Technical Note August 2004

Organic Cereal Varieties; The Results of four years of Trials

Exercising Choice and Following Fashion

Whenever farmers and/or growers meet together there is a reasonable chance that sooner or later their conversation will turn to considering the merits of plant varieties. All farmers have their favourite varieties but they also show a surprising willingness to try out new ones and to give the latest fashion a go.

The how and why of fashion trends - what becomes popular and what doesn't - is beyond the scope of this publication, but there is little doubt that variety recommended lists, whether from NIAB or from seed companies, and merchants play a part. Most compilers of such lists claim that they are basing their recommendations on variety trials. The farmer who studies the lists rarely questions the quality, scientific robustness and appropriateness of such trials and therefore the value of the recommendations.

We do not propose to pursue this issue further, other than to note that whilst the validity of variety trialling and recommended lists as currently practiced might be a question for conventional agriculture, it is certainly a problem for organic farmers.

The Problems with Organic Variety Trials

First of all, there is a significant lack of information in the UK on the relative performance of modern crop species and varieties under organic conditions. Institutions such as NIAB, EFRC, the Arable Research Centre and others have carried out some variety trials, although not nearly enough. Some commercial companies have made recommendations that they claim are based on trials but, which closer inspection reveals, range from the far from robust - not enough sites or years, unsatisfactory plot sizes, sited on inappropriate farms or position in the rotation and woefully inadequate statistical treatments - to the shambolic; we know of one cereal trial sited on a field that was in its second year of conversion following oil seed rape.

So to date, organic cereal variety trials have suffered from being too few in number of sites and years; a lack of consistency in design; a lack of scientific rigour in design and implementation relating to choice of site - particularly of farm and position in the rotation - and its management; and unsatisfactory statistical treatments. Overriding all of this however, is the issue of whether the right question is being addressed by the trials.

Plant Breeding and Organic Farming

Modern breeding is focussed on producing plants that perform well in a monoculture; they are designed to interfere minimally with their neighbours under high fertility conditions, where all ameliorable factors are controlled. The aim of this design is to provide a crop community that makes best use of light supply to the best advantage of grain production. Wheat is the most developed example of this approach - with a high proportion of seminal roots, erect leaves, large ears and a relatively dwarf structure - but all other cereal breeding follows it.

This 'pedigree line for monoculture' approach is highly successful but it has delivered crop communities that do best where light is the only, or the main, limiting factor for productivity. Therefore the products of this approach to breeding require inputs to raise fertility, and to control weeds, pests and diseases.

Clearly this is not the case in organic farming. Quick acting inputs are not generally available to control or mitigate negative abiotic and biotic interactions. Even within well-functioning organic systems the number of relatively uncontrollable factors and the complexity of their interaction across farms, fields and years are an order of magnitude different from conventional production.

Research Department, Elm Farm Research Centre, Hamstead Marshall, Nr. Newbury, Berkshire RG20 0HR United Kingdom

Tel +44(0)1488 658298 Fax: +044(0)1488 658503 E-mail: research@efrc.com

What Organic Variety Trials Should Look At

Whilst the goal of conventional plant breeding is to maximise yield within a monoculture where there is a high degree of control of all external factors other than light and water; the goal of organic plant breeding is to produce a yield that is stable in the face of the interactions of a wide-range of relatively uncontrollable factors.

Consequently in conventional variety trialling the potential of the variety under optimum conditions is the focus, whilst organic variety trials should focus on the adaptability and stability of the variety over different sites in different years.

The differences between organic systems, and even between fields on organic farms, are likely to have a greater influence on the yields of organic cereals than the seasonal differences in weather. Organic variety trials must therefore pay greater attention to yield stability over time and over a range of farming situations than to assessing maximum yield potential.

The EFRC Trials 2000-2004

In order to try to address these issues Elm Farm Research Centre, in partnership with a number of organic farmers around the south and east of England, has undertaken a series of organic cereal trials. Varieties and mixed varieties of triticale, wheat, barley and oats, both winter and spring, were included in the trials to try to understand how the stability of different species, as well as varieties, are affected across sites and seasons.

