

## O51

### Outstanding in their field: the phenotype of the 21st century plant breeder

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Plant breeding is a highly interdisciplinary science that requires the skills and teamwork of many disciplines and their scientists to be successful. In the 21<sup>st</sup> century, plant breeding will reap the benefits of the rapid advances in genomics research and understanding, as well as, advances in information and mechanical technology. The skill and success of a plant breeder will be determined by their ability to use their resources efficiently, retaining those proven methodologies and augmenting them with novel approaches to meet their breeding objectives. Once the objective is determined, the plant breeder must: 1. identify and incorporate the needed genetic variability, 2. inbreed and select the useful variant, and 3 evaluate the successful variants to determine those with commercial potential. It has long been understood that plant breeders need to be ruthless with their germplasm so as to avoid wasting time and resources on lines that will never have the opportunity to be released or become useful parents. It may be that with the plethora of new tools that efficient plant breeding will have to be equally ruthless with their access to and use of technology. Though the outcomes of plant breeding are new cultivars, the importance of plant breeding remaining an experimental science will be highlighted, especially for those with the responsibility of educating the next generation of plant breeders in an increasingly privatised world. Finally, some of the great challenges facing wheat improvement that can be addressed by genetics will be discussed as we look to the future.

## O52

### Effectiveness of marker assisted selection for resistance to Fusarium head blight in a wheat backcross breeding program

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The objective of this study was to determine the effectiveness of MAS relative to conventional visual selection (CVS) for resistance to FHB in a spring wheat backcross breeding program. BW301, a line susceptible to FHB, was crossed in 2002 with HC374, a line resistant to FHB and the F<sub>1</sub> backcrossed to BW301. A MAS population (MAS BC<sub>2</sub>F<sub>5</sub>) has been developed through F<sub>2</sub>-derived method, while two conventional visual selection populations (CVS BC<sub>1</sub>F<sub>6</sub> and BC<sub>2</sub>F<sub>5</sub>) have been developed through single seed descent. Seven lines with all three FHB QTLs were selected from the MAS population, while the top 10 resistant lines were selected from CVS BC<sub>1</sub> and CVS BC<sub>2</sub> populations, respectively, based on FHB symptoms in the FHB nursery of 2005. The 27 lines, plus two parents, were further evaluated for FHB resistance in a four replicate field experiment in 2006 and 2007. A combined analysis from two years data showed that the means for FHB incidence, severity and index and deoxynivalenol (DON) content for the MAS population were 39.2%, 27.3%, 11.2% and 4.6 ppm, for the CVS BC<sub>1</sub> population the values were 43.0%, 30.8%, 14.4% and 6.1 ppm and; for the CVS BC<sub>2</sub> population the values 50.6%, 41.2%, 21.6% and 9.1 ppm. Marker profiles showed that the lines in the CVS BC<sub>1</sub> population carried from 0 to 2 QTLs whereas none of the lines in CVS BC<sub>2</sub> population carried the FHB resistance QTLs. The results confirmed that MAS is more effective than CVS for improvement of resistance to FHB in this wheat backcross breeding program and indicated that the more backcrosses, the greater the risk of loss of resistance genes in backcross breeding if the CVS is

used. The results also suggested that minor genes have an important role for resistance to FHB of wheat.

## O53

### **Breeding strategies to improve grain yield and quality of short-season spring wheat for the steppe of Kazakhstan and Siberia**

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The steppe region of Northern Kazakhstan and Siberia grows more than 20 mln ha of spring wheat which is planted in May and harvested in September. Average grain yield is around 1.2-1.7 t/ha in low input wheat dominated production system. The objective of the study was to develop strategies for improvement of grain yield and quality and the stability of these traits through analysis of cooperative multilocational yield trials conducted in 2003-2006 across 11 locations in Kazakhstan and Siberia. The single most important trait affecting grain yield was reaction to leaf rust. The maturity group represents another important trait affecting adaptation to moisture deficit but its relationship with grain yield is variable. The majority of the local varieties represent tall non-dwarf type unlike the germplasm in the similar regions of Canada. This seems to be justified as long as low input production is maintained. Utilization of different genes, crossing and selection strategies are discussed. The region exports wheat grain outside and its quality is important. In general, the grain quality is characterized by high protein (14-16%) and gluten content. The gluten strength of the grain is slightly weaker as compared to Australian grain. There is variation in Iron and Zink content in the grain positively associated with protein content. The best quality genotypes are normally slightly inferior in yield. The strategy for grain quality improvement is discussed.

