

OAT LINK: The incorporation of important traits underlying sustainable development of the oat crop through combining 'conventional' phenotypic selection with molecular marker technologies

Part 4: ASSESSMENT OF TRAITS IMPORTANT IN ORGANIC PRODUCTION

Background

The emphases of breeding objectives for oats in organic systems are likely to be different from those for oats in conventional systems. Oats are the preferred second cereal in an organic rotation, but economic performance and performance as a source of on-farm feed needs improving. Moreover, agronomic performance in organic rotations may be improved by selecting oat types that are well-suited to the requirements of second cereals in organic systems. Grain quality requirements are similar or the same in both systems.

Straw is a useful product in mixed farming systems. Good organic oat varieties will produce a stable and high yield under stress (or non-optimal) conditions. Stress conditions are dynamic within and between seasons but include nutrient resource and weed competition dynamics, which, together with other stress factors, often interact. Therefore selection for stable economic and agronomic performance under stress or non-optimal conditions may offer different objectives than selection for high yield potential in high input or near optimal conditions. Grain must offer good economic performance; performance as a break crop against weeds and for establishing clover leys must be good.

Over the four trial years of the project a range of varieties and mixtures of husked and naked oats were trialled under organic production systems in the East and West of England. Other factors investigated were the impact of seed rate, undersowing with clover and performance in the first or second position within a rotation.

In addition to these trials a number of breeding lines were grown under organic conditions and assessed for their performance under these conditions.

Results

Variety Performance – Husked.

Over the 4 trial years of the project a number of old and new varieties were trialled. A small number of trials were lost due to bird damage or weed infestation. Performance between sites and over years varied. The trials can be seen in Table 1.

A range of agronomic assessments were undertaken throughout the growing season including emergence, establishment, plant survival, crop cover, leaf area index, weeds, disease and other taken at and post harvest.

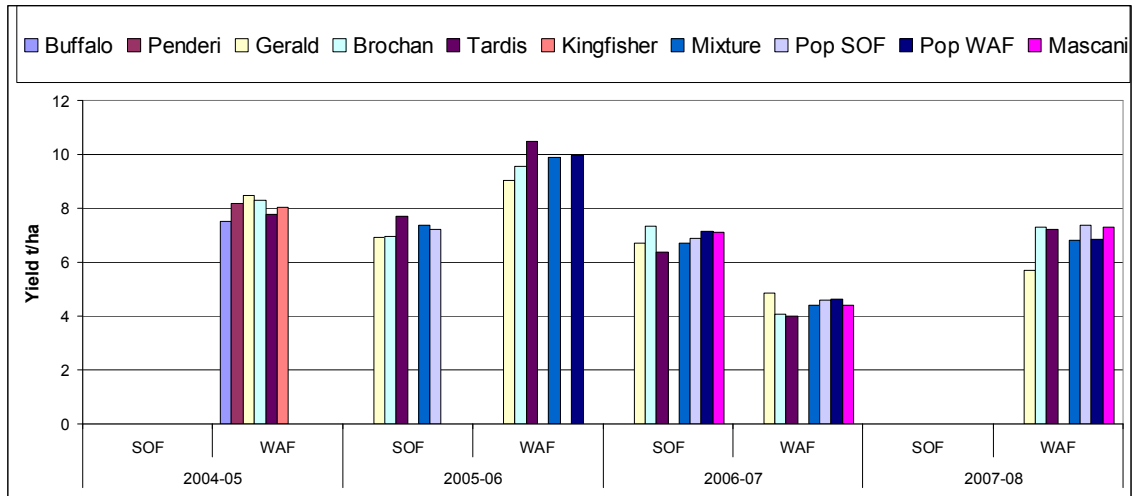


Figure 1 shows the yields of the varieties and mixtures trialed over the project. There was variation over years of the project and between sites with yields ranging from over 10 t ha⁻¹ down to 4 t ha⁻¹. No single variety performed significantly better over the period. But Brochan, Tardis and Gerald all performed well.