Over the four years of the project, six farms sites, all of them well-established organic systems have been used for the trials. The trial sites were chosen to represent a range of soil types and climatic conditions. Some 60 individual trials were established. Nonetheless, we acknowledge that this is still a limited number and that the location of all the farms in the south of England is a further limitation.

The following information is a brief summary of some of the results of these trials. Other results will be reported in future *Bulletins* and the full report will be available in the near future.

Measuring Stability

In order to get an idea of yield stability we have used a statistic called the Coefficient of Variation (CV). The % CV is calculated by dividing the variation within a data set by its mean and multiplying by 100.

In the following tables and text the % CV is used to indicate the stability of variety and species performance. A high figure indicates a large amount of variability and low degree of stability, where a low figure shows a low variability and a high degree of stability thus indicating a more consistent performance.

A notable feature of these trials is the range of CVs compared to those found in conventional trails which are highly controlled by inputs. In those trials CVs of around 5% are expected where as here only winter oats achieved such a figure. This indicates the high degree of variability and instability found in even the best organic systems where conventionally bred varieties are used.

Acknowledgments.

Elm Farm Research Centre would like to take this opportunity to thank everyone involved with this project over the years, particularly those farmers who allowed us to place trial plots on their farms. A special thank you to Triodos Bank and especially The Sheepdrove Trust for providing the funding.

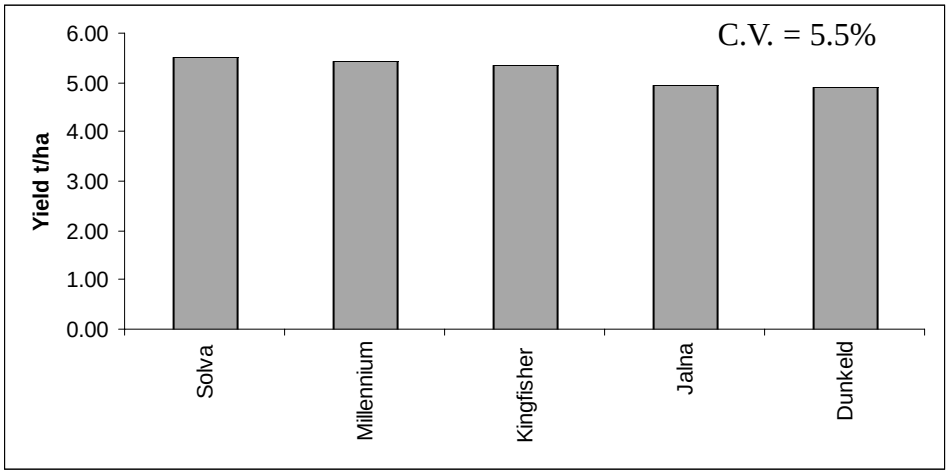

Figure 1.
The mean yield (t/ha) of all winter oat varieties grown during

Oats - Winter

The average yield for winter oats is around 5t/ha, with Kingfisher, Millennium and Solva producing slightly higher yields than Dunkeld and Jalna, although these differences are not statistically significant. The low CV for winter oats of 5.5% shows that they offer a consistent performance across the five varieties and there is a low degree of variability in performance between the varieties.

Notable factors: All varieties had similar yields and demonstrated overall stability.