## O54

### **The challenges of integrating new technologies into a wheat breeding programme**

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William Farrer, who is considered the father of wheat breeding in Australia, recognised the importance of adopting the latest in genetic and biological understandings to improve the efficiency and effectiveness of his breeding programme. Over the past 120 years, breeders around the world have used advances in science and technology to improve the rate of genetic gain that their breeding programmes achieve. Recently, the field of molecular biology has offered breeders the tools to select elite individuals based on their genotype rather than, or in addition to, their phenotype. But it is one thing to have the tools, and quite another to integrate them effectively within an applied breeding programme. This challenge is not just limited to molecular biology. There are constant developments in physiology, biometry, computer simulation, engineering, end-use quality assessment and robotics, amongst others, that need to be continually assessed to identify which will provide the greatest return in terms of rates of genetic gain and cost efficiency. This paper will present some recent technological

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developments, discuss their impacts on an applied breeding programme and present a view of what might be the possibilities and challenges into the future.

**O55**

**Population plant breeding: making a big picture from all the little pieces**

**Falk DE**

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Population plant breeding is based on the quantitative genetic principles of population structure that operate in an evolutionary context. Evolution brings about population genetic structure changes over time through natural selection and recombination among the individuals in the population. Mutation and drift may also play a role. Since natural selection is based on phenotype, those alleles that contribute to the selected phenotypes will increase in the population with ongoing cycles of recombination and selection. These desirable alleles will increase in the population over time. As the frequency of desirable alleles increases in a population, the probability that a single individual will be obtained which has the majority of the desirable alleles will also be increased. With this in mind, reducing the breeding cycle time, increasing the amount of recombination per cycle, and maximizing the effectiveness of evaluation can accelerate the rate of phenotypic (and genetic) improvement in a breeding population, thus increasing the evolutionary potential of that population. Introgression from other populations can replenish genetic variability that selection reduces to maintain the basis for further improvement of desired traits. Improved populations are the best source of new and improved cultivars. The major challenge in breeding is to fit all the pieces of the puzzle together into a comprehensive, integrated system that is biologically functional.

**O56**

**Breeding for biofuel production**

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The Stellenbosch University Plant breeding laboratory (SU-PBL) is currently conducting a study into the feasibility of wheat (and triticale) for bio-ethanol production in the Western Cape as an additional market for struggling producers. Since 2006 multi-location field trials were conducted, and material and field observations obtained used in order to develop and optimize analytical protocols for determining grain starch content and structure, fermentable sugar levels and ethanol yield. Correlations between grain ethanol yield and agronomic characteristics established, and used in order to quantify genetic variability of available germplasm. This data was also employed in order to establish a pre-breeding effort aimed at bio-ethanol yield advancement that will complement existing breeding activities. We have finished measuring the fermentable sugars, bio-ethanol yield and AAQ for the 2006 material and have observed that the current commercially available cultivars gave some of the best results. Especially SST 57 (63.86% starch, 11.88% protein and 692.99 mM ethanol), SST 88 (64.83% starch, 11.97% protein and 635.72mM ethanol) and SST 015 (59.52% starch, 11.8% protein and 659.11mM ethanol) performed very well. Among the SU-PBL breeding lines 03H86-8 (62.51% starch, 12.73% protein and 851.60mM ethanol) and 97K1-15 (61.65% starch, 12.53% protein and 801.96mM ethanol) yielded the highest in terms of ethanol. During 2007 a pre-breeding program was initiated based on the recurrent mass selection (RMS) technique developed by the SU-PBL. Starting material was screened using rust inoculations and molecular markers. Male parents were selected based on their starch yields and presence of *Sr2*, *Sr26* and *Sr36*. Female lines were selected which carry *Lr24/Sr24*, *Lr37/Sr38/Yr17* and *Sr31/Lr26/Yr9*, 11 out of 180 screened. These lines are currently undergoing a third round of RMS and parallel to this material sourced is used for the creation of double haploid lines for field screening during the 2008/2009 season.