Year/location	2004-05		2005-06		2006-07		2007-08	
Variety	SOF	WAF	SOF	WAF	SOF	WAF	SOF	WAF
Buffalo	O	X						
Penderi	O	X						
Gerald	O	X	X	X	X	X	X*	X†
Tardis	O	X	X	X	X	X	X*	X†
Brochan	O	X	X	X	X	X	X*	X†
Kingfisher	O	X					X*	X†
Mixture			X	X	X	X	X*	X†
Pop SOF			X	X	X	X	X*	X†
Pop WAF					X	X	X*	X†
Mascani					X	X	X*	X†

Table 1: Varieties and mixtures of husked oats grown in organic trials 2004/05 – 2007/08 (X – trials established and harvested; O – trials established but failed; X* - First cereal trials failed; X† - Second cereal trials failed).

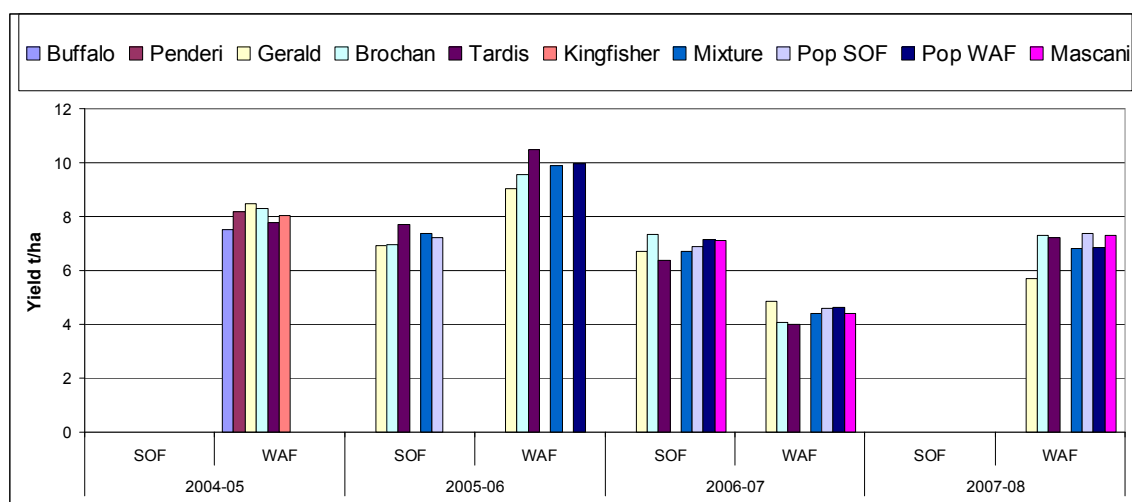


Figure 1: Mean yields ($t\ ha^{-1}$ at 15% moisture content) of husked oat varieties grown as 1st cereals at Sheepdrove, Berkshire and Wakelyns, Suffolk in the seasons 2005/05 – 2007/08.

Variety Performance – Naked.

Year/location	2004-05		2005-06		2006-07		2007-08	
Variety	SOF	WAF	SOF	WAF	SOF	WAF	SOF	WAF
Hendon	O	X						
Grafton	O	X	X	X	X	X	X*	X†
Expression	O	X	X	X	X	X	X*	X†
Racoon	O	X	X	X	X	X	X*	X†
Mix HeGr	O	X						
Mix HeEx	O	X						
Mix HeRa	O	X						
Mix GrEx	O	X						
Mix GrRa	O	X						
Mix ExRa	O	X						
Mix ExGrRa			X	X	X	X	X*	X†

Table 2: Varieties and mixtures of naked oats grown in organic trials 2004/05 – 2007/08 (X – trials established and harvested; O – trials established but failed; X* - First cereal trials failed; X† - Second cereal trials failed).

