Biotechnology Forum
A Look into the Future of Biotechnology

Reported by Karen Klotz and Roy Martens

The forum was organized and led by J. R. Stander of Betaseed and provided an overview of present and future directions for biotechnology from the perspective of the sugarbeet industry. Speakers included Rudolf Jansen of KWS, Klaas van der Woude from Van der Have, Gerhard Steinrucken from Syngenta, and Bruno Desprez of Florimond Desprez.

J. R. Stander provided an overview of the increasing use of transgenic crops in agriculture and the increasing presence of food and feed ingredients derived from transgenic crops in the food chain. Since 1996 when transgenic crops were first commercially grown, production of genetically engineered crops has increased 10% annually. In 2004, 200 M acres (81 mha) were planted globally to transgenic crops. Acceptance of biotech crops has increased globally and, in 2004, 56% of the soybeans, 28% of the cotton, 19% of the canola, and 14% of the corn produced world-wide was genetically engineered. A large number of food and feed ingredients are derived from GMO crops and are currently part of the global food supply.

Rudolf Jansen presented a historical perspective of the development of plant breeding technologies and how biotechnology is being used at KWS to address production and storage problems and introduce high quality traits into sugarbeet. Plant breeding technologies in use today include (1) traditional crossing and selection strategies (2) hybrid breeding (3) cell and tissue culture procedures, (4) DNA-diagnostics technologies including DNA fingerprinting, marker-assisted selection and marker-assisted backcrossing, (5) genetic engineering, and (6) genomics using genetic and physical maps, genome sequencing, EST databases and bioinformatics. Genetic engineering for beet necrotic yellow vein virus (BNYVV) resistance, nematode resistance, cercospera resistance, reduced storage losses, fructan biosynthesis, and reduction of harmful nitrogen are current projects and goals. Genomics is also being employed for the development of molecular markers, improvement of marker-trait associations, elucidation of gene functions, and identification of genes for future genetic engineering efforts.

Klaas van der Woude outlined financial and public acceptance concerns that limit the application of biotechnology to the sugarbeet crop. The expense to develop, obtain regulatory approval for, and deliver any genetically engineered product necessitates that engineered traits need to have a major market impact to be feasible. Genetically engineered sugarbeets with glyphosate resistance, BNYVV resistance, and the ability to produce short chain fructans have been developed. The development of transgenics with enhanced fungal resistance, enhanced drought and heat tolerance, non-bolting phenotype, or that produce alternative sugars or tailor-made products are also of interest. Technologies have been developed to support sugarbeet GMO production including a guard cell transformation system, marker and vector free transformation, identification and isolation of tissue-specific promoters, and the development of methods for enhanced expression of desirable genes.

Gerhard Steinrucken compared how traditional breeding involving the introgression of new genes from wild species compared with genetic transformation for the achievement of breeding goals. Many breeding goals, including resistance to most diseases and insects, are perhaps best achieved by traditional breeding since genetic variation for these traits exists and the gene(s) responsible for these traits are unknown. Other breeding goals, including herbicide resistance, production of nonsucrose sugars, sweeteners or high value products, and bolting resistance can only be achieved by genetic transformation, since genetic variation for these traits is limited or nonexistent. Where breeding goals can be achieved by either traditional breeding or genetic transformation, genetic transformation has the potential for greater and more rapid trait improvement. The development of nonbolting sugarbeets and BNYVV resistant sugarbeets are ongoing projects.

Bruno Desprez provided a holistic perspective on biotechnology and described the breadth of biotechnology and the importance of integrating biotechnology with other disciplines. Biotechnology encompasses numerous techniques of cellular and molecular biology including *in vitro* cloning, protoplast fusion, haploid generation, genetic transformation, molecular markers, genetic fingerprinting, gene mapping, and functional genomics. Integration of these techniques with other scientific disciplines including physiology, pathology, biochemistry, chemistry, agronomy, genetics, computer science, image analysis, and robotics is necessary to make the most effective use of the new technology. The techniques of biotechnology can be applied in many ways and at many levels within an organism. Biotechnological techniques can be useful for identifying, altering or studying genes, cells, tissues, organs, whole plants or the products derived from them. Because of these multiple uses, biotechnology can be used for breeding, seed production, seed marketing and the sugarbeet industry in general. The products of biotechnology, to date, include genetic markers, gene expression analyses, and gene function analyses, as well as genetically modified organisms. Biotechnology, however, is evolving rapidly, and new techniques and technologies will be available in the future.