Oats - Spring

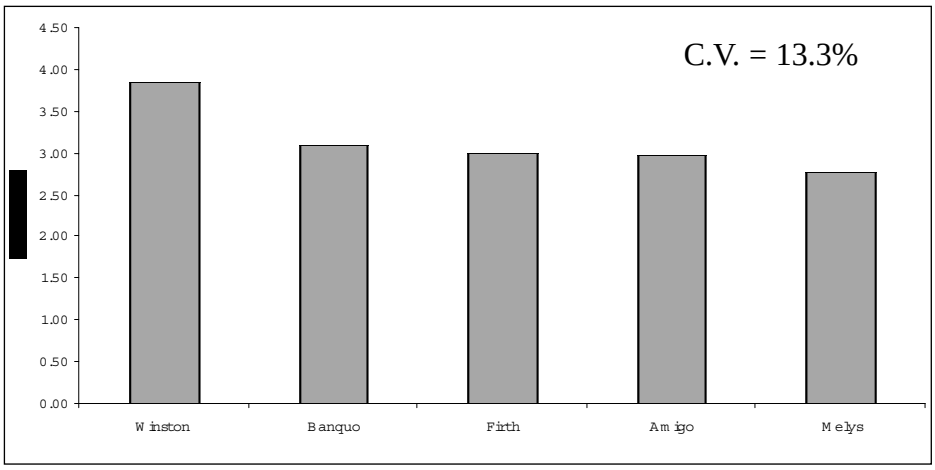

Figure 2.
The mean yield (t/ha) of all spring oat varieties grown over the four-year trial (data combined across sites & years).

Spring oats yield less than winter oats with a mean of 3.13t/ha compared with to 5.22t/ha (a 60% difference). Winston performs better than the other four varieties with a yield of 3.84t/ha, however this difference was not statistically significant. The spring oats also have a higher degree of variation than the winter oats as demonstrated by the higher CV, 13.3%. However they still show a lower variability than spring and winter wheat and spring barley.

Notable factors: Winston performed best within our trials although due to the high level of variation the yield was not significant from the other varieties.

Triticale

The triticale varieties ranged in yield from under 4 t/ha to more than 5 t/ha. Fidelio and Ego show the greatest yields (at around 5 t/ha) and Tricolor the lowest (at just under 4 t/ha), however differences between varieties were not statistically significant across sites and years. The low CV, 11.9%, demonstrates a relatively low variability compared with the spring and winter wheat and spring barley, however Triticale yields are not as stable as the winter oats.

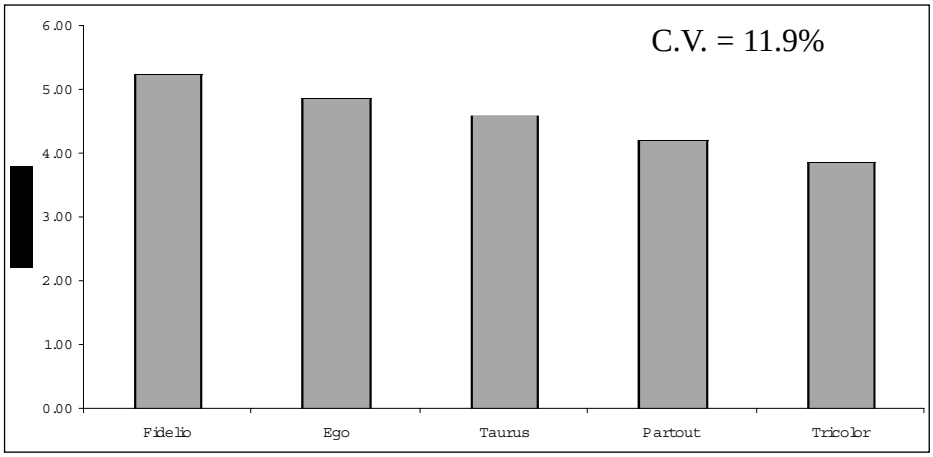

Figure 3.
The mean yield (t/ha) of all triticale varieties grown over the four-year trial (data combined across sites & years).

Notable factors: All varieties had statistically similar yields across sites and years.

