Dissecting the Components of Yield in Oats (*A. sativa*)

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Introduction

Yield is a complex trait with numerous components. Three main components of yield are panicles/m^2, grains/panicle and individual grain weight. Other traits that have been shown to improve yield in wheat are biomass accumulation and light interception. In many species dwarfing genes have been influential in yield increases. This project uses physiological, biochemical and molecular techniques to investigate yield and associated components in a range of varieties of dwarf and conventional height winter oats that have been bred in Aberystwyth over the past 30 years .

Materials and methods

- Ten cultivars were sown in a field trial (fig 1,2)
- Three cultivars dwarf, possessing *Dw6* gene
- A wide range of traits were measured, some direct yield traits plus other non direct traits.
- The genetic diversity of 16 cultivars was assessed, including all those used in the field trial, using 54 SSR makers widely spaced over the oat genome

Fig 1: Field trial 21st May.
Growth stage 39, Flag leaf emerged.

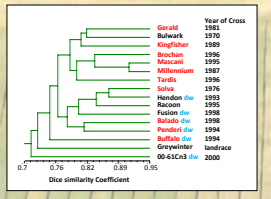

Fig 2: UPGMA dendrogram calculated using Dice similarity coefficient. Red represents cultivars used in field trial. dw = dwarf cultivars

Results

- The genetic diversity study split the cultivars into two main groups, which concurs with the available pedigree information (fig 2).
- Buffalo was the most genetically distinct cultivar of those tested in the field trial.
- Balado was the shortest cultivar at 0.8m, Kingfisher was the The lowest three internodes we re shorter in the dwarf cultivars
- Most cultivars had six internodes, expect Penderi that had seven and Brochan which had five
- The dwarf cultivars had less panicle extrusion (fig 3,4) which resulted in empty spikelets in the lower whorls.

Fig 3: Oat panicle which is not fully extruding from the flag leaf sheath.

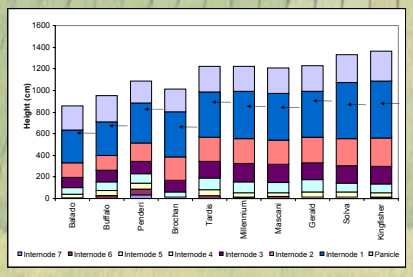

Fig 4: Height of main stem and internode length. Arrows indicate the position of the flag leaf ligule.; this indicates how far the panicle is emerging from the flag leaf sheath at harvest.

- There was a significant difference in yield between the cultivars (fig 5)
- As the height of the dwarf cultivars increased so did yield, however this relationship was not seen in the tall cultivars
- The three highest yielding cultivars, Mascani, Millennium and Penderi had the highest biomass accumulation throughout the season (fig 6).
- Penderi accumulated about 2 t/ha dry matter between every growth stage, whereas Mascani and Millennium had a sudden doubling of biomass between flowering and crop senescence.
- The panicle components, spikelets panicle^{-1} and number of grains spikelet^{-1}, show an interesting relationship with yield (fig 6). Higher yielding cultivars had fewer spikelets per panicle, but individual spikelets tend to have more grain.
- Millennium, Mascani and Brochan were the only cultivars to have six whorls per panicle with the lower two whorls containing over 60% of the grain. In the other cultivars only 50% of the grain comes from the lower two whorls. The three dwarf cultivars had the largest seventh whorl (fig 8).

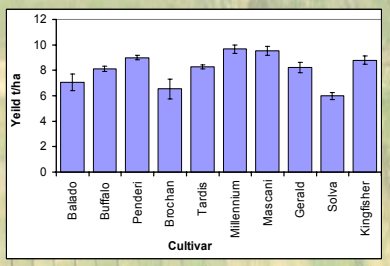

Fig 5: Yield. The three dwarf cultivars are on the left. Error bars represent the standard error.

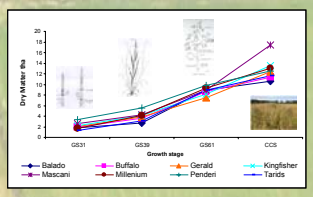

Fig 6: Dry matter accumulation for eight cultivars over four growth stages.

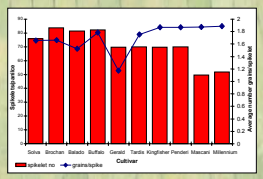

Fig 7: Panicle components, spikelets panicle^{-1} and grains spikelet^{-1}, and their relationship to yield. Cultivars presented in order of increasing yield from left to right

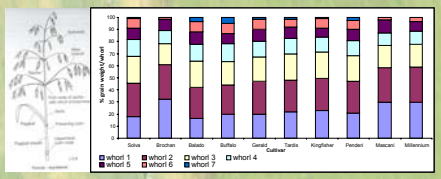

Fig 8: Panicle structure; the percentage of grain in each whorl

Conclusions

- Panicle extrusion of dwarf cultivars is important, poor extrusion leads to reduced yield.
- It has been shown that a smaller panicle i.e. one with fewer whorls is yielding better than those with a large panicle. Having more grain per individual spikelet also seems to be an important component.
- The greatest yield was obtained from cultivars with either a tall dwarf or short tall phenotype.

Buffalo Tardis

Fig 9: Buffalo and Tardis; parents of the mapping family

Future work

- A similar trial has been sown this year with the inclusion of two new dwarf cultivars which are selections from crosses between the highest yielding lines in this study.
- Measurements are going to be made on the Buffalo x Tardis mapping population (fig 9)
- An additional trial examining the effect of nitrogen on yield and its components is also being conducted.
- The genetic diversity study is going to be extended to included AFLP and DArT markers.

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In April 2008 IGER-Wales merged with the Institutes' of Biological Sciences and Rural Sciences at Aberystwyth University to form the Institute of Biological, Environmental and Rural Sciences (IBERS).

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