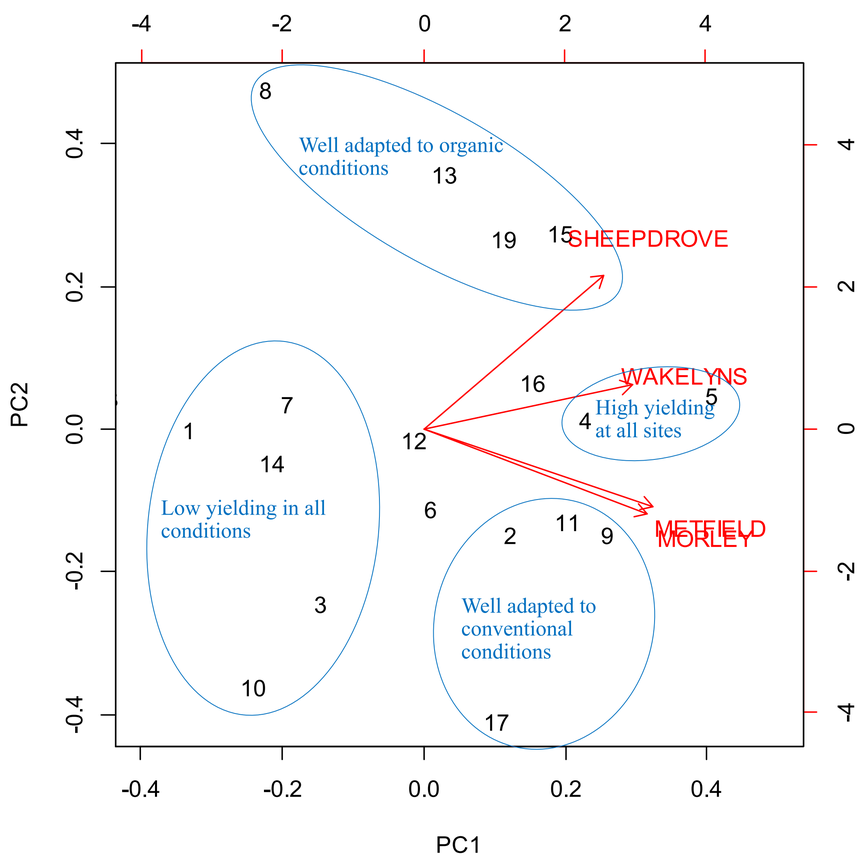
The lines were hand selected as single ears from an F11 Composite Cross Population (CCP) grown organically in 2011. Replicated plot trials were set up on two organic farms in the east of England. Varieties Alchemy and Solstice were included as high yield and quality commercial controls

RESULTS

Some varieties were found to be better suited to yield at the organic site (Fig. 1). There was a significant variety x system interaction ($P<0.01$) and variety performance over the three years was much more consistent at the two conventional sites than the two organic sites.

The lines selected under organic conditions performed well compared to the controls at the site from which they were selected (Wakelyns). However, the control varieties were both higher yielding than all the selected lines at Shimpling where yields were much lower due to high weed levels and soil compaction.

At Wakelyns, some of the selected lines had comparable yields to the high yielding control (Alchemy) and comparable milling quality to the high quality control (Solstice). Weed competitiveness and yellow rust resistance was also found to be better in the organic selected lines.



1 Bezostaya
2 Buchan
3 Cadenza
4 Claire
5 Deben
6 Hereward
7 HTL
8 Maris Widgeon
9 Mercia
10 Monopol
11 Option
12 Pastiche
13 Renan
14 Renesansa
15 Soissons
16 Spark
17 Tanker
18 Thatcher
19 Wembley

Figure 1. Biplot of the first and second principle components of mean yield over three growing seasons of 19 winter wheat varieties represented by numbers at two organic site (Sheepdrove and Wakelyns) and two non-organic sites (Metfield and Morley)

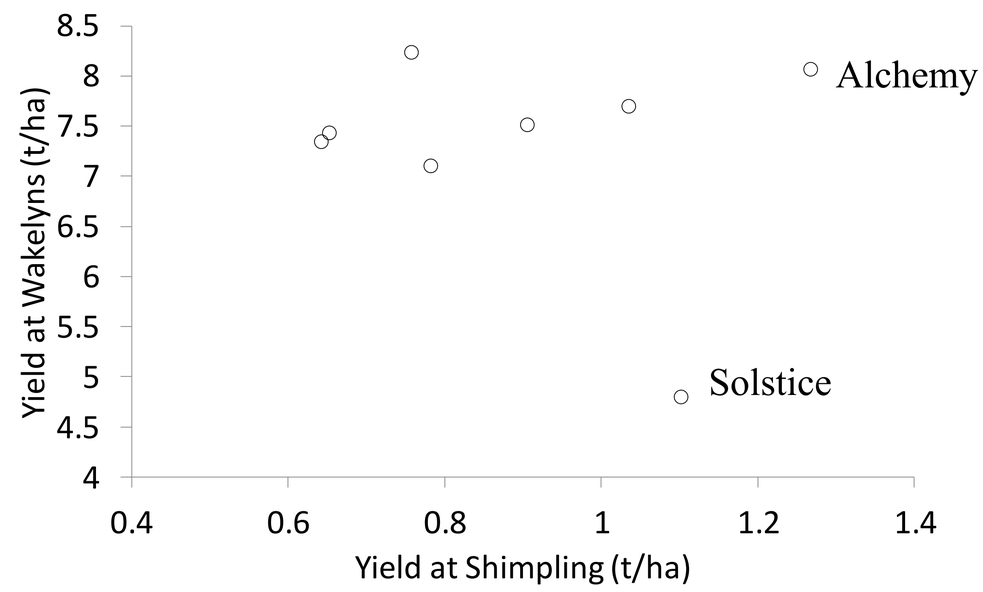


Figure 2. The relationship between mean yield of selected lines and control varieties at two organic sites in 2014-15

Table 1. Mean values of yield, baking qualities and weed competitiveness of selected lines grown at Wakelyns organic site in 2013-14.

	Yield (t/ha)	Hectolitre weight (g)	% protein (g/100g dmb)	Hamburg Falling No. (s)	SDS Sedimentation (ml)	Yellow rust incidence (% flag leaf cover)	Weed competitiveness (% weed cover after harvest)
Alchemy	6.7	79.9	9.5	317.0	33.0	0.4	33.5
Solstice	4.9	76.3	11.2	230.0	66.0	1.3	NA
YQ CCP	7.4	83.6	10.8	290.0	65.0	1.8	22.3
SL B30	8.1	84.0	10.2	336.0	55.0	0.0	6.5
SL B46	7.8	85.3	10.8	364.0	73.0	0.2	17.3
LSD	*1.8*	*2.5*	-	-	-	*1.3*	*25.5*

CONCLUSIONS

- Some varieties are better adapted to organic conditions so it is possible to breed for this interaction.
- Selecting pure-line wheat varieties from a population is an effective way to breed high yielding, good quality, disease resistant and weed competitive varieties for organic conditions
- Because of the larger genotype by site interactions among organic farms, selections should be made in the target environment on a site specific basis which could be enable by participatory plant breeding using genetically diverse wheat populations.
- This approach could also generate varieties and breeding material with greater resilience, lower input requirements and addresses the lack of suitable varieties available to organic farmers

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