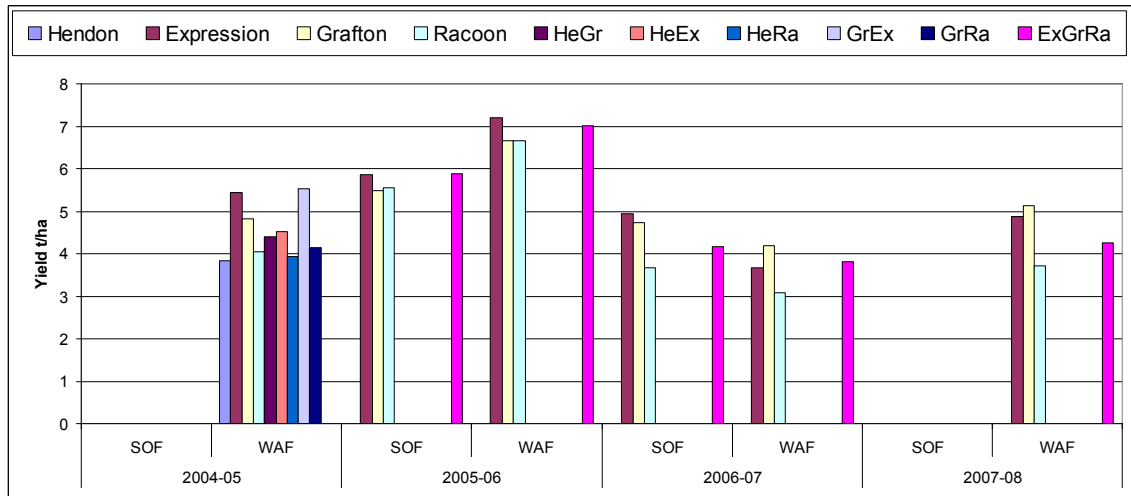


Figure 2: Mean yields ($t\ ha^{-1}$ at 15% moisture content) of naked oat varieties grown as 1st cereals at Sheepdrove, Berkshire and Wakelyns, Suffolk in the seasons 2005/05 – 2007/08.

Naked oats yielded less than husked varieties, as would be expected, with a yield range across years and sites of over $7\ t\ ha^{-1}$ to around $3\ t\ ha^{-1}$.

Again no specific variety stood out from the rest but Expression, Grafton and Racoon all performed well.

Mixture, Populations and Breeding Line Performance.

Figures 1 and 2 show yields of 1st cereal mixtures of oats. They included two-way and three-way mixtures of both husked and naked oats.

The more comprehensive trials were on with the three-way naked oat mixture. Yields were generally higher than those expected from the predicted yields from the component varieties.

This could be due to a number of factors but the mixtures had less disease than the average of its component varieties (18% in 2006/07 and 25% in 2005/06).

Populations of husked oats were grown on both trial sites. These populations were grown for three years and showed a similar trend to the naked oat mixtures. With a consistent performance during the trials and yields generally on the higher side.

A number of breeding lines were introduced throughout the project. Tardis and Brochan both entered the trials as lines but were subsequently named and we have used these names throughout this report. Other lines have also been trialled. For the husked oat lines 00-186ACn13, 01-47ACn9, 01-03ACn4 and 00-01Cn2 there is limited data for although they were established on two sites over two years, crop failures has meant there is only 1 years data on each site. However, from this data these lines look promising with performance and yields being greater or similar to the best of the current varieties.

Undersowing with Legumes.

The value of undersowing cereals with legumes is to provide added fertility to the cohort crop as well as to the crop following in the rotation (or as a way of establishing the ley). It is common practice with organic arable producers.

Trials undertaken on 2 sites over 3 seasons demonstrated the difficulty in using such an approach with oats due to their competitiveness.

In the initial trials oat seed rates of 200kg/ha were used. At this seed rate the oats were too competitive and the white clover failed to establish well. In subsequent years the seed rate was reduced to 150kg/ha. In the subsequent two years the undersowing failed to establish well in 3 of the 4 sites. On the fourth where it did establish it significantly increased yields of oats at the lower seed rates. However, since the yield of the low seed rate was significantly lower than that of the high seed rate, the increase due to the undersown clover only brought the yields back up to the same level as the high seed rate.

Position in Rotation.

Trials were established as both second and first cereals in the rotation.

The average yields of the husked and naked varieties as a second cereal were 97 % and 81 %, respectively, of the first cereal yields. The rankings of the varieties were similar in both rotational positions with the husked varieties Tardis and Mascani, and the naked varieties Expression and Grafton yielding well.

Mixtures generally yielded similarly to the means of component varieties but the husked and naked mixtures had 18 % and 12 % less disease, respectively, than the average of the component varieties.