Barley - Spring

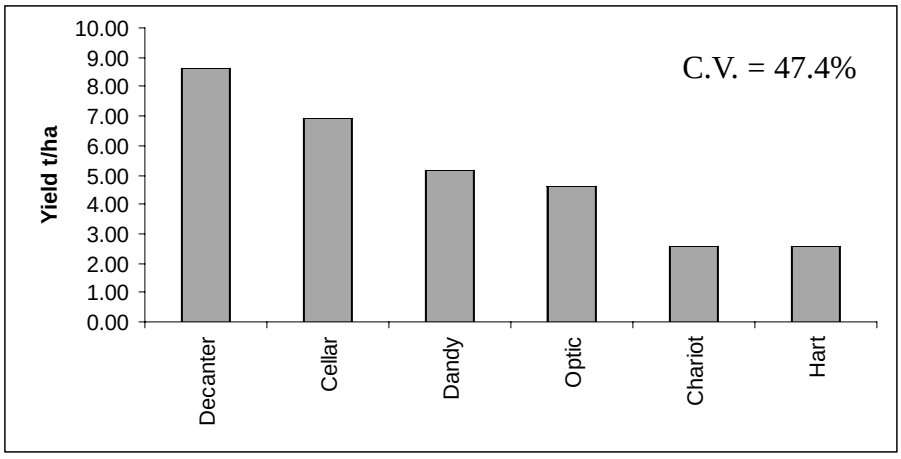

Figure 4.
The mean yield (t/ha) of all spring barley varieties grown over the four-year trial (data combined across sites & years).

The spring barley varieties produced a wide range of yields, some reaching over 8 t/ha while others barely 2.5 t/ha. Cellar and Decanter were the best performing spring barley varieties, while Hart and Chariot performed equally poorly. The CV for spring barley was very high, 47.4%; it exceeded the CV for all the other species by over 20% suggesting that there was great variation within the data and that the performance of spring barley was inconsistent. Differences between varieties for the combined data set were not statistically significant as variation of results between sites and years had a greater influence.

Notable factors: Decanter and Cellar performed the best in these trials although the variation in the data set was the most significant factor.

Wheat - Winter

The National Association of British and Irish Millers (Nabim) Group 3 biscuit/feed wheat Claire was the variety that produced the greatest yield. Amongst the bread-making (Nabim Group 1) wheat Hereward performed the best. These differences were statistically significant within wheat 'class' and are therefore likely to be reliable through time and across sites. Three German varieties, Aristos, Levendis, and Tataros, showed good potential for organic production, these varieties performed well and have a low variability as they compete well with weeds possibly because they tend to be tall and may have an improved ability to scavenge for nutrients.

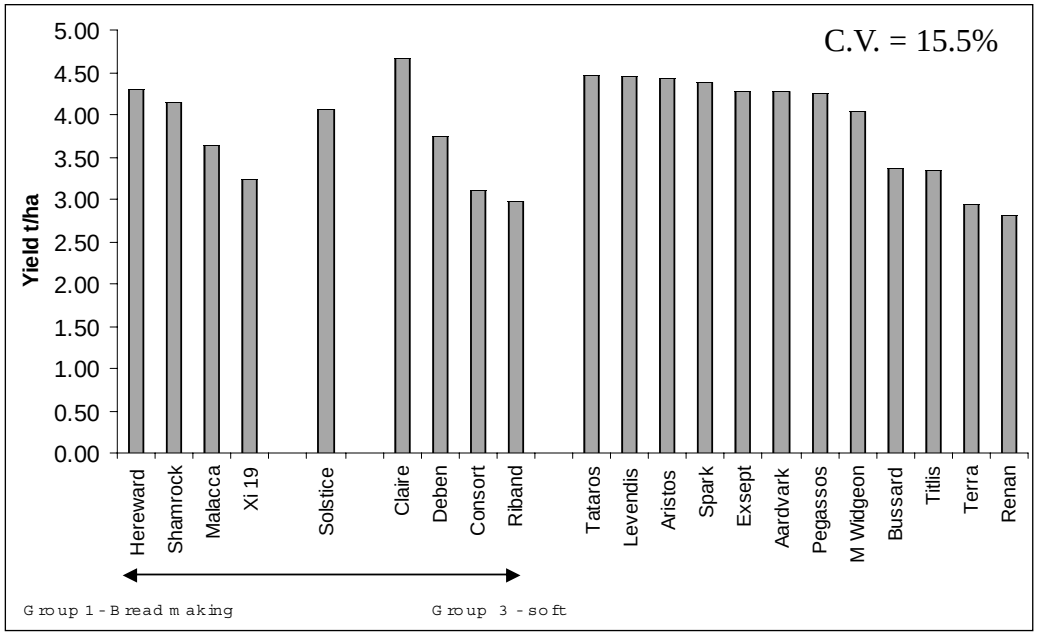

Figure 5.
The mean yield (t/ha) of all winter wheat varieties grown over the four-year trial (data combined across sites & years).

However, two other European varieties, Renan and Terra, performed poorly, with Consort also performing particularly poorly. These effects are robust as they were statistically significant and so we can expect Aristos, Levendis and Tataros to consistently outperform Renan and Terra. The CV of 15.5% is a mid range level of stability in these trials showing that winter wheat has a lower degree of variability than spring wheat and spring barley but is not as stable as the oats or triticale varieties.

Notable factors: In these trials Claire (feed) and Hereward (bread making) are statistically the highest yielding varieties in their respective classes. Aristos, Levendis and Tataros are interesting.

Wheat - Spring

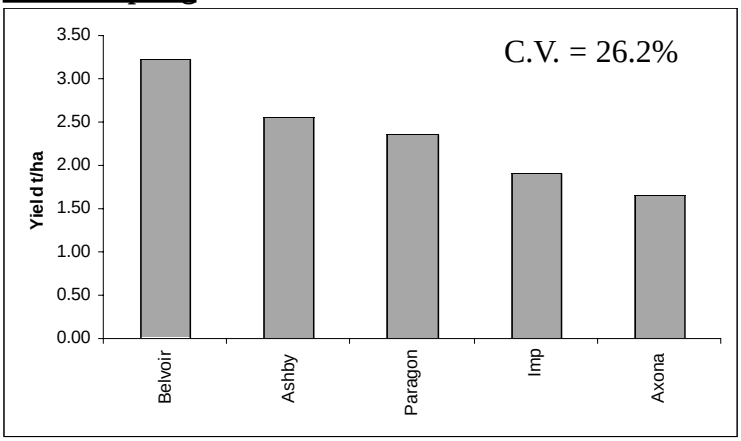

Figure 6.
The mean yield (t/ha) of all spring wheat varieties grown over the four-year trial (data combined across sites & years).

The spring wheat varieties performed poorly, producing yields about half those of the winter varieties. Ashby and Belvoir produced the highest yields. The CV was higher for spring wheat, 26.2%, than for winter wheat, 15.5%, only spring barley had a higher CV. This suggests that spring wheat is not as stable and shows a higher degree of variability than the other species. This reflects the more difficult agronomy with these varieties, particularly in terms of weed control on some of our sites. And, in common with other spring cereal species, despite apparently large differences between varieties, it is differences between sites and seasons that dominate.

Notable factors: Belvoir produced the highest yield but the differences in performance across sites and years is the most significant factor.

Conclusions

So what does this all mean for the farmer? The inescapable conclusion is that you should be risk averse and stick with any variety that does well for you whatever recommended lists or seed merchants tell you.

It also seems that as far as winter oats go, it doesn't matter too much which variety you choose. The same can be said for triticale, although with a little less certainty. Claire and Hereward have a proven track record amongst the winter wheat varieties. And we have a lot of work to do on spring cereals.

But it is also clear that we have a huge amount of work to do to improve organic systems. There is far too much variability in performance for anyone to think anything other than organic farming is still undeveloped. Appropriate plant breeding will make a significant contribution but one cannot help reflecting on the need to improve basic agronomy and systems management.