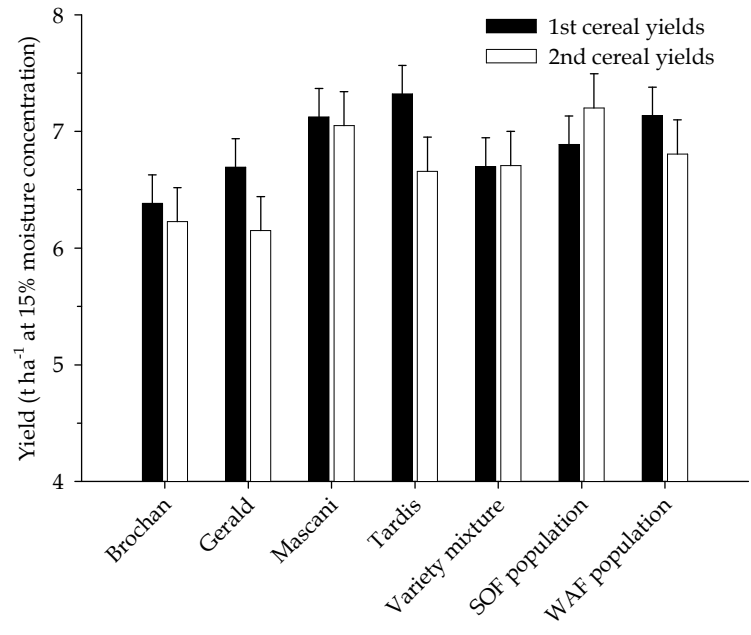


Figure 3: Yields (t ha⁻¹ at 15% moisture concentration) of: husked oat varieties Brochan, Gerald, Mascani & Tardis; the variety mixture; & the 'populations' from Sheepdrove (SOF) & Wakelyns (WAF) grown as either the first (black bars) or second (white bars) cereal in the rotation.

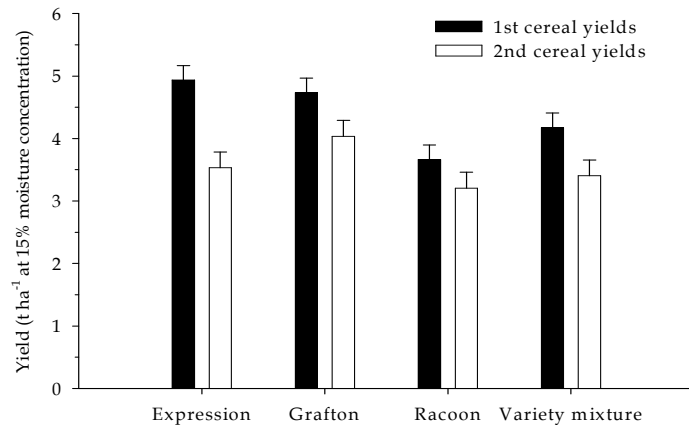


Figure 4: Yields (t ha⁻¹ at 15% moisture concentration) of: naked oat varieties Expression, Grafton & Racoon; and the variety mixture grown as either the first (black bars) or second (white bars) cereal in the rotation.

During the second season of investigating rotational position the crop at WAF failed largely due to weed competition. This data was not included in the analysis but it does demonstrate the risks of growing oats as a second cereal where weeds can be a problem.

Discussion and Conclusion.

The work within this project has shown that both older and more modern varieties of oats perform reasonably well within organic system.

Data was collected from a range of agronomic assessments with some but inconsistent differences found in such factors as crop establishment, Leaf Area Index and Yield.

Yields varied greatly between years and sites for both husked and naked oats. Generally it was found that the shorter strawed varieties yielded less than taller ones and it is suggested this could be due to weed competition. These were generally removed from subsequent years trials.

Variety mixtures, either two or three-way, generally performed better than their component varieties would have predicted and this method of production for organic farmers could be of benefit.

Populations of husked oats were grown over 3 seasons on two sites. They showed similar results to the mixtures.

New lines of husked oats were trialed, but although crop failure meant that the data was limited, these new lines appear to perform as well as or better than current varieties.

Undersowing of oats with a legume (in this case clover) was not successful with the clover failing to establish in 3 of the 4 trials. Where it did establish the benefits were limited.

Position in the rotation from 1st to 2nd cereal showed that oats perform reasonably in a second cereal position with a loss of yield compared to a 1st cereal position. This loss of yield is probably not significant at a farm level for husked oats but the yield depression is large for naked oats and may be of significance in this already lower yielding crop. But this could be of use to organic farmers to extend the time within a rotation for cash cropping. However, one of the four 2nd cereal trials failed due to weed pressure and this must be borne in mind in any recommendations made to farmers.

The trials within the organic element of this project were sited on organic farms and undertaken within a fully functioning organic rotation. The loss of a number of trials and the variability demonstrates some of the problems that are experienced when working within an environment where factors (such as weeds, fertility) can not be so easily controlled.